ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY

On Incineration-Enabled Waste Treatment, Storage and Disposal Facility (TSDF)

OCTOBER 28, 2026

SHEAM TSDF BD LTD
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Organization		
Institute of Appropriate Technology (IAT)	Bangladesh University of Engineering and Technology	Dhaka 1000, Bangladesh

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Table 1: Acronyms

Acronym	
STBL	Sheam TSDF BD Ltd.
AIE	Assessment of Impact on Environment
AQG	Air Quality Guideline
ASIE	Assessment of Social Impact on Environment
BECA	Bangladesh Environment Conservation Act
COD	Chemical Oxygen Demand
CPC	Commune People's Committee
CSSWM	Common System for Solid Waste Management
IEE	Initial Environment Examination
IL	Integrated Landfill
OI	Operational Instruction
LCC	Location Clearance Certificate
REA	Resource Recovery Facility
SIA	Social Impact Assessment
SWMC	Solid Waste Management Company
TSDF	Treatment, Storage, and Disposal Facility
WAC	Waste Acceptance Criteria
DoE	Department of Environment
ESIA	Environmental and Social Impact Assessment
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ECC	Environmental Clearance Certificate
ECR	Environmental Conservation Rules
ETP	Effluent Treatment Plant
APCD	Air Pollution Control Device
CEMS	Continuous Emission Monitoring System
HIRA	Hazard Identification and Risk Assessment
EPRP	Emergency Preparedness and Response Plan
O&M	Operation and Maintenance
OPEX	Operational Expenditure
CAPEX	Capital Expenditure
PLC	Programmable Logic Controller
SCADA	Supervisory Control and Data Acquisition
PPE	Personal Protective Equipment
HSE	Health, Safety, and Environment
MSW	Municipal Solid Waste
WAC	Waste Acceptance Criteria
TPD	Tons Per Day
WHB	Waste Heat Boiler
HRSG	Heat Recovery Steam Generator
ID Fan	Induced Draft Fan
FO	Furnace Oil
SDS	Safety Data Sheet
NCR	Non-Conformance Report
GPS	Global Positioning System
ISO	International Organization for Standardization
SDG	Sustainable Development Goal
UNEP	United Nations Environment Program
WHO	World Health Organization
EU	European Union
ESM	Environmentally Sound Management
BWDB	Bangladesh Water Development Board
GRM	A Grievance Redress Mechanism
IEF	Important Environmental Features
I&C	Instrumentation and Control

Table 2 Glossaries

GLOSSARY	
Ambient air	Surrounding air in the outdoor environment, excluding air inside buildings or enclosed spaces.
Aquatic	Growing, living, or occurring in or near water.
Arsenic	A naturally occurring toxic element that may contaminate groundwater, soil or industrial waste; long-term exposure can affect human health.
Baseline condition	The existing environmental, social and physical condition of an area before project implementation. It is used as a reference for impact assessment.
Beneficial Impacts	Positive effects of a project on the environment, society or economy, such as employment, pollution reduction or improved waste management.
Biological diversity	The variety of living organisms, including plants, animals, microorganisms and ecosystems in a particular area. Also called biodiversity.
Ecology	The study of relationships between living organisms and their surrounding environment.
Ecosystem	A natural system made up of living organisms and their physical environment, interacting as a functional unit.
Emission	Release of pollutants, gases, particles, smoke, vapor or other substances into the air, water or environment.
Environmental effects	Changes to the environment caused by project activities, either positive or negative.
Environmental Impacts	The direct or indirect effects of a project on air, water, soil, noise, ecology, public health, livelihood or social conditions.
Habitat	The natural place where a plant, animal or other organism lives, grows and reproduces.
Fauna	Animal life found in a particular area or ecosystem.
pH	A measure of how acidic or alkaline water, soil or liquid is. A pH of 7 is neutral; below 7 is acidic and above 7 is alkaline.
Negative Impact	An adverse effect of a project on the environment, people, health, safety, resources or social conditions.
Flora	Plant life found in a particular area or ecosystem.
EMP	Environmental Management Plan; a plan that describes mitigation measures, monitoring actions, responsibilities and procedures to manage project-related environmental and social impacts.
Bottom Ash	Heavier ash residue collected from the bottom of the incinerator after combustion.
Buffer Zone	A separation area between the project facility and nearby sensitive receptors to reduce environmental and safety risks.
Chemical Compatibility	The ability of different chemicals or waste types to be stored or handled together without causing unsafe reactions.
Combustion	A high-temperature burning process where waste reacts with oxygen and is converted into gases, heat and ash.
Disaster Management Plan	A plan for preparedness, response and recovery from emergency or disaster events such as fire, flood, explosion or chemical spill.
Effluent Treatment Plant (ETP)	A treatment system used to clean wastewater before reuse or discharge.
Emergency Response Plan	A plan that describes how to respond to accidents, fire, spills, explosions or other emergency situations.
Environmental Clearance Certificate (ECC)	Approval issued by the Department of Environment allowing a project to proceed subject to environmental conditions.
Environmental Monitoring	Regular measurement of air, water, soil, noise, emission and other parameters to verify compliance.
Fly Ash	Fine ash particles carried with flue gas and collected by air pollution control devices.
Flue Gas	Gas generated from the incineration process before or after treatment by pollution control devices.
Greenbelt	Plantation area developed around or within the project site to reduce dust, noise, visual impact and improve environmental quality.
Grievance Redress Mechanism (GRM)	A system for receiving, recording, investigating and resolving complaints from communities or stakeholders.

Groundwater	Water found below the ground surface in soil or rock formations, often used through tube wells.
Hazard	A source or situation that has the potential to cause harm to people, environment, property or operations.
HIRA	Hazard Identification and Risk Assessment; a method used to identify hazards and evaluate associated risks.
Impact Mitigation	Measures taken to avoid, reduce, control or compensate for adverse environmental and social impacts.
Incineration	Controlled high-temperature thermal treatment of waste to destroy pollutants, pathogens and combustible materials.
Leachate	Polluted liquid formed when water passes through waste, ash or contaminated materials.
Manifest System	A documentation system used to track waste from its source to transportation, treatment and final disposal.
Mitigation Hierarchy	The sequence of avoiding, minimizing, controlling, treating, monitoring and compensating impacts.
Occupational Health and Safety (OHS)	Measures to protect workers from injury, illness, exposure and workplace hazards.
Odor	Unpleasant smell generated from waste storage, handling, treatment or decomposition.
Residual Impact	Impact that remains after mitigation measures have been applied.
Secondary Combustion Chamber	Additional high-temperature chamber in an incinerator used to complete combustion of gases and pollutants.
Secured Landfill	Engineered landfill with liner, leachate collection and monitoring systems for safe disposal of hazardous residues.
Solidification/Stabilization	Treatment process used to immobilize hazardous substances in ash, sludge or waste before disposal.
Stack	Chimney or vertical structure through which treated flue gas is released into the atmosphere.
Surface Water	Water found on the surface of the earth, such as rivers, canals, ponds, lakes and drainage channels.
TCLP Test	Toxicity Characteristic Leaching Procedure; a laboratory test used to determine whether contaminants can leach from waste or ash.
Waste Acceptance Criteria (WAC)	Technical and regulatory criteria used to decide whether a waste can be accepted and how it should be treated.
Waste Characterization	Testing and assessment of waste to identify its composition, hazards, calorific value, moisture, reactivity and treatment suitability.
Wastewater	Used or contaminated water generated from industrial, domestic or operational activities.

Executive Summary

ES.1 Introduction. Sheam TSDF BD Ltd. proposes to establish an Integrated Treatment, Storage and Disposal Facility (TSDF) and Incineration Facility at Telihati, Sreepur Upazila, Gazipur District, for the scientific management of hazardous, special, confiscated, expired, contaminated and non-recyclable waste generated by airports, seaports, land ports, customs warehouses, industrial zones, healthcare-related sources, laboratories and commercial establishments in Bangladesh. Bangladesh currently has no integrated, licensed multi-sector TSDF, and much of this waste is stored for long periods, dumped, burnt in the open or mixed with municipal waste. The project is intended to provide a regulated, traceable and environmentally sound alternative. This Environmental and Social Impact Assessment (ESIA) has been prepared to support the environmental clearance process of the Department of Environment (DoE) and to guide the safe design, construction, operation and eventual closure of the facility.

ES.2 Project description. The facility will receive waste through a controlled acceptance system (entry control, weighbridge, manifest verification, inspection, sampling and laboratory testing), followed by segregation, pre-treatment, material recovery, quarantine of unknown or incompatible waste, controlled high-temperature incineration with a secondary combustion chamber, a multi-stage Air Pollution Control Device (APCD), Continuous Emission Monitoring System (CEMS), Effluent Treatment Plant (ETP), ash stabilization and secured disposal of residues. Supporting facilities include a laboratory, fire safety and emergency response systems, internal drainage, utilities and a greenbelt. The key design data presented in Chapter 2 are summarized below.

Table 3: Key project data (as presented in Chapter 2)

Parameter	Value	Remarks
Location	Telihati, Sreepur, Gazipur (approx. 24°15′56″N, 90°24′58″E)	Site boundary coordinates in Chapter 2
Land area	3 acres	Greenbelt: 33% of total land
Waste handling capacity	20 tones/day	To be reconciled with incinerator capacity
Incinerator capacity	6 tones/day (approx. 250 kg/h)	With secondary combustion chamber
Stack height	45 m above ground level	Dispersion modelling to confirm adequacy
ETP capacity	50 m^3/day	Treated water reused on site
Auxiliary fuel	Diesel approx. 250 L/day; furnace oil approx. 1,200 L/day	See fuel alternatives, Chapter 4
Manpower	Construction: 110; Operation: 130	Skilled, semi-skilled and unskilled

ES.3 Policy, legal and administrative framework. The project is governed principally by the Bangladesh Environment Conservation Act, 1995 (as amended) and the Environment Conservation Rules, 2023, under which a hazardous waste treatment and incineration facility falls within the highest environmental-risk category and requires a full ESIA, Environmental Management Plan and Environmental Clearance Certificate from the DoE. Other applicable instruments include the Solid Waste Management Rules, 2021, the Medical Waste Management and Processing Rules, 2008, the Bangladesh Labour Act, 2006 and Labour Rules, 2015, the

Fire Prevention and Fire Fighting Act, 2003, the Bangladesh National Building Code, the Road Transport Act, 2018, the Disaster Management Act, 2012 and the Bangladesh Water Act, 2013. The assessment also considers the international conventions to which Bangladesh is a party, and the IFC Performance Standards and the World Bank Group EHS Guidelines as international good practice. Applicable emission, ambient air, noise and effluent standards are summarized in Chapter 3.

ES.4 Analysis of alternatives. The no-project option was rejected because it would perpetuate unsafe storage, dumping and open burning of hazardous waste. An integrated TSDF (acceptance control, segregation, recovery, incineration, stabilization and secured disposal) was preferred to incineration-only or landfill-only approaches. Controlled high-temperature incineration with a secondary combustion chamber and a dry or semi-dry APCD with activated carbon injection and bag filter is the preferred technology configuration; cement-kiln co-processing is recognized as a complementary outlet for suitable high-calorific waste. Cleaner auxiliary fuel (diesel, LPG or natural gas) is recommended over furnace oil. The selected site is located within an industrially developed area with road access; documentation of the alternative sites considered by the proponent is to be added (Chapter 4).

ES.5 Approach and methodology. The ESIA followed the DoE EIA Guidelines for Industry (2021) and international good practice: screening and scoping, definition of the study area (project site, 1 km immediate impact zone and 5 km extended influence zone), primary and secondary baseline data collection, impact identification and prediction, significance evaluation based on magnitude and receptor sensitivity, development of mitigation measures following the mitigation hierarchy, residual impact evaluation, risk assessment, stakeholder consultation and preparation of the ESMP (Chapter 5).

ES.6 Environmental and social baseline. The site lies on the Pleistocene Madhupur Tract terrace, characterised by reddish-brown Madhupur Clay, generally flat to gently undulating land and a tropical monsoon climate with an average annual rainfall of approximately 2,000–2,100 mm, 75–85% of which falls between May and October. The surrounding area is a transitional rural, peri-urban and industrial landscape of factories, settlements, agricultural plots, homestead vegetation, ponds and drainage channels. No major river, navigation route or designated protected area has been identified within the immediate project area. Site-specific monitoring results for ambient air quality, noise, surface water, groundwater and soil, together with the socio-economic survey results and the sensitive receptor inventory, are to be incorporated in Chapter 6.

ES.7 Key impacts and mitigation measures. Pre-construction and construction impacts (dust, noise, runoff and drainage alteration, construction waste, traffic and worker safety) are temporary and of moderate significance, and can be reduced to low significance through standard good construction practice. The principal operational impacts and the residual significance after mitigation are summarised below (Chapter 7).

