



**WTE POWER PLANT NORTH
DHAKA PRIVATE LIMITED**

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) STUDY OF WASTE TO ENERGY INCINERATION POWER PROJECT AT AMIN BAZAR, DHAKA, BANGLADESH



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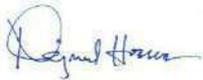
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EXECUTIVE SUMMARY

E-1 Introduction

Background of the Project

Waste is an inevitable byproduct of human activity. The volume and complexity of waste created have risen because of economic expansion, urbanization, and rising city living standards. Inefficient solid waste management and disposal in most cities in developing countries is an obvious source of environmental degradation. Municipal corporations in developing nations cannot handle the rapidly growing volumes of waste, leaving uncollected waste on the streets and other public areas. A sustainable waste management system must be developed, which needs institutional, financial, economic, and social sustainability. Waste to Energy is a very renowned technology for sustainable waste management.

Dhaka, the capital of Bangladesh, is expanding rapidly, turning it into a mega city with a huge population growth rate of around 6 percent a year. Solid waste is being generated faster, posing a serious management threat. A healthy life, a cleaner city, and a better environment are the rational demands for city dwellers as the municipality is traditionally funded for solid waste services from the municipal tax system for waste collection and disposal.

E-1.1 Project Brief

The waste in the north of Dhaka is discarded at will and cannot be treated in time and effectively. With the increase in urban population every year, the amount of garbage is also increasing, which has caused serious environmental and ecological problems and affected the city's development and the citizens' healthy life.

During 2014-2018, total dumping reaches 177870 tons of garbage. Among them, For the period 2016-2017, a total of 852 390 tons of landfill disposal; For the period 2017-2018, A total of 1039331 tons of landfill disposal, the growth rate is as high as 21.9%. Currently, the dump has reached a height of 30 feet. After 2018, Garbage should be stacked at a height of 60 feet to make full use of vertical space.

Landfills play a vital role in garbage management. All the garbage collected is dumped in the landfill. The tangible economic cost of original garbage dumping is very low, but the invisible environmental cost is very high. The land has brought a lot of pressure. If the landfill remains to be used between 2020 and 2035, DNCC will need 300-400 acres of land, which is a challenging task for land requisition.

This Environmental Impact Assessment (EIA) report has been prepared based on the findings of the reconnaissance field visit conducted by the EQMS team along with the project proponent. WTE Power Plant North Dhaka Private Limited has proposed to set up a Waste-to-Energy Power Plant at Amin Bazar, Savar of Dhaka Division. The proposed site is located on the south side of the Amin Bazar landfill area.

E-1.2 The Rationale of the Project

Waste production in Dhaka city has increased over the years for various reasons. The total area of DNCC is 196.23 square kilometers, and the current population is 6.1 million. Every day, 3,433 tons of waste are generated, according to the DNCC waste report 2019-20. In FY 2019-20, about 10,02,561 tons of waste were generated. This large volume of waste is disposed of at only one location, the Amin Bazar landfill. As a result, it requires more land at the existing landfill site and is increasing year over year. Moreover, community health risks, bad odors, and impacts on water and soil quality are major environmental and social concerns due to this landfill site. Increased generation of methane (CH₄) from this Municipal Solid Waste (MSW)

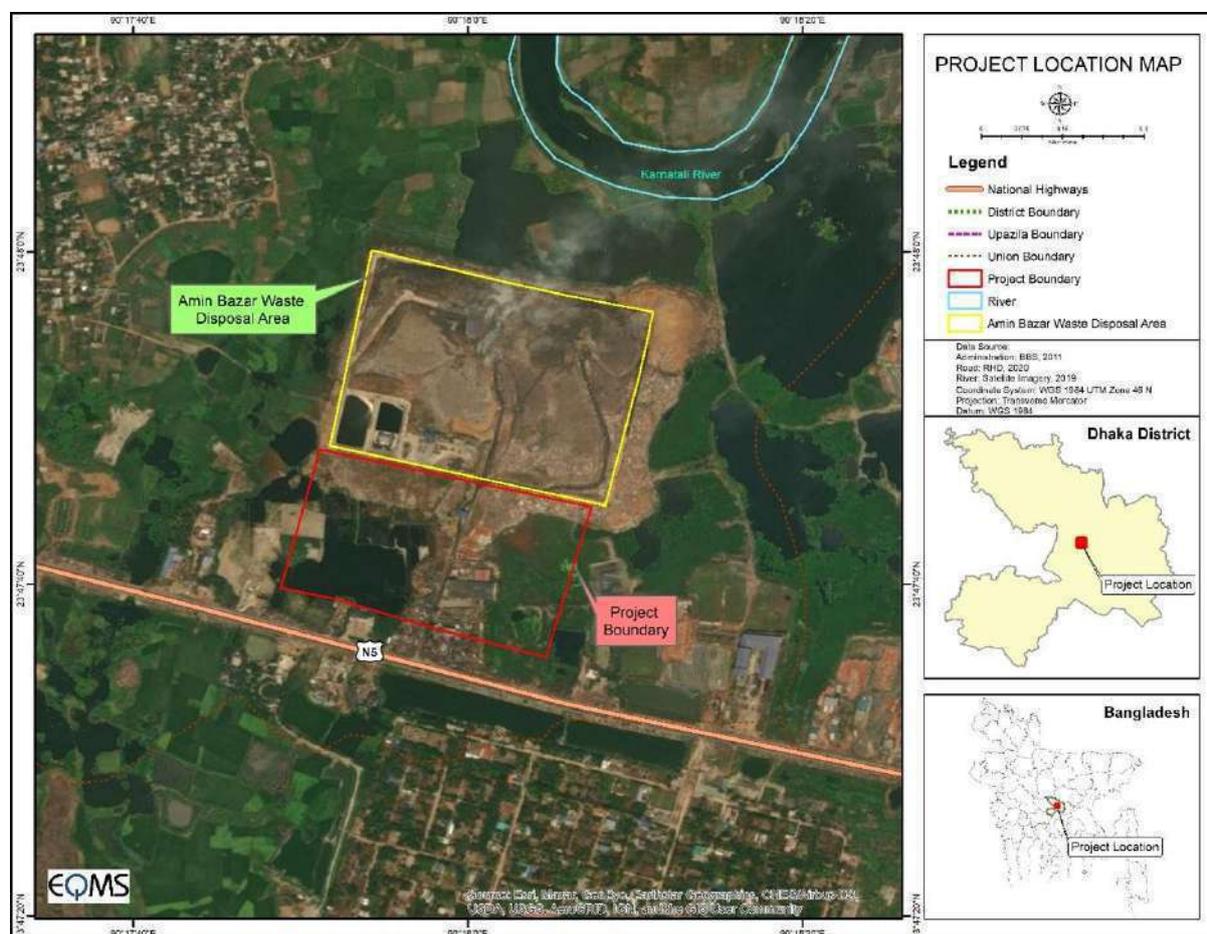
alarms the world to take proper initiative for the sustainable management of MSW because it is 34 times stronger than carbon dioxide¹. The proposed project is a project where electricity will be produced from the municipal solid waste collected by DNCC. This project is not only an effort for enriching the country's power generation towards sustainable waste management but also will reduce excessive consumption of landfill storage capacity, reduce land pressure, and environmental, and health safety impacts from current waste generation.

E-3 Project Description

E-3.1 Location of the Project

The proposed Power Plant project is located at Banagram union under Savar Upazila of Dhaka district. The required land for the proposed power plant project is 31.182 acres (126,187.41 m²) which is approximately 17 km northwest direction from the Center of Dhaka town. The site is accessible via Dhaka-Aricha Highway Road. Figure E-1 shows the project location.

Figure E-1: Location of the Proposed Project



Source: EQMS, 2021

E-3.2 Key Features of the Site and Surroundings

This site is primarily null land (নাল জমি) and low land. Some scattered commercial structures such as brickfields, CNG filling stations, and LPG filling stations are situated about 100 m away from the proposed project site. Within the 5 km radius around the project area, Bongaon Union

¹ Islam, K. M. "Municipal solid waste to energy generation in Bangladesh: possible scenarios to generate renewable electricity in Dhaka and Chittagong city." Journal of Renewable Energy 2016 (2016).

is on the North side. On the Southern side, there is Bhakurta Union. On the East and West portions of the project site, there is Amin Bazar and Hemayetpur Bazar area, respectively.

E-3.3 Land Requirement

According to the requirement of production process and function, the project is divided into four functional areas: the main building area, auxiliary area, water treatment area, and ash & slag comprehensive treatment area. The total site area within the red line is 31.182 acres (126,187.41 m²) where 53.96% is used for building occupation, 23% is a green area, and 12.37% will be used for road utilization construction where DNCC has procured the required land through the Deputy Commissioner (DC), Dhaka District. DNCC is the requiring body, and the DC is the acquiring body in the acquisition procedure. WTE Power Plant North Dhaka Private Limited leases 30 acres of land from DNCC.

E-3.4 Nature and Size of the Project

The WTE Power Plant North Dhaka Private Limited proposes to set up a waste-to-energy power project of 42.5 MWh (NET) capacity near the Savar Upazila in Dhaka District. The details of the proposed power plant are presented in Table E-1.

Table E-1: Brief Information of WTE Power Plant Project

Particulars		Basic Project Data
Net Plant Capacity	:	42.5 MWh (NET)
Planned land	:	31.182 acres (126,187.41 m ²) (Including incineration plant land and new access roads)
Treatment capacity	:	3000~3600 ton/day (entry capacity) with an annual waste disposal capacity of 1.095 million tons
Source of Waste	:	Dhaka North City Corporation (DNCC)
Incinerators	:	Four (4) sets of 750 t/d incinerators
Boilers	:	Four (4)
Turbine generator sets	:	Two (2) sets of 35 MW turbine generator sets
Steam turbine	:	Two (2)
Annual operation time	:	Not less than 8,000 hours
Leachate treatment station with a treatment capacity	:	1200 m ³ /day
Wet slag volume	:	182,500 t/a
Amount of flying ash	:	24,911 t/a
Cooling tower	:	Three (3) sets, Cooling water 7,000 t/h
Furnace type	:	Mechanical grate furnace with 4x750 t/d incineration line
Flue gas treatment system	:	Selective Non-Catalytic Reduction (SNCR) (urea water injection in the furnace)
Stack Height	:	100m
Number of Stack/Stack Inside Diameter	:	1 Stack/2.2m*4
Fuel Name	:	Diesel fuel
Source of Fuel	:	Local Market
Fuel Requirement	:	About 40 tons of diesel will be consumed for each start and

Particulars		Basic Project Data
		shutdown. Diesel consumption by ignition throughout the year = $40 \times 2 \times 4 = 320$ ton Electricity consumption: 0.73×10^8 kWh/a
Water Requirement	:	The main industrial water source will be both surface water and groundwater and will also be used as a reserve water source for industrial water purposes. The total industrial water supply scale of this project is approx. $332 \text{ m}^3/\text{d}$ $7968 \text{ m}^3/\text{d}$ and the total domestic water scale is $44 \text{ m}^3/\text{d}$.
Employment	:	Construction phase - 2,093 persons Operation phase - 220 persons
Power Evacuation	:	132 kV Savar Substation
Project Cost	:	BDT 1,131.16 crore
Project Duration	:	The preliminary preparation of the project is expected to be 6 months. The construction period is 24 months.

Source: Feasibility Report

E-4 Analysis of Alternatives

No Project Scenario: This alternative would result in no environmental or social impacts on the site or the local area. It provides the baseline against which other alternatives are compared and will be considered throughout the report. The no-project option considers the following:

- Continue the current dumping of waste as a method to manage waste for DNCC.
- Costs related to the project activities will be avoided.
- Further environmental changes to the proposed area will be avoided.
- Existing public suffering will continue to worsen due to the lack of a proper waste management system in the surrounding Amin Bazar landfill area.
- Electricity generation will remain constant (i.e., no additional energy generation will occur on the proposed site), and the local economy will not be diversified.
- There will be no opportunity for additional employment in an area.

However, the above-mentioned options would not be acquired if the 'No Project Scenario' alternative is chosen.

Suitability of the Site: The selection of the project site/location has been based on the following considerations:

Available Land Area: The nearest residential area (Nandonic Housing Society) is about 1.17 km away from the project site. A total of 31.182 acres ($126,187.41 \text{ m}^2$) of land is required which has been acquired by DNCC.

Existing Land Use: Currently, the land has been used for landfill purposes.

Approach Road: Existing Road (Dhaka-Aricha Highway (N5)) connections in the vicinity for the transportation of waste.

The present waste-to-energy project has been planned to address the issue of municipal solid waste of Dhaka North City Corporation. The existing landfill site has exhausted its capacities and is presently overburdened. Considering available land, existing land use, and good accessibility for waste transportation routes, the proposed site shall be chosen for establishing waste to energy power plant.

Alternative Incineration Technologies: There are four main types of solid waste incinerators: Mechanical grate furnaces, Fluidized bed incinerators, Pyrolysis incinerators, and Rotary kiln incinerators. Considering the Characteristics of furnace bed and body, Waste pretreatment, Heat Cauterization of Slag, processing scale of a single furnace at present, Combustion air supply, Dust content in flue gas, Automatic combustion control, Operating expenses, Flue gas treatment, and Maintenance workload, WTE Power Plant North Dhaka Private Limited selected the mechanical grate furnace as the incinerator for solid waste incineration and power generation projects.

E-5 Socio-economic Environment

The proposed project is in the Banogram Union of Savar Upazila. The Upazila consists of 11 Unions. In the 5-kilometer buffer study area, there are 3,53,438 households (HHs), including squatters with a total population of 14,51,727 that will be affected by the implementation of the Project. The average sex ratio is 114.9, and the average household size is 4. Within the 5 kilometers, radius buffer area from the project site total of 229 Households was found where 1086 different ethnic people live. Most of them belong to the Chakma ethnic group. The total household of households in the project study area is 2,85,122. The predominant structure of this study area is Semi-pucka (44.6%), followed by Pucka (35.4%), kutchra (18.2%), and Jhupri (1.8%). Housing tenancy in the study area is owned by (33.9%), rented (63.5%), and rent-free (2.6%). The major source of drinking water is Tap, where about 57.1% of the population uses Tap water. About 41.1% of people have access to Tube-well water. Other 1.8% of people have access to neither tube well nor tap water. Households that use the water-sealed sanitary latrine and non-water-sealed sanitary latrine facilities are 23.3% and 44%, respectively. At the same time, about 28.5% of households avail themselves of non-sanitary facilities. The rest, 4.2% of households, have no access to hygienic latrine facilities. On average, 96.2% of households have grid electricity connections. Approximately 59.9% and 52.8% of males and females are involved in Services. Moreover, significant numbers of the population, 23.8% male and 42.7% female in the project area, are employed in the industry sector.

E-6 Description of the Environment

Area of Influence

The AOI with respect to the environmental and social resources was considered based on the following reach of impacts:

- Impact on ambient air quality from vehicle exhaust- 500 meters from the project site. Air pollutants disperse from the project site up to 1 km from the power plant stack and Dust fall- typically up to 500 m from construction activities.
- Noise impact area (defined as the area over which an increase in environmental noise levels due to the project can be detected) - typically 500m from the power plant center and 100m from the access road.
- Surface water bodies within 1 km of the project footprint and Groundwater in a 1-2 km radius of the project footprint.
- The areas immediately adjacent to the project footprint within which a zone of ecological disturbance is created through increased dust, human presence, and project-related activities (e.g., trampling, water intake/outfall, transportation). This kind of disturbance has been estimated to occur within the project footprint and surrounding areas of about 500m to 1 km from the activity areas.
- The AOI for social receptors was fixed to include a 5 km radial zone which has been developed based on the reconnaissance site visits and stakeholder consultations with the local community.

E-6.1 Meteorological Data

Meteorological data for the last thirty years (1991-2021) of Dhaka Meteorological Station were analyzed. The lowest average temperature recorded in the past 30 years was in January 2013 (10.4°C). The highest average temperature reached 34.4°C in April 2014. The highest temperatures are generally from April through September, and the lowest is from November to February. The maximum temperature varies from 24.7°C to 34.0°C. The average monthly minimum temperature ranges from 13.4°C to 26.5°C. The average annual rainfall is about 2016.0 mm. The rainfall also varies considerably within a year with 88.4% of rainfall occurring within seven months, from April to October. The highest rainfall is recorded in September 2004 (839.0 mm). The meteorological data of relative humidity indicates that the monthly average relative humidity varies from 60.2% to 82.0%, with an average humidity of 73.7%. The wind direction in Dhaka meteorological station is generally from West-Northwest (WNW) to East-Southeast (ESE) direction. Average monthly wind speeds were also higher during March, June, and November, with the maximum wind speed of 8.3/s recorded during March. The wind blows from south to north during monsoon.

E-6.2 Ambient Air Quality

A total of eight (8) ambient air quality monitoring locations were selected in and around the project site in the study area. Ambient air quality results are compiled and presented in detail in the EIA report and most of the results reveal that the observed values are within the limits of prescribed standards.

E-6.3 Water Quality

Water samples were collected from ten (10) locations, mainly from groundwater (02 locations) and surface water sources (8 locations). These samples were taken as grab samples and analyzed for various parameters to be compared with the national standards.

Surface Water Quality

The analysis results indicate that the pH ranges between 7.10 to 7.87, which is well within the specified standard of 6.5 to 8.5. The conductivity varies from 160 to 180 $\mu\text{S}/\text{cm}$. Turbidity is observed to be ranging from 5.5 to 24.9 NTU. The BOD and DO vary between 0.8 to 1.2 mg/l and 5.5 to 6.6, respectively, which are within the national standards.

Groundwater Quality

The pH of the water sample collected ranges from 7.64 to 8.04, which is well within the specified standard of 6.5 to 8.5. The conductivity is found to be 270-420 $\mu\text{S}/\text{cm}$. The total dissolved solids are observed to be ranging from 130 to 210 mg/L. DO is 6.0. The iron concentrations are observed in the ranges of 0.00 to 0.01 mg/L. The arsenic concentration is found 0.00 mg/L. All the parameters are within the standards as per the national standards.

E-6.4 Ambient Noise Quality

Ambient noise level measurements were carried out at six (6) locations; one reading for every minute was taken for 24 hours. The day noise levels have been monitored from 6 am to 9 pm and night levels from 9 pm to 6 am at all the locations covered in a 500m radius of the study area and recorded results reveal that the measurement is well within the limits as per Noise Pollution (Control) Rules, 2006 except some variations.

E-6.5 Soil Characteristics

Two (2) soil samples were collected from the representative locations of the study area and analyzed for Physicochemical parameters to assess the existing soil characteristics.

Also, two (2) sediment samples were collected from the representative locations of the study area and analyzed for Physicochemical parameters to assess the existing soil characteristics.

E-6.6 Topography

According to DEM SRTM, 2013, the project area's minimum and maximum spot heights are 4.1 meters and 8 meters, respectively.

E-6.7 River System and Hydrology

The Karnatali, Buri, and Turag are the major rivers that flow through Amin Bazar and are close to the project area.

E-6.8 Flora and Fauna

The primary data collection of different flora species was conducted within a 5 km radius of the project site using the transect survey method. Major floral species were recorded during the field survey. In the project AOI, a total of thirty-eight (38) species under twenty-one (21) families were enumerated during the field survey. The most floral species (6 species) were recorded under the Fabaceae family, and the second-highest species (4 species) were under Moraceae.

A total of four (4) species of amphibians belonging to two (2) families and eight (8) species of reptiles belonging to six (6) families were listed from the project area based on primary and secondary data.

Nine (9) mammal species belonging to five (5) families were listed within the study area.

E-7 Potential Environmental Impacts

The potential impacts of the proposed project on different environmental and social components are systematically identified for evaluation of significance.

Positive Impact

There would be many positive impacts due to the establishment of the waste-to-energy power plant in the selected location. This "WtE" project will reduce the problem associated with the disposal of unprocessed waste as a landfill. Major positive impacts are identified as electricity generation, employment generation, enhancement of the local economy, the opportunity for local transporters, and socio-economic development for the project area. Moreover, this project would reduce some existing problems due to the current landfill system such as reducing community health risks, bad odors, and impacts on water and soil quality.

Negative Impacts

Alongside the project benefits, there will be potential negative environmental impacts during the three phases of the project cycle.

Involuntary Resettlement

The significant impacts which are expected for involuntary Resettlement during the construction phase include Loss of Land, Loss of structure, and Loss of Livelihood.

As per the study, A total of 31.182 acres (126,187.41 m²) of land will need to be acquired for the proposed power plant. As per the joint verification list of the DC office, 242 landowners have been affected by the project interventions.

Impact on Ambient Air Quality

Excavation for land development, movement of transporting vehicles carrying the construction materials, etc. are all part of the activity involved in building the power plant facilities, which include the main building, auxiliary area, water treatment area, Ash & Slag Comprehensive Treatment Area, and transmission line. All these operations would result in the release of dust

particles, which would have a temporary negative impact on the site's air quality. In addition to dust generation.

The proposed power plant has different provisions for air pollution abatement measures therefore, the model has been carried out considering mitigation measures. The proposed power plant has four sets of incinerators and waste heat boilers. A major source of the plant is NO₂, SO₂, CO, and Particulate Matter. Besides the criteria pollutants, the plant will also contribute heavy metals (Pb+Cr, Hg), HCL, Hydrogen Fluoride (HF), and Dioxin Furan (DF) to the atmosphere. Details of the air dispersion model are given in Chapter 7.

Dust from Construction Activities

The key construction activities likely to result in increased dust levels are the movement of trucks, transporting infrastructure to and from the site, and the movement of construction vehicles along dusty roads. An increase in traffic number is expected on the adjacent highway (N5) as a result of the vehicles carrying construction materials, machinery, and equipment that could increase dust pollution. Dust emissions are exacerbated by dry weather and high wind speeds. The impact of dust also depends on the wind direction and the relative locations of dust sources and receptors.

During the operation phase dust generation will be very minimum inside the project site. But still, the inflow of waste transporting and carrying workers during operation is likely to generate dust emissions.

Exhaust Emissions

Construction vehicles and equipment engine exhaust emissions include CO, PM_{2.5}, PM₁₀, and NO₂. These substances have been identified as criteria air pollutants by the United States Environmental Protection Agency (USEPA) on account of their effect on human receptors in particular those who are more susceptible to air quality changes such as asthmatics, children, and the elderly, and the prevalence of these substances in the urban ambient environment.

Pollutants of concern released by the power stations are Particulate Matter (PM), Oxides of Nitrogen (NO₂), Sulfur dioxide (SO₂), and Carbon Monoxide (CO). The waste-to-energy power station will also emit Hydrogen Fluoride (HF), Hydrochloric Acid (HCl), Dioxin & Furan, and Heavy Metals (Cadmium, Mercury, Titanium). The resulting ground level concentration (GLC) from air quality modeling will be referred to the applicable limits of ambient air quality from schedule 1 of Bangladesh air pollution control rules 2022.

Impact due to Odor from waste

The implementation of this project involves several types of construction works that may generate substances with bad odors. For example, land preparation and clearing work, sewage from mobile and stationary toilets, solid waste, slurry, etc. Moreover, odor from the existing landfill site can create a temporary nuisance to the workers and staff during preconstruction and during the construction period of this project.

Malodorous substances in waste (including Stench concentration, Ammonia, Hydrogen sulfide, Methylthiol, Methyl sulfide, Dimethyl sulfide, Trimethylamine, Acetaldehyde, and Styrene) can possess health risks to the workers and staff working during the operation phase. Respiratory problems, nausea, headache, and psychological stress could be the main impacts of waste odor. However, the existing landfill system is producing malodor that negatively affects the landfill workers, people of nearby villages, and those walking or traveling along the highway/roads. Malodor generated during the operation phase could pose fewer impacts than

the present negative impacts of the existing landfill. Once the project is finished, the existing landfill's harmful effects will be lessened.

Impact on Ambient Noise Levels

The potential sources of noise during the Project's construction phase include equipment, machinery, and transportation used for the construction activities. The heavy equipment used for construction activities will be a significant source of noise. This will include piling and preparing concrete foundations for plants and buildings. Transportation of construction materials to the stockyard for associated transmission lines may cause negligible noise pollution. The traffic volume will increase during the construction phase due to the transportation of equipment, construction materials, and workers on the access road, which will be the noise source to the closest receptor.

During the operational phase, the sources of noise emission are machine-generated noise mainly from process machines (Boilers, generators, and Cooling Towers), airflow-generated noise, compressors, and other sources like noise escaping from buildings or caused by the transport of materials. The predicted noise level at NL1 is 75.0 and 73.9 dB(A) for day and nighttime respectively which exceeded the IFC permissible limit. As the point is very close to the main power plant noise level will be higher. However, the noise level in the boundary of the power plant will vary from 55 to 60 dB(A) which is well below the IFC industrial permissible limit of 70 dB(A). NL3 is located beside the Dhaka-Aricha highway, therefore, the baseline noise is exceeded, and the project operation will increase the baseline noise by 0.1 dBA in the nighttime.

Impact on Water Quality

Surface water

Changes to surface water quality within the study area may also arise from chemical and waste storage and handling during the pre-construction and construction stages. Unplanned events such as hazardous material leakage from machinery, e.g., overflow of the existing surface runoff infrastructure caused by a major rainfall event could also impact surface water quality. Potential impacts are expected to be short-term and localized in nature.

During the operation of the project, sources of water pollution include Waste or scattered oil on the roads in the project area the means of transportation of garbage to the plant, Industrial and Domestic Wastewater, and Waste leachate. The surface water body in the study area may be affected by runoff from areas of storage of leachate, blow-down water from the cooling tower & boiler, effluent from the ash quenching area, or flow of untreated sewage.

Groundwater

Groundwater contamination during the construction phase may occur from unplanned events such as leaks and spills of oil, lubricants, fuel from heavy equipment, and improper handling of sewage. While there is a potentially significant impact on groundwater quality from construction, with the implementation of mitigation measures for proper handling of fuel, waste, and liquid effluents.

The depth of the aquifer varies between 6 and 17m in most places. As the Karnatali River flows close to the project site the groundwater recharge rate is quite well in the project study area. As mentioned above, the total amount of water will be needed to uptake from both surface and groundwater will be 364.7m³/hr (8,752.8 tons/day) whereas the domestic water requirement is about 44 m³/d. The consumption of surface water mainly comes from the consumption of domestic water, some production experimental water, evaporation loss of cooling towers, windage loss, sewage loss, fly ash solidification, flue gas treatment, demineralized water preparation, etc. This amount of water consumption will have a significant impact on surface water resources and the groundwater table as well.

Impact on Soil Quality

The project will also involve the use of paints for switchyard structures during construction which if not handled and used properly, may lead to contamination of soil. Improper disposal of hydraulic fluids, lubricating oils, and other used oils can also result in the contamination of soil. Improper storage of construction material can also result in the unwanted dispersal of contaminants into adjoining areas.

Once the project is commissioned there will be a limited disturbance to the soil, however, repair and maintenance of underground cables and associated utilities will lead to a generation of hazardous wastes such as used transformer oil. The defunct/damaged equipment will also be generated and storage/disposal on the unpaved ground can lead to contamination of soil is hazardous waste.

Impact due to Waste Generation

The main type of waste likely to be generated during construction activities is the construction debris resulting from the excavations for building foundations, construction of the building frame, internal fittings, electrical installation, and external works. Other wastes that will be generated include waste food and packaging materials littered by workers. The solid waste generated during construction sites may impact the surrounding soil as well as water quality. Improper management of waste during the construction stage might cause soil as well as water pollution.

The potential sources of waste generated during the operation of the Power plant are the following: Waste incineration, Boiler blow down water, Cooling water blow down, Domestic waste (solid and liquid), Effluent treatment plant, Leachate from the municipal waste, Powerhouse, and workshop area. The operation of waste in an energy power plant will generate both solid and liquid waste. Solid waste includes fly ash, bottom ash, general refuse, scrap, used metals, batteries, empty containers, used paint, engine oils, hydraulic fluids, as well as waste fuel, etc. The liquid waste will generate for this project can be considered to comprise domestic sewage, production sewage, waste leachate, and waste truck flushing sewage.

Impact on Terrestrial Flora

During the construction phase, activities that might impact terrestrial flora include vegetation clearance in the proposed project site, transportation and stockpiling of construction materials, and movement of construction vehicles in the project area. Dust generated from these activities will lead to dust deposition on plant leaves, twigs, and stems which may hamper photosynthesis, respiration, and other physiological processes. As a result, it will affect plant growth and cause diseases. However, the baseline study represents no threatened terrestrial plant species within the project AOI.

The major sources of impact on terrestrial flora during the operation phase include flue gas and fly ash production due to the incineration of wastes. The production of fly ash is 74.8 t/d or 24,908.4 t/year. Particulate matter of fly ash will be deposited on plant leaves, twigs, and stems which may hamper photosynthesis, respiration, and other physiological processes.,

Impact on Terrestrial Fauna

Dust and noise generated from construction activities and construction materials handling/ transportation may affect terrestrial fauna residing in the adjacent areas of the project sites. These activities might lead to habitat degradation or disturbance to the movement of wildlife. Also, excessive light generated from the construction sites will hamper the movement of nocturnal animals. In addition, the faunal movement might be hampered, and harm or death to wildlife might be occurred due to vehicle and equipment movement on the approach roads and negligence of workers and drivers. However, the baseline study represents to have no threatened terrestrial fauna within the project AOI.

Heavy metal components may enter the food chain of different terrestrial faunal species which might impact biogeochemical cycles. However, the dispersion of Flue gas emission and deposition of fly ash contents decreases over the distance considering wind speed, topography, and the presence of physical barriers. In addition, the generation of noise and light from the plant operation will impact the movement of nocturnal faunal species and degrade their habitat of them.

Impact on Aquatic Flora and Fauna

Without proper measures being taken, the following consequences may take place: during the construction phase, the primary impact may lead to degradation or even destruction of aquatic invertebrates. This might also trigger the eutrophication process and lead to the degradation of the aquatic ecosystem. A further impact will be on fisheries through habitat degradation and even habitat loss for them. The physiological processes and behavioral characteristics might get hampered or changed. The growth and production of fisheries might be reduced in the long run.

Impact on Traffic

During the construction phase of the project, construction materials like construction equipment and machinery will be transported to the site. An increase in local traffic is expected because of the vehicles carrying construction materials, machinery, and equipment. Moreover, vehicles carrying landfill material may increase traffic intensity on the adjacent main road. An increase in traffic volume on a national highway may cause traffic congestion and accidents. However, the extra traffic load during the construction stage is not too high to impose a high-level impact on the road.

A total of 140 trucks will be operational during the operation phase to transport waste to the plant. The existing highway (N5) has connected the capital city Dhaka to the northern part of Bangladesh. This highway remains busy with several kinds of vehicles. Road transportation will be used for waste commuting to and from the project site, there would be added existing traffic due to plying of trucks of DNCC. An increase in traffic numbers for this project may add extra traffic pressure that can result in obstruction of traffic near the site and around the site. The inflow of waste transporting and carrying workers during operation is likely to generate noise and dust emissions.

Local Conflict of Interest

As employment opportunities will be increased during the construction period, construction workers may have conflicts with the community. Based on the previous similar scales of the projects, approx. 300 to 400 persons/day of workers will engage during the construction. Throughout the whole construction period, approx. 2,093 persons are expected in total, including those who worked on construction.

Cultural Heritage

Nothing found in the study area would be affected by the development. Therefore, no impact is expected on cultural heritage due to the proposed project implementation.

Gender

Despite cultural practices, no gender-specific issues are observed and expected in the project area. The fact is that the participation of women in society is limited from a religious perspective, which has been observed during the first-round consultation meeting and second-round information disclosure meeting. However, during the construction phase, female labor engagement will not occur, and no major gender-related issue will trigger within the project location.

Children's Rights

There are some primary and high schools near the project area. There is a possibility of disruption to PAHs and local community children due to construction and relevant impacts created from it. Also, there is a risk of child labor during the construction period.

Infectious Diseases, such as HIV/AIDS

During Construction, in general, a lot of migrant workers flow into the sites, who may have the possibility of HIV/AIDS or any other infectious disease that can spread among local people.

During operation, in general, about 220 people will be involved in the plant operation. Some people might have chances to engage with the community people. Therefore, infectious diseases could spread to the community and plants as well.

Occupational Health and Safety

There would be a possibility to occur accidents and incidents during construction works for the implementation of the Project. Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, Chemical, Gases, dust, fumes, vapors, and liquids are the major hazards that are harmful to workers health.

Operation of the WTE plant and its components poses significant occupational health and safety risks. The most significant occupational health and safety impacts typically associated with workers at waste management facilities occur during the operational phase and include accidents and injuries, chemical exposure, and exposure to pathogens and vectors.

Community Health and Safety

Possible sources of impacts on community health and safety during the construction phase are Changes in environmental quality due to construction activities, Increased prevalence of disease arising from the influx of construction workers, and Heavy traffic movement.

During the operation phase of the project, the main sources of impact on community health and safety are Noise from the power plant, Vehicular movement, Gaseous emissions from the power plant, Accidental leakage of untreated water or leachate, Unwanted odor, etc.

E-8 Environmental Management Plan

Several mitigation measures to manage adverse impacts and recommendations to enhance benefits are captured in the Environmental Management Plan (EMP). The EMP also includes the following:

- Environmental Mitigation Plan
- Environmental Monitoring Plan

The EMP and other management plans have been developed in accordance with the requirements of regulations in Bangladesh. The EMP and other plans will be implemented during the construction and operation of the project. The EMP takes each of the impacts identified in the impact assessment of the EIA and sets out the management/mitigation measures needed to deal with the impacts as well as describes the responsibility for implementing these.

E-9 Environmental Monitoring Program

Environmental monitoring will help in:

- Assessing the changes in environmental conditions.
- Monitoring the effective implementation of mitigation measures.

- Measuring and deterioration of environmental quality for further preventive action(s).

The following monitoring programs are to be carried out at the project to meet the above objectives:

- Ambient air and noise, water, and soil quality
- Emission and discharge from the plant
- Greenbelt
- HSE audits
- Social parameters
- Inspection of prevention and control measures.

E-10 Consultation with Stakeholders

Several types of stakeholder consultations like Public Consultation Meetings (PCM), Focus Group Discussions (FGD), and Key Informants Interview (KII) have been conducted in all bottleneck areas of the project.

A range of stakeholder engagement and consultation methods have been used to identify concerns, issues, and suggestions for the project. Views from the local government administration, public, local political leaders, surrounding institutions, communities, and development partners who are interested in and/or would be potentially affected by the proposed project were consulted through interviews, focus group discussion, and public consultation meetings. On August 30, 2022, a public consultation was held with 65 participants to ensure that all interested and affected parties were informed about the project. The consultation aimed to provide a platform for individuals to voice their opinions, concerns, and suggestions regarding the project. Recorded stakeholders' views and preferences were essential to inform the identification of impacts and drawing up effective mitigation measures that are presented in this report.

E-11 Conclusion

The proposed project's construction complies with the relevant plans and national industrial policies. Both the online and cumulative emission of pollutants can meet the requirements of applicable regulations and will have a minimal impact on the outside environment by utilizing internationally advanced technology and essential equipment as well as conducting efficient pollution control methods.

Essentially primary data was used to assess the environmental impacts in a comprehensive manner. Site surveys for environmental data collection, public consultation, and specific studies (flora, fauna, land use,) were carried out to complete the environmental impact assessments and recommend suitable mitigation measures.

With the effective implementation of the Environment Management Plan (EMP) during the construction and operation activities, the proposed project can proceed without any significant negative impact on the environment.

Chapter 1

Introduction

1 INTRODUCTION

1.1 Background

Waste is an unavoidable byproduct of human activities. Economic development, urbanization, and improving living standards in cities, have led to an increase in the quantity and complexity of generated waste. The rapid growth of population and industrialization degrades the urban environment and places serious stress on natural resources, which undermines equitable and sustainable development. Inefficient management and disposal of solid waste is an obvious cause of degradation of the environment in most cities of the developing world. Municipal corporations in developing countries are not able to handle increasing quantities of waste, which results in uncollected waste on roads and other public places. There is a need to work towards a sustainable waste management system, which requires environmental, institutional, financial, economic, and social sustainability. Waste to Energy is a very renowned technology for waste sustainable management.

Dhaka, the Capital City of Bangladesh, is expanding rapidly turning it into a mega city with a huge growth of population at a rate of around 6 six percent a year. Solid waste is being generated at a faster pace, posing a serious management threat. The rapid growth of industries, lack of financial resources, inadequate trained manpower, inappropriate technology, and lack of awareness of the community are the major constraints of solid waste management in the fast-growing metropolis of Dhaka. A healthy life, a cleaner city, and a better environment are the logical demands for city dwellers as the municipality is traditionally funded for solid waste services from the municipal tax system for waste collection and disposal.

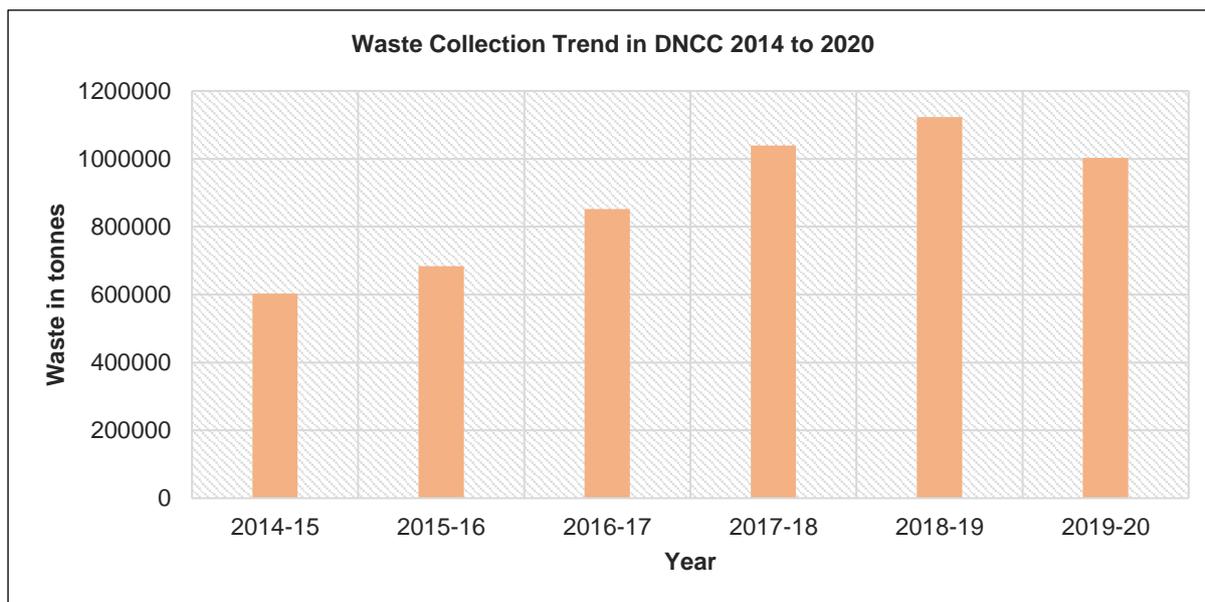
1.2 Brief Description

The waste in the north of Dhaka is discarded at will and cannot be treated in time and effectively. With the increase in urban population every year, the amount of solid waste is also increasing, which has caused serious environmental and ecological problems and affected the city's development and the citizens' healthy life. Until 2015, many designated and unspecified sites on the city road in North Dhaka were discarded at will; even large concrete boxes were used to store waste at some attractions, sidewalks, or roadside sites, and many more scavengers near landfills. In addition to polluting the urban sanitary environment, garbage can easily lead to traffic congestion. Unfortunately, such public demands did not receive official attention until the elected mayor took office. Government departments, relevant political parties, and people are now pressing for solutions to such problems.

One of the election manifestos for the mayor of Dhaka this year is "Clean Dhaka. " Since September 2016, Dhaka north city corporation (DNCC) has consistently addressed these issues. To realize the vision of the mayor cleaning Dhaka, the garbage problem must be solved, but the problem of neighborhood avoidance effect is encountered in the practice process. A sparsely populated location is the ideal place to build a transit station, but such an ideal area is impossible given the population density to reach the northern city. Within the scope of the project, there are 51 refuse transfer stations in DNCC. The existence of these refuses transfer stations can quickly transfer garbage to living areas, significantly improving the urban environment.

After improving garbage management in the collection and transportation field, the final disposal of garbage has become a more important issue. The only treatment facility corresponding to the DNCC service area is the Amin Bazar landfill, which began construction in 2005 and has been in operation since 2006, covering an area of about 53 acres. Now the landfill is only in DNCC operation. After many years of operation, the remaining operating life is estimated to be only 2-3 years.

Figure 1-1: Waste collection trend in tonnes in DNCC from 2014 to 2020



Source: Dhaka North City Corporation Waste Report

During 2014-2018, total dumping reaches 177 870 tons of garbage. Among them, for the period 2016-2017, a total of 852 390 tons of landfill disposal; For the period 2017-2018, a total of 1039331 tons of landfill disposal, a growth rate as high as 21.9%. During 2019-20 FY, a total of 1002561 waste has been generated. Currently, the dump has reached a height of 30 feet. After 2018, garbage should be stacked at a height of 60 feet to make full use of vertical space.

Landfills play a vital role in garbage management. All the garbage collected is dumped in the landfill. The tangible economic cost of original garbage dumping is very low, but the invisible environmental cost is very high. Mainly the land has brought a lot of pressure. If the landfill remains to be used between 2020 and 2035, DNCC will need 300-400 acres of land, which is a difficult task for land requisition. A Chinese company named WTE Power Plant North Dhaka Private Limited is the investor and intends to develop a 42.5 MWh waste-to-energy power plant, while the Ministry of Power, Energy, and Mineral Resources of Bangladesh will purchase the electricity. The plant will be constructed on the vacant land provided by the DNCC which is located on the right bank of the Karnatali River. Administratively, the site is situated at Banagram Union of Savar Upazila under Dhaka District. When the Amin Bazar waste-to-energy plant is in operation, it will require approx. 3,000 metric tons of garbage every single day. As a result, the expected outcomes of the proposed intervention will not only improve the city’s long-term electricity generation and power supply capacity for the city dwellers by best utilization of the domestic waste but also for the betterment of waste management practices in the Dhaka North City Corporation (DNCC) area. The amount of garbage (volumetric) those are commonly seen lying indiscriminately along the roadsides, drains, green spaces, etc. (including open dumps and unplanned burning results in the emission of smoke, VOC, NO₂, CO₂, Furan, etc.) under the present scenario, might be significantly reduced once the proposed waste-to-energy plant will become functional. That may also contribute to reducing the water logging crisis during peak monsoon by minimizing clogs in the city’s stormwater drainage system as well as improving environmental health in the DNCC area. The capacity of the proposed power plant is 42.5 MWh, which is expected to be generated from solid waste of 3,000 mt to be collected from Dhaka North City Corporation (DNCC) areas

1.3 Projection of Waste Management

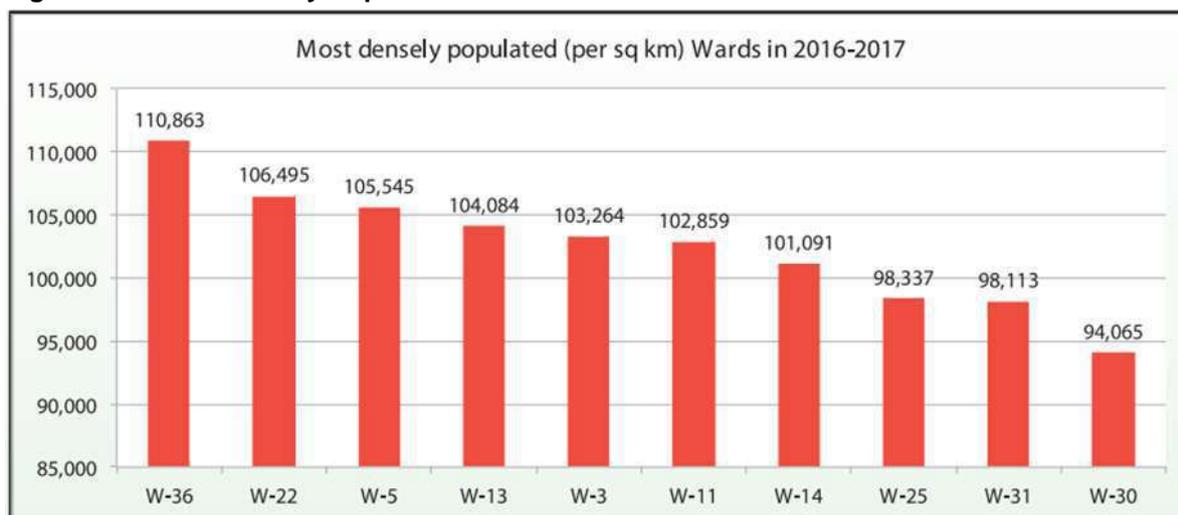
The production of garbage and human settlement are inextricably linked. It is the human being who produces various wastes for their means of subsistence, conveniences, and amenities. As civilization changes, the waste pattern also changes.

1.3.1 Past Scenario

The DNCC is experiencing exponential population growth and economic development, which has caused trash generation to rise and become more diverse. The city with the highest population density is Dhaka. It is one of the world's largest cities in terms of population. In 2016 and 2017, the population density in Dhaka North City was calculated to be 57,499 people per square kilometer. Wards have substantially higher population densities than the overall population. With 110,863 people per square kilometer, Ward 36 (Noyatola in the Mogbazar region) has the highest population density. With 22,300 people per square kilometer, Ward 19 has the lowest population density. The top ten most populated wards are Wards 3, 5, 11, 13, 14 (in the Mirpur area), Wards 30, 31 (in the Mohammadpur area), Ward 25 (Nakhla Para), and Ward 22 (in the Rampura area). The most densely populated wards of DNCC in 2016-2017 are shown in Figure 1-2.

Due to the growing population and need for more housing, healthcare, and educational opportunities, Dhaka city will continue to see an expansion in human settlement. In the context of waste management, population pressure needs to be countered by both vertical and horizontal organizational development. Processes for organizational development can take a while. Slow organizational development is thought to be a significant obstacle in tackling the enormous task that is looming huge on the horizon, especially against the backdrop of quick population expansion.

Figure 1-2: Most Densely Populated Wards of DNCC in 2016-2017



Source: DNCC Waste Report 2016-2017

Managing Municipal Solid Waste (MSW) is the waste management department's (WMD) main responsibility. The gathering, moving, and sloppy dumping of rubbish into landfills have been the main actions in waste management tasks. WMD has been carrying out these tasks while using a subpar organogram. Waste generation and collection have gradually increased in Dhaka city. The amount of garbage transported by DNCC to the dump in 2016-17 was 852,391 tons, a 24.77% increase over 2015-16. In 2019-2020, the total amount of collected waste was 1,002,561 tons. The projection of waste generation in DNCC for the Period 2007-2025 is shown in Table 1-2.

Figure 1-3 & Figure 1-4 shows the growth percentage and waste collection trend since 2014-2015 as an illustration of the previous state of waste management of DNCC².

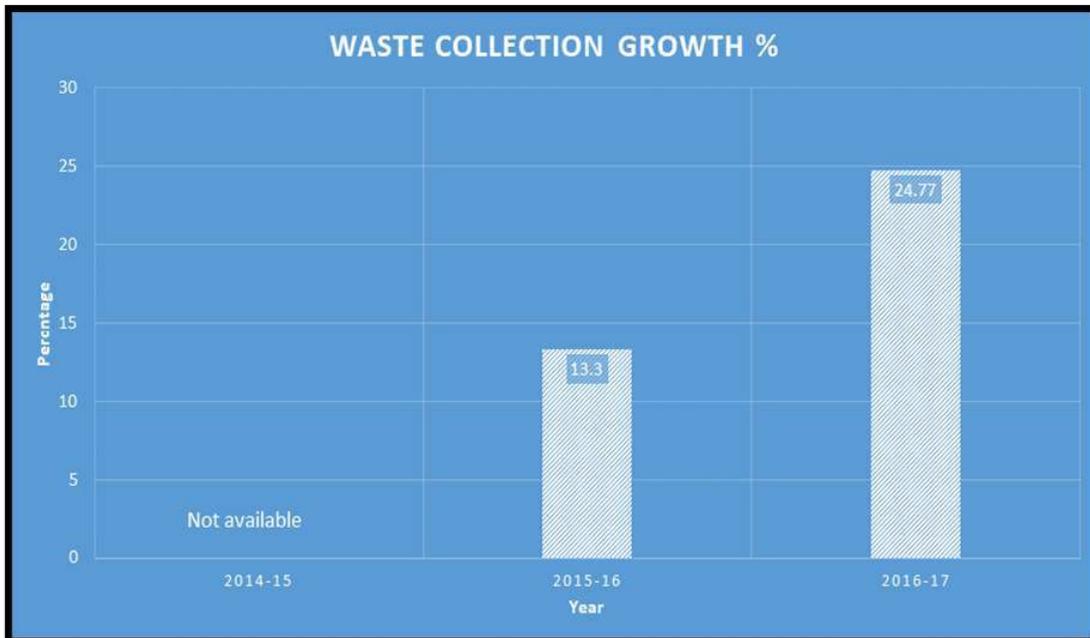
² Prodhan, A. H. M. & Kaeser, Aflatun. (2019). Municipal Solid Waste Management in Dhaka City: Present Status, Problems and Probable Solutions.

Figure 1-3: Waste collection trend in tones in DNCC from 2014-15



Source: “Municipal Solid Waste Management in Dhaka City: Present Status, Problems and Probable Solutions”, published at ResearchGate in April 2020.

Figure 1-4: Waste collection growth percentage in DNCC



Source: “Municipal Solid Waste Management in Dhaka City: Present Status, Problems and Probable Solutions”, published at ResearchGate in April 2020.

Facts, numbers, and the state of the situation make it clear that the graph of waste volume will keep rising. Population growth, lifestyle changes, and the addition of 113 square kilometers to the existing 82.638 square kilometers are factors that could have an impact on waste volume. According to the prediction, the DNCC may need to manage more than 5,637,728 tons of garbage during the next five years².

1.3.2 Present Scenario

Municipal solid waste, electronic waste, hazardous medical waste, food waste, construction trash, and industrial hazardous waste are just a few of the several forms of waste that are produced inside DNCC. The MSW is the primary focus of DNCC's waste management operations. Anything that individuals place in DNCC's garbage containers and collection locations is included in the MSW that DNCC handles. The number of infrastructure improvements, shopping centers, restaurants, marketplaces, bazars, together with roadside tea-stalls, floating vendors, and flower shops on the sidewalk, has led to a rise in the amount of waste produced within DNCC year over year.

Even though DNCC collects the municipal solid waste that local residents produce on a daily basis, occasionally people dump waste elsewhere outside DNCC's approved secondary collection places, such as into open areas, drains, canals, or their own backyards. A total of 1,002,561 tons of garbage were collected in 2019-2020. Road and drain cleaning, collection and transport, landfill development and operation, and repair work are the four subcategories of SWM operations in DNCC.

Ward 40 in this city has the most residents (256,719), while Ward 42 has the fewest (16,722). The largest and smallest population densities in DNCC are 103,255 and 2,693 per square kilometer in Wards 36 and 42, respectively. Wards 1, 17, 30, 39, and 40 have the largest population whereas Wards 22, 5, 13, and 36 have the highest density.

Currently, DNCC collects 80% of solid garbage utilizing its fleet of vehicles. By adding more cars and implementing a more effective and modernized collection system in the city, a 90% collection rate can be obtained. In the table below, total amount of collected waste and yearly waste growth from 2014-2015 to 2018-2019 have been displayed.

Table 1-1: Existing Waste Management Scenario at a Glance³

Year	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Total Waste Collection	602,975	683,174	852,390	1,039,331	1,122,478
Monthly Average Collection	50,248	56,931	71,033	86,611	93,540
Daily Average Collection	1,652	1,872	2,335	2,847	3,075
Yearly Waste Growth	-	13%	25%	22%	8%

Source: Dhaka North City Corporation Waste Report 2018-2019

1.3.3 Future Scenario

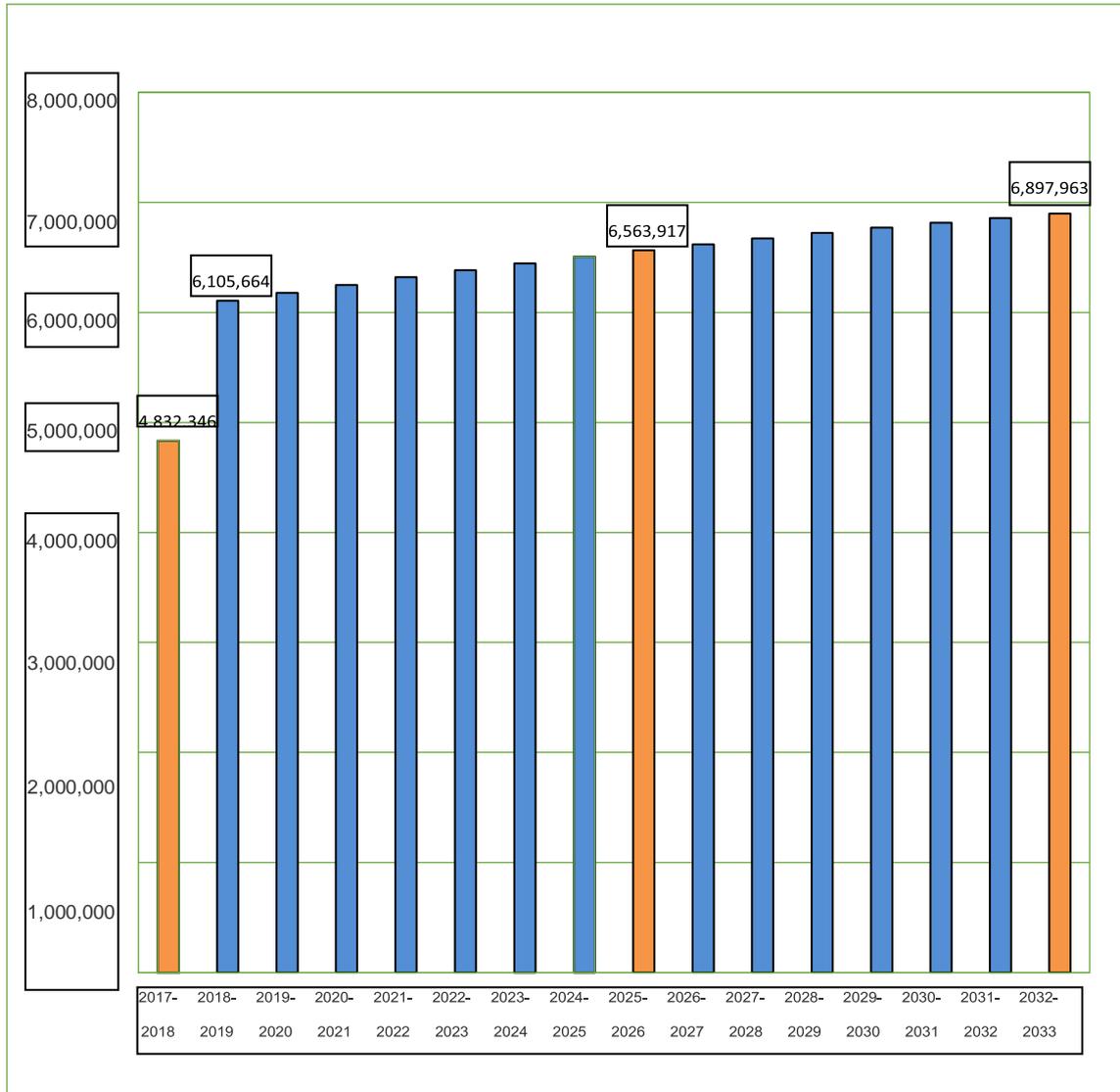
The Population and Housing Census-2022 report has revealed that more than 1.20 crore people reside in Dhaka City. The preliminary report of the census was released on 27 July 2022 (Wednesday) at the Bangabandhu International Conference Centre in the capital. According to the preliminary report, in the first census of the country held in 1974, the population of the country was 71,479,071. This number has doubled in the past 50 years. Dhaka division has a population of 4.42 crore, the report further states. Among them, 2 crores 24 lakh 59 thousand 822 are male and 2 crores 17 lakh 21 thousand 556 are female. Also, the number of transgenders in the Dhaka division is 4,577. The Bangladesh Bureau of Statistics (BBS) report mentions that the population in the two city corporations are – 5,979,537 and 4,299,345 – for Dhaka North and Dhaka South city corporations respectively.

³ DNCC Waste Report 2018-2019. (n.d.). Retrieved November 23, 2022, from https://dncc.portal.gov.bd/sites/default/files/files/dncc.portal.gov.bd/annual_reports/6693c776_0dde_49da_b85b_1928d398a7f4/2020-07-07-15-04-0388efe51e61d331efb81045a0648dd2.pdf

1.3.3.1 Population Projection of DNCC

The following figure shows the projected population for 15 years in DNCC⁴. The population is estimated on the basis of the 2011 population census, and its growth rate is applied in accordance with the “Population Projection of Bangladesh 2011-2061” calculated by the BBS. In 2032, which is the target year of the Master Plan, the total population is estimated to increase to about 6.8 million, including the expansion area.

Figure 1-5: Population Projection in DNCC (2017–2032)⁴



Source: New Clean Dhaka Master Plan 2018–2032 based on BBS “Population Census 2011,” and “Population Projection of Bangladesh 2011–2061”

The population of DNCC was predicted to reach 6.1 million in FY 2019-20 according to the New Clean Dhaka Master Plan 2018-2032 (under approval by the Local Government Division), up from 3.95 million in the census of 2011. Landfill demand for disposal of MSW of Dhaka assessed by projecting population and waste generation for the period 2007-2021 is represented in Table 1-2.

⁴ Clean Dhaka Master Plan 2018-2032. (n.d.). http://www.dncc.gov.bd/sites/default/files/files/dncc.portal.gov.bd/project/08a52c87_a283_4ac2_b044_0cf73eb76118/2022-03-02-09-58-eda90474b6a1318034357d4e6e231c32.pdf

Table 1-2: Projection of Waste Generation for the Period 2007-2021

Year	Projected Population	Daily Waste Generation (tons)	Yearly waste generation (M ton)	Cumulative Waste (M tons)	Cumulative Landfill Waste Volume (Mm ³)
2007	13.50	6750	2.5	2.5	4.93
2008	13.87	6934	2.5	5.0	9.99
2009	14.24	7122	2.6	7.6	15.19
2010	14.63	7316	2.7	10.3	20.53
2011	15.3	7515	2.7	13.0	26.01
2012	15.44	7719	2.8	15.8	31.65
2013	15.86	7929	2.9	18.7	37.44
2014	16.29	8145	3.0	21.7	43.38
2015	16.73	8367	3.1	24.7	49.49
2016	17.19	8594	3.1	27.9	55.77
2017	17.66	8828	3.2	31.1	62.21
2018	18.14	9068	3.3	34.4	68.83
2019	18.63	9315	3.4	37.8	75.63
2020	19.14	9568	3.5	41.3	82.61
2021	19.66	9828	3.6	44.9	89.79

Source: "Landfill demand and allocation for municipal solid waste disposal in Dhaka city—an assessment in a GIS environment" Journal of Civil Engineering (IEB), 37 (2) (2009)

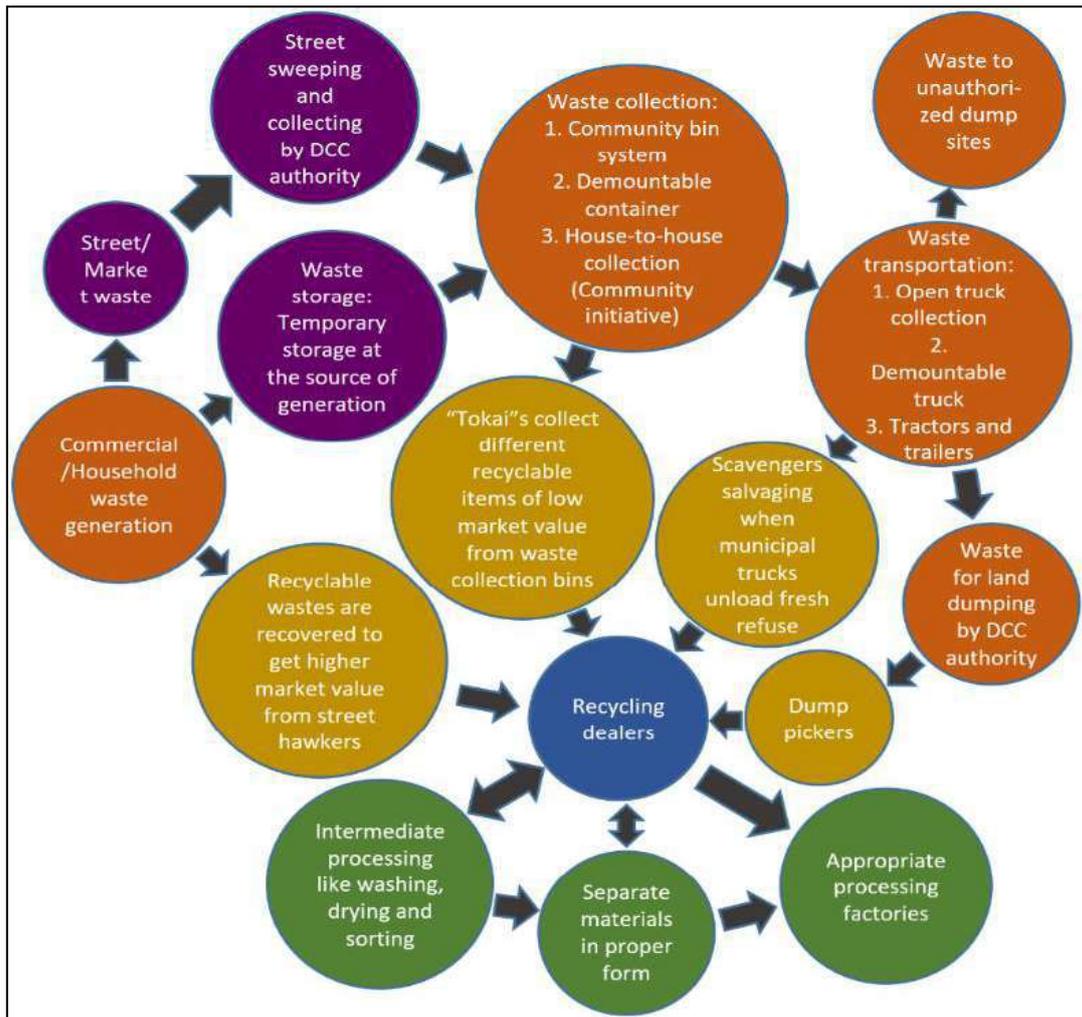
In order to keep up with the population's rapid growth, trash generation is rising. In order to introduce an integrated and sustainable approach in Dhaka city, garbage collection and transportation are handled by Dhaka City Corporation (DNCC and DSCC). The unpaid balances and unplanned garbage make drainage a serious issue, particularly during the monsoon season. The wide random dumping and disposal methods are unsanitary in a society where modern technology and devices are required. Large amounts of garbage do contain biodegradable materials that can be recycled or can generate electricity scientifically and sustainably.

1.3.4 Assessment of waste management practices and future projection

The Waste Management Department (WMD) of Dhaka City Corporation (DCC) was established in July 2008 to improve Solid Waste Management in replacing the conservation department (SWM). To improve waste collection, inefficient conventional collection methods were replaced with more efficient ones, and the WMD's DCC for garbage collection was improved. Around six thousand mini bins were installed at different points in Dhaka earlier in 2016. But the bins were installed not for houses or business entities, but for pedestrians so that they can put light garbage into those instead of hither and

thither. But the pedestrians do not use the bins as was expected. They throw waste on the street or footpaths. However, street vendors prefer bins. Dhaka has undertaken two significant initiatives for solid waste management. Japan International Cooperation Agency (JICA) undertook one in 2005 with the goals of formulating a master plan for Dhaka City and enhancing the capabilities and management skills of DCC. In 2010, the Department of Environment (DOE), Ministry of Environment, Forest and Climate Change launched the 3R Strategy (the 3Rs refers to the principle of reducing, reusing, and recycling resources and products). The 3Rs can play an important role in achieving sustainable waste management by reducing greenhouse gas emissions and transforming waste into valuable resources

Figure 1-6: Existing solid waste management system in Dhaka City⁵



Source: Solid Waste Management in Bangladesh. July 16, 2009, available in SSRN

The construction of STS in Dhaka has markedly improved waste management. The construction of 52 STS in DNCC has allowed the removal of a large number of waste containers from the roads. DSCC had planned to construct 45 STSs by this time, but only 12 have been completed. DNCC intends to construct 2-4 STSs in each of the 36 wards. In areas of primary collection, the Primary Waste Collection Service Provider (PWCS), a non-profit organization, coordinates household waste collection for STS. 340 private operators were registered with the PWCSPECIES in 2016-2017. There are also

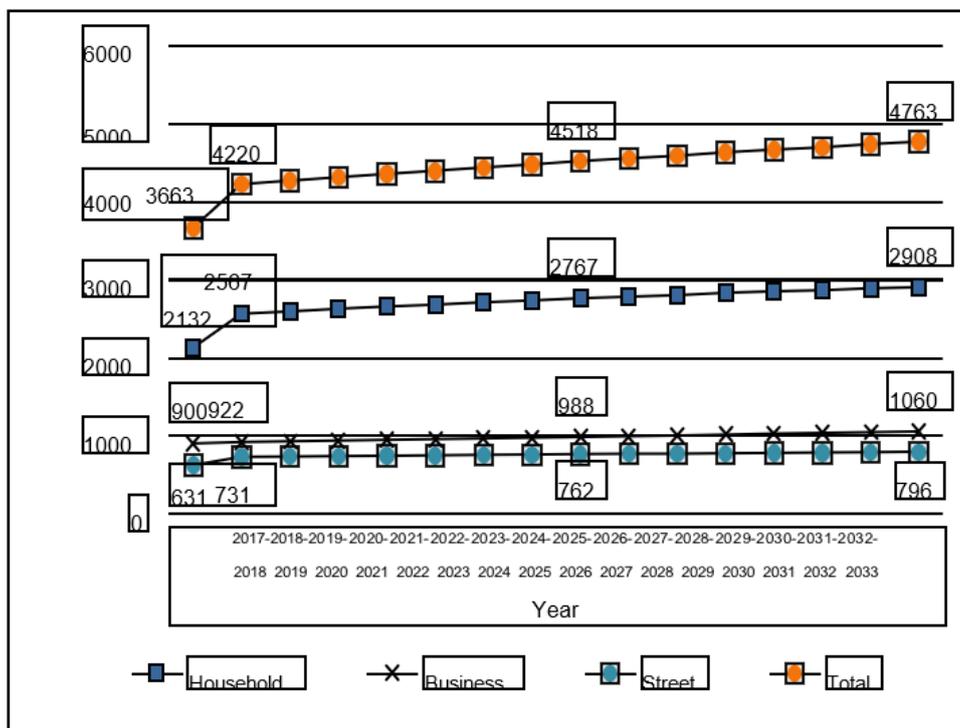
⁵ Shamsuddoha, Mohammad. Solid Waste Management in Bangladesh. July 16, 2009. Available at SSRN: <https://ssrn.com/abstract=1434967> or <http://dx.doi.org/10.2139/ssrn.1434967>

unregistered operators that collect residential waste for STS. Traffic bottlenecks caused by containers on the street were eliminated by the construction of STS.

1.3.5 Projection of Solid Waste Generation at DNCC

Municipal solid waste generation from FY 2017–2018 to FY 2032–2033 was estimated based on BBS “Population Census 2011⁶,” “Population Projection of Bangladesh 2011–2061⁷,” “Economic Census 2013⁸,” and “Waste Amount and Composition Survey Report (2018)⁹” as shown in the below Figure. The waste generation is estimated to increase from 3,663 tons/day to 4,763 tons/day for 15 years, which is calculated on the basis of the unit generation of household waste; business waste including that from markets, restaurants and hotels, offices, and street waste. Business waste and street waste were calculated to increase by 1% per year.

Figure 1-7: Estimation of Municipal Solid Waste Generation



Source: New Clean Dhaka Master Plan 2018–2032 based on BBS “Population Census 2011,” “Population Projection of Bangladesh 2011–2061,” “Economic Census 2013,” and “Waste Amount and Composition Survey Report (2018)”

1.3.6 Target Waste Collection Rate

The target waste collection rate was set as 90% of waste generation compared with 80% for the current waste collection rate. The following table shows the annual target waste collection amounts and rates. The waste collection rate dropped in FY 2018–2019 owing to the expansion of the service area.

⁶ Bangladesh Population And Housing Census 2011. (n.d.). Bangladesh Bureau of Statistics. Retrieved November 23, 2022, from <http://www.bbs.gov.bd/>

⁷ POPULATION PROJECTION OF BANGLADESH, Dynamics and Trends (2011-2061). (n.d.). PopMonographs. Retrieved November 23, 2022, from <https://18.65:8008/WebTestApplication/userfiles/Image/PopMonographs/PopulationProjection.pdf>

⁸ BBS Economic-Census-2013. (n.d.). Bangladesh Bureau of Statistics. Retrieved November 23, 2022, from <http://www.bbs.gov.bd/site/page/d13ee628-7458-4650-a824-6423d35d3620/Economic-Census-2013>

⁹ THE STUDY ON THE SOLID WASTE MANAGEMENT IN DHAKA CITY. (n.d.). Jica Reports. Retrieved November 24, 2022, from <https://openjicareport.jica.go.jp/pdf/11785243.pdf>

Table 1-3: Target Waste Collection Rate¹⁰

Year	Total Waste Amount	Total Waste Collection*	Waste Collection Rate
	(tons/day)	(tons/day)	(%)
2017–2018	3,663	2,919	80
2018–2019	4,220	3,123	74
2019–2020	4,265	3,241	76
2020–2021	4,309	3,318	77
2021–2022	4,354	3,396	78
2022–2023	4,321	3,457	80
2023–2024	4,287	3,472	81
2024–2025	4,251	3,486	82
2025–2026	4,217	3,500	83
2026–2027	4,211	3,537	84
2027–2028	4,203	3,572	85
2028–2029	4,203	3,615	86
2029–2030	4,196	3,650	87
2030–2031	4,183	3,681	88
2031–2032	4,182	3,722	89
2032–2033	4,168	3,751	90

*Total waste collection excludes the amount of generation reduction and informal recycling

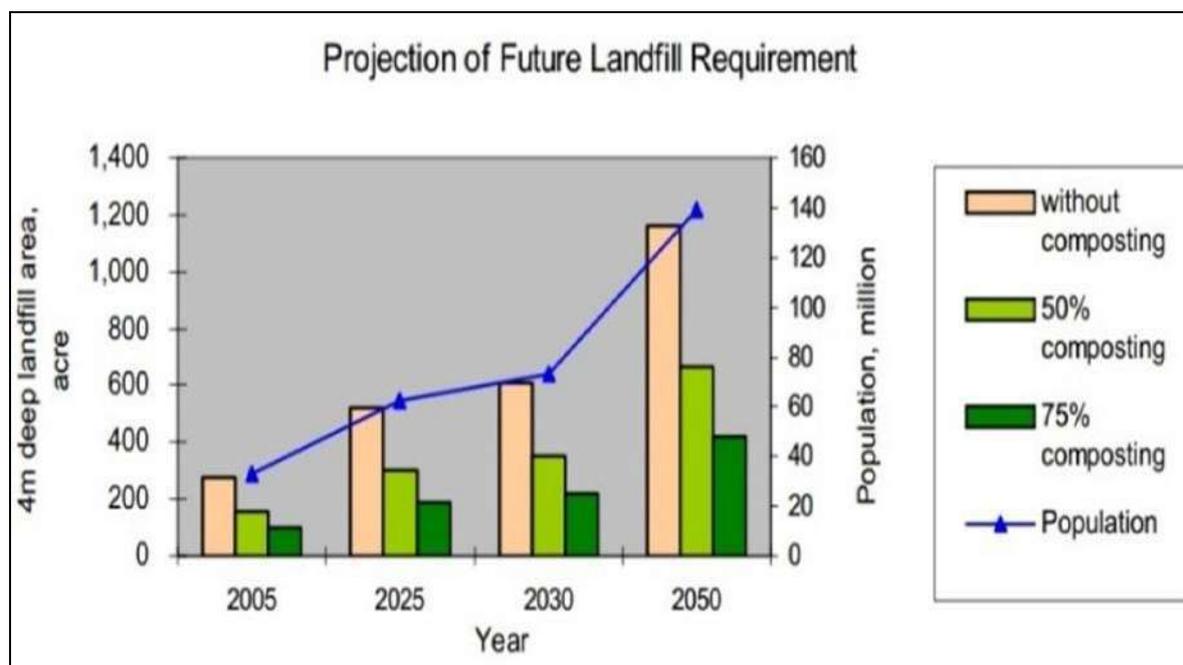
Source: New Clean Dhaka Master Plan 2018-2032

75% composting landfill requirement will be around only 400 acres by the year 2050. The landfill requirement without composting will exceed 1,000 acres by the same year. The future landfill requirement of Dhaka without composting and with composting is projected in Figure 1-8.

¹⁰ Clean Dhaka Master Plan 2018-2032. (n.d.).

http://www.dncc.gov.bd/sites/default/files/files/dncc.portal.gov.bd/project/08a52c87_a283_4ac2_b044_0cf73eb76118/2022-03-02-09-58-eda90474b6a1318034357d4e6e231c32.pdf

Figure 1-8: Projection of future landfill requirement of Dhaka



Source: Waste Concern Technical Documentation, Urban Solid Waste Management Scenario of Bangladesh: Problems and Prospects. June 06, 2005

The population of DNCC was predicted to reach 6.1 million in FY 2019-20 according to the New Clean Dhaka Master Plan 2018–2032 (under approval by LGD), up from 3.95 million in the census of 2011. Landfill demand for disposal of MSW of Dhaka assessed by projecting population and waste generation for the period 2007-2025 is already represented. The most considerable issue on the LFS scenario is more LFS construction associated with land acquisition which is very difficult to proceed with in Dhaka, and a growing population with waste generation. Considering the future sustainability of the DNCC’s SWM, the Scenario introducing a new concept under 3R with an intermediate treatment system (Eco-Town Scenario) as a preferred. DNCC shall work on establishing an effective intermediate treatment system such as Eco-Town, an intermediate treatment zone with various provisions of treatment facilities (WtE, biogas, composting, recycling, etc.), as an iconic symbol of Zero-Waste.

1.4 The Rationale of the Project

The number of infrastructure improvements, including shopping centers, restaurants, marketplaces, and bazaars, together with roadside tea stalls, floating vendors, and flower shops on the sidewalk, has led to a rise in the amount of waste produced within DNCC year over year. The total area of DNCC is 196.23 square kilometers, and the current population is 6.1 million. Every day, 3,433 tons of waste are generated, according to the DNCC waste report 2019-20. In FY 2019-20, about 1002561 tons of waste were generated. This large volume of waste is disposed of at only one location, the Amin Bazar landfill. As a result, it requires more land at the existing landfill site and is increasing year over year. Moreover, community health risks, bad odors, and impacts on water and soil quality are major environmental and social concerns due to this landfill site. Increased generation of methane (CH₄) from this Municipal Solid Waste (MSW) alarms the world to take proper initiative for the sustainable management of MSW because it is 34 times stronger than carbon dioxide¹¹. Bangladesh’s methane gas plumes cause alarm, as the country was found to be a major emitter of CH₄ likely to originate from a combination of rice

¹¹ Islam, K. M. "Municipal solid waste to energy generation in Bangladesh: possible scenarios to generate renewable electricity in Dhaka and Chittagong city." Journal of Renewable Energy 2016 (2016).

paddy fields, landfills, leaky natural gas pipelines, and coal stockpiles¹². Moreover, the mounting land scarcity issue around Dhaka city as a promising option, because of the waste to energy (WtE) strategy for MSW management in urban areas is a promising option, because WtE not only reduces the land pressure problem, but also generates electricity, and green jobs. The proposed project is a project where electricity will be produced from the municipal solid waste collected by DNCC. This project is not only an effort for enriching the country's power generation towards sustainable waste management but also will reduce excessive consumption of landfill storage capacity, reduce land pressure, and environmental, and health safety impacts from current waste generation.