Table 4: Summary of principal impacts, mitigation and residual significance

Activity / aspect	Potential impact	Before mitigation	Key mitigation	Residual
Waste transportation	Spill, leakage, road accident, odour	High	Dedicated covered vehicles, manifest and tracking, spill kits, trained drivers, route planning	Moderate

Activity / aspect	Potential impact	Before mitigation	Key mitigation	Residual
Waste receiving and storage	Odour, fire, leakage, chemical reaction, worker exposure	High	Waste Acceptance Criteria, compatibility testing, segregated and bunded storage, fire detection and suppression, storage time limits	Moderate
Incineration	Stack emissions (PM, acid gases, CO, NOx, heavy metals, dioxins/furans)	High	Secondary chamber temperature and residence-time control, APCD, activated carbon, CEMS, 45 m stack, periodic stack testing	Low to moderate
Scrubber / process wastewater	Surface water and soil pollution	High	ETP, segregated drainage, no untreated discharge, reuse of treated water	Low
Ash and APC residues	Hazardous residue exposure, leaching	High	Testing (TCLP), stabilization/solidification, covered storage, secured landfill	Moderate
Leachate	Soil and groundwater contamination	High	Impervious floors, HDPE liner, leachate collection and treatment, monitoring wells	Low to moderate
Occupational exposure	Injury, chemical and biological exposure, heat	High	OHS plan, PPE matrix, SOPs, permits-to-work, medical surveillance, training	Moderate
Fire and emergencies	Fire, explosion, toxic release	High	Emergency Response Plan, fire hydrant and detection systems, drills, Fire Service coordination	Moderate
Employment and waste services	Jobs, improved national waste management	Positive	Local recruitment, skills training, transparent service provision	Positive

ES.8 Stakeholder engagement. Stakeholders were identified and mapped by influence and interest. A focus group discussion and a public consultation meeting (Telihati, 1 September 2026), announced in national and local newspapers, were held with local residents, landowners, community leaders, educational professionals and elected Union Parishad representatives. The main concerns related to air emissions and odour, waste transportation and traffic safety, public health, fire safety, protection of water bodies and local employment. A Stakeholder Engagement Plan and a Grievance Redress Mechanism will be maintained throughout the project life cycle (Chapter 8).

ES.9 Hazard and risk assessment. The site is exposed to seismic hazard and to intense monsoon rainfall and waterlogging, while cyclone and riverine flood risk is comparatively low for this inland location. Operational hazards include fire and explosion in waste and fuel storage, reactive or incompatible waste, toxic gas release, spills during transport and unloading, and incinerator, APCD or ETP failure. With the proposed engineering controls, interlocks, Emergency Response Plan, trained Emergency Response Team and coordination with the Fire Service and hospitals, the residual risks are assessed as medium or low (Chapter 9).

ES.10 Environmental and Social Management Plan. The ESMP assigns responsibility for implementation to the proponent's ESHS unit, supported by contractors and an accredited monitoring laboratory, under the oversight of the DoE. It includes management measures for each project phase; specific plans for air quality, wastewater, residues, noise, greenbelt,

rainwater harvesting, occupational and community health and safety, contingency and emergency preparedness; a monitoring plan covering stack emissions, ambient air, noise, wastewater, surface water, groundwater, soil, waste and residues, worker and community health; a closure and post-closure management plan; and training, reporting and budget provisions (Chapter 10).

ES.11 Conclusions and recommendations. The project addresses a recognised national gap in hazardous waste management and is expected to deliver significant environmental and public health benefits. Its principal risks, namely stack emissions, hazardous waste storage, residues, leachate, fire and worker exposure, can be managed to acceptable levels provided that the design commitments, the ESMP and the monitoring programme are fully implemented. Before submission for clearance, the site-specific baseline data, air dispersion modelling, reconciliation of capacities, Bangladesh-specific cost estimates and complete consultation records should be incorporated (Chapter 11).

A. Project Location Map

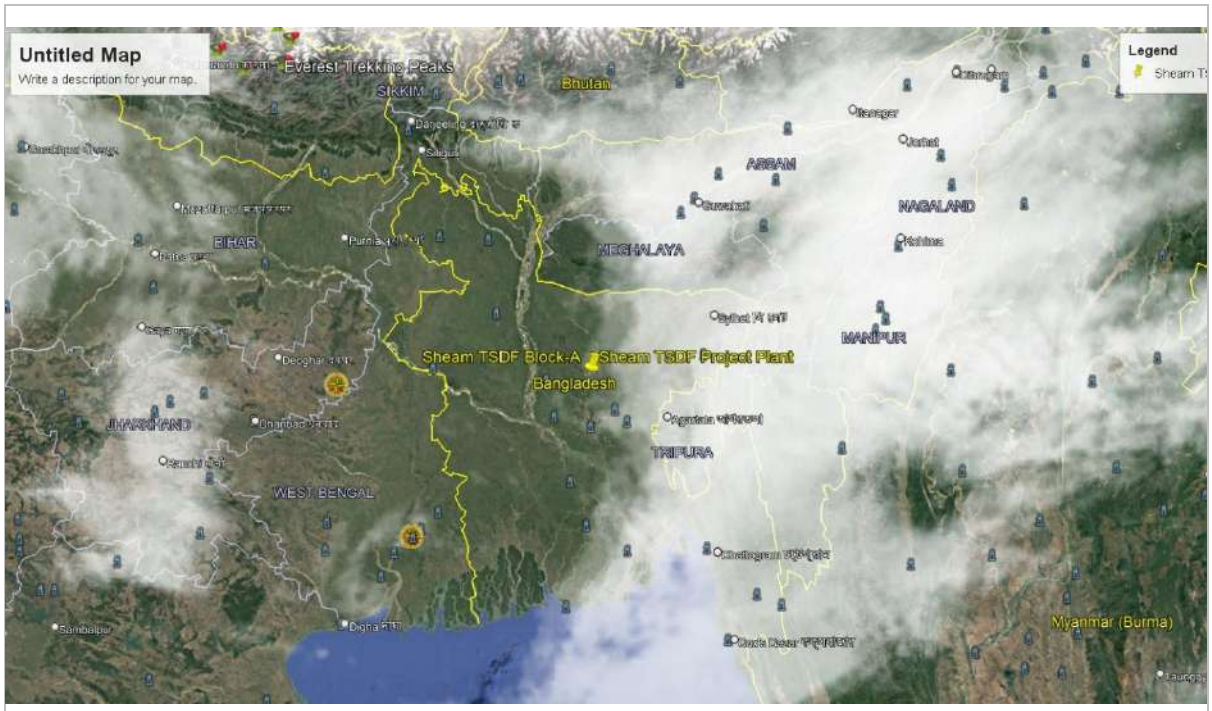


Figure 1: Bangladesh Map with TSDF Location

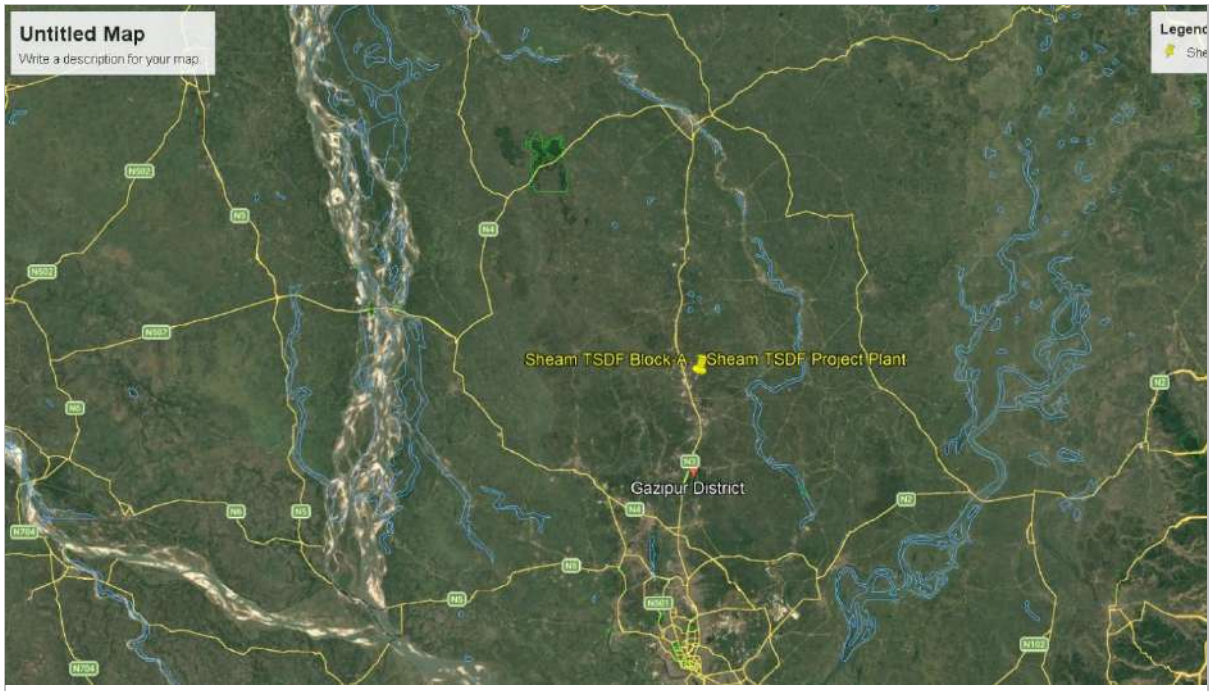


Figure 2: Gazipur District, Bangladesh



Figure 3: TSDF Project Location Map

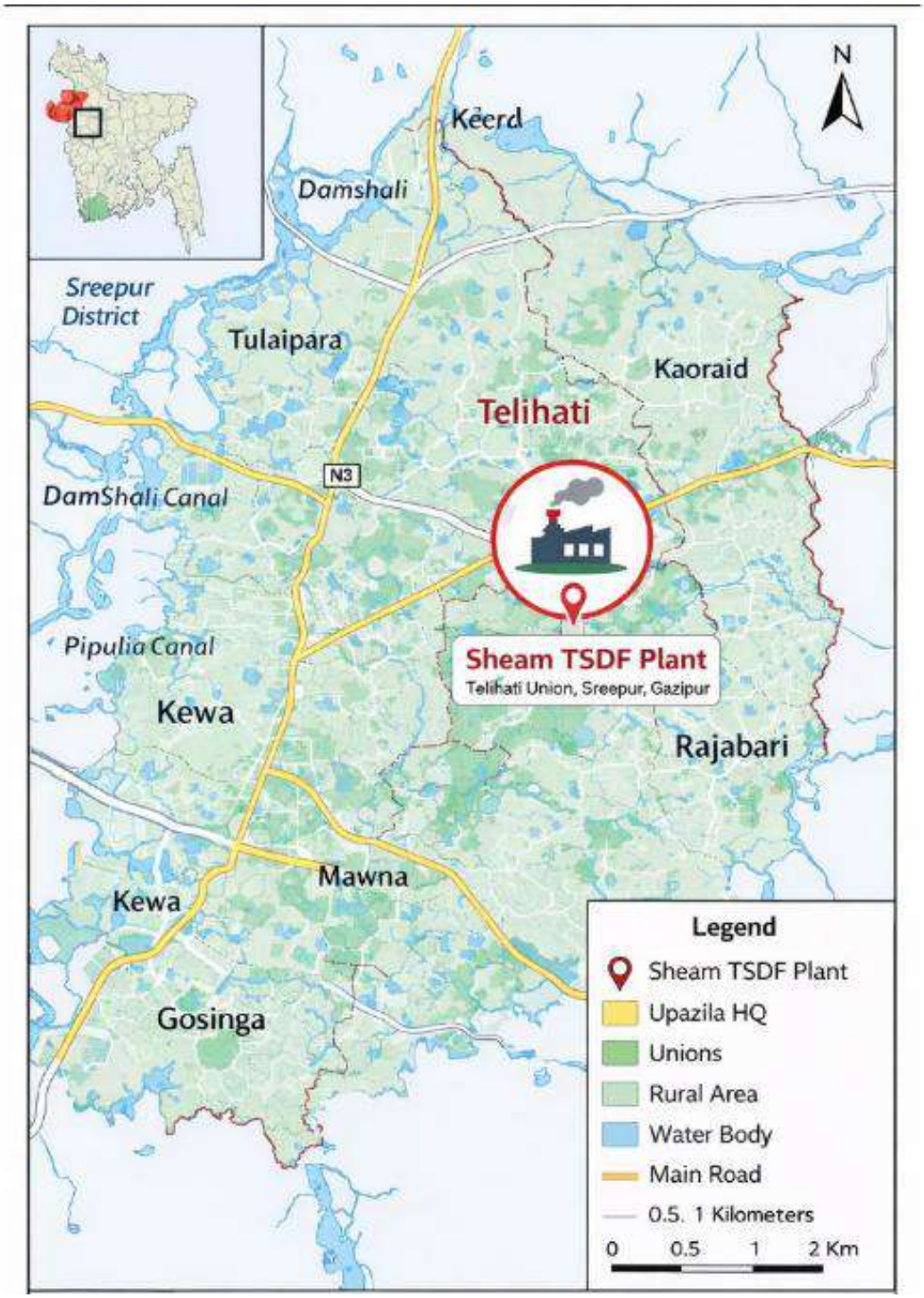


Figure 4: Telehati Upozila

B. Overall TSDF Process Flow

Waste receiving → segregation → material recovery → incineration → APCD → CEMS → ETP → residue disposal.

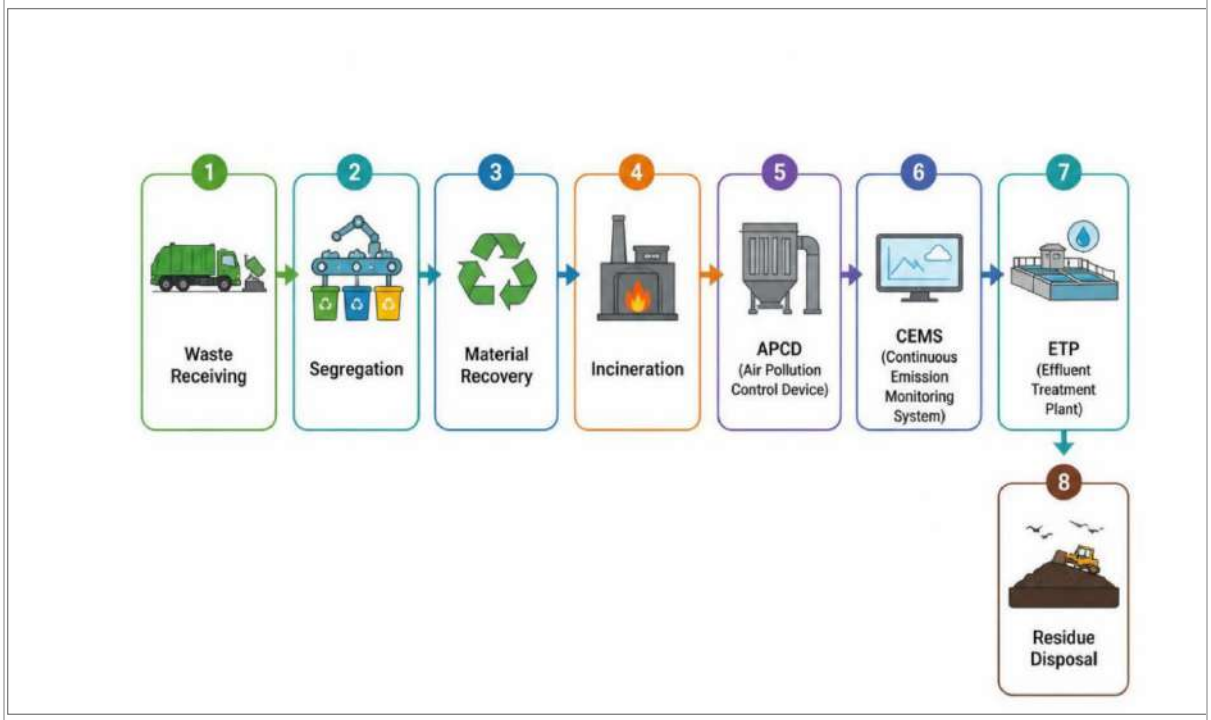
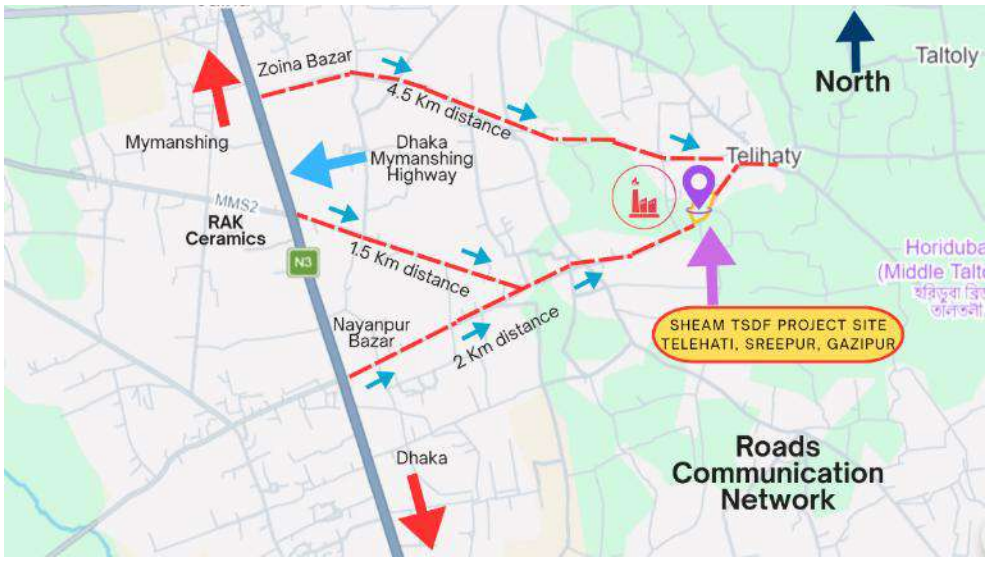


Figure 5: TSDF Process Flow

C. Project Site Photograph

Front view	 **Figure 6: Project Plant View**
Back View	 **Figure 7: Project Site Rearview**

Sky Eye View	 **Figure 8: Project Site Skyview Layout**
Access road	 **Figure 9: Project Access Road**

Existing land condition.	 **Figure 10: Project Site Existing Land Condition**
Incinerator Inside View	 **Figure 11: Incineration Shade Inside View**

TOR Compliance Matrix

Table 5: TOR Compliance

ToR requirement	Chapter / section	Compliance status	Remarks
Executive summary	Executive Summary	Addressed	Updated to the revised report structure
Introduction, purpose and scope	Chapter 1	Addressed	–
Project description	Chapter 2	Addressed	Reconciled capacities; revise cost in BDT; add schedule
Policy, legal and administrative framework	Chapter 3	Addressed	Confirmed ECR 2023 category and standards
Analysis of alternatives	Chapter 4	Addressed	Alternative site details to be provided by proponent
Approach and methodology	Chapter 5	Addressed	Added actual dates of field work
Baseline environment	Chapter 6	Addressed	Field monitoring data included
Impact assessment and mitigation	Chapter 7	Addressed	Site-specific data included
Public consultation	Chapter 8	Partly addressed	Added meeting records, issues raised, photos and attendance
Risk assessment and emergency response	Chapter 9	Addressed	Added flowcharts and emergency contacts
EMP and monitoring plan	Chapter 10	Addressed	Budget and responsibilities to be finalized during execution stage
Closure and post-closure plan	Chapter 10	Addressed	–
Conclusions and recommendations	Chapter 11	Addressed	–
Supporting documents	Appendix	Addressed	Annexures attached

CHAPTER 1

Introduction

This chapter introduces the proposed Integrated TSDF and Incineration Facility of Sheam TSDF BD Ltd. at Telihati, Sreepur, Gazipur. It sets out the background and rationale of the project, the purpose and scope of the ESIA, the project proponent, the national need for a centralized hazardous and special waste treatment facility, the ESIA team and the structure of this report.

1 INTRODUCTION

1.1 Background

Bangladesh is experiencing rapid growth in industrialization, international trade, urban development, healthcare services, logistics, aviation, seaport operations and land-port activities. With this growth, the generation of hazardous, special, contaminated, expired, seized, abandoned and non-recyclable waste is increasing significantly.

Table 6:Overview of Hazardous Waste Streams



Figure 12: Hazardous Waste



Figure 13: Waste Dumping Process



Figure 14: Plastic Wastes Sample



Figure 15: Medical Wastes Sample

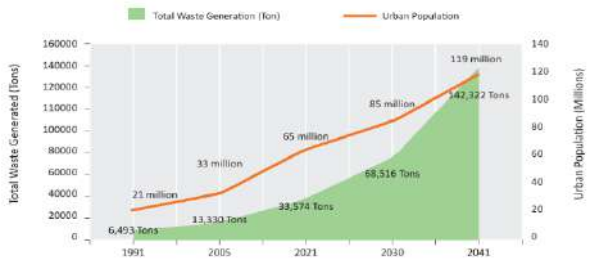


Figure 16: Waste generation vs population 2021 by waste concern

However, the country still has limited centralized infrastructure for the scientific treatment, storage, resource recovery and final disposal of such waste.

A considerable portion of hazardous and special waste is generated from airports, seaports, land ports, industrial zones, healthcare-related facilities, laboratories, chemical storage areas, commercial warehouses and manufacturing units.

Table 7: Overview of waste streams

		
Figure 17: Airport	**Figure 18: Sea Port**	**Figure 19: Land Port**
		
Figure 20: Medical Wastes	**Figure 21: Household Wastes**	**Figure 22: Industrial Wastes**

These waste streams may include expired chemicals, contaminated packaging, damaged cargo, seized goods, ETP sludge, chemical sludge, solvent waste, paint residue, contaminated plastics, rejected consumer products, pharmaceutical waste, infectious materials and other mixed waste requiring controlled treatment.

In the absence of a dedicated integrated TSDF, many of these waste streams are often stored for long periods, handled informally, dumped in uncontrolled areas, mixed with municipal waste or disposed of without proper treatment. Such practices may create risks to soil, surface water, groundwater, air quality, worker safety, public health and the surrounding environment. Therefore, a scientifically designed and regulated hazardous waste management facility is essential for Bangladesh's sustainable industrial and environmental development.

Sheam TSDF BD Ltd. proposes to establish an Integrated Treatment, Storage and Disposal Facility to provide a centralized and compliant solution for hazardous and special waste management in Bangladesh. The proposed facility will be designed to receive, identify, classify, segregate, store, treat, incinerate where appropriate, stabilize, recover recyclable materials and safely dispose of final residues through environmentally controlled systems.

As part of the regulatory approval process, Sheam TSDF BD Ltd. is undertaking an *Environmental and Social Impact Assessment study* to evaluate the potential environmental and social impacts of the proposed project. The ESIA will assess baseline environmental conditions, identify possible risks, evaluate project alternatives, analyze construction and operational impacts, and propose appropriate mitigation, monitoring and management measures.

The proposed Sheam TSDF BD project is intended to become a model facility for Bangladesh's hazardous and special waste management sector by introducing a structured, science-based and compliance-driven approach to waste treatment, storage, resource recovery and final disposal.

1.2 Purpose of the ESIA Study

The purpose of this ESIA study is to assess the potential environmental and social impacts associated with the proposed Integrated TSDF of Sheam TSDF BD Ltd. The study objective is to provide a systematic evaluation of the project's potential effects during **site preparation**, **construction**, **commissioning**, **operation**, **emergency situations**, **closure** and **post-closure** stages.

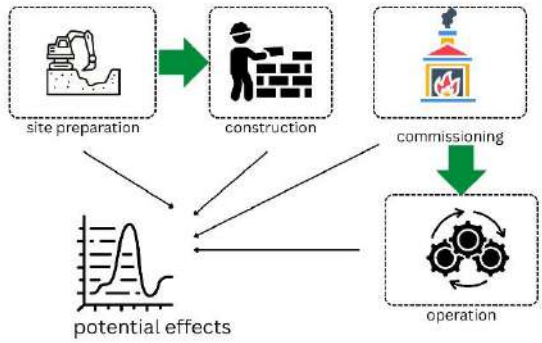


Figure 23: Purpose of ESIA Study

The ESIA study supports the regulatory review and approval process by identifying the existing environmental and social conditions of the TSDF project area, assessing potential risks and impacts, and recommending appropriate mitigation, management and monitoring measures. The study will also ensure that the proposed project will design and implemented in a manner consistent with the requirements of the DoE, Bangladesh, applicable national laws, relevant environmental standards and internationally accepted good practices for hazardous waste management.

The specific purposes of the ESIA study are to:

Table 8: List of ESIA study purposes

SL	Purposes
1	Establish the baseline environmental and social conditions of the project site and surrounding impact areas.
2	Identify and evaluate potential environmental, social, health and safety impacts arising from the proposed TSDF project.

3	Assess risks associated with hazardous waste collection, transportation, storage, treatment, incineration, residue handling and final disposal.
4	Review project alternatives, including the no-project scenario, site alternatives, technology alternatives and treatment/disposal options.
5	Recommend suitable pollution prevention and control measures for air emissions, wastewater, leachate, ash, odor, noise, soil and groundwater protection.
6	Develop an Environmental Management Plan (EMP) for construction, operation, emergency response, closure and post-closure phases.
7	Prepare an environmental monitoring framework covering air quality, stack emissions, surface water, groundwater, soil, noise, wastewater, ash quality and occupational health parameters.
8	Assess potential social impacts, including traffic, community health and safety, employment, stakeholder concerns and local environmental perception.
9	Develop a stakeholder engagement and grievance redress mechanism for effective communication with affected communities and relevant authorities.
10	Support informed decision-making by the project proponent, regulatory authorities, stakeholders and concerned institutions.[i]

1.3 Project Proponent

The proposed TSDF project is being developed by Sheam TSDF BD Ltd. to establish a controlled and environmentally compliant facility for treatment, storage, recovery and disposal of selected waste streams in Bangladesh. Md. Uzzal Ahamed, an entrepreneur and the founder of Sheam TSDF BD Ltd. With extensive experience in fields such as -waste management process, air cargo supply chain, disposal cargo management, recycle & cleaning management, Mr. Ahamed's strategic vision is to introduce a sustainable waste recycle management and incineration plant that shall produce waste-to-energy solution and that transforms Bangladesh's waste management landscape while promoting a cleaner, greener, and er future.

Sheam TSDF, under the leadership of Md. Ahamed, has diversified its business footprint beyond aviation services into high-impact environmental and infrastructure projects aimed at national development. The company shall share a unified commitment to innovation, sustainability, and social responsibility in every project undertake.

Mr. Ahamed follows a sustainability-driven investment philosophy one that prioritizes long-term environmental, social, and economic value creation over short-term profit.