1.5 Scope of Study

The study has been based on the environmental and socio-economic perspectives of the project site and that of the area of 5 km and the significant impacts of the proposed power project anticipated upon the existing environmental and socio-economic system pertaining to the project study area. The broad objectives of this study have been to provide a basis for a detailed assessment of the identified environmental and socio-economic impacts of the proposed power project and thereafter, to undertake mitigation measures toward minimizing adverse impacts and measures to enhance beneficial impacts, formulate environmental management and monitoring plans and plans for addressing health and safety issues.

The scope of work for the EIA study will be the following but is not limited to the following:

- Collection of environmental baseline data from the Project site and surrounding areas with reference to the physical, biological, and social components of the environment and preparation of baseline monitoring report.
- Identification, prediction, quantification, and evaluation of potential aspects and impacts (both short term and long term) of the proposed Project on various environmental components due to activities envisaged during:
 - Construction activities at the proposed site.
 - Relevant off-site construction activities; and
 - Operation of the project.
- Preparation of Emergency Response Plan.
- Delineation of Environmental Management Plan (EMP), including mitigation measures and monitoring plan for effective implementation of mitigation measures by the Project Personnel during the construction and operation phases of the Project.
- Preparation of the EIA report based on DoE-approved TOR for obtaining Environmental Clearance from the DoE.

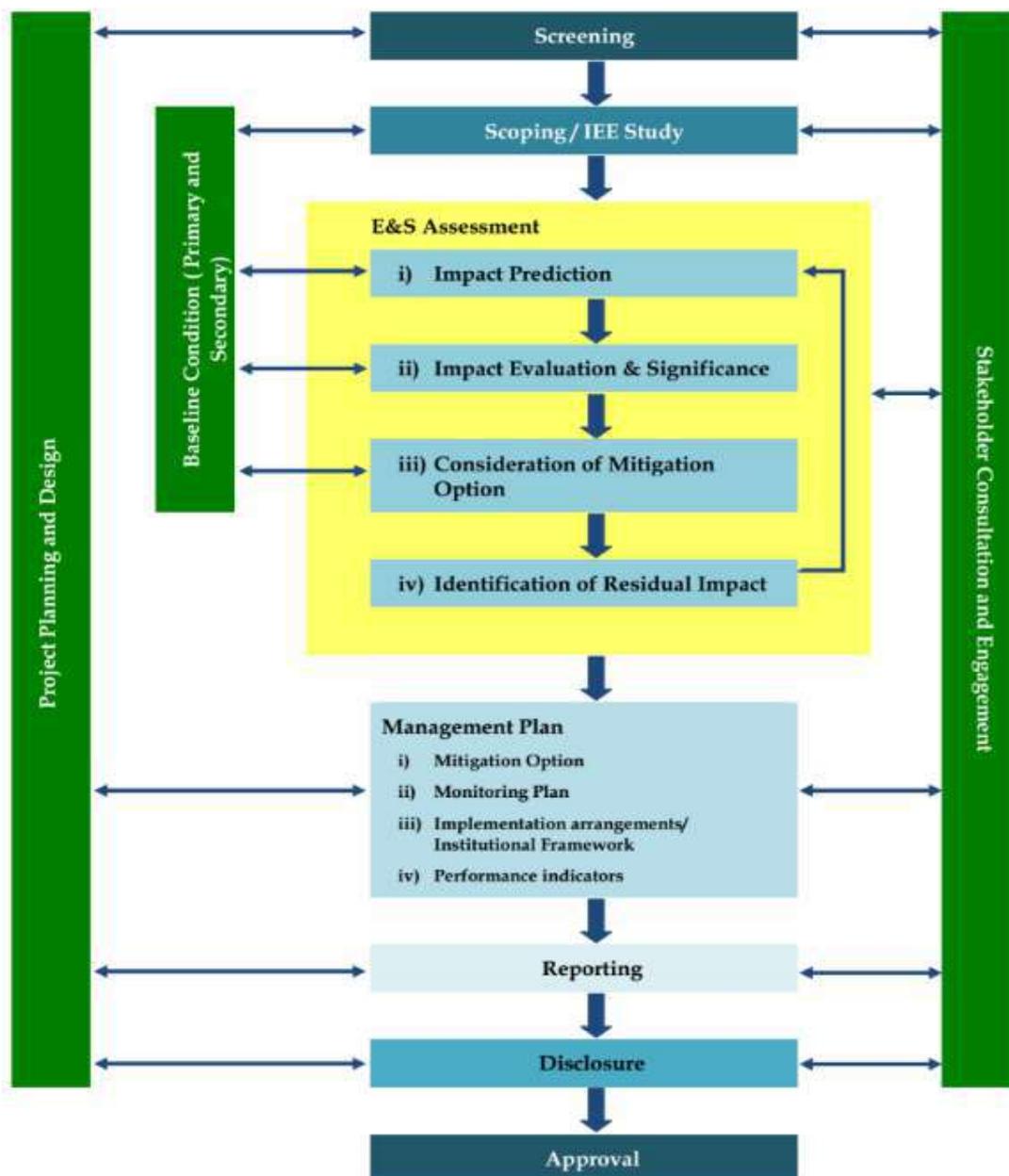
1.6 Methodology

The focus of the EIA has been anticipated environmental and social effects, both positive and negative, that may result from the project or its alternatives, as well as their potential magnitude, reversibility, period of occurrence, nature, etc. predictions, which have considered all aspects and phases of the project and any indirect environmental and social effects, cumulative effects, and any environmental effects that may result from accidents or malfunctions. The approach proposed for the EIA study is presented in **Figure 1-9**.

¹² Bangladesh methane gas plumes cause alarm, as country found to be major emitter.

<https://www.scmp.com/news/asia/south-asia/article/3128726/bangladesh-methane-gas-plumes-cause-alarm-country-found-be> [accessed 17 November 2021]

Figure 1-9: Approach of the EIA Study



Source: EQMS

The activities involved in conducting the EIA of a project are diverse and intensive efforts, including field surveying, are needed to prepare successful EIAs. The procedure for conducting EIA may be described in the following steps.

1.6.1 Screening and Categorization

Screening

EQMS reviewed the existing available data of the Project with the client and secondary information available in the public domain concerning the Project, Project location, and its surroundings. The screening process was undertaken to identify the project's environmental, social, and other sensitivities. A review of the applicability of the reference frame concerning the proposed project was also undertaken as part of this screening phase.

EQMS undertook a site visit to understand the site setting and environmental and social sensitivities, identify the relevant local stakeholders, and analyze the local and national level stakeholder requirements, which would be important for the secondary data generation and regulatory approval process of the project.

Categorization

The proposed Power Plant project falls under the Red category (Item 51: Incinerator Plant). The project requires an Environmental Clearance Certificate (ECC) from the Department of Environment (DoE).

WTE Power Plant North Dhaka Private Limited applied on 8 February 2022 on dated for Exemption from IEE and Approval of Terms of Reference (ToR) for EIA for the Waste to Energy Power Plant Project in North Dhaka. And the Department of Environment (DoE) approved the ToR dated 28 April 2022 (Memo no: 22.02.2600.137.72.18.22.58). The ToR has been given in **Appendix A**.

1.6.2 Scoping

At the initial stage of the EIA, preliminary information was obtained, and discussions were held to aid in the determination of what legal and other requirements were applicable to the Project. This step was conducted utilizing a high-level description of the Project and its associated facilities.

1.6.3 Environmental and Social Baseline Data Collection

The baseline covered a detailed description of the physical environment, water resources, land resources, agriculture, fisheries, ecosystems, and socioeconomic condition, including the identification of problems in respect of the resources. Field visits were carried out at the project site and the study area.

The main objectives of the visit were observation assessment and professional justification. These have been conducted to identify the Important Environmental and Social Components (IECs/ISCs) through a scoping process, including scoping sessions with the stakeholders. The visits also aimed for FGDs and KIIs as suggested in the EIA guidelines of DoE. Important parameters such as soil criteria, surface, and groundwater quality, noise, air quality, etc. of the baseline situations have been generated from long-term data collected from different organizations like Soil Resources Development Institute (SRDI), Bangladesh Water Development Board (BWDB), Bangladesh Inland Water Transport Authority (BIWTA), Department of Public Health and Engineering (DPHE), Upazila Agriculture Officer, Upazila Fisheries Officer, Upazila Education Office, Upazila Engineer, Bangladesh Meteorological Department (BMD) and Department of Environment (DoE). Field surveys and the BBS census have generated the most social and economic data. Moreover, EQMS has a database for different resource sectors, which also helped in conducting the EIA study.

1.6.4 Environmental Management Plan (EMP) and Environmental Monitoring Plan

Put more attention to parameters producing negative impact and identify the mitigating measures to be incorporated in the planning and implementing stages of the project to eliminate, reduce and offset negative impacts and thereby enhance net positive impact, i.e., the benefit of the project. Plan a monitoring program to ensure the implementation of mitigating measures. The management and monitoring plans have been discussed in detail in Chapters 8 and chapter 9 of the EIA report.

Requirements and details of the control measures have been suggested in the EMP for implementation by the Client during the construction and operation phases of the Project. The EMP comprises the following aspects based on the impacts assessed for the Project:

- Introduction to the purpose of the EMP.
- Institutional mechanism - roles and responsibilities for EMP implementation.
- Summary of significant adverse impacts and potential hazards.

- Mitigation measures and control technologies, safeguards, etc. to minimize adverse impacts on air, water, soil, and biological and socio-economic environment, measures to minimize associated hazards and control the emergency; and
- Project monitoring program for effective implementation of the mitigation measures and ascertain the efficacy of the environmental management and hazard control systems in place.

1.7 Limitation

Services performed by the consultant are conducted in a manner consistent with the level of care and skill generally exercised by members of the consulting profession. The report may not exhaustively cover an investigation of all possible circumstances that may exist. However, an effort is made to discover all meaningful areas within the stipulated time.

The Consultant assumes that the information provided is factual and accurate and accepts no responsibility for any deficiency, misstatement, or inaccuracies in this report due to the omission or misrepresentation of any person interviewed or contacted. However, the consultant notifies the contradictions and errors in the data where it seems appropriate.

Certain provisions in this EIA report assume Reliance on conceptual design and technical information. Suppose the design of the Project changes from that assessed due to design development. In that case, including new information, changing motivations, or any other reason, the results of any impact assessment or mitigation measures provided in this report may be inconsistent.

1.8 EIA team

EQMS Consulting Limited is a specialist consultancy firm contracted by WTE Power Plant North Dhaka Private Limited to prepare and deliver the EIA report for the proposed Project. EQMS Consulting Limited has utilized a multi-disciplinary team comprising environmental and social experts. The team members have extensive professional experience working in the fields of Environmental Impact Assessment and Social Impact Assessment in Bangladesh. The Team members for EIA Study can be seen below in Table 1-4.

Table 1-4: Team members for EIA Study

Name	Position
Kazi Farhed Iqbal	Project Director/EIA Expert
Md. Zahidul Islam	Senior Environmental Expert
Ferdowsi Rita	Senior Social Expert
Md Najmul Hossen Nahid	Senior Environmental Expert
Boloram Karmaker	Environmental Expert
Md Shafiqul Islam	Environmental Expert
Wasima Tabassum	Social Expert
SK Salauddin	Disaster Management Expert
Nourin Ahasan Habib	Ecologist
Farah Shamima Sultana	GIS Expert

1.9 References

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Chapter 2

Legislative, Regulation, and Policy Consideration

2 LEGISLATIVE, REGULATION, AND POLICY CONSIDERATION

2.1 Introduction

The environmental legislation of Bangladesh is framed to protect the valued/critical environmental components and comply with its commitment to the international community under various conventions and protocols. Bangladesh has a well-defined institutional and legislative framework. The legislation covers all components of the environment, viz. air, water, noise, soil, terrestrial and aquatic flora and fauna, natural resources, land use, wildlife protection, forest conservation, and sensitive habitats. Bangladesh is also a signatory to various international conventions and protocols. In the administrative framework set up with the Department of Environment (DoE) under the Ministry of Environment, Forest, and Climate Change (MoEFCC), the Government of the People's Republic of Bangladesh (GoB) is responsible for ensuring the application of environmental laws and issuance of necessary clearances for all kind of project as such.

To address the environmental and social risks of any proposed project and its associated components to protect and conserve the environment from any adverse impacts, the GoB has specified regulations, policies, and guidelines.

The following activities have been carried out under this section:

- Identification of national legal obligations in relation to the interventions which will be required to review under the EIA study of the proposed project.
- Exploration of the national legislative provisions and policy guidelines on environmental and social sectors.
- Identification of the international legal obligations and relevant provisions of multilateral environmental agreements related to the proposed project interventions.
- Identification of the standard guidelines at a regional and international level related to the Waste-To-Energy Incineration Power Project setup.

2.2 Applicable National Legal Requirements

All legal provisions relevant to environmental protection applicable to the planning, construction, and operation of waste-to-energy facility projects are identified and summarized in Table 2-1, along with their applicability to the proposed project.

2.2.1 Constitution of the People's Republic of Bangladesh

The Constitution of the People's Republic of Bangladesh has few provisions for the protection and improvement of the environment and biodiversity. According to the (15th amendment of the constitution) Act, 2011 (Act XIV of 2011), "protection and improvement of environment and biodiversity" is one of its state policies in accordance with Bangladesh's commitment to international obligations to the environment, protection of biodiversity, and sustainable development.

Article 18A of the constitution of the People's Republic of Bangladesh states that "the State shall endeavor to protect and improve the environment and to preserve and safeguard the natural resources, biodiversity, wetlands, forests, and wildlife for the present and future citizens.

Table 2-1: National Legal Provisions Applicable to the Proposed Project for Ensuring Environmental Protection

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
Environment Conservation Act, 1995, and its amendment in 2000, 2002 and 2010	Ministry of Environment, Forest, and Climate Change	<ul style="list-style-type: none"> • Declaration of Ecologically Critical Areas (ECAs). • Obtaining Environmental Clearance Certificate (ECC). • Regulation for vehicles emitting smoke which is harmful to the environment. • Regulation of development activities from an environmental perspective. • Promulgation of standards for quality of air, water, noise, and soil for different areas and different purposes. • Promulgation of acceptable limits for discharging and emitting waste. • Formulating environmental guidelines relating to the control and mitigation of environmental pollution, conservation, & improvement of the environment. 	<p>Applicable - According to the Act, “no industrial unit or project shall be established or undertaken without obtaining an ECC from the DoE.”</p> <p>Therefore, the act's provisions apply to all project intervention phases during the project life cycle.</p>
Environment Conservation Rules, 2023	Ministry of Environment, Forest, and Climate Change	<ul style="list-style-type: none"> • NEQS for ambient air, surface water, groundwater, drinking water, industrial effluents, emissions, noise, & vehicular exhaust. • Categorization of industries, development projects, and other activities based on actual (for existing industries/development projects/ activities) and anticipated (for proposed industries/development projects/activities) pollution load. • Procedure for obtaining ECC. • Requirements for undertaking IEE and EIA's as well as formulating EMP according to categories of industries/ development projects/activities; and • Procedure for damage claim by persons affected or likely to be affected due to pollution activities or activities causing hindrance to everyday civic life. 	<p>Applicable - as the Projects fall under Red Category and require site clearance/ EIA approval/ ECC from DOE, Bangladesh.</p> <p>Besides, it is stipulated that environmental quality standards and other relevant requirements shall comply during the project life cycle.</p>

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
		<ul style="list-style-type: none"> Schedule 1, Classification of industrial units and projects for purpose of issuance of into four categories: - (a) Green; (b) Yellow; (c) Orange; and (d) Red. 	
Environment Court Act, 2010 and its amendment in 2019	Ministry of Environment, Forest, and Climate Change. Judiciary	<ul style="list-style-type: none"> Establishment of one or more environmental courts in each district and one or more special magistrate courts in each district. Also provides the jurisdictions of the environment court, the penalty for violating the court's order, a trial procedure in a special magistrate court, power of entry and search, a procedure for investigation, procedure, and power of the environment court, the authority of the environment court to inspect, appeal procedure and formation of the environment appeal court. 	Applicable - the court has authority, under the act's provisions, over a trial for an offense or compensation under environmental law, imposing penalties for violation, etc.
Noise Pollution (Control) Rules, 2006	Ministry of Environment, Forest, and Climate Change	<ul style="list-style-type: none"> The Rules have been established to manage noise-generating activities, which have the potential to impact the health & well-being of workers and the surrounding communities. An area up to a radius of 100 meters around hospitals, educational institutions, offices, or similar types of institutions is designated as a silent area. The acceptable sound limit in the silent areas is 50 dB(A) for daytime and 40 dB(A) for nighttime. Dwellings primarily occupy residential areas. The acceptable sound limit in residential areas is 55 dB(A) for daytime and 45 dB(A) for nighttime. Mixed areas with a mix of residential, commercial & industrial land use. The acceptable sound limit in the mixed areas is 60 dB(A) for daytime and 50 dB(A) for nighttime. Businesses and officers primarily occupy commercial areas. The acceptable sound limit in commercial areas is 70 dB(A) for daytime and 60 dB(A) for nighttime. 	Applicable - the project will create noise within the project boundary and surroundings. Incremental noise can impact human and terrestrial faunal species. Therefore, it requires complying with these rules.

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
		<ul style="list-style-type: none"> Industrial areas are used for industry or manufacturing. The acceptable sound limit in industrial areas is 75 dB(A) for daytime and 70 dB(A) for nighttime. An area between 500 meters from the last limit of a residential area for construction-related activity, use of brick and stone crusher machine is prohibited, and operation of mixture machine and construction-related machinery and equipment are prohibited from 7 PM to 7 AM. The guidelines say exceeding the maximum noise level in certain areas is a punishable offense. 	
Air pollution (Control) Rules 2022	Ministry of Environment, Forest, and Climate Change	<ul style="list-style-type: none"> Aiming to protect environmental health, the government has published a new rule based on section 20 of The Bangladesh Environment Conservation Act, 1995. The main objectives of this rule are to prevent, control, and reduce air pollution. The government will appoint a director general who will be responsible for managing and maintaining the environmental issue. The Rule specified several types of pollution such as pollution caused by factories, vehicles, construction, garbage, etc. According to the new rule, there will be a committee that will impose damages and punishment for such pollution. As stated by the rule, the government will give rewards to those who will protest against pollution and do not cause any type of pollution. 	Applicable - the project will create air pollution within the project boundary and surroundings. Air pollution can impact human and terrestrial faunal species.
Ecologically Critical Areas (ECAs) Management Rules, 2016	Ministry of Environment, Forest, and Climate Change	<ul style="list-style-type: none"> The ECA Management Rule, 2016 has enabled the government to form a "National Committee" headed by the Secretary of MoEFCC. 	Applicable - the proposed project is located approximately 4 km away from the nearest ECA (Turag River).

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
		<ul style="list-style-type: none"> To implement the decision of the Directorate, the District and Upazila committee may be formed. For the conservation and development of the ecologically critical area, one or more teams may be formed. The team's responsibility would be to implement the decision and planning of the Government to improve the Environment for Ecology. The Rule also prohibited many activities and processes which are detrimental to the natural condition of habitat, tranquility, biodiversity, etc. 	<p>Extraction of surface water and other activities during operation can impact the Karnatali River and Turag River as well. Therefore, this rule must apply to this project. The developer must take necessary action to minimize the impacts on the natural condition of habitat, tranquility, biodiversity, etc.</p>
Biodiversity Act, 2017	Ministry of Environment, Forest, and Climate Change	<ul style="list-style-type: none"> The Act has enabled the government to form a "National Committee on Biodiversity." The functions of the committee are to conserve biodiversity, genetic biodiversity, identification of biodiversity-related important areas, heritage, etc. In consultation with local communities and bodies and in coordination with concerned ministries or departments, the government is empowered to declare any place or area significant for its biological heritage as a "Biodiversity Heritage Site." Prohibiting the taking of activities that may have an adverse effect on endangered animals or organisms, etc. No person shall take any such activity, viz (a) adversely affect, or may affect endangered species; (b) adversely affect or may affect the environmental characteristics of the endangered ecological community; or (c) In accordance with the Ramsar Convention, the wetland may adversely affect or affect the environment and environmental characteristics of the declared area. 	<p>Not Applicable - The project will be established in the Amin Bazar landfill area at Savar. During construction and operation, the project will impact the surrounding environment. However, no gazette endangered species is present in the project influence area. Therefore, this act is not applicable.</p>

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
Forests Act, 1927 and its amendment in 1982, 1989, 2000 and 2018	Ministry of Environment, Forest, and Climate Change	<ul style="list-style-type: none"> • The government can prohibit certain activities in the declared Reserved Forest area, causing any damage by negligence in felling any tree or cutting or dragging any timber, etc. • The act makes various provisions for the conservation of forests. • It defines the procedure to be followed for declaring an area to be a Reserved Forest, a Protected Forest, or a Village Forest. • It defines what a forest offense is, what acts are prohibited inside an RF, and penalties leviable on violation of the provisions of the act. • The act gives the government power to make any relevant rules to protect forests. • Guidelines for social forestry practice; and • Control and collection of timber and other forest products, and duties on those. 	Not Applicable - The proposed power plant is going to be established in Amin Bazar, Dhaka, and no forest (reserve, protected, social, mangrove, etc.) is found within the project site and 10 km radius.
Wildlife (Conservation and Security) Act, 2012	Ministry of Environment, Forest, and Climate Change	<ul style="list-style-type: none"> • Prohibition is related to capturing, killing, shooting, or trapping wildlife. No person shall hunt any wild animal without a license. • Determination of threatened flora and fauna in four (4) schedules. • Prohibitions, entry, and declaration procedure of protected areas (sanctuary, national park, community conservation area, safari park, eco-park, botanical garden, wild animal breeding center, landscape zone or corridor, buffer zone, core zone, special biodiversity conservation area, national heritage, memorial tree, sacred tree, and kunjaban, etc.). • No person, institution, or company shall establish or operate any industrial factory or brick field within 2 (two) kilometers from the boundary of a sanctuary. 	Not Applicable - There are no protected areas within the project site and within a 5 km radius.

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
Protected Area Management Rules, 2017	Ministry of Environment, Forest, and Climate Change	<ul style="list-style-type: none"> • The legal basis for the management and co-management of forest-protected areas. • Structures, functions, and obligations of management of some of the protected areas, excluding safari-park, zoos, botanical gardens, private parks, and wildlife fertility centers from their application. • The Rules have 33 sections and provide for a participatory co-management model consisting of forest-dependent communities, forest departments, civil administration, and civil society organizations. • The rules provide for financial benefits and income incentives to shareholders through participatory social forestry programs to be planted in buffer and landscape areas and eco-tourism. 	Not Applicable - The nearest PA from the Project Site is National Botanical Garden Mirpur. The distance of this PA from the project site is approximately 5.2 km (aerial distance).
Bangladesh Water Act, 2013	Ministry of Water Resources	<ul style="list-style-type: none"> • Any infrastructure or landfilling activities over any natural watercourses, stopping the natural flow or creating obstacles, or diverting or attempting to divert the direction is strictly prohibited. • According to the provision of section 43, all the costs may be incurred for the removal of infrastructure or landfilling materials from the person liable for making infrastructure or carrying on landfilling activities. • Any area or any part of any land connected with water resources can be declared as a Water Stress Area. • Ensuring safe abstraction of water from aquifers & executive authority may subject to the lowest safe yield of surface and groundwater. • Any infrastructure shall not be established in the immediate premises of the flood control embankment and ensure the sustainability and protection of the control structure. 	Applicable – as the project will use both surface and groundwater.

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
		<ul style="list-style-type: none"> No person shall not store, preserve, or divert the water of any water source in any natural or artificial reservoir. 	
Bangladesh Water Rules, 2018	Ministry of Water Resources	<ul style="list-style-type: none"> Provision of No Objection Certificate for the establishment of projects related to flood control and management project; surface water extraction, supply and use related project and part of the project; irrigation project using surface water; construction of hydraulic structures; water conservation project; flood-affected plain land and wetland development project; groundwater for industrial use; riverbank protection and river control; river excavation and dredging project; canal excavation and re-excavation project; fisheries development in surface water project; groundwater extraction, supply, & use related project & part of the project; and others project; According to Clause-16 of the rules, a NOC should be taken from the DG of WARPO, District Committee/DC, Upazila Committee/UNO, and Union Committee/Chairman based on the total investment of the specific project. 	Applicable – as the project will use both surface and groundwater. The project will require NOC from relevant authorities for surface water and groundwater extraction for industrial use.
National River Protection Commission Act, 2013	Ministry of Water Resources	<ul style="list-style-type: none"> An act to establish a Commission for preventing illegal occupation of rivers, pollution of water and environment, pollution of rivers caused by industrial factories, illegal constructions, and various irregularities and ensuring multidimensional use of rivers for socio-economic development including restoration of the normal flow of rivers, proper maintenance thereof and making them navigable. 	Applicable - The proposed project is located near to Karnatali river which may impact the water quality during the construction and operation phase.
Protection and Conservation of Fish Act, 1950, and its amendment in 1982 and Rules, 1985	Ministry of Fisheries and Livestock	<ul style="list-style-type: none"> The act was enacted to provide for the protection and conservation of fish. Under the Act, the Protection and Conservation of Fish Rules were adopted in 1985. No person shall destroy or attempt to destroy any fish with explosives, gun, bow, and arrow in inland or coastal waters. During the Project intervention, it should be noted that if waste 	Not Applicable - the proposed project site is a low land near the Amin Bazar landfill site under Dhaka North City Corporation. There is no

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
		<p>effluent is not treated, then it may cause significant damage to the local fishery and thus violate the provision of the law.</p> <ul style="list-style-type: none"> • No person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents or otherwise in inland waters; and • Protection and conservation of fish in government-owned water bodies. 	<p>designated fishing zone close to the project site and there is no physical intervention in the river by this project.</p>
Electricity Act, 2018	Ministry of Power, Energy, and Mineral Resources	<ul style="list-style-type: none"> • If the land acquisition is required for the establishment of a power generation plant or sub-station, it shall be deemed to have been necessary for the public interest, and the existing laws and regulations on the acquisition of land shall have to be followed. • If any private company holding a license requires any land for constructing any connection line with the power station. Sub-station or grid substation, the licensee may purchase or acquire such land from the concerned landowner in accordance with the existing laws and regulations regarding land acquisition. • No licensee shall harm or obstruct or interfere with railways, highways, airports, waterways, canals, docks, piers and jetties, and pipes during power generation, transmission, supply, or distribution. • The licensee shall take all logical precautions during the construction of power supply lines and doing civil works so as not to harm the communication system of the telegraph, telephone, or electromagnetic signal-emitting lines by induction or any other means. 	<p>Applicable - as the project will be subject to the act of generating electricity and supply through a transmission line.</p>
Bangladesh Energy Regulatory Commission Act, 2003	Ministry of Power, Energy, and Mineral Resources	<ul style="list-style-type: none"> • To determine the efficiency and standard of the machinery and appliances of the institutions using energy. 	<p>Applicable - as the subject project is related to primary energy.</p>

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
		<ul style="list-style-type: none"> To ensure efficient use, and quality services, determine tariff and safety enhancement of electricity generation. Suppose anybody obstructs any license or authorized representative in the installation or repair of an electricity line or gas pipeline or the construction or repair of associated equipment or installations. In that case, he shall be liable to be sentenced to imprisonment. 	
Imports and Exports (Control) Act, 1950	Ministry of Finance	<ul style="list-style-type: none"> No goods of the specified description shall be imported or exported except following the conditions of a license to be issued by the Chief Controller or any other officer authorized on this behalf by the Government. 	Applicable - as the machinery, equipment, and other stuff for the proposed project will be imported.
Acquisition and Requisition of Immovable Property Act (ARIPA), 2017	Ministry of Land	<ul style="list-style-type: none"> Current GoB Act, relating to acquisition and requisition of land. According to the law, the affected person will get an additional 200% of the assessed value for land and an additional 100% for structures, trees, crops, and other assets. This law deals with the social and economic impacts of land acquisition. 	Applicable -Upon request of the proponent, DNCC will procure the required land through the Deputy Commissioner (DC). DNCC is the requiring body, and the DC is the acquiring body in the acquisition procedure. WTE Power Plant North Dhaka Private Limited will lease the land from DNCC.
Boiler Act, 1923	Ministry of Industries	<ul style="list-style-type: none"> Prohibition of use of the unregistered or uncertificated boiler. Renewal of boiler certificate upon expiry, accidents, moving, structural alteration, or any dangerous condition. Regulating the inspection & examination of boilers and steam pipes. Prescribing the duties of the owner at an examination and production and transfer of certificates. 	Applicable - as the proposed project will use “waste firing in boilers”.

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
		<ul style="list-style-type: none"> • Exclusion of any specified area from the boiler operation. • Impose local limits and the power of an authorized person to oversee the limit. • Prescribing the maximum pressure at which a boiler may be used and describing the method of determining the maximum pressure. • Revocation of certificate or provisional order if the certificate is fraudulently obtained or the boiler is not in good condition. • Restriction on alterations and renewals of any registered boilers without written sanction of such alteration, addition, or renewal. • Reporting of accidents to boilers or steampipe must be made by the owner within twenty-four hours of the accident in written form. • The registration number allotted to the boiler must be marked on the boiler; otherwise, penalties apply. Any kind of invisibility of register number by removal, alter, or deface is also punishable; and • Prescribed penalties for illegal boiler use or using the boiler at a higher speed than the allowed limit. 	
Fatal Accidents Act, 1855	Ministry of Law, Justice, and Parliamentary Affairs	<ul style="list-style-type: none"> • Provide compensation to families for loss occasioned by the death of a person caused by actionable wrong. It is mentioned in s.1 that whenever a wrongful act shall cause the death of a person, neglect or default, and the act, neglect or default is such as would (if death had not ensued) have entitled the party injured to maintain an action and recover damages in respect thereof, the party who would have been liable if death had not ensued shall be liable to an action or suit for damages, notwithstanding the death of the person injured, and although 	Applicable - as the proposed project has a provision for unlikely and accidental events that may cause fatal accidents.

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
		<p>the death shall have been caused under such circumstances as an amount in law to a felony or other crime.</p>	
The Penal Code, 1860	Ministry of Law, Justice, and Parliamentary Affairs	<ul style="list-style-type: none"> • Valid provisions related to pollution management, environment protection, and health and safety protection. Chapter XIV of the Penal Code provides offenses effective public health, safety, convenience, decency, and morals: • Section 277: Falling Water or Public Spring or Reservoir. • Section 278: Making Atmosphere Noxious to Health. • Section 284: Negligent Conduct concerning Poisonous Substance. • Section 285: Negligent Conduct concerning Fire or Combustible Matter; and • Section 286: Negligent Conduct concerning Explosive Substance. 	Applicable - The proposed project has a provision for pollution impact on the surrounding environment.
Fire Prevention & Extinguish Act, 2003 and Rules, 2014	Ministry of Home Affairs	<ul style="list-style-type: none"> • Regulatory enactments regarding the prevention, the successful extinguishing of fire, and reduction of damages and consequences of fire. • States to obtain a license from the Director-General of Fire Service and Civil Defense in case of any warehouse. 	Applicable - proposed projects will store fuels during the construction and operation phases. During the operation phase, about 40 tons of Diesel will be used at each start and shutdown of the incinerator. During the construction and operation phase, there could be a fire incident if proper measures are not taken. WTE Power Plant North Dhaka Private Limited would comply with relevant provisions under this ACT.

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
<p>The Factories Act, 1965, and the Factories Rules, 1979</p> <p>Bangladesh Labor Act, 2006 and amendments 2009, 2010, 2013 and 2018</p> <p>Bangladesh Labor Rules, 2015</p>	<p>Department of Labor/Department for Inspection of Factories and Establishment/ Ministry of Labor and Employment</p>	<ul style="list-style-type: none"> • Pertains to the occupational rights and safety of factory workers and the provision of a comfortable work environment and reasonable working conditions. • Provides health, safety, and well-being to the workforce during the project life cycle. • Children under 18 years are not allowed to be employed during the project life cycle. • Safety precautions regarding explosive or inflammable dust/gas, protection of eyes, protection against fire, work with cranes and other lifting machinery, and lifting of excessive weight. • Safety measures like appliances of first aid, maintenance of safety record books, rooms for children, housing facilities, medical care, group insurance, etc. • No building, wall, chimney, bridge, tunnel, road, gallery, stairway, ramp, floor, platform, staging, or other structure, whether a permanent or temporary character, shall be constructed, situated, or maintained in any factory in such a manner as to cause risk of bodily injury (Rule 38) of factory rules 1979, etc. 	<p>Applicable - as it provides the workforce's health, safety, and well-being during the project life cycle. Besides, it also stipulated that children under 18 years are not allowed to be employed during the project life cycle; therefore, this law must be complied with.</p>
<p>EIA Guideline for the Industry 2021</p>	<p>Department of Environment</p>	<ul style="list-style-type: none"> • The EIA Guidelines for Industry, 2021, introduced by the Department of Environment, Bangladesh, is the only guideline for conducting an Environmental Impact Assessment in Bangladesh. It is not only for industries but also for all types of development works. It includes EIA procedures, methodology, guidelines for impact identification, forecasting, and evaluation, plans for mitigation measures, and monitoring programs. 	<p>Applicable -The project activities can create environmental, social, and ecological impacts during the construction and operation phases. EIA Guideline for Industries 2021 is the only guideline for conducting an Environmental Impact</p>

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
			Assessment in Bangladesh that includes guidelines for impact identification, prediction, and evaluation, plans for mitigation measures, and monitoring programs.
National 3R Strategy for Waste Management, 2010	Department of Environment	<ul style="list-style-type: none"> • The concept of this strategy is minimizing waste impacts in terms of quantity or ill effects by reducing the number of waste products with simple treatments and recycling the waste by using them as resources to produce the same or modified products. The principle of “3R” is stated as reducing waste, reusing, and recycling resources and products. • Reducing means choosing to use items with care to reduce the amount of waste generated. • Reusing involves the repeated use of items or parts of items that still have usable aspects. • Recycling means the use of waste itself as a resource. • It suggests ISO 14001 or any other EMS structure which is significant for developing strategies relevant to the industry and its social and environmental setting. ISO 14001 is increasingly important in international trade. 	Applicable - This strategy is applicable for the project for the management of waste (i.e., solid waste) to minimize/reduce environmental, social, and economic problems.
Solid Waste Management Rules 2021	Department of Environment	<ul style="list-style-type: none"> • When recovering resources from waste, the principles of management that consider the waste hierarchy, such as the 3Rs, segregation, and reduction, must be followed at all stages from waste generation to the final disposal. • Responsibilities of waste generators, consumers, and users: Dispose of waste in accordance with the regulations of authorities including local government; Dispose of waste separately; Do not dump, store, or burn waste outdoors. 	Applicable - This rule is applicable for the project for the management of waste (i.e., solid wastes) to minimize/reduce environmental, social, and economic problems.

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
		<ul style="list-style-type: none"> Responsibilities of manufacturers (*not defined) and importers of products: Collect non-biodegradable products such as glass, plastic, polyethylene, multi-layered packaging, bottles, and cans from consumers and recycle or dispose of them if appropriate; Determine work plans and implementation procedures for recycling and disposal; Ensure that Extended Producer Responsibility (EPR) is properly implemented; Submit an annual report to the Department of Environment (DoE) on the amount of plastic recycled; Raise public awareness of proper waste management. Any violation of the above provisions shall be subject to imprisonment for not more than two years or a fine not exceeding 200,000 Taka (BDT), or both. The Regulations also include provisions for the treatment of solid waste such as composting and energy recovery. 	
Antiquities Act, 1968 and Antiquities Preservation Rules, 1986	Department of Archaeology, Ministry of Cultural Affairs	<ul style="list-style-type: none"> No person shall deal in antiquities except under and in accordance with a license granted by the Director. No person shall remove any object of the immovable protected antiquity. No person shall damage, alter, deface, or imperil immovable protected antiquity. Any person preserving or storing any kind of movable antiquity without a license shall produce it to the Director on demand for verification of the source of its possession. 	Not Applicable - No archaeological and cultural sites are on the project site.

Source: Different Laws and Regulations of GoB

2.2.2 Relevant Policies

Other relevant policies in Bangladesh and their key features and applicability to the subject project are detailed in Table 2-2.

Table 2-2: Policies and Plans Relevant to the Project

Policy/Plans	Responsible Agency-Ministry/Authority	Key Features	Applicability
National Environment Policy, 2018	Ministry of Environment, Forest, and Climate Change	<ul style="list-style-type: none"> • Encourage collection and promotion of low carbon emission technology in the country. • Identifying and controlling all types of environmental pollution and degradation activities. • Ensure sustainable, long-term, and environmentally friendly use of all-natural resources. • To take PPP for the development of the environment. • Maintain and streamline environmental policies and strategies, among other policy strategies, in the interest of sustainable development. • Ensure the EIA and SEA are in all necessary sectors. • Act to reduce poverty through environmental protection. • Strengthen observations on proper compliance with environmental laws and regulations. 	Applicable - as the proposed project has the likeliness of having an impact on the surrounding environment
Bangladesh Climate Change Strategy and Action Plan, 2009	Ministry of Environment, Forest, and Climate Change	<ul style="list-style-type: none"> • Food security, social protection, and health. • Comprehensive disaster management. • Infrastructure. • Research and Knowledge management. • Mitigation and low carbon development. • Capacity building and institutional strengthening. 	Applicable - As the project has the potential to generate pollutants in the air and GHG emissions.
National Forest Policy, 2016	Bangladesh Forest Department/ Ministry of Environment, Forest, and Climate Change	<ul style="list-style-type: none"> • Manage all existing forests, wildlife, and other forestry resources, adhering to the principles of sustainable management and climate resilience. • Enrich degraded forest areas and enhance land areas under forest/ tree cover. • Produce various goods and ecosystem services to benefit Bangladesh's present and future generations. 	Not Applicable - The proposed project site is a designated landfill site and will be developed as a waste-to-energy project. However, there is no designated forest in the 5

Policy/Plans	Responsible Agency- Ministry/Authority	Key Features	Applicability
			KM buffer of the project boundary.
National Water Policy, 1999	Ministry of Water Resources	<ul style="list-style-type: none"> • Protection and prevention of the natural environment for ensuring sustainable development. • Minimize disruption to the natural aquatic environment in streams and water channels. • Water development plans will not interrupt fish movement and will make adequate provisions in control structures for allowing fish migration and breeding. • Water development projects should cause minimal disruption to navigation and, where necessary, adequate mitigation measures should be taken. • Full consideration of environmental protection, restoration, and enhancement measures consistent with NEMAP and the NWMP. • Ensure adequate upland flow in water channels to preserve the coastal estuary ecosystem threatened by the intrusion of salinity from the sea. 	Applicable – The project proponent should minimize water pollution and minimize disruption of the aquatic environment and navigation system in the adjacent water body.
National Fisheries Policy, 1999	Ministry of Fisheries and Livestock	<ul style="list-style-type: none"> • Provide provisions for the protection and conservation of fish in freshwater and brackish water bodies. • Preservation, management, and exploitation of fisheries resources in inland open water. • Fish cultivation and management in inland closed water. • Prawn and fish cultivation in coastal areas. • Preservation, management, and exploitation of sea fishery resources. • Conserve fish breeding grounds and habitats, and • promote fisheries development and conservation in all water bodies. 	Not Applicable - the proposed project site is not a designated fishing zone. Fish capture and culture are absent from the project site.

Policy/Plans	Responsible Agency- Ministry/Authority	Key Features	Applicability
National Agriculture Policy, 2018	Ministry of Agriculture	<ul style="list-style-type: none"> • Ensure food security and socio-economic development through the productivity of crops, boosting production and raising farmers' income, diversifying crops, producing safe foods, and developing a marketing system, profitable agriculture & use of natural resources. • Increasing food availability, rights, and purchasing power by increasing crop productiveness and production. • Discourage the use of agricultural land for non-agricultural work to ensure sustainable food security. • Soil, water, flora, fauna, and overall environmental conservation and effective use initiative adoption; 	Not Applicable - the project will be established in the designated landfill area and land from DNCC. There is no impact on agricultural land and productivity due to the implementation of the proposed project.
National Land Use Policy, 2001	Ministry of Land	<ul style="list-style-type: none"> • Resisting the current trend of alarmingly declining, the total amount of agricultural land used to produce adequate food for a growing population for a variety of reasons. • To prevent arbitrary use of land. • To formulate guidelines for the maximum use of land according to the natural differences in different parts of the country. • In the case of land acquisition for urbanization and development projects or any other purpose, to ensure its best use by acquiring the least amount of land and to avoid the acquisition of excess land as required. • Arranging for the preservation of such lands, especially government Khas lands, which may be required in the future for various development activities. • To ensure that the use of land is compatible with the natural environment. • Making the best use of land to alleviate poverty and increase employment; and 	Applicable - As the proposed project is going to be established in the leased land from the government authority Following the National Land Use Policy 2001, the required land will be used for development purposes and will be established in less productive land. In that case, the project's contribution to the national economy will be higher than the current productivity of that land.

Policy/Plans	Responsible Agency- Ministry/Authority	Key Features	Applicability
		<ul style="list-style-type: none"> To play a helpful role in preventing the increase in the number of landless. 	
National Energy Policy, 1995	Ministry of Power, Energy, and Mineral Resources	<ul style="list-style-type: none"> Utilization of energy for sustainable economic growth, supply to different zones of the country, development of indigenous energy sources & environmentally sound sustainable energy development programs. It highlights the importance of protecting the environment. EIA should be made mandatory and should constitute an integral part of any new energy development project. Use of economically viable environment-friendly technology. Public awareness regarding environmental conservation; and Ensure environmentally sound sustainable energy development programs cause minimum damage to the environment. 	Applicable - As the proposed project is a waste-to-energy project.
Power Policy, 1995	Ministry of Power, Energy, and Mineral Resources	<ul style="list-style-type: none"> Policy statement on demand forecast, long-term planning and project implementation, investment terms, fuels and technologies, load management, institutional issues, private sector participation, technology transfer and research program, environmental policy, and legal issues. 	Applicable - As the proposed project is a waste of energy project.
Power System Master Plan, 2016	Ministry of Power, Energy, and Mineral Resources	<ul style="list-style-type: none"> The power sector was heavily dependent on gas. Even two/three years back, almost 90% of the electricity used was generated from the natural gas of the country and the rest by hydroelectricity and coal. Stressed on diversification of the fuel such as natural gas, coal, furnace oil, diesel, etc., as well as renewable energy sources. The target composition of power supply as of 2030 is set at 50% for domestic and imported coal, 25% for domestic and imported (in the form of LNG) natural gas, and 25% for other sources such as oil, nuclear power, and renewable energy. 	Applicable - the proposed project will use waste for electricity generation.

Policy/Plans	Responsible Agency- Ministry/Authority	Key Features	Applicability
National Industry Policy, 2016	Ministry of Industries	<ul style="list-style-type: none"> • The policy emphasized green productivity and the use of green technology, thereby protecting the environment; setting up of ETPs, and CETPs would be encouraged by the government. • Advocates for setting up the Clean Development Mechanism or CDM in the industries. • Adoption of the 3R principle (Reduce, Reuse, Recycle) strategy would be encouraged for all industries; and • Discourages activities that use agricultural land for industrial purposes. 	Applicable - the project will use municipal waste for electricity production and maintain a good environment.
National Occupational Health and Safety Policy, 2013	Department for Inspection of Factories and Establishment/ Ministry of Labor and Employment	<ul style="list-style-type: none"> • Necessary measures to ensure workplace safety and health protection considering international Conventions/Declarations/ Recommendations/ Instruments. • Review and updating of all laws relating to Occupational Health and Safety (OHS). • Inclusion of OHS issues in the policies and programs of all related Ministries and agencies. • Establish labor courts in the industrial zone so the workers and trade unions can have easy access to the courts for implementing the mandatory provisions of OHS. • Impose mandatory terms and conditions upon construction agencies to follow the OHS policies during govt. Run construction works; and • To ensure maximum safety standards during construction and implement all standards and regulations in an internal safety environment. 	Applicable - as the policy pertains to the occupational rights and safety of workers and has the provision of a comfortable work environment and reasonable working conditions for all employees.

2.3 Environmental Standards

The appropriate national environmental standards are applied under the ECR-2023. The standards, commonly known as Environmental Quality Standards (EQS), are legally binding. There is a separate schedule for industry-specific standards other than the general industrial emission and effluent standards. The Bangladesh standards for ambient air, water, noise, odor, sewage, and industrial effluent are given in Appendix F.

2.4 Administrative Setup related to Environment in Bangladesh

The Ministry of Environment, Forest, and Climate Change is the nodal agency in the administrative structure of the GoB for overseeing all environmental matters relating to national environmental policy and regulatory issues in the country. The Ministry of Environment, Forest, and Climate Change supervises the activities of the following technical/implementing agencies:

- Department of Environment (DoE).
- Forest Department (FD).
- Bangladesh Forest Industries Development Corporation (BFIDC).
- Bangladesh Forest Research Institute (BFRI); and
- Bangladesh National Herbarium (BNH).

2.4.1 Department of Environment (DoE)

The DoE has been placed under the Ministry of Environment, Forest, and Climate Change as its technical wing and is statutorily responsible for implementing the ECA-1995. The department was created in 1989 to ensure sustainable development and conserve and manage Bangladesh's environment. The principal activities of the DoE are:

- Defining EIA procedures and issuing environmental clearance permits, the latter being the legal requirement before the proposed Project can be implemented.
- Providing advice or taking direct action to prevent degradation of the environment.
- Pollution control, including the monitoring of effluent sources and ensuring mitigation of environmental pollution.
- Setting Quality Standards for environmental parameters.
- Declaring ECAs, where the ecosystem has been degraded to a critical state; and
- Review and evaluation of IEEs and EIAs prepared for projects in Bangladesh.

2.4.2 Procedure for obtaining ECC from DoE, Bangladesh

The EIA process consists of three stages, screening, IEE, and detailed EIA:

- Projects categorized as Green and Yellow require IEE for environmental clearance; however, the proponent must apply in a prescribed format along with specified documents.
- Projects categorized as Orange require an IEE to be submitted to the DoE along with an application in a prescribed format and other specified documents; and
- Red category projects require both IEE and EIA. An IEE is required for the location clearance, and an EIA is required for the environmental clearance.

As per the ECR 2023, the proposed project falls under the "RED" category project. So, IEE was exempted, and a TOR for the EIA was approved by the Department of Environment (DoE).

2.5 Relevant International Treaties and Conventions

Bangladesh is a party to a number (of 30¹³ international environmental conventions, treaties, and agreements. The international treaties and conventions relevant to the Project and their status are detailed in Table 2-3.

Table 2-3: Project Relevant International Treaties and Conventions

Environment-related international conventions and Treaties	Status	Applicability
International Plant Protection Convention (Rome, 1951.)	01.09.78 (ratified)	Not Applicable
International Convention for the Prevention of Pollution of the Sea by Oil (London, 1954 (as amended on 11 April 1962 and 21 October 1969.)	28.12.81 (entry into force)	Not Applicable
Plant Protection Agreement for the Southeast Asia and Pacific Region (as amended) (Rome, 1956.)	04.12.74 (accessed) (entry into force)	Not Applicable
International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (Brussels, 1969.)	04.02.82 (entry into force)	Not Applicable
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, 1971) ("Ramsar Convention").	20.04.92 (ratified)	Not applicable as no Ramsar site in Project AOI
Convention Concerning the Protection of the World Cultural and Natural Heritage (Paris, 1972.)	03.08.83 (accepted) 03.11.83 (ratified)	Not applicable as no such site in Project AOI
Convention on International Trade in Endangered Species of Wild Fauna and flora (Washington, 1973.) ("CITES convention")	18.02.82 (ratified)	Applicable
United Nations Convention on the Law of the Sea (Montego Bay, 1982.)	10.12.82 (ratified)	Not Applicable

¹³ Department of Environment, Bangladesh

Environment-related international conventions and Treaties	Status	Applicability
Vienna Convention for the Protection of the Ozone Layer (Vienna, 1985.)	(accessed) (Entry into force)	Applicable
Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal 1987.)	02.08.90 31.10.90 (accessed) (entry into force)	Applicable
London Amendment to the Montreal Protocol on substances that Deplete the Ozone Layer (London, 1990)	(accessed) (Entry into force)	Applicable
Copenhagen Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, Copenhagen, 1992	27.11.2000 (accepted) 26.2.2001 (entry into force)	Applicable
Montreal Amendment of the Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1997	27.7.2001 (Accepted) 26.10.2001 (Entry into force)	Applicable
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel, 1989.)	01.04.93 (accessed)	Applicable
International Convention on Oil Pollution Preparedness, Response, and Cooperation (London, 1990.)	30.01.90 (signed) In the process of ratification	Not Applicable
United Nations Framework Convention on Climate Change, (New York, 1992.)	09.06.92 (signed) 15.04.94 (ratified)	Applicable
Convention on Biological Diversity, (Rio De Janeiro, 1992.)	05.06.92 (signed) 03.05.94 (ratified)	Applicable
International Convention to Combat Desertification, (Paris 1994.)	14.10.94 signed) 26.01.1996 (ratification) 26.12.1996 (entry into force)	Not Applicable
Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, (Geneva, 1976.)	03.10.79 (accessed) (entry into force)	Not Applicable

Environment-related international conventions and Treaties	Status	Applicability
Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982 (New York, 1994.)	28.07.96 (signed)	Not Applicable
Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and their Destruction (Paris, 1993.)	14.01.93 (signed)	Not Applicable
Convention on Persistent Organic Pollutants, Stockholm	23.5.2001 (signed) 12.03.2007 (ratified)	Not Applicable
Kyoto protocol to the United Nations Framework Convention on Climate Change	21.8.2001 (accessed)	Applicable

Chapter 3

Project Description

3 PROJECT DESCRIPTION

3.1 Location of the project site

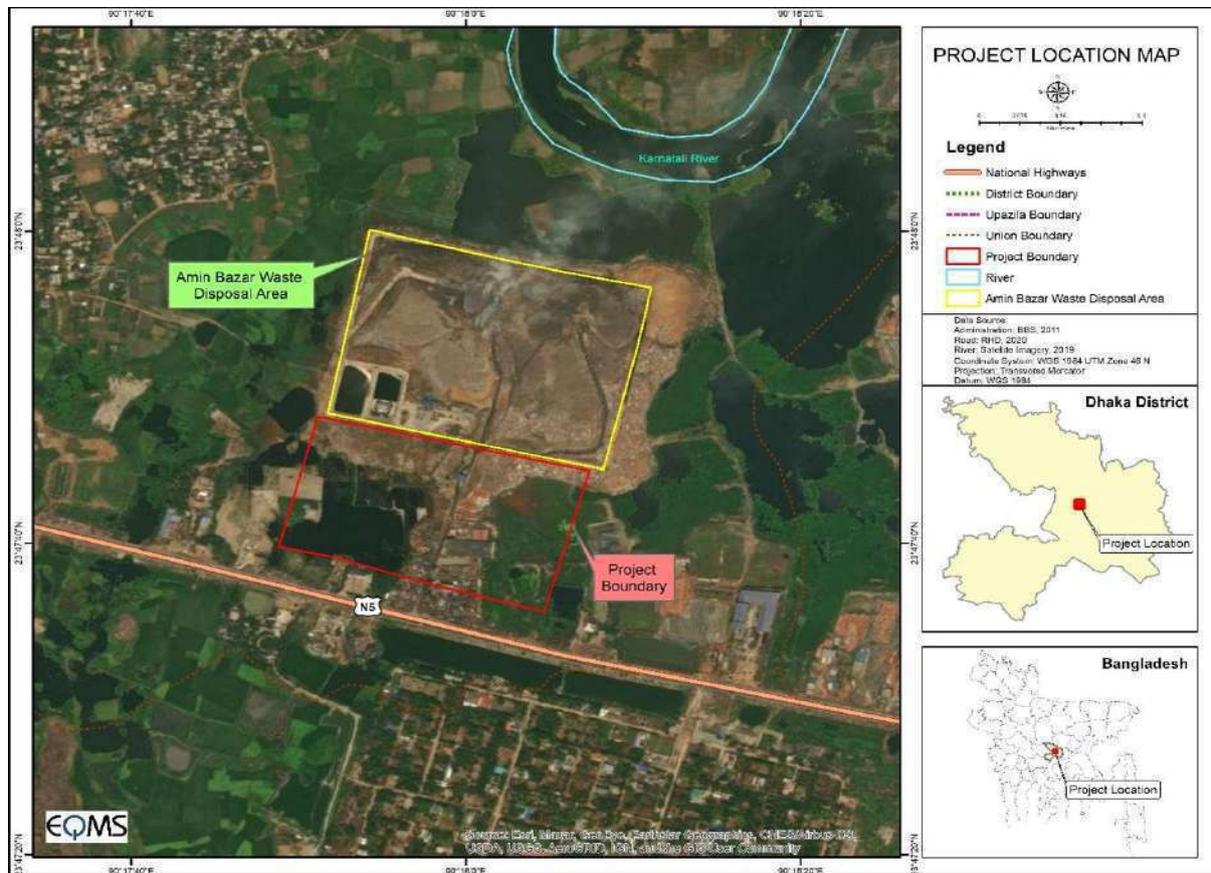
The proposed Power Plant project is located at Banagram union under Savar Upazila of Dhaka district. The required land for the proposed power plant project is 31.182 acres (126,187.41 m²) which is approximately 17 km northwest direction from the Center of Dhaka town. The site is accessible via Dhaka-Aricha Highway Road. Geographical coordinates of the proposed waste to the energy project site are presented in Table 3-1.

Table 3-1: Geographic coordinates of the proposed project

Points	Direction/Corner	Latitude	Longitude
1	South-West	23°47'39.80"N	90°17'48.86"E
2	South-East	23°47'35.62"N	90°18'4.64"E
3	North-East	23°47'44.63"N	90°18'7.37"E
4	North-West	23°47'48.10"N	90°17'51.16"E

The land used for the proposed power plant is null land (নাল জমি) and low land. The project area has no permanent water body and a hill. This project will fill no pond/canal/other water bodies, and no hill needs to be cut for this project. The proposed project site is located adjacent to the Amin Bazar landfill site and Karnatali River on the North, Agricultural land on the east side, and Dhaka-Aricha Highway Road on the South. Following Figure 3-1 shows the project location.

Figure 3-1: Location Map of Proposed Power Plant Project at Savar



Source: EQMS,2022

3.2 Justification for Selecting the Site

Due to land scarcity in the country, seeking an alternative site for establishing the power plant area is quite difficult. Also, land acquisition is a lengthy and complex procedure under Bangladesh's existing Land Acquisition Law (LA Ordinance 1982). Not only that, but the conceptual project development over alternative sites are quite difficult because the waste transfer process might create social conflicts and risks for the project. The substation is also close to the selected site, so it will be convenient to supply electricity to the substation. Also, the selected power plant site is adjacent to the Amin Bazar Landfill area, so there will be easy access to the raw materials without creating any nuisance to the local environment. The waste generated in the DNCC jurisdiction is dumped in the existing Amin Bazar landfill. The landfill is currently being kept operational through vertical expansion as the inner part of the landfill is full. The landfill cannot be kept operational after 2022. As a result, there will be complex problems in the management of a huge amount of waste in Dhaka North City Corporation. Moreover, the proposed location is close to Dhaka North City Corporation (DNCC) periphery and adjacent to the Dhaka-Aricha highway, so transporting raw materials from the other waste disposal point will be easier. The proposed site has already been acquired by DNCC through Deputy Commissioner (DC). According to field visits and consultation with local people, no agricultural activities were found in the proposed project area in recent years. So, Considering the factors above, the proposed power plant site is more suitable than the other sites in Dhaka.

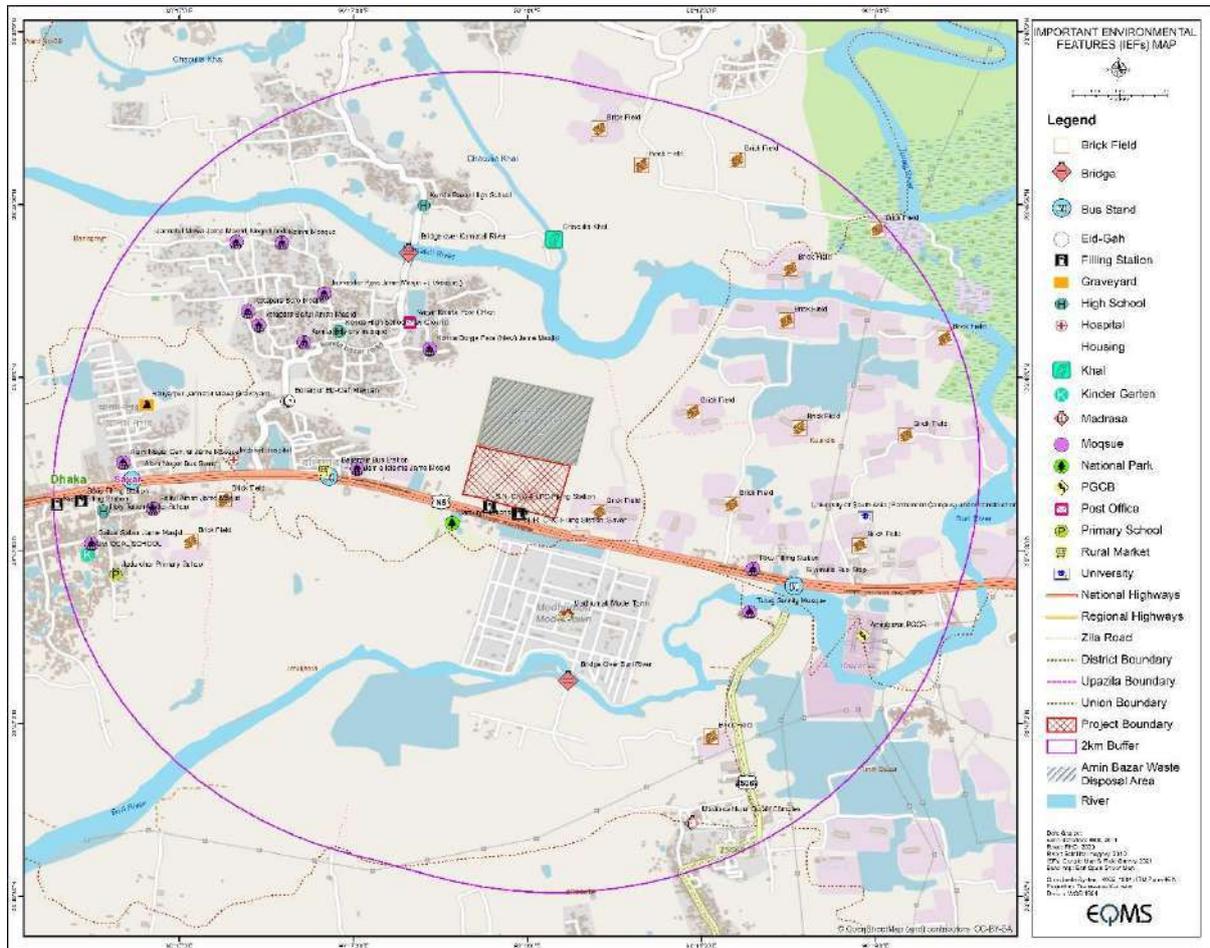
To avoid or minimize the impacts resulting from the project's activities, the project authority (WTE Power Plant North Dhaka Private Limited) is expected to adopt the appropriate technological design, improvements or adjustments, and policy, including good site operational practices and applicable EMP, etc. The overall strategy shall follow the following sequence:

- Impact avoidance or minimization.
- Adequate Compensation where impacts are unavoidable.
- Enhancement Measures-Employment benefits enhancement measures proposed by the consultants.

3.3 Key Features of the Site and Surroundings

This site is primarily null land (নাল জমি) and low land. Some scattered commercial structures such as brickfields, CNG filling stations, and LPG filling stations are situated about 100 m away from the proposed project site. Within the 5 km radius around the project area, Bongaon Union is on the North side. On the Southern side, there is Bhakurta Union. On the East and West portions of the project site, there is Amin Bazar and Hemayetpur Bazar area, respectively. Key features around the project site are presented in Figure 3-2. Photographs taken from the project site are shown in Figure 3-3.

Figure 3-2: Key features around the proposed project site



Source: EQMS, 2022

Figure 3-3: Pictures of Key features around the proposed project site



Proposed Project Site



Existing Access Road to the project site



N.R. CNG Filling Station (approximately 400m southern directions from the Project Site)



Karnatali River (approximately 450m away from the Project Site)



Vegetable Cropping on the North side of the Landfill area (approximately 460m away from the Site)



Beraid Government Primary School (approximately 1.2km North-West direction from the Project Site)



Konda Bazar (approximately 1.3 km North-West direction from the Project Site)



Konda High School (approximately 1.1 km North-West direction from the Project Site)



Nandonic Housing Society (approximately 1.17km Southern direction from the Project Site)



Brick Field near the Proposed Project Site (approximately 750m North-East directions from the Project Site)



Agriculture activities on the West side (Adjacent to the project site)



Konda Bazar (approximately 1.3 km North-West direction from the Project Site)



Settlement at the Around 540m North-west sides of the project site



A bridge on the West side (around 900m away) of the project site



92 No Baliarpur Government Primary School (West side approximately 880m) to the project site



Baliarpur community clinic (approximately 950m North-West directions from the Project Site)



Temple at Nagar Konda (approximately 1.1km North-West direction from the Project Site)



Konda-Beraid Road (approximately 1.4km North-West direction from the Project Site)

3.4 Cadastral Map Showing Land Plots

The proposed project site is located at Baliarpur Mouza, JL no-185 (BS), Savar Upazila under Dhaka District. The total leased land amount is 30 acres. Land plots of the proposed project site are given in Table 3-2 and Figure 3-4.

Table 3-2: Land Plots of Proposed Project Site

SL	BRS Plot No	Land Amount
1.	3012, 3013, 3014, 3015, 3016, 3017, 3018, 3019, 3020, 3021, 3022, 3023, 3024, 3025, 3026, 3027, 3028, 3029, 3030, 3031, 3032, 3033, 3320, 3321, 3322, 3323, 3324, 3325, 3326, 3327, 3328, 3329, 3330, 3331, 3332, 3333, 3335, 3336, 3337, 3338, 3339, 3340, 3341, 3342, 3343, 3344, 3345, 3346, 3347, 3319/3349, 3319/3350, 5303, 5304, 5305, 5311, 5312, 5313, 5314, 5315, 5316, 5321, 5322, 5323, 5324	30 acres

Source: Dhaka North City Corporation (DNCC)

3.5 Access Road

The Dhaka-Aricha Highway (N5) passes beside the project site. Fuel and equipment can be transported by road using the highway. The government has taken the initiative to upgrade nearly 20 kilometers (Gabtoli to Nabinagar) of the Dhaka-Aricha highway from four-lane to 10-lane. Gabtoli bridge is a highly busy bridge. It is not in good condition. So, Government has planned to renovate it. The bridge will be upgraded from four-lane to eight-lane, and Salehpur bridge-2 will be 4-lane, located in the Amin Bazar area.¹⁴

The south side of the proposed plant site is Dhaka-Aricha Highway (N5), which can be used as the main road for waste transportation. A new connecting road is planned to relate to the N5 highway, which is used as the entry road of the project. The logistic road for waste transportation is located by the east border of the red line with a total length of around 360m, and the passenger channel is about 70m for staff entry.

3.6 Land Requirement

According to the requirement of production process and function, the project is divided into four functional areas: the main building area, auxiliary area, water treatment area, and ash & slag comprehensive treatment area. The total site area within the red line is 31.182 acres (126,187.41 m²) where 50.81% is used for building occupation, 23.58% is a green area, and 14.66% will be used for road utilization construction where DNCC will procure the required land through the Deputy Commissioner (DC), Dhaka District. DNCC is the requiring body, and the DC is the acquiring body in the acquisition procedure. WTE Power Plant North Dhaka Private Limited will lease the land from DNCC.

This area is composed of an emergency fly ash landfill and a slag comprehensive utilization workshop. The proposed plant layout is shown in Table 3-3.

Table 3-3: List of Major Functional Area Cover

No	Name	Quantity	Unit
1	Land Area within the Red Line	126,187.41	m ²
2	Total Area Covered	64,114.58	m ²
	Building Coefficient	50.81	%
3	Total Floorage	55,171.28	m ²
	Total Calculated Plot Ratio Area	86,152.66	m ²
	Plot ratio	0.68	—
4	Green area	29,753.90	m ²
	Greening rate	23.58	%
5	Road and Site Paving Area	18,500.00	m ²
6	Road utilization factor	14.66	%
7	Gate	2	Set

Source: Feasibility Study Report

¹⁴ <https://www.thedailystar.net/bangladesh/news/dhaka-aricha-highway-be-upgraded-10-lane-quader-2042025>

3.7 Details on the Requirement of Raw Materials

The energy and raw materials required for this project include solid waste, auxiliary fuel, water, electricity, slaked lime, activated carbon, chelating agent, urea, sand, etc.

3.7.1 Solid waste

Solid waste is an available resource needed for this project's reductive and harmless treatment as fuel for the incinerator. As per the agreement with DNCC, the solid waste will be supplied by DNCC. The solid waste requirement of this project will be 3,000 t/d, which can completely meet the processing requirements. Notwithstanding the above, the Company may, at its own discretion, seek and obtain additional waste supply from other sources in case of insufficient waste supply by DNCC.

3.7.2 Auxiliary fuel

Diesel is mainly used for incinerator startup and shutdown. Each incinerator shall be maintenance maintained once every six months, 2 times a year. About 40t diesel fuel will be consumed for each start and shutdown. Diesel fuel consumption by ignition throughout the year = $40 \times 2 \times 4 = 320$ t. There is an underground oil depot in the plant, and the fuel will be transported to the plant by the fuel supply company by fuel tankers. The diesel oil storage tank diagram is given in the **Appendix G**:

3.7.3 Water source

In the dry season, the demand for groundwater intake has been estimated (tentatively) at about 364.7m³/hr. In the wet season, water will be uptake from both surface and groundwater sources. The total amount of water will be needed to uptake from both surface and groundwater will be 338.2 m³/hr (8,116.80 tons/day) plus 1% of redundancy considering the leakage of the whole pipeline system, with the total demand up to 341.6 m³/h (8,198.4 tons/day) and the total domestic water scale is 44 m³/d. Most of the amount of water will be taken from surface water sources like a nearby river named "Karnatali River" located north of the project boundary. The project will be installing three deep tube wells for the abstraction of groundwater from the site. The project authority must get permission from the relevant authority for ground and surface water intake. **Appendix B-2**:

3.7.4 Others

The slaked lime, activated carbon, sand, urea, and chelating agent for production are supplied externally and transported to the plant by automobiles.

3.8 Resource and Utility Demand

3.8.1 Road

The roads in the factory area are arranged in circular form to meet the requirements of production, transportation, and fire control. The road pavement width is mainly 7.0 meters, and the road bending radius in the main factory area is 12.0 meters. The minimum bending radius of roads dedicated to waste transportation was 18.0 meters.

3.8.2 Electricity Requirement

According to the processing load of the whole plant, the operation condition of the incineration line, and the power supply range of the plant transformer, the statistical calculation of the plant load per hour is carried out, and the house-service consumption rate is about 15.3%. Electricity consumption for this project will be 0.73×10^8 kWh/a.

3.8.3 Telecommunication System

In this project, due to the small unit capacity, the production management communication is combined with the production dispatching communication, and a set of dispatching program-controlled switches with a capacity of 160 lines is configured in the plant, which is also used as an administrative switch.

To meet the needs of mobile communication for production and maintenance personnel, an application for 10 pairs of wireless walkie-talkies shall be submitted to the local radio committee.

3.8.4 Manpower Requirement

The waste incineration power plant, the slag's comprehensive utilization, treatment facilities, and the fly ash landfill all need certain personnel to operate and maintain.

The manpower during the peak time of the construction period will be about 2,093 people. Personnel in the operational stage will be about 220 people.

3.9 Nature and Size of the Project

The WTE Power Plant North Dhaka Private Limited proposes to set up a waste-to-energy power project of 42.5 MWh (NET) capacity near the Savar Upazila in Dhaka District. The details of the proposed power plant are presented in Table 3-4.

Table 3-4: Brief Information of WTE Power Plant Project

Particulars		Basic Project Data
Net Plant Capacity	:	42.5 MWh (NET)
Planned land	:	31.182 acres (126187.41 m ²) (Including incineration plant land and new access roads)
Treatment capacity	:	3000~3600 ton/day (entry capacity) with an annual waste disposal capacity of 1.095 million tons
Source of Waste	:	Dhaka North City Corporation (DNCC)
Incinerators	:	Four (4) sets of 750 t/d incinerators
Boilers	:	Four (4)
Turbine generator sets	:	Two (2) sets of 35 MW turbine generator sets
Steam turbine	:	Two (2)
Annual operation time	:	Not less than 8,000 hours
Leachate treatment station with a treatment capacity	:	1200 m ³ /day
Wet slag volume	:	182,500 t/a
Amount of flying ash	:	24,911 t/a
Cooling tower	:	Three (3) sets, Cooling water 7000 t/h
Furnace type	:	Mechanical grate furnace with 4x750t/d incineration line
Flue gas treatment system	:	Selective non-catalytic reduction (SNCR) (urea water injection in the furnace)
Stack Height	:	100m
Number of Stack/Stack Inside Diameter	:	1 Stack/2.2m*4
Fuel Name	:	Diesel fuel
Source of Fuel	:	Local Market
Fuel Requirement	:	About 40 tons of diesel will be consumed for each start and shutdown. Diesel consumption by ignition throughout the year = 40 × 2 × 4 = 320 ton Electricity consumption: 0.73×108kWh/a

Particulars		Basic Project Data
Water Requirement	:	The main industrial water source will be both surface water and groundwater and will also be used as a reserve water source for industrial water purposes. The total industrial water supply scale of this project is approx. 332 m ³ /d 7968 m ³ /d and the total domestic water scale is 44m ³ /d.
Employment	:	Construction phase – 2,093 persons Operation phase - 220 persons
Power Evacuation	:	132 kV Savar Substation
Project Cost	:	BDT 1,131.16 crore
Project Duration	:	The preliminary preparation of the project is expected to be 6 months. The construction period is 24 months.

Source: Feasibility Report

3.10 Layout plan

The total land including incineration plant land and new access roads is planned about 31.182 acres (126,187.41m²). Land requirements for the facility, including its breakup for various purposes, are given in Figure 3-5.

According to the requirement of production process and function, the project is divided into four functional areas: the main building area, auxiliary area, water treatment area, and ash & slag comprehensive treatment area.

1) Main Building Area

The main building area is composed of the main powerhouse, a concentrated green area in front of the main building, and the booster station. The main building includes a waste tipping hall, waste pool, incineration boiler house, flue gas cleaning house turbine house, central control room, and chimney.

2) Auxiliary area

This area is composed of a guard room, weighbridge room, access ramp, and oil depot.

3) Water Treatment Area

This area is composed of an industrial fire tank, a comprehensive water pump house, a cooling tower, a water purification station, and so on.

4) Ash & Slag Comprehensive Treatment Area

This area is composed of an emergency fly ash landfill and a slag comprehensive utilization workshop.

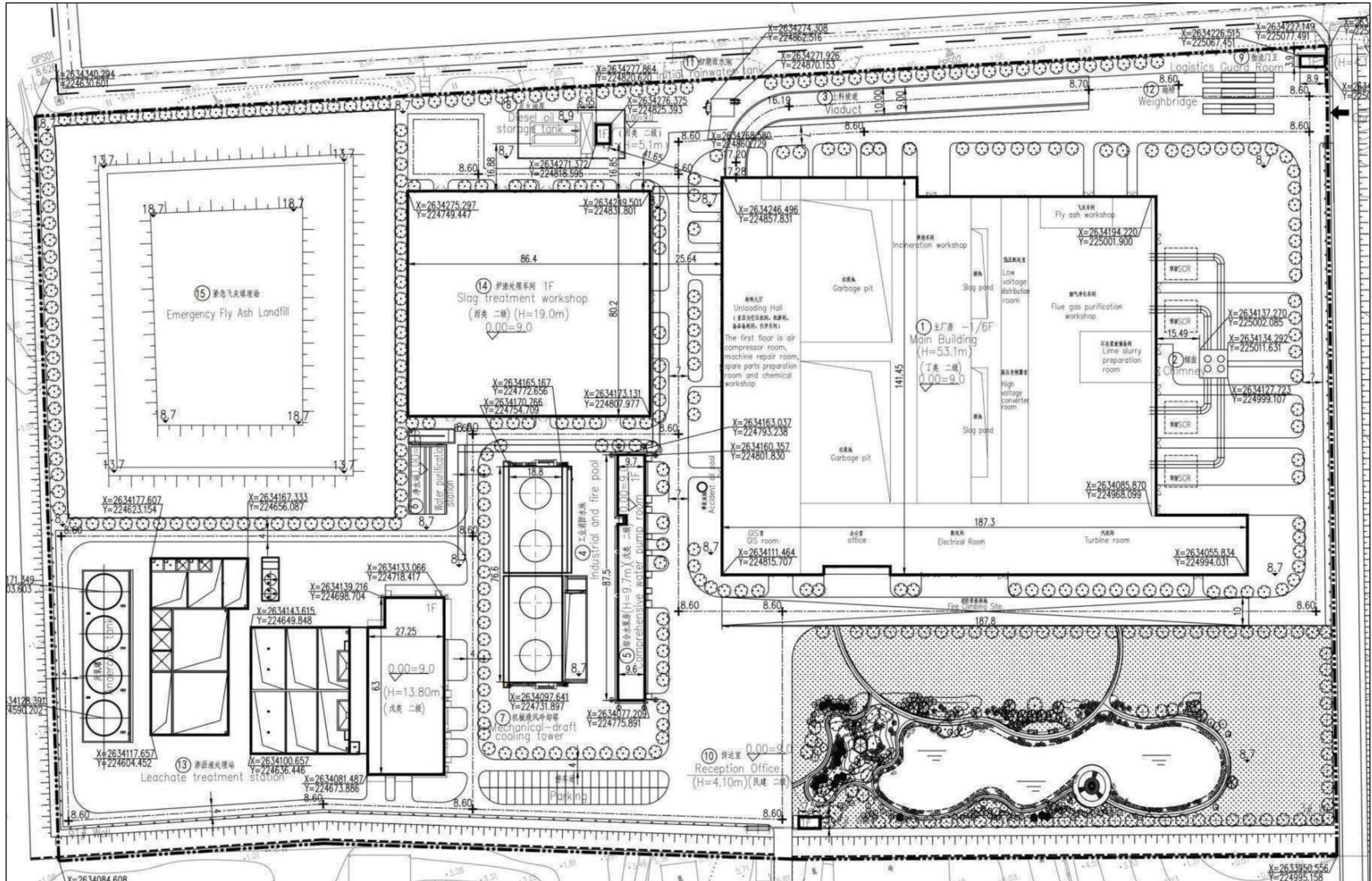
Table 3-5: Land requirements for various purposes

No.	Name	Floorage (m ²)	Calculated Plot Ratio Area (m ²)	Area Covered (m ²)
1	Main building	44,022.10	67,714.00	22,005.60
2	Chimney	—	—	100.00
3	Viaduct	—	—	1600
4	Industrial and fire pool	—	—	Under the cooling tower

No.	Name	Floorage (m ²)	Calculated Plot Ratio Area (m ²)	Area Covered (m ²)
5	Comprehensive water pump house	843.10	1,203.30	830.90
6	Water purification station	—	—	560
7	Mechanical-draft Cooling tower	—	—	2,110.00
8	Diesel oil storage tank	34.00	34.00	681.00
9	Logistics guard room	34.70	34.70	34.70
10	Reception Office	38.10	38.10	38.10
11	Initial rainwater tank	—	—	70.00
12	Weighbridge	—	—	300.00
13	Leachate treatment station	3,270.00	3,270.00	11,855.00
14	Slag treatment workshop	6,929.28	13,858.56	6,929.28
15	Emergency fly ash landfill	—	—	17,000.00
	Total	55,171.28	86,152.66	64,114.58

Source: Feasibility Study Report, 2022

Figure 3-5: General Layout Plan of Proposed Power Plant



Source: Feasibility Study, 2022

3.11 Main Project Components

3.11.1 Incinerator

At present, there are four main types of solid waste incinerators: mechanical grate furnace, fluidized bed incinerator, pyrolysis incinerator and rotary kiln incinerator. However, the solid waste incinerator types with more applications and mature technologies are mainly the mechanical grate furnace and fluidized bed incinerator. At present, grate type incinerator is the mainstream equipment abroad, which occupies an absolute advantage; while grate type incinerator and fluidized bed incinerator are the main equipment in China, and the former has more advantages. These four types of incinerator are briefly introduced and compared below.