1.4 Project Summary

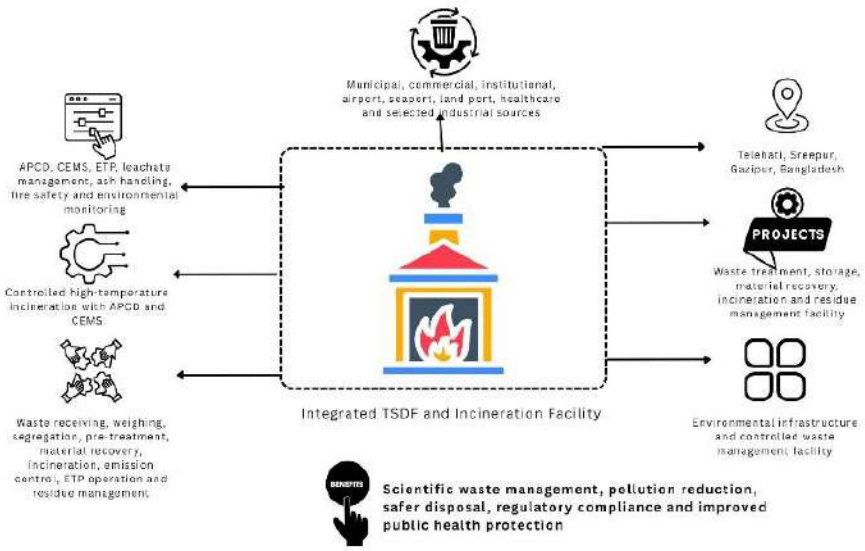


Figure 24: TSDF Project Summary Infographic

Table 9: Project Summary

Item	Description
Project Name	Integrated TSDF and Incineration Facility
Company	Sheam TSDF BD Ltd.
Project Location	Telihati, Sreepur, Gazipur, Bangladesh
Project Type	Waste treatment, storage, material recovery, incineration and residue management facility
Project Nature	Environmental infrastructure and controlled waste management facility
Project Phase	Phase-1, Phase-2, Phase-3
Main Waste Sources	Commercial, institutional, airport, seaport, land port, Municipal, healthcare and selected industrial sources
Major Activities	Waste receiving, weighing, segregation, pre-treatment, material recovery, incineration, emission control, ETP operation and residue management
Key Technology	Controlled high-temperature incineration with APCD and CEMS
Environmental Control Systems	APCD, CEMS, ETP, leachate management, ash handling, fire safety and environmental monitoring
Expected Benefits	Scientific waste management, pollution reduction, safer disposal, regulatory compliance and improved public health protection

1.5 Importance of the Project

1.5.1 Problem Statement

Rapid urbanization and industrial expansion in Bangladesh have placed severe pressure on existing solid waste management systems, particularly in major cities and critical infrastructures such as various industries zones, government institutions, airports, seaports and hospitals. Conventional practices—dominated by open dumping and uncontrolled landfilling—are no longer sustainable and pose significant risks to public health, environmental quality, and urban livability.

Table 10: Key Challenges

1	Absence of Dedicated Hazardous Waste Treatment System
2	Accumulation of Confiscated and Expired Goods
3	Inadequate Segregation and Classification
4	Environmental and Health Risks
5	Regulatory and Logistical Bottlenecks
6	Limited Access to Authorized Disposal Facilities

Based on the current assessment, the following major issues have been identified:

1.5.1.1 Operational Issues

Table 11: Operational Issues

1	No standardized hazardous waste handling and disposal protocol
2	Lack of trained personnel in hazardous waste management
3	Absence of digital tracking system for waste inventory

1.5.1.2 Technical Issues

Table 12:Technical Issues

1	No on-site treatment or pre-treatment facility
2	Inadequate storage conditions for hazardous materials
3	Absence of emission-controlled disposal systems

1.5.1.3 Environmental Issues

Table 13: Environmental Issues

1	Risk of air pollution due to volatile substances
2	Water contamination from chemical leakage
3	Soil contamination due to improper storage

1.5.1.4 Regulatory Issues

Table 14: Regulatory Issues

1	Fragmented coordination between agencies
2	Fragmented coordination between agencies
3	Delays in obtaining disposal approvals

1.5.1.5 Economic Issues

Table 15: Economic Issues

1	Increased cost due to prolonged storage
2	Loss of value in recoverable materials
3	Inefficiency in disposal logistics

1.5.1.6 National hazardous waste scenario

Bangladesh is experiencing rapid industrialization, urban expansion, and growth in logistics and aviation sectors, which has significantly increased the generation of hazardous waste across the country. Key industrial sectors such as textile and dyeing, pharmaceuticals, chemical manufacturing, leather processing, and light engineering are major contributors to hazardous waste streams.

In addition to industrial sources, airport cargo operations, customs confiscations, healthcare facilities, and commercial establishments also generate diverse hazardous and semi-hazardous waste, including expired pharmaceuticals, chemical residues, contaminated packaging, and electronic waste.

Current estimates indicate that hazardous waste generation in Bangladesh is increasing steadily, driven by:

- Expansion of industrial zones in Dhaka–Gazipur–Narayanganj belt
- Growth of pharmaceutical and chemical industries
- Increasing import-export activities through airports, landports and seaports
- Rising healthcare and institutional waste generation

A significant portion of this waste contains toxic, flammable, corrosive, or reactive components that require controlled handling, treatment, and disposal. However, due to the absence of adequate treatment infrastructure, much of this waste is either stored for prolonged periods or disposed of through environmentally unsafe methods.

This growing hazardous waste burden presents a serious challenge to environmental sustainability, public health, and regulatory compliance in Bangladesh

1.5.1.7 Existing disposal gaps

Despite the increasing volume of hazardous waste, Bangladesh currently lacks sufficient centralized, licensed, and technologically advanced TSDF. Existing waste

management practices remain fragmented, informal, and often non-compliant with environmental regulations.

The major gaps in the present waste management system include:

Table 16: Major gaps present waste management

Absence of Centralized TSDF Infrastructure	There is no comprehensive, multi-sector TSDF facility capable of handling diverse hazardous waste streams such as industrial sludge, pharmaceutical waste, airport confiscated goods, and chemical residues.
Inadequate Treatment Capacity	Most industries rely on in-house or third-party solutions that are limited to basic treatment (ETP), which are not designed for hazardous waste destruction or safe disposal.
Improper Disposal Practices	**Common practices include:** • Open dumping • Uncontrolled burning • Disposal into landfills without treatment • Mixing hazardous waste with municipal waste
Lack of Segregation and Tracking	**There is insufficient implementation of:** • Waste classification systems • Digital tracking mechanisms • Manifest-based transportation
Limited Regulatory Enforcement Support	Although regulations such as the Environmental Conservation Rules (ECR 2023) exist, enforcement is constrained by the lack of authorized facilities where industries can safely dispose of hazardous waste. These gaps highlight the urgent need for a modern TSDF facility to ensure safe, compliant, and environmentally sound waste management.

1.5.1.8 Demand & Supply Gap Analysis

The demand for hazardous waste treatment services in Bangladesh significantly exceeds the available supply of compliant treatment and disposal infrastructure.

Demand Side	
Industrial Sector	Textile dyeing sludge, chemical residues, solvents, heavy metal-containing waste
Pharmaceutical Industry	Expired drugs, rejected batches, chemical by-products
Airport and Logistics Sector	Confiscated goods, expired imports, chemical cargo residues

Healthcare Sector	Biomedical waste, contaminated materials, The Dhaka–Gazipur–Narayanganj industrial corridor alone generates a substantial volume of hazardous waste daily, making it one of the most critical regions requiring TSDF services.
Supply Side	
Currently	• No fully integrated TSDF facility exists for multi-sector hazardous waste • Limited treatment options are available • Industries often lack access to licensed disposal channels
Gap Analysis	
The mismatch between waste generation and treatment capacity results in:	
	• Accumulation of untreated hazardous waste • Increased environmental and health risks • Regulatory non-compliance by industries • Economic inefficiencies due to improper waste handling.

1.5.1.9 Need for TSDF in Bangladesh

Considering the increasing hazardous waste generation, existing infrastructure gaps, regulatory requirements, and environmental risks, the establishment of a modern TSDF facility in Bangladesh is both critical and inevitable.

The proposed TSDF will:
• Provide a centralized, compliant solution for hazardous waste management • Support industries in meeting regulatory requirements • Reduce environmental pollution and public health risks • Enable safe destruction of hazardous and toxic materials • Promote circular economy practices through waste recovery • Furthermore, the project presents a strong commercial opportunity due to: • High and growing demand for waste treatment services • Limited competition in the sector • Regulatory-driven market expansion
The proposed TSDF facility is strategically justified, environmentally necessary, and economically viable, making it a vital infrastructure investment for sustainable development in Bangladesh.

1.5.1.10 National Benefits

The rapid growth of urbanization, industrialization, and population has resulted in an alarming increase in solid and hazardous waste generation. Conventional waste disposal methods such as open dumping and uncontrolled landfilling are no longer sustainable due to limited land availability, uncontrolled emissions, and the threat of environmental pollution. In many regions, waste accumulation has reached critical levels, creating severe challenges in terms of public health, sanitation, and environmental safety.

The establishment of a waste recycling management & incineration plant is, therefore, justified by the following key factors:

Environmental Necessity	The regular practice of waste management systems fails to control harmful emissions and leachate contamination. Incineration provides a scientifically controlled and environmentally compliant solution by reducing waste volume and neutralizing harmful substances.
Land Scarcity and Landfill Overload	With limited land for new landfill sites and rising waste generation, incineration offers an efficient alternative that reduces landfill dependency.
Public Health and Safety	Open burning and unmanaged waste disposal release dioxins, furans, and pathogens into the environment, directly affecting human health. Incineration ensures sterilization and destruction of harmful biological and chemical waste.
Sustainability and Resource Recovery	Advanced waste management and incineration technology allows the recovery of energy and recyclable by-products such as bottom ash, enabling circular economic practices.
Alignment with National and Global Policies	This project aligns with the National Waste Management Policy, Renewable Energy Policy, and SDG Goals 11, 12, and 13, supporting cleaner cities, responsible production, and climate action.
Regulatory Compliance & Development Commitment	The Department of Environment (DoE) and municipal authorities encourage modern waste treatment facilities that adhere to WHO, EU Directive 2000/76/EC, and ISO 14001 environmental management standards.
Economic Viability	The sheam enterprise waste management & incineration plant project demonstrates strong financial sustainability through multiple revenue sources, including waste processing fees, sale of recovered energy, and carbon credit incentives.
Technology Transfer & Local Empowerment	Enhancing national capacity by introducing proven global waste-to-energy technologies and empowering local engineers, technicians, and operators through training and knowledge sharing.
Circular Economy Integration	Turning waste into valuable resources by generating renewable electricity, recovering recyclable materials, and striving toward zero-waste-to-landfill operations.

1.6 Scope of the ESIA Study

The scope of this Environmental and Social Impact Assessment (ESIA) study covers the assessment of potential environmental, social, health, safety and regulatory impacts associated with the proposed Integrated Treatment, Storage and Disposal Facility (TSDF) and Incineration Facility of Sheam TSDF BD at Telihati, Sreepur, Gazipur, Bangladesh. The study will evaluate the project from site preparation and construction through operation, emergency response, closure and post-closure stages.

The ESIA will be conducted to identify the existing baseline conditions of the project area, predict possible impacts arising from the proposed facility, assess environmental and social risks, recommend mitigation measures, and prepare a practical Environmental and Social Management Plan for safe and compliant project implementation.

The scope of the ESIA study includes the following key areas:

Project Description and Technical Review	The study will review and describe the proposed project components, process flow, waste management system and supporting infrastructure. **This will include:** • Waste receiving and documentation system • Weighbridge and vehicle control • Waste inspection, classification and acceptance procedure • Segregation and pre-treatment system • Material recovery and recyclable storage • Quarantine area for unidentified or special waste • Controlled incineration unit • Secondary combustion chamber • Air Pollution Control Devices • Continuous Emission Monitoring System • Effluent Treatment Plant • Ash and residue handling system • Secured storage and final disposal arrangements • Fire safety and emergency response facilities • Internal roads, drainage, utilities and greenbelt development
Review of Legal and Regulatory Requirements	The ESIA will review applicable environmental, social, health, safety and waste management requirements under the regulatory framework of Bangladesh. The study will consider the requirements of the Department of Environment (DoE), relevant provisions of the Bangladesh Environment Conservation Act, Environment Conservation Rules 2023, hazardous waste management requirements, occupational health and safety requirements, fire safety requirements, and other applicable national standards. Where appropriate, the study may also refer to relevant international good practices for hazardous waste treatment, incineration, emission control, residue management and environmental monitoring.
Baseline Environmental and Social Assessment	The ESIA will establish the baseline environmental and social conditions of the project site and surrounding study area. Baseline assessment will include:
	Component Scope of Assessment

	Air Quality	Ambient air monitoring for particulate matter, gaseous pollutants and relevant hazardous parameters
	Noise	Daytime and nighttime noise level monitoring
	Surface Water	Assessment of nearby water bodies, drainage channels and water quality
	Groundwater	Groundwater quality assessment from representative sources
	Soil	Soil quality, texture and contamination indicators
	Land Use	Existing land use pattern within the project influence area
	Ecology	Flora, fauna, vegetation and sensitive ecological features
	Traffic	Existing road condition, traffic movement and transport routes
	Socio-economic Condition	Settlement pattern, livelihood, community facilities and stakeholder concerns
	Health and Safety Context	Existing public health, occupational exposure and emergency response conditions
Waste Inventory and Waste Characterization	The ESIA will assess the expected types, sources and characteristics of waste to be received by the proposed facility. The study will identify waste streams from: • Municipal and commercial sources • Institutional establishments • Airports • Seaports • Land ports • Customs and confiscated goods storage areas • Healthcare-related sources • Selected industrial sources • Warehouses and logistics facilities The study will also define the need for waste acceptance criteria, waste segregation, compatibility assessment, sampling, laboratory testing and rejection protocols for unsuitable waste.	
Impact Identification and Assessment	The ESIA will identify and evaluate potential impacts during construction and operation phases. **Construction phase impacts may include:** • Site clearing and earthwork impacts • Dust generation • Noise and vibration • Construction waste generation • Traffic movement • Worker health and safety risks • Temporary disturbance to nearby communities **Operational phase impacts may include:** • Air emissions from incineration • Odor from waste storage and handling	

	• Wastewater generation from scrubber, washing and leachate • Ash and residue management risks • Soil and groundwater contamination risk • Noise from equipment and vehicles • Traffic and transport safety issues • Fire and explosion hazards • Chemical incompatibility risk • Occupational health and safety risks • Community health and safety concerns
Air Emission and Pollution Control Assessment	As the project includes controlled thermal incineration, the ESIA will specifically assess potential air emission issues and pollution control requirements. The study will review: • Combustion temperature and residence time requirements • Secondary combustion system • Particulate and gaseous emission control • APCD design requirements • Stack height and dispersion considerations • Continuous Emission Monitoring System • Periodic stack emission testing • Emergency shutdown and upset condition management
Wastewater, Leachate and Drainage Management	The scope will include assessment of wastewater and contaminated runoff generated from the facility. **This will cover:** • Scrubber wastewater • Floor wash water • Vehicle washing wastewater • Leachate from waste storage or residue areas • Stormwater drainage • ETP requirements • Treated water reuse or discharge options • Prevention of soil and groundwater contamination
Risk Assessment and Emergency Preparedness	The ESIA will include a risk assessment for potential hazardous events. **This will cover:** • Fire risk • Explosion risk • Chemical reaction and incompatibility risk • Waste spill during transport or unloading

	• Incinerator malfunction • APCD failure • ETP failure • Hazardous exposure to workers • Emergency waste storage incident • Natural hazard risks such as flooding or heavy rainfall. A Disaster Management Plan and Emergency Response Plan will be prepared, including emergency communication, firefighting arrangements, spill control, evacuation, medical response, coordination with local authorities and mock drill requirements.
Occupational Health and Safety Assessment	The study will assess occupational health and safety issues related to waste handling, incineration, chemical exposure, equipment operation, fire risk, confined spaces, vehicle movement, ash handling and laboratory activities. **The ESIA will recommend:** • PPE requirements • Worker training • SOPs • Medical checkup program • Exposure monitoring • Emergency response training • Incident reporting and investigation system
Social Impact and Stakeholder Engagement	The ESIA will assess potential social impacts and stakeholder concerns related to the project. **This will include:** • Community perception of waste treatment and incineration • Traffic safety • Employment opportunities • Public health and safety concerns • Land-use compatibility • Grievance redress mechanism • Consultation with local communities, authorities and waste generators. Stakeholder engagement will involve relevant government agencies, local administration, nearby communities, industrial representatives, airport/port/customs stakeholders, healthcare-related sources and other concerned parties.
Analysis of Alternatives	The study will assess reasonable alternatives to the proposed project, including: • No-project alternative • Alternative site options

<table>
<tr><td></td><td>

Alternative waste treatment technologies
Incineration-only versus integrated TSDF approach
Alternative waste transportation routes
Alternative layout and pollution control options

The objective will be to justify the selected project option based on environmental, technical, social, regulatory and economic considerations.
</td></tr>
<tr><td>Environmental and Social Management Plan</td><td>The ESIA will prepare a comprehensive Environmental and Social Management Plan covering mitigation, monitoring and institutional responsibilities. The plan will include:

Air emission management
Wastewater and leachate management
Ash and residue management
Hazardous waste storage management
Odor control
Noise control
Traffic management
Occupational health and safety
Emergency preparedness
Community health and safety
Environmental monitoring
Reporting and documentation
Training and capacity building

</td></tr>
<tr><td>Environmental Monitoring Plan</td><td>The ESIA will propose a monitoring framework for construction and operation phases. Monitoring may include:</td></tr>
<tr><td></td><td>
<table>
<tr><th>Parameter</th><th>Monitoring Area</th></tr>
<tr><td>Ambient air quality</td><td>Project site and surrounding receptors</td></tr>
<tr><td>Stack emission</td><td>Incinerator stack</td></tr>
<tr><td>CEMS data</td><td>Real-time emission monitoring</td></tr>
<tr><td>ETP outlet</td><td>Treated wastewater quality</td></tr>
<tr><td>Surface water</td><td>Nearby water bodies and drainage channels</td></tr>
<tr><td>Groundwater</td><td>Monitoring wells or representative sources</td></tr>
<tr><td>Soil quality</td><td>Site and surrounding area</td></tr>
<tr><td>Noise level</td><td>Boundary and sensitive receptors</td></tr>
<tr><td>Ash quality</td><td>Bottom ash and fly ash testing</td></tr>
<tr><td>Occupational health</td><td>Worker exposure and medical surveillance</td></tr>
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1.7 ESIA Team

The ESIA examination team has been constituted to independently review, validate, and assess all aspects of the ESIA prepared for the proposed Incineration Enabled Waste TSDF project.

The Team is multidisciplinary, draws from relevant sectoral expertise, and operates in full accordance with the ECR 2023, ECA 1995 (amended), and applicable international best practices (for hazardous waste management).

The Team shall uphold technical independence, professional integrity, and impartiality throughout the review process.

Position	Name
Team Leader	Prof. Dr. Mohidus Samad Khan
Associate	Research Prof. Dr. Iftekhar Uddin Bhuiyan
Associate	Prof. Dr. Easir Arafat Khan
Associate	Research Asst. Prof. Farid Ahamed
Assistant	Md. Saifur Rahman, B.Sc and M.Sc in Soil, Water and Environment (DU)
Assistant	Md Fahim Faisal Rafi, B.Sc. in Chemical Engineering (BUET)
Assistant	Md. Shamim Shekh, M.Sc. In Environmental Science (Jahangirnagar Uni)
Assistant	Dr. Md. Atiqul Haque, MBBS, (RMCH), MPH, Epidemiology BMU, Medical Officer
Assistant	Sadia Afroz Esha, BSc and MSc in Soil, Water, and Environment (DU)
Assistant	Sanjeev K. Roy, IT and Communications

1.8 Structure of the Report

This ESIA report has been organised in accordance with the DoE EIA Guidelines for Industry (2021) and internationally accepted ESIA practice. In addition to the Executive Summary and the ToR Compliance Matrix, the report comprises eleven chapters and an appendix, as outlined below.

Table 17: Structure of the ESIA report

Chapter	Title	Content
–	Executive Summary	Concise summary of the project, key findings, impacts, mitigation and conclusions
1	Introduction	Background, purpose and scope of the ESIA, proponent, need for the project, ESIA team
2	Project Description	Nature, size and location; components; technology and process; utilities; schedule and cost
3	Policy, Legal and Administrative Framework	National laws, policies and standards; DoE clearance procedure; international requirements
4	Analysis of Alternatives	No-project, site, approach, technology, pollution control, fuel, wastewater, residue and layout alternatives
5	Approach and Methodology (Work Plan)	ESIA approach, screening, scoping, study area, baseline methods, significance criteria, work plan and limitations
6	Environmental and Social Baseline	Physical, biological and socio-economic conditions of the study area
7	Impact Assessment and Mitigation Measures	Stage-wise impacts with corresponding mitigation, significance, cumulative and residual impacts
8	Stakeholder Engagement	Stakeholder identification, consultation, disclosure, engagement plan and grievance redress
9	Hazard and Risk Assessment	Disaster impact assessment, hazard identification, risk evaluation, emergency response
10	Environmental and Social Management Plan	Institutional arrangements, management plans, monitoring, closure, training, reporting and budget
11	Conclusions and Recommendations	Overall conclusions and recommendations
–	Appendix	Supporting documents and annexures

CHAPTER 2

Project Description

This chapter describes the proposed project: its nature, size and location, functional components and zoning, technology and process flow, major plant systems, pollution control measures, resource and utility demand, manpower, implementation schedule, cost and provision for future expansion. It forms the technical basis for the impact assessment in subsequent chapters.

2 PROJECT DESCRIPTION

2.1 Project Overview

The proposed Treatment, Storage and Disposal Facility (TSDF) and Incineration Facility by Sheam TSDF BD Ltd. is a comprehensive environmental infrastructure initiative designed to address the growing challenges of solid, special and hazardous waste management in Bangladesh. The project objective is to establish a modern, environmentally compliant and scientifically managed waste treatment facility integrating waste receiving, inspection, segregation, pre-treatment, material recovery, controlled thermal treatment, residue stabilization and safe final disposal within a single coordinated system.

The facility will provide a centralized solution for the management of waste generated from *airports, seaports, land ports, customs warehouses, municipal areas, commercial and institutional establishments, healthcare facilities and selected industrial sources.* Considering the increasing volume of mixed, contaminated, expired, confiscated and non-recyclable waste in Bangladesh, the project is expected to play an important role in reducing unsafe storage, open dumping, uncontrolled burning and informal disposal practices.

Incoming waste will be received through a controlled waste acceptance system. Each consignment will undergo weighment, documentation, visual inspection, classification, segregation and pre-treatment before further processing. Waste streams will be assessed based on their physical and chemical characteristics, compatibility, combustibility and treatment suitability. Recyclable materials will be recovered where feasible, while non-incinerable fractions will be separated and managed through appropriate treatment or disposal routes. Only approved combustible waste streams meeting defined as Waste Acceptance Criteria **(WAC)** will be processed through the incineration system.

The proposed incineration unit will operate under high-temperature controlled combustion conditions to ensure effective destruction of organic pollutants, pathogens and hazardous constituents. The system will be designed to significantly reduce waste volume, typically by 80–90%, thereby minimizing the quantity of waste requiring final disposal. The incineration process will include proper combustion control, secondary combustion, residence time management and safe handling of bottom ash, fly ash and other residues.

To ensure environmental protection and regulatory compliance, the facility will be equipped with appropriate Air Pollution Control Devices (APCDs) and a Continuous Emission Monitoring System (CEMS). These systems will be designed to control particulate matter, acid gases, toxic pollutants and other combustion-related emissions. Stack emissions will be monitored continuously and verified through periodic third-party testing in accordance with applicable national standards and relevant international good practices.

The project will also include supporting infrastructure such as waste storage areas, quarantine zone for unidentified or special waste, material recovery area, laboratory/testing support, Effluent Treatment Plant (ETP), ash and residue handling system, secured storage, internal drainage, fire safety system, emergency response arrangements, occupational health and safety facilities and environmental monitoring provisions. Wastewater generated from scrubber systems, floor washing, vehicle washing, leachate and other operational activities will be collected and treated through the ETP before reuse or discharge, subject to regulatory approval.

The project location has been selected and developed to ensure *operational efficiency, logistical accessibility, environmental compliance, safety and long-term sustainability*. Site selection considerations include land-use compatibility, access roads, distance from sensitive receptors, buffer requirements, drainage condition, flood risk, availability of utilities, proximity to waste generation sources and scope for future expansion. The facility layout will be planned to maintain safe movement of waste vehicles, controlled waste handling areas, separate clean and contaminated zones, fire safety access and environmental protection measures.

The proposed facility emphasizes *environmental protection, public health improvement, regulatory transparency and sustainable waste management*. It will be supported by structured environmental monitoring, occupational health and safety systems, emergency preparedness, stakeholder engagement and community grievance mechanisms. Through this initiative to establish a scalable, policy-aligned and compliance-driven waste management platform that supports urban resilience, institutional accountability and long-term environmental sustainability in Bangladesh.

The project development initiative has been categorized into three phases:

Table 18: Targeted phases of project development initiatives

Phase	Caption	Description
Phase-1	Establishment and Initial Operation	**Target incineration capacity: 6 MT/day** **Establish the core TSDF infrastructure and commence controlled operation after obtaining all required approvals.** • Land development, internal roads, drainage and boundary security. • Waste reception, weighbridge, inspection, sampling and laboratory. • Waste segregation, quarantine and temporary storage. • Initial incineration module with complete air pollution control, stack and applicable CEMS. • ETP, fire protection, emergency response and occupational health and safety systems. • Dedicated bottom ash and APCD residue handling and approved final disposal arrangements. Waste streams: **Airport, seaport and land-port waste:** Rejected cargo, confiscated goods, contaminated packaging and selected inspection-related waste

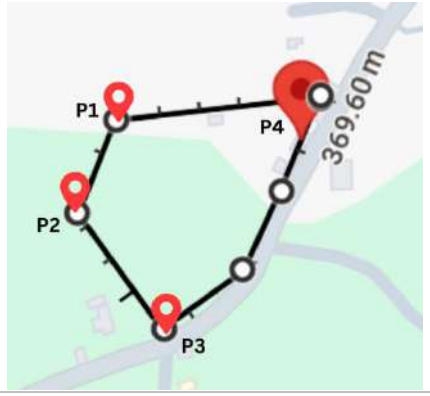
		Expired, rejected and confiscated products: Selected expired consumer goods, cosmetics, pharmaceuticals and other rejected products **Industrial solid waste:** Rejected production materials, contaminated packaging, non-recyclable process solids
Phase-2	Capacity Expansion and Process Integration with multi variation waste streams	**Target incineration capacity: 12-15 MT/day** Expand treatment capacity based on verified waste supply and streams, operational performance and regulatory authorization. • Install a second incineration module or expand the approved system. • Increase waste storage, segregation and pre-treatment capacity. • Expand APCD, ETP, residue storage and associated utilities as required. • Improve waste characterization, laboratory testing and digital tracking. • Introduce resource recovery for suitable recyclable materials. • Strengthen environmental monitoring, staff competency and preventive maintenance. Waste Streams: **Hazardous industrial waste:** Contaminated absorbents, filters, protective clothing, oil-contaminated solids and selected chemical residues. **Healthcare and medical waste:** Infectious waste, contaminated disposable materials and selected healthcare waste **Commercial and institutional waste:** Non-recyclable packaging, contaminated paper, textiles and dry combustible residuals
Phase-3	Full Capacity and Operational Optimization	**Complete the planned facility and optimize performance across the full treatment chain.** • Install the third module, or equivalent capacity approved in the final engineering design. • Complete the required expansion of waste handling, storage, utilities and pollution-control systems.