Comparison of characteristics of four types of common household waste incinerators

Item	Mechanical Grate Furnace	Fluidized Bed Incinerator	Pyrolysis Incinerator	Rotary Kiln Incinerator
Hearth and Furnace Features	The area of the mechanical grate and the volume of the furnace are relatively large	Fixed hearth, small furnace volume	Mostly vertical fixed grate, 1~2 combustion chambers	Relying on the rotation of the furnace body to drive the garbage to move
Garbage Pretreatment	Unnecessary	Need	Needed for lower calorific value	Unnecessary
Equipment Occupation	Big	Small	Middle	Middle
Slag Thermal Loss Rate	Easy to reach	Continuous combustion can reach the standard	Difficult to meet the standard	Difficult to meet the standard
Garbage Residence Time in Furnace	Long	Short	Longest	Long
Excess Air Factor	Big	Middle	Small	Big
The Max Processing Scale of one Unit of Furnace	1200t/d	800t/d	200 t/d	500t/d
Combustion Air Supply	Easy to adjust	Easy to adjust	Difficult to adjust	Difficult to adjust
Adaptability to the Moisture Content of Garbage	Adapt to garbage with different moisture content by adjusting the movement of the drying section	The furnace temperature is easy to fluctuate with the change of the moisture content of the garbage	It can adapt to the change of the moisture content of the garbage by adjusting the residence time of the garbage in the furnace	It can adapt to the change of moisture content of garbage by adjusting the rotation speed of the drum

Item	Mechanical Grate Furnace	Fluidized Bed Incinerator	Pyrolysis Incinerator	Rotary Kiln Incinerator
Adaptability to litter inhomogeneity	The garbage can be reversed by the grate to make it homogeneous	Heavier garbage reaches the bottom of the furnace quickly and is not easy to burn completely	It is difficult to turn over the garbage in the furnace, and the large pieces of garbage are difficult to burn	The air is not adjusted in sections, and the large pieces of garbage are not flammable
Dust Content in Flue Gas	Low	Very High	Low	High
Combustion Carrier	No carrier	Quartz sand in need	No carrier	No carrier
Automatic Combustion Control	Easy	Not easy	Not easy	Not easy
Operating Costs	Low	Low	High	High
Flue Gas Treatment	Easy	Difficult	Difficult	Easy
Maintenance Workload	Less	Much	Less	Less
Operating Performance	Most popular	Less in foreign countries, relatively more in mainland China	Not popular	Popularly used for industrial waste, not for solid waste
Summary	Strong adaptability to garbage, few failures, good treatment performance and environmental protection performance, low cost	It requires pre-treatment and has a high failure rate, and it needs to be incinerated with coal, so it is difficult to meet environmental protection standards.	The non-melting pyrolysis furnace is not flammable, and the slag heat loss rate is high, and the environmental protection is not easy to meet the standard.	Requires high calorific value of waste (above 2500kcal/kg) and high operating cost.
Applicability of this project	Applicable	N/A	N/A	N/A

The mechanical grate type waste incinerator has the following characteristics compared with other furnace types:

- ◆ The technology is mature and reliable. Most of the large-scale domestic waste incineration power plants in developed countries use mechanical grate furnaces, and most of the large-scale incineration power plants that have been built or are under construction in China

also use this type of furnace.

- ◆ The use of incineration waste heat to generate electricity has certain energy-saving and economic benefits. The CO₂ emission reduction effect is better than other domestic waste treatment facilities.
- ◆ Strong adaptability to changes in garbage composition; it has an independent preheating and drying area, and the heat generated by incineration of garbage in the furnace can preheat and dry newly entered garbage, especially adapting to the characteristics of high moisture and low calorific value of garbage.
- ◆ Simple and convenient operation, not easy to cause secondary pollution.
- ◆ The incinerator is stable and reliable, and the equipment has a long service life, meeting the requirement that the annual operating time is greater than 8000 hours.

The circulating fluidized bed type waste incinerator has the advantages of low slag thermal ignition loss rate, etc., but has the following obvious shortcomings: ① According to the research results, the CO₂ emission is significantly higher than that of the grate type incinerator; ② Operation stability Not enough, the frequency of furnace shutdown is high, and the annual operation time is generally 6000~7000h; ③ Since the waste is mainly burned by volatile matter, the fixed carbon combustion only accounts for about 20%, resulting in too fast combustion rate, which cannot realize automatic combustion well control (ACC).

Based on the above analysis, the mechanical grate furnace is selected as the type of incinerator for the domestic waste incineration power generation project in Dhaka.

According to the requirements of the project's processing scale of 3000t/d, combined with the experience of the completed projects, the incineration production line should be configured theoretically according to 3~5 lines, that is, the choice between the processing capacity of a single furnace and the production line can be as follows:

- ◆ Option 1: Three lines, with a single line processing capacity of 1000t/d;
- ◆ Option 2: Four lines, with a single line processing capacity of 750t/d;
- ◆ Option 3: Five lines, with a single processing capacity of 600t/d.

If there are more than five incineration lines, the processing capacity of a single line will be below 500t/d. In terms of operation and maintenance.

There are no problems, but the footprint is too large to be considered. The selection of the number of incineration lines and the scale of a single line shall comply with the following principles:

- ◆ Investment Cost;
- ◆ Operating Cost;
- ◆ Technical Maturity (including construction and operation);
- ◆ Optionality in the market;
- ◆ The storage capacity of the garbage pool in case of downtime in case of failure.

The second option is recommended for this project, that is, the configuration of four 750t/d incineration production lines, which will improve the reliability of operation and bring significant economic benefits.

According to the requirements of the processing scale of 3000 t/d in this project and the experience of the completed project, 4 incineration production lines will be configured with a processing capacity of 750t/d of a single furnace, and the production line which will improve the reliability of operation and bring significant economic benefits.

3.11.2 Waste Heat Boiler

A waste heat boiler is the main component of this power plant where four (4) boilers will be installed. The total amount of steam generated by the matching waste heat boilers of four incinerators with a

pressure of 5.3 MPa and a temperature of 430 °C was $4 \times 77.07 = 308.28$ t/h. The waste heat boiler design parameters of this project are shown in Table 3-6.

Table 3-6: Waste heat boiler technical parameters

No.	Project	Parameters
1	The overheated steam temperature of the waste heat boiler	430°C
2	Waste Heat Boiler Overheated Steam Pressure	5.3 MPa (g)
3	Single boiler overheated steam-rated flow	77.07 t/h
4	Exhaust Temperature of Waste Heat Boiler	190°C
5	Feed water temperature of waste heat boiler	130°C
6	Incinerator - Heat Efficiency of Waste Heat Boiler	About 80 percent
7	Number of operational hours per year	> 8000 h

Source: Feasibility Study, 2022

Waste heat boiler composition

A waste heat boiler for waste incineration is generally a single drum natural circulation water tube boiler composed of 3-4 channels, which can be usually divided into the vertical boiler and horizontal boiler according to the arrangement form of its convection heating surface, and many designs combine horizontal and vertical boilers. The main basis for the determination of the arrangement of convection heating surface is cost, steel consumption, service performance, the convenience of installation, and maintenance. A horizontal waste heat boiler will be used in this project.

Blowdown system

For this blowdown system of waste heat boiler, four furnaces will be used to set one continuous blowdown flash tank, and continuous row expansion steam will be introduced into the deaerator for recovery and utilization. The emergency drain of the boiler will be sent to the fixed drain. The regular discharge of the boiler will be 1-2 times per shift, depending on the water quality test of the furnace.

3.11.3 Turbine Generator

Steam Turbine: Two (2) units of the steam turbine will be required for this power project which rated power will be 35 MW. The turbine has a three-stage non-adjustable steam extraction. The Steam pressure and temperature in front of the mainstream will be 5.1 MPa and 425°C respectively. After the condensate water and recharge water off the steam turbine generator group are heated to 130 °C through the steam turbine regenerative system and deaerator, they are sent to the boiler economize through the boiler feed water pump to transfer with boiler Flus Gas to heat.

Table 3-7: Main technical parameters of steam turbine

Items	Parameters
Quantity	2 units
Model	N35-5.1/425°C
Rated power	35MW
Steam turbine-rated intake	155 t/h
Steam pressure in front of the main steam	5.1 MPa
The steam temperature in front of the main steam	425°C

Extraction Series	3 non-adjusted extraction
Designed back pressure	~6.5Kpa
Feed water temperature	130°C
Designed cooling water temperature	27°C
Maximum cooling water temperature	33°C

Source: Feasibility Study, 2022

Generator: Two sets of 35MW generators will be used for this project, with an output voltage is 10.5 kV, a rated speed of 3000 r/min and an efficiency is more than 97.4%. This project uses the solid waste incinerator and waste heat boiler with international advanced level and higher thermal efficiency, as well as the turbine generator unit with higher power generation efficiency, which saves energy to the greatest extent.

Table 3-8: Main technical parameters of the generator

Items	Parameters
Quantity	2 units
Model	QF-35-2
Rated power	35MW
Output voltage	10.5kV
Rated speed	3000r/min
Power factor	0.8
Frequency variation range	48.5~51.5 HZ
Cooling mode	Air cooling
Generator efficiency	>97.4%

Source: Feasibility Study, 2022

3.11.4 Cooling Tower

The factory has three sets of countercurrent mechanical ventilation cooling towers (considering a 110% margin) with a cooling water volume of 7000 t/h, equipped with a fiberglass axial flow fan. The single power is 205 kW. The cooling tower building dimensions are a length of 75m, a Width of 22.6m, and a Height of 16.5m.

The working principle of the mechanical ventilation cooling tower is to spray hot circulating water from the top of the cooling tower and then flow to the sump, At the same time, dry air is pumped by the cooling tower, and enters the tower from the bottom to top in reverse with the water flow. Therefore, when the water film on the packing is widely contacted with the cold air, the mass and heat transfer process occur between different media, which takes away the heat of the circulating water, to achieve the purpose of cooling.

The circulating cooling water system adopts the main pipe water supply, which is divided into two separate water supply systems.

- Circulating cooling water system of steam turbine generator set
- The cooling water system of process equipment

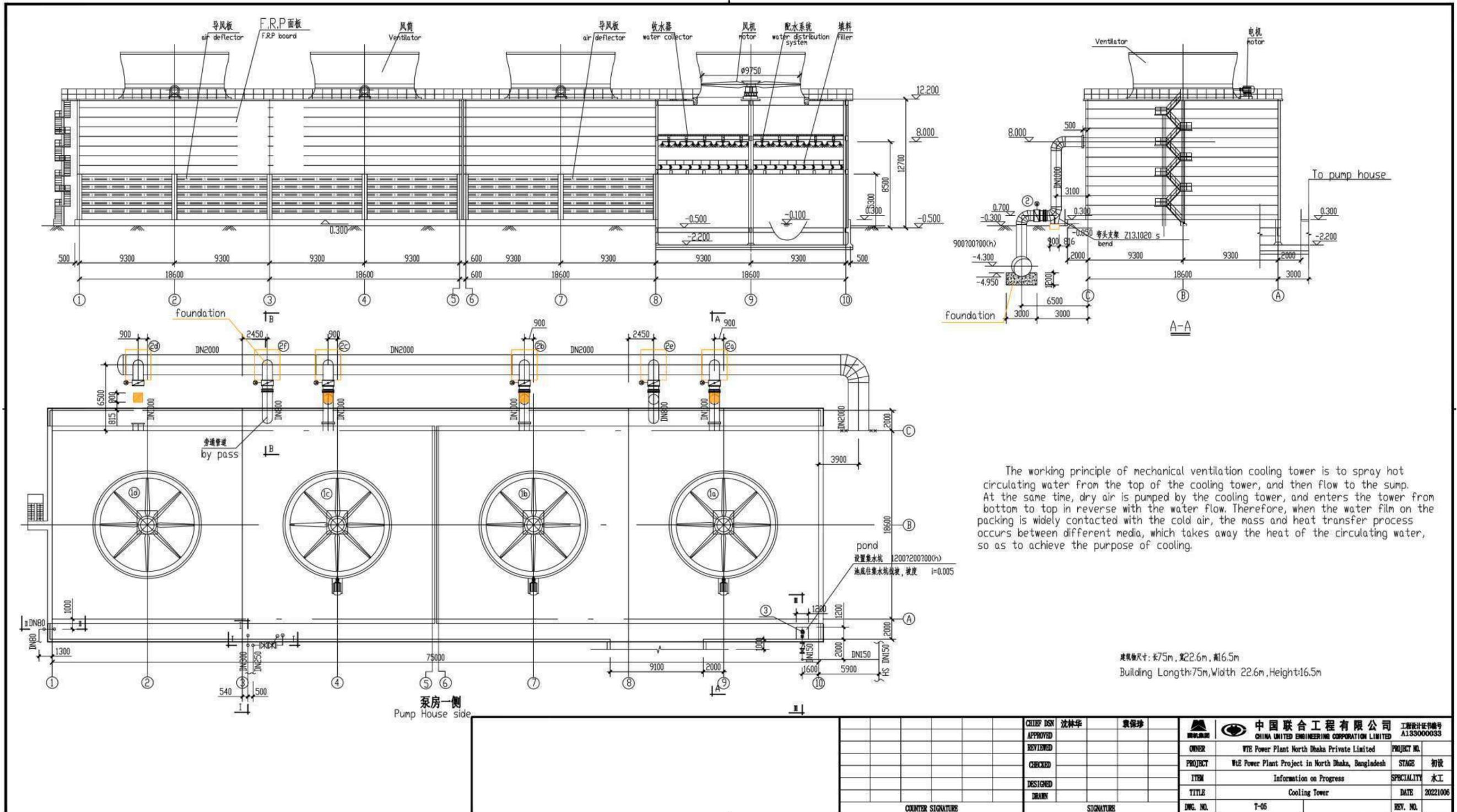
The feed water of the circulating cooling water system of the steam turbine unit is supplied to the steam turbine room of the main workshop by the steam turbine circulating water pump set in the circulating

water pump room through the outdoor circulating water supply pipe, and then sent to the two-steam turbine generator sets and supporting equipment respectively.

The cooling water system of the process equipment is supplied to the process equipment such as heat exchangers in the main workshop by the industrial cooling water pump allocated in the circulating water pump room through the outdoor circulating water supply pipe. The above cooling water effluent is merged into the cooling water return jelly pipe and sent back to the cooling tower.

The cooling facility adopts 4 mechanical ventilation cooling towers with water-collecting pools. The working principle of the mechanical ventilation cooling tower is the high temperature circulating water after heat exchange by the condenser and heat exchanger is sent to the top of the cooling tower for spraying, and then flows into the water collection tank. The air is drawn from the bottom to the top, and the water film on the filler is in extensive contact with the cold air, and the mass transfer and heat transfer process occurs, taking away the heat of the circulating water. The evaporation and loss of circulating water are about 7,265t/d. Therefore, it needs to be replenished in time with fresh industrial water. The water source of industrial water comes from purified river water and groundwater. The cooling tower design has been given in Figure 3-6.

Figure 3-6: Design of Cooling Tower



Source: Feasibility Study, 2022

3.11.5 Stack

In this Waste to Energy project, one stack will be used, and the height will be 100m. The inside diameter of the stack will be 2.2m*4. The gas exit temperature will be ~140°C and the velocity will be 10~20m/s. The Gas flow rate for one line will be ~150000Nm³/h. The details of the main technical parameters of Stack are given in Table 3-9.

Table 3-9: Main technical parameters of Stack

Sl.	Item	Value
1.	Number of Stacks	1 no.
2.	Stack Height	100m
3.	Stack Inside Diameter	2.2m*4
4.	Emission Concentration	
	NO ₂ (Daily average)	200mg/Nm ³
	SO ₂ (Daily average)	50mg/Nm ³
	PM ₁₀ (Daily average)	NA
	PM _{2.5} (Daily average)	NA
	Dust (Daily average)	10mg/Nm ³
	CO (Daily average)	50mg/Nm ³
5.	Gas exit temperature	~140°C
6.	Gas exit velocity	10~20m/s
7.	Gas exit flow rate	~150000Nm ³ /h for one line and 150000Nm ³ /h *4=600000Nm ³ /h (140°C) for the whole plant.
8.	Emission rate	
	NO ₂ (Daily average)	8333mg/s*4
	SO ₂ (Daily average)	2083mg/s*4
	PM ₁₀ (Daily average)	NA
	PM _{2.5} (Daily average)	NA
	Dust (Daily average)	417mg/s*4
	CO (Daily average)	2083mg/s*4
9.	Boundary wall height	2.2m

Source: Feasibility Study, 2022

By setting up a Continuous Emission Monitoring System (CEMS) at the outlet of the chimney, the concentration of HCl, SO₂, NO_x, dust and other pollutants can be monitored online. When the instantaneous value of the pollutant is detected to exceed the standard, it will be fed back to the flue gas purification control system to adjust the spray amount of the relevant agent to ensure that the emission standard is met.

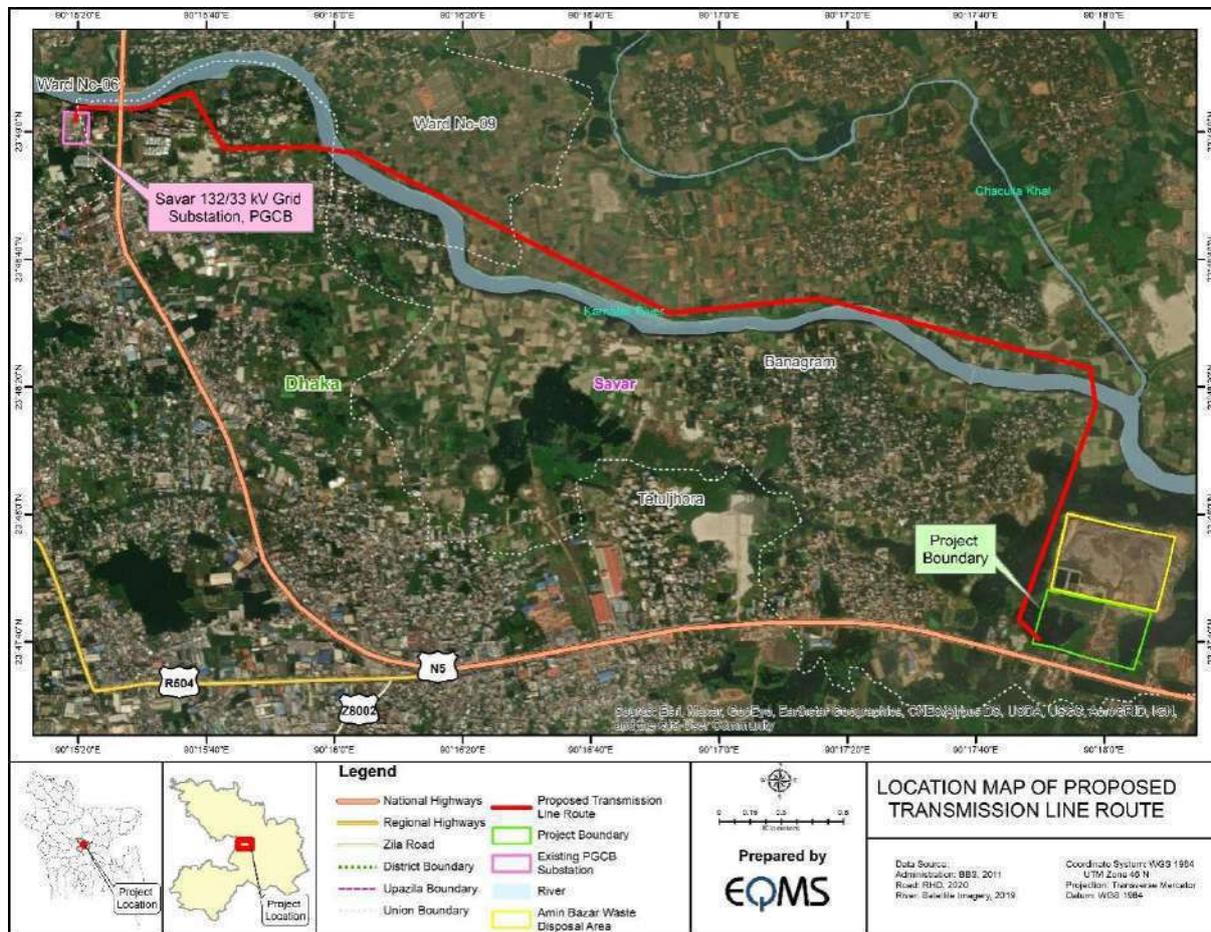
3.12 Power Evacuation

According to PPA, this project uses a dual loop 132kV line to connect to the Savar 132/33kV substation. The length of the 132kV transmission line is about 6km. The Savar 132/33 kV substation transformer's capacity is 3x50/75 MVA, with a maximum load of 158 MW and a minimum load of 147 MW.

The benefits of the option are:

- The most reliable portion from the view of fault occurs because of several faults in 132kV.
- transmission rarely occurs.
- Low Interconnection losses 0.278 MW
- Space available for constructing Interconnection facilities at Savar 132kV Substation.
- This option does not create any additional network constraints at the 132kV Grid Network.

Figure 3-7: Interconnection Proposal to Savar 132/33kV Substation



3.13 Process Flow of Waste to Energy

After the waste transport vehicle enters the factory and is weighed and measured by the weighbridge, it enters the waste tipping hall, discharges the waste into the waste storage pit for storage, and mixes the waste with the waste grab crane before sending the waste into the incinerator. The system mainly includes the following facilities: Weighbridge, waste tipping hall, waste tipping gate, waste storage pit, waste crane, and deodorization facilities. The description of the process involved in the generation of electricity from municipal waste is given below:

3.13.1 Weighing and receiving

Waste weighing system

The main function of the waste weighing system is to count and weigh the waste that enters the factory, mainly weighing, recording, transmission, printing, and data processing. The Waste Weighing system consists of 3 sets of automatic electronic automobile scales, two sets with a maximum weighing capacity of 60 tons and one set of 80 tons, with an accuracy of 20 kg.

Tipping hall

The entrance of the unloading platform is equipped with red-green signal lights and coil-type vehicle detectors, and the crane control room controls the incoming and outgoing vehicles. When the waste truck enters from the south side of the tipping hall, the tipping port can be reached by one turn; when the transport vehicle is tipping, there has enough space on the left on the east side of the tipping hall for other vehicles to enter and exit.

Tipping gate

Ten sets of electro-hydraulic driven double-open tipping halls were set on the tipping gate, and the size was tentatively set at 3600 (width) × 6500 (height). The opening and closing of the tipping gate shall be interlocked with the feeding and grasping of the waste grab crane, and the opening and closing of the waste grab crane can be controlled by control room operators in the tipping gate.

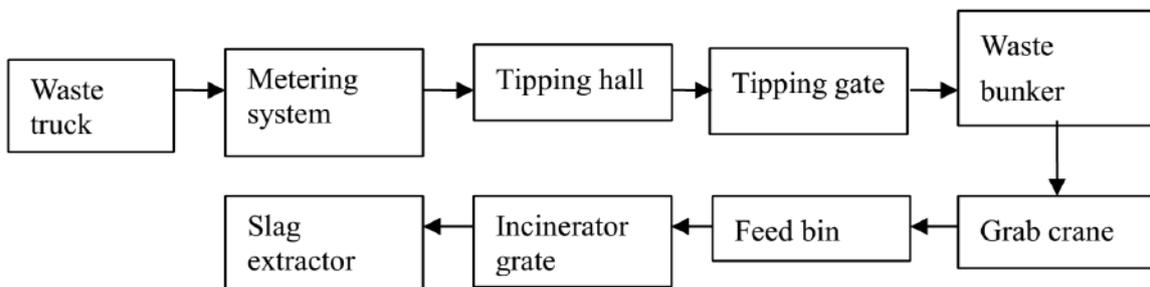
Waste Pit

The waste pond is a closed reinforced concrete pond with anti-seepage and anti-corrosion functions. The total volume design of two waste tanks set in this project is about 52,080 m³. According to the average bulk density of waste stored in the tank of 0.5 t/m³ and the average daily intake of 3000t, the incineration amount of about 10 days can be stored.

Waste grab crane

The waste grab crane is located above the waste storage pit; this project has four semi-automatic garbage bucket cranes and one spare garbage bucket, which mainly undertake the feeding, handling, stirring, collating, and accumulating waste. The waste grab crane is equipped with a metering device, which has the functions of automatic weighing, automatic display, automatic accumulation, printing, overload protection, and limit protection.

The storage and transportation block diagram of waste is as follows:



The waste was transported by a truck to the incineration plant, weighed by a car balance, entered the tipping hall through the ramp, and discharged into the waste bunker for temporary storage. The waste crane grab sends the waste into the feed hopper of each incinerator. The waste passes through the feed hopper and chute and is pushed by the feeder into the incinerator.

The waste falls on the grate and is made dry through the grate drying section, and it is pushed to the combustion section with the motion of the grate reciprocating and completes the combustion in the combustion section in turn. The burnt slag falls into the slag extractor through the slag outlet.

There are four types of domestic waste incinerators: mechanical grate furnaces, fluidized bed incinerators, pyrolysis incinerators, and rotary kiln incinerators. The main domestic waste incinerators with more applications and mature technology are mechanical grate furnaces.

3.13.2 Mechanical Grate Furnace

Layered combustion technology is used in mechanical grate furnaces, which has the advantages of a low requirement for waste pretreatment, a wide range of adaptation to the calorific value of waste, and easy operation and maintenance. A mechanical grate furnace, the most used municipal solid waste incinerator with the largest processing capacity and the best applicability globally, is widely used in developed countries such as Europe and the United States, with a maximum processing capacity of 1200 t/d and mature and reliable technology. The waste passes through three sections on the grate: Preheating and drying, combustion, and burnout. The waste is ignited on the grate, and the heat comes not only from the furnace's radiation and the flue gas's convection but also from the interior of the waste layer. The waste that has been ignited on the grate, through the reciprocating motion of the grate, produces strong flipping and agitation, causing waste combustion at the bottom. Continuous flipping and agitation also loosen the waste layer and strengthens air permeability, which is conducive to waste drying, ignition, combustion, and burnout. The performance and characteristics of the common waste incinerators are given in Table 3-10.

Table 3-10: Performance and characteristics of the common waste incinerators

Project	Mechanical grate
Characteristics of Furnace Bed and Furnace Body	Large mechanical grate area and furnace volume
Waste Pretreatment	No required
The floor area of the equipment	Large
Heat Cauterization of Slag	Easy to reach the standard
The resident's time of waste in the Furnace	Longer
Excess air coefficient	Large
Maximum processing scale of a single furnace at present	1200 t/d
Combustion air supply	Easy to adjust
Adaptability to the moisture content of waste	Adapt to waste with different water content by adjusting the movement of the drying section
Adaptability to inhomogeneity of waste	It can be reversed by toggling the waste through the grate to homogenize it
Dust content in flue gas	Low
Combustion medium	No carrier
Automatic combustion control	Easy
Operating expenses	Low
Flue gas treatment	Easy
Maintenance workload	Less
Operational performance	Maximum

Project	Mechanical grate
Comprehensive evaluation	It has strong adaptability to waste, few faults, good treatment performance and environmental protection performance, and low cost

Source: Feasibility Study, 2022

The mechanical grate-type waste incinerator has the following characteristics compared with other furnace types:

- It has matured and reliable technology. Most of the large solid waste incineration power plants in developed countries use the mechanical grate furnace type. The large incineration power plants built or under construction in China also mostly use this furnace type.
- It uses the residual heat generated by incineration for power generation, which has certain energy-saving and economic benefits. It has a better CO₂ emission reduction effect than other solid waste treatment facilities.
- It has strong adaptability to the characteristics of waste composition change; it has an independent preheating and drying area, and the heat generated by waste incineration in the furnace can preheat and dry the newly entered waste, and it can especially adapt to the characteristics of high moisture and low calorific value of waste.
- It is easy to operate and does not easy to cause secondary pollution.
- The incinerator is stable and reliable, the equipment life is long, and the annual operation time is greater than 8000 hours.

3.13.3 Air combustion system

The combustion air system includes two parts: primary air and secondary air. The primary air is introduced by the PA fan through the space above the waste tank while ensuring that the waste tank is in a negative pressure state to avoid odor leakage. After a steam-air preheater preheats the primary air, it enters the bellows through the lower part of the grate and then enters the furnace for combustion support by the grate air supply hole and the waste layer on the grate.

The secondary air is drawn through the SA fan from the hot area in the upper part of the incineration room while decreasing the temperature of the top region of the incinerator. Two sets of high-speed nozzles spray the secondary air into the combustion chamber. The high-temperature Flue Gas in the combustion chamber forms a turbulent flow so that the incompletely burned volatiles are entirely burned. CO and other Flue Gas pollutants in the high-temperature Flue Gas are reduced.

The cooling air of the furnace wall is drawn from the incineration room by a cooling fan. After cooling the furnace wall's temperature through the furnace wall's air layer, it is directly blown into the furnace by the primary air (PA) duct.

3.13.4 Waste incineration process

The incinerator has an ignition burner, an auxiliary burner, and light diesel as auxiliary fuel. The function is to make the outlet temperature of the incinerator reach the rated operating temperature (more than 850°C) through natural gas when the incinerator is ignited without waste, and then to start to put waste into the furnace to prevent waste from being put into the furnace at a low temperature, resulting in excessive exhaust pollutants. Also, in the normal shutdown process, the burner input is required to maintain a temperature above 850 °C when the furnace's waste is not entirely burned out. When the calorific waste value is low, the water content is high, and the Flue Gas temperature of the furnace outlet cannot be maintained above 850 °C, enabling the burner at this time can increase the furnace temperature and stabilize combustion. During the shutdown process, the burner must be started before stopping the waste feed until the grate is burned.

The waste passes through three areas on the grate: drying, burning, and burnout. The combustible portion of the waste has been entirely burned, and the slag falls into the slag extractor. The slag extractor acts as a water seal and cooling slag and pushes the slag to the slag storage pit. Detailed incineration process has been presented in Appendix-O.

In order to ensure the stable operation of the incinerator within the calorific value range of this project, the incinerator design and control not only need to ensure that the low calorific value waste can burn stably, but also consider the problems caused by the increase in furnace load during the combustion process of high calorific value waste.

For low calorific value waste, there are the following design and control adjustment methods to ensure stable combustion:

- ✧ Extend the fermentation time of garbage in the garbage tank and increase the calorific value of garbage entering the furnace
- ✧ A leachate collection hopper is designed in the lower part of the ejector to reduce the moisture carried by the waste when it enters the furnace
- ✧ Reduce the grate movement speed of the drying section and the combustion section, and increase the primary air temperature to make the garbage fully dry on the drying section
- ✧ Each section of the grate is set with a high drop section to realize the flipping and crushing of garbage and strengthen the complete combustion of garbage.

In view of the increase of furnace heat load when high calorific value garbage is burned, the following optimization design and adjustment methods are adopted to reduce coking:

- ✧ Reduce the primary air volume and air temperature, increase the proportion of secondary air volume, and reduce the temperature of the furnace
- ✧ Reduce the feeding speed of the ejector
- ✧ Set up an air-cooled furnace wall structure to prevent coking on the furnace wall;
- ✧ Independent air chambers are set under each section of the grate to achieve independent air distribution;
- ✧ Through primary air cooling of the grate block, prevent the grate piece from overheating and extend the service life of the grate piece;

The automatic combustion control system can control the main steam flow, garbage layer thickness, combustion position, thermal burning reduction rate, furnace temperature and oxygen concentration of the boiler, optimize the combustion status of the incinerator, and realize the continuous and stable operation of the incinerator.

3.13.5 Flue Gas Process

The order of heat incinerator within the Flue Gas passes through the waste heat boiler, Flue Gas Treatment System, drawn by the ID fan, and discharged into the atmosphere through the chimney.

3.13.6 Slag process

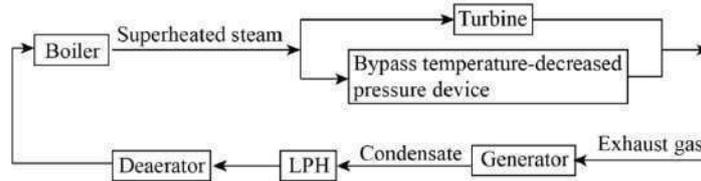
The slag after solid waste incineration falls into the slag extractor through the slag outlet at the grate tail. A conveyor transported the leaked slag from the grate to the slag remover. The boiler ash collected by the duct ash hopper at the rear of the boiler is controlled into the scraper conveyor by an ash removal valve and delivered to the slag extractor. The slag in the slag pond is lifted by a grab truck and sent to the comprehensive utilization workshop.

3.13.7 Fly ash process

The fly ash collected by the Flue Gas Treatment System consists of the fly ash collected by the semi-dry reaction tower and the ash hopper of the bag filter. Fly ash is transported to the hoist through scraper conveyors, fed into the ash bin, and then stabilized by fly ash. The fly ash treatment technology in this project is selected as the main scheme: synergistic treatment with cement kiln; and stabilization of chelating agent ("chelating agent + water" fly ash solidification landfill) can be as the backup.

3.13.8 Steam and water process

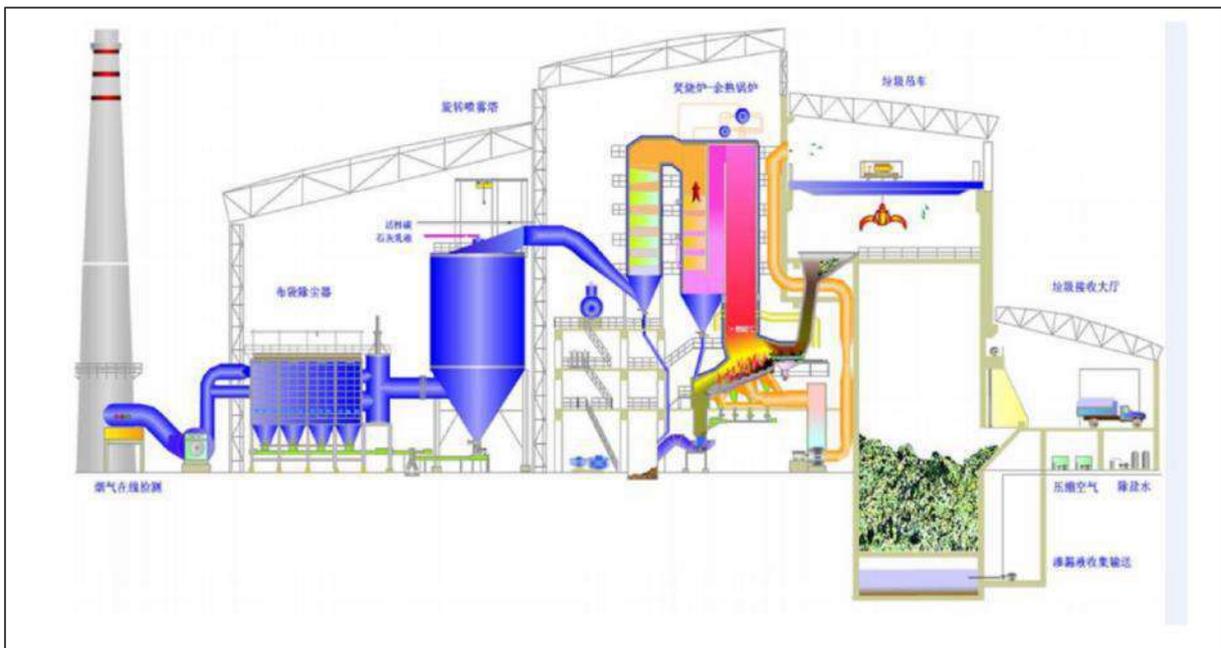
The flow chart of the steam and water system is as follows:



The superheated steam generated by the waste heat boiler was sent to the steam wheel generator group. The steam expands in the turbine to work, and the exhaust gas is discharged into the condenser. The exhaust gas condenses into water in the condenser. It enters the deaerator for deaeration through the condensate pump heater, the low-pressure heater, and the boiler replenishing water, respectively, and is temporarily stored in the deaeration water tank. The deoxygenated water reaching 130 °C was pressurized by a feed water pump and sent to the boiler economizer. The waste heat boiler uses water as a working fluid to absorb heat in the hot Flue Gas, which produces a vapor of 5.3 MPa (g), 430 °C, for power generation in the turbine generator group. In addition to the electricity generated for the use of this factory, the excess electricity is sent to the regional power grid.

The steam for primary air heating is supplied in two stages, a steam turbine extracts the primary heated steam, the secondary heated steam uses saturated steam, and the condensate is produced after the steam heat returns to the deaerator.

Figure 3-9: Flow chart of the waste disposal process



Source: Feasibility Study, 2022

3.13.9 Water Balance

1. **Total water consumption:** The total summer water consumption of the whole factory is 8,752.8 t/d.
2. **Domestic Water:** The number of staff in the whole factory is 130 people. The quota of comprehensive water use is 140 ~ 170 L/man-day, and the daily water consumption is 32 m³/d. The unforeseen water volume is 10 m³/d, and the water consumption of the laboratory is 2m³/d, considering disinfected water and groundwater. Total water needs about 44m³/d.

3. Water for production:

i. Circulating cooling water consumption

The main feedwater objects of circulating cooling water are steam engine condenser, air cooler, oil cooler, and other equipment, and the total circulating cooling water volume is 414,240 t/d.

Circulating cooling water also supplies the cooling water of auxiliary equipment in the Main Building. The feed water objects mainly include Turbine Workshop high-pressure feed water pump cooling water, Incineration Hall sampling device cooling water, the primary and the secondary fan cooling water, incinerator hydraulic system cooling water, flame detector cooling water, ID fan bearing cooling water, etc., with a total water consumption of 9,638.4 t/d.

ii. Water consumption for reuse

Considering that the cooling water of the slag machine, vehicle flushing, and flue gas purification process have low water quality requirements, the quality of circulating water can meet the requirements. Therefore, it is considered to use the sewage from the collective pool of the cooling tower to realize the reuse of water, and to save the plant area. For water use, the water consumption of this part is 654.1t/d.

iii. Consumption of chemical water

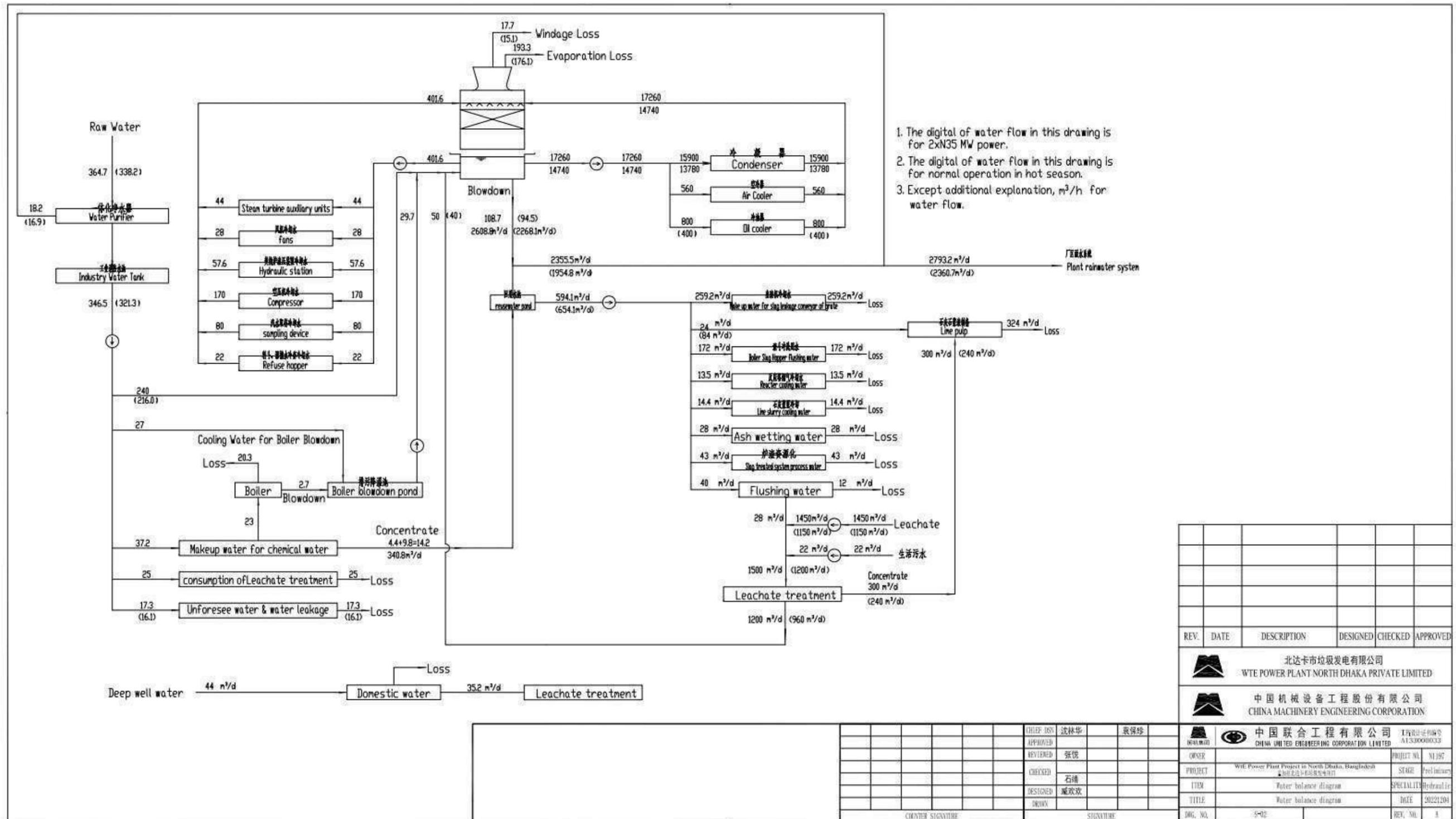
The daily consumption of chemical water is 892.8m³/d, using industrial water after treatment.

4. Firewater:

The fire control system of the whole factory includes an indoor hydrant feed water system and an outdoor hydrant feed water system.

The Main Building refractory is grade II, belonging to the Class D workshop. Take 30 L/s indoor hydrant water consumption and 50 L/s outdoor hydrant water consumption and the fire duration is 2 hours; set the fire monitor in the waste bunker and water consumption of the fire monitor fire extinguishing system is 60 L/s and fire duration is 1 hour. The design flow of firefighting water required for one fire extinguishing in the Main Building is $30 + 50 + 60 = 140$ L/s; water consumption for one t fire extinguishing: $3.6 \times (30 \times 2 + 50 \times 2) + 3.6 \times 60 \times 1 = 792$ m³. See below Figure 3-10 for the water balance diagram of the whole factory.

Figure 3-10: Water Balance Diagram of the Proposed Project



Source: Feasibility Study, 2022

3.14 Details of the Treatment Process

3.14.1 Flue Gas Treatment System

In the Flue Gas generated by the WtE process, there are many pollutants, and the main pollutants are the following:

Dust: Inert metal salts, metal oxides, or incomplete combustion substances in the waste.

Acidic gas: Include hydrogen chloride, hydrogen fluoride, sulfur oxides (SO₂ and SO₃), and nitrogen dioxides (NO₂).

Heavy metal contaminants: Include lead, chromium, mercury, cadmium, arsenic, and other elemental states, oxides, and chlorides.

Dioxin: PCDDS/PCDFS.

Depending on their quantity and nature, these substances mentioned above can be hazardous to the environment to varying degrees. The design and operation management of an Efficient Flue Gas Treatment System is the key to preventing secondary pollution in waste incineration plants. It also guarantees that the Flue Gas Treatment effect reaches the specified emission index.

3.14.1.1 Design Parameters of Flue Gas

The composition of solid waste, combined with the pollutant concentration parameters of conventional waste incineration plants. The main components of Flue Gas at the boiler outlet are given in Table 3-11.

Table 3-11: Table of main components of Flue Gas at boiler outlet

SL	Project	Unit	Quantity
1.	Flue gas	Nm ³ /h	139782
2.	N ₂	%	67.15
3.	CO ₂	%	7.86
4.	O ₂	%	8
5.	NO ₂	mg/Nm ³	400
6.	SO _x	mg/Nm ³	600
7.	HCl	mg/Nm ³	1200
8.	Dust	mg/Nm ³	3000
9.	Cd, Ti	mg/Nm ³	0.8
10.	Hg	mg/Nm ³	0.26
11.	Sb, As, Pb, Cr, Co, Cu, Mn, Ni	mg/Nm ³	65
12.	PCDD & PCDF	ng/Nm ³	4

Source: Feasibility Study, 2022

3.14.1.2 Temperature Control and Dioxin solution

Measure 1: Apply the 3T Technique (turbulence, temperature, time) to the incinerator, reasonably control the combustion air coefficient to fully burn the garbage and control the retention time of the flue gas in the furnace with temperature above 850 °C for more than 2 seconds to ensure the full decomposition of dioxins. According to the theory of the US EPA on the generation of toxic and harmful substances such as dioxins, the decomposition of dioxins varies with temperature. When the flue gas stays at a temperature greater than 850 °C for more than 2 seconds, the decomposition rate of dioxins reaches 99.99%.

Implementation: After being stored in a garbage pit for a period of time for fermentation and dehydration, domestic waste is transported to the feeding hopper through a garbage crane and falls into a pusher and then fed into the incinerator, where it is dried by primary air and the radiation heat from the incineration furnace on the grate, and then ignited and burned out. The full combustion of household waste relies on the following engineering process: firstly, steam is extracted and heated by primary air, which has a higher temperature, providing favorable conditions for the drying, combustion, and incineration of waste; secondly, the combustion of garbage in a mechanical grate incinerator is divided into solid-phase combustion in the bed layer and gas-phase combustion in the furnace space. Secondary air nozzles are arranged at the front and rear arches of the incinerator, the high-speed secondary air is sprayed into the front and rear arches to promote sufficient disturbance and combustion of combustible gases in the furnace space. Based on experience, the outlet temperature of the incinerator is about 1050°C; Thirdly, laying refractory materials in the incinerator furnace and the first flue can help to reduce the heat absorption of the furnace and the water-cooled wall of the first flue and ensure that the flue gas temperature stays above 850 °C for more than 2 seconds.

In addition, an auxiliary burner is installed on the side wall of a flue. When the calorific value of the garbage entering the furnace is low or the combustion is unstable, and the furnace temperature is below 850°C, the auxiliary combustion system will automatically put into operation to ensure that the flue gas stays for more than 2 seconds at a temperature greater than 850°C to ensure the full decomposition of dioxins.

Under MCR conditions, the temperature design range of incinerator outlet is 950°C~1050°C.

When the furnace temperature is low, the adjustment measures taken:

- ✧ Sufficient drying of the garbage on the drying section;
- ✧ Each section of the grate is set with a high drop section to realize the flipping and crushing of garbage;
- ✧ crease the temperature of the primary air into the furnace and reduce the secondary air volume.

When the furnace temperature is high, the adjustment measures taken:

- ✧ Increase the secondary air volume to reduce the furnace temperature;
- ✧ Reduce the feeding speed of the ejector;
- ✧ Lower the primary air temperature.

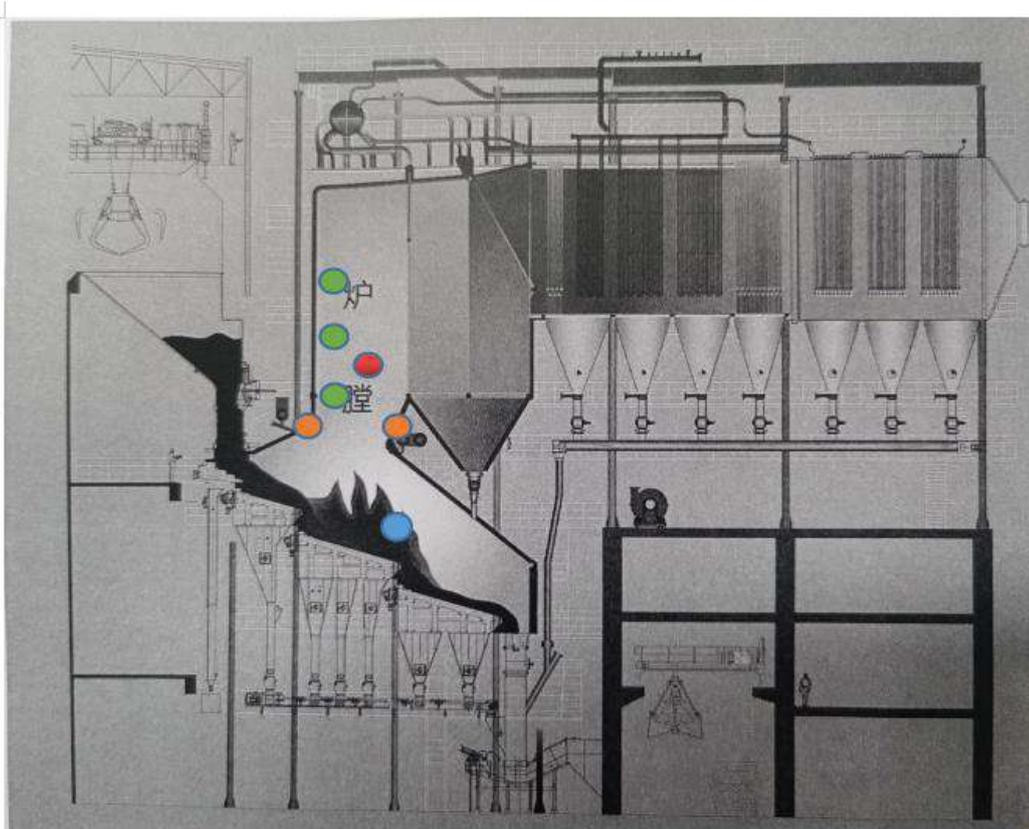
The first channel of the waste heat boiler is equipped with three layers of flue gas temperature measurement points. The retention time of flue gas in areas above 850 °C is calculated based on the flue gas passing through the three layers of temperature measurement points. The calculation results are shown below, and the relevant arrangements are shown in the attached figure.

Table 3-12: Details of Temperature Control System

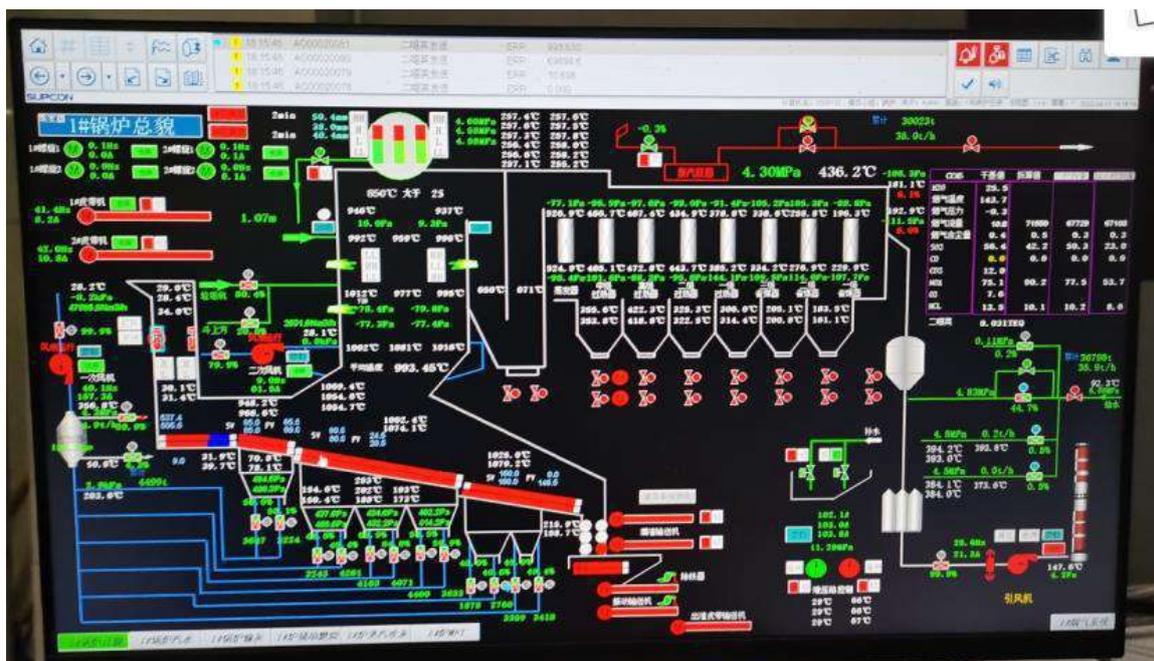
No.	Name	Figure	Unit
1	Chamber width	6	m
2	Chamber depth	8.1	m
3	Chamber cross section area	48.6	m ²
4	Flue gas speed	3.84	m/s
5	Flue gas volume (working condition)	671978	m ³ /h
6	Flue gas volume (normal)	150000	Nm ³ /h
7	First sensor temperature(design)	1050	°C

8	Third sensor temperature(design)	850	°C
9	Distance between first and third sensor	9.4	m
10	Retention time	2.45	second

Figure 3-11: Temperature Control System



- Primary oxygen feeder
- Secondary oxygen feeder
- Temperature sensor
- Auxiliary burning facility



Measure 2: Add absorbent to remove dioxins from flue gas.

Activated carbon injection: Engineering research and practice have proven that activated carbon can adsorb and remove dioxins in flue gas. To realize such purpose, a compressed air inlet device mixed with activated carbon will be installed on the inlet flue of the bag filter, spraying activated carbon with a specific surface area greater than 800 m²/g into the flue gas to adsorb/remove dioxins.

Measure 3: Bag filter removal

The bag filter has a good removal effect on dioxins and heavy metals. When the flue gas passes through the activated carbon injection device and the bag filter, due to the powder layer adhered to the filter bag and the activated carbon powder with large surface area, the generated dioxins will be adsorbed and gradually gathered on the dust layer, hence removed from the flue gas.

3.14.1.3 Original parameters of Flue Gas

The pollutants in the flue gas of domestic waste incineration can be divided into particulate matter (dust), acid gas (HCl, HF, SO₂, NO_x, etc.), heavy metals (Hg, Pb, Cr, etc.) and organic highly toxic pollutants (dioxin, furans, etc.) in four categories. In order to prevent secondary pollution to the environment during the waste incineration process, strict measures must be taken to control the emission of waste incineration flue gas by using the flue gas purification system.

The flue gas conditions at the inlet of the flue gas purification equipment of this project are shown in the Table 3-13.

Table 3-13: Inlet flue gas condition table

SL No	Project	Unit	Scope
1	Treated flue gas volume (wet basis, real oxygen)	Nm ³ /h	150000
2	Inlet flue gas temperature	°C	175~210
3	Imported flue gas negative pressure	Pa	- 1 000
4	O ₂	Vol%	6~12%
5	H ₂ O	Vol%	18~25%

SL No	Project	Unit	Scope
6	CO ₂	Vol%	7~10%
7	CO	mg/Nm ³	≤50
8	Dust	g/Nm ³	2~6
9	HCl	mg/Nm ³	≤1500
10	SO _x	mg/Nm ³	500~900
11	HF	mg/ Nm ³	20
12	NOx _	mg/ Nm ³	≤350
13	Hg	mg/ Nm ³	≤10
14	Cd	mg/ Nm ³	≤2.5
15	Total Pb+Cu+As+Sb	mg/ Nm ³	≤100
16	Dioxins / furans	ngTEQ/ Nm ³	3~5

Table 3-14: Smoke Emission Standard

SL No	Pollutant name	one bit	European Union 2010/75/EU		Guaranteed value of this project	
			Daily average	half an hour average	daily average	half an hour average
1	soot	mg/ Nm ³	10	30	10	30
2	HCl	mg/ Nm ³	10	60	10	60
3	HF	mg/Nm ³	1	4	1	4
4	SO _x	mg/Nm ³	50	200	50	200
5	NO _x	mg/Nm ³	200	400	200	400
6	CO	mg/Nm ³	50	100	50	100
7	TOC	mg/ Nm ³	10	20	10	20
8	Hg	mg/ Nm ³	0.05 (measured mean)		0.05 (measured mean)	
9	Cd+T1	mg/ Nm ³	0.05 (measured mean)		0.05 (measured mean)	
10	Pb+Cr and other heavy metals	mg/ Nm ³	0.5 (measured mean)		0.5 (measured mean)	
1 1	Dioxins (TEQ)	ng-TEQ/ Nm ³	0.1		0.1	

3.14.1.4 Flue Gas Treatment Process

The flue gas purification method of the project adopts the " SNCR furnace denitrification (urea) + semi-dry deacidification + activated carbon injection + dry spray deacidification + bag dust removal + SCR (reserved)" process to ensure that the flue gas pollutants reach the project Environmental emission requirements. The flue gas purification system is designed according to the configuration of 4 sets of 4 incinerators.

The flue gas purification process selected for this project consists of the following systems: furnace denitrification system, lime slurry preparation system, spray reaction system, slaked lime injection system, activated carbon injection system, dry injection deacidification system, bag filter system, induced draft fan and flue systems.

The in-furnace denitration SNCR system is a proven high-efficiency in-furnace denitrification system, which can effectively reduce the emission of nitrogen oxides in the factory. The chemical reaction process of the SNCR system is to reduce nitrogen oxides to nitrogen and water by injecting a reducing agent, and no by-products that are harmful to the environment are produced during the reaction process. The reducing agent is 10% urea solution, which is sprayed into the incinerator, and reacts with the nitrogen oxides in the flue gas generated by the incinerator under optimal temperature conditions to generate nitrogen and water.

190 °C temperature at the outlet of waste incineration waste heat boiler enters the top of the semi-dry method (rotary spray reaction tower). The top channel of the rotary spray reaction tower is equipped with a guide plate, which can make the flue gas move downward in a spiral shape. The rotary atomizer is located on the upper part of the spray reactor. The lime slurry from the lime slurry preparation system enters the rotary atomizer. Due to the high-speed rotation of the atomizer, the lime slurry is atomized into tiny droplets, which are in a spiral direction. The flue gas moving downward forms a counter current and is carried downward by the huge flue gas flow. During this process, the lime slurry reacts with the acid gases HCl, HF, SO₂ and so on in the flue gas. In the first stage of the reaction process, a neutralization reaction occurs by gas - liquid contact, the water in the lime slurry droplets is evaporated, and the flue gas is cooled at the same time; in the second stage, the gas - solid contact is further neutralized and a dry solid reaction is obtained Products CaCl₂, CaF₂, CaSO₃ and CaSO₄ etc. This

cooling process also causes condensation of dioxins, furans and heavy metals. The reaction product falls into the reactor cone and is discharged from the bottom of the cone. Fly ash passes through the rotary valve and is discharged to the public scraper conveyor of the fly ash conveying system through the fly ash conveyor under the reaction tower, and the flue gas carrying fly ash and various dusts enters the bag filter. In order to prevent the reaction product from absorbing moisture and depositing, the cone of the spray reaction tower is equipped with an electric heating device to heat and keep warm when the system is started in a cold state and the temperature of the ash hopper is low. In addition, the cone part of the reaction tower is equipped with a rapping device, and the ash outlet is equipped with a discharge crushing device, which can prevent large ash blocks from blocking the outlet.

In the reaction tower, the rotary atomizer sprays lime slurry into the flue gas, and the flue gas evaporates the sprayed desuperheating water to reduce the temperature of the flue gas to about 150~160 °C. The cooled flue gas is exported from the lower side of the reaction tower and enters the bag filter through the flue.

Activated carbon injectors and slaked lime injectors are arranged on the flue connecting the reaction tower and the bag filter. Activated carbon powder and slaked lime powder enter the flue through the nozzle respectively and are fully mixed with the flue gas in the mixer. Heavy metals and dioxins in the flue gas the particles are adsorbed by activated carbon and enter the bag filter along with the flue gas, and the slaked lime reacts further with the acid gases SO₂ and HCl in the flue gas. The heavy metals, dioxins and dust adsorbed by activated carbon are separated in the bag filter, discharged through the ash hopper, and then entered the ash bin through the conveying equipment.

The flue gas temperature at the outlet of the bag filter is about 150 °C.

The flue gas is discharged into the atmosphere through the 100m high chimney after passing through the induced draft fan.

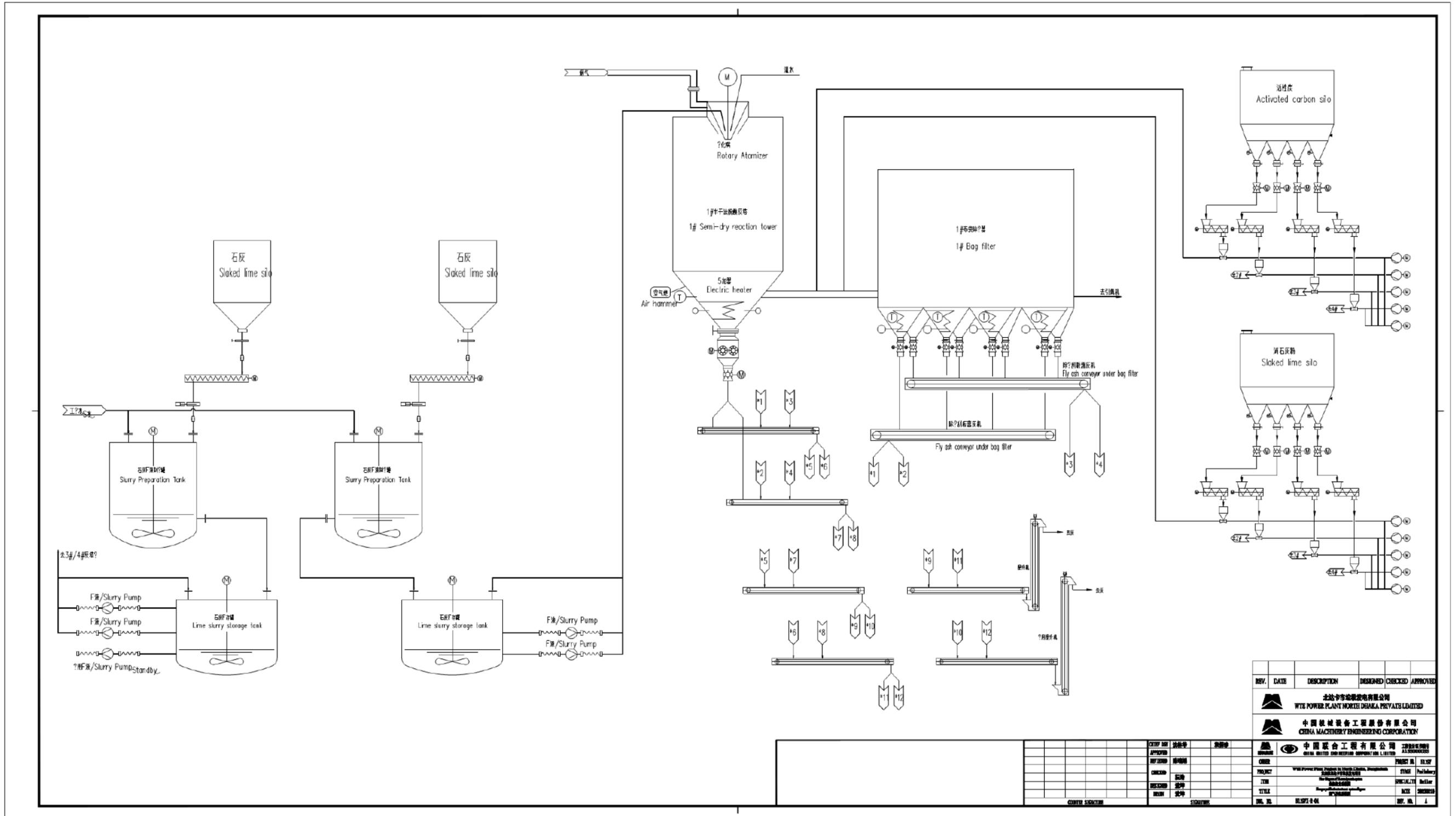
In this project, 4 flue gas purification lines are set up, corresponding to 4 incineration lines. The setting of all public facilities (urea, slaked lime, activated carbon, etc.) can meet the requirements of 4 flue gas purification lines.

The flue gas purification process of this project mainly includes the following systems:

1. SNCR denitrification system
2. Semi-dry spray deacidification system
3. Slaked lime storage and lime slurry preparation system
4. Slaked lime injection system
5. Activated carbon storage and injection system.
6. Bag filter system
7. Exhaust system/Chimney

The details flow diagram of Flue Gas Purification Treatment and SNCR System have been given in Figure 3-12 & respectively.

Figure 3-12: Flow diagram of Flue Gas Purification Treatment

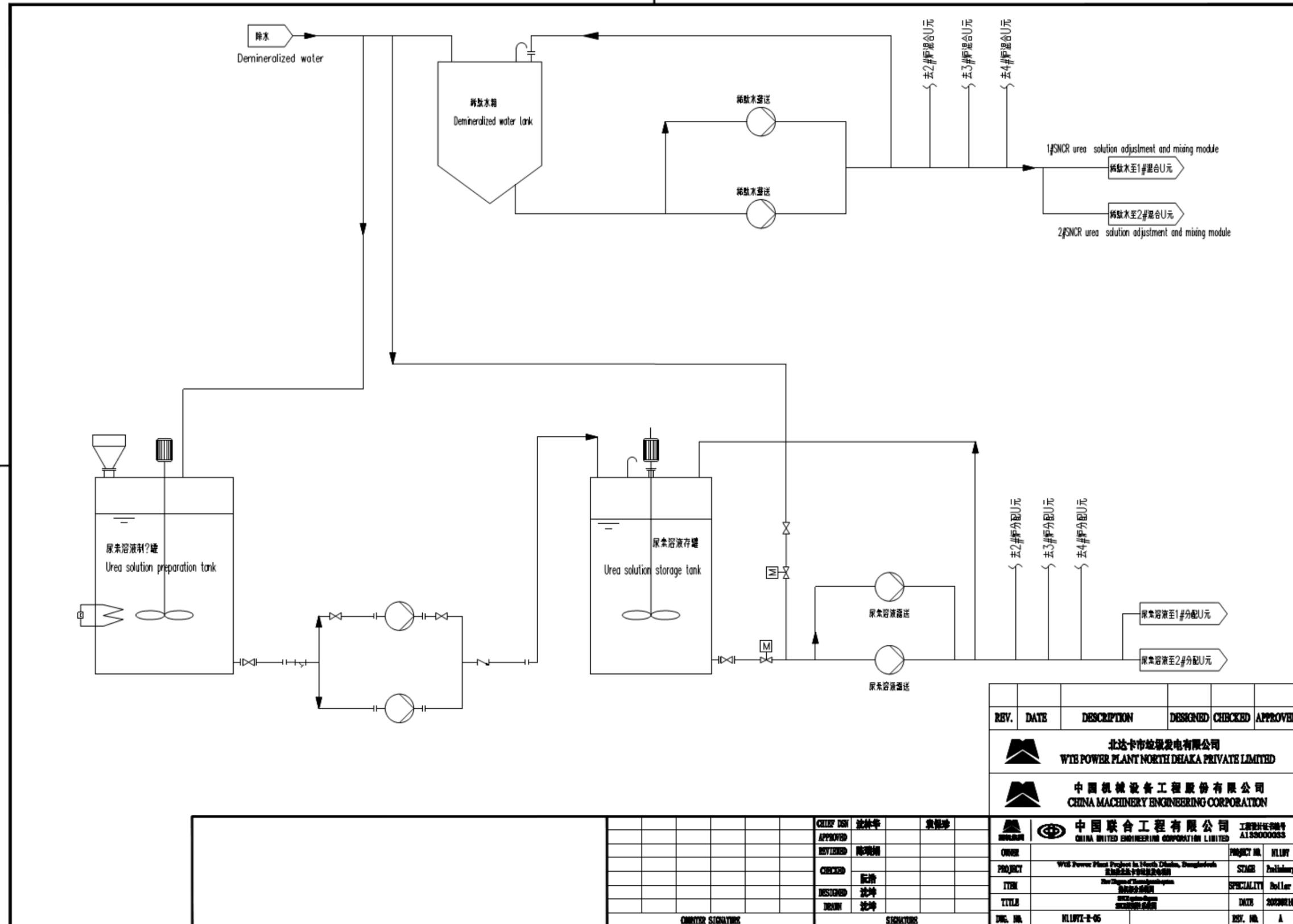


REV.	DATE	DESCRIPTION	DESIGNED	CHECKED	APPROVED

北达卡特姆机电有限公司
 WTE POWER PLANT NORTH DHAKA PRIVATE LIMITED
 中国机械装备工程股份有限公司
 CHINA MACHINERY ENGINEERING CORPORATION
 中国联合工程有限公司
 CHINA UNITED ENGINEERING CORPORATION LIMITED

DATE	REV.	DESCRIPTION	DESIGNED	CHECKED	APPROVED
2012-04	1				

Figure 3-13: Flow diagram of SNCR system



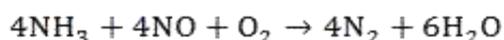
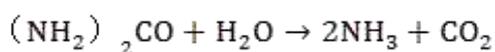
3.14.1.5 Composition of Flue Gas Treatment System

The Flue Gas Treatment System of this project consists of the following sections:

- SNCR system
- Semi-dry reaction tower system
- Activated carbon storage and injection system.
- Dry powder (Ca (OH)₂ powder) spray pre-coating system
- Bag filter system
- ID fan system
- Fly ash transportation and storage system.
- Chimney and flue system

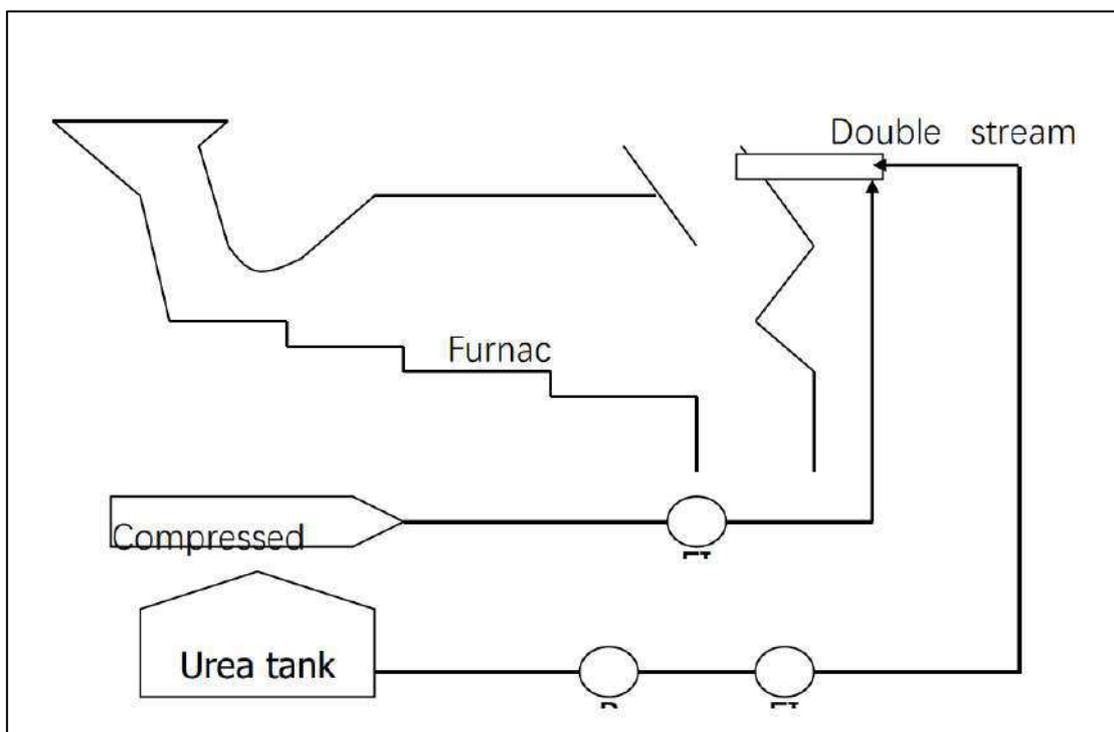
3.14.1.5.1 SNCR system

In this project, the SNCR system uses urea as the reducing agent, and at high temperatures of 850 ~ 1100°C, urea reacts with nitrogen oxide as follows:



The urea solution is ejected into the post-combustion chamber through multiple nozzles, and its cooling or atomizing medium is compressed air and water. The reducing agent is sprayed into the combustion furnace through the nozzle. A three-layer nozzle is set, and a nozzle is equipped, and the specific level used will be determined during the equipment debugging stage.

Figure 3-14: Process flow diagram of the SNCR method



Source: Feasibility Study Report, 2022

Ammonia, carbon monoxide, hydrogen carbide, and other thermal decomposition gases produced during waste drying are used to restore NO_2 ; the NO_2 concentration in Flue Gas is less than 400 mg/Nm^3 when no urea is sprayed into the furnace.

NO_2 -reducing agent urea is sprayed into the high-temperature part of an incinerator at $850 \sim 1000^\circ\text{C}$ and reacts with NO_2 to generate harmless nitrogen (N_2). Ammonia has the effect of preferential reduction of NO_2 under a high-temperature atmosphere. After spraying urea, the NO_2 concentration was below 200 mg/Nm^3 in the final emitted Flue Gas.

In this project, the incinerator can inhibit the emission concentration of NO_2 below 400 mg/Nm^3 by using ACC for combustion management. The SNCR technique can reduce the NO_2 concentration to less than 200 mg/Nm^3 .

3.14.1.5.2 SDA system

The Flue Gas is mixed with lime slurry and water in a semi-dry deacidification tower. The reaction tower has two important functions: One function is to create the best conditions for neutralization reaction, which makes the Flue Gas distributed evenly in the whole reaction tower, and ensures that the Flue Gas is fully mixed with the highly uniform atomized lime solution; and to ensure that the sufficient residence time is sufficient to obtain the dry reaction product; The other function is to cool the Flue Gas in a limited time by using the evaporation of water to absorb heat so that the Flue Gas reaches the set optimal reaction temperature, and the dry reaction product is obtained.

The Flue Gas was discharged from the lower part of the reaction tower after SDA treatment. Part of the dust in the Flue Gas would fall to the bottom of the ash hopper of the reaction tower due to the change in the direction of the flue flow. After an ash hopper collects the dust at the bottom of the reaction tower, it is sent to the fly ash conveying equipment by a rotary valve. An electric heater is installed at the bottom of the ash hopper of the reaction tower to prevent dust accumulation and corrosion.