		• Optimize combustion, energy consumption, APCD performance and residue stabilization. • Strengthen secured disposal capacity and leachate management where included in the approved project scope. • Implement integrated digital records for waste manifests, treatment batches, emissions and residue disposal. • Establish a mature environmental monitoring, compliance reporting and continuous-improvement programme. Waste Streams: **Contaminated packaging and PPE:** Contaminated bags, containers, protective clothing and absorbents. **Selected municipal solid-waste residuals:** Dry, combustible, non-recyclable waste remaining after segregation **Incineration and pollution-control residues:** Bottom ash, fly ash, spent sorbents, APCD residues and scrubber sludge



Figure 25: Flow diagram of TSDF operations

Project technical and quantitative data:

	Particulars	Content/Data	Details/Justifications
1	Land size	2.5 acre (Phase-1+2+3)	Sufficient area for TSDF plant, green belt, utilities, ETP, Incinerator, Roads, Storage, Future expansion
2	Coordinates	GPS coordinates of site boundary	
3	Plant capacity	20 ton/day For **Phase-1**	
4	Incinerator capacity	6 ton/day For **Phase-1**	Dedicated Hazardous & Non-recyclable Waste Incineration
5	Stack height		As per guidelines for common waste treatment facilities the minimum stack height shall be

Boundary Point	Latitude	Longitude
P1	24°15'57.5"N	90°24'57.2"E
P2	24.265520” N	90.415733” E
P3	24°15'54.1"N	90°24'57.6"E
P4	24°15'57.2"N	90°25'00.5"E

Stack Height (Provided)	45 m	from Ground Level
Incinerator capacity	6 TPD	
Stack diameter (at top)	~1.2 m	
Flue gas temperature	~180°C	
Exit velocity	~12 m/s	
h – building/structure height	15 m	assumed
KVA – incinerator capacity	250 kg/hr	6,000 kg/day ÷ 24
Minimum stack height formula	H = h + 0.2√KVA	CPCB O&M Manual for Waste Incineration
Calculated minimum H	18.16 m	15 + 0.2√250 = 15 + 3.16

<table>
<tr><td></td><td></td><td><table><tr><td>Provided stack height assessment</td><td>45 m</td><td>Adequate and well above calculated minimum</td></tr></table></td><td></td></tr>
<tr><td>6</td><td>ETP capacity</td><td>Phase – 1: 1 m³/hr with a provision for future expansion</td><td>Effluent Treatment Plant; treated effluent reused for gardening, flushing and process make-up</td></tr>
<tr><td>7</td><td>Water demand</td><td><table><tr><th>Phases</th><th>Demand (m³/day)</th></tr><tr><td>Construction Phase</td><td>50</td></tr><tr><td>Operation Phases</td><td>25</td></tr></table></td><td>• Dust suppression, curing, construction activities, laboratory & domestic use.
• Process use, cooling, washing, gardening, domestic use</td></tr>
<tr><td>8</td><td>Fuel demand</td><td>Phase-1
<table><tr><td>Disel</td><td>250 L/day</td></tr><tr><td>Furnes Oil</td><td>800 L/day</td></tr></table></td><td>For incinerator auxiliary burner</td></tr>
<tr><td>10</td><td>Manpower</td><td>Phase-1
<table><tr><th>Phase</th><th>Skilled</th><th>Semi-skilled</th><th>Unskilled</th><th>Total</th></tr><tr><td>Construction Phase</td><td>15</td><td>20</td><td>10</td><td>45</td></tr><tr><td>Operation Phase</td><td>30</td><td>15</td><td>10</td><td>55</td></tr></table></td><td></td></tr>
<tr><td>11</td><td>Project cost</td><td>Phase-1
<table><tr><th>Particulars</th><th>Amount (INR)</th><th>Notes</th></tr><tr><td>CAPEX (Estimated)</td><td>INR 6–6.50 Crore</td><td></td></tr><tr><td>OPEX (Estimated)</td><td>INR 4.5–5.0 Crore per annum</td><td></td></tr></table></td><td>Manpower, Power & Fuel, Maintenance & Spares, Consumables & Chemicals, Waste Disposal & Transportation</td></tr>
<tr><td>12</td><td>Project schedule</td><td>Gantt chart or phase-wise implementation schedule will be developed during implementation</td><td></td></tr>
</table>

2.2 About TSDF

TSDF means **Treatment, Storage and Disposal Facility**. It is a specialized environmental infrastructure facility designed for the safe handling, temporary storage, treatment, recovery and final disposal of hazardous, special, contaminated and non-recyclable waste.

A TSDF is not a simple dumping site. It is a controlled facility where every waste consignment is received, documented, inspected, classified, treated and monitored. The purpose is to prevent unsafe dumping, open burning, soil contamination, groundwater pollution, air pollution and public health risks.

The proposed TSDF is an integrated environmental infrastructure facility for the scientific management of hazardous, special, contaminated, expired, confiscated and non-recyclable waste generated from airports, ports, customs warehouses, industrial units, healthcare-related sources, commercial establishments and institutional facilities.

2.3 Objectives of the TSDF Project

The objectives of TSDF in an ESIA study are:

Objective	Explanation
Safe waste management	To prevent uncontrolled disposal of hazardous and special waste.
Waste treatment	To reduce toxicity, volume, reactivity and environmental risk.
Material recovery	To recover recyclable or reusable materials before final treatment.
Controlled incineration	To destroy approved combustible waste under high-temperature controlled conditions.
Secure storage	To temporarily store waste before testing, treatment or disposal.
Residue management	To safely handle ash, sludge and non-recyclable residues.
Pollution prevention	To protect air, water, soil and groundwater.
Regulatory compliance	To support DoE requirements and environmental standards.
Traceability	To maintain waste manifest, source records and disposal documentation.
Emergency preparedness	To manage fire, spill, explosion, leakage and chemical reaction risks.

2.4 Description of the Project Objectives

The main objective of the proposed *Integrated Treatment, Storage and Disposal Facility (TSDF) and Incineration Facility **of** Sheam TSDF BD Ltd.* is to establish a modern, environmentally compliant and scientifically managed waste treatment facility for the safe handling, treatment and disposal of solid, special, contaminated, non-recyclable and selected hazardous waste streams in Bangladesh.

To provide a centralized waste management solution through controlled waste receiving, segregation, material recovery, pre-treatment, thermal treatment, pollution control, residue management and continuous environmental monitoring.

Descriptions objective of the project are as follows:

To establish a centralized waste treatment and disposal facility	To develop a dedicated TSDF and incineration facility capable of receiving and managing waste from municipal, commercial, institutional, healthcare, port, customs and selected industrial sources in a controlled and environmentally responsible manner.
To reduce unsafe waste disposal practices	To minimize open dumping, uncontrolled burning, informal disposal, long-term unsafe storage and unregulated handling of waste that may create risks to air, soil, water, public health and the surrounding environment.
To ensure scientific segregation and pre-treatment of waste	To introduce a structured waste acceptance and segregation system where incoming waste will be weighed, documented, inspected, classified and pre-treated before being sent for recycling, incineration, stabilization or safe disposal.
To recover recyclable and reusable materials	To promote material recovery by separating recyclable and reusable fractions from incoming waste before final treatment, thereby supporting waste minimization, resource efficiency and circular economy principles.
To safely treat combustible waste through controlled incineration	To process only approved combustible waste streams through a high-temperature controlled incineration system designed to destroy organic pollutants, pathogens and hazardous constituents while significantly reducing waste volume.
To control air emissions and ensure regulatory compliance	To install appropriate *Air Pollution Control Devices (APCDs)* and *Continuous Emission Monitoring System (CEMS)* to control and monitor stack emissions in accordance with applicable standards, DoE requirements and relevant international good practices.
To manage wastewater, leachate and contaminated runoff	To collect and treat wastewater generated from scrubber systems, floor washing, vehicle washing, leachate and contaminated runoff through an appropriate *Effluent Treatment Plant (ETP)* before reuse or discharge, subject to regulatory approval.
To ensure safe ash and residue management	To handle bottom ash, fly ash, sludge and other residues through proper collection, testing, stabilization, storage and final disposal arrangements to prevent soil, groundwater and surface water contamination.
To protect occupational health and safety	To establish safe working conditions for employees through personal protective equipment, standard operating procedures, worker training, medical surveillance, emergency drills and exposure control measures.
To protect community health and the environment	To minimize potential impacts on nearby communities through proper siting, pollution control, traffic management, odor control, emergency preparedness, grievance redress and continuous environmental monitoring.
To support institutional and regulatory waste governance	To introduce a traceable waste management system with proper documentation, waste manifest, generator records,

	monitoring reports and compliance reporting to support transparent regulatory oversight.
To create a scalable model for Bangladesh	To develop the project as a scalable and replicable environmental infrastructure model that can support Bangladesh's long-term needs for scientific waste treatment, pollution prevention and sustainable waste management.

2.5 Nature and Size of the Project

The project is an Integrated Treatment, Storage and Disposal Facility (TSDF) with controlled incineration and supporting waste management infrastructure, to be developed and operated by Sheam TSDF BD ltd..

The project is environmental infrastructure in nature and is intended to provide a centralized, scientifically managed and regulatory-compliant solution for the treatment, storage, material recovery, thermal destruction and safe disposal of solid, special and hazardous waste streams generated from selected sources in Bangladesh.

The facility will be designed to receive waste from municipal areas, commercial and institutional establishments, airports, seaports, land ports, customs facilities, healthcare facilities and selected other industrial sources.

The project will handle different categories of waste through a structured system of waste acceptance, documentation, segregation, pre-treatment, recyclable material recovery, incineration of approved combustible waste, residue stabilization and safe final disposal.

The project will not be designed to operate as a conventional dumping site. Rather, it will be operated as a controlled environmental management facility, where all incoming waste will undergo inspection, classification and acceptance procedures. Only waste that meets the approved Waste Acceptance Criteria (WAC) and is suitable for controlled thermal processing will be processed through the incineration unit. Recyclable, recyclable, non-combustible and restricted waste fractions will be segregated and managed through appropriate recovery, processing or disposal methods.

The size and operational capacity of the project will be determined based on the projected waste generation volume, source-wise waste availability, waste characterization results, technology design, regulatory requirements and phased development plan. The facility will be developed in phases to allow gradual capacity enhancement as waste supply, institutional agreements and regulatory approvals mature.

The initial phase will focus on establishing the core TSDF infrastructure, including waste receiving, segregation, controlled incineration, air pollution control, ETP, residue handling and environmental monitoring systems.

Future expansion will include additional incineration capacity, enhanced material recovery, secured landfill cells, laboratory facilities, resource recovery units subject to environmental clearance and operational requirements.

The project will require land for the main processing facility, waste storage zones, treatment units, internal roads, utility areas, safety buffer zones, drainage systems, greenbelt development and possible future expansion. The site layout will be designed to ensure safe traffic movement,

separation of clean and contaminated zones, controlled waste handling, emergency access, environmental protection and efficient operational flow.

Block diagram:
Entry Gate → Weighbridge → Documentation → Inspection → Segregation → Material Recovery / Quarantine / Incineration → APCD/CEMS → ETP → Residue Disposal

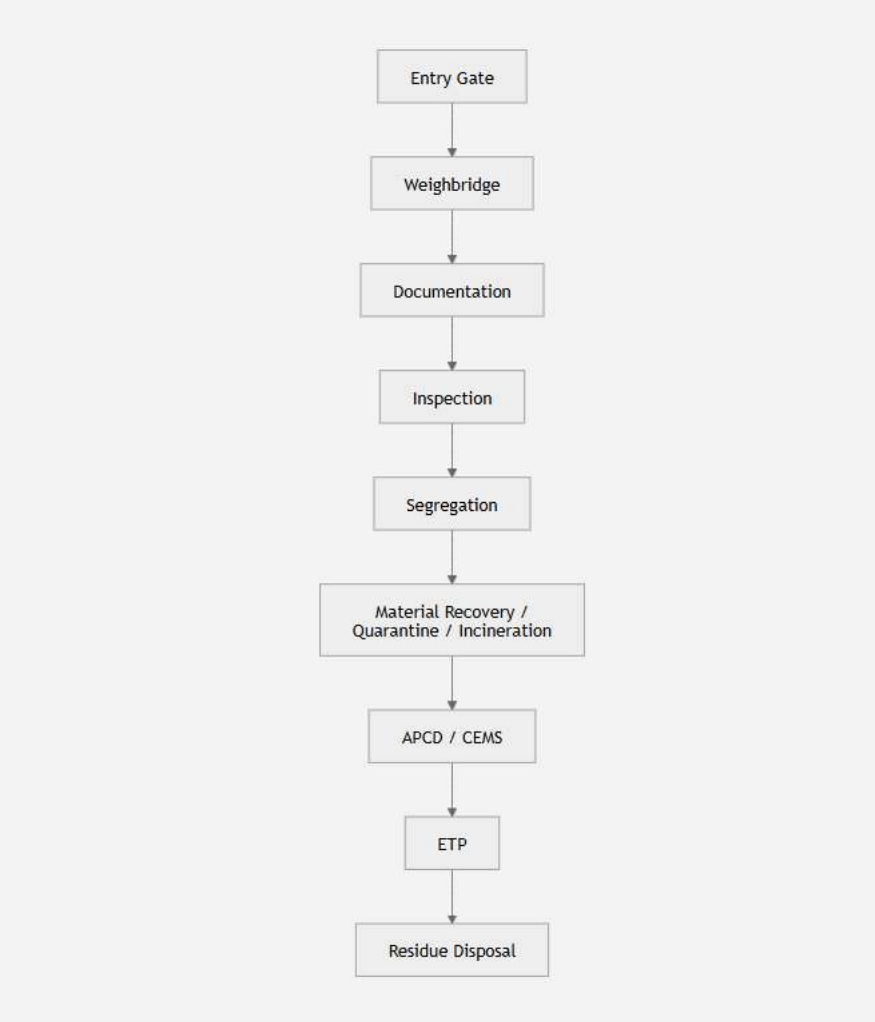


Figure 26: TSDF Project Work Flow Chart

Table 19: Land and infrastructure size description:

Project Component and Area	Area and Description
Land Classification	Industrial, Approved setback distances from residential areas
Block-A	
a) Waste Receiving area	10000 Sqft
b) Waste segregation and pre-treatment	10000 sqft
c) Primary Waste Storage area	10000 sqft
d) Secondary waste storage area	5000 sqft
e) Recycle management	5000 sqft
f) Direct landfill area	15000 sqft

g) After test landfill area	3000 sqft
Block-B	
a) Primary waste input area	2000 sqft
b) Secondary waste input area	1000 sqft
c) Incinerator	1500 sqft
d) Testing Lab	700 sqft
e) APCD	n\a
f) CEMS	n\a
g) Fire Safety	n\a
h) Administration & Operation Center	1500 sqft
i) ETP	1000 sqft
j) Utility	1000 sqft
k) OHS room	1000 sqft
l) Maintenance room	800 sqft
Green belt (mandatory)	33% of total land
Plant total land size	2.5–acres



Figure 27: Project Land Size

In terms of environmental classification, the project is considered a *high-sensitivity waste management and treatment project* due to the handling of solid, special, contaminated and hazardous waste streams and the operation of a controlled incineration system. Therefore, the project requires detailed environmental and social assessment, risk assessment, pollution control planning, emergency preparedness and long-term environmental monitoring.

Overall, the proposed project represents a *medium-to-large scale integrated environmental infrastructure facility,* depending on its final design capacity and phased implementation plan. It is intended to support Bangladesh's long-term waste management needs by providing a safe, traceable and policy-aligned system for waste treatment, resource recovery, controlled incineration and final residue management.

2.6 Location of the Project

The proposed Integrated TSDF and Incineration Facility of Sheam TSDF BD is to be located at ***Telihati, Sreepur, Gazipur, Bangladesh***. The site is situated within one of the important industrial growth areas of Bangladesh, where various manufacturing, commercial, logistics and institutional activities are concentrated. The location has been selected considering its accessibility, industrial relevance, waste-source proximity and potential suitability for developing a centralized environmental infrastructure facility.

Table 20: Project GEO Position

Geographic Position & Accessibility
The site complies with environmental buffer requirements, ensuring safe separation from schools, hospitals, and densely populated zones. The selected site is positioned within an industrially compatible zone with: • Direct access to main roads/highways for smooth waste transportation • Connectivity to municipal waste collection routes • Proximity to utility networks (electricity, water, telecommunications) • Adequate turning radius and entry/exit access for heavy vehicles

Gazipur is one of the major industrial districts of Bangladesh and hosts a wide range of industrial establishments, including textile and garment industries, dyeing and washing units, packaging industries, pharmaceuticals, food processing, engineering workshops, warehouses and other manufacturing facilities. Due to this industrial concentration, the area generates different categories of solid, special and industrial waste that require scientific collection, treatment, resource recovery and environmentally safe disposal.

The proposed location at Telihati, Sreepur offers strategic advantages for a TSDF facility because of its connectivity with surrounding industrial clusters, commercial establishments, logistics routes and urban growth centers. The site can serve as a regional waste management hub for selected waste streams generated from Gazipur and nearby industrial belts, while also supporting waste management requirements from other approved sources such as ports, airports, customs facilities, healthcare facilities and institutional establishments, subject to regulatory approval and operational planning.

The project site will be developed with appropriate consideration of environmental, social and regulatory requirements. Key site selection factors include land availability, road access, distance from sensitive receptors, surrounding land use, drainage condition, flood risk, transportation feasibility, buffer requirements, utility availability and future expansion potential. The final site layout will be designed to ensure safe vehicle movement, controlled waste handling, emergency access, greenbelt development and separation between operational, administrative and environmental control zones.

As part of the ESIA study, the project location and surrounding influence area will be assessed in detail to understand the baseline environmental and social conditions. The assessment will cover existing land use, nearby settlements, industrial activities, road network, surface water bodies, drainage pattern, groundwater condition, air quality, noise level, ecological features and socio-economic characteristics of the surrounding area.

National Location Map

- **Bangladesh map showing Gazipur.**



Figure 28: Gazipur Districts

District Location Map

- **Gazipur map showing Sreepur.**



Figure 29: Sreepur Upozila

Upazila Location Map

- **Sreepur map showing Telihati.**

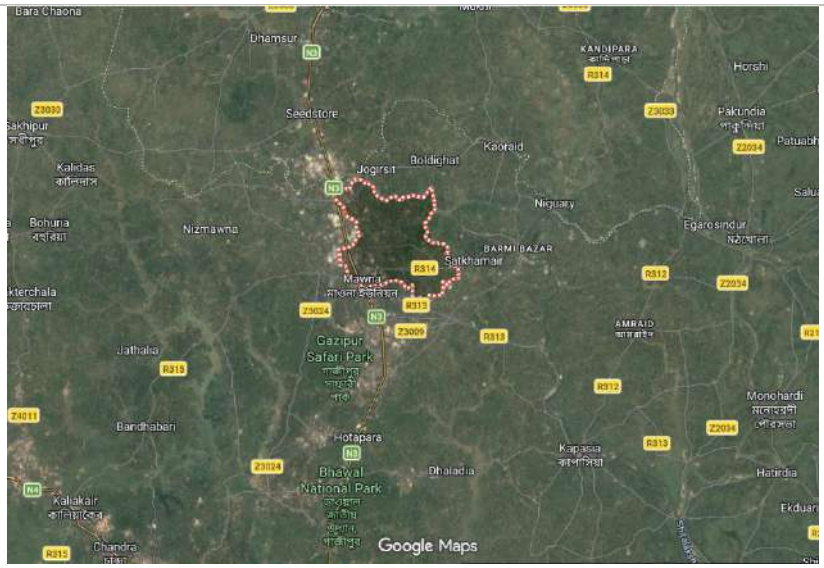


Figure 30: Telihati Unioin

Satellite Image

- **Site boundary marked with polygon.**

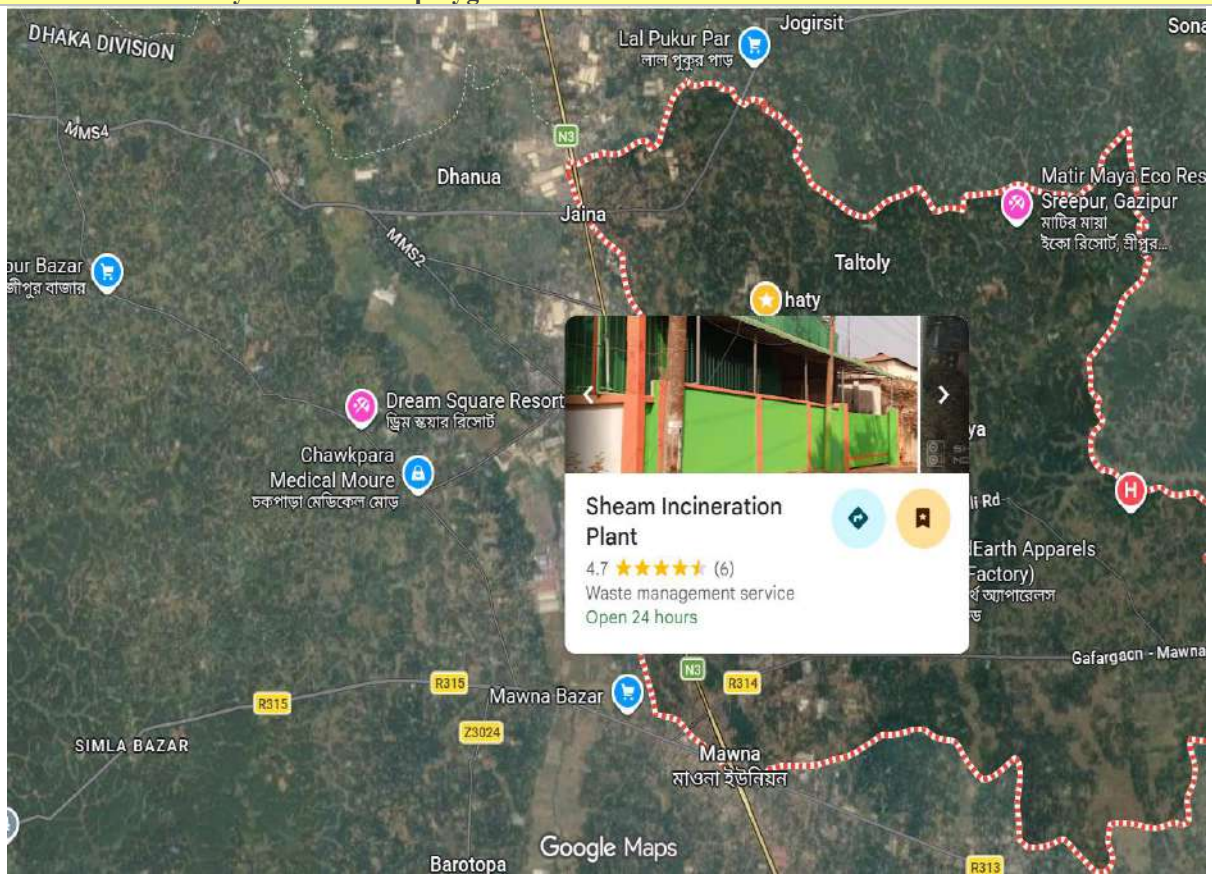


Figure 31: Satellite image for TSDF Plant

1 km and 5 km Buffer Map

- **Around project boundary.**



Figure 32: Project Sites 5Km Radious Boundary

Access Route Map

- **Main road to project site.**



Figure 33: Access Road

Distance from Important Features	
Road	1 Km
School	2
Mosque	1
Market	2
Hospital	1
Canal	1
Pond	2
Fire Station	No

2.7 Main Functional Components of TSDF

A Treatment, Storage and Disposal Facility (TSDF) is composed of several integrated units designed to receive, inspect, treat, store and safely dispose of solid, special and hazardous waste in a controlled and environmentally compliant manner. TSDF will consist of waste receiving, documentation, inspection, segregation, material recovery, quarantine storage, controlled incineration, air pollution control, continuous emission monitoring, wastewater treatment, ash/residue handling, stabilization and secured disposal systems. These components will operate together to ensure that incoming waste is properly identified, treated, monitored and disposed of in an environmentally safe and regulatory-compliant manner. The facility will also include supporting infrastructure such as internal roads, drainage, fire safety, emergency response, laboratory, administrative facilities and greenbelt development.

Table 21: Functional components of TSDF

Sl.	Component	Main Function
1	Entry Gate and Security Check	Controls vehicle entry, verifies authorization, and prevents unauthorized waste unloading.
2	Weighbridge	Measures incoming and outgoing vehicle weight to record the actual quantity of waste received and treated.
3	Waste Documentation / Manifest System	Tracks waste source, quantity, type, transporter details, treatment route and final disposal record.
4	Inspection and Sampling Area	Checks waste type, packaging, physical condition and collects samples for testing where required.
5	Waste Receiving / Unloading Area	Provides a controlled area for unloading approved waste under safe and monitored conditions.
6	Quarantine Storage Area	Temporarily stores unknown, suspicious, incompatible or special waste until laboratory verification and approval.
7	Segregation and Pre-treatment Area	Separates recyclable, combustible, non-combustible and restricted waste; prepares waste for treatment.
8	Material Recovery Area	Recovers recyclable or reusable materials such as metal, glass, selected plastic and packaging materials.
9	Incineration Unit	Treats approved combustible waste under high-temperature controlled combustion conditions.
10	Secondary Combustion Chamber	Ensures complete destruction of organic pollutants, pathogens, odor and harmful gases.
11	Air Pollution Control Device (APCD)	Controls particulate matter, acid gases, toxic pollutants and other emissions before stack release.
12	Continuous Emission Monitoring System (CEMS)	Continuously monitors stack emission parameters for compliance and operational transparency.
13	Effluent Treatment Plant (ETP)	Treats scrubber wastewater, floor wash, vehicle wash, leachate and contaminated runoff.
14	Ash and Residue Handling Area	Collects, cools, stores, tests and manages bottom ash, fly ash and APCD residues safely.
15	Stabilization / Solidification Unit	Reduces the leachability of hazardous residues before secured storage or disposal.
16	Secured Storage / Disposal Area	Provides safe containment for treated residues, stabilized ash and non-recyclable hazardous fractions.

17	Leachate and Drainage Management System	Collects contaminated liquid and prevents soil, surface water and groundwater contamination.
18	Fire Safety and Emergency Response System	Includes hydrants, extinguishers, alarms, spill kits, emergency plan and evacuation arrangements.
19	Administrative and Laboratory Facility	Supports documentation, compliance reporting, waste testing, environmental monitoring and management.
20	Greenbelt and Buffer Zone	Reduces dust, noise, visual impact and provides environmental separation from surrounding areas.