3.14.1.5.3 Dry powder spray pre-spray system

$\text{Ca}(\text{OH})_2$ is transported from the plant by a tanker and fed into the storage bunker with compressed air. Then $\text{Ca}(\text{OH})_2$ was quantitatively exported from the storage bunker and sprayed into the pipeline between the SDA and the bag filter with a jet fan. Here, $\text{Ca}(\text{OH})_2$ reacts with acidic gases (SO_2 , HCl, etc.) in the Flue Gas and ensures that the concentration of acidic gases is below the emission standard.

Five sets of $\text{Ca}(\text{OH})_2$ supply fans (one standby) were set up, and dry powder was sprayed into the flue before the bag filter. The top of the storage bunker is provided with a ceiling bag filter, which belongs to the pulse-blowing bag filter.

3.14.1.5.4 The activated carbon injection system

The activated carbon is sprayed into the Flue Gas pipeline before entering the dust collector, which absorbs heavy metals and dioxins and ensures the discharge of heavy metals and dioxins reaches the standard.

Activated carbon is transported to the activated carbon storage bunker by a tanker. A blockage prevention device is arranged at the bottom of the storage bunker, the activated carbon of the storage bunker is discharged to the disc feeder, a quantitative feeding device is arranged at the bottom of the disc feeder, 4 Flue Gas Treatment lines can be supplied at the same time, the materials are discharged to the activated carbon injection device through the rotating discharge valve, and the activated carbon injection fan sends them into the Flue Gas pipeline before the bag filter after spraying in the semi-dry reaction tower.

The activated carbon storage bunker is equipped with an N_2 protection system, mainly composed of N_2 gas cylinders and solenoid valves. A temperature measuring element is installed in the activated carbon storage bunker to monitor the temperature in the activated carbon storage bunker.

Five sets of activated carbon supply fans were set up (4 with 1 preparation), and activated carbon was injected into the flue before the bag filter. An active bag filter is installed on the activated carbon storage bunker to absorb the positive pressure during activated carbon loading. The bag filter not only operates in the process of receiving activated carbon in the activated carbon storage bunker but also operates at regular intervals after receiving activated carbon.

3.14.1.5.5 Bag filter system

Pulse dust collector and off-line ash cleaning are selected for bag filter, which is suitable for dust Flue Gas treatment with high temperature, high humidity, and strong corrosion generated by waste incineration. The dust in the Flue Gas is removed, and the Flue Gas reacts with acidic substances and hydrated lime powder for a further reaction so that the Flue Gas meets the discharge requirements.

The bag filter consists of the following equipment: Ash hopper, bag, cage, maintenance, and overhaul passageway devices, isolation baffles for inlet and outlet flue of each chamber, bypass flue and baffle devices, ash hopper heating, bag sweep controllers, pulse valves, etc. Each bag filter consists of a gas-welded steel shell and compartment, which can be completely isolated from the Flue Gas flow when cleaning the ash. The body and compartment are designed to withstand the maximum pressure differential within the system. The supporting structure adopts a steel structure.

Each compartment is equipped with inlet and outlet isolation barriers. When a compartment is isolated, it can keep the bag filter working usually. In other words, when the bag filter is in operation, it can replace the filter bag of the compartment online. Adequate inspection and maintenance of doors are provided for this purpose.

The gap between the top of the bag filter and the top of the chamber is large enough for operation when changing the bag. Steel beams for the hoist for bag replacement are also available if necessary. The design of electrical and mechanical connection holes on the shell, maintenance door, and shell can ensure the sealing performance of the bag filter.

To achieve good uniform Flue Gas distributions, a flue gas equal-flow device inside the flue is considered in advance.

The bag filter will be equipped with heat preservation and heating to prevent condensation of acid and water. The insulation is thick enough to prevent the wall temperature from falling below the dew point.

Heating systems are considered for the outer walls of bag filters, conveyor systems, and equipment to prevent the bridging and accumulation of ash and reaction products in the storage bunkers of the equipment (e.g., hoppers, valves, piping, etc.). The hopper of the bag filter uses electric tracing.

The filter material of the bag filter is resistant to a temperature higher than the maximum temperature of the economizer outlet Flue Gas. It will not cause damage to the filter material of the bag filter even if the Flue Gas temperature out of the economizer does not decrease. The ash hopper of the dust collector is equipped with electric tracing to ensure that its temperature is not less than 140 °C. When starting at a low temperature, the ash hopper must be preheated to at least 140°C before introducing the Flue Gas (temperature above 140°C).

During start-up and short stops, hydrated lime powder is sprayed on the upstream flue of the bag filter to add to the ash-facing surface of the bag filter when the bag filter needs to be protected.

The hopper must be dry and warm during conditioning to prevent condensation. Because once there is condensate, the effect of ash removal would be hindered. The ash hopper is equipped with a mature ash arch breaking device arranged on the outer wall of each ash hopper as a permanent device, which can be operated on a platform under the ash hopper when the bag filter is running.

The lower part of the ash hopper is equipped with a conveyor, a rotary valve, and a rotary sealing valve. Special consideration is given to ensure that the flue gas is uniformly distributed on the surface of the cloth bag.

The bag dust collector includes support and accessories designed to ensure effective flue gas cleaning and long service life.

The cleaning system shall be optimized to ensure high dust removal efficiency, low-pressure drop, and long service life. Compressed air used for the instrument will be used for cleaning the filter bags (i.e., compressed air pulse system). Compressed air shall be of a nature that ensures that no obstructions or caking occur in the filter media.

This system is mainly composed of the following main equipment:

- Filter housing with inlet and outlet air ducts
- Access door and maintenance entrance
- Gas distribution system
- Support and accessories of the filter bag
- The automatic ash removal system
- Ash hopper
- Ash hopper electric tracing
- Flying ash discharge device
- Control system
- A lifting device is required for the change of the filter bag.
- Platforms, stairs, and rails

3.14.1.5.6 ID fan system

An ID fan shall be set after each bag filter to maintain a certain negative pressure in the furnace and ensure the normal and stable operation of the incineration and flue gas treatment system. The ID fan is controlled by "electric baffle + frequency conversion." The bearing cooling water comes from the process water and circulating water, respectively, and can be used separately, and the return water directly enters the circulating water system. The ID fan shall be provided with a maintenance bracket to ensure disassembly and transportation. Appropriate measures shall be taken to check lubrication systems, field thermometers, and temperature transducers and ensure that alarm signals can be transmitted to the central control Room. ID fan can be started or stopped in situ or DCS. The temperature detector shall be installed in the motor coil of the fan, the temperature values of each phase shall be displayed on the DCS, and an alarm shall be set.

Each flue gas treatment line shall be equipped with one ID fan. When the fan is selected, the maximum air volume shall meet the requirement of 120% of the air volume under MCR operating conditions. The head of delivery shall be 120% of the pressure loss calculated according to the MCR operating conditions.

This system is mainly composed of the following main equipment:

- ID fan and motor
- Frequency conversion control panel (including transformer)
- Suction baffle and drive device
- Accessories

3.14.1.5.7 Flue pipeline system

The flue gas pipeline and pipe fittings include all accessories connected between various equipment from the outlet of the boiler to the chimney through flue gas treatment equipment. The flue gas pipeline system mainly includes:

- Flue gas pipeline system (including expansion joint, maintenance pipe base, manhole, etc.)
- Various bezel and switch devices
- Stent

- Maintenance of steel platforms and stairs
- Accessories
- Insulating paint

3.14.1.5.8 Chimney

The flue gas is sent to the chimney made of steel pipes with a height of 100 m for discharge. Each incineration line shall be provided with a separate cylindrical carbon steel flue gas pipe with anti-corrosion treatment inside and a concrete sleeve outside. The flue gas online monitoring room is located at the bottom of the sleeve.

3.14.1.5.9 Flue gas online monitoring

A local industrial computer automatically controls the flue gas treatment system; The information of the flue gas sampling detector, SO₂ analyzer, NO₂ analyzer, HCl analyzer, CO analyzer, dust analyzer, and flue gas flowmeter for online monitoring, and other monitoring information is transmitted to the central control room via sensors and displayed by a computer. Each production line shall be equipped with an online monitoring device.

3.14.1.5.10 Flying ash conveying and storage system

This system is the equipment that conveys the flying ash from the reaction tower and the flying ash from the bag filter (bag ash) to the fly ash silo and stores it in the storage warehouse.

Flying ash from the deacidification reaction tower is conveyed to the common scraper conveyor for flue gas treatment through the bag filter and star discharging valve; flying ash from the bag filter is conveyed to the scraper conveyor at the bottom of the bag filter through the plug valve and star unloading valve, then enters the common scraper conveyor for flue gas treatment through three-way reversing valve, which is connected with bucket elevator, and then is sent to the ash silo through spiral distribution conveyor.

3.14.2 Flying Ash Collection and Treatment System

This system starts from the bottom of the rotating spray semi-dry Ca(OH)₂ reaction tower and the ash hopper of the bag filter to the discharge valve at the bottom of the flying ash storage silo, including the rotating spray semi-dry Ca(OH)₂ reaction tower, bag filter flying ash collection, conveying and storage equipment, driving device, auxiliary facilities, and other relevant facilities. Flying ash shall be conveyed mechanically. The flying ash collected by the four incineration lines will be discharged onto two common scraper conveyors, conveyed to the top of the flying ash storage silo by bucket elevator, and distributed to the two storage bins by the two-way screw conveyor at the top of the storage silos. Requirements for main functions and design of fly ash collection system.

3.14.2.1 Flying ash treatment system

The output of flying ash under the rated operating conditions of this project (waste is dumped for 365 days and incinerated for 333 days) is 74.8t/d.

The fly ash treatment technology in this project is selected as the main scheme: synergistic treatment with cement kiln; and stabilization of chelating agent ("chelating agent + water" fly ash solidification landfill) can be as the backup.

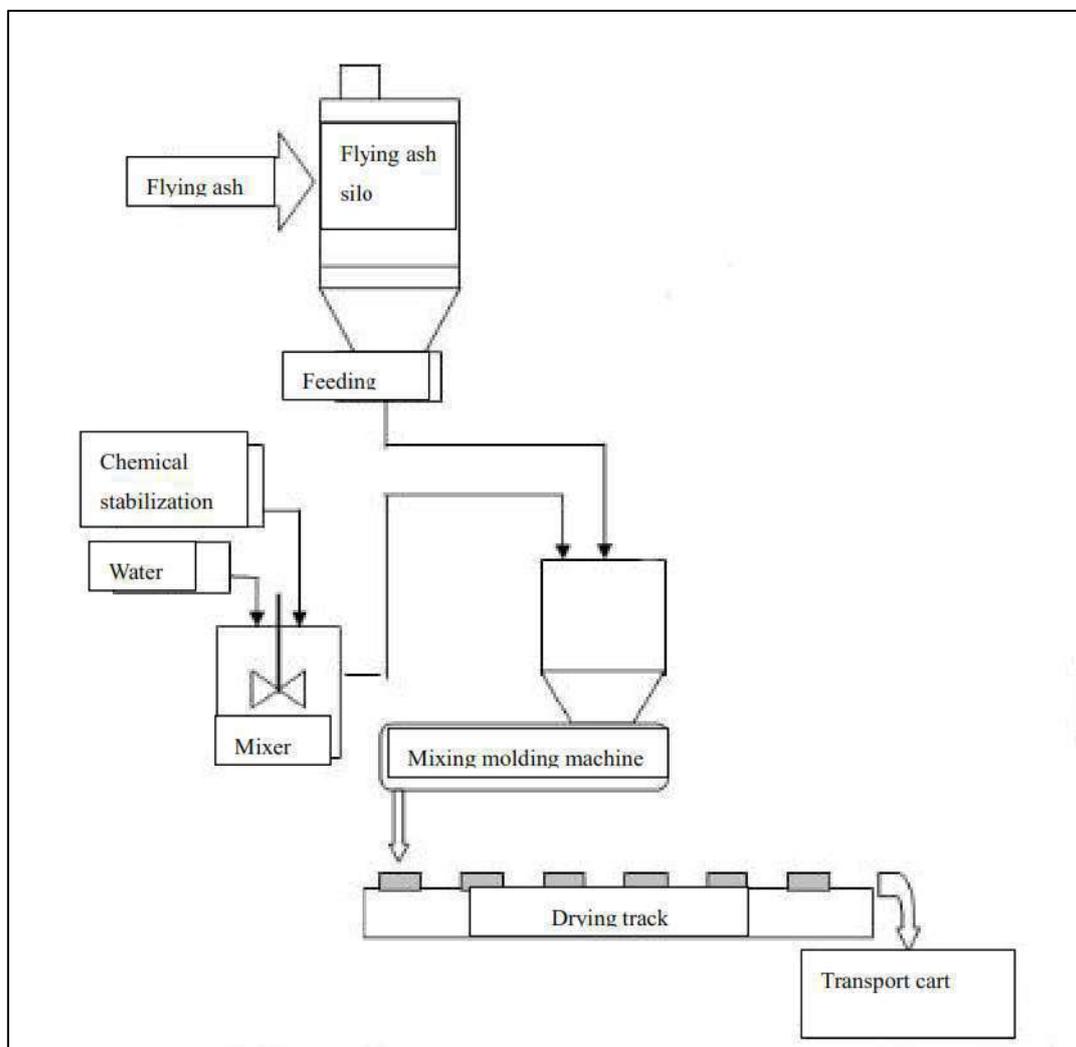
1. Introduction to the scheme

The flying ash in the silo is sent to the flying ash metering device through the discharging valve. The flying ash metering device continuously discharges the quantitative flying ash into the mixer. At the same time, the stirred chelating agent is added to the mixer through the delivery metering pump according to the proportion set with the flying ash amount, and the remaining solution is returned to the solution reservoir through the pipeline. The mixer is continuous production equipment. The stabilized

flying ash is transferred to the loading workshop through the discharge conveyor for discharging, ensuring that the environment of the flying ash stabilization operation room is clean.

The operator shall flush the mixer after each day of work. The wastewater from flushing shall be discharged into a low-concentration sewage system.

Figure 3-15: Flying Ash Solidification Process Flow Chart



Source: Feasibility Study Report, 2022

After stabilization treatment and the requirements in the Standard for Pollution Control on the Landfill Site of Municipal Solid Waste (GB 16889-2008) are met, it shall be sent to the landfill site for safe disposal.

2. Disposal standards

Chelating agent stabilization method: the fly ash generated by waste incineration contains a high leaching concentration of heavy metals and other dangerous wastes, so the hazardous Waste Identification Standard - Leaching Toxicity Identification (GB5085.3-2007) and the Pollution Control Standard of Domestic garbage Landfill (GB 16889-2008) must be implemented in the disposal of fly ash according to the requirements of hazardous solid waste disposal. After solidification/stabilization treatment, the fly ash will be transported to the landfill site for safe disposal if the following conditions are met: (1) Water content is less than 30%; (2) dioxin content is less than 3 µg-TEQ/kg; (3) Concentration of hazardous components in leach solution prepared in accordance with HJ/T 300 is lower than the limits specified in Table 3-15.

Table 3-15: Concentration limit of contaminants in leach solution (mg/l)

SL No.	Pollutant project	Concentration limits	SL No.	Pollutant project	Concentration limits
1	Mercury	0.05	7	Barium	25
2	Copper	40	8	Nickel	0.5
3	Zinc	100	9	Arsenic	0.3
4	Lead	0.25	10	Total chromium	4.5
5	Cadmium	0.15	11	Hexavalent chromium	1.5
6	Beryllium	0.02	12	Selenium	0.1

Source: Feasibility Study Report

Flying ash shall be conveyed in closed equipment, and the material storage and conveying equipment shall be equipped with ventilation and dust removal facilities. All equipment of the flying ash stabilization system can be operated automatically and continuously through the local control panel, and the main operating signals are sent to the DCS system. At the same time, each piece of equipment can also be operated manually locally separately.

3.14.3 Fly Ash Conveying and Stabilization Systems

3.14.3.1 Composition of fly ash

Fly ash and reaction products are composed of the following parts:

- Smoke from waste incineration.
- Particles produced by the reaction of $\text{Ca}(\text{OH})_2$ with acid gas, among which CaCl_2 and CaCO_3 are components that are easy to absorb moisture and become sticky.
- 2 remaining from incomplete reaction.
- Activated carbon and other impurities.

3.14.3.2 Description of fly ash conveying process

This system starts from the manual valve under the reaction tower and bag filter ash hopper to the dry ash bulk machine at the bottom of the fly ash storage bin, including the collection, transportation and storage of reaction tower fly ash and bag filter fly ash Equipment, drives, auxiliary facilities, and other related facilities. Fly ash is transported mechanically. The fly ash collected by the four incineration lines in the reaction tower and dust collector is discharged to the public scraper conveyor, transported to the top of the fly ash storage bin by the bucket elevator, and sent to the storage bin by the two-way conveyor on the top of the storage bin. The conveying equipment in the public part is 1 for use and 1 for standby. There are two fly ash storage bins, and the total volume can meet the storage capacity of the whole plant for not less than 3 days. The fly ash conveyors and storage bins in this system require electric heat tracing.

The fly ash under the deacidification reaction tower is conveyed to the scraper conveyor at the bottom of the deacidification reaction tower through the gate valve and the ash discharge valve, and then enters the public scraper conveyor for flue gas treatment; the fly ash under the bag filter passes through the gate valve and the ash discharge valve It is transported to the scraper conveyor at the bottom of the bag filter, enters the special scraper conveyor for flue gas treatment, is transported to the bucket elevator through transfer, and then sent to the ash bin through the screw distribution conveyor.

The fly ash scraper conveyor adopts a fully enclosed casing, no material leakage when the equipment is running, the site environment is clean, and the sealing effect is good. Bucket elevators are used in the fly ash conveying system to lift fly ash to the ash bin. Fully enclosed casing, no material leakage

when the equipment is running, and good sealing effect. The ash bin is equipped with a bag filter device, which has a good sealing effect.

Another feature of fly ash is the high moisture content and small particle size. In order to prevent sticking during the transportation of fly ash, its temperature should be kept at 130-140°C. For this reason, the conveyor needs heat tracing and insulation. This design uses electric heat tracing and is equipped with a temperature feedback device. Electric heat tracing is calculated as not less than 300W/m², and the heat tracing cable layout does not exceed 2/3 to 3/4 of the height of the equipment. The outside of the electric heat tracing is insulated so that the external temperature does not exceed 50°C.

The system should include the following facilities:

- Deacidification reaction tower bottom slide valve, crusher, ash unloading valve, scraper conveyor.
- Bottom flap valve, ash unloading valve, scraper conveyor of bag filter.
- Public conveyors 1 and 2 (arranged on the platform)
- Bucket elevator 1, 2
- Fly ash silo top conveyor 1, 2
- Fly ash silo top conveyor outlet electric flapper valve
- Fly Ash Storage
- Electric heat tracing for fly ash storage bins, conveyors and bucket elevators
- Compensator, ash conveying pipe and support.
- Ash bin bottom ash unloading plug valve, rotary ash unloading valve.
- Fly ash bulk machine
- Instrument valves etc.

3.14.3.3 Description of fly ash stabilization process

This project mainly adopts Sinotrans cement kiln synergy. At the same time, a fly ash stabilization process of "fly ash + chelating agent + water" is set up in emergency situations to stabilize the fly ash collected by the flue gas purification system. While ensuring that the contaminants in the fly ash are fixed within the product, it also imparts a certain strength to the product for final disposal.

The fly ash in the fly ash bin is sent to the fly ash metering device through the discharge valve, and the fly ash metering device discharges the quantitative fly ash into the mixer in batches according to the capacity of the mixer, and the mixer feeds. After the completion, the pneumatic valve under the fly ash metering device is automatically closed and no more material is fed. After the feeding is completed, the mixer starts to work. At the same time, the chelating agent and cement that have been stirred are added to the mixer through the delivery metering pump according to the set ratio of the amount of fly ash, and the remaining solution is returned to the solution storage tank through the pipeline. While injecting the solution, the mixer continued to stir. After about 1.5 minutes, the fly ash and chelating agent were fully mixed with the cement solution. The mixer stopped working and began to discharge materials, and the solution metering pump stopped working at the same time. The cycle of each stirring is about 10 minutes, and 6 stirring procedures can be carried out per hour. The stabilized fly ash is discharged into a mold with a size of about 1m³, and after curing in the factory area for 3 days until it is basically formed, it is transported to a designated landfill for landfill.

After the daily work is completed, the operator flushes the mixer. The flushed wastewater is discharged into the outdoor sewage system.

The transportation of fly ash and auxiliary materials in the fly ash stabilization system is carried out in closed equipment. Corrosion-resistant and wear-resistant materials are considered for each pipeline and equipment. Each equipment and pipeline are equipped with measures to prevent dust from flying, prevent blocking and prevent sticking.

This system includes but is not limited to the following:

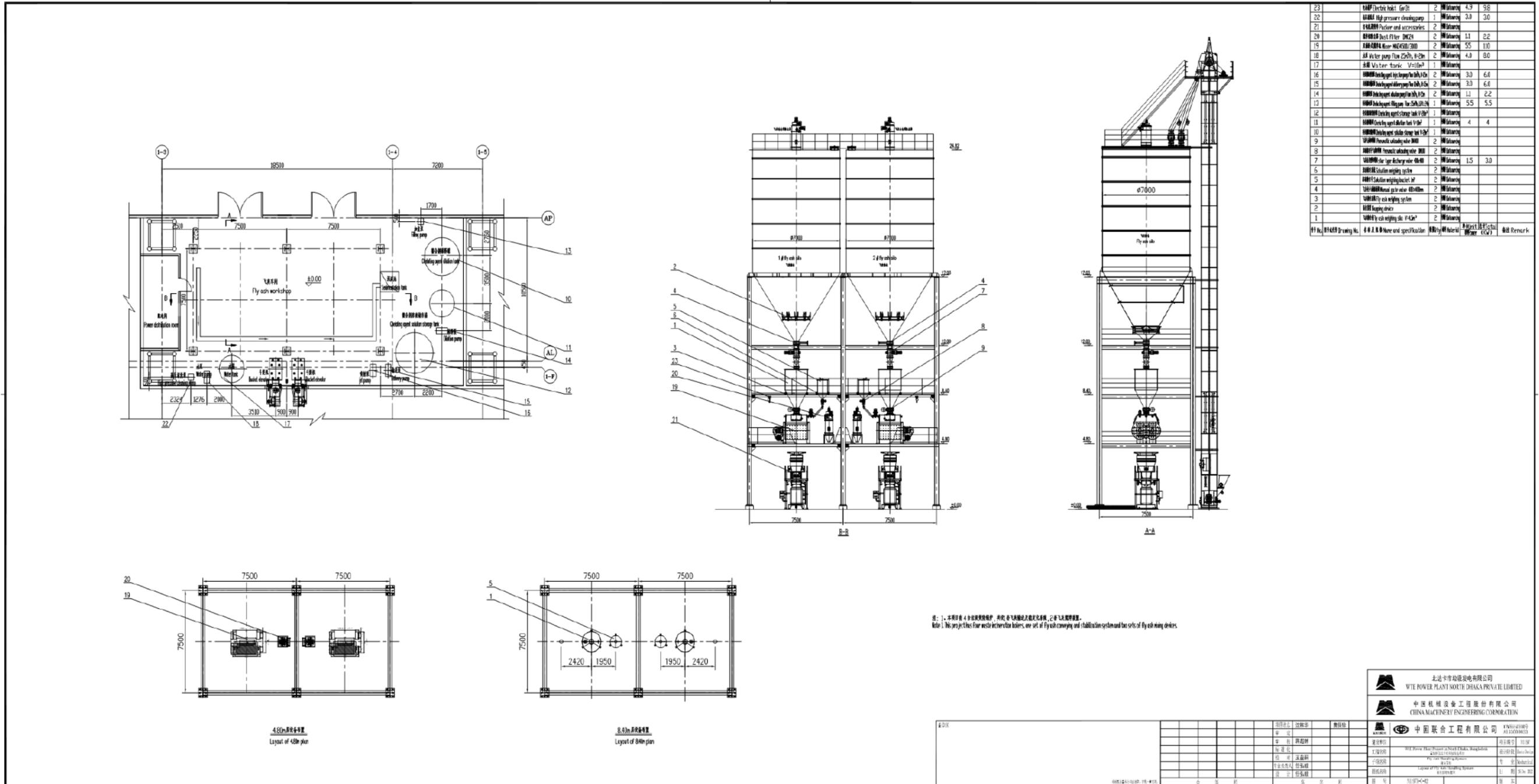
1. Fly ash metering and dosing device
2. Chelating Agent Storage Unit
3. Chelator Hive
4. Cement metering device.
5. mixed unit
6. Unloading device
7. Accessories such as pipes, valves, instruments, expansion joints, supports and hangers.
8. Equipment steel frame, platform, escalator

3.14.3.4 Delivery Process and Sealing Measures when Fly Ash is Transported Outside

When the fly ash is transported outside to cooperate with the cement kiln for processing, the outlet of the fly ash bin is equipped with a dry ash bulk loader to unload the ash. This equipment can be interlocked with the feeding facilities under the silo. Through the control system, the automation of the loading and unloading process is realized. It has high loading efficiency, good sealing performance and no dust pollution. It is an ideal equipment for loading bulk powder materials into trucks and ships. The cement plant will arrive in time every day to transport the fly ash away.

If the cement factory does not arrive in time for transportation, the project also considers the process of temporarily packing and storing fly ash. There is also a packaging device at the outlet of the fly ash bin. The fly ash packaging equipment adopts a clamping and sealing structure at the feeding port, which can prevent secondary environmental pollution caused by fly ash jet splashing and dust leakage during the production process. Reduce the occupational health hazards of production personnel. The packaged fly ash is stored in the fly ash temporary storage room, and then sent to the cement plant in a sealed vehicle.

Figure 3-17: Layout of Fly Ash Stabilization system



3.14.3.5 Fly ash Landfill Process

This project is a solidified ash landfill supporting the WtE power generation project in Dhaka City, Bangladesh. It is mainly responsible for the fly ash generated by the WtE power generation project in Dhaka City, Bangladesh. The output of flying ash under the rated operating conditions of this project (waste is dumped for 365 days and incinerated for 333 days) is 74.8t/d. The main scheme is to apply fly ash in cement kilns as auxiliary raw materials.

The alternative scheme is the stabilization of the chelating agent using “chelating agent+water” .

3.14.3.5.1 Brief introduction of landfill area project

The landfill is a plain-type landfill located northwest of the power plant, near the south area of the existing landfill regulation pool. The total area is about 19350 m², and the construction plan of the landfill area is as follows:

- Set a dam on the west side of the landfill site, make a dam on the other three sides based on the current situation and designed terrain, and form an embankment around the field as the initial storage capacity; A ring road is set on the embankment to facilitate operation. A vertical anti-seepage system is set up along the embankment to prevent the influence of groundwater on the reservoir area.
- A flood interception ditch is set along the outer edge of the landfill reservoir area to reduce the surface runoff into the site and divert rainwater and sewage.
- The foundation in the landfill reservoir area shall be treated appropriately, and the bottom of the site and the slope shall be provided with a horizontal impermeable layer. The leachate drainage system is above the horizontal impermeable layer, and the groundwater drainage system is below.

3.14.3.5.2 Calculation of total storage capacity and service life of landfill area

1. Calculation of storage capacity of solidified fly ash landfill area

The total storage capacity of a landfill is usually divided the designed landfill stack into several sections horizontally according to different elevations, calculate the volume of each section, and then accumulate to obtain the total designed stack volume, which is the landfill storage capacity. Each section can be considered as a platform body and is calculated according to the following platform body calculation formula:

$$V = \frac{1}{3} \cdot H \cdot (S_{upper} + \sqrt{S_{upper} \cdot S_{lower}} + S_{lower})$$

V - Volume of platform body, m³.

H - Height of platform body, m.

S_{upper}-Upper surface area of platform body, m².

S_{lower}-Lower surface area of platform body, m².

Notes: This calculation is an estimate made without a topographic map and is subject to detailed design when a topographic map is provided.

Table 3-16: Year-by-year storage capacity demand

Period(Y)	Daily capacity (m ³)	The storage capacity required for the year (m ³)	Cumulative capacity required(m ³)

1	73.6	24,512	24,512
2	73.6	24,512	49,024
3	73.6	24,512	73,536
4	73.6	24,512	98,048
5	73.6	24,512	122,560

Source: Feasibility Study Report

Based on the calculation in the above table, the storage capacity of a landfill for 5 years is about 150,000 cubic meters. The existing landfill site can meet the requirements of operation and maintenance for 5 years, and the project will adopt the way of fly ash and cement kiln to handle fly ash. This landfill is used as an emergency fly ash landfill.

3.14.3.5.3 Overall process flow of Fly ash Landfill

The elevation of the fly ash landfill shall be above the flood level with a return period of no less than 50 years. The east, south, and north sides of the landfill area are relatively high-lying, while the west and middle areas are low-lying, which is a flat landfill. A dam will be built on the west side of the landfill, and the other three sides will use the current situation and design terrain as dams, and a dike will be formed around the site, and no above-ground dike will be set. The storage capacity of landfill for 5 years will require about 150,000 m³. Therefore, the design storage capacity of the landfill is determined to be 152,500 m³, the elevation of the bottom of the reservoir is about -5.3m (relative elevation), and the height of the upper part is about 10m. The existing landfill site can meet the requirements of operation and maintenance for 5 years, and the subsequent project company will adopt the way of fly ash and cement kiln to handle fly ash. This landfill is used as an emergency fly ash landfill.

After stabilization treatment, it is temporarily stored in the fly ash workshop of the domestic waste incineration plant. After passing the test, it is transported to the landfill operation area by car. After arriving at the unloading platform at the northeast corner of the storage area, the ton bag is hoisted into the storage area by a crane. The forklift evenly and neatly stacks the fly ash chelate in the storage area. During the landfill process, it is necessary to cover it tightly with a 1.00mm thick HDPE anti-seepage film to prevent the rainwater from washing the fly ash solidification during the rainy season and causing a large amount of seepage Liquid.

3.14.3.5.4 Transportation System Design

The transportation of fly ash in this project is in-plant transportation, and the transportation is by car, with a distance of about 240m.

The transport items involved in this project are road dangerous goods, and real-time monitoring and management will be carried out on the operation process of the road transport vehicles and drivers.

3.14.3.5.5 Workmanship

1. It is tested in the existing waste incineration power plant and can only enter the landfill reservoir area for landfill operations after meeting the entry standards. Fly ash that does not meet the entry standards cannot leave the fly ash temporary storage room.
2. Establish 3D grid graphics and fill in landfill records. Landfills in this project have different properties. In order to track landfills, 3D grid graphics must be established. The method of landfill for each landfill unit shall be documented.

3.14.3.5.6 Landfill process

1. **Landfill technology under embankment:** The first layer of landfill under the embankment adopts the pit filling method, that is, the transport vehicle enters the operation unit from the temporary road, passes through the transition platform paved with roadbed boxes, and drives

to the unloading platform. The material under the ground is hoisted 10m away from the unloading platform, and the material is pushed in the depth direction from top to bottom by a forklift along the corner line of the bottom slope.

2. Embankment landfill process: The unloaded materials are piled up to 2.5m in the depth direction on the 1:4 slope operation surface by a forklift to form a platform, and then the vehicle unloads the materials on the operation platform; the forklift adopts the same operation method as under the embankment, so Repeat until the design elevation is reached for the third time.
3. **Covering process:** After the fly ash is landfilled, in order to maintain a good environment, prevent the landfill from scattering, and prevent rainwater from entering the pile to form leachate, the working surface should be covered with a 1.00mm thick HDPE film in time.

3.14.3.6 Details on Residual Generation and Management

Sludge generated during the leachate process includes the Grid slag of the grid system and residual sludge of the biochemical treatment system. The sludge is pumped to the sludge tank by a sludge lift pump and lifted through a screw pump into the dewatering room for treatment. The mud cake with less than 80% moisture content after dewatering is transported to the waste bunker for incineration treatment. The supernatant fluid in the sludge cell and portions of dehydrated filtrate return to the biochemical system.

3.14.3.7 Fly ash landfill Anti-seepage Engineering

The main purpose of the anti-seepage project is to prevent leachate from polluting groundwater and the surrounding environment. Landfills must be treated against seepage to prevent contamination of groundwater and surface water while preventing groundwater from entering the landfill area. The permeability coefficient of natural clay lining and modified clay lining shall not exceed 1×10^{-7} cm/s, and the thickness of field bottom and four-wall lining shall not be less than 2m.

3.14.3.7.1 Vertical anti-seepage

For vertical anti-seepage measures, use the natural impervious layer at the bottom of the reservoir area as the bottom anti-seepage layer, and then build a circle of anti-seepage walls around the reservoir area. The bottom of the anti-seepage wall is 2m deep into the natural impermeable layer to form a complete and relatively Independent hydrogeological unit. The project recommends the use of double-axis cement mixing piles and double-row construction technology as vertical anti-seepage measures.

3.14.3.7.2 Horizontal anti-seepage

The most commonly used geo-membrane in this project is high-density polyethylene (HDPE). HDPE membrane not only has a small permeability coefficient, which can reach 10-12cm/s; it also has excellent mechanical strength, heat resistance, chemical corrosion resistance, environmental stress cracking resistance and good elasticity. , Yield point strength, tear strength, and puncture strength gradually increase.

The 1.5mm or 2.0mm thick HDPE film used in this project has accumulated rich experience in the construction of HDPE film in China. The anti-seepage method is as follows:

Anti-seepage structure in this project, combined with the site geological conditions, the anti-seepage standard of the landfill adopts a double-layer liner anti-seepage system, and the details are as follows:

1. Bottom
 - 200g/m² geotechnical filter
 - Full pavement of pebbles, particle size 20~40mm, thickness 300mm (partial blind ditch)
 - Non-woven geotextile (600g/m²)
 - 2.0mm thick HDPE geo-membrane layer (double smooth)

- Three-rib composite drainage net 6mm
- 1.5mm thick HDPE geo-membrane layer (double smooth)
- GCL betonies blanket ($\geq 5000\text{g/m}^2$)
- Compacted clay 300mm (compaction degree greater than 95%)
- Full pavement of crushed stones, particle size 60mm, thickness 300mm (partial blind ditch)
- Soil compaction

2. Slope:

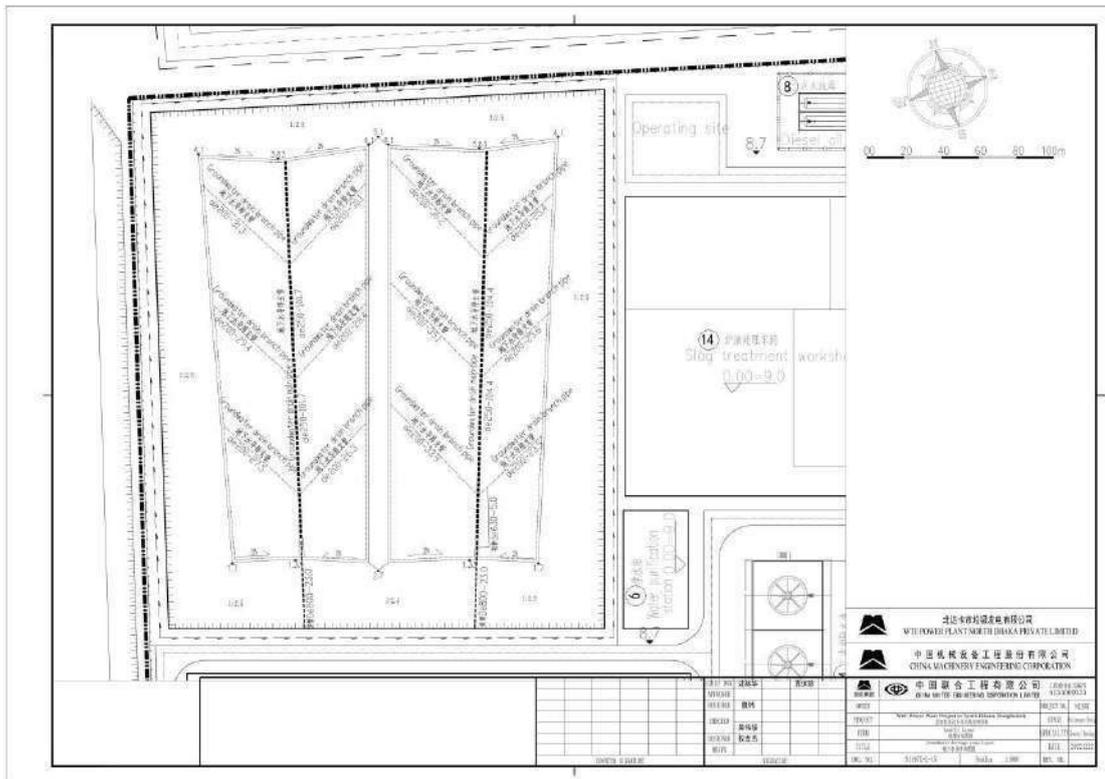
- Bagged gravel cover
- Non-woven geotextile (600g/m^2)
- Double rough HDPE geo-membrane (2.0mm thick, rough side down)
- Three-rib composite drainage net 6mm
- Double rough HDPE geo-membrane (1.5mm) thick
- GCL betonies blanket ($\geq 5000\text{g/m}^2$)
- Non-woven geotextile (600g/m^2)
- Three-rib composite drainage net 6mm
- Soil compaction.

3.14.3.8 Fly ash landfill Drainage System

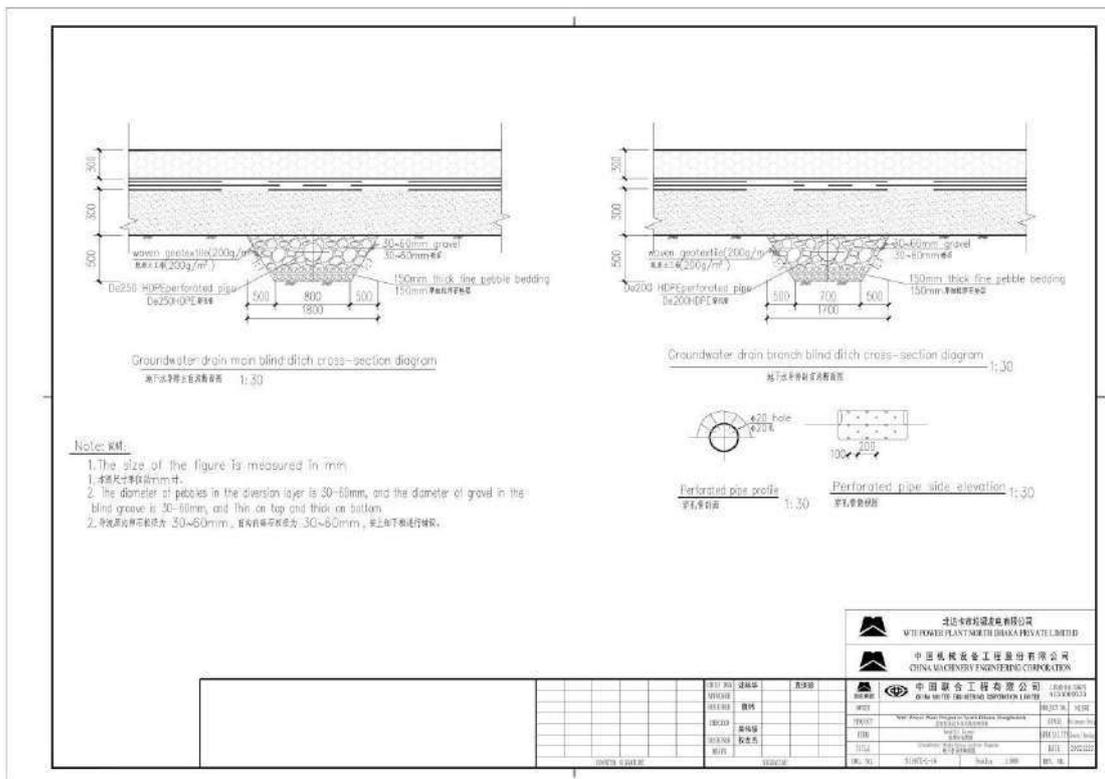
3.14.3.8.1 Groundwater drainage project

The groundwater collection and drainage project includes full pavement diversion layer, main (auxiliary) guiding and drainage blind ditch, water collection pipe and discharge pipe, etc. The full pavement guide layer adopts graded gravel with a particle size of 30mm~60mm and a thickness of 300mm. The main blind ditch is laid along the base clearing control line at the lowest part of the reservoir bottom. The section of the main blind ditch adopts a trapezoidal form, the bottom width is 800mm, the upper bottom width is 1600mm, and the depth is 400mm. 600mm graded gravel, with De250 HDPE flower pipe inside, in order to prevent the surrounding sediment from entering the drainage pipe through the drainage layer, use 600g/m^2 non-woven geotextile to wrap the gravel and the water collection pipe. Auxiliary blind ditches shall be set at intervals of 20m on both sides of the main blind ditches. The blind ditch at the foot of the reservoir bottom slope and the auxiliary blind ditch have the same section form, both adopt trapezoidal section, the lower bottom is 600mm wide, the upper bottom is 1400mm wide, and the depth is 400mm. For the gravel, the HDPE flower tube of De200 is set inside, and the gravel and the water collection pipe are wrapped with 600g/m^2 non-woven geotextile. At the same time, it is connected with the main blind ditch.

Groundwater drainage plane layout (see Appendix J-13)



Groundwater drains cross-section diagram (see Appendix J-14)



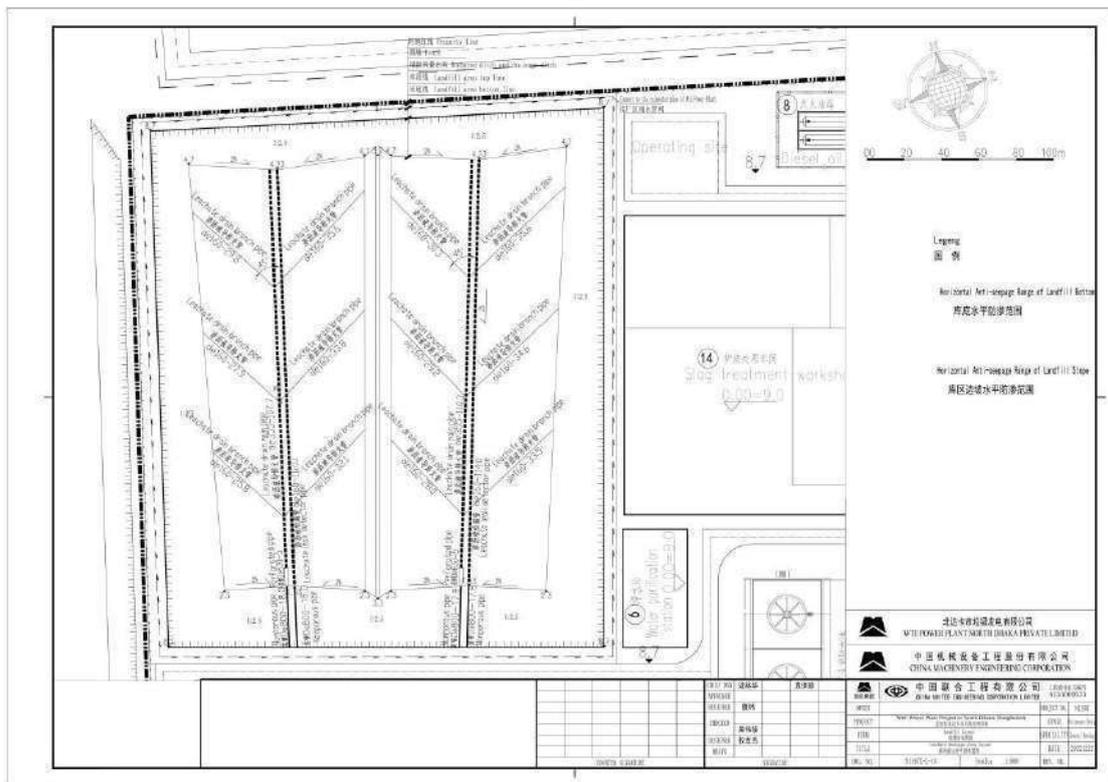
3.14.3.8.2 Leachate drainage project

In order to prevent the leachate from accumulating in the field and affecting the operation and polluting the environment, this project is designed to collect and guide the leachate reasonably. The leachate collection system is composed of gravel layer, blind ditch and water collection pipe. The selection

scheme of the leachate diversion layer is as follows: a 300mm thick gravel layer is laid on the protective layer, and the gravel particle size is 16-32mm.

A leachate drainage layer is laid on the bottom of the reservoir, and a leachate drainage blind ditch is partially provided. The main blind ditch is located in the middle of the reservoir area, arranged in a north-south direction, and the leachate guiding and draining branch blind ditch is arranged at a certain distance on both sides of the main blind ditch. A leachate drainage well is installed at the end of the main blind ditch for leachate collection in the reservoir area, and a drainage pump is installed in the well. The leachate is lifted by the drainage pump and leads to the rainwater ditch and the leachate delivery pipe respectively.

Leachate drainage plan layout (see Appendix J-11)



- The rainwater accumulated in the non-landfilled unit utilizes the leachate collection well of the unit and the sewage pump to switch the valve to close the access to the adjustment tank and directly discharge to the rainwater open ditch on the embankment.

Rainwater drainage measures on embankment

Rainwater open ditches shall be set around the slope foot of each layer to be discharged into the surrounding water bodies.

Rainwater ditches on embankment. Rainwater open trenches can be divided into three categories according to the length of life: permanent rainwater open trenches, semi-permanent rainwater open trenches, and temporary rainwater open trenches.

- Permanent rainwater open ditch: set up around the landfill operation unit and on the steps of the closure cover system.
- Semi-permanent rainwater open ditch: set on the middle covering film of the landfill pile, and introduce rainwater into the permanent open ditch for discharge.
- Temporary rainwater open ditch: used to divert rainwater out of the landfill area and flow to (semi) permanent rainwater open ditch. When the landfill covers these open ditch, it will lose the function of rainwater drainage.

Rainwater from fly ash transportation lines

For the initial rainwater of the transportation line, the final environmental assessment shall prevail.

Rinse water

The washing water of the car washing station is recycled, and the peak period of the leachate treatment station is staggered, and it is regularly discharged into the leachate treatment station for treatment.

3.14.4 Slag Treatment System

The system includes the conveying, storage, and delivery of slag.

3.14.4.1 Characteristics and output of slag

The slag in this project is mainly the residue after waste combustion, and its generation depends on waste composition; its main components are MnO, SiO₂, CaO, Al₂O₃, Fe₂O₃, and a small amount of unburned organic matter, scrap metals, etc.

The reciprocating grate incinerator is used in this project to ensure that the slag thermal ignition reduction rate can be $\leq 3\%$.

Slag amount under rated operating condition: the project produces about 500 t/d wet slags per day and 182,500 t/a wet slags per year under the designed treatment condition of the power plant.

The main plant is equipped with slag pits that can meet the storage capacity of the whole plant for more than 3 days. After being loaded by crane, the slag in the slag pool is sent to the comprehensive utilization workshop for disposal and production of asphalt concrete or the slag treatment plant for landfill. The slag treatment station diagram is given in **Appendix H**:

3.14.4.2 Slag collecting and conveying system

1) Slag type:

- The slag, after complete combustion, falls into the slag extractor from the slag discharge tube.
- The leaked slag of the incinerator grate is collected by the grate slag conveyor and then sent to the slag extractor through the grate leaked slag conveyor.

- Ash deposits in the residual heat boiler are conveyed to the slag extractor or directly to the slag silo using a boiler bottom ash conveyor. The corresponding ash deposits are collected at the ash hopper and horizontal convection heating surfaces of the second and third galleries. A scraper conveyor shall be set along the total width of the second and third galleries. Under the conveyor and the ash hopper of the horizontal gallery, there shall be a rotary valve, a cast structure, and a carbon steel plate. The boiler ash is then conveyed through the conveyor to the slag conveyor and slag extractor.

2) The main functions of this system are as follows:

- Collection and conveying of leaked slag under a grate.
- Collection, extinguishing, and conveying of grate slag.
- Conveying of wet ash residue to the ash slag storage room
- Considering the local maintenance control box of conveying equipment, the setting of the control box shall include the local/remote transmission transfer switch, Local start/stop button, emergency stop button, audible and visual alarm, etc.
- The setting of necessary operation platforms, maintenance platforms, stairs, and rails.

3) Slag extractor design description

- If the slag extractor is in the form of a water bath, the slag shall be extinguished by wastewater, and the slag extractor's design shall meet the water-saving requirements.
- The slag extractor shall be completely sealed to prevent steam generated during slag cooling from eroding the surrounding equipment and structure.
- The slag extractor's hydraulic device shall have sufficient thrust to ensure safe operation in any condition.
- For maintenance and inspection, the slag extractor shall be easily accessible from all sides.
- The shell of the slag extractor shall be made of steel plates.
- In the design, it shall be considered to prevent the splashing of the water bath caused by deflagration in the furnace or when a large piece of ash falls.
- Access holes shall be set on the side wall of the water storage tank to prevent any air from entering the boiler from the slag extractor.
- All high-load and high-exposure components of the slag extractor shall be easily replaceable wear-resistant components, and all wear-resistant components shall be easily installed and removed.
- The fault signal shall be transmitted to the central control room.

3.14.4.3 Slag storage

Slag composition: After combustion from the incinerator, the residue is mainly non-combustible inorganic matter and partially non-combustible combustible organic matter. There are two electric bridge grab cranes (lifting weight capacity is 10t, grab volume 4m³,) in the slag silo to realize the reverse transport and loading of slag.

3.14.4.4 Slag Pretreatment & Segregation Process Description

In accordance with the principle of "reduction, harmlessness, and recycling", the slag is treated as a resource under the premise of realizing clean production, and the unburned substances and metals in the slag are sorted out, and the finished product after the slag treatment. The resource utilization of sand material transportation.

In this project, a raw material slag receiving and stacking area is set at the end of the slag treatment workshop, and the raw material slag is transported into the raw material slag receiving and stacking area through the vehicle factory for unloading. The stacking area is about 20m×35m, surrounded by retaining walls with a height of 4m, and the stacking height is 6m, and about 3,000 tons of slag can be stacked. The raw material slag stacking area is equipped with a forklift for dumping and sorting the slag.

In order to prevent dust during the slag stacking, a spray dust suppression device is installed above the stacking area, and a mobile fog cannon is equipped.

In order to facilitate feeding, the feeding hopper and feeder are installed in the raw material workshop, and the feeding is carried out through the driving grab (slag crane), and the vibrating feeder can continuously and evenly supply the incinerator slag to the receiving material through simple harmonic vibration. device to ensure continuous and stable follow-up processing load. The slag is sent out of the bin body, and the raw slag is sent to #1 trommel screen through the belt conveyor.

1# trommel screen passes through the iron remover and magnetic separation equipment and then returns to the slag storage for circulation.

After passing through the iron remover (iron powder is sent to the iron removal line), the sieved material of the 1 # trommel screen is divided into two routes running in parallel, passing through the sand making machine, magnetic separator and 3# (4#) trommel screen respectively. The upper material returns to the slag storage for circulation, and the underscreen material is sent to the jig.

The jig is equipped with a screen, and the concentration on the screen is manually selected and sent to the feeding bin for aggregation, and then enters the sand blasting machine in the rail removal line. The material under the screen passes through the action of the jig machine, and the material with light specific gravity is dehydrated and separated by 5# (6#) drum screen and sent to the aluminum throwing line, and the material with heavy specific gravity enters the next stage of jig machine.

The second-level jig is basically similar to the first level. The jig is equipped with a screen, and the concentration on the screen is manually selected and sent to the feeding bin for aggregation, and then enters the shaker in the rail removal line. The material under the sieve passes through the action of the jig, and the material with a light specific gravity is sent to the aluminum throwing line, and the material with a heavy specific gravity enters the shaker, and the precious metal is sorted out, and the material with a light specific gravity passes through the 5# (6#) drum Sieve out the water and send it to the aluminum throwing line .

In addition to the railway line, the 4# trommel under screen is mixed with the concentrate on the first-stage jig machine, then enters the sand making machine, and after being crushed, it is sent to the jig machine. The mixed materials enter the shaker, and the materials with light specific gravity enter the grit chamber.

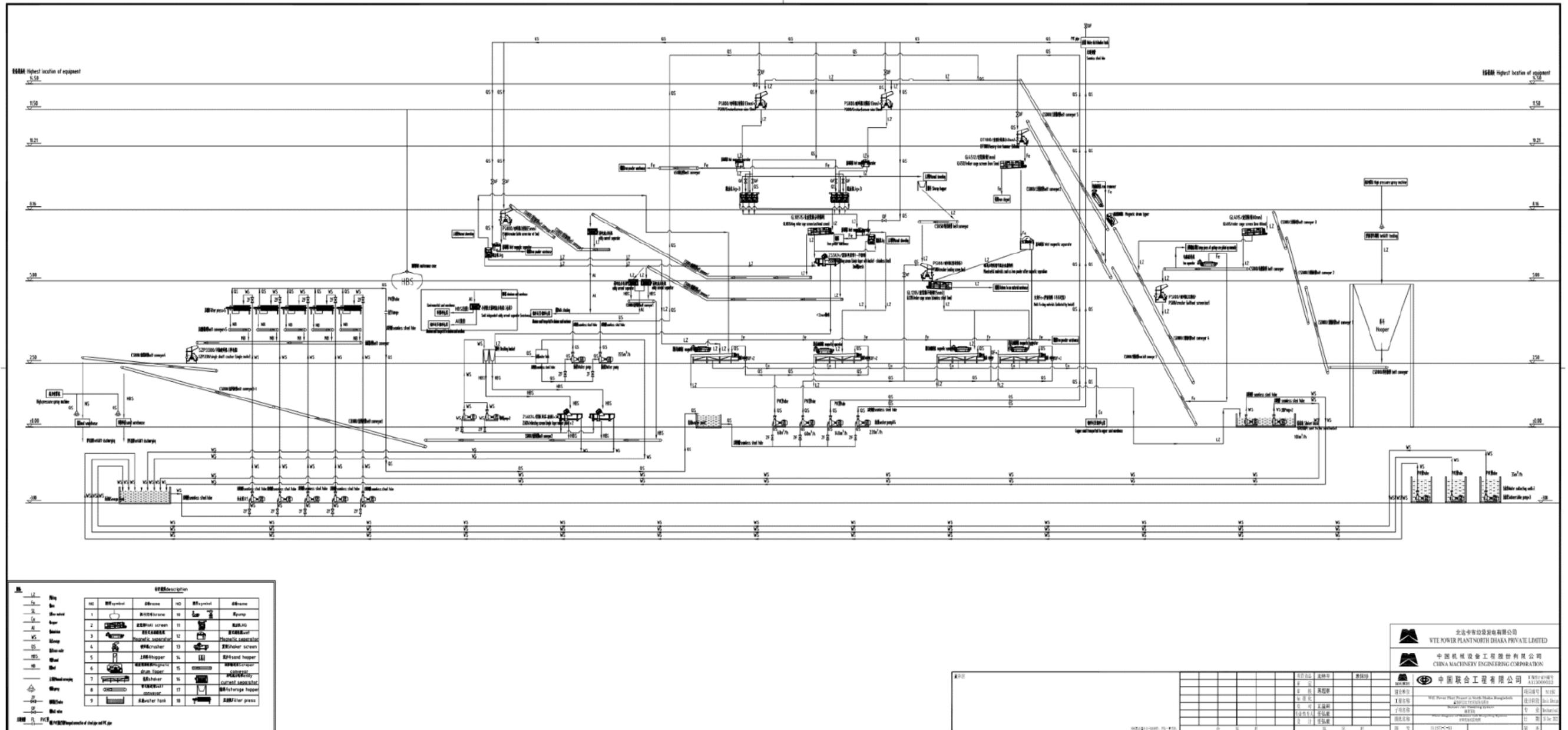
The materials sent by the jig machine to the aluminum throwing machine go through the drum screen to remove water and then enter the aluminum throwing machine. The aluminum materials are sorted out under the action of the eddy current, and the remaining materials are sent to the grit chamber.

The materials in the grit chamber are precipitated, screened by a dewatering sieve, filtered by a filter press, and then sent to the finished product slag warehouse for resource utilization.

Sorted metal takeaway handles.

The unburned material is sent to the garbage pit for incineration.

Figure 3-18: Flow diagram of Slag pretreatment system



3.14.4.5 Slag Recycling System

The slag after waste incineration, grate leakage slag, waste heat boiler combustion chamber, the third flue ash drop, and economizer ash drops to the slag machine and then discharged into the slag bin. The average daily slag output is about 500t/d. Then comprehensive slag treatment system will be set up with dust prevention, fly control, sewage overflow control, and other facilities.

The main raw material of this project is the slag of the waste-to-energy plant, which belongs to the general industrial waste solid. The main components are masonry fragments, stone, glass, smelted slag, iron, other metals, etc. The particle size distribution is concentrated in 2~50 mm. The project transports slag from the slag pit to the comprehensive slag treatment system. The slag is cooled to normal temperature by soaking in the slag discharging extractor. The slag coming through the transport vehicle is wet material with water of about 20% at normal temperature.

Because of the high moisture content of slag, there will be no dust when the slag is transported to the production site of the project. The temporary storage time of slag in the raw material area is not more than 2 days, and a large amount of water will volatilize naturally in the process of slag stacking. Regularly sprinkle slag, maintain slag humidity to prevent dust, and set up an artificial sprinkler.

In this comprehensive slag treatment system, the main productive individuals of slag resource utilization will be arranged integrally in a comprehensive plant house. When the slag enters the plant, it can be stored in the incoming material stacking area (divided into the finished product slag stacking area and the emergency raw slag stacking area). Other areas are divided into the feeding area, sorting area, and related warehouse and stacking area. The components after sorting and sifting will be treated according to their nature, e.g., the metal to be sold and the rest will be sold to other companies to make bricks. So, the project does not include brick-making facilities.

3.14.5 Leachate Treatment Process

3.14.5.1 Production amount and treatment scale of leachate

Waste leachate is derived from the water fluid exuded from solid waste in waste storage pits. The leachate exuded from the waste is collected by the collecting ditch of the refuse storage pit into the leachate collection and storage tank and then transported by leachate transfer pump to the leachate treatment station pond for treatment after pressurization.

The current waste moisture content fluctuates between 55%-75%. After 7-10 days in the waste bin, part of the water content will be removed, and the waste moisture content in the furnace is around 50%. Therefore, the project is expected to produce 330 m³/d~1344 m³/d of leachate treatment.

The treatment process of waste leachate is designed according to the maximum daily production, leaving a certain amount of residue, and the total scale of its leachate design treatment capacity is defined as 1500 m³/d. The leachate treatment station diagram is given in **Appendix I**:

3.14.5.2 Determination of Leachate Treatment Process

3.14.5.2.1 Raw water quality and treatment standards

According to the characteristics of waste incineration power generation projects, the garbage generally stays in the garbage pit for only about 5 days, which is relatively short. Therefore, the time factor of garbage stacking has little influence on the change of leachate wastewater water quality, but really affects the water quality of garbage leachate. According to experience, the following water quality will be used as the influent standard.

Table 3-17: Design influent water quality -of leachate treatment station

Sewage type	COD Cr (mg/L)	BOD5 (mg /L)	NH 3 -N (mg/L)	pH	SS (mg/L)
Landfill leachate	≤ 6 5 000	≤ 3 5 000	≤ 2000	5~9	≤ 15000

The water quality standard for open circulating cooling water in Table 1 of "Urban Sewage Recycling Industrial Water Quality".

3.14.5.2.2 Description of Treatment Process

Conventional process flow is adopted for landfill leachate treatment: anaerobic + aerobic + membrane method (ultrafiltration + nanofiltration + reverse osmosis) process combination.

The primary sedimentation tank through the special collection pipeline through the pretreatment equipment (such as the drum grille machine) and realizes solid-liquid separation by using the material density in the high-turbidity sewage. After removing SS, it passes through It flows into the adjustment tank by gravity, and a submersible mixer is installed at the bottom of the tank to stir the leachate to prevent the sedimentation of suspended solids, and play a role of uniformity and uniformity, which can reduce the impact load on the subsequent process.

The leachate in the adjustment tank is sent to the UASB anaerobic reactor through the sewage lifting pump. The UASB anaerobic reactor has a high volumetric organic load rate and can remove most of the organic matter. Create favorable conditions, and the effluent enters the A/O pool of the MBR system. The biogas produced by the anaerobic system is equipped with a furnace combustion interface, and an emergency flare is installed at the leachate treatment station.

The A/O pool has a high ability to remove organic matter. The nitrifying liquid in the aerobic pool flows back to the anoxic pool, and through the action of denitrifying bacteria, most of the nitrogen-containing substances in the water are converted into nitrogen gas, thus having high-efficiency denitrification ability. After treatment, the effluent is pumped into the MBR membrane system, and the sludge and water are separated through the tubular ultrafiltration membrane. The intercepted sludge is divided into two parts: one part is returned to the A /O pool, and the remaining part is returned to the sewage mud concentration pool. Due to the high interception capacity of the tubular ultrafiltration membrane, on the one hand, it can intercept organic matter, and on the other hand, it can intercept activated sludge, so that the sludge concentration in the A/O pool can reach 15g/L~20g/L, so the biochemical has High organic matter removal capacity and denitrification capacity.

BOD5, ammonia nitrogen and other pollutants in the leachate. The clean water from the nanofiltration system enters the reverse osmosis system to further remove pollutants such as COD and total nitrogen. Through the high interception capacity of the reverse osmosis system for salt and organic matter, the soluble small molecule organic matter, chloride ions, and nitrate ions in the leachate are further removed. Wait for the pollutants to finally reach the standard and return it to the circulating water for replenishment. After the nanofiltration concentrated water is treated by "coagulation and sedimentation", and the reverse osmosis concentrated liquid is treated by DTRO reduction, the clear liquid and the RO system effluent are reused for circulating water replenishment, and the concentrated water is reused for lime slurry preparation or back spraying incinerator. The product water recovery rate of the whole leachate treatment system is not less than 80 %.

Combined with the project characteristics of the waste incineration power station, the odor pollution sources of the leachate treatment system (such as primary sedimentation tank, regulating tank, biochemical tank, sludge treatment system, etc.) are covered and sealed, and centrifugal fans + odor collection and delivery pipes are used the road system collects the odor and transports it to the main plant for unified treatment.

By the primary sedimentation tank, high-efficiency anaerobic reaction system and A/O tank is transported to the sludge tank through the sludge pipeline for further concentration, and then pumped by the screw pump to the centrifugal dehydrator for dehydration treatment. PAM is added during the dehydration process to condition After the sludge properties, it enters the centrifugal dehydrator. After dehydration, the moisture content of the sludge is lower than 80 %, and it is sent to the incinerator for incineration.

Table 3-18: Estimated processing rate of main processing unit

Name		COD (mg/L)	BOD (mg/L)	NH ₃ -N (mg/L)	TN (mg/L)	SS (mg/L)
preprocessing	Influent water quality	65000	35000	2000	2300	15000
	Estimated effluent quality	58500	33250	2000	2300	13500
	Removal rate (%)	10	5	0	0	10
Efficient Anaerobic Reactor	Influent water quality	58500	33250	2000	2300	13500
	Estimated effluent quality	11700	1995	2000	2300	5670
	Removal rate (%)	80	94	0	0	58
MBR(A/O +UF)	Influent water quality	11700	1995	2000	2300	5670
	Estimated effluent quality	936	20	20	92	5.7
	Removal rate (%)	92	99	99	96	99.9
NF	Influent water quality	936	20	20	92	6
	Estimated effluent quality	140.40	1	14	61.4	0
	Removal rate (%)	85%	95	30	33.3	100
reverse osmosis system	Influent water quality	140.4	1	14	61.4	0
	Estimated effluent quality	19.66	0.4	4	18.5	0
	Removal rate (%)	86	66	72	70	100
reuse standard		≤ 60	≤ 10	≤ 10	-	-

3.14.6 Water Treatment Process

According to the requirements of Raw Water quality and boiler feed water quality, this system intends to adopt a "RO + EDI" chemical water treatment process, to ensure that the system produces stable and qualified demineralized feed water system water quality and water volume requirements for Waste heat boiler system. The process flow is as follows:

PAC Scale Inhibitor

↓ ↓

Incoming water from factory water purifier → Raw water tank → raw water pump → multi-media filter → activated carbon filter → security filter → high-pressure pump → two-stage RO device → intermediate water tank → intermediate water pump → EDI device → desalination water tank → demineralized water pump → water point

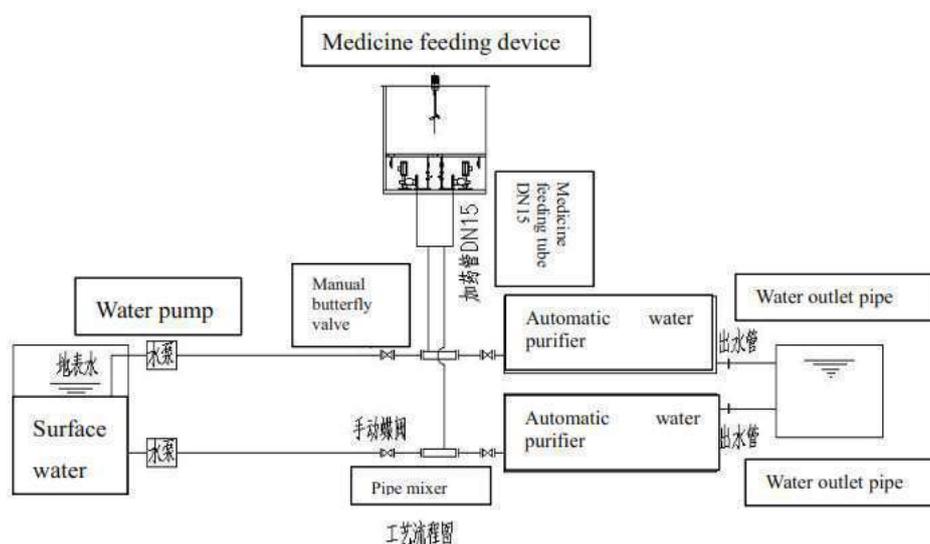
Brief description of the process: The incoming water of the chemical water treatment system uses treated industrial water. After entering the raw water tank, the raw water pump is pressurized and then fed into a multi-media filter to remove some impurities in the raw water. After removing some heavy metals, free chlorine, and other impurities from the water through the activated carbon filter, the water is pumped into the RO treatment system through a high-pressure pump to remove anions, cations, inorganic salts, organics, heavy metals, bacteria, and viruses. The water treated by the RO treatment system enters the intermediate water tank and enters the EDI device after the intermediate pump is pressurized. After all, the dissolved solids and other impurities in the water are deeply removed from the EDI device, and the water that meets the standard for water for the waste heat boiler enters the

desalination water tank. The desalination water is pumped into the deaerator by the demineralized water pump and is used as the supplementary water for boiler feed water.

3.14.7 Feed Water Treatment Plant

The design of this scheme uses two sets of integrated automatic water purifiers, and the treated water quality meets the circulating water and industrial water use requirements. The equipment integrates mixed reaction, flocculation precipitation, and filtration of effluent water, and automatically completes the operating procedures of medicine feeding, water distribution, sludge discharge, backflushing, sewage discharge, etc., through the special device of the equipment itself combined with electrical control. Automatic water purifier automatic operation, with no need for personnel operation, to avoid water quality instability caused by the artificial operation. The water quality after treatment is excellent and stable. The process flow is as follows:

Figure 3-19 Process flow Diagram for Purification System



Source: Feasibility Study Report, 2022

The integrated water purification device includes Coagulating basin, sedimentation basin, filter basin, back purge system, etc. Its main process segments are described as follows:

1. **Coagulating basin:** The raw water added with the coagulant enters the coagulating basin from the inlet pipe so that the suspended matter in the water is fully in contact with the coagulant and reacts to form alum flowers.
2. **Sedimentation room:** After adding a coagulant to the water, alum flowers are formed and flow into the sedimentation basin of the equipment for sedimentation. The sedimentation basin uses the inclined tube sedimentation method. The solid-liquid separation is completed by sedimentation in the trapezoidal inclined plate sedimentation room. The sedimentary sludge is discharged into the mud bucket and sent to the sludge treatment station for treatment.
3. **Filter basin:** The sedimentary water flows into the filter basin. The filter structure is: The bottom is water distributor, the middle is quartz sand, and the upper is anthracite. The filtration rate is 10 m/h, and finally, the clear water flows into the industrial fire-fighting pool for use in the factory area. The filter basin backflush cycle is approximately 12 hours, and the backflush time is 5 to 10 minutes.
4. **Gravity sludge thickener:** Receive the sludge water discharged from the flocculation sedimentation basin and the sludge water discharged from the filtration area of the integrated water purifier; use the principle that the sludge concentration is greater than the water, sludge

settles to the bottom of the basin and is pumped to the sludge press system for asphalt treatment through the sludge pump.

5. **Supernatant basin and recovery of supernatant:** Collect the supernatant on the sludge concentration basin and use the pump to deliver it to the water inlet of the integrated water purifier for further clarification.

3.14.8 Details of Effluent Treatment Plant

The content of suspended matter in the leachate from the waste bunker is high, and these suspensions are removed by the leachate entering the primary sedimentation tank through a special collection pipeline. And a hydraulic net is installed on the pipeline which is at the entrance of the primary sedimentation tank to remove the floaters with larger particles. The effluent water of the initial sedimentation tank enters the conditioning pond. The leachate from the waste bunker at different times stays mixed here, playing a role in balancing the water volume, homogenizing the water quality, and cooling. The Conditioning Pond is divided into two functional areas to regulate water quality and water volume, respectively. Conditioning pond has the function of pre-fermentation to reduce the concentration of organic matter in part of the influent through fermentation. and the lattice design plays the role of accident mediation. Two sets of stirring devices were set up. Wastewater after homogenization was pumped to the Efficient Anaerobic Reactor through the supply pump of the Anaerobic Reactor. In the Anaerobic Reactor, high high-concentration organic wastewater is converted into biogas for discharge, and most of the organic matter in the wastewater was degraded and digested. After being filtered by a bag filter, anaerobic effluent enters MBR through the water distribution system to remove biochemical organic matter. The MBR consists of denitrification, nitrification, and ultrafiltration units. The remaining sludge produced by the biochemical system was dehydrated and sent to the incineration plant for incineration. And the supernatant fluid after dehydration was returned to the biochemical system for treatment.

Sludge generated during the processing of the leachate includes Grid slag of the grid system and residual sludge from the biochemical treatment system. The sludge is pumped to the sludge tank by a sludge lift pump and is lifted through a screw pump into the dewatering room for dewatering treatment, and the mud cake with a moisture content of less than 80% after dewatering is transported to the waste bunker for incineration treatment. The supernatant fluid in the sludge cell and portions of dehydrated filtrate return to the biochemical system.

Combined with the discharge requirements of this project, the stability of simple biological effluent is relatively poor and cannot meet the needs. Physical methods such as membrane technology should be combined to treat the residual pollutants after biological treatment. Eventually, the sewage treatment process combination of this project is determined as "in leachate tank transfer pump + drum grating machine + Conditioning Pond + anaerobic (UASB) + membrane bioreactor (MBR) + nanofiltration (NF) + Reverse osmosis (RO) (NF concentrate is reduced by TUF + STRO)." RO concentrate is used for lime pulping and fly ash stabilization, and the water yield of the overall system is not less than 75%.

The leachate processing equipment consists of seven parts, including (1) a Pretreatment system; (2) an Anaerobic treatment system; (3) MBR biochemical reaction treatment system; (4) a Membrane deep treatment system (NF/RO); (5) Concentrate treatment system; (6) Sludge treatment system; (7) Methane (odor) treatment system.

3.15 Existing Waste Management Scenario

The waste generated within DNCC encompasses several types such as municipal solid waste (MSW), electronic waste, hazardous medical waste, food waste, construction waste, and industrial hazardous waste. DNCC waste management function is mainly focused on MSW. The composition of MSW that DNCC deals with includes 'anything' that people throw into DNCC's waste bins and collection points. The amount of waste generated within DNCC is increasing year by year due to the increased number

of infrastructure developments, shopping complexes, restaurants, markets, and bazaars along with roadside tea stalls, floating vendors, and flower markets on the footpath.

Though DNCC collects municipal solid waste generated by citizens daily, people sometimes discharge waste into open spaces, drains, canals, or their own backyards rather than DNCC's designated secondary collection points. In 2019-2020, the total amount of collected waste is 1,002,561 tons. The SWM operation in DNCC is categorized into four types: i) Cleaning of roads and drains, ii) Collection and transport, iii) Landfill development & operation, and iv) Repair works.

Dhaka is the largest urban city in Bangladesh and one of the largest and most densely populated cities in the world¹⁵. Employment opportunities, health care services, and educational services are readily available in Dhaka city which influences rapid human settlement. As daily waste generation amount is augmenting simultaneously with rapid urban growth, the solid waste management system is getting more intricate and diversified.

According to New Clean Dhaka Master Plan 2018-2032 (under approval process by LGD), the population of DNCC has been estimated as 6.1 million in FY 2019-20, which was 3.95 million in the census of 2011. In this city, Ward 40 has the highest population (256,719); while Ward- 42 has the lowest population (16,722). DNCC has an average population density of 31,488 per sq. km with a maximum and minimum population density of 103,255 and 2,693 in Ward-36 and 42, respectively. Both population and population density have been divided into five classes on the map given on the following page. According to the classification, Ward-1, 17, 30, 39, and 40 falls into the class of the highest population; while Ward-36, 22, 5, 13, and 36 into the class of the highest density.

Waste collection from the points of generation i.e., households or buildings is usually considered primary collection if such wastes are disposed to the secondary collection point of municipal services of DNCC. Door-to-door waste collection activity is common in almost all the wards of DNCC. It is prevalent due to high population density and the long distance of the secondary collection point. The entities providing primary collection or door-to-door collection services are recognized as PCSP or Primary Waste Collection Service Providers. Waste accumulated in SCPs (STs, containers, and dustbins) is categorized into three types based on the source of waste: household waste, street waste including sludge from drainage, and business waste. There are four different types of secondary collection receptacles: concrete bins/dustbins, containers, arm-roll containers, and compactors for direct transport without waste storage. Open curbside waste accumulation is sometimes used at designated points for areas where container placement is difficult.

Waste vehicles: There are altogether 147 waste collection and transport vehicles in DNCC among which 140 vehicles are under operation and other vehicles are under repair. DNCC is gradually shifting towards a compactor-driven waste collection and transportation system considering its environmental friendliness. There are altogether 46 compactors in DNCC which is 31 % of the total waste collection vehicles. The summarized list of the collection and transport vehicles of DNCC is stipulated in the table on the following page.

Table 3-19: Existing waste management scenario at a glance

Total Area	196.23 sq. km
Population	6.1 million ¹⁶
Average Population density	31,488 per sq. km
Total Number of Zone	10
Total Number of Ward	54

¹⁵ The World's Cities Data Booklet, United Nations.

¹⁶ New Clean Dhaka Master Plan 2018-2032

Amount of Waste Generation		3,433 tons/day
The total amount in FY 2019-20		1,002,561 ton
Waste Collection percentage		80% ¹⁷
Total Number of Trips		2,08,808 nos.
Waste collection	Highest in a month	1,00,630 tons (August 2019)
	Lowest in a month	60,710 tons (April 2020)
SWM Cleaners	DNCC cleaners	2,479 nos.
	Private company cleaners	1,435 nos.
Number of Sanitary Landfill		One (Amin Bazar landfill site)
Load Per Trip		4.8 ton/trip
Number of Waste Collection Vehicles &		Waste collection vehicle: 147
Heavy Equipment		Heavy equipment: 16
Average Waste Disposal in Landfill		2,750 tons/day
Landfill Operation Cost		244.41 BDT/ton

Source: Waste report, 2019-20, Waste management department, Dhaka North City Corporation

3.16 Details of Disposal of Sludge

The sludge in this project is obtained from the feed water Treatment System and the leachate treatment system.

Feed Water Treatment System: Gravity sludge thickener can receive the sludge water discharged from the flocculation sedimentation basin and the sludge water discharged from the filtration area of the integrated water purifier; use the principle that the sludge concentration is greater than the water, sludge settles to the bottom of the basin and is pumped to the sludge press system for asphalt treatment through the sludge pump.

Sludge generated during the processing of the leachate includes Grid slag of the grid system and residual sludge from the biochemical treatment system. The sludge is pumped to the sludge tank by a sludge lift pump and is lifted through a screw pump into the dewatering room for dewatering treatment, and the mud cake with a moisture content of less than 80% after dewatering is transported to the waste bunker for incineration treatment.

3.17 Management Plan for Solid/Hazardous Waste Generation, Storage, Utilization, and Disposal

3.17.1 Main Pollutants and Pollution Sources

3.17.1.1 Wastewater

The wastewater produced in this project mainly consists of domestic sewage, production sewage, waste leachate, and waste truck flushing sewage, and the main pollution factors include pH, SS, COD, Cr, BOD₅, NH₃-N, and coli group.

1. Sewage

The industrial sewage of the whole factory mainly comes from the leachate produced by the waste pit, the vehicle flushing water in the factory, and the ground flushing water in the separate system. This water will be fully collected and goes into the Leachate treatment station for treatment. After treatment,

¹⁷ Mostly uncollected from drain and newly extended area

the effluent reaches Municipal Sewage Regeneration and Utilization Industrial Water Quality (GB19923-2005).

The open circulating cooling water system replenishes the water and then reuses it to the factory for cooling tower rehydration.

The domestic sewage in the factory is collected and transferred to the Leachate treatment station for processing.

2. Wastewater

The industrial wastewater in the factory is prepared for drainage, and the water quality is good. It is preferentially reused as a secondary water source to supply a part of industrial production water, such as cooling water for cooling and cooling.

3. Clean water

The drainage of the water purification station and the remaining part of the circulating water is directly discharged to the existing rainwater pipe network outside the plant as clean sewage.

3.17.1.2 Malodor

The source of malodor pollution mainly comes from the original waste entering the plant and the produced leachate. The waste transport vehicle will emit malodorous gas during the unloading process, and the waste heap will be placed in the waste tank. The leachate may also emit malodorous gas in the collection facilities and transmission process. The main components and concentration reference values of malodorous substances are shown in **Table 3-20**

Table 3-20: Types and concentration reference values of malodorous substances in waste

Serial number	Odorous substances	Molecular formula	Unit	Concentration value	Odor characteristic
1	Stench concentration			2500	
2	Ammonia	NH ₃	ppm	1.0	Urinary odor
3	Hydrogen sulfide	H ₂ S	ppm	0.5	Smelly eggs
4	Methanethiol	CH ₃ SH	ppm	0.05	Bad cabbage
5	Methyl sulfide	(CH ₃) ₂ S	ppm	0.02	Bad vegetable flavor
6	Dimethyl sulfide	(CH ₃) ₂ S	ppm	6	Dimethyl sulfide
7	Trimethylamine	(CH ₃) ₃ N	ppm	0.02	Irritant fish odor
8	Acetaldehyde	CH ₃ CHO	ppm	0.05	The smell of wood
9	Styrene	C ₈ H ₈	ppm	0.01	Rubber odor

Source: Feasibility Study Report

3.17.1.3 Slag residue

According to the relevant national standards, the incinerator residue and flying ash collected by dust removal equipment shall be collected, stored, and transported separately. Calculating based on 3,000t of waste burnt daily, under the design treatment condition of the power plant, the daily wet slag output of the project is about 500t/d, the maximum daily slag output can reach 600t /d, the annual wet slag output is 182,500t/a, and the daily fly ash output of the whole plant is about 74.8tons/day (waste is dumped for 365 days, incinerated for 333 days).

3.17.2 Pollutant control measures

3.17.2.1 Wastewater treatment

The Domestic Sewage is disposed of by septic tank and then discharged into the sewage pipe network of the plant area and transported to the Leachate treatment station for unified treatment.

The main plant floor flushing wastewater is discharged into the sewage pipe network of the plant area and transported to the Leachate treatment station for unified treatment.

Waste tipping platforms and waste trucks flushing wastewater enter the waste leachate system due to the water's high content of BOD and COD. They are transported to the waste Leachate treatment station for unified treatment and the leachate is in the waste tank.

Setting up sewage discharge detection instrument to detect the concentration of clean water discharge such as circulating water discharge. Reduction measures: try to reuse the reuse water system such as the slag discharger cooling water, and the excess part is discharged.

3.17.2.2 Treatment of Slag residue

The dust from the Flue Gas Treatment system is referred to as Fly Ash. The slag in this project is mainly the residue after waste combustion, and its generation depends on the composition of waste, and its main components are MnO, SiO₂, CaO, Al₂O₃, Fe₂O₃, and a small amount of unburned organic matter, scrap metals, etc. Fly ash contains heavy metals, dioxins, and other harmful substances and should be treated as hazardous waste. Fly ash is solidified in an incineration power plant and meets the requirements of leaching toxicity standard in Hazardous Waste Identification Standard-Leaching Toxicity Identification GB5085.3-1996 and Standard for Pollution Control on the Landfill Site of Municipal Solid Waste GB15085-2008, and then sent to fly ash safe landfill for landfill treatment.

3.17.2.3 Malodor control measures

Aiming at the source of malodorous pollution in waste tanks, the following control measures are mainly taken:

- The waste loading ramp is capped to control the malodorous diffusion caused by the waste truck's dissipation from the leachate.
- An Air curtain was set up at the inlet and outlet of the tipping hall to prevent malodor escape.
- Negative pressure was maintained inside the waste tank to prevent the spread of malodor inside the waste tank.
- Aiming at the characteristics that malodor can be decomposed at high temperatures, the gas in the pit is extracted from the upper part of the waste tank by a PA fan and fed into the incinerator after preheating and used as secondary air for combustion.
- In the incinerator and maintenance, to ensure the negative pressure in the waste tank, the odor in the waste tank is pumped out by the deodorizer and fed into the activated carbon adsorption deodorizer. The odor pollutants are adsorbed, filtered by the activated carbon, and discharged into the atmosphere after reaching the national malodor discharge standard.
- In abnormal operation (when the shutdown state or the negative pressure is not enough), the deodorizing fan of the deodorizing system feeds the odor of the waste tank into the activated

carbon deodorizing device located in the deodorizing room for adsorption and filtration and then drains it to the upper air, to ensure the air quality in the incineration power plant area.

- The waste leachate collection chamber comprises a leachate sump, leachate pump room, and corridor, and these areas will produce a large amount of odor. Therefore, the air supply and exhaust outlets are set in the space of the leachate collection room, the air supply fan feeds fresh air, and the exhaust fan introduces the odor generated in this space into the waste tank and burns and decomposes in the PA fan inhalation incinerator.

Chapter 4

Analysis of Alternative Resources and Technologies

4 ANALYSIS OF ALTERNATIVE RESOURCES AND TECHNOLOGIES

The project alternative is the course of action in place of another, that would meet the same purpose and need, but would avoid or minimize negative impacts and enhance project benefits.

The project has been considered and investigated for several alternatives to reduce the environmental and social impacts. The alternatives assessed were not limited to environmental and social aspects, but the assessment also included the technical aspects of different options.

The Project has considered alternatives in terms of site location, design, and technology options. An analysis of these alternatives has been undertaken for the proposed Project including consideration of a no-Project scenario. The no-go option, or not building the proposed waste-to-energy project, is based on the supposition that the project won't proceed. No environmental or social repercussions would be caused by this choice of location or neighborhood. It serves as the standard against which other options are measured and will be considered throughout the report.

4.1 No Project Scenario

The no-go alternative assumes that the proposed project will not go ahead, i.e., it is the option of not constructing the proposed waste-to-energy project. This alternative would result in no environmental or social impacts on the site or the local area. It provides the baseline against which other alternatives are compared and will be considered throughout the report. The no-project option considers the following:

- Continue the current dumping of waste as a method to manage waste for DNCC.
- Costs related to the project activities will be avoided.
- Further environmental changes to the proposed area will be avoided.
- Existing public suffering will continue to worsen due to the lack of a proper waste management system in the surrounding Amin Bazar landfill area.
- Electricity generation will remain constant (i.e., no additional energy generation will occur on the proposed site), and the local economy will not be diversified.
- There will be no opportunity for additional employment in an area.

While the “no project scenario” alternative will not result in negative environmental impacts, it will also not result in positive community development or socio-economic benefits. It will also not assist the government in addressing climate change and reaching its set targets for converting waste to energy, nor will it assist in supplying the increasing electricity demand within the country. Therefore, the “no project” option is not recommended.

4.2 Suitability of the Site

Due to land scarcity in the country, seeking an alternative site for establishing the power plant area is difficult. Aside from this, land acquisition is a lengthy and complex process to acquire land for development projects. Not only that, but the conceptual project development over alternative sites are quite difficult because the waste transfer process might create social conflicts and risks for the project. Further, because of the scarcity of land in the city and an increasing amount of solid waste, it is crucial to process the MSW to the maximum extent possible to minimize dumping at landfill sites. The selection of the project site/location has been based on the following considerations:

Available Land Area: Availability of adequate land for the proposed plant. A total of 31.182 acres (126,187.41 m²) of land is required which has been acquired by DNCC.

Existing Land Use: Currently, the land has been used for landfill purposes.

Approach Road: Existence Road (Dhaka-Aricha Highway (N5)) connections in the vicinity for the transportation of waste.

The present waste-to-energy project has been planned to address the issue of municipal solid waste of Dhaka North City Corporation. The existing landfill site has exhausted its capacities and is presently overburdened.

To avoid or minimize the impacts resulting from the project's activities, WTE Power Plant North Dhaka Private Limited authority is expected to adopt the appropriate technological design, improvements or adjustments, policy including good site operational practices and applicable EMP, etc. The overall strategy shall follow the following sequence:

- Impact avoidance or minimization.
- Adequate Compensation where impacts are unavoidable.
- Enhancement Measures-Employment benefits enhancement measures proposed by the consultants.

4.3 Alternative Incineration Technologies

There are four main types of solid waste incinerators:

1. Mechanical grate furnace,
2. Fluidized bed incinerator,
3. Pyrolysis incinerator,
4. Rotary kiln incinerator.

Presently, a grate-type incinerator is mainstream equipment abroad, which occupies an absolute advantage; a grate-type incinerator and fluidized bed incinerator are the main equipment in China, and the former has more advantages. These four types of incinerators are briefly introduced and compared below.

Table 4-1: Comparison of Characteristics of Four Types of Common solid waste incinerators

Item	Mechanical grate furnace	Fluidized bed incinerator	Pyrolysis incinerator	Rotary kiln incinerator
Characteristics of furnace bed and body	Large mechanical grate area and furnace volume	Fixed furnace bed, smaller furnace volume	Vertical fixed grate, 1 ~ 2 combustion chambers	Moving waste by rotating the furnace body
Waste pretreatment	Not required	Required	Required at low calorific values	Not required
The floor area of the equipment	Large	Small	Medium	Medium
Heat Cauterization of Slag	Easy to reach the standard	Can reach the standard under the condition of continuous ignition support	Not easy to reach the standard	Not easy to reach the standard
Maximum processing scale of a single furnace at present	1200 t/d	800 t/d	200 t/d	500 t/d
Combustion air supply	Easy to adjust	Easier to adjust	Not easy to adjust	Not easy to adjust
Dust content in flue gas	Low	Very high	Low	High

Item	Mechanical grate furnace	Fluidized bed incinerator	Pyrolysis incinerator	Rotary kiln incinerator
Combustion medium	No carrier	Quartz sand required	No carrier	No carrier
Automatic combustion control	Easy	Not easy	Not easy	Not easy
Operating expenses	Low	Low	High	High
Flue gas treatment	Easy	More difficult	Not easy	Easy
Maintenance workload	Less	More	Less	Less
Comprehensive evaluation	It has strong adaptability to waste, few faults, good treatment performance and environmental protection performance, and low cost	Pretreatment and the failure rate are high, coal incineration is required, and environmental protection is not easy to reach the standard.	It is not easy to realize the burnout of waste in the non-melting pyrolysis furnace, the slag thermal burning reduction rate is high, and environmental protection is not easy to reach the standard	It requires high calorific heat (above 2500 kcal/kg) of waste and high operating costs
Applicability of this project	Applicable	Not suitable	Not applicable	Not applicable

Source: Feasibility Study Report, 2022

A mechanical grate waste incinerator has the following characteristics relative to other furnace types:

- It has matured and reliable technology. Most large solid waste incineration power plants in developed countries use the mechanical grate furnace type. The large incineration power plants built or under construction in China also mostly use this furnace type.
- It uses the residual heat generated by incineration for power generation, which has certain energy-saving and economic benefits. It has a better CO₂ emission reduction effect than other solid waste treatment facilities.
- It is easy to operate and does not easy to cause secondary pollution.
- The incinerator is stable and reliable, the equipment life is long, and the annual operation time exceeds 8000 hours.

The circulating fluidized bed waste incinerator has the advantage of the low loss of ignition, but it has the following more apparent shortcomings:

- According to the research results, its CO₂ emission is higher than that of a grate incinerator.
- The operation stability is still insufficient, the frequency of furnace shutdown is high, and the annual operation time is generally 6,000 ~ 7,000h.
- Because the volatile components of waste are mainly burned, fixed carbon combustion accounts for only about 20%, resulting in a high combustion rate, and automatic combustion control (ACC) cannot be well realized.

Based on the above analysis, WtE Power Plant North Dhaka Private Limited selected the mechanical grate furnace as the incinerator for solid waste incineration and power generation projects.

Chapter 5

Socio-economic Environment

5 SOCIO-ECONOMIC ENVIRONMENT

5.1 Population

5.1.1 Demography

In the 5-kilometer buffer study area, there are 3,53,438 households (HHs), including squatters with a total population of 14,51,727 that will be affected by the implementation of the Project. The average sex ratio is 114.9, and the average household size is 4. Table 5-1 shows the Demography of the project study area.

Table 5-1: Demography of the study area

District	Upazila/ Thana	Union	Total population	Total HHs	Average HH size	Sex Ratio	Literacy (%)
Dhaka	Adabor	Ward No-43	186639	45761	4	117	66.7
		Ward No-46 (Part)	17350	3839	4.4	103	85.7
	Darus Salam	Ward No-09	71260	16936	4.1	126	65.6
		Ward No-10	87879	23128	3.8	116	68.4
	Savar	Amin bazar	37500	8907	3.9	119	54
		Banogram*	33627	7813	4.2	112	51.7
		Bhakurta	44947	9520	4.7	112	48.2
		Biralia	41188	10070	4	119	60.3
		Kaundia	27796	6182	4.2	116	54.1
		Savar	45887	11981	3.8	113	67.5
		Tetuljhora	106929	26287	4	119	63.9
		Ward No-06	43545	12399	3.5	112	80.8
		Ward No-07	50053	13192	3.7	110	73.3
		Ward No-08	30904	7944	3.8	107	75.8
		Ward No-09	33120	9028	3.6	122	54
	Keraniganj	Taranagar	9465	4295	4.5	103	58.6
	Shah Ali	Ward No-08	111251	27116	4	115	71.5
	Mirpur	Ward No-12	116544	27286	4.2	117	80.4
	Mohammadpur	Ward No-46 (Part)	355843	81754	4.2	125	69.3
	Total			1451727	353438	4.0	114.9

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS).

*Project located in this union

5.1.2 Ethnic Composition

According to the population and housing census (2011), within the 5 kilometers, radius buffer area from the project site total of 229 Households was found where 1086 different ethnic people live. Most of them belong to the Chakma ethnic group. The following Table 5-2 indicates the various ethnic composition of the project study area.

Table 5-2: Ethnic Profile of the Study Area

Upazila/ Thana	Union	HH	Ethnic Population			Ethnic Population in main groups			
			Total	Male	Female	Gar o	Chakm a	Marm a	Other s
Adabor	Ward No-43	45	201	131	70	46	62	14	79
	Ward No-46 (Part)	11	50	28	22	10	13	0	27
Darus Salam	Ward No-09	0	0	0	0	0	0	0	0
	Ward No-10	4	22	4	18	8	8	0	6
Savar	Amin bazar	3	10	1	9	3	7	0	0
	Banogram*	3	12	8	4	1	0	0	11
	Bhakurta	0	0	0	0	0	0	0	0
	Biralia	4	99	4	95	0	10	0	89
	Kaundia	1	4	2	2	0	4	0	0
	Savar	11	43	23	20	27	6	0	10
	Tetuljhora	11	37	25	12	17	15	0	5
	Ward No-06	20	55	31	24	16	0	0	39
	Ward No-07	10	48	35	13	0	16	0	32
	Ward No-08	27	232	126	106	28	0	84	120
	Ward No-09	16	41	25	16	5	24	0	12
Keranig anj	Taranagar	0	0	0	0	0	0	0	0
Shah Ali	Ward No-08	11	45	19	26	0	14	0	31
Mirpur	Ward No-12	32	106	69	37	32	43	2	29
Moham madpur	Ward No-46 (Part)	20	81	41	40	36	22	0	23
Total		229	1086	572	514	229	244	100	513

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS).

*Project located in this union

5.2 Settlement and housing

According to the population census (2011), the total number of households in the project study area is 2,85,122. The predominant structure of this study area is Semi-pucka (44.6%), followed by Pucka

(35.4%), kutchha (18.2%), and Jhupri (1.8%). Housing tenancy in the study area is owned by (33.9%), rented (63.5%), and rent-free (2.6%). Table 5-3 and Table 5-4 show the Type of structure and Housing tenancy in the project study area.

Table 5-3: Types of structure and housing tenancy in the study area

Upazila	Union	Number of Households	Type of Structure (%)			
			Pucka	Semi-pucka	Kutchha	Jhupri
Adabor	Ward No-43	43895	50.6	34.4	13.7	1.3
	Ward No-46 (Part)	3747	86.5	7.6	5	0.8
Darus Salam	Ward No-09	15941	41	49	7.7	2.2
	Ward No-10	21323	37.9	44.1	14.1	3.9
Savar	Amin bazar	8786	46.1	36.1	14.3	3.4
	Banogram*	7742	21.4	49	28.5	1
	Bhakurta	9366	12.9	22	64.5	0.6
	Biralia	9829	15.9	54.2	27.1	2.9
	Kaundia	6107	28	49.1	21.3	1.6
	Savar	11575	13.5	63.8	22.3	0.5
	Tetuljhora	25867	29.6	56.3	13.7	0.4
	Ward No-06	11890	25.8	63.8	9.9	0.5
	Ward No-07	12772	35	58.2	6.3	0.5
	Ward No-08	7751	16.2	73.4	9.7	0.6
Keraniganj	Ward No-09	8471	30.6	60.3	8.7	0.3
	Taranagar	9456	14.9	33	51.4	0.7
Shah Ali	Ward No-08	26009	44.1	39.8	11.3	4.8
Mirpur	Ward No-12	26033	64.6	30.8	3.8	0.8
Mohammadpur	Ward No-46 (Part)	18562	58.5	21.9	11.6	8
Total		285122	35.4	44.6	18.2	1.8

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS).

*Project located in this union

Table 5-4: Housing tenancy in the project area

Upazila	Union	Number of Households	Housing Tenancy (%)		
			Owned	Rented	Rent free
Adabor	Ward No-43	43895	9	87.7	3.3
	Ward No-46 (Part)	3747	28	69.2	2.7
Darus Salam	Ward No-09	15941	14.3	82.5	3.1
	Ward No-10	21323	12.9	83.2	3.9
Savar	Amin bazar	8786	44.2	54.9	0.9
	Banogram*	7742	78.5	19.6	1.9
	Bhakurta	9366	87.3	8.9	3.8
	Biralia	9829	57.3	34.2	8.5
	Kaundia	6107	59.8	38.3	1.9
	Savar	11575	30.5	67.2	2.3
	Tetuljhora	25867	26.2	72.7	1.1
	Ward No-06	11890	14.4	84.7	0.9
	Ward No-07	12772	16	82.9	1.1
	Ward No-08	7751	30.6	65.9	3.5
	Ward No-09	8471	15.5	82.2	2.3
Keraniganj	Taranagar	9456	81.2	16.8	2
Shah Ali	Ward No-08	26009	14.4	83.9	1.7
Mirpur	Ward No-12	26033	12.7	85.3	1.9
Mohammadpur	Ward No-46 (Part)	18562	10.8	86.4	2.8
Total		285122	33.9	63.5	2.6

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS).

*Project located in this union

5.3 Traffic and Transport

The total Metalled, semi-metalled, and Unmetalled (Kacha) road is 4501 Kilometers in the study area. The total Railway (all broad gauge, meter gauge, and dual gauge) is 356 kilometers. The waterway in monsoon (river + canal) is 243 Kilometers. The waterway round the year (river + canal) is 176 Kilometers. The study area has a total of 8 railway stations, 5 Steamer/launch stations, and 58 bus stands. (Source: District Statistics 2011, Bangladesh Bureau of Statistics (BBS)).

5.4 Public Utilities

5.4.1 Water Supply

In the project study area, the major source of drinking water is Tap, where about 57.1% of the population uses Tap water. About 41.1% of people have access to Tube-well water. Other 1.8% of people have access to neither tube well nor tap water. An overview is depicted in Table 5-5.

Table 5-5: Sources of Drinking Water in the study area

Upazila	Union	Number of Households	Source of Drinking Water (%)		
			Tap	Tube-well	Other
Adabor	Ward No-43	43895	81	18.1	0.9
	Ward No-46 (Part)	3747	99.3	0.7	0
Darus Salam	Ward No-09	15941	84.7	15.1	0.1
	Ward No-10	21323	82.8	9.7	7.5
Savar	Amin bazar	8786	8.8	90.8	0.4
	Banogram*	7742	1.7	92.5	5.8
	Bhakurta	9366	0.5	99.3	0.2
	Biralia	9829	46.7	48.3	5
	Kaundia	6107	17.6	79.6	2.8
	Savar	11575	75.1	23.9	1
	Tetuljhora	25867	39.2	60.3	0.5
	Ward No-06	11890	67.6	32.2	0.2
	Ward No-07	12772	83.5	16.3	0.2
	Ward No-08	7751	78.1	21.5	0.4
	Ward No-09	8471	71	28.8	0.2
Keraniganj	Taranagar	9456	4.4	94.6	1
Shah Ali	Ward No-08	26009	86	10	4
Mirpur	Ward No-12	26033	84.6	14.4	1
Mohammadpur	Ward No-46 (Part)	18562	72.1	25	2.9
Total		285122	57.1	41.1	1.8

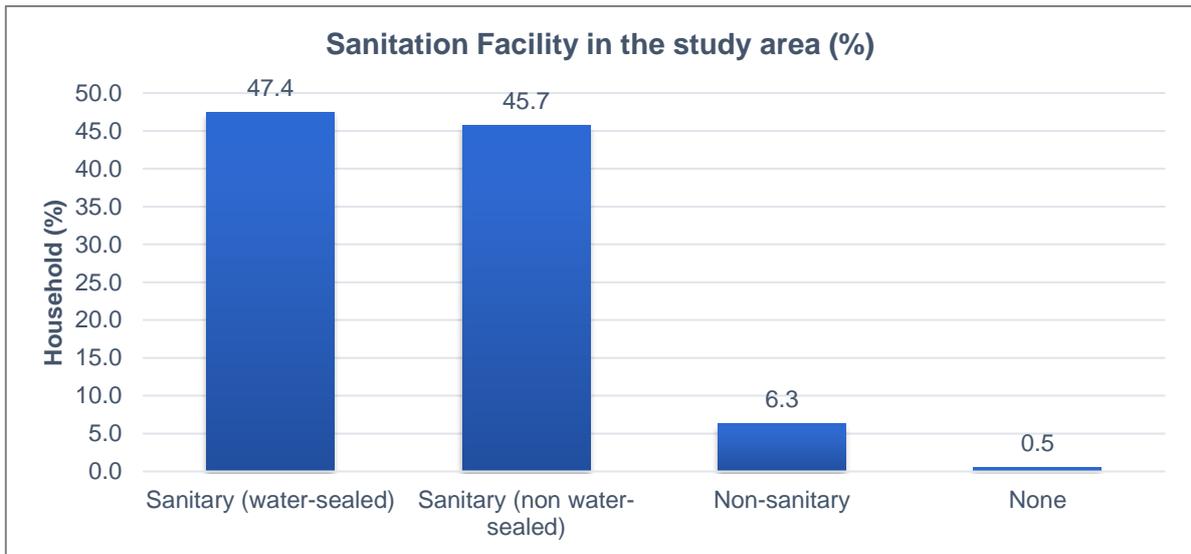
Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS).

*Project located in this union

5.4.2 Sanitation

In the study area, households that use the water-sealed sanitary latrine and non-water-sealed sanitary latrine facilities are 23.3% and 44%, respectively. At the same time, about 28.5% of households avail themselves of non-sanitary facilities. The rest, 4.2% of households, have no access to hygienic latrine facilities. The following Figure 5-1 shows the sanitation facility of the project area.

Figure 5-1: Sanitation facility in the study area



Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS).

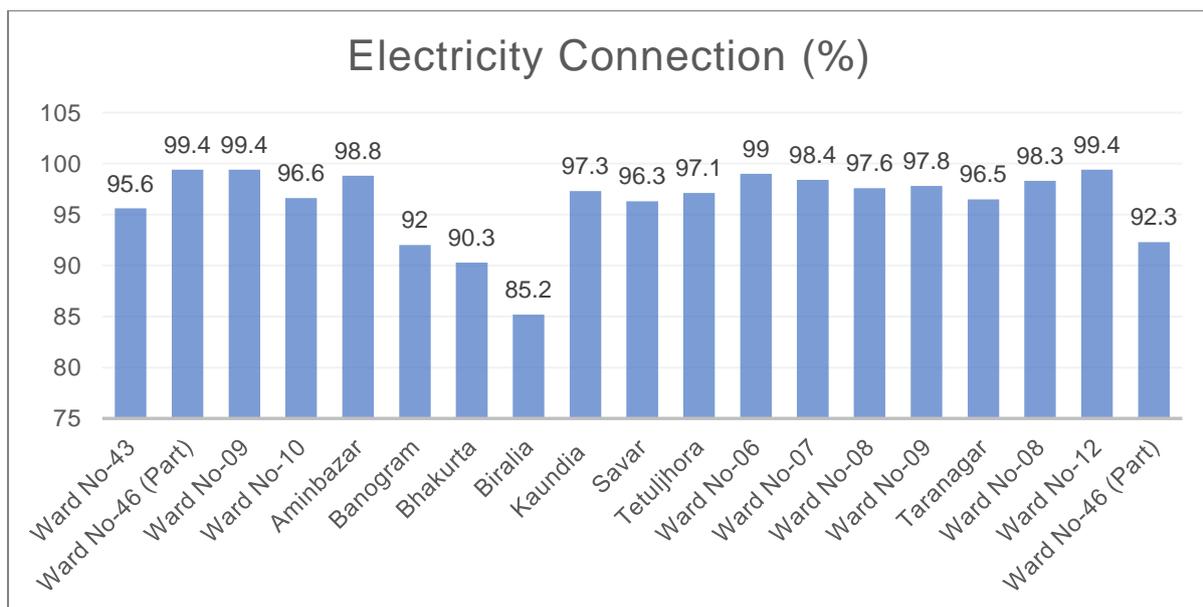
5.4.3 Solid Waste

Uncontrolled waste generation coupled with inadequate collection and disposal systems can lead to pollution, environmental degradation, and disease. While no specific data on local waste management was collected from the study area, it is likely that – as with many other parts of rural Bangladesh– the villages within the study area have no formal waste management facilities and that, in general, people dispose of their waste in landfills or fallow land.

5.4.4 Electricity

Electricity is an important indicator for measuring the quality of life in the Study area. In the study area, on average, 96.2% of households have grid electricity connections. Figure 5-2 shows the detailed electricity connection situation by the union.

Figure 5-2: Electricity connection of the study area



Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS).

5.4.5 Health Care Facility

Seven Thanas/Upazilas, Adabor, Darus Salam, Mirpur, Mohammadpur, Shah Ali, Keraniganj, and Savar, laid under the project area. Within these Thanas/Upazilas, the Number of MBBS and FCPS is 1893 persons. The study area has 669 private hospitals/clinics and related health personnel. Also, 1056 diagnostic centers are found (*Source: District Statistical 2011, BBS*).

5.5 Economy and Employment

In accordance with the Census of Bangladesh (2011), the Service sector is the dominant source of employment in the project study area. Approximately 59.9% and 52.8% of males and females are involved in Services. Moreover, significant numbers of the population, 23.8% male and 42.7% female in the project area, are employed in the industry sector. Table 5-6 shows the employment status of the project area.

Table 5-6: Employment status of the study area

Upazila	Union	Population Aged 7+, not attending school, and employed		Field of Activity											
				Agriculture				Industry				Service			
				Male		Female		Male		Female		Male		Female	
				Pop.	%	Pop.	%	Pop.	%	Pop.	%	Pop.	%	Pop.	%
Adabor	Ward No-43	16125	8050	256	1.6	31	0.4	1823	11.3	2121	26.3	14046	87.1	5898	73.3
	Ward No-46 (Part)	343	374	1	0.3	0	0.0	22	6.4	14	3.7	320	93.3	360	96.3
Darus Salam	Ward No-09	6728	2183	104	1.5	7	0.3	1096	16.3	910	41.7	5528	82.2	1266	58.0
	Ward No-10	5972	3065	141	2.4	24	0.8	1563	26.2	1263	41.2	4268	71.5	1778	58.0
Savar	Amin bazar	4600	1429	201	4.4	36	2.5	85	1.8	117	8.2	4314	93.8	1276	89.3
	Banogram*	3731	476	2140	57.4	57	12.0	318	8.5	128	26.9	1273	34.1	291	61.1
	Bhakurta	5789	575	2651	45.8	88	15.3	1499	25.9	283	49.2	1639	28.3	204	35.5
	Biralia	3973	962	2031	51.1	61	6.3	935	23.5	630	65.5	1007	25.3	271	28.2
	Kaundia	3592	651	183	5.1	10	1.5	1431	39.8	133	20.4	1978	55.1	508	78.0
	Savar	3119	1552	726	23.3	81	5.2	815	26.1	1109	71.5	1578	50.6	362	23.3
	Tetuljhora	8738	4370	2351	26.9	197	4.5	4017	46.0	3261	74.6	2370	27.1	912	20.9
	Ward No-06	2224	1600	157	7.1	9	0.6	784	35.3	1078	67.4	1283	57.7	513	32.1
	Ward No-07	2668	1545	212	7.9	67	4.3	1233	46.2	897	58.1	1223	45.8	581	37.6
	Ward No-08	1789	955	170	9.5	5	0.5	403	22.5	777	81.4	1216	68.0	173	18.1

Upazila	Union	Population Aged 7+, not attending school, and employed		Field of Activity											
				Agriculture				Industry				Service			
		Male	Female	Male		Female		Male		Female		Male		Female	
				Pop.	%	Pop.	%	Pop.	%	Pop.	%	Pop.	%	Pop.	%
	Ward No-09	1785	1056	120	6.7	2	0.2	613	34.3	683	64.7	1052	58.9	371	35.1
Keraniganj	Taranagar	3725	417	1865	50.1	115	27.6	409	11.0	28	6.7	1451	39.0	274	65.7
Shah Ali	Ward No-08	7313	4262	467	6.4	98	2.3	2083	28.5	2350	55.1	4763	65.1	1814	42.6
Mirpur	Ward No-12	3850	2470	63	1.6	11	0.4	1038	27.0	884	35.8	2749	71.4	1575	63.8
Mohammadpur	Ward No-46 (Part)	6202	3604	49	0.8	11	0.3	946	15.3	474	13.2	5207	84.0	3119	86.5
Total		92266	39596	13888	16.3	910	4.5	21113	23.8	17140	42.7	57265	59.9	21546	52.8

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS).

*Project located in this union

Chapter 6

Description of the Environment

6 DESCRIPTION OF THE ENVIRONMENT

As a part of the environmental and social assessment of the proposed waste-to-energy power plant project, an environmental baseline survey has been carried out in areas surrounding the proposed location. This section includes the existing environmental and social baseline status of the Project area, covering both the natural and social environments. The analysis was completed using a combination of secondary data sources in addition to baseline studies to establish an understanding of the environmental and socio-economic baseline of the Project area. The likely impacts on the environment are based on the actual and foreseeable events/project activities. For the impact assessment, wherever necessary, professional judgment, experience, and knowledge of similar projects will be used. Data for this chapter were collected from:

- **Secondary Sources:** This included data from literature reviews, maps, and monitoring reports.
- **Primary Sources:** This included gathering information from field surveys, laboratory analysis, and public consultations in the project area.

The baseline condition of environmental quality in the locality of the project site serves as the basis for the identification, prediction, and evaluation of impacts. The baseline environmental quality is assessed through field studies within the impact zone for various components of the environment, viz. air, noise, water, soil, sediment, socio-economic, etc.

Data was collected from secondary sources for the macro-environmental setting like climate (temperature, rainfall, and humidity), physiography, geology, etc. Firsthand information has been collected to record the micro-environmental features within and adjacent to the project area. The collection of primary information includes extrapolating environmental features on the proposed project design, location, and measurement of socio-cultural features adjoining the proposed project area. Ambient air, noise, and water quality, Soil, and Sediment samples were collected in terms of environmental quality to prepare a baseline database. The consultation was another source of information to explain local environmental conditions, impacts, suggestions, etc.

The following section describes the baseline environment into four broad categories:

- Physical Environment: Geology, Topology, Land-use, Soils, Meteorology, and Hydrology.
- Biological Environment: factors related to life such as habitats, aquatic life, fisheries, terrestrial habitats, flora, and fauna.
- Environmental Quality: Air, Water, Noise Quality, Soil, and sediment.
- Socio-economic Environment: Anthropological factors like demography, income, and infrastructure.

6.1 Area of Influence (AOI)

The Area of Influence (AOI) of the project comprises the project site and the surrounding area, where the influence of the project activities is anticipated. The areas likely to be affected by the project and its associated activities include:

- The project activities and facilities that are directly owned operated or managed by the project proponent (including by contractors) and that are components of the project, such as the main power plant, switchyard, control room, and transmission line to power grid sub-stations.
- Impacts from unplanned but predictable developments caused by the project that shall occur later or at a relaxed location such as an increase in traffic on the approach road.
- Impacts on biodiversity or on ecosystem services upon which affected communities' livelihoods are dependent.

Further to this, the AOI with respect to the environmental and social resources was considered based on the following reach¹⁸ of impacts:

Air Quality

- Impact on ambient air quality from vehicle exhaust- 500 meters from the project site
- Air pollutants disperse from the project site up to 1 km from the power plant stack.
- Dust falls- typically up to 500 m from construction activities.

Noise

- Noise impact area (defined as the area over which an increase in environmental noise levels due to the project can be detected) - typically 500 m from the power plant center and 100 m from the access road.

Water

- Surface water bodies within 1 km of the project footprint
- Groundwater within a 1-2 km radius of the project footprint

Flora and Fauna (Terrestrial and Aquatic)

- The areas immediately adjacent to the project footprint within which a zone of ecological disturbance is created through increased dust, human presence, and project-related activities (e.g., trampling, water intake/outfall, transportation). This kind of disturbance has been estimated to occur within the project footprint and surrounding areas of about 500 m to 1 km from the activity areas.

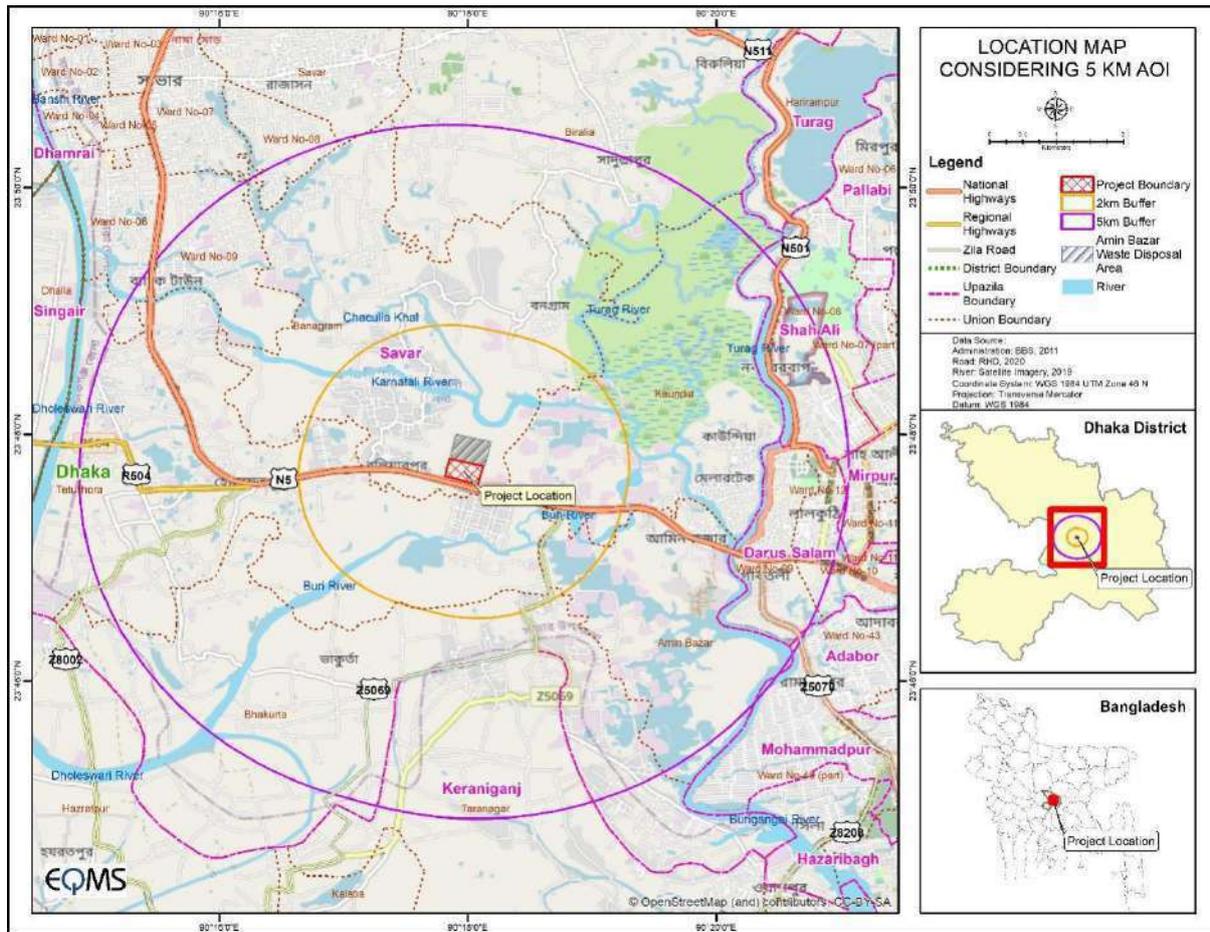
Based on the above the AOI for environmental studies was limited to 5 km from the project site.

Socio-economic/Social

The AOI for social receptors was fixed to include a 5 km radial zone which has been developed based on the reconnaissance site visits and stakeholder consultations with the local community.

¹⁸ Distance based on EQMS's experience with similar project.

Figure 6-1: AOI (5 km) map of the study area



Source: EQMS Study Team

6.2 Climatic Condition

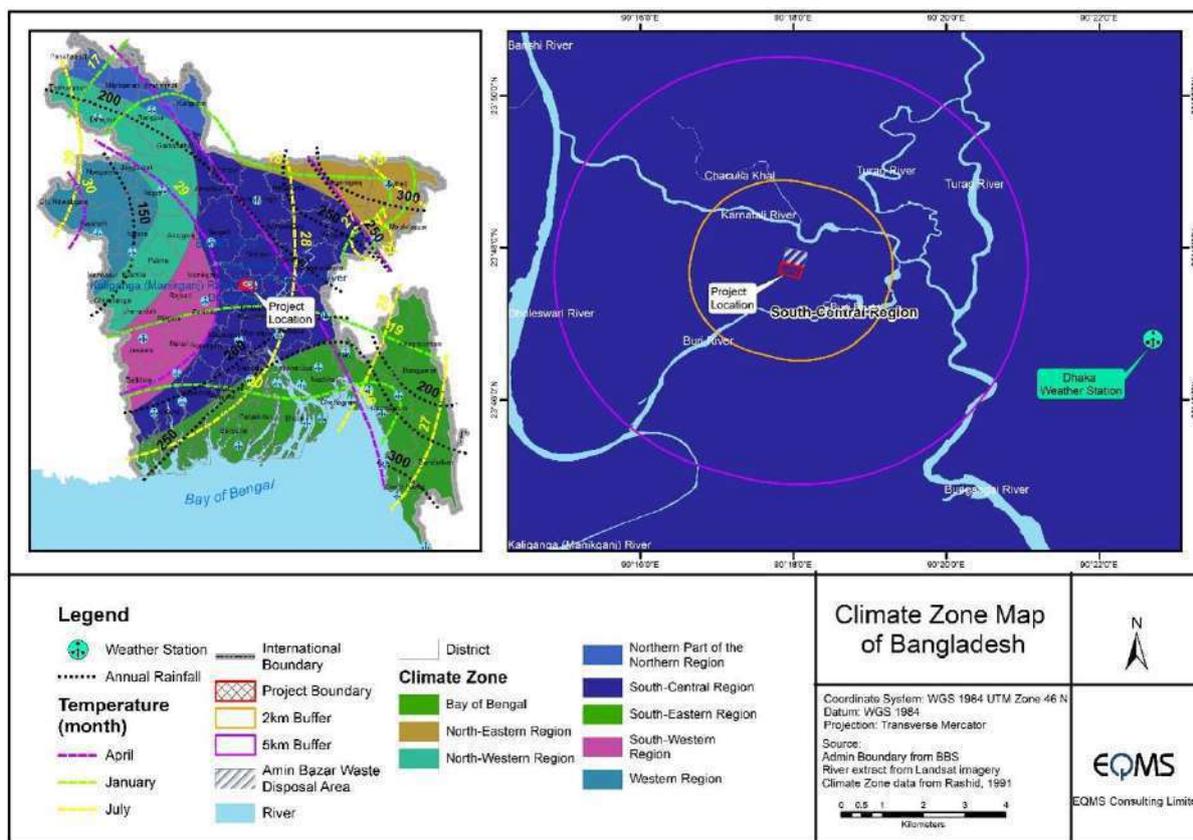
6.2.1 Meteorology

The Asiatic monsoon heavily influences the climate of Bangladesh. The monsoonal influence results in three distinct seasons:

- Pre-monsoon hot season (from March to May).
- Rainy monsoon season (from June to September); and
- Cool, dry winter season (from October to February).

Bangladesh is in the tropical monsoon region, and its climate is characterized by high temperatures, heavy rainfall, often excessive humidity, and fairly marked seasonal variations. The Climate zone of Bangladesh is given in Figure 6-2.

Figure 6-2: Climatic zones in Bangladesh



Source: Rashid, Haroun Er, 1991

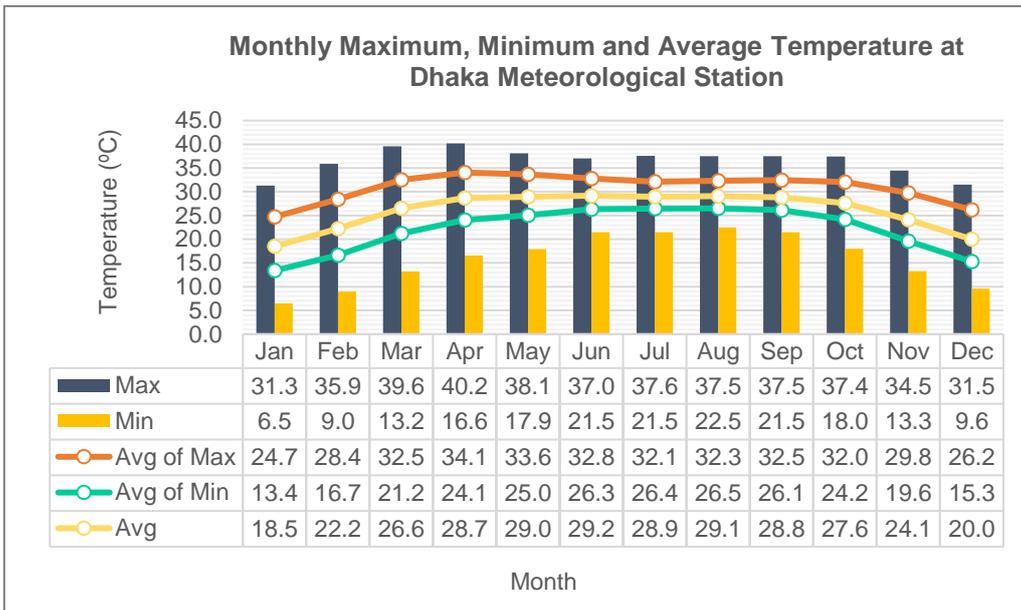
From a climatic point of view, three distinct seasons can be recognized in Bangladesh - the cool, dry season from November through February, the pre-monsoon hot season from March through May, and the rainy monsoon season, which lasts from June through September. January is the coolest month, with temperatures averaging near 26°C, and April is the warmest, with temperatures from 33 to 36°C. Most places receive more than 1,525 mm of rain a year, and areas near the hills receive 5,080 mm yearly. Most rains occur during the monsoon (June-September), and little occurs in winter (November-February). Moderate rains are also reported in March, April, and October.

Climatic sub-regions of Bangladesh are presented in Figure 6-2, and Dhaka District falls in the South-Central zone. The Bangladesh Meteorological Department monitors different climate components in 35 weather stations in Bangladesh. The climatic data for the study area were obtained from the meteorological station located in Dhaka and maintained by the Bangladesh Meteorological Department (BMD).

6.2.1.1 Temperature

Based on temperature data recorded at Dhaka Meteorological Station for the last 30 years (1991 to 2021), the maximum and minimum ambient temperatures are observed to be ranging from 24.7°C to 34.1°C and 13.4°C to 26.5°C, respectively. The lowest average temperature was in January 2013 (10.4°C). The highest average temperature reached 34.4°C in April 2014. The period from March to October is marked by a continuous increase in temperatures. August is the hottest month of the year with an average maximum and minimum temperature (in August) of 37.5°C and 22.5°C, respectively. From November onwards, both the day and night temperatures decrease, and January is the coldest month, with average monthly maximum and minimum temperatures of 31.3°C and 6.5°C, respectively. The monthly variation of the maximum, minimum, and average temperature at Dhaka Meteorological Station is shown in Figure 6-3.

Figure 6-3: Temperature variation at Dhaka Meteorological Station (1991 to 2021)

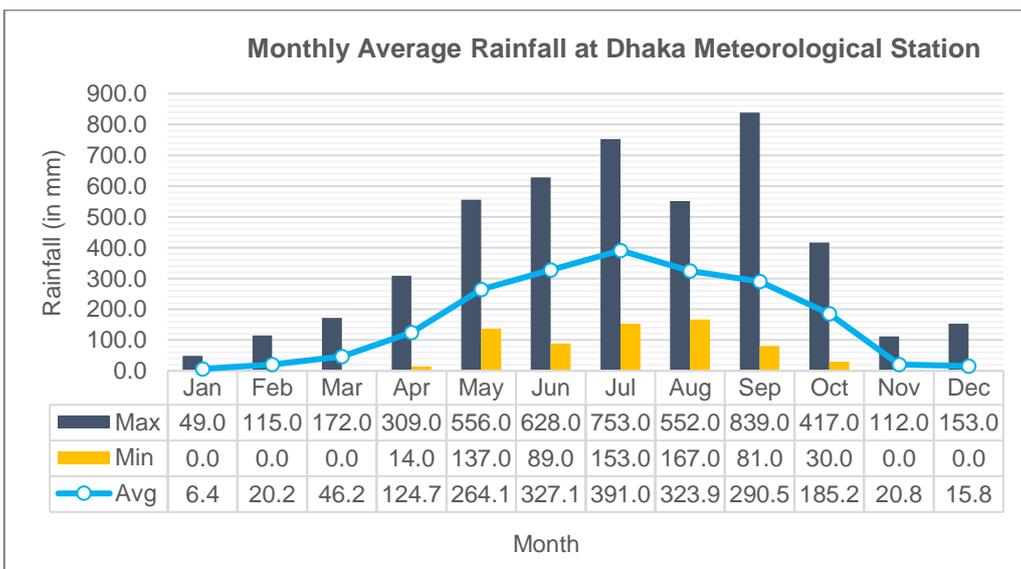


Source: Bangladesh Meteorological Department (BMD)

6.2.1.2 Rainfall

The average annual rainfall based on rainfall data recorded at Dhaka Meteorological Station for the last 30 years (1991 to 2021) is 2016.0 mm. Annual rainfall shows considerable variability from year to year. The rainfall also varies considerably within a year (Figure 6-4) with 88.4% of rainfall occurring within the six months from April to October. The highest rainfall is recorded in September 2004 (839.0 mm). An insignificant amount of rainfall has also been recorded in winter (November to February).

Figure 6-4: Average of Total Monthly Rainfall in mm (1991 to 2021) at Dhaka Meteorological Station



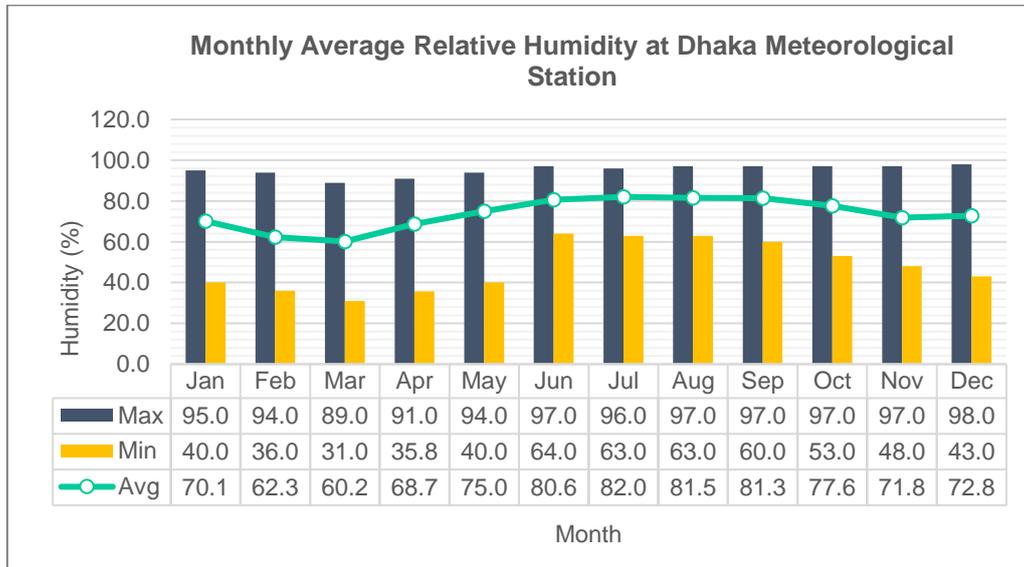
Source: Bangladesh Meteorological Department (BMD)

6.2.1.3 Humidity

Due to the heavy rainfall and proximity to the Bay of Bengal, the humidity levels in Bangladesh remain high. Based on humidity data recorded at Dhaka Meteorological Station for the last 30 years (1991 to 2021), relative humidity in Dhaka Meteorological Station is generally above 68% throughout the year

except in February and March. The monthly average relative humidity varies from 60.2% to 82.0% with average humidity at 73.7%. Humidity remains higher in the monsoon (June to September) season and comparatively lower in the winter season. The month of March is the driest with relative humidity around 60%. The monthly average relative humidity at the Dhaka Meteorological Station is shown in Figure 6-5.

Figure 6-5: Average Monthly Relative Humidity in % (1991 to 2021) at Dhaka Meteorological Station

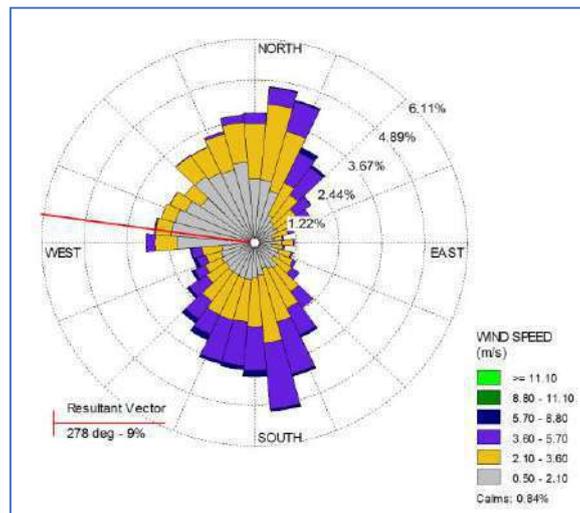


Source: Bangladesh Meteorological Department (BMD)

6.2.1.4 Wind speed and direction

Like the country’s wind characteristics, the region is characterized by the southerly wind from the Bay of Bengal during monsoon and northwesterly wind from the Himalayas during winter. As per BMD, the wind direction in Dhaka meteorological station is generally from West-North-West (WNW) to East-Southeast (ESE) direction. Average monthly wind speeds were also higher during March, June, and November with the maximum wind speed of 8.3/s recorded during March. The wind blows from south to north during monsoon. Annual wind direction distribution in (%) is shown in Figure 6-6.

Figure 6-6: Wind Direction Distribution in (%) at Dhaka Meteorological Station

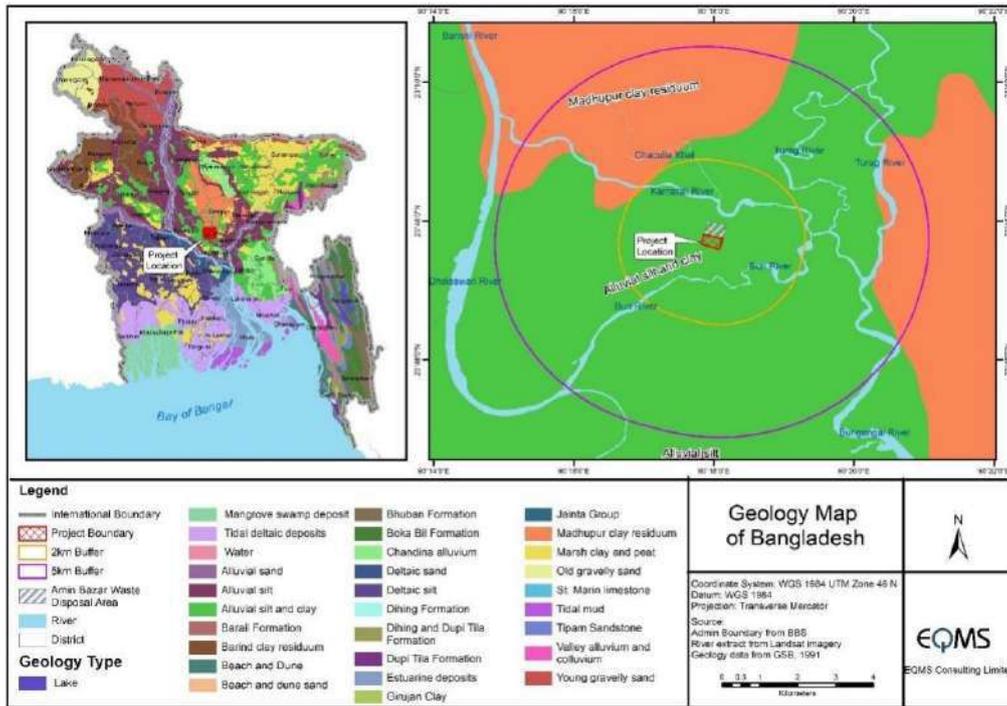


Source: Bangladesh Meteorological Department (BMD)

6.2.2 Geology

Bangladesh's geology profile reflects the country's location, as Bangladesh is a riverine country. The geological evolution of Bangladesh is related to the uplift of the Himalayan mountains and the outbuilding of deltaic landmass by major River systems originating in the uplifted Himalayas. This geology is characterized by the rapid subsidence and filling of a basin in which a huge thickness of deltaic sediments was deposited as a mega delta built out and progressed towards the south. The floodplains of the Ganges, the Brahmaputra (Jamuna), and the Meghna Rivers cover approximately 40% of Bangladesh. The geology map of Bangladesh indicating the project area is given in Figure 6-7.

Figure 6-7: Geology map of Bangladesh showing the project area



Source: Geological Survey of Bangladesh, 1991

Geology of Project Area

The project area covers the geology type named Alluvial silt and clay. The geology of the Project area is shown in Figure 6-7.

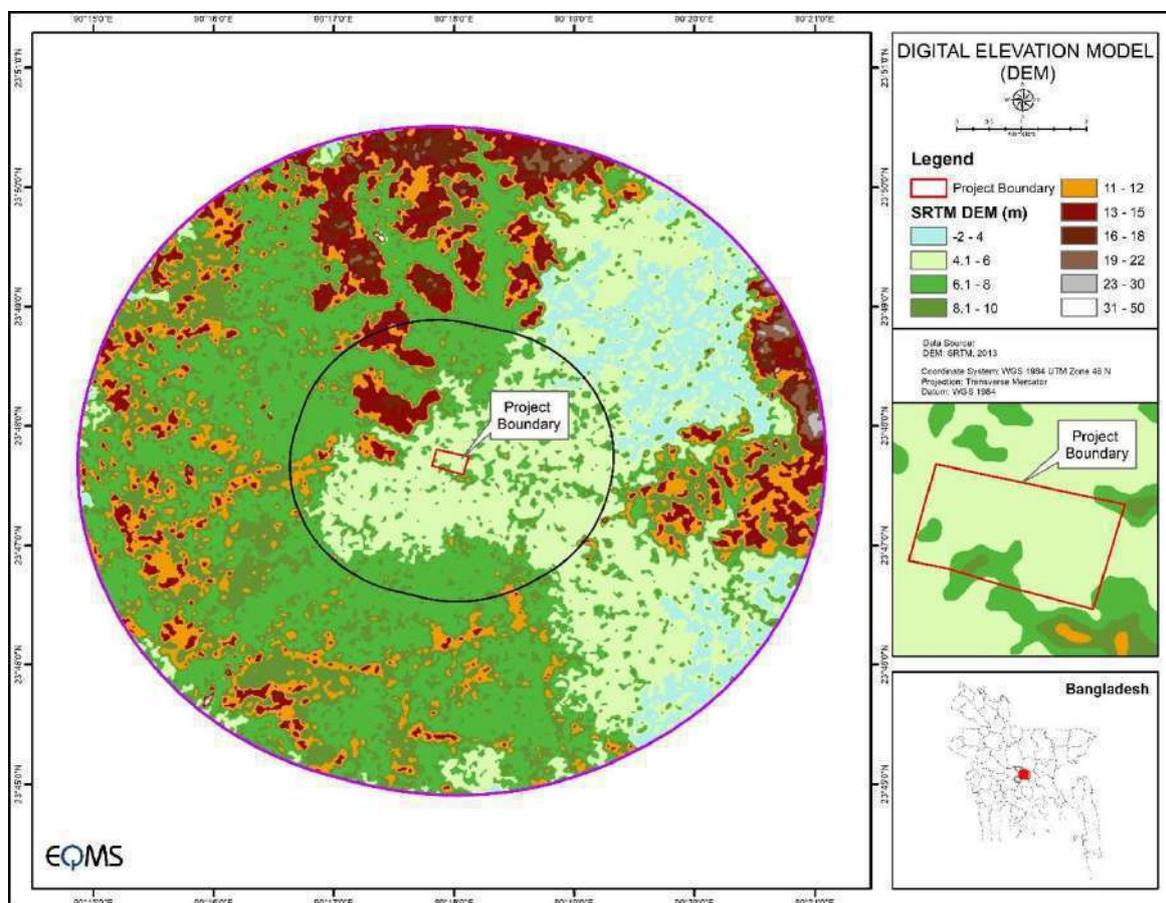
Alluvial silt and clay—Medium to dark-grey silt to clay; color is darker as the number of organic materials increases. The map unit combines alluvial and paludal deposits, including flood-basin silt, back swamp silty clay, organic-rich clay in Sag ponds, and large depressions. Some depressions contain peat. Large areas under this unit are dry only a few months of the year; the deeper part of depressions and bills (bills) contain water throughout the year.

6.2.3 Topology

According to DEM SRTM, 2013, the minimum and maximum spot height of the project area are 4.1 meters and 8 meters respectively. A digital elevation model (DEM) or 3-D representation of the terrain surface of the 5 km study area is shown with the height range in (Figure 6-8). Contours of the study area are generated from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) relief maps. Topo sheets were not available for the study area and therefore all the relevant information was extracted from the Shuttle Radar Topography Mission (SRTM) DEM only. All the processing was done with the ARC GIS 10.1 software. The contour map derived from DEM shows that the topography of the 5 km study area is predominantly a high terrain with maximum elevation in the

western part on the bank of the project area. The highest elevation levels are 50 m whereas the lowest is -2 m.

Figure 6-8: DEM of the project study area



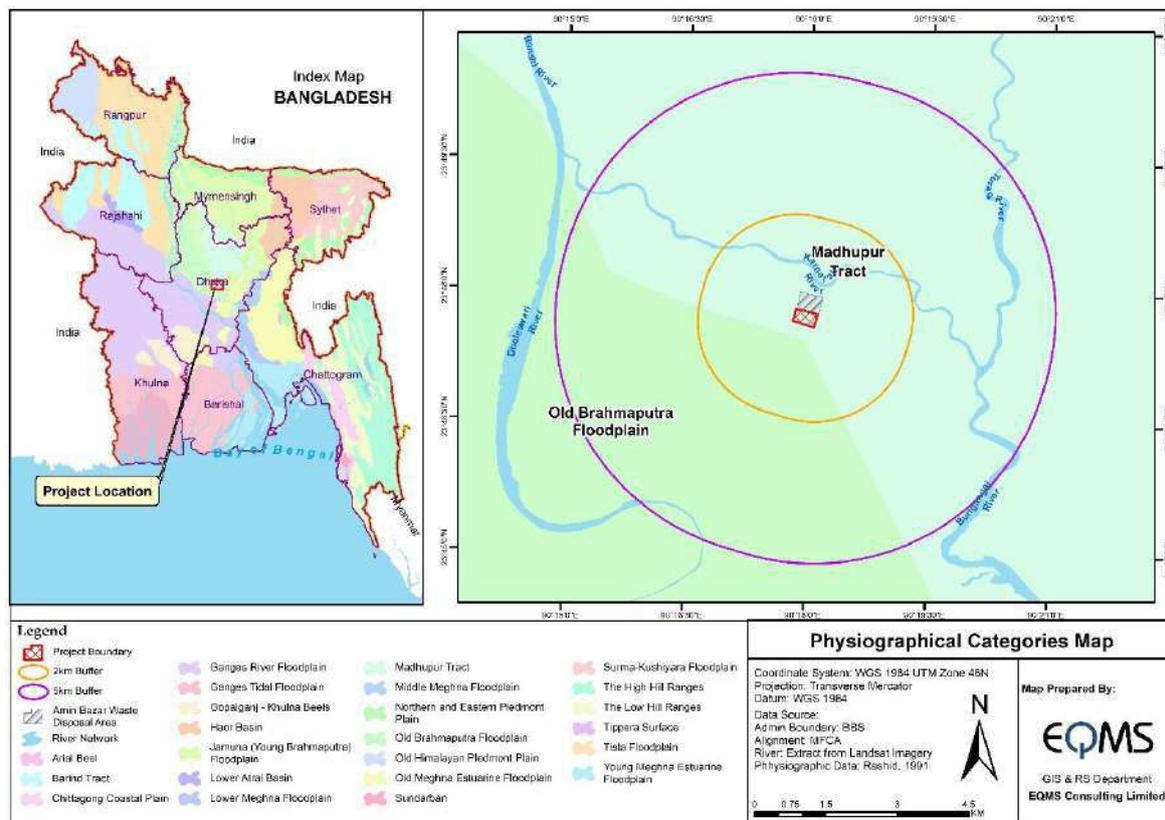
Data Source: DEM, SRTM, 2013

6.2.4 Physiography

According to the Physiography of Bangladesh, the proposed project study area falls under the physiographic unit of “**Madhupur Tract.**”

Madhupur Tract Another Pleistocene upland block in the Bengal Basin is in the central part of Bangladesh, comprising greater Dhaka and Mymensingh districts, between the courses of the Old Brahmaputra and the Jamuna rivers. Towards the south, this physiographic sub-region extends north of Dhaka, the country’s capital. Madhupur Tract measures about 4,105 sq km. Comparable to the Barind Tract, the area belongs to a Pleistocene terrace consisting mainly of red-colored and mottled clays. It is characterized by plateau-like hillocks varying in height from 9 to 18.5m and a dendritic drainage pattern typical of all Pleistocene terraces in Bangladesh. The valleys, mostly flat, are cultivated. The Madhupur jungle contains Shal trees (*Shorea robusta*), the hardwood which is second to teak in value. The physiography of the proposed bridge area is given in Figure 6-9.

Figure 6-9: Physiography Map of Bangladesh Showing the Project Area



Source: SRDI, 1997; Rashid 1991, Reimann, 1933

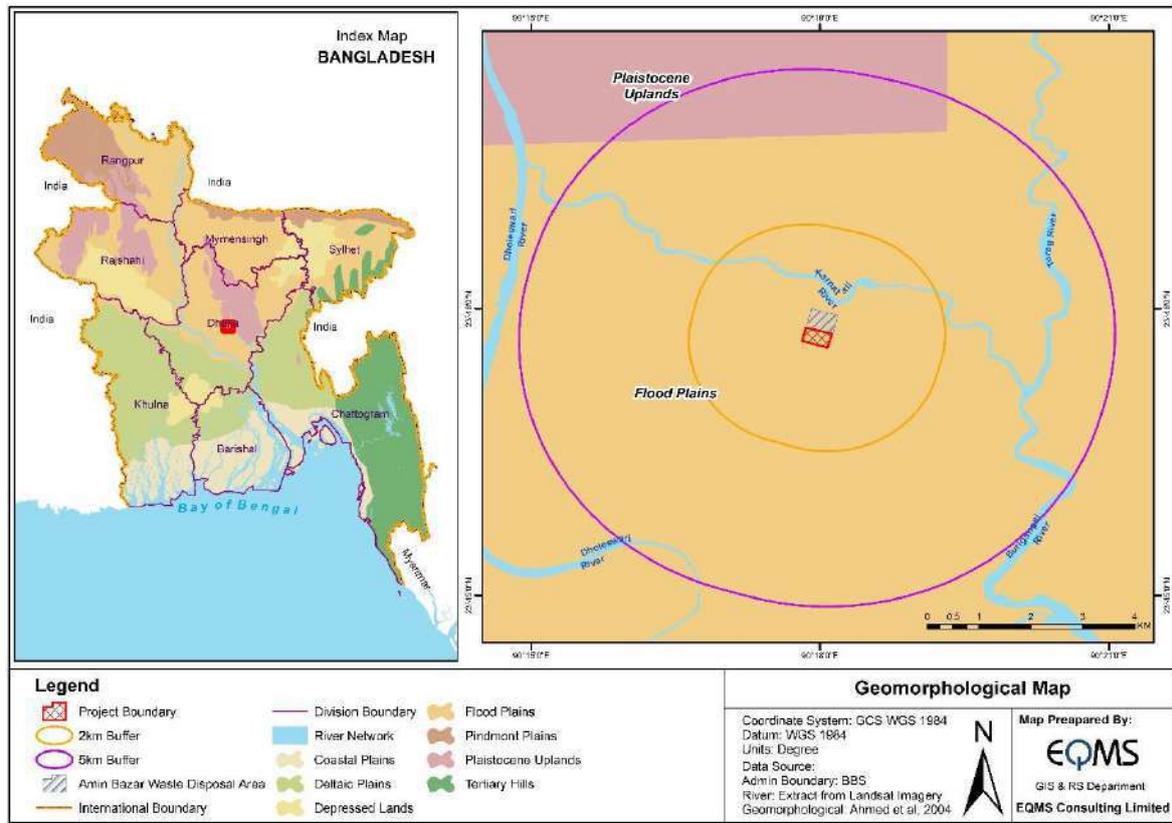
6.2.5 Geomorphology

The proposed project study area falls under the geomorphic unit- “Flood Plains.”

Flood Plains- The flood plains of the Ganges, the Atrai, the Brahmaputra-Jamuna, the Old Brahmaputra, and the Meghna rivers cover approximately 40% of Bangladesh. The elevation of the major part of the floodplain ranges from 3 to 5 meters. The floodplain covers the country's central, north, and northeastern parts. The Brahmaputra-Jamuna Flood Plain is located between the Barind and Madhupur Tracts. The elevation of this surface is 29 m in the north and about 6 m in the south. In 1887, a remarkable change during the Brahmaputra took place. That year, the river shifted from a course around the eastern edge to the western side of the Madhupur Tract and changed from a meandering river to a braided river. The Old Brahmaputra degenerated into a small seasonal channel and rarely spilled over the previously built-up levees.

The Ganges Flood Plain extends from the western border of the country, south of the Barind Tract, as far east, where it merges with the Jamuna Flood Plain. The Meghna Flood Plain merges with the southern part of the Old Brahmaputra Flood Plain in the northwest and with the Sylhet Depression in the north. The landform of the floodplain is characterized by natural levees distributed in a mottled pattern which forms shallow depressions and small ridges. The maximum height of the levees is 30 m above sea level. The flood plain has numerous small depressions (beels/haors). The level of the rivers gently slopes towards these depressions. Silty clay, clay, and sandy silt with local peat beds are the major constituents of the floodplain area. The geomorphology of the proposed bridge area is given in Figure 6-10.

Figure 6-10: Geomorphology Map of Bangladesh Showing the Project Area

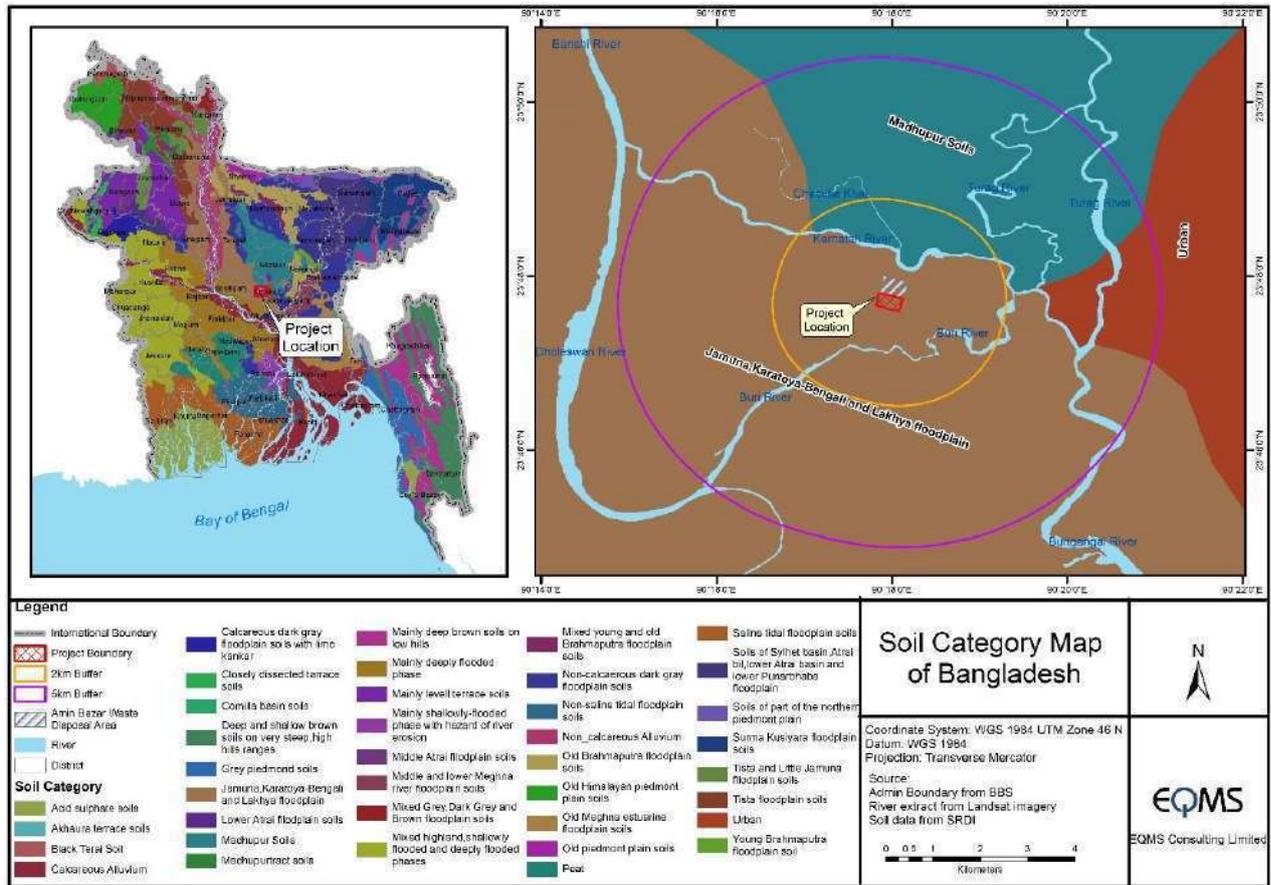


Source: Ahmed et al., 2004

6.2.5.1 Soil Texture

A major part of Bangladesh is on the delta formed by the three major rivers Brahmaputra, Ganges, and Meghna. Bangladesh soil map with the project site is shown in Figure 6-11. Jamuna Karatoya Bengali and Lakhya Floodplain are the soil types of the project area. Non-calcareous Alluvium Similar to calcareous alluvium, except they are non-calcareous in soil profiles. These soils occupy extensive areas on the active Teesta and Brahmaputra-Jamuna floodplains. They are sandy or silty, grey, or olive, neutral to slightly alkaline. Most of these soils have been included as Eutric Fluvisols.

Figure 6-11: Soil map of Bangladesh showing the project area



Source: BARC

6.2.5.2 Land use

The proposed project area is nonagricultural land (fallow land). Land use/cover inventories are essential in land resource evaluation and environmental studies due to the changing nature of land use patterns. The land use study for the proposed project and its 5 km buffer was undertaken with the following objectives:

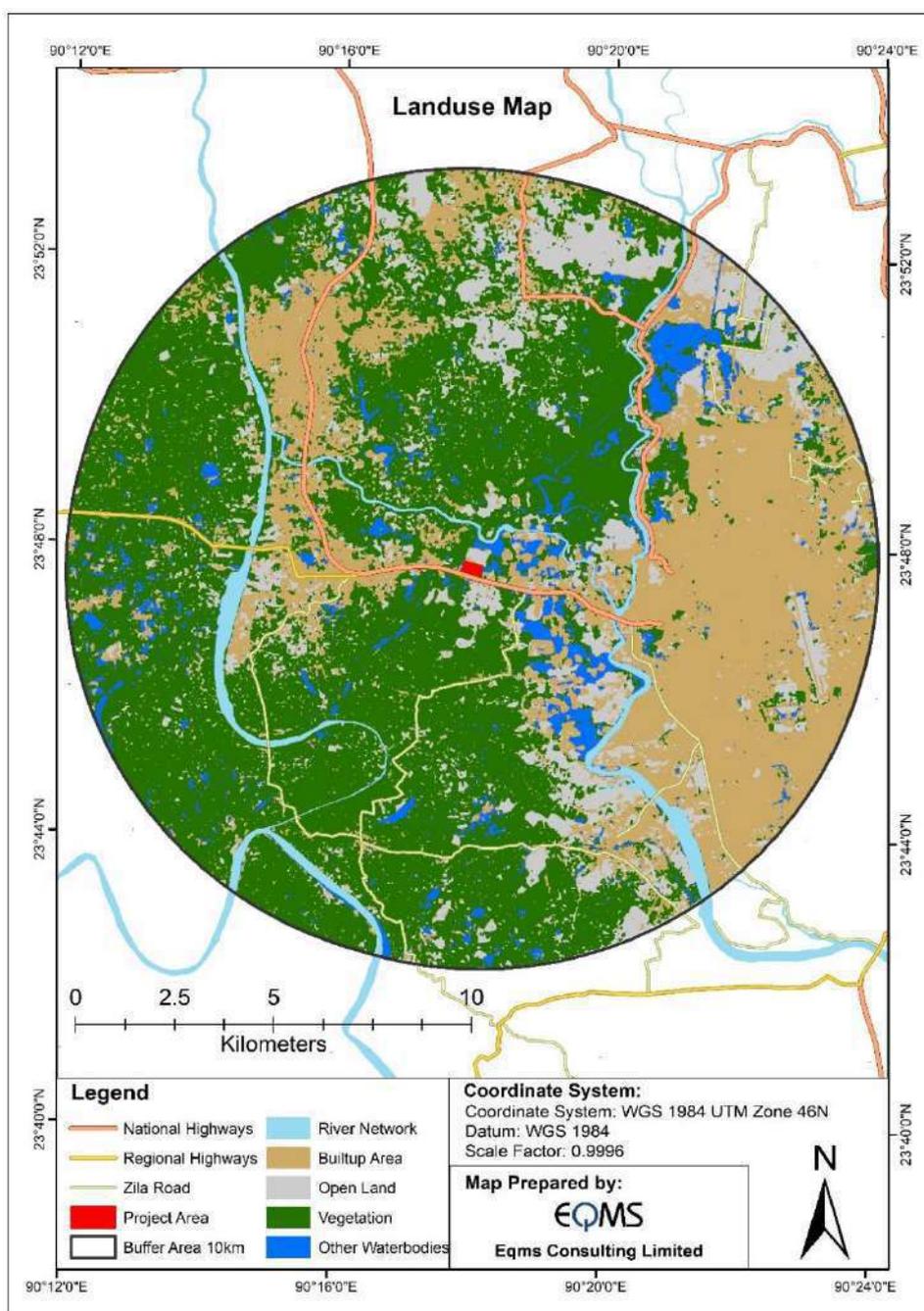
- To study the land use/cover in the 5 km radius areas of the proposed project site and provide inputs for environmental planning of the proposed project by analyzing the existing land use/land cover scenario: and
- To establish the existing baseline scenario using a GIS database to incorporate thematic information on the different physical features, including Built-up, Open Land, Vegetation Waterbodies, etc.

The evaluation of the existing environmental status of the study area was considered 5 km. This revealed that the land use/land cover consists mainly of Built-up, Open Land, Vegetation Waterbodies, etc. Table 6-1 shows the existing land use composition around 5 km of the project study area. Figure 6-12 gives the Land use/Land cover map showing the land use pattern within 5 km of the study area.

Table 6-1: Existing Land Use Composition around 5 km of the Project Area

Land use Category	Area in (Acres)	Percentage (%)
Built-up	97.53	29.60
Open Land	42.48	12.89
Vegetation	167.29	50.77
Waterbodies	22.21	6.74
Total	329.51	100

Figure 6-12: 5 km Land use map of the Study Area

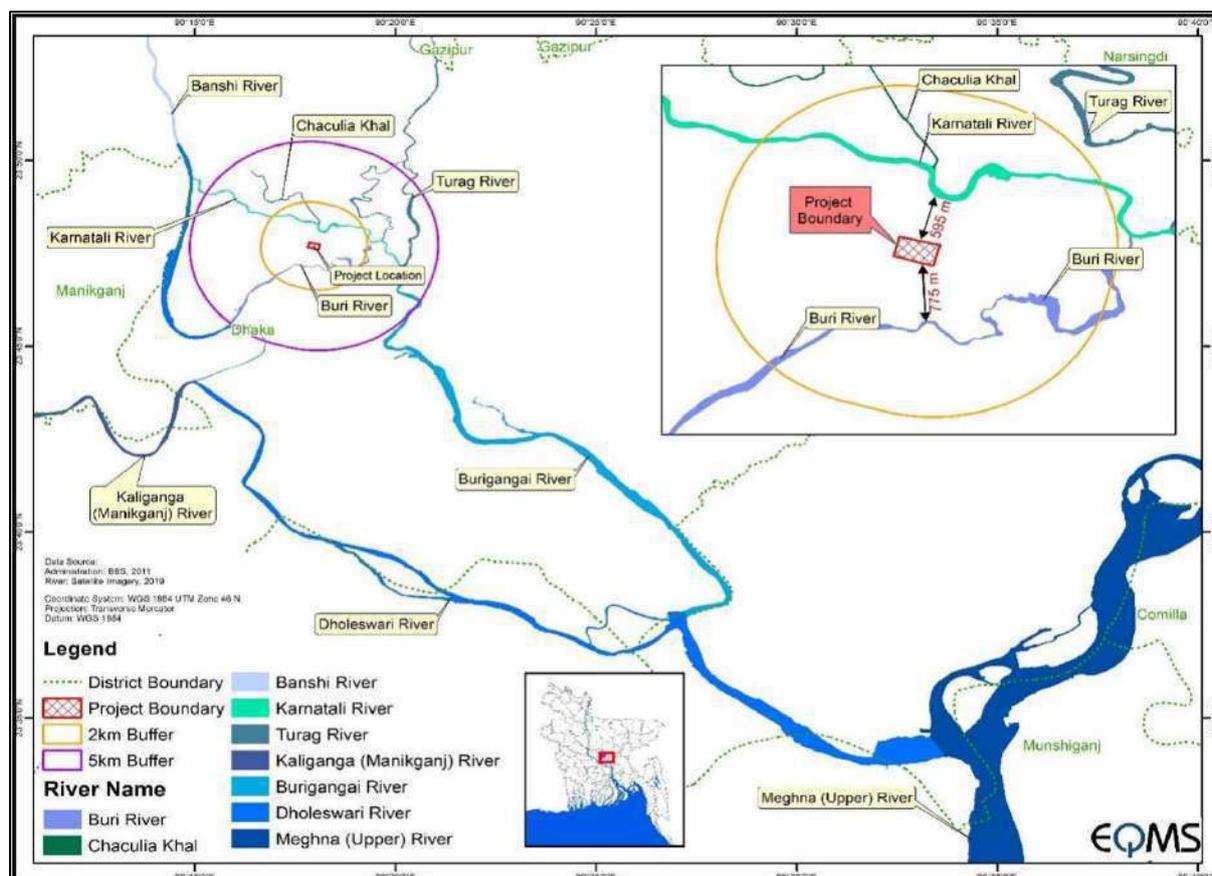


Source: Google earth image analysis

6.2.6 River System and Hydrology

The Karnatali, Buri, and Turag are the major rivers that flow through Amin Bazar and are close to the project area. The Karnatali River about 595m north of the proposed plant site, is wide, and has a large water volume, with a minimum monthly water supply of 0.48m³/s and a minimum water level of 0.86m (which can meet the water demand of the project), which can also be considered as the water source of this project. Figure 6-13 shows major rivers and water bodies around the project area.

Figure 6-13: Drainage map around the project area



Source: GIS and RS Department, EQMS Consulting Limited

6.3 Environmental Quality

6.3.1 Air Quality

The objective of the ambient air quality monitoring program was to gather the current air quality data and establish the baseline ambient air quality in the study area. Air quality was monitored during the study period (April 2022).

6.3.1.1 Selection of Sampling Locations

The ambient air quality monitoring locations were based on the following aspects of the field survey plan developed before the fieldwork.

- The meteorological conditions of the area are based on information from the BMD observatory at Dhaka station.
- Topography of the study area; and
- Location of sensitive receptors such as significant settlements.

6.3.1.2 Air Quality Monitoring Location

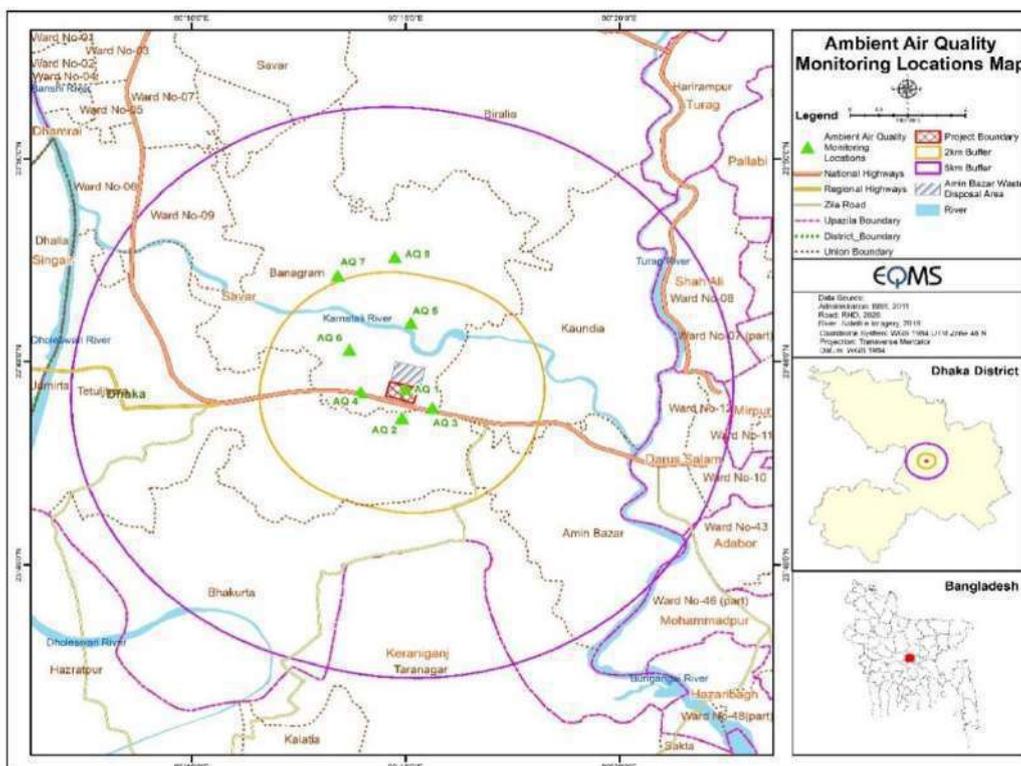
The EQMS team has searched air pollution sources around the project site. There are some brick kilns around the project site. These brick kilns can disperse SO_x in the area. Generally, air pollution sources in the study area consist of road dust, industry, brick kilns, black smoke from diesel engine vehicles, wind-blown dust from Amin Bazar waste landfill and agricultural lands, domestic heating, and cooking. EQMS has determined eight air quality monitoring locations around the project site based on prevailing wind direction and the importance of the receptors. Location details and points of Ambient Air quality sampling are depicted in Table 6-2 and Figure 6-14, respectively.

Table 6-2: Ambient Air Quality Sampling Locations

SL.	Monitoring Locations	Monitoring ID	Coordinates
1	Project Site, Banagram, Savar, Dhaka	AQ1	23°47'42.30"N 90°17'59.77"E
2	Modhumoti Model Housing, Banagram, Savar, Dhaka	AQ2	23°47'27.20"N 90°17'57.86"E
3	Raj filling station, Banagram, Savar, Dhaka	AQ3	23°47'33.33"N 90°18'14.79"E
4	Baliarpur, Banagram, Savar, Dhaka	AQ4	23°47'42.25"N 90°17'34.92"E
5	Beraid lake city, Banagram, Savar, Dhaka	AQ5	23°48'22.48"N 90°18'3.06"E
6	Nagar Konda, Savar, Dhaka	AQ6	23°48'7.356"N 90°17'28.518"E
7	Beraid Gandaria, Savar, Dhaka	AQ7	23°48'51"N 90°17'22"E
8	Chakullia, Banagram, Savar, Dhaka	AQ8	23°49'2"N 90°17'54"E

Source: Field Survey by EQMS, April 2022

Figure 6-14: Ambient Air Quality Monitoring Location



Source: Field Survey by EQMS, April 2022

Photographs taken during air quality monitoring are shown in **Figure 6-15**.

Figure 6-15: Photographs of Ambient Air Quality Monitoring

 <p>11 Apr 2022 12:41:45 pm 23°47'44" N 90°17'60" E Dhaka - Aricha Highway Bongaon Union Dhaka District Dhaka Division</p>	 <p>11 Apr 2022 9:26:14 am 23°47'27" N 90°17'58" E Unnamed Road Dhaka District Dhaka Division</p>
<p>AQ1</p>	<p>AQ2</p>
 <p>14 Apr 2022 12:45:50 pm 23°49'33" N 90°18'15" E 6 Dhaka - Aricha Highway Dhaka District Dhaka Division</p>	 <p>21 Apr 2022 8:55:46 am 23°47'42.21" N 90°17'34.824" E</p>
<p>AQ3</p>	<p>AQ4</p>
 <p>23 Apr 2022 8:01:52 am 23°48'23" N 90°18'11" E Konda - Bongaobag Road Nagar Kanda Bongaon Union Dhaka District Dhaka Division</p>	
<p>AQ5</p>	<p>AQ6</p>
	
<p>AQ7</p>	<p>AQ8</p>

Source: Field Survey by EQMS Team, April 2022

6.3.1.3 Methodology

The ambient air quality was monitored at eight (08) locations. AQM-09 Air Quality Monitoring System machine was used to collect ambient air quality monitoring data, including Dioxides of Nitrogen (NO₂), Carbon Monoxide (CO), Sulfur Dioxide (SO₂), and Particulate Matter (PM₁₀ and PM_{2.5}). Sampling and analysis of ambient air quality were conducted by following the United States Environmental Protection Agency (USEPA) recommendation. The air quality monitoring device records one reading every minute and stores it automatically in memory, which is later retrievable. Monitoring and analysis of ambient air quality were conducted by referring to the United States Environmental Protection Agency (USEPA) recommendation.

Table 6-3: Air quality and weather monitoring system

Parameter	Machine	Methods of Testing	Sensors
PM _{2.5}	AQM-09	On-Site Recording	Light Scattering Technique
PM ₁₀	AQM-09	On-Site Recording	Light Scattering Technique
Nitrogen-di-oxide	AQM-09	On-Site Recording	High Sensitivity Electrochemical
Sulfur dioxide (SO ₂)	AQM-09	On-Site Recording	High Sensitivity Electrochemical
Carbon monoxide (CO)	AQM-09	On-Site Recording	High Sensitivity Electrochemical

As per the national and international standards, CO was monitored for 8 hours to compare with the standard. The standard duration for PM₁₀, PM_{2.5}, SO₂, and NO₂ is 24-hour data. A conversion equation was used to convert the data from a specific time to the expected time. Many agencies (e.g., New York State Dept. of Environmental Conservation, California Office of Environmental Health Hazards Assessment, USEPA, Ontario Ministry of Environment) used a conversion process by applying Pasquill's (1961) air mass dispersion tables defining six air mass stability classes (**Table 6-4**) and a set of meteorological conditions (**Table 6-5**). Using the simple power law, Schroeder and Jugloff (2012) described the steps for converting eight-hour readings to 24-hour/annual values. The stability classes (**Table 6-4**) are related to average wind speed, daytime solar radiation, and night-time cloud cover (**Table 6-5**); refining these relationships was also developed by Pasquill.

Table 6-4: Pasquill-Gifford Air Dispersion Stability Classes and Associated Dispersion Exponents¹⁹

Stability Class	P	Definition
A	0.5	Very Unstable
B	0.5	Unstable
C	0.333	Slightly Unstable
D	0.2	Neutral
E	0.167	Slightly Stable
F	0.167	Stable

¹⁹ Julie Schroeder and Denis Jugloff (2012), Interpretation of 24-hour sampling data: Development of 24-hour ambient air quality criteria and their use in Ontario, Human Toxicology & Air Standards Section, Standards Development Branch, Ontario Ministry of the Environment, Toronto, ON, Canada

Table 6-5: Meteorological conditions define the P-G Stability Classes

Surface Wind Speed	Day Time Incoming Solar Radiation	Nighttime Cloud Cover	Surface Wind Speed	Day Time Incoming Solar Radiation	Nighttime Cloud Cover
m/s	Strong	Moderate	Slight	>50%	<50%
<2	A	A-B	B	E	F
2-3	A-B	B	C	E	F
3-5	B	B-C	C	D	E
5-6	C	C-D	D	D	D
>6	C	D	D	D	D
m/s	Strong	Moderate	Slight	>50%	<50%

Weather data was not recorded during the monitoring period. So, from the Bangladesh context, the annual average wind speed in the Dhaka area is about <2 m/s. Considering the wind speed, from **Table 6-5** (1st row as the average wind speed in all the area is <2 m/s), the project stability class was calculated as 0.39 (see below):

$$= 0.389 \approx 0.39$$

The value of the exponential factor is calculated based on the stability class of the study area (**Table 6-4**). The study area's wind speed and stability classes are A, B, E, and F. Hence, the P value will be the average of the respected P values of these stability classes. This suggests a somewhat unstable air mass, resulting in considerable dilution of an eight-hour sample spread over 24 hours. To provide 24-hour averages for the five parameters, the following power-law equation, as defined in Schroeder and Jugloff 2012 was applied:

$$C_{long} = C_{short} (t_{short}/t_{long})^p$$

Where,

C_{long} = Expected output in a specific period of time

C_{short} = Outcome during Monitoring Period

t_{short} = Specific time period during monitoring (in minutes)

t_{long} = Expected time period (in minutes)

p = Exponential factor where the value is 0.39

6.3.1.4 Ambient Air Quality Monitoring Results

Ambient air quality monitoring test results have been given in Table 6-6.

Table 6-6: Results of Average ambient air quality testing in the dry season

Time	CO (ppm)	NO ₂ (µg/m ³)	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	O ₃ (µg/m ³)
	8-hr	24-hr	24 - hr	24 - hr	24-hr	8 - hr
AQ1	1.12	82.24	95.33	37.51	57.07	36.25
AQ2	0.43	58.17	61.84	22.62	50.83	35.87
AQ3	0.62	70.35	147.11	34.40	62.42	38.22
AQ4	0.70	92.02	93.18	48.92	52.02	36.14
AQ5	0.59	63.46	64.57	38.80	39.40	34.97
AQ6	0.48	57.87	65.23	24.98	52.83	36.05
AQ7	0.44	53.13	58.84	23.19	50.65	33.54
AQ8	0.42	52.83	58.27	22.06	51.64	33.53
Duration (hours)	8	24	24	24	24	8
Weather Condition	Sunny					
Bangladesh Standard²⁰	5	80	150	65	80	100

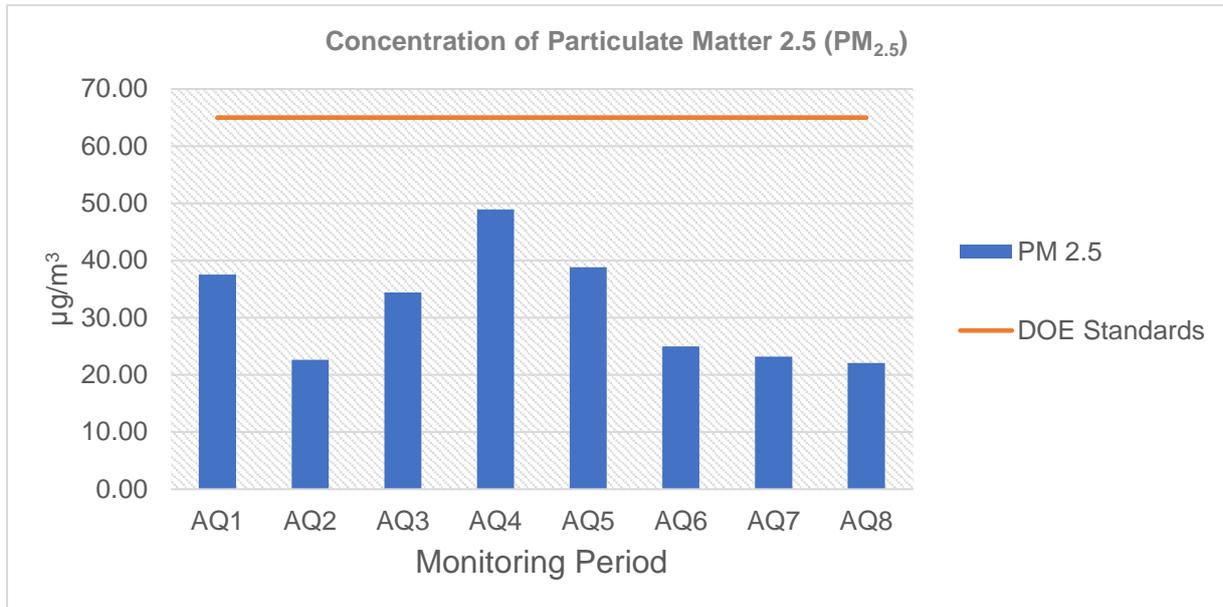
6.3.1.5 Analysis and Discussion of Result

PM_{2.5}

Particulate matter is the term for tiny particles found in the air. These particles can include dust, dirt, smoke, and liquid droplets. The 24-hourly average PM_{2.5} concentration in ambient air in the study area for 8 locations was recorded in the range of 22.06 µg/m³ – 48.92 µg/m³. All the monitoring locations' result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for PM_{2.5} in Bangladesh. The concentrations of PM_{2.5} in the study area are shown in Figure 6-16.

²⁰ Air Pollution (Control) Rule, 2022

Figure 6-16: Concentrations of PM_{2.5} in the study area

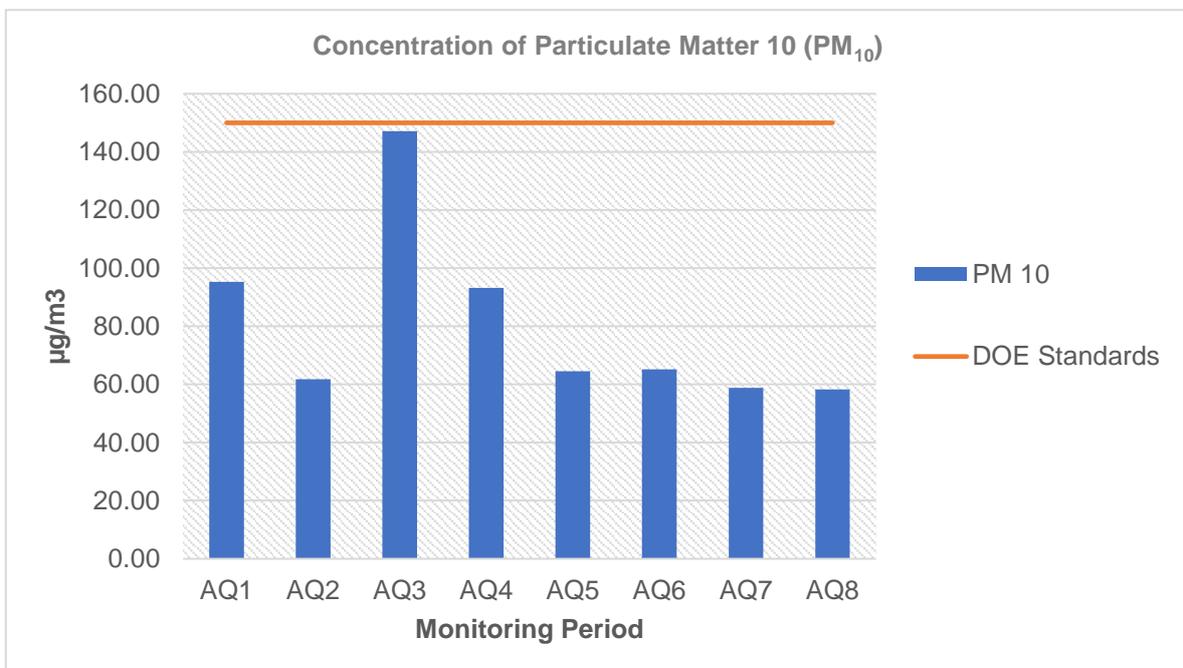


Source: Field Monitoring and Laboratory Analysis by EQMS, 2022

PM₁₀

The 24-hourly average PM₁₀ concentration in ambient air in the study area for 8 locations was recorded in the range of 58.27 µg/m³–147.11 µg/m³. All the monitoring location result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for PM₁₀ in Bangladesh). The concentrations of PM₁₀ in the study area are shown in Figure 6-17.

Figure 6-17: Concentrations of PM₁₀ in the study area

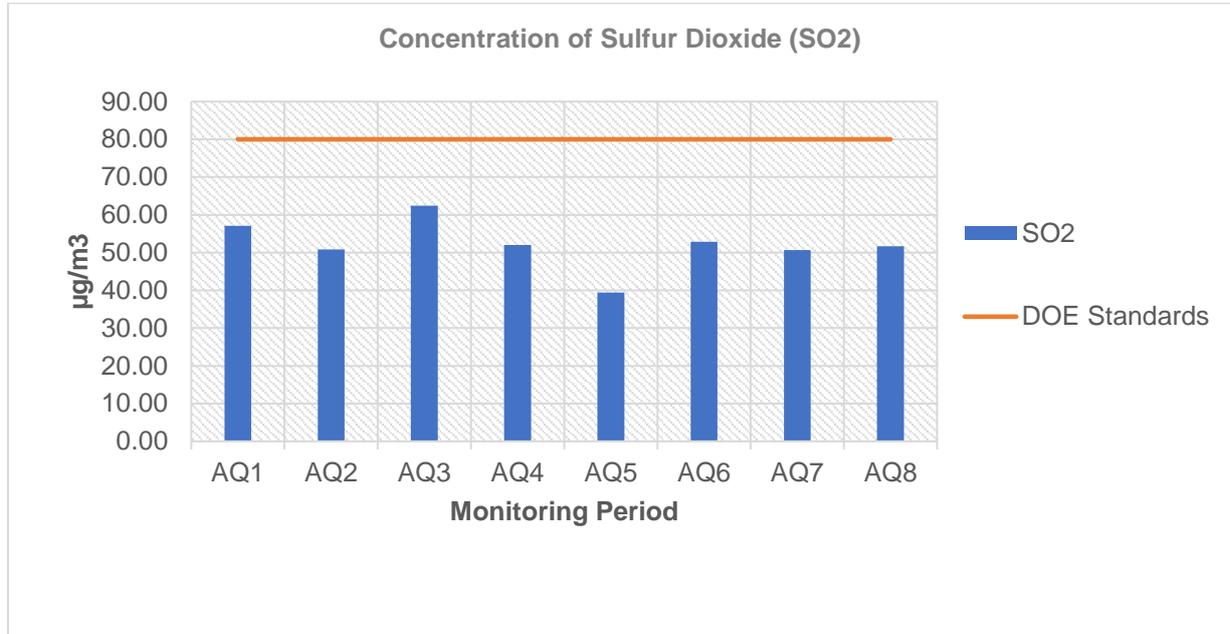


Source: Field Monitoring and Laboratory Analysis by EQMS, 2022

SO₂

The 24-hourly average SO₂ concentration for 8 locations was recorded in the range of 39.40 µg/m³–62.42 µg/m³. All the monitoring locations result within the 24-hourly National Ambient Air Quality Standard (NAAQS) for SO₂ in Bangladesh. The concentrations of SO₂ in the study area are shown in Figure 6-18

Figure 6-18: Concentrations of SO₂ in the study area



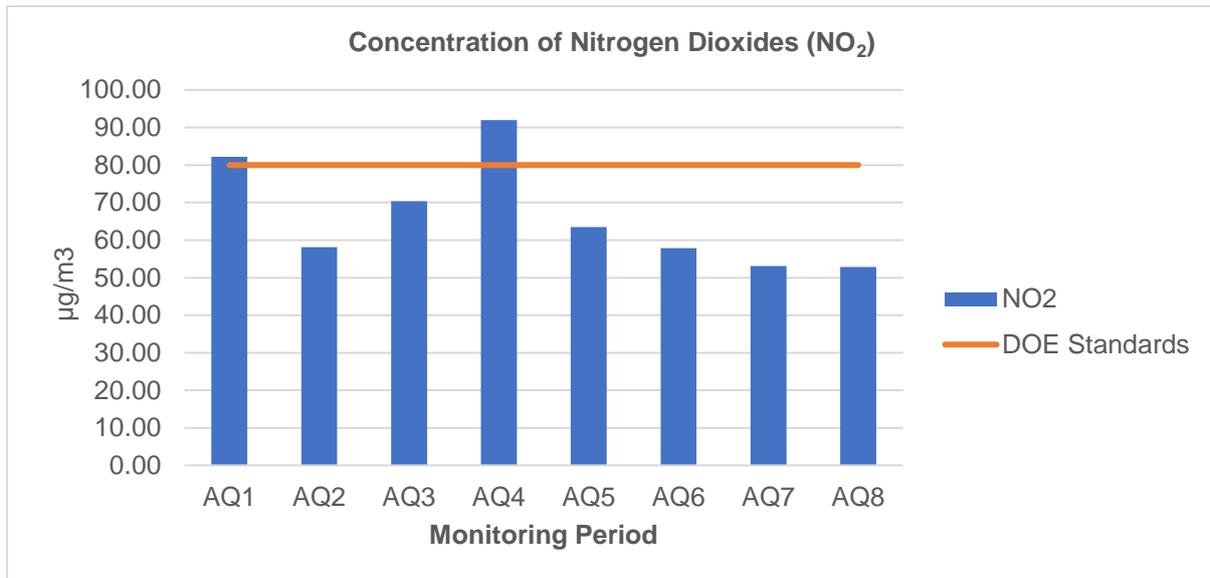
Source: Field Monitoring and Laboratory Analysis by EQMS, 2022

During the monitoring period, the maximum SO₂ concentration was reported in the AQ3 monitoring location. SO₂ concentrations at all the monitoring locations were reported to be well below 80µg/m³, which is the National Ambient Air Quality Standard (NAAQS) for SO₂ in Bangladesh.

NO₂

The 24-hourly average NO₂ concentration for 8 locations was recorded in the range of 52.83 µg/m³–92.02 µg/m³. All the monitoring location result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for NO₂ in Bangladesh except for the AQ4 monitoring location. The concentrations of NO₂ in the study area are shown in Figure 6-19.

Figure 6-19: Concentrations of NO₂ in the study area

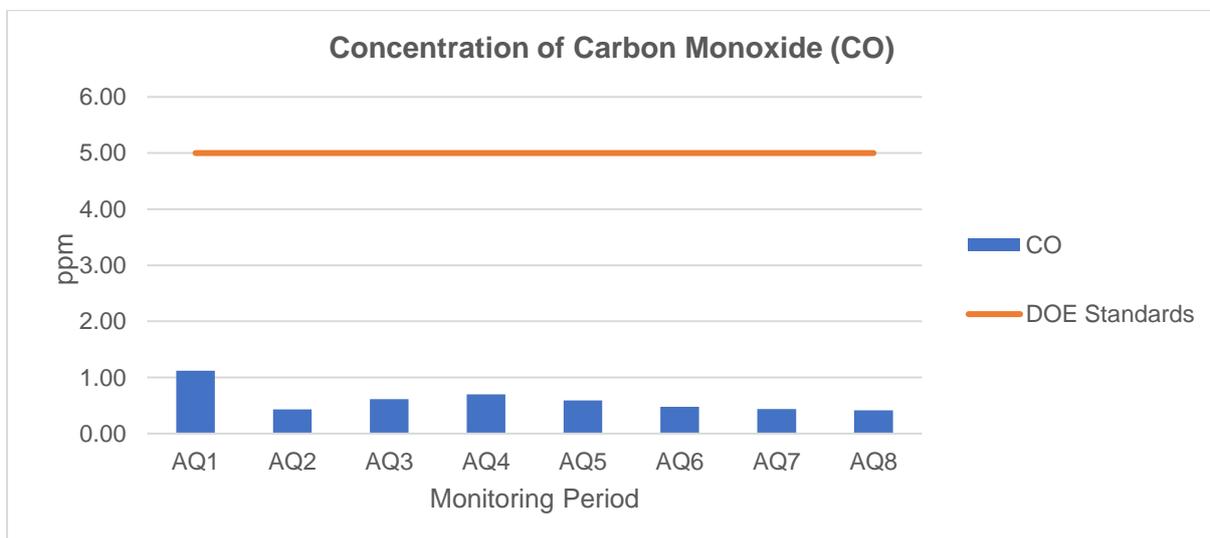


Source: Field Monitoring and Laboratory Analysis by EQMS, 2022

CO

The 8-hourly CO concentration for the 8 locations monitoring period was recorded in the range of 0.42 ppm- 1.12 ppm. CO concentrations were reported to be low at all the monitoring locations compared with the Bangladesh Standards (5 ppm). The concentrations of CO in the study area are shown in Figure 6-20.

Figure 6-20: Concentrations of CO in the study area

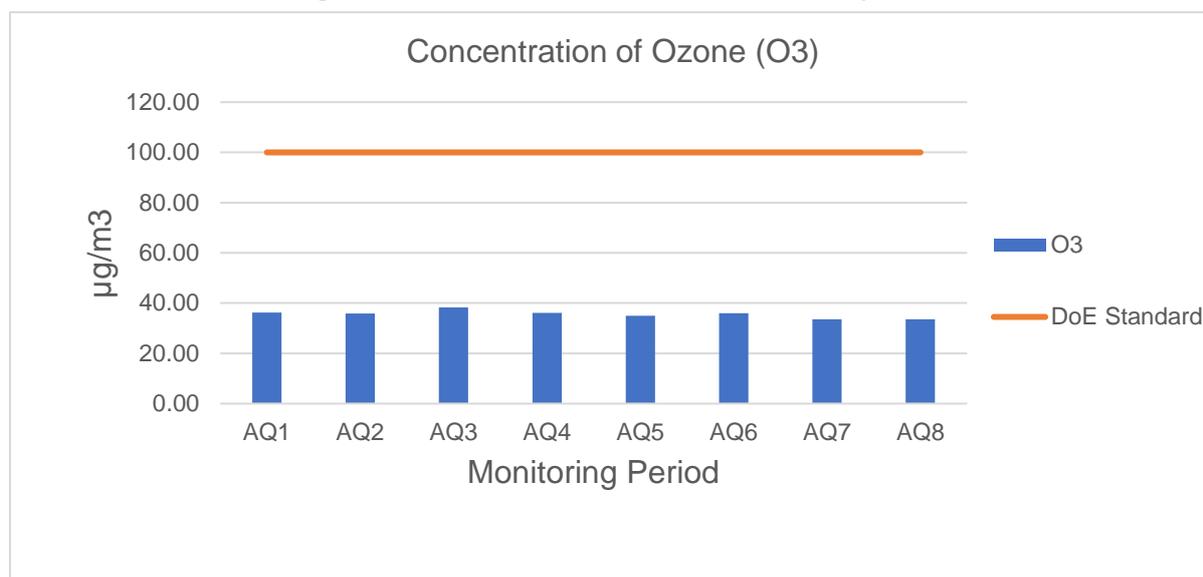


Source: Field Monitoring and Laboratory Analysis by EQMS, 2022

Ozone (O₃)

The 8-hourly average O₃ concentration for 8 locations was recorded in the range of 33.53 µg/m³– 38.22 µg/m³. All the monitoring location result was within the 8-hourly National Ambient Air Quality Standard (NAAQS) for O₃ in Bangladesh. The concentrations of O₃ in the study area are shown in Figure 6-21.

Figure 6-21: Concentrations of O₃ in the study area



Source: Field Monitoring and Laboratory Analysis by EQMS, 2022

6.3.2 Water Quality

The EQMS team has observed various water sources around the project site. The river Karnatali is about 595 m away from the project site. This water body remains almost dry in the winter season. The EQMS team has collected two ground and eight surface water samples as representative water sources in the study area.

The water samples were collected following standard sample collection procedures. Firstly, one liter of water sample was taken into an air-tightened plastic bottle without any air bubbles. This bottle was preserved for laboratory testing. Then, another sample was taken from the exact location for onsite testing. Finally, the preserved and air-tightened sample bottle was sent for laboratory testing. Some parameters, e.g., temperature, pH, and Dissolved Oxygen (DO), were tested onsite as their values may change in a different environment other than the sampling point. On the other hand, other parameters, e.g., Color, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solid (TSS), Turbidity, Total Coliforms, Arsenic, Oil, and Grease, etc. have been tested in EQMS laboratory.

The samples were analyzed per the standard procedure/method given in Standard Method for Examination of Water and Wastewater Edition 20, published by APHA. Water quality parameters are checked against Environment Conservation Rules (ECR), 2023-Schedule 2 (a), and ECR-2023 Schedule-2 (b). Details of the analysis method are presented in **Table 6-7**.

Table 6-7: Methods of Water Analysis

SL	Parameter	Method/Instrument
1.	Temperature (°C)	Ion Electrode Method/ Hanna HI98108
2.	Turbidity	Turbidimetric Photoelectric Method/Portable digital Turbidity meter
3.	Total Dissolved Solids (mg/l)	Ion Electrode Method/ Hanna HI 99301
4.	Conductivity (µmhos/cm)	Ion Electrode Method/ Hanna HI 99301

SL	Parameter	Method/Instrument
5.	Dissolved Oxygen (mg/l)	Ion Electrode Method / Lutron DO-5509
6.	pH	Digital pH meter/ Hanna HI98108
7.	Salinity	Digital Salinity Meter/ AZ 8371
8.	Chemical Oxygen Demand (COD)	Adoption of the USEPA 410.4 approved method for COD determination on water/ Hanna HI 801 Spectrophotometer (iris)
9.	Iron (Fe) (mg/l)	EPA Phenanthroline method 315 B / HI 801 Spectrophotometer (iris)
10.	Cadmium (Cd) (mg/l)	EPA 200.8 method /MASS SPECTROMETRY
11.	Arsenic (As) (mg/l)	Modified Gutzeit method
12.	Zinc	The standard method for the examination of water and wastewater 18th edition, Zincon Method/ HI 801 Spectrophotometer (iris)
13.	Chromium	ASTM D1687-92 diphenylcarbohydrozide method/HI 801 Spectrophotometer (iris)
14.	Magnesium	Calmagite method/ HI 801 Spectrophotometer (iris)
15.	Aluminum	Adoption of the aluminon method/HI 801 Spectrophotometer (iris)
16.	Coper	Adoption of EPA 200.8 method/HI 801 Spectrophotometer (iris)
17.	Hardness	The titrimetric method by EDTA
18.	Ammonia	Adoption of ASTM D 1426-92 method for water Ammonia analysis by Nessler method/HI 801 Spectrophotometer (iris)
19.	Ammonium	Adoption of ASTM D 1426-92 method for water Ammonium analysis by Nessler method HI 801 Spectrophotometer (iris)
20.	Manganese (Mn)	Periodate method by standard method for the examination of water and wastewater analysis 18th edition /HI 801 Spectrophotometer (iris)
21.	Nitrogen (Nitrate)	Cadmium Reduction method/HI 801 Spectrophotometer (iris)
22.	Nitrogen (Nitrite)	Ferrous Sulfate method/HI 801 Spectrophotometer (iris)
23.	Phosphate	Amino acid method by standard method for the examination of water and wastewater analysis 18th edition HI 801 Spectrophotometer (iris)
24.	Total Suspended Solid	Standard Methods (2005), 2540D and EPA (1983) Method 160.2 followed by Gravimetric Analysis
25.	Oil & Grease	USEPA1 Hexane Extractable Gravimetric Method followed by Gravimetric Analysis
26.	Biochemical Oxygen Demand (BOD)	5 days incubation followed by ion electrode method

Surface water quality was compared with the standards for Inland Surface Water, Environment Conservation Rules (ECR)-2023-Schedule-2 (a). In contrast, the groundwater was compared with the Drinking Water Standard ECR-2023-Schedule-2(b), and the WHO Guidelines.

6.3.2.1 Surface Water Quality

The surface water sampling was collected from 100 m upstream and downstream of Karnatali river close to the project area. Eight surface water samples were collected (SW1, SW2, SW3, SW4, SW5, SW6, SW7, and SW8) in August 2022. Among them, four samples were collected from 100m upstream, and four samples were collected from 100m downstream. Details of surface water sampling locations are depicted in Table 6-8.

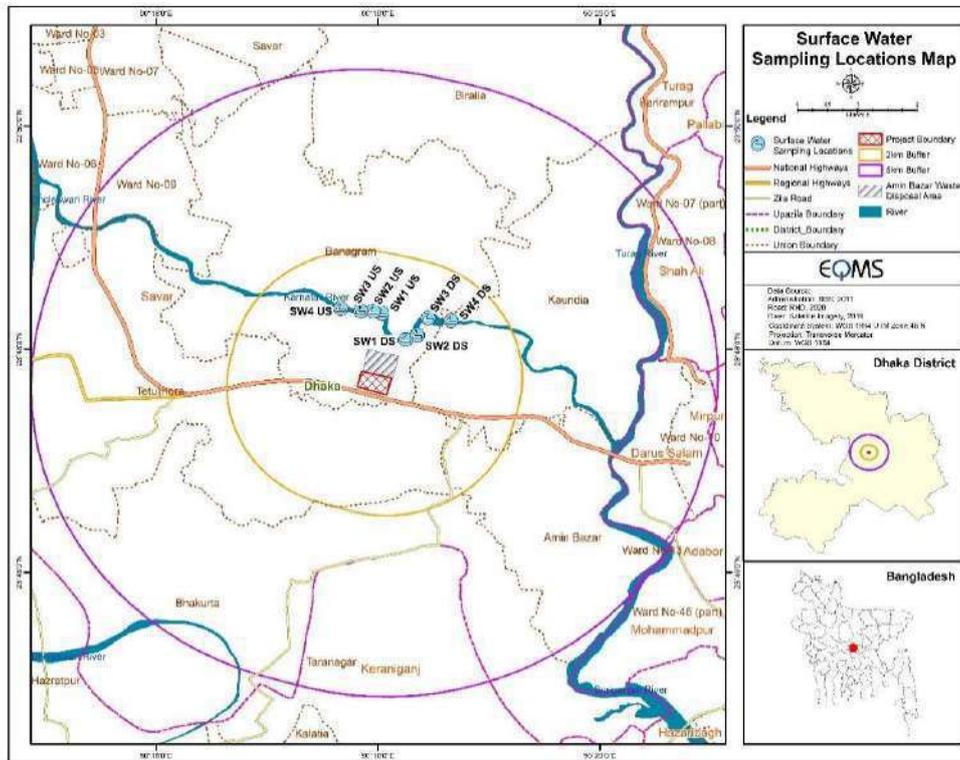
Table 6-8: Details of Surface Water Sampling Locations

SL.	Sampling Location	Code	Geographical Location	Type of Source
1.	Upstream of Karnatali River	SW1_US	23°48'19.602" N 90°18'1.572" E	River Water
2.	Upstream of Karnatali River	SW2_US	23°48'20.706" N 90°17'56.214" E	River Water
3.	Upstream of Karnatali River	SW3_US	23°48'20.85" N 90°17'49.2" E	River Water
4.	Upstream of Karnatali River	SW4_US	23°48'21.978" N 90°17'40.452" E	River Water
5.	Downstream of Karnatali River	SW1_DS	23°48'5.364" N 90°18'15.15" E	River Water
6.	Downstream of Karnatali River	SW2_DS	23°48'7.542" N 90°18'20.85" E	River Water
7.	Downstream of Karnatali River	SW3_DS	23°48'16.968" N 90°18'27.198" E	River Water
8.	Downstream of Karnatali River	SW4_DS	23°48'15.918" N 90°18'38.016" E	River Water

Source: Field Survey by EQMS Team, August 2022

The sampling locations of surface water collection are shown in Figure 6-22.

Figure 6-22: Surface Water sampling location



Source: EQMS, April 2022

Pictures taken during the surface water sampling are shown in Figure 6-23.

Figure 6-23: Photographs were taken during surface water sampling.





Source: Field Survey by EQMS Team, August 2022

Results Analysis

Analytical results from the surface water sampling test are presented in Table 6-9.

Table 6-9: Surface Water Quality Testing Result

Parameters	Unit	Concentration Present								Bangladesh Standard ²¹ (ECR-2023: Schedule 2(A)-1)					
		SW1_US	SW2_US	SW3_US	SW4_US	SW1_DS	SW2_DS	SW3_DS	SW4_DS	a	b	c	d	e	f
DO	mg/L	6.0	5.5	6.6	6.1	6.4	5.6	6.6	6.0	≥ 6	≥ 5	≥ 5	≥ 5	≥ 1	-
BOD	mg/L	0.9	1.1	0.8	0.9	0.8	1.2	0.8	1.0	≤ 2	≤ 3	≤ 3	≤ 6	12	≤ 12
Temperature	(°C)	22.1	22.2	22.0	22.1	22.0	22.3	22.2	22.3	-	-	-	-	-	-
Electric Conductivity (EC)	µS/cm	180	170	160	160	170	170	170	160						
Turbidity	NTU	5.7	8.5	8.9	16.8	5.5	9.0	8.7	24.9						
pH		7.87	7.80	7.24	7.13	7.39	7.50	7.11	7.10	6.5-8.5	6.5-8.5	6.0-9.0	6.0-9.0	6.5-8.5	6.5-8.5
TDS	mg/L	90	80	80	80	80	80	80	80	1000	1000	1000	1000	1000	1000
Salinity	ppt	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07						
Iron	mg/L	0.02	0.04	0.04	0.01	0.03	0.05	0.06	0.02						
Arsenic	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
Phosphate	mg/L	1.2	1.4	1.4	1.8	1.0	1.2	1.3	1.6	0.1	0.5	0.5	0.5	-	2.0
Zinc	mg/L	0.02	0.04	0.08	0.03	0.01	0.05	0.07	0.06						
Chromium	mg/L	0.00	0.00	0.02	0.04	0.01	0.01	0.02	0.06	0.02	0.2	0.02	0.05	0.1	0.1
Nitrate	mg/L	1.7	2.1	2.0	1.8	1.6	2.2	2.2	1.6	7.0	7.0	7.0	7.0	-	5.0
Magnesium	mg/L	12	16	12	14	10	14	11	12						
Aluminum	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
Coper	mg/L	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01						

²¹ Bangladesh Environment Conservation Rules, 2023- Schedule 2 (A) (Standards for Inland Surface Water).

Parameters	Unit	Concentration Present								Bangladesh Standard ²¹ (ECR-2023: Schedule 2(A)-1)					
		SW1_US	SW2_US	SW3_US	SW4_US	SW1_DS	SW2_DS	SW3_DS	SW4_DS	a	b	c	d	e	f
COD	mg/L	11	14	12	15	13	16	11	12	10	10	25	50	100	100
Hardness (as CaCO ₃)	mg/L	78	93	105	84	84	90	99	81						
Ammonia	mg/L	0.48	0.38	0.41	0.40	0.47	0.38	0.41	0.37						
Ammonium	mg/L	0.47	0.37	0.40	0.40	0.46	0.36	0.40	0.36	0.1	0.3	0.3	0.3	2.7	1.5
Color	PCU	37	27	26	26	39	29	28	25						
TSS	mg/L	128	122	126	115	110	114	128	108						
Oil and Grease	mg/L	11.42	10.28	8.85	5.42	11.24	10.18	8.81	5.41						

Source: Laboratory Analysis by EQMS Laboratory, 2022

Note:

a = Source of drinking water for supply only after disinfecting

b = Water usable for recreational activity

c = Source of drinking water for supply after conventional treatment

d = Water usable by fisheries

e = Water usable by various process and cooling industries

f = Water usable by irrigation

Notes:

In water used for irrigation water, electrical conductivity is 2250 μ S/cm (at a temperature of 25°C); Sodium is less than 26%; boron is less than 0.2%.

The analyzed results for surface water were compared to Bangladesh Standards (ECR, 2023). Most of the surface water parameters are not yet standardized in ECR, 2023. The surface water samples' testing results are presented in Table 6-9. The results found that most parameters comply with the national standard, while some parameters don't comply with the standard limits. Some of the water quality parameters are discussed below.

pH

The pH ranges from 7.10 to 7.87. The test result found that the pH of the surface water is within the acceptable limit of Bangladesh standards.

DO

The dissolved oxygen for surface water ranges from 5.5 to 6.6, which is below the Bangladesh Standard. The lower concentration of DO indicates a higher amount of organic waste materials present in the water body.

Turbidity

Turbidity is a measure of the cloudiness of water, which represents the degree to which the water loses its transparency due to the presence of suspended particulates. Turbidity ranges between 5.5 to 24.9 NTU.

Total hardness

Total hardness in the surface water samples ranges between 78 to 105 mg/L, respectively.

BOD₅

BOD is another important parameter, representing the amount of oxygen needed to break down the organic matter in water. Biochemical Oxygen Demand varies from 0.8 to 1.2 mg/l, which exceeds the national standard.

Total Dissolved Solids (TDS)

Total Dissolved Solids for surface water varies 80 to 90 mg/L.

Oil & Grease

Oil & grease for surface water ranges from 5.41 to 11.24 mg/L.

Chromium

In the sampling locations, chromium for surface water ranges from 0.00 to 0.06 mg/L.

Some other physical and chemical properties of water, e.g., Chemical Oxygen Demand, Temperature, Electric Conductivity (EC), Salinity, Iron, Arsenic, Phosphate, Zinc, Nitrate, Magnesium, Aluminum, copper, Ammonia, Ammonium, Color, and Total Suspended Solid (TSS), have been tested for which no national standard is established.

6.3.2.2 Ground Water Quality

The water sampling and analysis were undertaken to understand the overall baseline water quality of the groundwater in the study area. Groundwater samples were taken from representative selected groundwater sources representing different parts of the study area.

The groundwater sampling locations were selected to obtain a representative water sample from various study areas. The EQMS team has collected two groundwater samples (GW1 & GW2) from the study area. Table 6-10 represents the sampling location of groundwater in and around the project site.

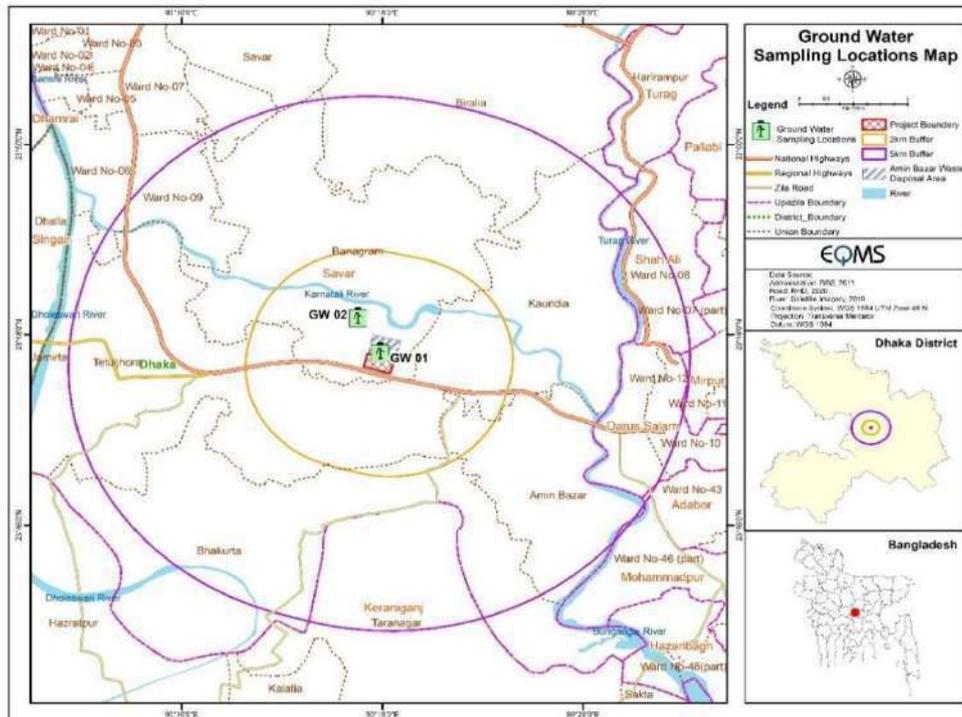
Table 6-10: Details of Ground Water Sampling Locations

SL.	Sampling Location	Code	Geographical Location
1.	Project Site, Banagram, Savar, Dhaka	GW1	23°47'48.822" N 90°17'58.992" E
2.	Konda Majhipara, Banagram, Savar, Dhaka	GW2	23°48'10.44" N 90°17'45.528" E

Source: EQMS EIA Study Team, August 2022

Sampling locations of groundwater are shown in Figure 6-24.

Figure 6-24: Groundwater Sampling Location



Source: EQMS, April 2022

Pictures captured during groundwater sampling are shown in Figure 6-25.

Figure 6-25: Photographs were taken during groundwater sampling.



Source: Field Survey by EQMS Team

Analytical results from the groundwater sample test are presented in Table 6-11.

Table 6-11: Ground Water Quality Analysis Result

SL	Parameter	Unit	GW1	GW2	Bangladesh Standard ²²	WHO ²³
1.	Temperature	°C	22.0	21.9	20-30	-
2.	Electric Conductivity (EC)	µS/cm	290	420	--	(2,000 by EPA)
3.	Turbidity	NTU	0.05	0.08	5.0	
4.	pH		6.81	6.78	6.5 – 8.5	6.5 – 8.5
5.	TDS	ppm	140	210	1000	1500
6.	DO	mg/L	6.0	6.1		-
7.	Salinity	ppt	0.12	0.19	--	-
8.	Iron	mg/L	0.00	0.00	0.3 – 1.0	0.3
9.	Fluoride	ppm	0.8	0.9	1.0	
10.	Arsenic	mg/L	0.00	0.00	0.05	
11.	Total Coliform	CFU/100 mL	0	0	0	-
12.	Fecal Coliform	CFU/100 mL	0	0	0	-
13.	Chloride	mg/L	16	15	250 ²⁴	
14.	Total Alkalinity	mg/L	245	185	--	--
15.	Total Hardness	mg/L	85	70	500	

Source: Laboratory Analysis, EQMS laboratory, May 2022

The analyzed results for groundwater were compared to the Bangladesh Standards (ECR, 2023) and WHO guidelines. The groundwater analysis reveals that all the parameters are within the standard value of ECR, 2023, and WHO guidelines. Considering the groundwater testing result, it can be assumed that the groundwater quality is satisfactory for drinking in the study area.

²² Ministry of Environment, Forest, and Climate Change. Bangladesh Environment Conservation Rules, 2023 (Schedule-2). The People's Republic of Bangladesh.

²³WHO Standards for Ground Water Quality

²⁴ In coastal area, the standard for chlorine is 1000 mg/L.

6.3.3 Ambient Noise Quality

The objective of monitoring the ambient noise level was to establish the baseline ambient noise level in the project area.

The residence places around the project site is a quitter. Noise levels besides the highway were higher due to the high frequency of heavy vehicles. No heavy industries are within 2 km of the project site, which creates high noise. Noise generated from the proposed power plant during construction and operation should be compared with the present baseline noise level to know the impact of the power plant on the ambient environment. Noise levels were recorded as sound pressure levels with the help of a digital sound level meter. The ambient noise level measurement determined sound intensity at the monitoring locations. These locations were chosen to record representative data all over the project site. The sound level is recorded as A-weighted equivalent continuous sound pressure level values using A-weighting filters in the noise measuring instrument.

Details of noise level measurement sampling locations are depicted in Table 6-12.

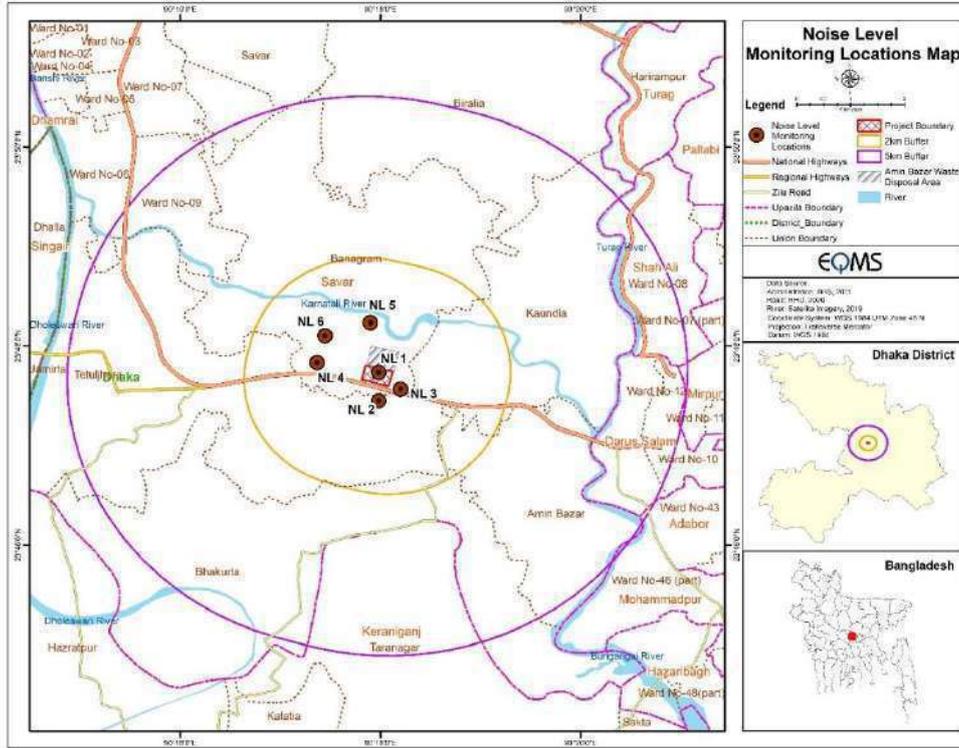
Table 6-12: Details of Noise Level Measurement Sampling Locations

SL.	Code	Location	Geographic location	Location setting
1.	NL1	Project Site, Banagram, Savar, Dhaka	23°47'43.09"N 90°17'58.95"E	Industrial
2.	NL2	Modhumoti Model Housing, Banagram, Savar	23°47'26.31"N 90°18'0.15"E	Residential area
3.	NL3	Raj filling station, Banagram, Savar	23°47'33.84"N 90°18'12.02"E	Mixed
4.	NL4	Baliarpur Uttarpara Jame Masjid, Banagram, Savar	23°47'49.86"N 90°17'21.44"E	Mixed
5.	NL5	Nagar Konda Road, Banagram, Savar	23°48'14.26"N 90°17'54.17"E	Residential area
6.	NL6	Konda High School and College, Konda, Savar	23°48'6.28"N 90°17'26.74"E	Silent area

Source: EQMS Field Survey, April 2022

The geographical locations of Noise monitoring are shown in Figure 6-26.

Figure 6-26: Noise Level Monitoring Location



Source: EQMS Field Survey, April 2022

Pictures taken during noise monitoring in and around the project site are shown in Figure 6-27.

Figure 6-27: Pictures were taken during Noise level measurement.



NL1



NL2



NL3



NL4



NL5

NL6

Source: Field Survey by EQMS Team

Noise Level Monitoring Results

Ambient noise level monitoring results are given in the following Table 6-13

Table 6-13: Noise Level Parameter in and around the Proposed Site

Location	Noise level (dB(A)) ²⁵						Bangladesh Standard (dB(A)) ²⁶		Location setting
	Leq (day)	L _{max}	L _{min}	Leq (night)	L _{max}	L _{min}	Day	Night	
NL1	66.8	84.4	35.9	57.5	78.3	35.5	75	70	Industrial
NL2	54.8	76.6	34.6	43.1	59.9	36.2	55	45	Residential area
NL3	67.3	89.3	34.3	64.6	85.1	35.5	60	50	Mixed
NL4	76.9	97.1	46.6	72.8	96.6	42.2	60	50	Mixed
NL5	55.1	76.3	40.2	44.6	53.7	34.4	55	45	Residential area
NL6	51.5	67.4	37.2	43.2	55.32	34.7	50	40	Silent area

Source: EQMS Field Survey, April 2022

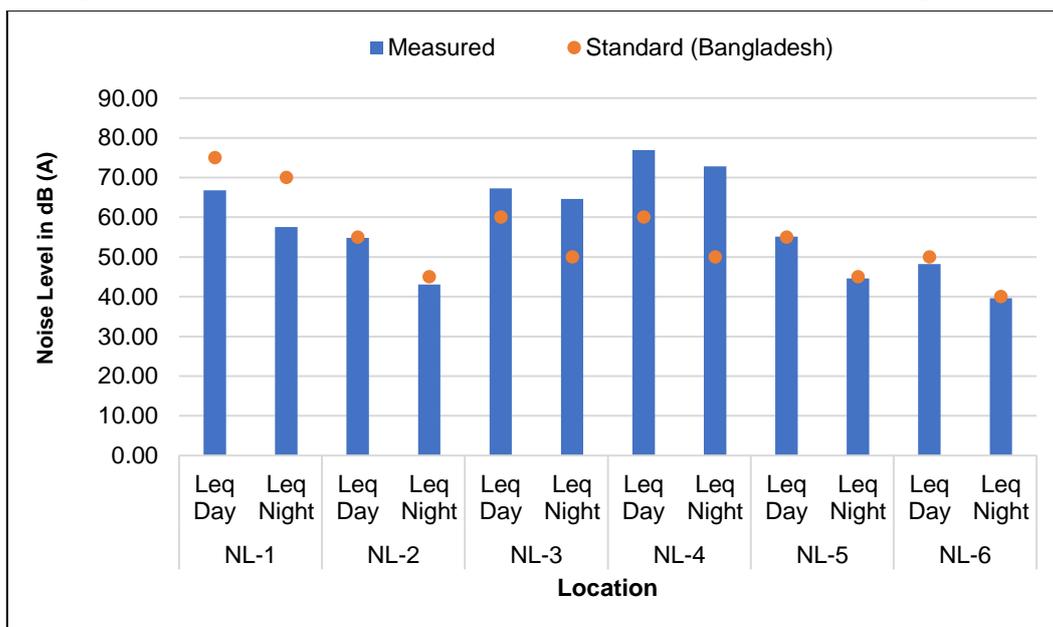
Ambient daytime noise level (Leq_{day}) was recorded in the range of 51.5 to 76.9 dB (A). In contrast, the study area's ambient nighttime noise levels (Leq_{night}) varied from 43.1 to 72.8 dB (A). Maximum noise levels (L_{max}) for daytime at the monitoring locations were recorded in the range of 67.4 to 97.1 dB (A), and the minimum noise levels (L_{min}) for daytime at the monitoring locations were recorded in the range of 34.3 to 46.6 dB (A). Maximum noise levels (L_{max}) for nighttime at the monitoring locations were recorded in the range of 53.7 to 96.6 dB (A), and the minimum noise levels (L_{min}) for nighttime at the monitoring locations were recorded in the range of 33.2 to 42.2 dB (A). The highest and lowest noise level during daytime was recorded at 76.9 dBA and 51.5 dBA at NL4 and NL6, respectively.

²⁵ A-weighted decibel, abbreviated dB(A), is an expression of the relative loudness of sounds in air as perceived by the human ear. In the A-weighted system, the decibel values of sounds at low frequencies are reduced, as the ear is less sensitive to low audio frequencies, especially below 1000 Hz, than to high audio frequencies.

²⁶ Ministry of Environment, Forest, and Climate Change. (2006). Noise Pollution (Control) Rules, 2006 (S.R.O. No. 212-Law/2006). The People's Republic of Bangladesh.

On the other hand, the highest noise level at nighttime was recorded at 72.8 dBA at NL4, and the lowest was 43.1 dBA at NL2 during the monitoring period. According to the Noise level measurement result, the noise level for NL3 exceeded the Bangladesh standard on both day and nighttime. And the noise level for NL4 exceeded the Bangladesh standards on both day and nighttime. It is because the location of Noise level measurement in NL3 and NL4 is beside the Dhaka-Aricha highway and thousands of vehicles pass through the highway. So, it might be the significant reason for the exceedance of Noise level.

Figure 6-28: Graphical representation of noise level at the monitoring points



Source: Field Monitoring and Laboratory Analysis by EQMS, 2022

The Project will comply with the noise emission criteria as per the standards stipulated in the reference framework, i.e., Noise Pollution (Control) Rules, 2006.

6.3.4 Soil and Sediment Quality

Sampling Method and Locations

Soil and sediment quality is a measure of the condition of soil relative to the requirements of one or more biotic species and or to any human need or purpose. According to the United States Department of Agriculture Natural Resources Conservation Service, "Soil and sediment quality is the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation." The European Commission's Joint Research Center proposed a definition, stating that "Soil quality is an account of the soil's ability to provide ecosystem and social services through its capacities to perform its functions under changing conditions. Soil quality reflects how well soil performs the functions of maintaining biodiversity and productivity, partitioning water and solute flow, filtering and buffering, nutrient cycling, and providing support for plants and other structures. Soil management has a major impact on soil quality.

The soil and sediment sampling strategy were designed to assess the existing soil and sediment quality over the project area. Each location used a composite sampling technique for soil and sediment sampling.

A total of four (2) soil samples were collected from two locations. Similarly, A total of four (2) sediment samples were collected from two locations. Soil and Sediment sampling was done during April. Details of soil and sediment sampling locations are depicted in Table 6-14.

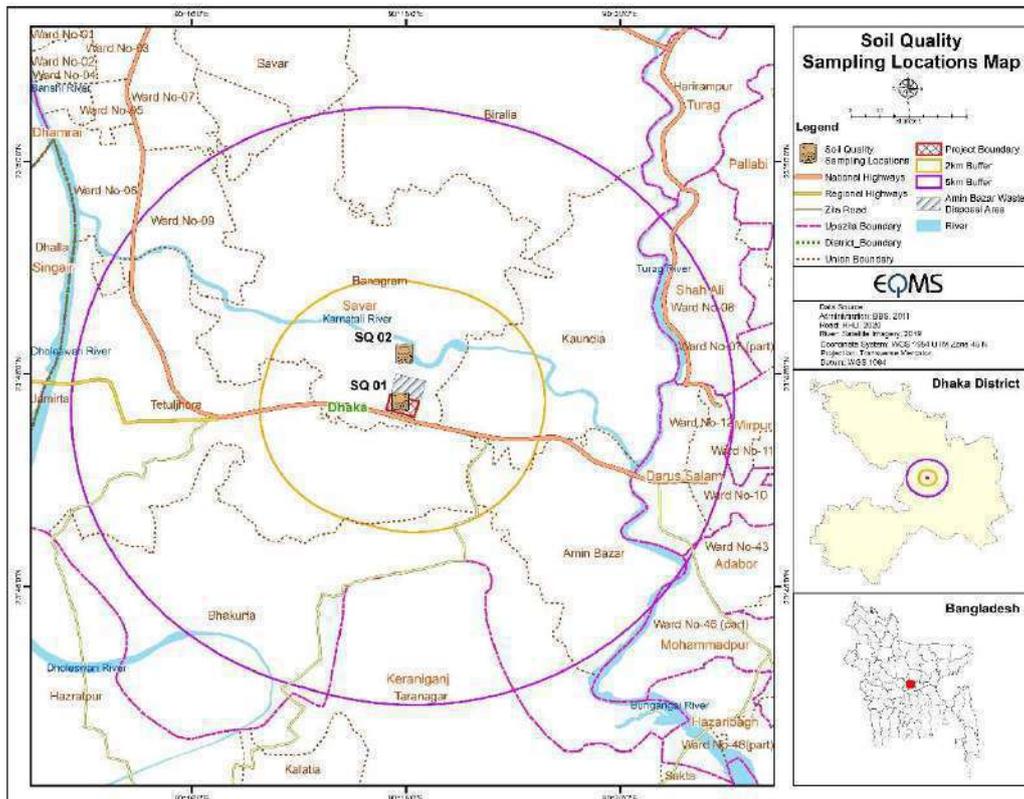
Table 6-14: Details of Soil & Sediment Sampling Locations

SL.	Sampling Location	Code	Monitoring data		Type	Geographical Location
			Dry season	Wet season		
1.	Project Site, Banagram, Savar, Dhaka	SQ1	12 April 2022	16 August 2022	Soil	23°47'44.29"N 90°17'56.84"E
2.	Nagar Konda Road, Banagram, Savar, Dhaka	SQ2	12 April 2022	16 August 2022	Soil	23°48'11.43"N 90°17'59.30"E
3.	Upstream of Karnatali River	Sed1	12 April 2022	16 August 2022	Sediment	23°48'20.53"N 90°17'50.59"E
4.	Downstream of Karnatali River	Sed2	12 April 2022	16 August 2022	Sediment	23°48'10.45"N 90°18'19.84"E

Source Field Survey by EQMS, April and August 2022

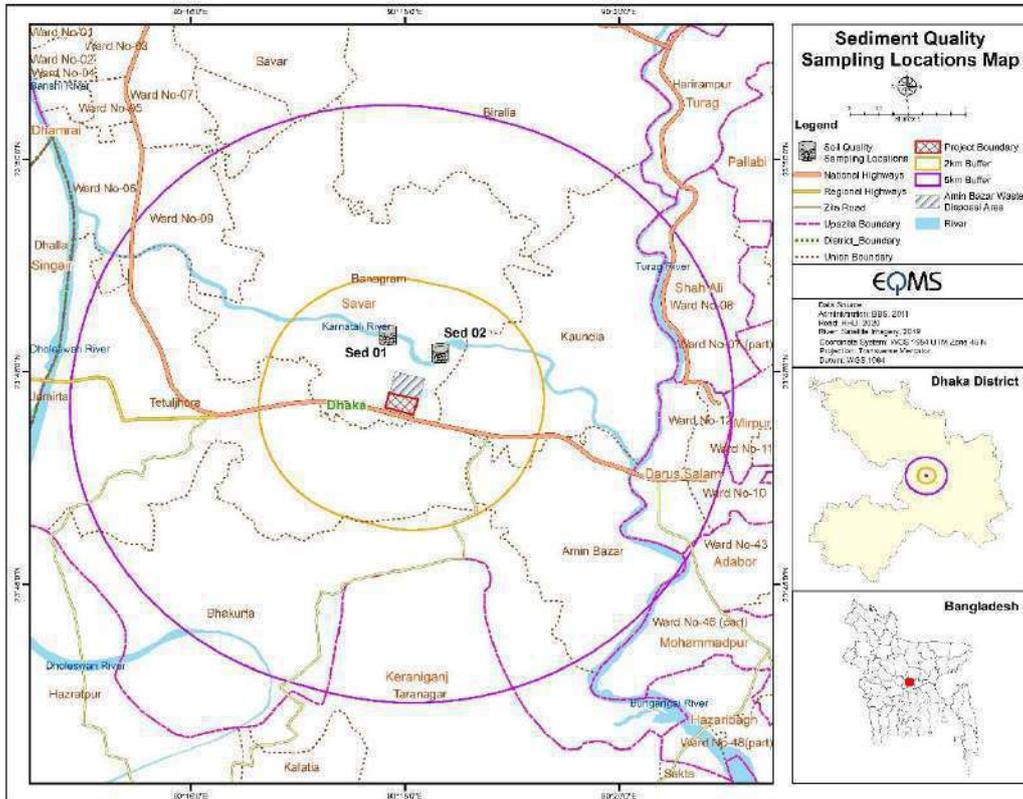
Soil and sediment sampling location maps are given in Figure 6-29 and Figure 6-30, respectively.

Figure 6-29: Soil Sampling Location



Source: EQMS

Figure 6-30: Sediment Sampling Location



Source: EQMS

Soil samples were collected using tools from a depth of 45 cm from the topsoil surface. At each location, soil samples were collected from two spots and homogenized. The homogenized samples were collected following the quartering technique and then packed in polyethylene plastic jars and sealed. The sealed samples were sent to the laboratory for analysis.

Pictures taken during soil and sediment collection are shown in Figure 6-31 and Figure 6-32, respectively.

Figure 6-31: Pictures were taken during the Soil collection.



Source: Field Survey by EQMS Team

Sediment samples were collected from the Karnatali River using the Ekman dredger. At each location, sediment samples were collected from two spots and homogenized. Care was taken to minimize the

surface disturbance to the sediments. The homogenized samples were then packed in polyethylene plastic bags, sealed, and sent to the laboratory for analysis.

Figure 6-32: Pictures were taken during the Sediment collection.



Source: Field Survey by EQMS Team

Analysis Results and Discussions

The analysis results of physicochemical parameters of soil and sediment samples are presented in Table 6-15 and Table 6-16, respectively.

Table 6-15: Soil Quality Analysis Result

SL.	Testing Specification	Method	Unit	SQ1	SQ2	
1	Texture	Marchel triangle using sand, silt, and clay %.	--	Sandy Loam	Sandy Loam	
2	Particle Size Distribution	Hydrometer Method	%	Sand	63.6%	57.97%
				Slit	26.3%	27.19%
				Clay	10.1%	14.84%
3	Salinity	Salinity is measured from soil-saturated paste extract. Salinity measuring meter HACH, USA	ppt	2.41	2.53	
4	pH	Benchtop pH meter Metrohm 906, Switzerland	-	7.27	7.19	
5	Cation Exchange Capacity	Soil leaching column method	Meq/100 g soil	6.78	57.43	
6	Nitrogen (Total)	Kjeldahl nitrogen digestion and distillation method	%	0.219	0.224	
7	Potassium	Flame Photometer	ppm	2288	2189	
8	Magnesium	Flame Atomic Absorption Spectrometry (AA 7000, Shimadzu, Japan)	ppm	4170	4051	
9	Sodium	Flame Atomic Absorption Spectrometry (AA 7000, Shimadzu, Japan)	ppm	294.4	287.19	

SL.	Testing Specification	Method	Unit	SQ1	SQ2
10	Phosphorus	Vanadomolybdophosphoric acid colorimetric method using UV-Visible Spectrophotometer	ppm	1580	1560
11	Iron	Flame Atomic Absorption Spectrometry (AA 7000, Shimadzu, Japan)	%	1.785	1.491
12	Chromium	Flame Atomic Absorption Spectrometry (AA 7000, Shimadzu, Japan)	ppm	37.825	29.91
13	Cadmium	Flame Atomic Absorption Spectrometry (AA 7000, Shimadzu, Japan)	ppm	0.223	0.197

Source: Laboratory Analysis by Bangladesh Council of Scientific and Industrial Research (BCSIR) Laboratory, 2022

Soil pH is critical in absorbing and utilizing essential trace elements required for healthy plant growth. The ideal pH range varies for plants; however, most plants favor a mildly acidic growing environment of around 5.8 to 6.2. Most plants will endure pH environments ranging from pH 5.0 to 7.0.

It has been observed that the texture of the soil is primarily sandy loam in the study area. The pH of the soil ranged from 7.19 to 7.27, indicating that the soil is moderate to slightly alkaline.

The Salinity was observed to be in the range of 2.41 to 2.53 $\mu\text{S}/\text{cm}$ during the study period. The phosphorus values ranged from 1560 to 1580 ppm. The potassium value ranged from 2189 to 2288 ppm. The magnesium values have varied from 4051 to 4170 ppm. The iron concentrations were observed to be ranging from 1.491 to 1.785 %. The total Nitrogen and Sodium concentration value ranged from 0.219 to 0.224 % and 287.19 to 294.4 ppm, respectively. Chromium and Cadmium concentration values range from 29.91 to 37.825 ppm and 0.197 to 0.223 ppm, respectively. The analysis results reveal that these soils are moderate to slightly alkaline with acceptable ranges of potassium, iron, and magnesium content and less to medium ranges of phosphorous, which is good for better crop yields.

Table 6-16: Sediment Quality Analysis Results

SL.	Testing Specification	Method	Unit	SedQ1	SedQ2
1.	pH	Benchtop pH meter Metrohm 906, Switzerland	-	7.51	7.47
2.	Nitrogen (Total)	Kjeldahl method, (Nitrogen Digestion and Distillation Apparatus, VELP, Italy)	%	0.1287	0.101
3.	Potassium	Flame Photometer, (Jenway, UK)	ppm	3432	3086
4.	Calcium	Flame Atomic Absorption Spectrometry (AA 7000, Shimadzu, Japan)	ppm	1674	1661
5.	Magnesium	Flame Atomic Absorption Spectrometry (AA 7000, Shimadzu, Japan)	ppm	8249	8769
6.	Sodium	Flame Photometer, (Jenway, UK)	ppm	472.5	441.81
7.	Phosphorus	Vanadomolybdophosphoric acid colorimetric method using UV-Visible Spectrophotometer	ppm	695	671

SL.	Testing Specification	Method	Unit	SedQ1	SedQ2
8.	Iron	Flame Atomic Absorption Spectrometry (AA 7000, Shimadzu, Japan)	%	3.249	3.153
9.	Zinc (Zn)	Atomic absorption spectrometry (AAS)	ppm	126	120
10.	Cadmium	Flame Atomic Absorption Spectrometry (AA 7000, Shimadzu, Japan)	ppm	1.423	1.132

Environment Conservation Rules (ECR), 2023 has no soil quality standard. The pH of the sediment ranged from 7.47 to 7.51, indicating that the sediment is moderate to slightly alkaline.

The potassium value ranged from 3086 to 3432 ppm. The magnesium values have varied from 8249 to 8769 ppm. The iron concentrations were observed to be ranging from 3.153 to 3.249 %. The phosphorus values ranged from 671 to 695 ppm. The Zinc and Cadmium concentrations ranged from 120 to 126 ppm and 1.132 to 1.423 ppm, respectively. Total nitrogen, calcium, and sodium concentration ranged between 0.101 to 0.1287 %, 1661 to 1674 ppm, and 441.81 to 472.5 ppm. The analysis reveals that these sediments are moderate to slightly alkaline with acceptable sodium, iron, and magnesium content and less to medium phosphorous ranges.

6.4 Biological Environment

6.4.1 General Description

Ecology is a science branch concerned with organisms' interrelationships and surrounding environments. It is studied at various levels, including organisms, human science, population, community, ecosystem, and biosphere. The distribution and abundance of any organism on earth are shaped by biotic (living organism) and abiotic (non-living or physical) factors.

On the other hand, the term "Biodiversity" (from "biological diversity") is used to describe the enormous variety of life on Earth. Biodiversity includes not only species considered rare, threatened, or endangered but also every living thing—from humans to organisms that are known little about, such as microbes, fungi, and invertebrates.

The biological environment of any area comprises ecosystem and biodiversity combinedly. In Bangladesh, the biological environment and its wildlife species are distributed in forested areas, coastal shorelines, massive river systems, floodplains, and homestead vegetation. More than 133 mammals, 711 bird species, 174 species of reptiles, and 64 amphibian species are known to occur in Bangladesh¹.

6.4.2 Terrestrial Ecology

The terrestrial ecosystem of the study area consists of different habitats, i.e., homestead vegetation, agricultural lands, roadside, and fallow land vegetation.

Homestead Vegetation: The areas of the surrounding village areas are classified as homestead habitats. Homestead vegetation was recorded near villages and settlements. Common species include Coconut (*Cocos nucifera*), Jackfruit (*Artocarpus heterophyllus*), Mango (*Mangifera indica*), Guava (*Psidium guajava*), Papaya (*Carica papaya*), Mahogany (*Swietenia mahagoni*), Banana (*Musa sp.*), Koroi (*Albizia sp.*), etc. These vegetations support many wildlife species such as birds, herpetofauna, and mammals around the project AOI.

Agricultural lands: Different agricultural practices were observed within the project AOI. The predominant agricultural method is the mono-cropping of paddies. Other cultivated crops are Potato, Chilli, Onion, Pumpkin, and other vegetables. Tree species observed near the agricultural lands are Coconut (*Cocos nucifera*), Mango (*Mangifera indica*), Date palm (*Phoenix sylvestris*), etc.

Roadside Vegetation: The major roadside vegetation consists of Acacia (*Acacia auriculiformis*), Bot (*Ficus benghalensis*), Mahogany (*Swietenia mahagoni*), etc. This vegetation is an additional habitat for many birds and small mammal species.

Fallow Land: Uncultivated upland near the village, generally used for plantation, is categorized as fallow land. The shrubs, herbs, weeds, and grasses germinate during the monsoon and form the ground cover. The major plant species of these sites are Akshmoni (*Acacia auriculiformis*), Koroï (*Albizia lebbek*), Narikel (*Cocos nucifera*), and Mahogany (*Swietenia mahagoni*).

Khan, M.A.R. 2015. Wildlife of Bangladesh: Checklist and guide. Chayabithi, Dhaka. Pp. 568.

6.4.2.1 Flora

The primary data collection of different flora species was conducted within a 5 km radius of the project site using the transect survey method. Major floral species were recorded during the field survey. In the project AOI, a total of thirty-eight (38) species under twenty-one (21) families were enumerated during the field survey. The most floral species (6 species) were recorded under the Fabaceae family, and the second-highest species (4 species) were under Moraceae.

A list and photographic plate showing the observed terrestrial flora in the AOI have been presented in Table 6-17 & Figure 6-33.

Table 6-17: Floral Species Observed in the Project AOI

SL#	Local Name	Common name	Scientific name	Family	Uses	Local Status*
1.	Aam	Mango	<i>Mangifera indica</i>	Anacardiaceae	Fruit	C
2.	Akashmoni	Acacia	<i>Acacia auriculiformis</i>	Fabaceae	Timber	C
3.	Amra	Hog Palm	<i>Spondias mombin</i>	Anacardiaceae	Fruit	C
4.	Arjun	Arjun tree	<i>Terminalia arjuna</i>	Combretaceae	Medicinal	C
5.	Ashwath	Sacred fig, Bodhi tree	<i>Ficus religiosa</i>	Moraceae	Fruit	C
6.	Ata	Custard apple	<i>Annona reticulata</i>	Annonaceae	Fruit	C
7.	Bael	Wood apple	<i>Aegle marmelos</i>	Rutaceae	Fruit	VC
8.	Bansh	Bamboo	<i>Bambusa spp.</i>	Poaceae	Timber	VC
9.	Boroï	Indian plum	<i>Zizyphus mauritiana</i>	Rhamnaceae	Fruit	C
10.	Bot	Banyan	<i>Ficus benghalensis</i>	Moraceae	Fruit	C
11.	Chalta	Chalta	<i>Dillenia indica</i>	Dilleniaceae	Fruit	R
12.	Debdaru	False ashoka	<i>Polyalthia longifolia</i>	Annonaceae	Aesthetic	C
13.	Deshi Gaab	Indian persimmon	<i>Diospyros peregrina</i>	Ebenaceae	Fruit	C
14.	Dumur	Cluster fig	<i>Ficus hispida</i>	Moraceae	Fruit	C
15.	Jam	Java Plum	<i>Syzygium cumini</i>	Myrtaceae	Fruit	C

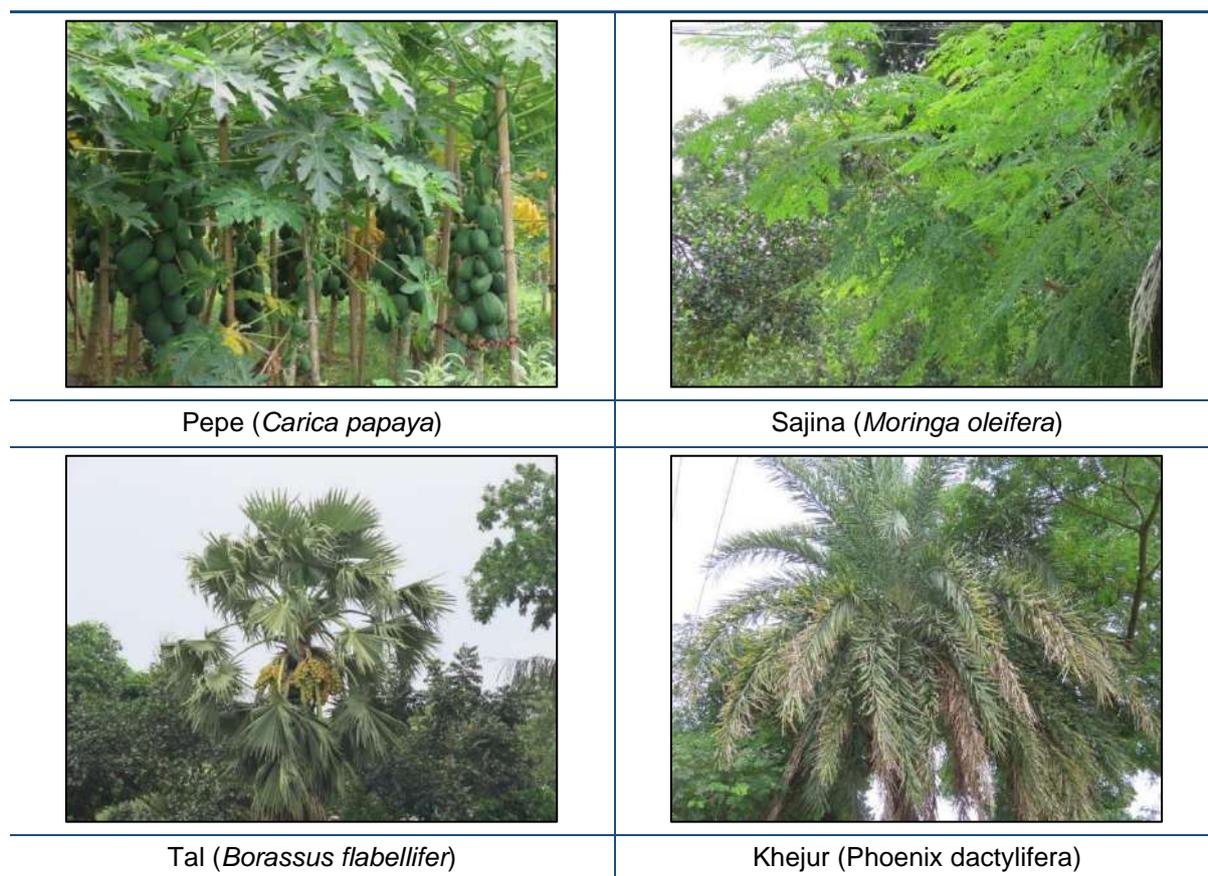
SL#	Local Name	Common name	Scientific name	Family	Uses	Local Status*
16.	Kath Badam	Indian almond	<i>Terminalia catappa</i>	Combretaceae	Fruit	R
17.	Kala Koroï	Shirish	<i>Albizia lebbek</i>	Fabaceae	Timber	VC
18.	Kathal	Jackfruit	<i>Artocarpus heterophyllus</i>	Moraceae	Fruit	VC
19.	Khejur	Date palm	<i>Phoenix dactylifera</i>	Arecaceae	Fruit	VC
20.	Kodom	Bur flower Tree	<i>Neolamarckia cadamba</i>	Rubiaceae	Aesthetic	C
21.	Kola	Banana	<i>Musa sapientum</i>	Musaceae	Fruit	VC
22.	Krishno chura	Dwarf poinciana	<i>Caesalpinia pulcherrima</i>	Fabaceae	Aesthetic	C
23.	Lebu	Lemon	<i>Citrus spp.</i>	Rutaceae	Fruit	VC
24.	Madar	Purple coral tree	<i>Erythrina fusca</i>	Fabaceae	Medicinal	C
25.	Mahogany	Mahogany	<i>Swietenia mahagoni</i>	Meliaceae	Timber	VC
26.	Narikel	Coconut	<i>Cocos nucifera</i>	Arecaceae	Fruit	VC
27.	Neem	Neem	<i>Azadirachta indica</i>	Meliaceae	Medicinal	C
28.	Pepe	Papaya	<i>Carica papaya</i>	Caricaceae	Fruit	VC
29.	Peyara	Guava	<i>Psidium guajava</i>	Myrtaceae	Fruit	VC
30.	Pitali	False White Teak	<i>Trewia nudiflora</i>	Euphorbiaceae	Timber	VC
31.	Sajna tree	Drumstick tree	<i>Moringa oleifera</i>	Moringaceae	Fruit	C
32.	Shegun	Teak tree	<i>Tectona grandis</i>	Verbenaceae	Timber	VC
33.	Shimul	Cotton tree	<i>Bombax ceiba</i>	Malvaceae	Fruit	R
34.	Shishu	Indian Rosewood	<i>Dalbergia sissoo</i>	Fabaceae	Timber	VC
35.	Supari	Areca palm	<i>Areca catechu</i>	Arecaceae	Fruit	C
36.	Taal	Palm	<i>Borassus flabellifer</i>	Arecaceae	Fruit	C
37.	Tetul	Tamarind tree	<i>Tamarindus indica</i>	Fabaceae	Fruit	VC
38.	Jambura	Pomelo fruit	<i>Citrus maxima</i>	Rutaceae	Fruit	C

* VC = Very Common, C= Common, R= Rare

Source: Field Survey by EQMS Team, August 2021

Figure 6-33: Plant Species Observed in the Project AOI

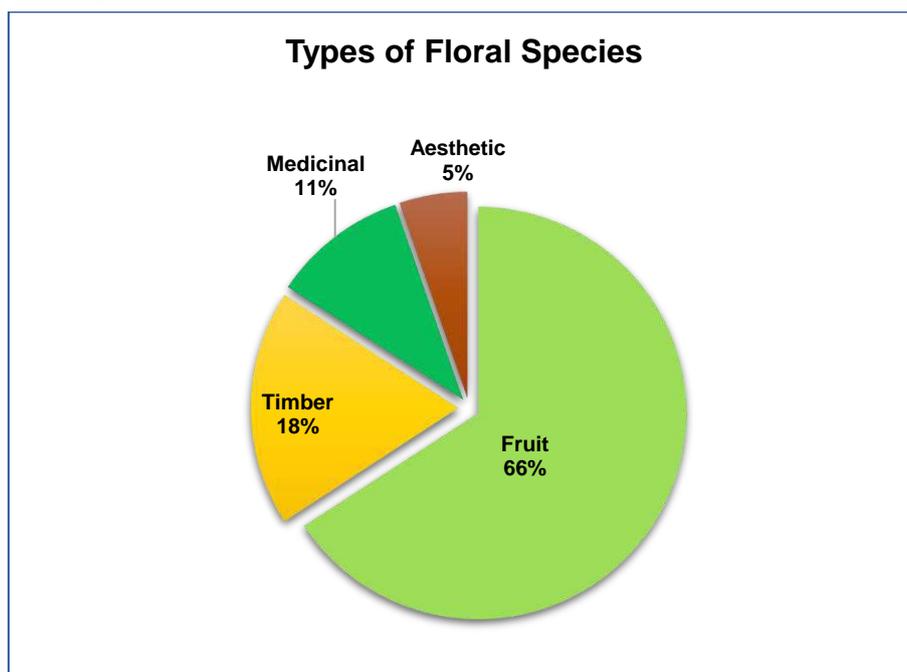
	
Ata (<i>Annona reticulata</i>)	Boroi (<i>Ziziphus mauritiana</i>)
	
Jambura (<i>Citrus grandis</i>)	Bael (<i>Aegle marmelos</i>)
	
Pitali (<i>Trewia nudiflora</i>)	Bot (<i>Ficus benghalensis</i>)
	
Deshi Gab (<i>Diospyros peregrina</i>)	Bash (<i>Bambusa</i> sp.)



Source: EQMS Field Survey, August 2021

A comparison of all the flora species has been shown in Figure 6-34 based on their uses. Most of the recorded species produce fruits (66%) and timber (18%).

Figure 6-34: Comparison of floral species based on their uses.



Source: EQMS

6.4.2.2 Fauna

6.4.2.2.1 Avifauna

The avifaunal study was conducted using the transect method and direct visual observation from dawn to dusk. Existing roads and walkways were considered transects. Each transect was one (01) km long, and while walking through the transects, the team observed both sides of the transects line in a belt of 50 meters (25 meters on each side). Besides, opportunistic observation was also considered.

The birds were identified by seeing visually and by hearing their calls. Photographs were taken for confirmation of identification. This method involves identifying all the birds; it has been seen or heard while standing at a series of points along with a transect (Straight line through the site). Bird transects were conducted in the early morning and the evening as it is the time of maximum bird movement as birds' feeding activity increases this time. To reduce overestimates, particularly when a member observes, try to ensure that each bird is recorded only once. Hence, ensure that at least one team member is watching. Discussions with local people were conducted to get information on the local species in the project area. A checklist showing the avifaunal species found in the project area is shown in Table 6-18.

Table 6-18: Checklist of Bird Species Observed in the Project AOI

SL#	Common Name	Local Name	Scientific Name	Family	IUCN Bangladesh Status, 2015*	IUCN Global Status 2021-2*	Wildlife Conservation & Security Act, 2012
1.	Black kite	Bhubon Chil	<i>Milvus migrans</i>	Accipitridae	LC	LC	SCH II
2.	Brahminy Kite	Shonkho Chil	<i>Haliastur indus</i>	Accipitridae	LC	LC	SCH II
3.	Crested Serpent Eagle	Tila Nag Eagle	<i>Spilornis cheela</i>	Accipitridae	LC	LC	SCH I
4.	White-breasted Kingfisher	Dhola gola Machranga	<i>Halcyon smyrnensis</i>	Alcedinidae	LC	LC	SCH II
5.	Common King Fisher	Chhoto Maachranga	<i>Alcedo atthis</i>	Accipitridae	LC	LC	SCH I
6.	Little Egret	Choto boga	<i>Egretta garzetta</i>	Ardeidae	LC	LC	SCH II
7.	Intermediate Egret	Majhari Bok	<i>Ardea intermedia</i>	Ardeidae	LC	LC	SCH I
8.	Great Egret	Majhari Bok	<i>Casmerodius albus</i>	Ardeidae	LC	LC	SCH II
9.	Indian pond heron	Kani Bok	<i>Ardeola grayii</i>	Ardeidae	LC	LC	SCH I
10.	Green-Backed Heron	Shobuj Bok	<i>Butorides striata</i>	Ardeidae	LC	LC	-
11.	Cattle Egret	Go Boga	<i>Bubulcus ibis</i>	Ardeidae	LC	LC	SCH II
12.	Ashy Woodswallow	Mete Bon ababil	<i>Artamus fuscus</i>	Artamidae	LC	LC	SCH II
13.	Red-wattled Lapwing	Hottiti	<i>Vanellus indicus</i>	Charadriidae	LC	LC	SCH I
14.	Lesser Sandplover	Chhoto Dhuljiria	<i>Charadrius mongolus</i>	Charadriidae	LC	LC	SCH I
15.	Common Tailor Bird	Tuntuni	<i>Orthotomus sutorius</i>	Cisticolidae	LC	LC	SCH II
16.	Spotted Dove	Tila Ghughu	<i>Streptopelia chinensis</i>	Columbidae	LC	LC	SCH I
17.	Eurasian Collared Dove	Raj Ghughu	<i>Streptopelia decaocto</i>	Columbidae	LC	LC	SCH I

SL#	Common Name	Local Name	Scientific Name	Family	IUCN Bangladesh Status, 2015*	IUCN Global Status 2021-2*	Wildlife Conservation & Security Act, 2012
18.	Red Turtle Dove	Lal Ghughu	<i>Streptopelia tranquebarica</i>	Columbidae	LC	LC	SCH I
19.	Rufous Treepie	Harichacha	<i>Dendrocitta vagabunda</i>	Corvidae	LC	LC	SCH II
20.	Large-billed Crow	Dar kak	<i>Corvus macrorhynchos</i>	Corvidae	LC	LC	SCH I
21.	House Crow	Pati Kak	<i>Corvus splendens</i>	Corvidae	LC	LC	SCH I
22.	Greater Coucal	Boro Kanakukka	<i>Centropus sinensis</i>	Cuculidae	LC	LC	SCH I
23.	Black Drongo	Kala Fingey	<i>Dicrurus macrocercus</i>	Cuculidae	LC	LC	SCH II
24.	Common Kestrel	Pati Krestrel	<i>Falco tinnunculus</i>	Falconidae	LC	LC	SCH I
25.	Bronze-winged jacana	Jolpipi	<i>Metopidius indicus</i>	Jacanidae	LC	LC	SCH I
26.	Long-tailed Shrike	Badami Koshai	<i>Lanius cristatus</i>	Laniidae	LC	LC	SCH II
27.	Jungle Babbler	Bon Chatare	<i>Turdoides striata</i>	Leiotherichidae	LC	LC	SCH I
28.	Oriental Magpie Robin	Doel	<i>Copsychus saularis</i>	Muscicapidae	LC	LC	SCH II
29.	Black hooded Oriole	Kalomatha Benebou	<i>Oriolus xanthornus</i>	Oriolidae	LC	LC	SCH I
30.	House Sparrow	Pati choro	<i>Passer domesticus</i>	Passeridae	LC	LC	SCH II
31.	Little Cormorant	Choto Pankowri	<i>Microcarbo niger</i>	Phalacrocoracidae	LC	LC	SCH II
32.	Baya Weaver	Babui	<i>Ploceus philippinus</i>	Ploceidae	LC	LC	SCH I
33.	Red-vented Bulbul	Bangla bulbul	<i>Pycnonotus cafer</i>	Pycnonotidae	LC	LC	SCH II
34.	White-breasted Waterhen	Dahuk	<i>Amaurornis phoenicurus</i>	Rallidae	LC	LC	SCH I
35.	Common Myna	Salik/Bhat Salik	<i>Acridotheres tristis</i>	Sturnidae	LC	LC	SCH II
36.	Jungle Myna	Juti Shalik	<i>Acridotheres fuscus</i>	Sturnidae	LC	LC	SCH II

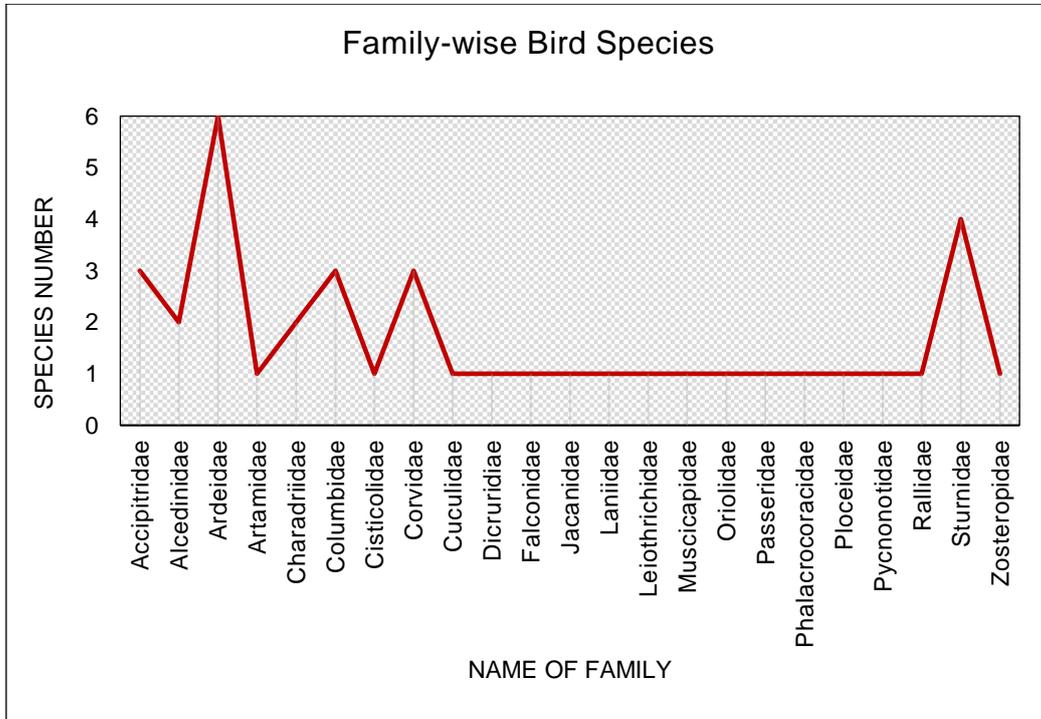
SL#	Common Name	Local Name	Scientific Name	Family	IUCN Bangladesh Status, 2015*	IUCN Global Status 2021-2*	Wildlife Conservation & Security Act, 2012
37.	Asian Pied Starling	Go Shalik	<i>Sturnus contra</i>	Sturnidae	LC	LC	SCH II
38.	Oriental White Eye	Shetakkhi/ Babunai	<i>Zosterops palpebrosus</i>	Zosteropidae	LC	LC	SCH I

*LC= Least Concern

Source: EQMS Field Survey, August 2021

A total of 38 species under 23 families were recorded within the study area. Among them, the highest number of birds (6 species) dominated in the study area belonging to the family Ardeidae (which mainly consists of waterbird species), and the family Sturnidae represented the second-highest group of bird species (4 species) shown in AOI Figure.

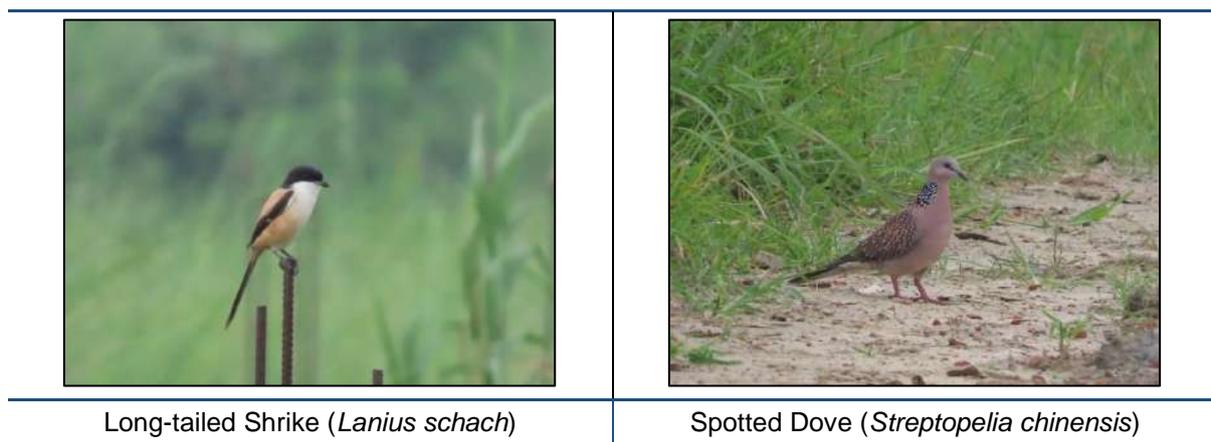
Figure 6-35: Family-wise bird species recorded from Project AOI



Source: EQMS

Some significant avifaunal species recorded from project AOI are shown in Figure 6-36. All the bird species found in the study area are the Least Concerns (LC).

Figure 6-36: Birds Species Observed in the Project AOI





House Sparrow (*Passer domesticus*)



White-Throated Kingfisher (*Halcyon smyrnensis*)



Greater Coucal (*Centropus sinensis*)



Red-vented Bulbul (*Pycnonotus cafer*)



Red Turtle Dove (*Streptopelia tranquebarica*)



Indian Pond Heron (*Ardeola grayii*)



Asian Pied Starling (*Sturnus contra*)



Baya Weaver (*Ploceus philippinus*)

	
<p>Black Drongo (<i>Dicrurus macrocercus</i>)</p>	<p>House Crow (<i>Corvus splendens</i>)</p>

Source: EQMS Field Survey, August 2021

6.4.2.2.2 Reptiles

Amphibians and reptiles combinedly, known as Herpetofauna, were confirmed through direct visual observations and interviews with local community people (Figure 6-37). Besides, the calling of amphibian species was considered to identify their appropriate habitats. Opportunistic observations were also recorded for both amphibians and reptiles during the survey period at the project AOI.

A total of four (4) species of amphibians belonging to two (2) families and eight (8) species of reptiles belonging to six (6) families were listed from the project area based on primary and secondary data (Table 6-19 & Table 6-20). Among the recorded amphibian species, the highest number of amphibians (3 species) dominated the study area belonging to the family Dicroglossidae. On the other hand, the highest number of reptilian species (3 species) were recorded under the Colubridae family, and the rest of them have only single species.

All the amphibian species are included in the Bangladesh Wildlife (Conservation and Security) Act, 2012, in Schedule II, which protects them from hunting, killing, and capturing. On the other hand, two (2) Near Threatened (NT) reptile species, such as Bengal Monitor Lizard (*Varanus bengalensis*) and Spectacled Cobra (*Naja naja*), were found in the study area.

Table 6-19: Checklist of Amphibians Recorded in the Project AOI

SL	Common Name	Local Name	Scientific Name	Family	IUCN Bangladesh Status, 2015*	IUCN Global Status 2021-2*	Wildlife Conservation & Security Act, 2012
1.	Asian Common Toad	Kuno bang	<i>Duttaphrynus melanostictus</i>	Bufoidea	LC	LC	SCH II
2.	Indian BullFrog	Kola bang	<i>Hoplobatrachus tigerinus</i>	Dicroglossidae	LC	LC	SCH II
3.	Indian Skipper Frog	Katkati bang	<i>Euphlyctis cyanophlyctis</i>	Dicroglossidae	LC	LC	SCH II
4.	Bombay Wart Frog	Dakshinatter Jhi-Jhi Bang	<i>Fejervarya syhadrensis</i>	Dicroglossidae	LC	LC	SCH II

*LC=Least Concern

Source: EQMS Field Survey, August 2021

Table 6-20: Checklist of Reptiles Recorded in the Project AOI

SL	Common Name	Local Name	Scientific Name	Family	IUCN Bangladesh Status, 2015*	IUCN Global Status 2021-2*	Wildlife Conservation & Security Act, 2012
1.	Common Garden Lizard	Rokto chosa	<i>Calotes versicolor</i>	Agamidae	LC	LC	SCH II
2.	Checkered Keelback	Dhora Shap	<i>Xenochrophis piscator</i>	Colubridae	LC	LC	SCH I
3.	Indian Rat snake	Daraj Shap	<i>Ptyas mucosus</i>	Colubridae	LC	LC	SCH I
4.	Spectacled Cobra	Gokhra Shap	<i>Naja naja</i>	Colubridae	NT	NT	SCH II
5.	Common House Gecko	Pati Tiktiki	<i>Hemidactylus frenatus</i>	Gekkonidae	LC	LC	SCH I
6.	Common Smooth-scaled Water Snake	Painna Shap	<i>Enhydryis enhydryis</i>	Homalopsidae	LC	LC	SCH I
7.	Indian Mabuya	Achil	<i>Eutropis carinata</i>	Scincidae	LC	LC	SCH II
8.	Bengal Monitor Lizard	Gui shap	<i>Varanus bengalensis</i>	Varanidae	NT	NT	SCH II

*LC= Least Concern, NT= Near Threatened

Source: EQMS Field Survey, August 2021

6.4.2.2.3 Mammals

The "Observational method" was followed during the inventory of this project area within the stipulated short time, including imaging records by the digital camera, identification of dung or feces, footprint, tracks, other signs, etc. Consultation with the Forester and local people was also conducted to get secondary data during this inventory of mammals in the study area (Figure 6-37).

Figure 6-37: Discussion with local people for herpetofauna and mammal study



Source: EQMS Field Survey

Nine (9) mammal species belonging to five (5) families were listed within the study area, as shown in Table 6-21. The highest number of mammals (3 species) dominated in the study area belong to the family Muridae (group of rats and mice). The rest of the four families consist of single species. All the bird species found in the study area are the Least Concerns (LC).

Table 6-21: Checklist of Mammals Recorded in the Project AOI

SL#	Common Name	Local Name	Scientific Name	Family	IUCN Bangladesh Status, 2015*	IUCN Global Status 2021-2*	Wildlife Conservation & Security Act, 2012
1	Golden Jackal	Pati-Siyal	<i>Canis aureus</i>	Canidae	LC	LC	SCH I
3	Small Indian Mongoose	Choto Beji	<i>Herpestes auropunctatus</i>	Herpestidae	LC	LC	SCH I
4	Common Indian Field Mouse	Metho Idur	<i>Mus boodug</i>	Muridae	LC	LC	SCH III
5	House Mouse	Nengti Idur	<i>Mus musculus</i>	Muridae	LC	LC	SCH III
6	Common House Rat	Idur	<i>Rattus rattus</i>	Muridae	LC	LC	SCH III
8	Indian Flying Fox	Badur	<i>Pteropus giganteus</i>	Pteropidae	LC	LC	SCH I
9	Irrawaddy Squirrel	Kathbirali	<i>Callosciurus pygerythrus</i>	Sciuridae	LC	LC	SCH I

*LC= Least Concern

Source: EQMS Field Survey, August 2021

6.4.3 Fisheries

6.4.3.1 Introduction

Bangladesh is crisscrossed by various water bodies such as rivers, lakes, haors and beels, ponds, baors, estuaries, coastal belts, seashores, etc., which all together offer tremendous opportunities for fisheries development. All these water bodies provide an immense scope and potential for augmenting fish production and livelihood support of the people living around these inland water bodies. The fisheries sector plays an outstanding role in the national economy and nutrition. It provides about 60% of the animal protein intake, and more than 11% of the country's total population is directly or indirectly involved in this sector for their livelihoods. According to the yearbook of fisheries statistics 2018-19, the inland fisheries of Bangladesh are the most productive sources of fish production, and the total areas of capture and culture fisheries are 38,90,228 ha and 8,21,923 ha, which contribute 28.19% and 56.76% of the total fish production respectively. The fisheries sector contributes 3.50% to the national GDP and more than one-fourth (25.72%) to the agricultural GDP. Annual fish production was 43.84 lakh metric tons (MT) in the 2018-19 fiscal year, contributing about 60% to the nation's animal protein intake.

Fisheries resources of the 5 km radius study area are rich and diversified. The study area consists of Karnatali River and Turag River, aquaculture ponds, beels, and Khals. Details of the study area fisheries are given in the sections below.

6.4.3.2 Habitat Description

6.4.3.2.1 Riverine Habitat of Karnatali River and Turag River

Karnatali River starts from the Dhaleshawri River and divides into two branches: Turag and Buriganga near Gabtoli. Karnatali is a perennial river but is subject to a drastic change in water level between monsoon and dry months of winter and summer. Approximately 11km of the river passes through the area of influence. Periodically almost every year during the monsoon, the river flooded some of its banks, mostly the agriculture fields and brickfields. The river carries only wastewater for eight months (October to May). No aquatic animal can survive in the dead river water, even during this time. From June to September, fishermen do their fishing activities in the river on a small scale. Throughout the year, inhabitants near the river suffer a lot because of the foul-smelling water of the Karnatali.

The Turag River is the upper tributary of the Buriganga, a major river in Bangladesh. It originates from the Bangshi River, a vital tributary of the Dhaleshwari River, flows through Gazipur and joins the Buriganga at Mirpur in Dhaka District. It is navigable by boat year-round. The entire regime of the Turag River is almost a semi-funnel-shaped basin and a total area of 386 square miles. Water covers about 10,000 ha at full flood but diminishes to less than 700 ha at the end of the dry season. This flood fishery plays a very important role in alleviating rural poverty and supplying food to the poor fishing community. Around 6 km of the river passes through the eastern side of the study area. During the dry season, the water volume level decreases, and the water condition becomes worse than during the wet season. The people surrounding the river depend on the water of the Turag River in many ways, such as domestic, fisheries, drinking, and agricultural purposes.

According to the Department of Environment (2010), The Turag River has been declared an ecologically critical area.

The only habitat type that can be considered a "Natural Habitat" within the study area is the "Riverine Habitat of Karnatali River and Turag River."

6.4.3.2.2 Canals/ Stream

Natural drainage canals in the study area ultimately drain into Karnatali and Turag Rivers. During monsoons, often when the water level of Rivers rises, backflow from the rivers through the canals occasionally results in massive flooding. The canals of the study area provide a home for aquatic macrophytes, insects, birds, fishes, etc. They also play a major role as a water source for the local

inhabitants and agricultural crop fields. During the site visit (August 2021), most of these canals were in a wet state.

6.4.3.2.3 Floodplain Area

Floodplain also called an Alluvial Plain, is a flat land area adjacent to a stream composed of unconsolidated sedimentary deposits (alluvium) and subject to periodic inundation by the stream. Floodplains are produced by the lateral movement of a stream and overbank deposition; therefore, they are absent where downcutting is dominant. These floodplains support a dense human population and are intensively used for agriculture, fishing, and other aquatic resources. In the study area, there are so many floodplain areas. During the monsoon, they become integrated into a single biological productive system. Fish come to the shallow water area for breeding, nursing, and feeding. In the dry season, local people cultivate various vegetables there.

6.4.3.2.4 Ponds

Ponds are largely located within villages and associated with individual houses or Mosques. Traditionally ponds were dug to use the soil to elevate the household land or to use soil as raw material for building “clay huts.” But today, clay is hardly used as a construction material, but ponds remain and are often maintained in villages to fulfill the water requirement for household use.

6.4.3.3 Fish Production and Effort

The study area has two rivers, floodplains, and various small ponds. The area has rich and diverse fisheries. According to the consultation with the Senior Upazila fisheries officer, the total fish production of the Savar Upazila is 3,433.989 metric tons. Out of the total fish production, 1,166.501 MT is produced from Capture fisheries, and 1,775.228 MT is produced from culture fisheries. There are 2254 fishermen involved in capture fisheries, and 1378 fish farmers are involved in fish farming. A glimpse of general information on fisheries resources is provided in Table 6-22.

Table 6-22: General information of fisheries resources of Savar Upazila (2019-2020)

Capture Fisheries		
Major Capture Species	Rui, Catla, Mrigal, Shol, Taki, Gojar, Aair, Puti, Tengra, Baim, Gulsha, Bacha, Shrimp, etc.	
Major Capture Indigenous Species	Rui, Catla, Mrigal, Shol, Taki, Gojar, Aair, Puti, Tengra, Baim, Gulsha, Bacha, etc.	
Average Production (kg/ha)	1,166.501	
Total Capture Area (ha)	342.86	
Culture Fisheries		
Major Culture Species	Rui, Catla, Mrigal, Silver Carp, Bighead, Pangas, Monosex Telapia, Koi, Thai Punti etc.	
Major Culture Indigenous Species	Rui, Catla, Mrigal, Koi	
Average Production (kg/ha)	1,775.228	
Total Capture Area (ha)	342.86	

Source: Savar Upazila Fisheries Office, August 2021

The study team also conducted FGD and consultation with fishermen, local people, fish farmers, and fish market surveys to understand the fishing efforts of the study area (Figure 6-38). As the rivers do not have much tidal influence, the fishermen capture fish in the Karnatali and Turag Rivers during the daytime. The average fishing is 5-6 hours a day, and some catch fish twice daily. Only non-mechanized boats were observed for fishing during the study period, and in a boat, 2-3 fishermen caught fish in a group. According to the consultation of fishermen and visual observation, different types of fishing gear

of two categories (active and passive gear) were observed to harvest fish in the study area. Dominant gears are Ber Jal, Poa Jal, Dacon Jal, Jhaki Jal, Dharma Jal, Current Jal, Moiya Jal, Ber Jal, Thella Jal, Bair, Chandi bair, Chai Jal, Borshi, etc. The highest number of fish species are found in Ber jal, and the lowest number is in Box Chai Jal.

Figure 6-38: Photographs of consultation and fisheries survey

	
<p>Focus group discussion with local fishermen</p>	<p>KII with Senior Upazila Fisheries Officer, Savar</p>
	
<p>Checking fish catch in floodplains in the study area</p>	<p>Consultation with local fishermen at the local fish market</p>
	
<p>Long line fishing activity in the floodplain area</p>	<p>Fishermen using a non-mechanized fishing boat in the Karnatali River</p>

	
<p>Repairing of Thela Jal by a fisherman</p>	<p>Chai Jal Fishing in the Turag River</p>
	
<p>Consultation with fishermen near the Karnatali Riverbank</p>	<p>Fish market survey during the study period</p>

6.4.3.4 Fish Migration

Migration is an instinct and facilitating activity to fulfill bio-physiological urges in animals. Fish are no exception and constitute one of the distant migrating groups in the aquatic sphere. For some fish species, migration is intra-environmental, limited to a shorter range of distance; for others, trans-environmental migration extends from a few hundred to thousands of kilometers. Karnatali River plays a significant role in fish migration. Fishes pass from Dhaleshawri to Turag and Buriganga through the Karnatali River. During the monsoon, fresh water comes from upstream along with fish. Fish move to the floodplains for breeding. Only this time can fishermen catch fish from the river, and most fish are small. The fish use the floodplains as a nursery, breeding, and feeding ground and move to the other rivers before the beginning of the dry season. Fishes like Tengra, Rui, Catla, Shol, Taki, Pungus, Gulsha Tengra, Shing, Magur, Koi, Puti, etc., are widespread in these floodplain areas. Some threatened and endangered fishes are also found rarely in this area.

6.4.3.5 Fish Biodiversity

The consultation was crucial in gathering information regarding fish resources in the AOI. The fish survey was carried out based on direct observation of fishing boats, consultation with the fishermen and Senior Upazila Fisheries Officer (SUFO) of Savar Upazila, and fish markets within the 5 km buffer zone (AOI) for fish species captured and cultured in the project area.

A total of 47 fish species under 18 families have been enlisted based on primary observation from fishing activity, consultation with fishermen, and literature review (Table 6-23; Figure 6-38). Among all the fish families, Cyprinidae (26%) family was the most abundant (Figure 6-39). During this study, five endangered species (*Mastacembelus armatus*, *Clupisoma garua*, *Botia Dario*, *Channa marulius*, *Chitala chitala*) and four vulnerable species (*Monopterus cuchia*, *Sperata aor*, *Gudusia chapra*, *Labeo boggut*) were enlisted.

Table 6-23: List of recorded fish species in the study area

SL#	Family	Common Name	Local Name	Scientific Name	IUCN Bangladesh Status, 2015*	IUCN Global Status 2021-2*
1.	Cobitidae	Long Whiskered	Ayre	<i>Sperata aor</i>	VU	LC
2.	Cyprinidae	Bata Labeo	Bata, Bhangon Bata	<i>Labeo bata</i>	LC	LC
3.	Gobiidae	Tank Goby	Bele, Bailla	<i>Glossogobius giuris</i>	LC	LC
4.	Nandidae	Mottled Nandus	Bheda, Meni	<i>Nandus nandus</i>	NT	LC
5.	Cyprinidae	Bighead Carp	Bighead	<i>Aristichthys nobilis</i>	LC	LC
6.	Siluridae	Wallago	Boal	<i>Wallago attu</i>	LC	VU
7.	Cyprinidae	Common carp	Carpu	<i>Cyprinus carpio</i>	LC	LC
8.	Synbranchidae	Indian Gagata	Cenia, Jungla	<i>Gagata cenia</i>	LC	LC
9.	Cyprinidae	Swamp Barb, Chola Barb	Chalapunti, Puntti	<i>Puntius chola</i>	LC	LC
10.	Clupeidae	Indian River Shad	Chapila	<i>Gudusia chapra</i>	VU	LC
11.	Notopteridae	Humped Featherback	Chital, Chetol	<i>Chitala chitala</i>	EN	NT
12.	Notopteridae	Grey Featherback	Foli, Fholui	<i>Notopterus notopterus</i>	LC	LC
13.	Channidae	Walking Snakehead	Gachua, Cheng	<i>Channa orientalis</i>	LC	LC
14.	Channidae	Great Snakehead	Gajar	<i>Channa marulius</i>	EN	LC
15.	Schilbeidae	Garua Bacha, Gagra	Garua Bacha	<i>Clupisoma garua</i>	EN	LC
16.	Cyprinidae	Boggut Labeo	Ghania, Gohria	<i>Labeo boggut</i>	VU	LC

SL#	Family	Common Name	Local Name	Scientific Name	IUCN Bangladesh Status, 2015*	IUCN Global Status 2021-2*
17.	Mastacembelidae	Striped Spinyeel	Guchi Baim	<i>Macragnathus pancalus</i>	LC	LC
18.	Cobitidae	Day's Mystus	Gulsha Tengra	<i>Mystus tengara</i>	LC	LC
19.	Cobitidae	Guntea Loach	Gutum	<i>Lepidocephalichthys guntea</i>	LC	LC
20.	Clupeidae	Hilsa Shad	Ilish	<i>Tenualosa ilisha</i>	LC	LC
21.	Schilbeidae	Gangetic Ailia	Kajuli, Bashpata	<i>Ailia coila</i>	LC	NT
22.	Cyprinidae	Black Rohu, Kalbasu	Kalibaus, Baus	<i>Labeo calbasu</i>	LC	LC
23.	Belonidae	Needle Fish	Kankila, Kakila	<i>Xenentodon cancila</i>	LC	LC
24.	Cyprinidae	Catla	Katla	<i>Catla catla</i>	LC	NE
25.	Mastacembelidae	Stripled Gourami	Khalisha, cheli	<i>Colisa fasciata</i>	LC	LC
26.	Anabantidae	The Climbing Perch	Koi, Kai	<i>Anabas testudineus</i>	LC	LC
27.	Synbranchidae	Cuchia	Kuchia, Kuicha	<i>Monopterusuchia</i>	VU	VU
28.	Ambassidae	Highfin Glassy Perchlet	Lal Chanda	<i>Pseudambassis lala</i>	LC	NE
29.	Cyprinidae	Mola carplet	Mola, Moa	<i>Amblypharyngodon mola</i>	LC	LC
30.	Cyprinidae	Mrigal carp	Mrigal, Mirka	<i>Cirrhinus cirrhosus</i>	NT	VU
31.	Cichlidae	Nile Tilapia	Nilotica, Tilapia	<i>Oreochromis niloticus</i>	LC	LC
32.	Sciaenidae	Pama Croaker, Pama	Poa, Poma	<i>Otolithoides pama</i>	LC	NE
33.	Cichlidae	Green puffer fish	Potka	<i>Tetraodon fluviatilis</i>	LC	LC

SL#	Family	Common Name	Local Name	Scientific Name	IUCN Bangladesh Status, 2015*	IUCN Global Status 2021-2*
34.	Pangasiidae	Pungas	Pungas	<i>Pangaius pangaius</i>	LC	LC
35.	Cyprinidae	Spotfin Swamp Barb	Punti, Jat Punti	<i>Puntius sophore</i>	LC	LC
36.	Cobitidae	Bengal Loach	Rani	<i>Botia dario</i>	EN	LC
37.	Cyprinidae	Rohu, Rohu Carp	Rui, Rohit	<i>Labeo rohita</i>	LC	LC
38.	Mastacembelidae	Tire-track Spiny Eel	Sal Baim, Bro Baim	<i>Mastacembelus armatus</i>	EN	LC
39.	Cyprinidae	Olive Berb	Sar Punti	<i>Puntius sarana</i>	NT	NT
40.	Heteropneustidae	Stinging Catfish	Shing, Jiol	<i>Heteropneustes fossilis</i>	LC	LC
41.	Channidae	Common Snakehead	Shol	<i>Channa striata</i>	LC	LC
42.	Cyprinidae	Silver Carp	Silver Carp	<i>Hypophthalmichthys molitrix</i>	LC	LC
43.	Channidae	Spotted Snakehead	Taki	<i>Channa punctatus</i>	LC	LC
44.	Mastacembelidae	Lesser Spiny Eel	Tara Baim	<i>Macrogathus aculeatus</i>	NC	NE
45.	Cobitidae	Stripped Dwarf catfish	Tengra	<i>Mystus vittatus</i>	LC	LC
46.	Cyprinidae	Java Barb	Thai Sarpunti	<i>Barbonymus gonionotus</i>	LC	LC
47.	Cichlidae	Tilapia	Tilapia	<i>Oreochromis mossambicus</i>	LC	LC

*LC= Least Concern, CR= Critically Endangered, EN=Endangered, NT= Near Threatened, V=Vulnerable

Source: EQMS Field Survey, August 2021

Figure 6-39: Family-based fish species diversity in the study area

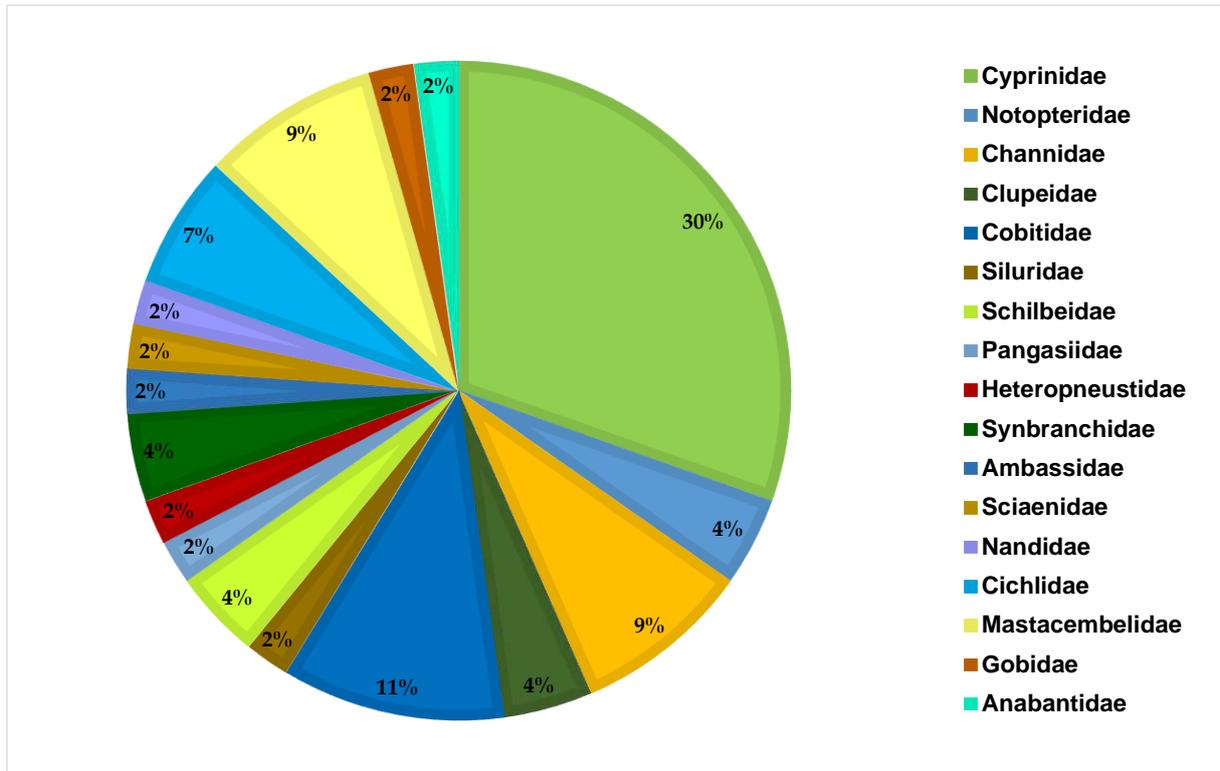


Figure 6-40: Photograph of fish species during a market survey



	
<p>Mola (<i>Amblypharyngodon mola</i>)</p>	<p>Rui (<i>Labeo rohita</i>)</p>

Source: EQMS Field Survey

6.4.3.6 Fisheries Management, Problem, and Issues

Fisheries management is to produce sustainable biological, social, and economic benefits from renewable aquatic resources. Project activities will not directly interface with fisheries activities and hence are not likely to disturb any fisheries. Project authorities will ensure that no obstruction is caused during the project's construction and operation phase for the fishermen's movement. Any additional measures required will be taken care of by the project authority with the guidance of the Department of Fisheries to manage fisher

Chapter 7

Potential Environmental Impacts and Mitigation Measures

7 POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Assessment of potential impacts is based on activities involved in the project implementation, the nature and extent of the proposed activities, and the present environmental setting of the project area.

7.1 Impact Assessment Methodology

The impact assessment involves predicting, evaluating, and mitigating impacts and reports on impacts, including residual and cumulative impacts. The main EIA steps are summarized below and comprise:

- Potential Impact Prediction: determination of what could potentially happen to resources/receptors because of the Project and its associated activities.
- Impact Evaluation: The significance of the predicted impacts is evaluated by considering their magnitude and likelihood of occurrence and the sensitivity, value, and importance of the affected resource/receptor.
- Mitigation and Enhancement Measures: Identify appropriate and justified measures to mitigate negative and enhance positive impacts.
- Residual Impact Evaluation: Evaluation of the significance and scale of the environmental impacts predicted to remain after the application of mitigation measures.

7.1.1 Potential Impact Prediction

Prediction of environmental impacts is the most important component in the impact assessment study as it provides quantitative information on likely environmental impacts from a project well in advance. The diverse potential impacts in the impact assessment process result in various prediction methods, including quantitative, semi-quantitative, and qualitative techniques.

7.1.2 Impact Evaluation

Once the identification of potential impacts is completed, each potential impact is described in terms of its relevant characteristics (e.g., nature, extent, duration, intensity/ severity, irreplaceable loss of resources, and probability).

7.1.2.1 Nature of Impacts

The nature of impact is an assessment of the activity's effect on the surrounding environment. The description includes what is being affected and its magnitude. The nature of the impact will be classified as positive or negative and direct, indirect, and induced.

Direct	Potential/possible Impacts will be generated directly from the project activities and associated facilities, which are directly linked with the project. (e.g., discharge of untreated wastewater from construction camps into a nearby water body may lead to a decline in water quality).
Indirect	Potential/possible Impacts will be generated from secondary sources which are induced by the project activities. (e.g., impacts of air emissions such as CO ₂ on climate change, NO ₂ may lead to acid rains, and VOC may lead to low-level atmospheric ozone when combined with NO ₂ in the presence of sunlight).
Induced	Potential/possible Impacts will be generated (which are not part of the Project) due to the project's effect/consequence/outcome (e.g., an influx of camp followers resulting from the importation of a large project workforce).

7.1.2.2 Extent and Location of Impacts

Extent and location indicate the spatial area that may be affected by the proposed project activities or its associated facilities (Table 7-1).

Table 7-1: Geographical Extent of Impacts

Extent	Description
Project Site	Potential/possible impacts' area only at or within the project site/project boundary.
Local	Potential/possible impacts' area is not only limited to the site but also its immediate surrounding areas/receptors.
Regional	Potential/possible impacts area extends to the immediate surrounding and adjacent areas.
National	Potential/possible impacts are considered at a national level.
Trans-Boundary	<ul style="list-style-type: none"> The impact is considered at the national level and within the neighboring country. The impact is considered at a global level.

7.1.2.3 Duration of Impacts

Duration measures the impact's lifetime/existence/continuation (Table 7-2).

Table 7-2: Duration of Impacts

Duration	Description
Short Term	Potential/possible impact duration is a minimal time or length of construction/decommissioning period.
Medium Term	Potential/possible impact duration will continue after the construction period but stop/discontinue/cease within 10 years.
Long Term	Potential/possible impact duration will continue for more than 10 years or the entire operational life of the project.
Permanent – Mitigated	Potential/possible impact will remain after the operational life of a project, but appropriate mitigation measures reduce the impact.
Permanent – No Mitigation	<ul style="list-style-type: none"> Potential/possible impact will remain after the operational life of the project. No mitigation measures will reduce the impact after implementation.

7.1.2.4 Intensity/severity of Impacts

Intensity/severity is the degree to which the project affects or changes the environment; it includes a measure of the reversibility of impacts (Table 7-3).

Table 7-3: Intensity of Impacts

Intensity	Description
Insignificant	Changes due to potential/possible impact are minor, not visible/noticeable, natural functioning of the environment is not affected.
Low	<ul style="list-style-type: none"> The natural functioning of the environment is minimally affected. Natural, cultural, and social functions and processes can be reversed to their original state if mitigation measure is taken.
Medium	<ul style="list-style-type: none"> Environment remarkably distorted/disturbed/impacted, still functions, if in a modified way.

Intensity	Description
	<ul style="list-style-type: none"> Negative impacts cannot be fully reversed.
High	<ul style="list-style-type: none"> Cultural and social functions and processes are distorted/disturbed/impacted. Potentially ceasing Environmental function temporarily. Negative impacts cannot be fully reversed.
Very High	<ul style="list-style-type: none"> Natural, cultural, and social functions and processes permanently cease, and valued, important, sensitive, or vulnerable systems or communities are substantially affected. Negative impacts cannot be reversed.

7.1.2.5 Potential for Irreplaceable Loss of Resources

The potential for Irreplaceable Loss of Resources is the degree to which the project will cause a loss of irreplaceable resources (Table 7-4).

Table 7-4: Potential for Irreplaceable Loss of Resources

Potential for Irreplaceable Loss of Resources	Description
Low	No irreplaceable/unique resources will be impacted.
Medium	Irreplaceable/unique resources can be replaced with mitigation measures/efforts and will be replaced after a certain period of time.
High	Potential/possible Impact replaces a particular/vulnerable resource.

7.1.2.6 Probability

Probability is the likelihood or the chances that the impacts will occur (Table 7-5).

Table 7-5: Probability of Impacts

Probability	Description
Unlikely	Under normal conditions, no potential/possible Impact is expected.
Low	The probability of the impact occurring is low due to its design or historical experience.
Medium	There is a distinct probability of the impact occurring.
High	It is most likely that the impact will occur.
Definite	The impact will occur regardless of any prevention measures.

7.1.2.7 Magnitude

The magnitude is calculated as extent + duration + intensity + potential impact on irreplaceable resources.

Magnitude essentially describes the intensity of the change that has the potential to occur in the resource/receptor because of the potential impact. The magnitude designations themselves are universally consistent, but the definitions for these designations vary depending on the resource/receptor.

In the case of a potential positive impact, no magnitude designation (aside from 'positive') is assigned. It is considered sufficient for the EIA to indicate that the project has the potential to result in a potential positive impact without characterizing the exact degree of positive change that may occur.

7.1.2.8 Significance

The significance will be rated by multiplying the consequence of the impact and the probability of occurrence (i.e., Magnitude × Probability = Significance).

Table 7-6: Significance of Issues (Based on Environmental Parameters)

Significance	Description
Positive Impact	Potential/possible impacts that have a beneficial impact on affected media
Very low	No action is required.
Low	<ul style="list-style-type: none"> Impacts are within the acceptable range. Potential/possible impacts include localized or short-term effects on habitat, species, or environmental media.
Medium-Low	<ul style="list-style-type: none"> Impacts are within the acceptable range but should be mitigated to lower significant levels wherever possible. Potential/possible impacts include localized, long-term degradation of sensitive habitat or widespread, short-term impacts on habitat, species, or environmental media.
Medium-High	<ul style="list-style-type: none"> Potential/possible impacts are significant and require attention. Mitigation is required to reduce the negative impacts to acceptable levels. Potential/possible impacts include localized but irreversible habitat loss or widespread, long-term effects on habitat, species, or environmental media.
High	<ul style="list-style-type: none"> Impacts are of great importance, and mitigation is crucial. Potential impacts include significant, widespread, and persistent habitat, species, or environmental media changes. Potential impacts include persistent reduction in ecosystem function on a landscape scale or significant disruption of a sensitive species.
Very High	<ul style="list-style-type: none"> Impacts are unacceptable. Potential impacts include the loss of a significant portion of a valued species or the loss of effective ecosystem function on a landscape scale.

Potential social impacts are inherently variable because community response to a potential impact, perceptions of existing and changing conditions, and the degrees of vulnerability depend heavily on local conditions and the human factor. The significance of designations for potential social impacts considers social science expertise and previous experience in Bangladesh regarding the relationships between individuals, communities, government agencies, NGOs, special interest groups, and different industries.

Table 7-7: Potential Social Impact Significance

Significance	Definition
Positive Impact	Potential/possible impacts that have a beneficial impact on affected stakeholders.
Very Low	Potential/possible impacts are practically indistinguishable from the social baseline, with little to no potential impacts or concerns from affected external stakeholders.
Low	Potential/possible impacts that are short-term nuisance or inconvenience; potentially affected external stakeholders concerned but likely able to adapt with relative ease.

Significance	Definition
Medium-Low	Potential/possible impacts include localized or short-term effects; potentially affected stakeholders are concerned but likely able to adapt with relative ease.
Medium-High	Potential/possible impacts include local-to-regional (sub-national) or medium-term effects; potentially affected stakeholders are concerned and raise the issue as a high priority but may be able to adapt with some targeted support or assistance.
High	Potential/possible impacts such as local-to-national or long-term effects; potentially affected stakeholders concerned and raised as a high priority; may not be able to adapt without targeted support or assistance to maintain a pre-impact livelihood.
Very High	Potential/possible impacts such as local-to-global or irreversible long-term effects; potentially affected stakeholders concerned raise the issue as a high priority and are likely unable to adapt without targeted support or assistance.

To determine potential public health impacts, the assessment team considers the public, which has the potential to be exposed to various aspects and potential impacts of the project, whether it is a permanent resident with continuous exposure or periodic exposure to a fisherman transiting through the project area. The significance of determinations for potential public health impacts considers local and regional public health expertise and previous experience in Bangladesh regarding the relationships between individuals, communities, health care providers, government agencies, NGOs, and different industries.

Table 7-8: Potential Public Health Impact Significance

Significance	Definition
Positive Impact	Potential/possible impacts that have a beneficial impact on the affected stakeholder.
Very low	No impact on the public.
Low	Potential/possible illness or adverse effect with limited or no impact on the ability to function and medical treatment is limited or unnecessary.
Medium-Low	Potential/possible illness or adverse effects with mild to moderate functional impairment requiring medical treatment or management.
Medium-high	Potential/possible serious illness or severe adverse health effects requiring a high level of medical treatment or management.
High	Potential/possible severe illness or chronic exposure of a few resulting in life-shortening effects.
Very High	Potential/possible severe illness or chronic exposure of many resulting in life-shortening effects.

7.1.3 Mitigation and Enhancement Measures

Once the significance of an impact has been characterized, the next step is to evaluate what mitigation and enhancement measures are defensible. These are commonly incorporated into the project as commitments. Mitigation is aimed at preventing, minimizing, or managing significant adverse impacts to as low as reasonably practicable and optimizing and maximizing any potential benefits of the project, where applicable.

The priority in mitigation is to first apply mitigation measures to the source of the impact (i.e., to avoid or reduce the magnitude of the impact from the associated project activities) and then to address the

resultant effect on the resource/receptor via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably possible mitigations have been applied to reduce the impact magnitude.

7.1.4 Residual Impact Evaluation

Once mitigation and enhancement measures are declared, the next step in the impact assessment process is to assign residual impact significance. Importantly, this is a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation and enhancement measures.

7.2 Impact Identification

The potential impacts have been identified through a systematic process whereby the activities (both planned and unplanned) associated with the project have been considered for their potential to interact with environmental and social resources or receptors.

The interaction matrix enables a methodical identification of the potential interactions each project activity may have on the range of resources/receptors within the area of influence i.e., the study area of the project. The interaction matrix for the project activities and likely impacted resources/receptors are presented in Table 7-9.

7.2.1 Positive Impact

Waste-to-Electricity (WtE) projects are considered one of the most economical and environment-friendly solutions for tackling the problem of municipal waste. This will reduce air, water, and soil contamination and odor also. This will improve the quality of life in society and will provide safe & hygienic surroundings.

Electricity Generation

The main positive impacts due to this project can be considered as generating electricity by incinerating waste that could reduce the burden of the existing waste management system of DNCC. The implementation of this project can better achieve the sustainable development of solid waste disposal in Dhaka City, realizing "reduced, resourceful and harmless solid waste".

Employment Generation

Employment generation will be a significant contribution to the project, especially considering the employment scenario in the project area during the construction phase. The project is expected to employ at least 2093 people during the construction phase and 220 people for the operations phase through contractors. Waste pickers will be recruited at the plant as per the needs. The potential impacts due to the employment generation are considered to be positive.

Enhancement of Local Economy

During the operation period, people from various parts of the country, as well as globally, will be employed for long days. During this time all kinds of commodities relevant to the livelihoods of workers and engineers will be supplied by the local community. As a result, local business opportunities and the enhancement of the economy will create a positive impact on the community.

Opportunity for local transporters

The project operator will require several transportation services including regular requirements for commuting short-term visitors and industrial provisioning of a range of materials. Hence, this would create business opportunities for local transporters.

Community Benefits

The electricity produced from the power plants is supplied to the distribution grid and GoB decides on the areas to which the power generated is to be supplied. There will be an increase in the local government's efforts to electricity settlements because of the demand from the local community. The local community will also expect an increase in development activities associated with WTE Power Plant North Dhaka Private Limited's social responsibility commitments.

Reducing Community Health risk

Currently, People living close to the landfills may suffer from pneumonia, bronchial and skin diseases from the huge amounts of waste dumped there, as reported by the FGD respondents. Nearby dwellers also suffer from regular headaches, stomach problems, and a loss of appetite due to the foul smell.

Farmers working near the landfill face many injuries, with rashes occurring commonly after submerging their feet in contaminated rivers or agricultural fields. They can't dip their body in the water as it causes deep rashes on the skin. Mosquito breeding is higher within and around the landfills and contributes to the spread of various vector-borne diseases among nearby dwellers. The nearby people of the landfill can't even stay properly inside the house due to the disturbance of flies and mosquitoes.

Above mentioned community health risk of the existing landfill will be reduced after completing the project.

Reducing Odors

Odors in landfill gas are caused primarily by hydrogen sulfide and ammonia, which are produced during the breakdown of waste material. The emission of foul stench from landfills is a huge problem for landfill workers and adjacent households. The nearby dwellers' lives have become unbearable due to the landfill's emitted odor. This also negatively affects those walking or traveling along the highway/roads beside the landfills and contaminates the air. The odors from the existing landfill will be reduced after the completion of the project.

Reducing impacts on water quality

The leachate and the waste mixing with the groundwater adversely affect the surrounding water bodies, killing the fish population and hampering fishermen's livelihoods. The river (Turag, nearby Amin Bazar) has become ruined by waste entering it. The leachate treatment plant does not fully reduce leachate percolation into the nearby waterbodies, making them polluted and unsuitable for fish cultivation. Thus, many farmers and fishermen have been forced to switch livelihoods. The impact on water quality due to the current landfill will be lessened by the proposed project.

Reducing impacts on Soil Quality

Dwellers beside the Amin Bazar landfill cannot cultivate crops due to the soil and groundwater contamination caused by leachate permeation and waste dumping. Many agricultural lands are located around a 200–300 m radius of the dumping zone of the Amin Bazar landfill which is a highly risky zone. Furthermore, especially during the monsoon, the waste becomes clogged in the farmland, causing soil infertility. The proposed project will reduce the impacts on the soil quality of the surrounding area.

7.2.2 Impacts during Pre and Construction Phase

Impacts during the pre and construction stage are given below.

7.2.2.1 Involuntary Resettlement

The construction phase of the project will involve the pre-construction preparatory phase and intense construction activities which require site preparation, transportation of construction material, rapid mobilization of the labor force, etc. The significant impacts which are expected for involuntary Resettlement during the construction phase include:

- Loss of Land
- Loss of structure
- Loss of Livelihood

As per joint verification of the Deputy Commissioner (DC) Office of Dhaka District, A total of 31.182 acres (126,187.41m²) of land will need to be acquired by the Dhaka North City Corporation (DNCC) for the proposed power plant which will be used by Waste to Energy Power Project North Dhaka Limited in a rental basis. As per the list of the DC office, 242 landowners have been affected by the project interventions. Two business entities have been identified there with other associated facilities. Mainly transportation depot and workshop, repair, and maintenance shop with one water treatment plant and a cow farm will be impacted due to the land acquisition. Structures, mainly pucca, semi-pucca, and some tin sheds will be impacted. Proper compensation will be provided as per PWD's schedule rate against the structures and lost material with the structures. The details of involuntary resettlement have been described in the Resettlement Action Plan. The impact magnitude is medium therefore the impact is High.

Impact	<i>Involuntary Resettlement</i>		
Impact Nature	Direct	Indirect	Induced
Impact Scale	<i>Within the project area</i>		

Frequency	<i>Before the construction phase</i>					
The extent of Affected Stakeholders	Insignificant	Low	Medium	Moderate	High	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceability/Vulnerability	Low		Medium		High	
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider			Very High		

Mitigation Measure

- Where procuring of private land cannot be avoided and it will be done through a land acquisition process through the enforcement of the Acquisition and Requisition of Immovable Property Act, 2017 (ARIPA), the landowner will be duly compensated as per the provisions mentioned in the Entitlement Matrix of Resettlement Action Plan.
- Compensation will be provided to the affected as per Cash Compensation Law (CCL) as specified in ARIPA, 2017, or replacement cost, whichever is greater.
- A stakeholder Engagement Plan and Grievance Redressal Mechanism should be implemented.
- Compensation for loss of income and other investment-related loss for the affected households will be assessed, determined, and paid based on the entitlements specified in the entitlement matrix of the Resettlement Action Plan (RAP).
- The Concessionaire must establish an effective grievance redress mechanism, which should be properly communicated to all the affected persons and stakeholders; this will be a platform to raise their concerns and complaints.
- In case the affected person is not satisfied with the compensation, he/she has the right to express concern through formal application to the grievance process.
- It should be ensured that compensation for the income loss is paid to the affected persons before the start of any physical work.

7.2.2.2 Impact on Air Quality

During the construction of the power plant facilities (including the main building, auxiliary area, water treatment area, Ash & Slag Comprehensive Treatment Area, and transmission line), the activity would involve excavation for the land development, movement of transporting vehicles carrying the construction materials, etc. All these activities would give rise to the emission of dust particles thereby affecting air quality marginally at the site which will be transitory in nature. The major sources of impacts on ambient air quality are given below:

- Site preparation and leveling.
- Exhaust emission from the movement of equipment by trucks, and other heavy loaders.
- Operation of diesel generators and other diesel-based construction machinery.
- Earthworks, including excavation, and soil stripping.

- Site clearance including removal of topsoil.
- Construction sites generate dust from construction materials, waste, loose earth, moving excavated material, and transporting wastes on vehicles.
- Heavy machinery causes air pollution.
- Loading and unloading construction materials.
- Handling and mixing cement.
- Concreting works, including operation of concrete batching plant.

7.2.2.2.1 Dust from Construction Activities

The key construction activities likely to result in increased dust levels are the movement of trucks transporting infrastructure to and from the site, and the movement of construction vehicles along dusty roads. An increase in traffic number is expected on the adjacent highway (N5) because of the vehicles carrying construction materials, machinery, and equipment that could increase dust pollution. Dust emissions are exacerbated by dry weather and high wind speeds. The impact of dust also depends on the wind direction and the relative locations of dust sources and receptors.

The presence of dust can be a nuisance to site users, including construction workers and other nearby receptors. Settlements (Nagar Konda Village about 500m away from the proposed plant) is however surrounded by thick homestead plantations which will act as a barrier reducing the magnitude of any dust impacts. Based on the above factors, the magnitude of the impact associated with the emission of dust during construction activities is predicted to be low. However, the significance of the impacts is assessed to be low.

Impact	Dust from Construction Activities					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Settlement within the 500 m of the project boundary					
Frequency	Limited to the Construction Phase					
Extent and Location	Project Site	Local	Regional	National	Trans Boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceable Loss of Resources	Low		Medium		High	
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Low					

Mitigation Measures for dust control

- Implementation of regular watering and sprinkling dust suppression regime, during the dry season.
- The concrete batching plant will be located within the protected site to keep it away from sensitive receptors.

- Restricting heights from which materials are dropped as far as practicable, to minimize the fugitive dust arising from unloading/loading.
- Stockpiles will be maintained at the site only, which is a fenced area. No stockpiles will be maintained outside, and the maximum possible distance between the stockpiles and receptors will be maintained.
- Use effective dust suppression techniques, such as on-site watering and street cleaning.
- Water the material stockpiles, access roads, and bare soils on an as-required basis to minimize the potential for environmental nuisance due to dust.
- Effective water sprays should be used to control potential dust emission sources.
- Cover haul vehicles carrying dusty materials moving outside the construction site.
- Establish adequate locations for storage, mixing, and loading of construction materials, in a way that dust dispersion is prevented because of such operations.
- Dusty activities should be re-scheduled where possible if high-wind conditions are encountered.
- Crushing of rocky and aggregate materials shall be wet-crushed or performed with particle emission control systems.
- Waste from construction will not be burned.
- The movement of construction vehicles will be minimized, and a 20 km/hr speed limit will be enforced around the construction site,

The impact due to dust generation will have medium intensity with local extent for a short-term duration which will result in an overall low impact without mitigation. However, with proper implementation of the suggested mitigation, the impact will be reduced to very low.

7.2.2.2.2 Exhaust Emissions

In addition to dust generation, construction vehicles, and other construction equipment will generate exhaust emissions. Heavy equipment such as bulldozers, excavators, dump trucks, and compactors will be used onsite. Emissions from this equipment and from diesel generator sets used to generate power will cause impacts on ambient air quality. It is not anticipated that large volumes of exhaust emissions will be generated during the construction phase of the power plant and transmission line as well. Impacts from vehicle emissions decrease rapidly with increasing distance from the source. The distance between the project site boundary and the closest residential dwelling is 500m to the western boundary of the project site.

Construction vehicles and equipment engine exhaust emissions include CO, PM_{2.5}, PM₁₀, and NO₂. These substances have been identified as criteria air pollutants by the United States Environmental Protection Agency (USEPA) on account of their effect on human receptors in particular those who are more susceptible to air quality changes such as asthmatics, children, and the elderly; and the prevalence of these substances in the urban ambient environment.²⁷

However, the air quality impacts associated with vehicular and equipment emissions during construction activities are assessed to be of medium-low potential significance. This implies the effects to be of localized nature and temporary which indicates that any deterioration in the air quality at the project location is unlikely to be significant and is expected to be transient. The impact due to the exhaust emission from the vehicle is assessed to be Medium-Low.

Impact	<i>Exhaust Emission</i>		
Impact Nature	Direct	Indirect	Induced
Impact Scale	Settlement within the 500 m of the project boundary		

²⁷ USEPA. (2021, August 16). *Criteria Air Pollutants*. <https://www.epa.gov/criteria-air-pollutants>

Frequency	Limited to the Construction Phase					
Extent and Location	Project Site	Local	Regional	National	Trans Boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceable Loss of Resources	Low		Medium		High	
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Medium-low					

Mitigation Measures for Exhaust Emissions

Exhaust emissions will be minimized by following mitigation measures:

- All diesel-powered equipment will be regularly maintained, and idling time reduced to minimize emissions.
- Low Sulphur diesel (S<0.5%) will be used in diesel-powered equipment in collaboration with best management practices.
- Vehicle/equipment air emissions will be controlled by good practice procedures (such as turning off equipment when not in use).
- Vehicle/equipment exhausts observed emitting significant black smoke in their exhausts will be serviced/ replaced.

The implementation of good site practices, such as the regular maintenance of vehicles and equipment, using cleaner fuels, and switching of vehicles when not in use will be used to reduce exhaust emissions from the operation of diesel-powered construction equipment and therefore minimize adverse air quality impacts. The impact of exhaust emission will have high intensity with local extent for a short-term duration which will result in an overall medium-low impact without mitigation. However, with proper implementation of the suggested mitigation, the impact will be reduced to very low.

7.2.2.2.3 Offensive Odor

The implementation of this project involves several types of construction works that may generate substances with bad odors. For example, land preparation and clearing work, sewage from mobile and stationary toilets, solid waste, slurry, etc. Moreover, odor from the existing landfill site can create a temporary nuisance to the workers and staff during the preconstruction and construction period of this project. However, considering the possibility of producing such a bad odor and its public exposure level, the impact seemed less significant. The impact due to the offensive odor is assessed to be Very Low.

Impact	<i>Offensive Odor</i>					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Within the 500 m of the project boundary					
Frequency	Limited to the Construction Phase					
Extent and Location	Project Site	Local	Regional	National	Trans Boundary	

Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceable Loss of Resources	Low		Medium	High		
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Very Low					

7.2.2.3 Impact on Noise and Vibration

7.2.2.3.1 Impacts from Noise Emissions

Noise and vibration are very common outcomes of any development project. Noise can lead to annoyance due to interference with communication or disturbance to receptors involved in leisure activities, as well as sleep disturbance²⁸. It is expected that, due to the nature of this project, this project will also produce noise and vibration during the construction phase. The potential sources of noise during the construction phase of the Project include equipment, machinery, and transportation used for the construction activities. The heavy equipment used for construction activities will be the major source of the noise. This will include piling and preparing concrete foundations for plants and buildings. Transportation of construction materials to the stockyard for the associated transmission line may cause negligible noise pollution. The traffic volume will be increased during the construction phase due to the transportation of equipment, construction materials, and workers on the access road which will be the source of noise to the closest receptor.

In general, noise is attenuated over distance from the source due to the dissipation of sound energy through the atmosphere. From a review of the land uses within and around the project area, noise-sensitive receptors include:

- Staff and workers in the proposed waste-to-energy power plant and associated facilities. About 2,093 people will be working throughout the construction phase.
- Residential areas located around the project area. (Nagar Konda- 550m and Baliarpur Village- 800 meters and Nandonic Housing Society- about 1170 meters from the project site).
- The school and mosque are located between 880 m to 1500 m from the construction work site.
- Fauna within and around the project site.

The nearest settlement is located adjacent to the North-western boundary which is about 550m away from the project site. Construction traffic is expected to be generated throughout the entire construction period; however, the volume and type of traffic generated will depend on construction activities being conducted, which will vary during the construction period. There is potential for disturbance to habitations in the proximity of the construction site. Approximately 90-92 dB(A) of noise is expected to be generated from construction activity which will attenuate to less than 45dB(A).

Noise is also one of the aspects which may cause hearing impacts on workers associated with construction activities and communities in the immediate vicinity, especially during early morning and nighttime construction work activities. As the closest receptor is present adjacent to the project site so the impact assessment has been considered medium-low.

²⁸ World Health Organization. (1999). *Guidelines for Community Noise*. <https://apps.who.int/iris/handle/10665/66217>

Impact	<i>Impact on noise level during the construction period</i>					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Within the 500 m of the project boundary					
Frequency	Limited to the Construction Phase					
Extent and Location	Project Site	Local	Regional	National	Trans Boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceable Loss of Resources	Low		Medium		High	
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Medium-low					

Mitigation Measure

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

- The machinery and vehicles should be equipped with mufflers, silencers, foam, rubber, and other sound soundproofing materials, whatever is necessary, to reduce operation noise; the diesel generators should be covered with a canopy.
- Only well-maintained equipment will be operated on-site.
- Regular maintenance of equipment such as lubricating moving parts, tightening loose parts, and replacing worn-out components should be conducted.
- Machinery and construction plants that may be in intermittent use (e.g., trucks) shall be shut down or throttled down during non-work periods.
- Low-noise equipment shall be used as far as practicable.
- The amount of equipment operating simultaneously shall be reduced as far as practicable.
- Equipment known to emit noise strongly in one direction should be orientated so that the noise is directed away from nearby NSRs as far as practicable.
- Noisy plants (such as breakers and rollers) shall be located as far away from receptors as practicable.
- The contractor should consider the noise emission characteristics of equipment when selecting equipment for the project and select the least noisy machine available to perform the specific work.
- Mobile noise sources such as cranes and earth-moving equipment shall be routed in such a way that there is minimum disturbance to receptors.
- Only limited construction activities shall be carried out during night-time.
- Restrict the nighttime vehicle movement through the access road.
- Adopt the vehicle speed (20 km/hr.) limit on the access road.
- Temporary noise barriers shall be provided surrounding the high noise-generating construction equipment.

- The personnel involved in high noise-generating activities shall be provided with personal protective devices to minimize their exposure to high noise levels.
- Construction vehicles and machinery will be well maintained and not kept idling when not in use.

The impact of noise will have high intensity with local extent for a short-term duration which will result in an overall medium-low impact without mitigation. However, with proper implementation of the suggested mitigation, the impact will be reduced to low.

7.2.2.3.2 Impacts from Vibration

The construction activities using heavy machinery during soil compacting and rolling, lifting cranes, etc. will generate moderate to high vibration. Ground-borne vibration will likely be generated during the installation of driven piles and other construction equipment during the construction period.

In general, vibration propagated through the ground during earthworks is attenuated within a short distance from the source. Formulae from empirical studies generally consider a distance of approximately 110 m from the vibration source²⁹. Human receptors that may be exposed to vibration impacts from the project, therefore, include those who would be within 110 m of the project construction work area boundary and comprise the plant staff and workers, as well as personnel temporarily residing within the exclusive use areas.

Vibration can lead to annoyance due to sleep disturbance. Low levels of perceptible vibration may also cause disturbance and can cause concern about structural damage to nearby buildings. It is noted however that the potential for actual cosmetic damage is limited to buildings that are very close to high energy sources such as driven piling. Guidance on the effect of vibration levels on human receptors was published by the British Standard Institute and is presented in Table 7-10.

Table 7-10: Guidance on effects of vibration levels

Vibration Level (mm.s ⁻¹)	Effects
0.14	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3	Vibration might be just perceptible in residential environments.
1.0	It is likely that vibration of this level in residential environments will cause complaints but can be tolerated if prior warning and explanation have been given to residents.
10.0	Vibration is likely to be intolerable for any more than very brief exposure to this level.

Source: British Standards Institution, 2014 29

Vibration levels are expected to attenuate within 110 m of the construction work area. There is no significant receptor within this range. It is anticipated that the staff and workers at the construction work area may be exposed to vibration levels over a short-term duration, i.e., up to a few hours a day. However, the significance of the impacts is assessed to be very low.

Impact	Impacts due to Vibration		
Impact Nature	Direct	Indirect	Induced
Impact Scale	Within the 500 m of the project boundary		

²⁹ British Standards Institution. (2014). *Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration*. BS 5228-1:2009+A1:2014. The British Standards Institution.

Frequency	Limited to the Construction Phase					
Extent and Location	Project Site	Local	Regional	National	Trans Boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceable Loss of Resources	Low		Medium	High		
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Very Low					

7.2.2.4 Impact on Water Resources

The potential sources of impact on surface and groundwater resources are as follows:

- Earthworks in the proposed Power Plant area may increase erosion, especially during rainfall events, which may increase the suspended sediment concentrations and pollute water sources.
- Sewage will arise from the construction workforce (toilets and washing facilities).
- Liquid effluents will also arise from the washing of construction equipment and vehicles.
- Leakage or spillage of fuels, chemicals, waste materials, etc. stored on the project site during the construction of the power plant and transmission line that could enter water bodies.

The baseline study for the project identified the Karnatali River as the surface water-sensitive receptor due to its proximity to the project area. The Karnatali River is the major surface water body in the 5 km study area which flows near the project site. During the project construction, groundwater as well as Karnatali River (about 595 m away from the project site) water will be used. During the monsoon season, many fish species of Bangladesh are found in the Karnatali River. Groundwater is the main source of drinking water in the project study area.

7.2.2.4.1 Impacts on Surface Water

During the construction phase, the primary water use requirement will be for dust control. However, water may also be required to moisture condition the soil for proper compaction of internal roads and foundations within the site premises. Temporary ablution facilities will be required during construction (i.e., portable toilets). It is estimated that 10-12kilo liters/day is required for the construction phase on daily basis (which includes water requirements for foundation work and domestic requirements of workers). Water will be sourced from the Karnatali River. Bore well(s) will also be installed within the site premises to cater to the domestic water requirement during the construction phase.

The Transmission line alignment crosses 3 times of Karnatali river; however, as these are overhead crossings the impacts associated with the construction of the TL will be minimal, though there may be some temporary impacts due to the construction of access roads and foundations at locations near the water bodies. Surface water could be affected by construction activities near rivers or other surface water, excavations in areas of shallow groundwater, and spills of fuel or other materials into or near water.

Changes to surface water quality within the study area may also arise from chemical and waste storage and handling during the pre-construction and construction stages. Unplanned events such as

hazardous material leakage from machinery, e.g., overflow of the existing surface runoff infrastructure caused by a major rainfall event could also impact surface water quality. Potential impacts are expected to be short-term and localized in nature. The potential impact on surface water is low.

Impact	<i>Impacts on surface water</i>					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Impact on Karnatali River					
Frequency	Limited to the Construction Phase					
Extent and Location	Project Site	Local	Regional	National	Trans Boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceable Loss of Resources	Low		Medium		High	
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Low					

Mitigation Measures for Surface Water

Mitigation measures for surface water quality include the following:

- Phase dust-generating activities such as land clearance, earthworks, and building construction to minimize the area of ground exposed and the volume of soil and construction material handled at any one time.
- Waste management measures should include provisions to contain and dispose of construction wastes, prohibit waste discharge on the ground or any surface watercourse, and practice recycling as far as practicable.
- Implement a regular maintenance program for all equipment and machinery to prevent fuel spillage or leakage during construction activities.
- Properly store and manage hazardous materials during construction activities. Strategically locate areas for the temporary storage of hazardous materials away from surface water resources and preferably down the topographic gradient of watercourses. Chemicals and fuels must be properly labeled and stored in a bunded area. Storage of hazardous materials on-site should be limited to minimize the impacts of any spillage or mitigation failure.
- Spill kits should be provided and all personnel managing hazardous materials should be adequately trained in hazardous materials handling and disposal. Such spill kits should be available where equipment and machinery are temporarily stored and used.
- Oil and grease separators shall be used for wastewater generated from cleaning activities.
- Refueling, oil changing, and engine maintenance of machinery, equipment, and vehicles should be undertaken in designated areas with containment to prevent any oil spills from washing away, at a distance of at least 100 m from any water course.
- Cover temporary stockpiles with tarpaulin when not in use.
- Wherever reasonable and practicable, re-vegetate exposed ground as soon as possible to stabilize surfaces.

- Control water suppression during excavation and earth handling to minimize excess water and sediment disposal into surface water.
- Discharge of wastewater from excavation to the surface water bodies will be strictly prohibited due to ecological sensitivities.
- Disposal of construction wastes into the waterbodies will be strictly prohibited.
- Vehicle maintenance and mechanical repairs are to occur in dedicated, designed locations, bounded to capture, and control oil, grease, and other spills to prevent flow into surface water resources.
- Adequate sanitary facilities, i.e., toilets provided for the construction workforce.
- Workers trained in the use of designated areas/bins for waste disposal and encouraged to use toilets.
- Septic tanks will be provided to treat sanitary wastewater and
- All sewage and liquid effluent will be treated to meet the standards specified in Schedules 3 and 4 of the ECR, 2023.

The impact on surface water will have low intensity with a short-term duration which will result in an overall low impact without mitigation. However, with proper implementation of the suggested mitigation, the impact will be reduced to very low.

7.2.2.4.2 Impacts on Groundwater

Construction activities causing impacts on groundwater resources are likely to include the following:

- Land clearance and grading for preparation of construction work areas.
- Diversion of underground utilities.
- Construction of aboveground and underground structures.
- Leakage or spillage of fuels, chemicals, waste materials, etc. stored on the project site during construction that could enter the groundwater aquifer.

The existing groundwater quality analysis around the project does not reveal any existing contamination or pollution. Soil compaction may increase the intensity and volume of surface water runoff as a result of a decrease in water infiltration recharging the groundwater.

Direct impacts on groundwater due to TL are not likely to occur or to be minimal, due to the small-scale nature of the project at individual locations. Groundwater could be affected by construction activities, excavations in areas of shallow groundwater, and spills of fuel or other materials into or near water.

Improper disposal of sewage and wastewater from the labor camp and construction debris can contaminate the groundwater resources in the area.

Groundwater contamination during the construction phase may occur from unplanned events such as leaks and spills of oil, lubricants, fuel from heavy equipment, and improper handling of sewage. While there is a potentially significant impact on groundwater quality from construction, with the implementation of mitigation measures for proper handling of fuel, waste, and liquid effluents, the impact on groundwater from spills and leaks is assessed to be low.

Impact	<i>Impacts on groundwater</i>				
Impact Nature	Direct	Indirect			Induced
Impact Scale	Groundwater in the project site and surrounding				
Frequency	Limited to the Construction Phase				
Extent and Location	Project Site	Local	Regional	National	Trans Boundary
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation

Impact Intensity/ Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceable Loss of Resources	Low		Medium	High		
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Low					

Mitigation Measures for groundwater

The following measures can be taken to minimize the impact on groundwater during the construction phase.

- Ensure proper spill control and management at the site.
- Ensured storage of hazardous material and waste in a proper manner and disposed of the waste in a hazardous waste landfill site.
- The surface runoff or extracted groundwater contaminated by silt and suspended solids will be collected by the on-site drainage system and discharged into storm drains.
- Monitor groundwater from time to time to detect any contamination.

The impact on groundwater contamination will have low intensity with local extent for a short duration which will result in an overall low impact without mitigation. However, with proper implementation of the suggested mitigation, the impact will be reduced to very low.

7.2.2.5 Impacts on Soil

The potential source of impact on land resources during the construction phase activities includes:

- Topsoil removal
- Site Cleaning, Levelling (cutting, stripping, excavation, earth movement, and compaction)
- Transportation and storage of construction materials/equipment
- Civil construction activities
- An influx of Labor and the construction of temporary houses
- Storage, Transportation, and Disposal of Construction Debris
- Waste disposal from the construction camp

The total 31.182 acres (126.187.41m²) acres of nonagricultural fallow land will be altered to an industrial area. There are some fallow lands on the west and east side of the project boundary that might be affected due to the land development.

7.2.2.5.1 Soil Compaction and Erosion

Preparation of the site for the power plant includes the main building (waste tipping hall, waste pool, incineration boiler house, flue gas cleaning house, turbine house, central control room, and chimney), auxiliary area (guard room, weighbridge room, access ramp, and oil depot); water treatment area (industrial fire tank, comprehensive water pump house, cooling tower, water purification station), Ash and slag comprehensive treatment area during the construction phase will require some site leveling and grading and soil compaction. The area required for the buildings and access tracks linking infrastructure is considerable.

Further, the transport of materials and equipment will involve additional movement of vehicles; construction machinery which will also lead to some degree of compaction within the site premises.

Soil compaction and possible damage to the soil structure due to heavy vehicular movement will only be limited to the vicinity project site. Based on the impact assessment matrix given below the impact was assessed as low.

Impact	<i>Impact on soil due to compaction</i>					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Within the project boundary and transmission line RoW					
Frequency	Limited to the Construction Phase					
Extent and Location	Project Site	Local	Regional	National	Trans Boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceable Loss of Resources	Low		Medium		High	
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Low					

Mitigation Measures

The following measure will be implemented to mitigate soil compaction and erosion:

- The area to be cleared must be clearly demarcated and this footprint strictly maintained.
- Soil conservation measures will be implemented such as stockpiling topsoil or gravel for the remediation of disturbed areas.
- Scheduling activities (as far as possible) to avoid extreme weather events such as heavy rainfall and high winds.
- Work areas will be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint.
- Construction vehicles will remain on designated and prepared compacted gravel roads.

The impact on topsoil compaction and erosion will have medium intensity within the project site for a short duration which will result in an overall low impact without mitigation. However, with the proper implementation of suggested mitigation measures, the overall impact will be very low.

7.2.2.5.2 Soil Contamination

The project will also involve the use of paints for switchyard structures during construction which if not handled and used properly, may lead to contamination of soil. Improper disposal of hydraulic fluids, lubricating oils, and other used oils can also result in the contamination of soil. Improper storage of construction material can also result in the unwanted dispersal of contaminants into adjoining areas.

Spills could have a long-term impact on soil quality but are expected to be localized in nature. During the construction stage of the power plant including the transmission line, a large number of workers/employees (about 2093 persons) will be engaged with the proposed project. At the same time, a significant amount of solid waste will be produced from domestic waste, garbage, sludge from food waste, by-product material, etc. Solid waste can contaminate soil if it is not managed properly. Project activities of TL with the greatest potential to affect geology and soils include land-clearing and

vegetation removal, excavation for tower foundations and improper handling of excavated soil, and generation of wastes at the construction site may affect the soil quality of adjacent land.

The waste, both solid and small quantities of hazardous waste generated from the proposed project will be handled as per the GOB ECR 2023 guideline. Liquid effluents arising from construction activities will be treated to the standards specified in Schedules 3 and 4 of ECR, 2023 of the GOBs and the applicable international guidelines before discharge. Therefore, the likelihood of unplanned events leading to soil contamination is possible but low. Based on the matrix the impact has been considered as low.

Impact	<i>Soil Contamination from Spills and Leaks</i>					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Within the project boundary and transmission line RoW					
Frequency	Limited to the Construction Phase					
Extent and Location	Project Site	Local	Regional	National	Trans Boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceable Loss of Resources	Low		Medium		High	
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Low					

Mitigation Measures

The following measure will be implemented to mitigate soil contamination:

- Fuel, lubricating oil, and used oil storage areas will be contained in bunds of 110 percent capacity of the stored material.
- Spill containment and clean-up kits will be available onsite and clean-up from any spill will be appropriately contained and disposed of.
- Construction vehicles and equipment will be serviced regularly and off-site.
- The Contractor will prepare guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel, or chemicals.
- Surface run-off from bunded areas will pass through oil/water separators before discharge to the stormwater system.
- Ensure storage areas have impermeable floors and containment.
- The contractor will restore tower footprints and other areas disturbed by construction as soon as practicable once major construction activity in that area is complete, and while construction is continuing at other sites, and not wait until construction is complete along the entire corridor.
- The construction contractor will implement a training program to familiarize staff with emergency procedures and practices related to contamination events.

The impact on topsoil contamination due to spills and leaks will have medium intensity within the project site for a short duration which will result in an overall low impact without mitigation. However, with the proper implementation of suggested mitigation measures, the overall impact will be very low.

7.2.2.6 Impacts due to Waste Generation

The main type of waste likely to be generated during construction activities is the construction debris resulting from the excavations for building foundations, construction of the building frame, internal fittings, electrical installation, and external works. Other wastes that will be generated include waste food and packaging materials littered by workers.

Some of the waste streams include the following:

- Hazardous wastes such as solvents, thinners, cleaners, cutting oils, paints, contaminated rags, packaging and containers, adhesives, light bulbs, and batteries.
- Non-hazardous wastes such as food and canteen waste, scrap metal waste, wastepaper, wood, and cardboard packaging.
- Other wastes such glass, uncontaminated soil, rubble, plastics, and rubber.

There is potential for the spread of construction debris to areas outside that are marked for construction. The debris generated from construction activities can be carried along with the river flowing in the proximity of the plant. Construction debris can also contaminate wells, agricultural land, etc. in the proximity of the activity. Sanitary waste will also be generated during the construction phase.

The improper management of the above wastes may have potentially significant impacts on the environment in the absence of appropriate mitigation measures. Therefore, the impact significance is assessed as low.

Impact	<i>Waste generation</i>					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	In and around the project site					
Frequency	Limited to the Construction Phase					
Extent and Location	Project Site	Local	Regional	National	Trans Boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceable Loss of Resources	Low		Medium		High	
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Low					

Mitigation Measures

Measures to avoid, minimize, and limit the magnitude of waste generation impacts caused by the project's construction phase are outlined in the following.

- Any construction debris generated at the site will be removed from the site immediately after the completion of construction activities and the site will be leveled as the original.

- All storage areas must also be properly demarcated and, if the material is hazardous, there should be adequate labeling and security at the facility.
- Properly store and manage hazardous materials during construction activities. Chemicals and fuels must be properly labeled and stored in a bunded area. Storage of hazardous materials on-site should be limited to minimize the impacts of any spillage or mitigation failure.
- Dispose of debris and waste in designated areas. Workers will be strictly instructed about the random disposal of any waste generated from the construction activity. Arrangements will be made to collect and prevent littering by workers on site.
- Waste will be segregated according to type and stored in a separate bin with a label.

With the implementation of the mitigation measures mentioned above, impacts on waste would be negligible.

7.2.2.7 Impact on Ecosystem and Biodiversity

7.2.2.7.1 Impact on Terrestrial Flora

During the construction phase, activities that might impact terrestrial flora include vegetation clearance in the proposed project site, transportation and stockpiling of construction materials, and movement of construction vehicles in the project area. Dust generated from these activities will lead to dust deposition on plant leaves, twigs, and stems which may hamper photosynthesis, respiration, and other physiological processes. As a result, it will affect plant growth and cause diseases. However, the baseline study represents no threatened terrestrial plant species within the project AOI.

Considering the project activities and potential biological receptors within the project AOI, the impact on terrestrial flora during the construction phase might be less significant. Therefore, it is assessed as **Low**.

Impact	Impact on Terrestrial Flora					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Limited to Project Site and adjacent area					
Frequency	Limited to the Construction Phase					
Extent and Location	Project Site	Local	Regional	National	Trans Boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceable Loss of Resources	Low		Medium		High	
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Low					

As the project impact will be for the short term to a local extent within the adjacent areas of the project site, the potential impact on terrestrial flora can be reduced to Very Low by following proper mitigation measures.

- Reduce unnecessary clearance of vegetation cover.
- Dust mitigation measures i.e., water spraying, covering stockpiles during transportation, etc. should be followed.
- Workers should be aware of the importance of natural resources and should not unnecessarily break branches, twigs, flowers, etc. of adjacent vegetation.

7.2.2.7.2 Impact on Terrestrial Fauna

Dust and noise generated from construction activities and construction materials handling/ transportation may affect terrestrial fauna residing in the adjacent areas of the project sites. These activities might lead to habitat degradation or disturbance to the movement of wildlife. Also, excessive light generated from the construction sites will hamper the movement of nocturnal animals. In addition, the faunal movement might be hampered, and/ or harm or death to wildlife might be occurred due to vehicle and equipment movement on the approach roads and negligence of workers and drivers. However, the baseline study represents to have no threatened terrestrial fauna within the project AOI.

Considering the project activities and potential biological receptors within the project AOI, the impact on terrestrial fauna during the construction phase might be less significant. Therefore, it is assessed as **Low**.

Impact	<i>Impact on Terrestrial Fauna</i>					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Limited to Project Site and adjacent area					
Frequency	Limited to the Construction Phase					
Extent and Location	Project Site	Local	Regional	National	Trans Boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/ Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceable Loss of Resources	Low		Medium		High	
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Low					

As the project impact will be for the short term to a local extent within the adjacent areas of the project site, the potential impact on terrestrial fauna can be reduced to Very Low by following proper mitigation measures.

- Dust mitigation measures should be followed.
- Noise mitigation measures should be followed and machinery with lesser noise production should be used.
- Workers should be aware of the importance of natural resources and should not do any harm or death to wildlife.
- Nighttime work should be limited and the use of lights at night should not disrupt the movement of nocturnal wildlife species.

7.2.2.7.3 Impact on Aquatic Flora and Fauna

During the baseline study, a total of forty-seven (47) fish species were recorded from the nearby river, floodplains, beels, and ponds within Project AOI. Among them, five endangered species (*Mastacembelus armatus*, *Clupisoma garua*, *Botia Dario*, *Channa marulius*, *Chitala chitala*) and four vulnerable species (*Monopterus cuchia*, *Sperata aor*, *Gudusia chapra*, *Labeo boggut*) were enlisted according to IUCN Bangladesh (2015). These threatened fish species were recorded mostly from the fish market survey and few of them are rarely found in the adjacent Karnatali River in the monsoon period. In addition, a total of six (6) species of prawns and shrimps under two (2) families were recorded. None of them have threatened species as per the IUCN Red List of Bangladesh, 2015. Also, a total of 10 (Ten) species of aquatic macrophyte were observed in the study area during the field visit.

Without proper measures being taken, the following consequences may take place: during the construction phase, the primary impact may lead to degradation or even destruction of aquatic invertebrates. This might also trigger the eutrophication process and lead to the degradation of the aquatic ecosystem. A further impact will be on fisheries through habitat degradation and even habitat loss for them. The physiological processes and behavioral characteristics might get hampered or changed. The growth and production of fisheries might be reduced in the long run.

Considering the project activities and potential biological receptors within the project AOI, the impact on aquatic flora and fauna during the construction phase might be less significant. Therefore, it is assessed as **Low**.

Impact	<i>Impact on Aquatic Flora and Fauna</i>					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Limited to Project Area of Influence					
Frequency	Limited to the Construction Phase					
Extent and Location	Project Site	Local	Regional	National	Trans Boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceable Loss of Resources	Low		Medium		High	
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Low					

The project impact will be long-term to a regional extent within the project AOI of the project site, but the probability of impact will be low. Therefore, the potential impact on aquatic flora and fauna can be reduced to Very Low by following proper mitigation measures.

- A plan for accidental hazardous chemical spillage should be prepared.
- Ensure to keep the hazardous chemical in a secure place with secondary containment.
- Workers should be aware of the importance of natural resources and should not dispose of anything in the waterbodies.
- A septic tank and sedimentation pool will be adopted for wastewater treatment.

7.2.2.8 Impact on Traffic

The main source of road traffic will be vehicles carrying equipment, construction material, and vehicles carrying workers on the project site. The river will not be used for carrying construction equipment and materials for this project.

The project will increase the volume of traffic and vehicular movement on the existing road which has heavy traffic volume at present, bearing the important economic exchanges in Dhaka-Aricha highway, National Highway (N5), so traffic maintenance is the highlight of the project. According to the data from DNCC, 140 waste collection and dumping vehicles engaged in 4 trips by each vehicle per day, which will increase during the construction phase for carrying construction materials and other relevant associated things for construction. Labor movement at the site during the construction phase also may cause traffic congestion at the site.

During the construction phase of the project, construction materials like construction equipment and machinery will be transported to the site. An increase in local traffic is expected as a result of the vehicles carrying construction materials, machinery, and equipment. Moreover, vehicles carrying landfill material may increase traffic intensity on the adjacent main road. An increase in traffic volume on a national highway may cause traffic congestion and accidents. However, the extra traffic load during the construction stage is not too high to impose a high-level impact on the road. Therefore, the impact significance is assessed as low.

Impact	<i>Impact on Traffic</i>					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	In and around the project site					
Frequency	Limited to the Construction Phase					
Extent and Location	Project Site	Local	Regional	National	Trans Boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/ Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceable Loss of Resources	Low		Medium		High	
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Low					

Mitigation Measures

The following steps should be taken to minimize the impact due to increasing road traffic.

- All vehicles would undergo routine repair and maintenance to keep the vehicle in good operating condition.
- Drivers and operators would be checked for fitness and any driver/operator impaired due to any reason, including but not confined to the influence of drugs and/or alcohol would not be allowed to drive.

- A speed limit of 20 km/hr. within the site would be followed and the use of mobile phones while driving would be prohibited.
- Implementation of a safety program (signage, speed restrictions, lights on trucks, truckload restrictions, etc.) within the construction area
- All drivers shall follow the speed limit, the direction of the signalman, sensitive locations, horn usage restrictions, etc.

With the implementation of the precautionary and mitigation measures mentioned above, impacts on traffic movement would be negligible.

7.2.2.9 Local Conflict of Interest

As employment opportunities will be increased during the construction period, construction workers may have conflicts with the community. Based on the previous similar scale of the projects, approx. 300 to 400 persons/day of workers will engage during the construction. Throughout the whole construction period, approx. 2,093 persons are expected in total, including those who worked on construction.

Impact	<i>Local Conflict of Interest</i>					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	<i>Within the project area</i>					
Frequency	<i>Limited to the construction phase</i>					
The extent of Affected Stakeholders	Insignificant	Low	Medium	Moderate	High	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceability/Vulnerability	Low		Medium		High	
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Very Low					

7.2.2.10 Cultural Heritage

Nothing found in the development area would be affected by the development. Therefore, no impact is expected on cultural heritage due to the proposed project implementation.

7.2.2.11 Gender

Despite cultural practices, no gender-specific issues are observed and expected in the project area. The fact is that the participation of women in society is limited from a religious perspective, which has been observed during the first-round consultation meeting and second-round information disclosure meeting. However, during the construction phase, female labor engagement will not occur, and no major gender-related issue will trigger within the project location.

Impact	<i>Gender</i>
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Impact Nature	Direct	Indirect			Induced	
Impact Scale	<i>Within the project area</i>					
Frequency	<i>Limited to the construction phase</i>					
The extent of Affected Stakeholders	Insignificant	Low	Medium	Moderate	High	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/ Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceability/ Vulnerability	Low		Medium		High	
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Very Low					

7.2.2.12 Children's Rights

There are some primary and high schools near the project area. There is a possibility of disruption to PAHs and local community children due to construction and relevant impacts created from it. Also, there is a risk of child labor during the construction period.

Impact	<i>Child Rights</i>					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	<i>Within the project area</i>					
Frequency	<i>Limited to the construction phase</i>					
The extent of Affected Stakeholders	Insignificant	Low	Medium	Moderate	High	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/ Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceability/ Vulnerability	Low		Medium		High	
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Very Low					

7.2.2.13 Infectious Diseases, such as HIV/AIDS

The entire construction phase will require the labor of unskilled, semi-skilled, skilled, and highly skilled nature. However, it is envisaged that outsourced personnel will comprise mostly skilled laborers and workers. During Construction, in general, a lot of migrant workers flow into the sites, who may have the possibility of HIV/AIDS or any other infectious disease that can spread among local people.

Impact	<i>Infectious Diseases, such as HIV/AIDS</i>					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	<i>Within the project area</i>					
Frequency	<i>Limited to the construction phase</i>					
The extent of Affected Stakeholders	Insignificant	Low	Medium	Moderate	High	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceability/Vulnerability	Low		Medium		High	
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Very Low					

7.2.2.14 Occupational Health and Safety

The potential source of impact is given below:

- Noise from construction activities
- Impure drinking water
- Accidental injury
- Unhygienic sanitation system
- Congestion in dormitory

The effect of high noise levels on the operating person has to be considered as this may cause permanent hearing loss. It is known that continuous exposure to high noise levels above 85 dB(A) affects the hearing acuity of the workers/operators and hence, should be avoided.

Pure drinking water along with a proper sanitation system is essential to keep the worker in good health. Accidental injury may happen during construction work. Congestion in workers living places may influence the spread of contagious diseases among the workers. Thus, the overall impact significance during the construction phase of the power plant will be **Medium-Low**.

Impact	<i>Occupational Health and Safety</i>					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	<i>Within the project location</i>					
Frequency	<i>Limited to the Construction Phase</i>					

Extent and Location	Project Site	Local	Regional	National	Trans Boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation	
Impact Intensity/ Severity	Insignificant	Low	Medium	High	Very High	
Potential for Irreplaceable Loss of Resources	Low		Medium	High		
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very Low	Low	Medium-low	Medium-high	High	Very High
	Significance of impact consider Medium-low					

Mitigation Measure

The following mitigation measures should be taken to minimize the impact on occupational health and safety.

- The Contractor will prepare and implement a Health and Safety Plan before commencing work. This plan will include method statements for working methods, construction sequence, and safety arrangements.
- Measures will be implemented to reduce the likelihood and consequence of the following hazards:
 - falling from height.
 - falling into the water.
 - entanglement with machinery.
 - tripping over permanent obstacles or temporary obstructions.
 - slipping on greasy or icy walkways.
 - falling objects.
 - asphyxiation.
 - explosion.
 - contact with dangerous substances.
 - electric shock.
 - mistakes in operation.
 - variable weather conditions.
 - lifting excessive weights; and
 - Traffic operations.
- Competent and adequate resources of subcontractors will be used where construction activities are to be subcontracted.
- All persons working on site will be provided information about risks on Site and arrangements will be made for workers to discuss health and safety with the Contractor.
- All workers will be properly informed, consulted, and trained on health and safety issues.
- Personal Protective Equipment (PPE) shall be worn at all times on the Site. This shall include appropriate safety shoes, safety eyewear, and hard hats. Non-slip or studded boots will be worn to minimize the risk of slips.

- Before starting work all the appropriate safety equipment and the first-aid kit will be assembled and checked as being in working order. The breathing apparatus will be tested at regular intervals in the manner specified by the makers.
- All lifting equipment and cranes will be tested and inspected regularly.
- Where sound levels cannot be reduced at the source, suitable hearing protection will be provided when noise levels indicate a Leq of more than 90 dB(A).
- The Contractor shall provide appropriate safety barriers with hazard warning signs attached around all exposed openings and excavations when the work is in progress.

The impact on Occupational Health and Safety will have medium intensity with project site extent for a medium duration which will result in an overall medium-low impact without mitigation. However, with proper implementation of the suggested mitigation, the impact will be reduced to very low.

7.2.2.15 Community Health Safety

Possible sources of impacts on community health and safety during the construction phase are:

- Changes in environmental quality due to construction activities.
- Increased prevalence of disease arising from the influx of construction workers; and
- Heavy traffic movement.

Receptors can be considered as project site workers; settlements close to the Project site (within 500 m) and along the access road (with 100 m) are potential receptors of health impacts from construction-related activities.

Changes in the environmental quality of air, surface water, groundwater, and soil quality may occur as a result of construction activities. High noise levels are also expected from the operation of heavy machinery. The discharge of domestic waste effluent from sanitary facilities for construction workers may have the potential to cause contamination of surface water and groundwater in this area.

The influx of workers to the community may have an impact on public health, especially an increase in the prevalence of diseases. The influx of migrant laborers during construction can cause a mixing of the migrant workforce with the local people. This mixing of the groups may cause some adverse impacts on public health in the neighboring villages with the potential for the spread of infectious diseases like Acquired Immune Deficiency Syndrome (AIDS) and COVID-19.

Measures such as proper collection, storage, and disposal of wastes, and construction of septic tanks to prevent contamination of water resources from sanitary effluents generated from labor camps will be implemented. Mitigation measures will be implemented to reduce the likelihood of contamination of surface and groundwater from sanitary effluents generated during construction. Thus, the overall impact significance during the construction phase of the power plant will be Low.

Impact	<i>Community Health and Safety</i>				
Impact Nature	Direct	Indirect		Induced	
Impact Scale	Adjacent Communities and project workers				
Frequency	Limited to the Construction Phase				
Extent and Location	Project Site	Local	Regional	National	Trans Boundary
Impact Duration	Short Term	Medium Term	Long-term	Permanent-mitigated	Permanent-no mitigation
Impact Intensity/ Severity	Insignificant	Low	Medium	High	Very High

Potential for Irreplaceable Loss of Resources	Low		Medium		High	
	Unlikely	Low	Medium	High	Definite	
Probability of Impact	Very Low	Low	Medium-low	Medium-high	High	Very High
Impact Significance	Significance of impact consider Low					

Mitigation Measures

The following mitigation measures will be put in place to reduce impacts on community receptors:

- Barriers will be provided to prevent the ingress of persons into the construction site and also to protect the public from exposure to hazards associated with construction activities.
- Avoiding the formation of stagnant water pools in and around the site.
- Implementation of a vector control program in labor camps and surrounding areas; and
- Emphasizing safety aspects among drivers, particularly concerning the speed limit of 20 km/hr that will be enforced.
- Ensuring that the Project employs only licensed drivers.
- Avoiding peak hours for heavy vehicle movement where possible.
- Collaboration with local communities and responsible authorities to improve signage (e.g., pedestrian crossings, speed limits, etc.), visibility, and awareness of traffic and pedestrian safety.
- Screening, surveillance, and treatment of workers, through the provision of medical facilities and, where required, immunization programs.

The impact on Community Health and Safety will have low intensity within adjacent communities and project workers for a short duration which will result in an overall medium impact without mitigation. However, with the proper implementation of suggested mitigation measures, the overall impact will be very low.

7.2.3 Impacts during Operation Phase

Due to the nature of the project as a waste treatment plant with a relatively large scale of combustion, the level of impact causing pollution to the environment is quite large. The main source of contamination arises from the burning of garbage from the plant, from the waste transport to the plant, and the daily activities of employees in the factory such as the generation of daily general waste, domestic wastewater, transportation gas, local flood, etc. In addition, during the operation, there may be some problems such as fire, traffic accidents, minor impacts on biodiversity, etc.

The potential impacts associated with waste treatment during the operation phase are summarized in the following Table 7-11.

Table 7-11: Potential Impacts During Operation Phase

SL. NO	Aspects	Pollutions	Impacts
1.	Dust	<ul style="list-style-type: none"> • Dust arising from internal traffic. From the transport vehicles, garbage discharged into the plant 	<ul style="list-style-type: none"> • Air environment • Water Environment

SL. NO	Aspects	Pollutions	Impacts
2.	Emissions smells	<ul style="list-style-type: none"> Emissions from transportation mean transporting waste into the factory using gasoline. Emission from the incinerator. Smells arise from garbage storage areas, garbage trucks, garbage incineration 	<ul style="list-style-type: none"> Air environment Health workers working in the factory
3.	Common solid waste	<ul style="list-style-type: none"> Waste of employees' daily life Waste of office space. 	<ul style="list-style-type: none"> Water Environment Air environment Soil environment Workers at the factory
4.	Slag, fly ash	<ul style="list-style-type: none"> Derived from waste incinerator 	<ul style="list-style-type: none"> Water Environment Air environment Soil environment Workers at the factory Biodiversity
5.	Hazardous waste	<ul style="list-style-type: none"> Hazardous waste derived from living activities: broken bulbs, waste batteries, etc. 	<ul style="list-style-type: none"> Air environment Soil environment Workers at the factory
6.	Domestic wastewater	<ul style="list-style-type: none"> Wastewater from the activities of employees. 	<ul style="list-style-type: none"> Water Environment Soil environment
7.	Leachate	<ul style="list-style-type: none"> Leachate from the garbage dump 	<ul style="list-style-type: none"> Water Environment Soil environment Health workers in the factory and neighboring households.

7.2.3.1 Impacts on Air Quality

7.2.3.1.1 Emission Inventory

The waste-to-energy project will use 3000 t/d waste. The project consists of four sets of 750 t/d incinerators and waste heat boilers and two sets of 35 MW turbine generator sets with an annual operation time of not less than 8,000 hours.

Pollutants of concern released by the power stations are Particulate Matter (PM), Dioxides of Nitrogen (NO₂), Sulfur dioxide (SO₂), and Carbon Monoxide (CO). The waste-to-energy power station will also emit Hydrogen Fluoride (HF), Hydrochloric Acid (HCl), Dioxin & Furan, and Heavy Metals (Cadmium, Mercury, Titanium). The resulting ground level concentration (GLC) from air quality modeling will be referred to the applicable limits of ambient air quality from schedule 1 of Bangladesh air pollution control rules 2022. Substances not specified in the Government of Bangladesh regulation and WHO global air quality guidelines; environmental standard criteria fare taken from UK Environmental Agency's air emission risk assessment guidance.

The project will have different flue gas treatment systems. The flue gas treatment process is to remove pollutants such as soot, acidic gases (HCl, HF, SO₂ as well as NO₂, etc.), heavy metals (Hg, Pb, Cr,

etc.) and dioxins from the flue gas emission according to flue gas standards to meet the emission standards of the project.

To improve the removal efficiency of acid gas from the flue gas treatment system, firstly the flue gas will be cooled. The water component evaporates rapidly by spraying the atomized droplet reaction agent into the flue gas and mixing it with the flue gas, which will make the flue gas temperature drop to the appropriate reaction temperature. The reactant components as well as the hydrated lime powder will be sprayed into the flue and are neutralized with acidic gases such as hydrogen chloride, sulfur oxide, and hydrogen fluoride in the flue gas to generate salts.

Heavy metals such as dioxin and mercury in the flue gas will be adsorbed by activated carbon sprayed into the flue, and the acidic substances continue to react with hydrated lime sprayed into the flue. Salt particles generated by the acid-base neutralization reaction and activated carbon particles adsorbed with dioxin and heavy metals will be removed in the subsequent bag filter and mixed into the fly ash, which will be sent to the fly ash stabilization system by the fly ash delivery equipment for stabilization treatment. The bag filter that passes through the flue gas enters the chimney and is then excreted into the atmosphere.

Emission concentration control of acidic gas---according to the flue gas from the top of the chimney, monitor the acid gas content online and adjust the deacidification dose.

Control of removal of dioxin and heavy metals — according to the measured flue gas quantity, the feed quantity will be adjusted by the way of quantitative feed of activated carbon.

Emission control of nitrogen dioxide gas - the operating conditions of the Selective Non-catalytic Reduction (SNCR) system will be regulated based on online monitoring of nitrogen dioxide concentrations by the chimney on flue gas.

The emission inventory has been presented based on the guaranteed emission concentration from equipment. The emission inventory of the power plant is presented in **Table 7-12**. As per the IFC-WB guideline for thermal power plants running on solid fuel, the lowest guaranteed emission concentration for NO₂ is 200 mg/Nm³.

Table 7-12: Emission Inventory of Waste to Energy Power Plant

Pollutant	Unit	Average Time	Emission Concentration (Daily average) EU standard DIRECTIVE 2010/75/EU	Emission Concentration (Daily average) Solid Waste Management Rules, 2021
Particulate Matter (PM)	mg/Nm ³	24 hr	10	20
Nitrogen Dioxide (NO ₂)	mg/Nm ³	24 hr	200	250
Sulfur Dioxide (SO ₂)	mg/Nm ³	24 hr	50	80
Carbon Monoxide (CO)	mg/Nm ³	24 hr	50	80
Mercury (Hg)	mg/Nm ³	0.5-8 hr	0.05	0.05
Hydrogen Chloride (HCl)	mg/Nm ³	24 hr	10	50
Hydrogen Fluoride (HF)	mg/Nm ³	0.5 hr	1	1.0
Cd+Ti	mg/Nm ³	0.5-8 hr	0.05	0.1
Pb+Cr and other heavy metals	mg/Nm ³	0.5-8 hr	0.5	0.5
Dioxins and Furans	ng-TEQ/Nm ³	6-8 hr	0.1	0.1

Source: EU standard DIRECTIVE 2010/75/EU

Source: Solid Waste Management Rules, 2021

7.2.3.1.2 Background Concentration

The baseline concentration of the criteria pollutants is accounted for a different duration. Primary ambient air quality samples were taken from eight locations in both wet and dry seasons. The highest concentration of primary ambient air quality result shows that the criteria pollutants (NO₂) concentrations are higher than the ambient air quality standard whereas other pollutants (PM₁₀, SO₂, and CO) concentrations are well within the standard limit. Long-term air quality data is required to determine whether the airshed is degraded or non-degraded. Hence, CAMS-3 data has been used to determine the airshed of the project area. The CAMS-3 station is located approximately 6 km from the project location at Darus Salam. This location is characterized by heavy traffic; a large number of vehicles from the northern part of the country enter the city in this way. Major brick kiln clusters are also near the site. The CAMS site is situated about 100 meters away from the main road. The characteristic of the CAMS-3 location is similar to the project site. Air pollution varies from the measured CAMS-3 for several reasons such as unaccounted sources of criteria pollutants like a brick kiln, cooking, construction works, dust particles from the road, and intrusion of pollutants from outside of the domain throughout the year.

Nevertheless, the background concentration from CAMS-3 was converted into various averaging periods for compliance monitoring. The concentration of criteria pollutants has been converted to different averaging periods using the following USEPA-recommended conversion factors.

Table 7-13: Averaging Time Conversion Factors³⁰

Convert to \ Convert from	1 hour	8 hours	24 hours	Annual
1 hour	1	0.7	0.4	0.08
8 hours	1.67	1	-	-
24 hours	2.5	-	1	0.2
Annual	12.5	-	5	1

Table 7-14 shows the background concentration from CAMS-3 operated by the DoE in the CASE Project funded by the World Bank and the national ambient air quality standards, Air pollution Control Rules 2022.

Table 7-14: Background Concentration of Criteria Pollutants at CAMS-3, Case Project

Criteria Pollutants	Standard Concentration (APCR, 2022)		2014	2015	2016	2017	2018
	Averaging time	µg/m ³					
Carbon Monoxide (CO)	8-hr	5000	4600	4010	4580	6680	4400
	1-hr	20000	7682	6697	7649	11156	7348
Nitrogen Dioxide (NO ₂)	Annual	40	29.4	40.2	42.1	24.2	27.5
	24-hr	80	147.1	200.8	210.4	121.1	137.7
Particulate Matter (PM ₁₀)	Annual	50	57.2	58.2	67.0	60.6	65.4
	24-hr	150	286.0	291.0	335.0	303.0	327.0

³⁰ U.S. EPA document Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised, EPA-454/R-92-019

Sulfur Dioxide (SO ₂)	24-hr	80	77.29	42.18	78.34	81.0	54.23
	1-hr	250	193.2	105.5	195.8	202.6	135.6

7.2.3.1.3 Air Dispersion Model

The air dispersion modeling input data consisted of meteorological data, detailed information on the physical environment (including building dimensions and terrain features), and design details for all emission points on-site. Using this input data, the model predicts ambient ground level concentrations beyond the site boundary for each hour of the modeled meteorological years. The model post-processes the data to identify the location and concentration of the worst-case ground-level concentrations.

Emissions from the site have been modeled using the AERMOD dispersion model (Version 11.2.0) which has been developed by the United States Environmental Protection Agency (USEPA). The model is a steady-state Gaussian plume model used to assess pollutant concentrations associated with industrial sources. The model has been designated the regulatory model by the USEPA for modeling emissions from industrial sources in both flat and complex terrain. Resulting GLCs were determined specifically for NO₂ -24hr and Annual average, CO-1hr and 8 hr, SO₂ and PM₁₀ -24 hr and Annual average.

The resultant NO₂ concentrations are largely driven by the ambient chemical environment (i.e., the reaction of NO with ambient ozone to form NO₂) and the initial NO₂/NO_x ratio of the emissions. The model has been run for NO₂ considering Tier 2 (minimum NO₂/NO_x ratio- 50% and maximum NO₂/NO_x ratio 90%). According to the Support for Regulatory Atmospheric Modeling (SCRAM) of USEPA³¹, the NAAQS has been using a Tier-3 approach for additional stringency of the new 1-hr NO₂ of EPA-issued guidance since April 2010. They issued additional guidance on March 1, 2011, allowing for a default In-Stack Ratio (ISR) of 0.5 in absence of more appropriate source-specific information. This recommended default ISR may still be too conservative for many applications. The equilibrium NO₂/NO_x ratio is considered 0.90.

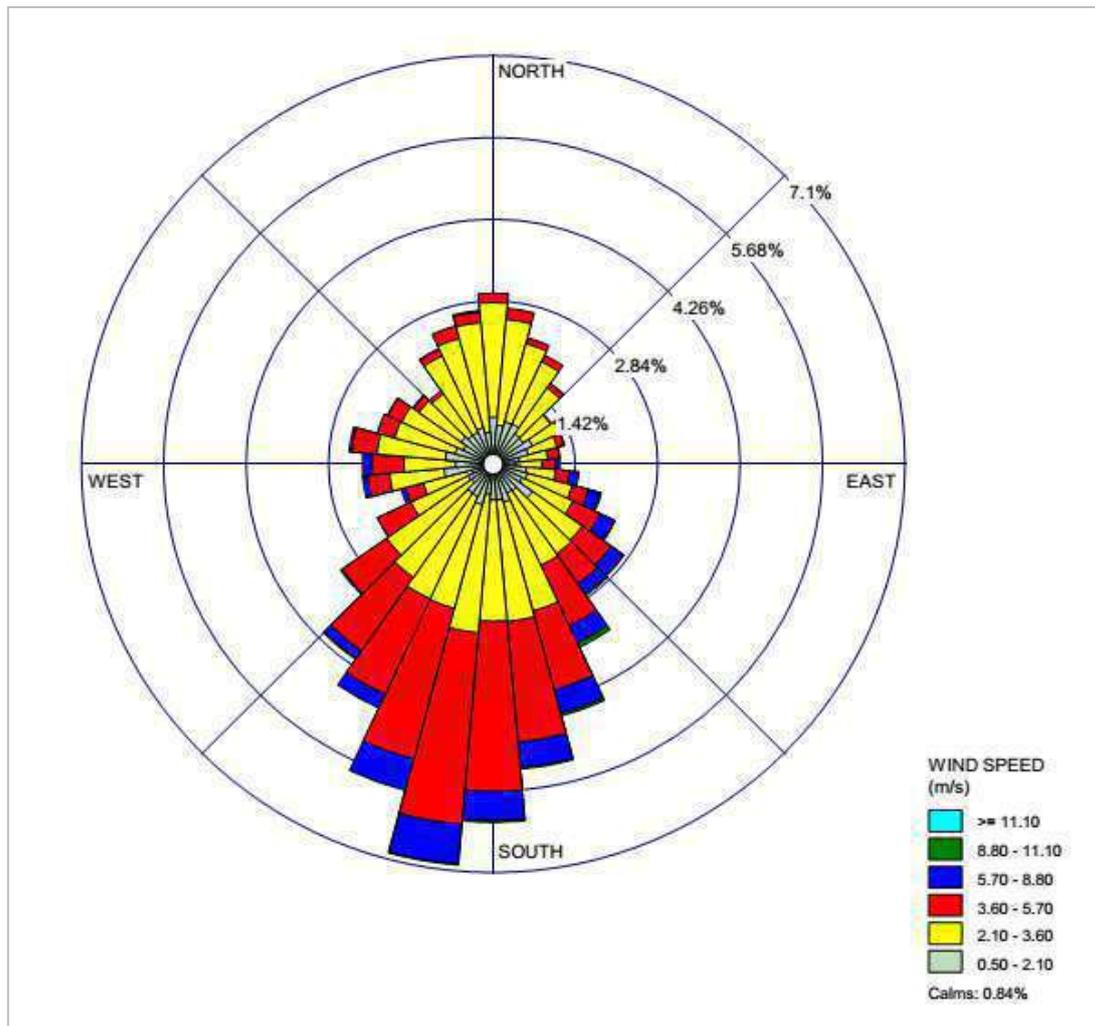
7.2.3.1.3.1 Meteorology

Air quality is dependent on the rate of pollutant emissions into the atmosphere and the ability of the atmosphere to disperse the pollutant emissions. The dispersion of air pollutants is affected by local meteorological patterns. The wind direction controls the path that air pollutants follow from the point of emission to the receptors. In addition, wind speeds affect the time taken for pollutants to travel from source to receptor and the distance over which air pollutants travel. As a result, wind speeds also impact the dispersion of air pollutants. Therefore, it is important to assess local meteorological patterns to assess potential air quality effects.

AERMET (Version #11.2.0), AERMOD's meteorological pre-processor requires hourly surface observations along with concurrent twice-daily upper air observations. As such, the dispersion modeling used three years (2019-2021) of meteorological data from lakes environment WRF data. **Figure 7-1** shows a 3-year (2019-2021) wind rose for meteorological data over the study area. The prevailing wind direction throughout the year is from South by the west to North by east followed by south to north and SSW to NNE. **Figure 7-2** shows a frequency distribution of the wind over 6 wind speed class ranges. The highest wind speed varies between 2.10-3.60 m/s at 45.8% whereas 0.84% calm wind. The average wind speed over the study area is 3.11 m/s. It has been concluded that the receptors present in the North direction are more susceptible to pollution generated by the plants.

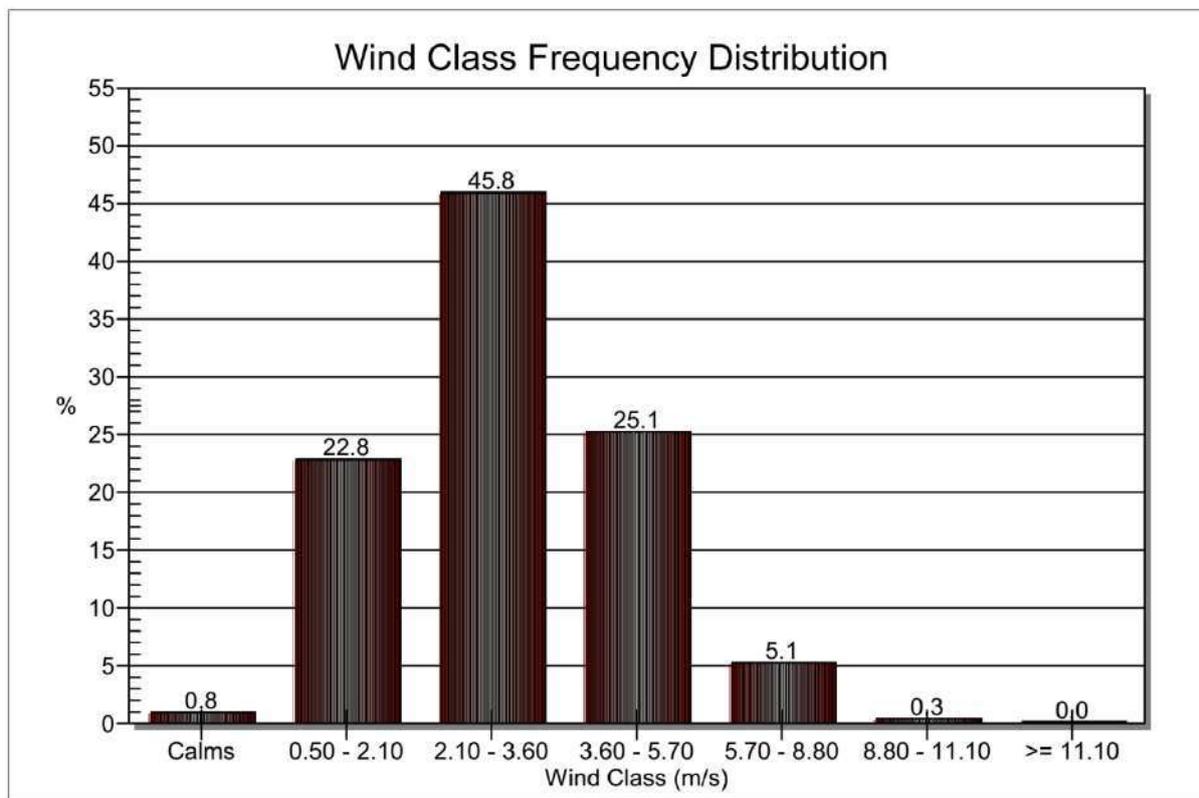
³¹ [http://USEPA/Nitrogen%20Dioxide_Nitrogen%20Oxide%20InStack%20Ratio%20\(ISR\)%20Database%20_%20Support%20Center%20for%20Regulatory%20Atmospheric%20Modeling%20\(SCRAM\)%20_%20US%20EPA.html](http://USEPA/Nitrogen%20Dioxide_Nitrogen%20Oxide%20InStack%20Ratio%20(ISR)%20Database%20_%20Support%20Center%20for%20Regulatory%20Atmospheric%20Modeling%20(SCRAM)%20_%20US%20EPA.html)

Figure 7-1: Annual Wind Rose of the Study Area



Source: Data acquired from Lakes Environmental

Figure 7-2: Wind Class Frequency Distribution of Meteorological Data (Jan. 1, 2019 – Dec. 31, 2021)

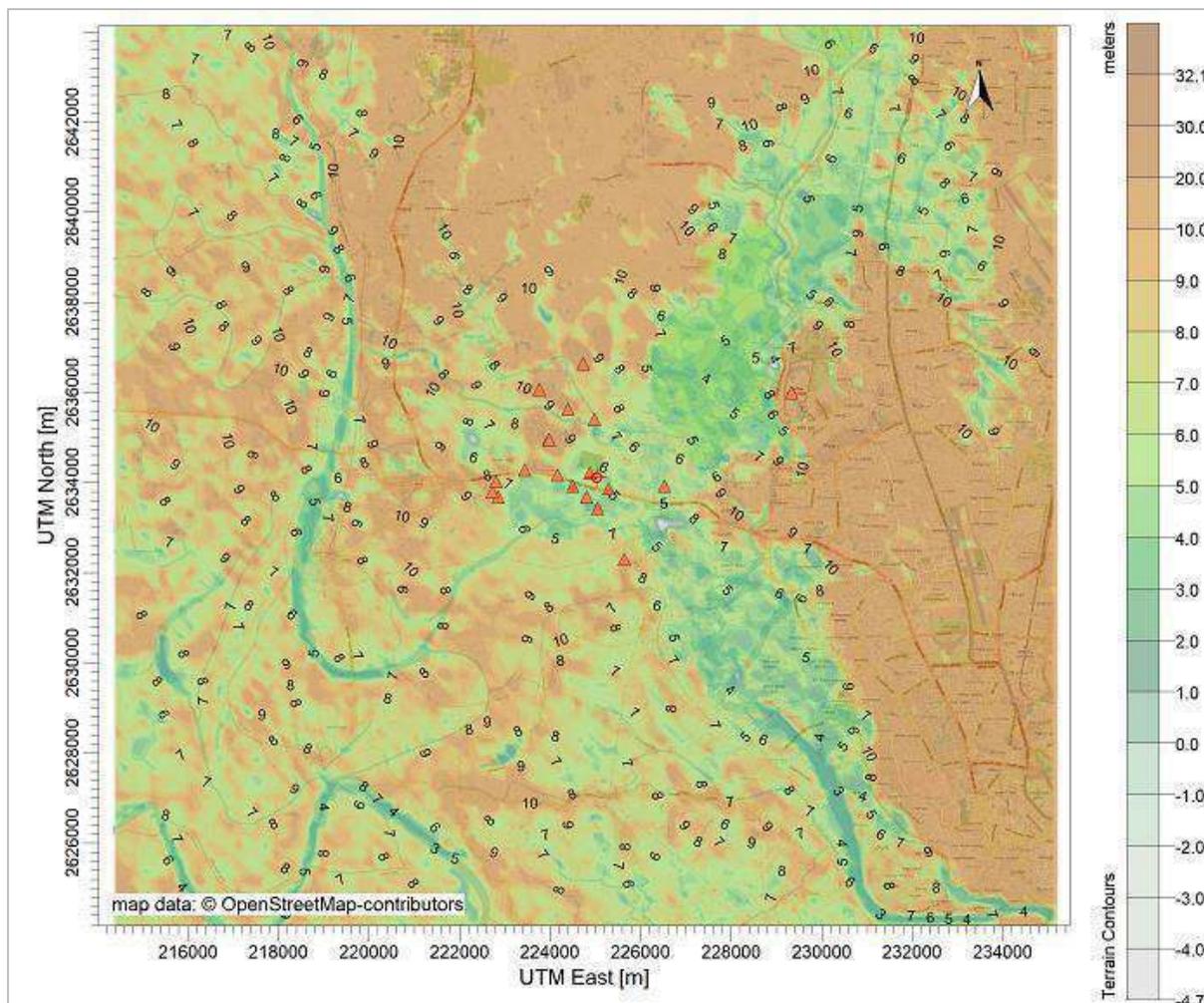


Source: Data acquired from Lakes Environmental

7.2.3.1.3.2 Terrain

A terrain height for each of the receptors on the grid was input into the model to accurately represent the changing elevations of the surrounding landscape. Terrain data for the AERMAP model were taken from the 30 m SRTM database. The elevation of the 10 km area varies between 0.20 to 27.65 m. The highest elevation of the study is found as 27.65 meters at 229505.00 m, 2636865.00 m. The land elevation of the study area is presented in **Figure 7-3**.

Figure 7-3: Land Elevation of the Study Area



Source: Shuttle Radar Topography Mission (SRTM)

7.2.3.1.3.3 Study Area

An area of 10 km x 10 km centering the proposed waste-to-energy plant has been selected for the air quality analysis. The plant boundary and air quality-modeling domain are presented in **Table 7-15**.

Table 7-15: Project Site Coordinates

Model Domain	Easting (m)	Northing (m)
Project Center	224755.00	2634161.00
Southeast Corner	234738.00	2624169.00
Northeast Corner	234755.00	2644161.00
Northwest Corner	214748.00	2644179.00
Southwest Corner	214755.00	2624161.00

UTM Zone: N 45

The model was set up to examine the impact of emissions on the area surrounding the site using a series of receptors. A receptor is a location at which the model will calculate maximum process contributions (PCs) / GLCs. A multi-tier grid receptor system was established with the site at its center. A multi-tier grid with 3 receptor grids of a varying resolutions was established.

A 1km x 1km grid with receptors at 50m spacings was created with the development site at its center. Around this, a coarser 3km x 3km grid with 100m receptor spacings was created from the center. A

third 10km x 10km grid with 300m receptor spacings was created around this. The grid network is presented in **Table 7-16**.

This network used Cartesian (X, Y) receptors with UTM coordinates. The base elevation of all the receptors was found using terrain elevations interpolated from SRTM (~30 m) Digital Elevation Model (DEM) data. In addition, 19 discrete cartesian receptors are also taken into consideration, where the sensitive receptors are located (**Table 7-17**).

Table 7-16: Multi-Tier Grid Receptors

Tier	Distance from Center (m)	Tier Spacing (m)
1	1000	50
2	3000	100
3	10000	300

7.2.3.1.3.4 Sensitive Receptors

It is important to identify the sensitive receptors in and around the project surroundings for the air quality impact assessment. A total of eight air quality samples were collected from different sensory receptors. Besides, another eleven discrete sensitive receptors have been identified based on the field visit and google imagery analysis. **Table 7-17** and **Figure 7-4** show the sensitive receptor locations surrounding the project location.

Table 7-17: Location of Sensitive Receptors

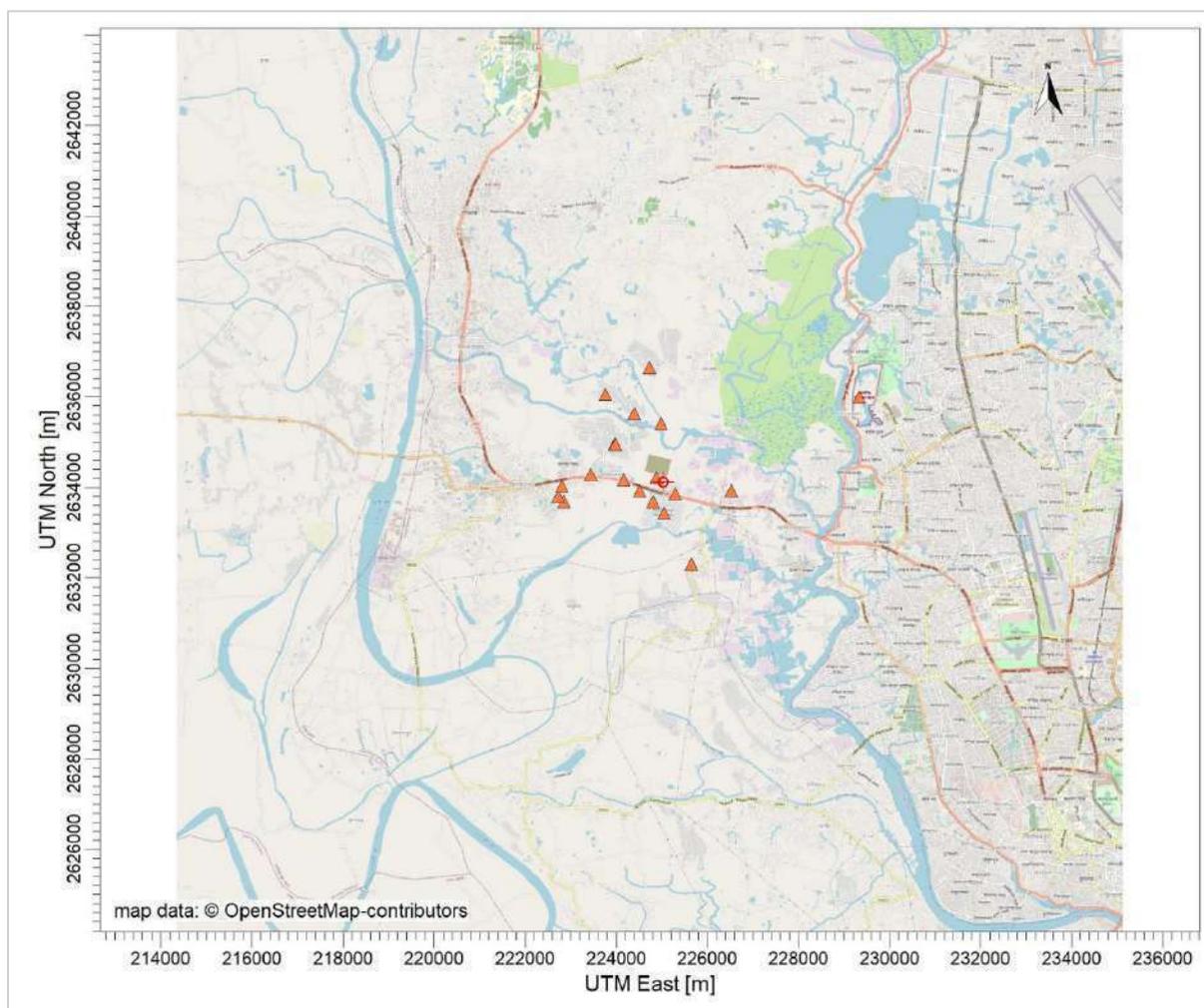
ID	Receptor's Location Name	Coordinate*		Distance and direction from the plant boundary
		X	Y	
AQ1	Project Site, Banagram, Savar, Dhaka	224871.0	2634156.0	Project site
AQ2	Modhumoti Model Housing, Banagram, Savar, Dhaka	224808.4	2633692.9	323 m south
AQ3	Raj filling station, Banagram, Savar, Dhaka	225291.0	2633872.0	312 m east
AQ4	Baliapur, Banagram, Savar, Dhaka	224167.0	2634168.0	409 m west
AQ5	Beraid lake city, Banagram, Savar, Dhaka	224988.0	2635391.0	1151 m north
AQ6	Konda High School, Nagar Konda, Savar, Dhaka	223983.4	2634952.7	892 m NW
AQ7	Beraid Gandaria, Savar, Dhaka	223761.8	2636061.6	1930 m NNE
AQ8	Chakullia Banagram, Savar, Dhaka	224732.6	2636644.4	2320 m north
SR1	Jamuna Natural Park	224505.0	2633930.0	157 m south
SR2	University of South Asia	226524.0	2633925.0	1468 m east
SR3	Konda High School and College	223973.0	2634964.0	910 m NW
SR3	Nurul Quran Madrasa	225645.0	2632305.0	1763 m SE
SR4	Jadurchar Primary School	222857.0	2633687.0	1762 m WSW

ID	Receptor's Location Name	Coordinate*		Distance and direction from the plant boundary
		X	Y	
SR6	Aim Ideal School	222723.1	2633796.0	1872 m WSW
SR7	Holy Touch Model School	222803.4	2634026.0	1755 m west
SR8	INOBHAT Hospital	223444.7	2634287.0	1145 m west
SR9	Baraid Govt. Primary School	224398.9	2635629.0	1315 m NW
SR10	Modhumati Model Town	225050.8	2633428.0	574 m south
SR11	National Zoo	229340.8	2635994.0	4452 m NE

*UTM-46

Source: Field Visit and Google Earth, 2022

Figure 7-4: Location of Sensitive Receptors



7.2.3.1.3.5 Building Structure

Airstreams blowing across buildings can become disrupted, with turbulent eddies occurring downwind in the building wake. If an emission point is sufficiently close to a building, then the plume may become entrained in the turbulent eddies of the building wake.

This entrainment can cause plume downwash resulting in elevated emission concentrations close to the emission point. The stacks modeled are subject to downwash and, as a result, direction-specific building dimensions were calculated.

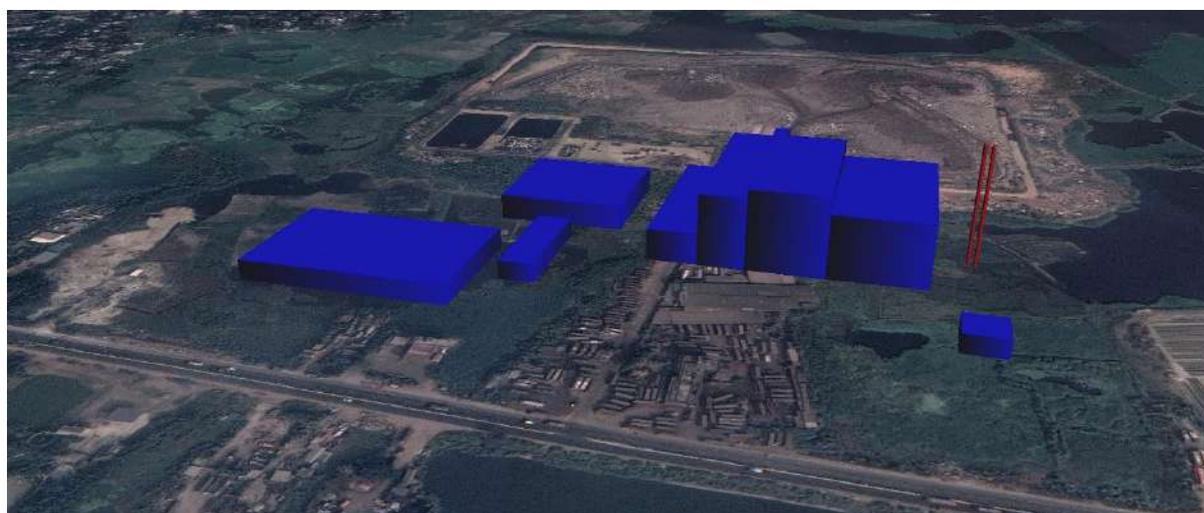
The AERMOD model interprets the influence zone of each building for a given wind direction using the Building Profile Input Program (BPIP). All the main buildings on the site were included in the modeling analysis. Building details of the power plant are presented in **Table 7-18**. The power plant 3D view is presented in **Figure 7-5**.

Table 7-18: Detail of Power Plant Building

Description	Base Elevation [m]	Height [m]
Tripping hall	4.82	20.9
Waste pit	3.84	48.2
Main building	2.15	54.3
Flue gas purification	4.77	43
Cooling tower	4.77	12.2
Booster station	6.3	12.2
Slag treatment workshop	4.26	17
Oil pump house	5.07	5
Leachate treatment station	6	13.5

Source: WTE Power Plant North Dhaka Private Limited

Figure 7-5: 3D Model of Major Project Components



7.2.3.1.3.6 Model Input Data

The input parameters considered for the air dispersion modeling have been summarized in **Table 7-19**.

Table 7-19: Input Data Considered for Air Dispersion Modeling Exercise

No.	Scenario	Value
1	Control Pathway	
	Dispersion option	Non-Default Option with flat terrain, Stack-tip downwash, Output warnings, and checks for non-sequential met-data.

No.	Scenario	Value
	Terrain	Flat
2	Meteorological Input	
	Met Input Data	Meteorological data from 1 January 2019 to 31 December 2021 (Pre-processed Meteorological Data)
	Wind Speed Categories	Default
	Latitude	23.79511°N
	Longitude	90.2988°E
	Anemometer Height	14 m since the wind data were supplied as MM5 data (Lakes Environmental)
	Base Elevation	8.96 m
3	Receptor Pathway	
	Tier	Distance (m)
	1	1000
	2	3000
	3	10000
	Sensitive Receptor	19
4	Source Pathway	Point Source
5	Output Pathway	Pollutants Ground Level Concentration
	PM ₁₀	1 Hourly, 24 Hourly, and Annual
	SO ₂	1 Hourly, 24 Hourly, and Annual
	NO ₂	1 Hourly, 24 Hourly, and Annual
	CO	1 Hourly, 8 Hourly, and Annual
	HCL	1 Hourly, 24 Hourly, and Annual
	Pb	1 Hourly, 24 Hourly, and Annual
	Hg	1 Hourly, 24 Hourly, and Annual
	HF	1 Hourly, 24 Hourly, and Annual
	DF	1 Hourly, 24 Hourly, and Annual

7.2.3.1.3.7 Emission Source

The proposed power plant can be considered located in a mixed area interspersed with residential and commercial uses. There are no major industries around the project site. There are many brickfields and the Dhaka-Aricha highway roads contributing to emissions within the same airshed (10kmX10km study area). Moreover, air pollution coming outside the project grid, transboundary air pollution and local construction works, paved and unpaved road, residential cooking, river vehicle, and city vehicular movement is contributing to the air pollution of the airshed. Primary air quality sampling and analysis from 8 locations for both dry and wet seasons. To establish a strong baseline, data from the CAMs-3 station has been used as the background concentration of this modeling study.

The project adopts the form of a multi-tube chimney. There are 4 steel inner cylinders, one for each combustion line with reinforced concrete outer cylinders. The chimney/stack height is 100 m above the finished ground level. The finished ground base elevation for the stack has been considered to be 9

meters. The locations of the stacks are presented in **Table 7-20**. There is no planned major air polluting industry in and around the same airshed. Therefore, the cumulative impact on air quality has not been carried out for this project.

Table 7-20: Stack Location

Stack	Name	X coordinate (meter)	Y coordinate (meter)	Base Elevation
1	Stack 1	225029.22	2634117.52	9.0
2	Stack 2	225033.83	2634116.23	9.0
3	Stack 3	225028.31	2634114.39	9.0
4	Stack 4	225032.87	2634113.15	9.0

Source: WTE Power Plant North Dhaka Private Limited

The air quality modeling assessment was based on the maximum plant load factor. This involves both electricity generation and equipment at maximum rates. The maximum concentrations modeled are based on the plant operating 24 hours per day, seven days per week. The facility will operate not less than 8,000 hours per annum. The point source input parameter and emission rate are presented in **Table 7-21**.

Table 7-21: Source Input Parameter and Emission Rate of the Plant

Parameter	Unit	Stack 1	Stack 2	Stack 3	Stack 4
Stack Height	m	100	100	100	100
Stack Internal Diameter	m	2.2	2.2	2.2	2.2
Stack Exit Temperature	k	413	413	413	413
Gas Exit Velocity	m/s	16	16	16	16
Gas exit flow rate	Nm ³ /s	39.4	39.4	39.4	39.4
Emission Rate					
NO ₂	g/s	6.30	6.30	6.30	6.30
PM	g/s	0.39	0.39	0.39	0.39
CO	g/s	1.97	1.97	1.97	1.97
SO ₂	g/s	1.97	1.97	1.97	1.97
Hg	g/s	0.002	0.002	0.002	0.002
HCL	g/s	0.39	0.39	0.39	0.39
HF	g/s	0.04	0.04	0.04	0.04
Cd+TI	g/s	0.002	0.002	0.002	0.002
Pb+Cr and other heavy metals	g/s	0.02	0.02	0.02	0.02
DF	g/s	0.004	0.004	0.004	0.004

Source: WTE Power Plant North Dhaka Private Limited

Note: the pollutant mass emission rates from the waste combustion process (in g/s) have been calculated by multiplying the daily average by the volumetric flow rate at reference conditions.

7.2.3.1.3.8 Modeling Result and Discussion

The following assumptions were used for the air quality modeling:

Background level concentration: Primary air quality data for both dry and wet seasons have been collected from the study area. Long-term CAMS-3 data has been analyzed for background concentration. The highest concentration data were used for NO₂, SO₂, CO, and PM₁₀. Different scenarios considered for the air dispersion modeling as follows–

- A. Only Project Contribution (Project only)** – Primary data and detailed study of monitoring data from CAMS-3 show that the airshed is degraded on PM₁₀ and NO₂ in a particular period (winter season) of a year. Air dispersion modeling was done considering the model input data, stack details, gas exit temperature, velocity, and emission rate presented in **Table 7-19** and **Table 7-21**. The PM emission from Table 6(B) of the IFC-WB EHS Guidelines for Thermal Power Plant 2008 does not give the breakdown of PM₁₀ or PM_{2.5}. Hence, the PM has been considered PM₁₀ during the modeling.
- B. Project Operation Period (Project Contribution + background concentration)** – this includes project contribution and background concentration from CAMS-3 of the CASE Project by DoE. The highest background concentration has been taken for analyzing the worst-case scenario.

The proposed power plant has different provisions for air pollution abatement measures therefore, the model has been carried out considering mitigation measures. The proposed power plant has four sets of incinerators and waste heat boilers. A major source of the plant is NO₂, SO₂, CO, and Particulate Matter. Besides the criteria pollutants, the plant will also contribute heavy metals (Pb+Cr, Hg), HCL, Hydrogen Fluoride (HF), and Dioxin Furan (DF) to the atmosphere. The maximum ground-level concentration of different pollutants due to the plant operation is presented in **Table 7-22**. Pollutants' contribution due to plant operation to the receptors located around the plant is also analyzed and presented in **Table 7-23**.