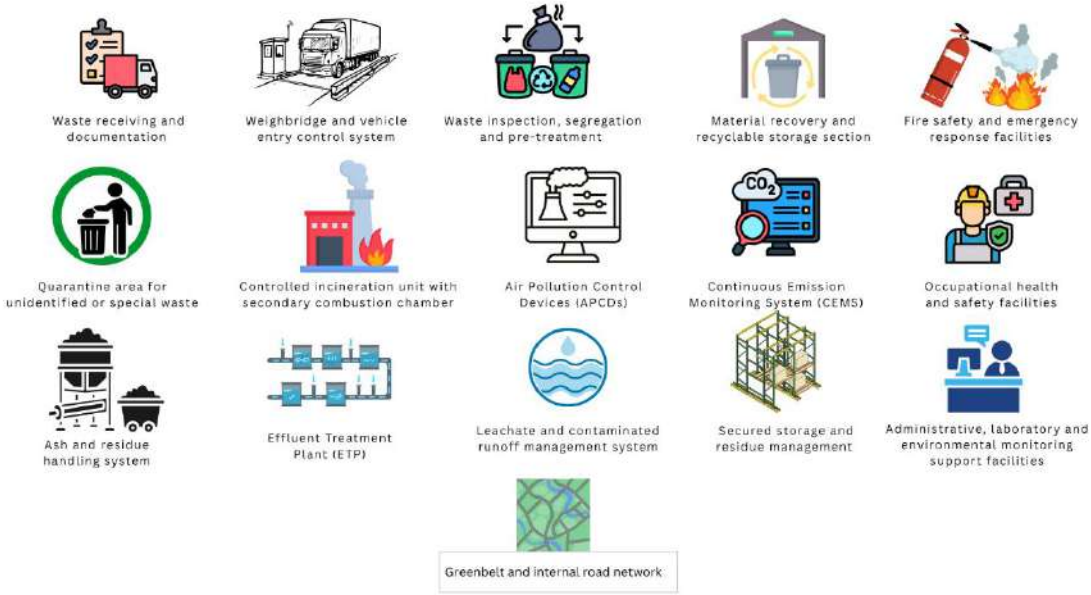


Figure 34: Key project components

The layout will be designed based on the nature of incoming waste, treatment process requirements, site conditions, traffic movement, pollution control needs and future expansion potential.

The facility layout will follow a controlled zoning approach, separating the site into administrative, operational, treatment, storage, utility, environmental control, emergency response and greenbelt areas. The design will ensure that clean areas and contaminated waste handling areas are properly separated to reduce environmental, occupational and community health risks.

Land Layout



The facility layout will be organized into functional zones to ensure safe and logical movement of materials, people and vehicles.

Zone	Function
Administrative Zone	Office, security, documentation, staff facilities and visitor control
Waste Reception Zone	Vehicle entry, weighbridge, waste documentation, inspection and sampling
Waste Processing Zone	Segregation, pre-treatment, material recovery and preparation for incineration
Thermal Treatment Zone	Incinerator, secondary combustion chamber, APCD, CEMS and stack
Residue Management Zone	Ash collection, stabilization, testing and secured storage/disposal
Wastewater Management Zone	ETP, leachate collection, scrubber wastewater and contaminated runoff treatment
Utility and Maintenance Zone	Power supply, generator, workshop, water supply and maintenance support
Emergency and Safety Zone	Fire safety system, emergency response area, spill control and assembly point
Greenbelt Zone	Boundary plantation, environmental buffer and visual screening

2.8 Operational Flow

The proposed layout will follow a one-directional operational flow to avoid cross-contamination and traffic conflict. The general movement of waste within the facility will be as follows:

Entry Gate → Weighbridge → Waste Documentation → Inspection and Sampling → Waste Receiving Area → Segregation and Pre-treatment → Material Recovery / Quarantine / Incineration

→ Ash and Residue Handling → Stabilization / Secured Storage or Disposal → Vehicle Exit through Weighbridge



This flow will help maintain traceability of each waste consignment from entry to final treatment or disposal.

2.9 Environmental Protection Features

The project layout will incorporate environmental protection measures from the design stage.

These include:

- Impervious flooring in waste handling and storage areas
- Separate clean stormwater and contaminated runoff drainage systems
- Leachate collection system
- Covered storage for waste and residues
- ETP for contaminated wastewater
- Controlled stack location and emission monitoring access
- Greenbelt around the project boundary
- Firewater containment and emergency spill control
- Safe storage for chemicals, fuel and reagents
- Proper distance between high-risk units and administrative areas

2.10 Safety and Emergency Access

The layout will include adequate space for firefighting access, emergency evacuation and emergency response activities. Fire hydrants, extinguishers, firewater storage, spill control equipment and emergency assembly areas will be located at strategic points within the facility.

The incineration unit, waste storage areas, fuel storage, chemical storage and residue handling areas will be treated as high-risk zones and will be provided with appropriate safety distance, signage, restricted access and emergency control measures.

2.11 Greenbelt and Buffer

A greenbelt will be developed around the facility boundary and other suitable internal areas. The greenbelt will help reduce dust, noise, visual impact and wind-blown particles, while also improving the environmental appearance of the project site. Native and pollution-tolerant plant species will be preferred for plantation.

2.12 Access to the Site

The site is situated within an industrially active region of Gazipur and is expected to be accessible through the existing regional and local road network connecting Sreepur, Gazipur industrial areas and nearby commercial/logistics corridors.

Access to the site is an important consideration for the project because the facility will receive waste from multiple sources, including *municipal, commercial, institutional, healthcare, port, customs and selected industrial sources*. Therefore, safe and controlled transportation of waste-carrying vehicles to and from the project site will be essential for operational efficiency, environmental protection and community safety.

The site access arrangement is planned to ensure smooth movement of waste transport vehicles, service vehicles, staff vehicles, emergency vehicles and regulatory inspection vehicles. The access road and internal circulation system will be designed to minimize traffic congestion, prevent accidental spillage, reduce disturbance to nearby communities and maintain safe separation between waste vehicles and general movement.

The project site is expected to be connected with nearby industrial roads and regional routes serving the Sreepur-Gazipur industrial cluster. This location provides logistical advantages for collecting and transporting waste from nearby industrial establishments, commercial centers, institutional facilities and approved external sources. The availability of road access will also support transportation of equipment, construction materials, fuel, chemicals, spare parts and treated residues during both construction and operation phases.

During operation, all waste-carrying vehicles will enter the facility through a *controlled main gate*. At the entrance, vehicles will be checked for authorization, waste documentation, manifest records and safety compliance. Vehicles will then proceed to the weighbridge for recording of incoming waste quantity before moving to the waste receiving, inspection and unloading area.

The general vehicle movement sequence will be:

Access Road → Main Gate/Security Check → Weighbridge → Waste Documentation → Inspection and Sampling Area → Waste Receiving/Unloading Area → Treatment or Storage Zone → Exit Weighbridge → Vehicle Wash, if required → Exit Gate



The project site access design will consider the following requirements:

Access Requirement	Description
Main Entrance Gate	Controlled entry for waste vehicles, staff, visitors and emergency vehicles
Security and Documentation Point	Verification of vehicle, driver, waste manifest and source approval
Weighbridge Access	Proper approach and exit lane for accurate vehicle weighing
Internal Road Network	Paved road system for movement between receiving, treatment, storage and utility areas
Emergency Access	Clear access route for fire service, ambulance and emergency response vehicles
Vehicle Turning Area	Adequate turning radius for waste collection trucks and heavy vehicles
Traffic Signage	Direction signs, speed limits, hazard signs and restricted access zones
Spill Control Area	Provision for immediate response to accidental leakage or spillage
Vehicle Washing Area	Decontamination or wheel washing before exit, where required
Separate Movement Control	Separation of pedestrian, visitor and waste vehicle movement as far as practicable

To ensure safe waste transportation, vehicles carrying waste to the facility will be required to follow approved routes, carry proper documentation and use covered or enclosed transport systems where necessary. For hazardous, contaminated or odor-generating waste, vehicles should be leak-proof, covered, labeled and equipped with basic emergency response materials.

Traffic management measures will be implemented to reduce potential impacts on nearby roads and communities.

These measures include but are not limited to:

- Scheduling waste vehicle movement to avoid peak traffic periods where feasible
- Maintaining speed limits near settlements, markets, schools and sensitive receptors
- Using covered vehicles to prevent littering, odor and wind-blown waste
- Providing driver training on hazardous waste transport and emergency response
- Ensuring vehicles are roadworthy and regularly maintained
- Maintaining waste transport records and manifest documentation
- Implementing spill response procedures during transport and unloading
- Providing signage at site entrance and internal roads
- Restricting unauthorized access to waste handling areas

The ESIA study will assess the existing access road condition, traffic movement, nearby sensitive receptors, accident risk, road width, drainage condition and suitability of the transport route. Any required improvement to the access road, entry gate, turning radius, internal road, drainage or traffic control system will be recommended as part of the Environmental Management Plan.

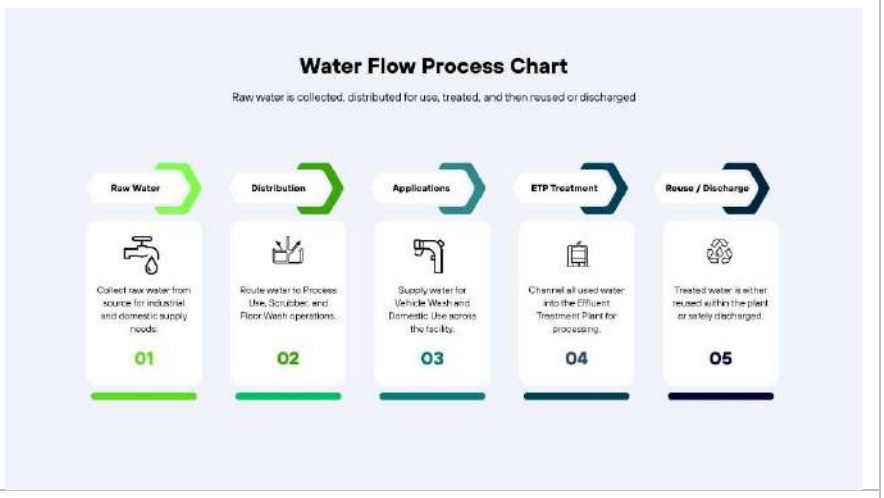
Emergency access will be given special consideration in the project layout. Fire service vehicles, ambulance and emergency response teams must be able to reach high-risk areas such as waste storage, incineration unit, fuel storage, chemical storage, ETP and residue handling areas without obstruction. Emergency access roads should remain clear at all times.

2.13 Resources and Utility Demand

The proposed *Integrated TSDF and Incineration Facility of Sheam TSDF BD* is requiring land, fuel, construction materials, water, electricity, manpower and supporting utilities during both construction and operational phases. The quantity and specification of resources will depend on the final plant capacity, technology selection, engineering design, waste volume, operating schedule and regulatory requirements.

The project is to be designed to use resources efficiently and to minimize wastage through planned construction, controlled operation, recycling of treated water where feasible, energy-efficient equipment and proper inventory management.

Table	Required Content
Land Requirement Table	area allocation for each component
Water Balance Table	source, use, quantity, reuse, discharge

	(Raw Water → Process Use / Scrubber / Floor Wash / Vehicle Wash / Domestic Use → ETP → Reuse / Discharge) 
Power Demand Table	connected load, DG backup, critical load
Fuel Requirement Table	construction fuel, incinerator auxiliary fuel, DG fuel
Manpower Table	construction and operation manpower

2.13.1 Land Requirement

The project will require adequate land for the development of the main TSDF and incineration facility, internal roads, waste receiving areas, storage zones, treatment units, environmental control systems, safety buffer and future expansion.

The land requirement will include space for the following components:

Component	Land Use Purpose
Main entrance and security gate	Controlled access and vehicle verification
Weighbridge area	Measurement of incoming and outgoing waste quantity
Administrative building	Office, record keeping, control room and staff facilities
Waste receiving area	Unloading and initial inspection of waste
Segregation and pre-treatment area	Sorting, separation, shredding and preparation of waste
Material recovery area	Recovery and temporary storage of recyclable materials
Quarantine storage area	Temporary storage of unidentified or special waste
Incineration unit	Controlled thermal treatment of approved waste
APCD and stack area	Air pollution control and emission monitoring
ETP area	Treatment of wastewater, scrubber water, leachate and wash water
Ash and residue handling area	Cooling, storage, testing and stabilization of residues
Secured residue storage/disposal area	Safe management of treated residue and non-recyclable fractions
Utility area	Transformer, generator, pump room, water tank and maintenance facilities

Internal roads	Movement of waste vehicles, staff vehicles and emergency vehicles
Fire safety and emergency area	Firewater tank, hydrant system, emergency equipment and assembly point
Greenbelt and buffer zone	Environmental buffer, visual screening and dust/noise reduction
Future expansion area	Additional treatment, storage or resource recovery facilities

2.13.2 Fuel Requirement

Fuel will be required during both construction and operation stages. During construction, fuel will mainly be used for construction equipment, vehicles and temporary power backup. During operation, fuel may be required for waste transport vehicles, standby generators, incinerator start-up/support firing and other auxiliary systems.

Fuel use will be controlled through proper storage, handling and consumption monitoring. All fuel storage areas will be provided with secondary containment, fire safety equipment and spill control arrangements.

2.13.2.1 During Construction Stage

During the construction phase, fuel will be used for:

- Excavators, loaders and earthmoving equipment
- Concrete mixers and construction machinery
- Cranes and lifting equipment
- Trucks carrying construction materials
- Site vehicles and supervision vehicles
- Temporary diesel generators, if grid power is not available

The main fuel type during construction is expected to be **diesel**, with smaller quantities of petrol or lubricants for light vehicles and small equipment.

Indicative fuel requirement during construction will depend on construction duration, equipment deployment and work intensity. Fuel consumption will be minimized through equipment maintenance, efficient scheduling and avoidance of unnecessary engine idling.

Fuel-related mitigation measures during construction will include:

- Use of designated fuel storage area
- Secondary containment for fuel drums or tanks
- Spill kits at fuel storage and equipment areas
- Prohibition of open fuel handling near drains or soil
- Fire extinguishers near fuel storage
- Regular inspection of machinery for leakage
- Proper disposal of used oil, filters and oily rags

2.13.2.2 During Operation Stage

During operation, fuel may be required for the following purposes:

- Incinerator start-up and auxiliary firing
- Maintaining combustion temperature during low-calorific waste processing
- Standby generator operation
- Forklifts, loaders or internal handling equipment
- Waste collection and transport vehicles
- Emergency response equipment, where applicable

The main fuel may include **diesel** depending on the final incinerator design and availability of utilities. The incinerator will primarily process approved combustible waste; however, auxiliary fuel may be required during start-up, shutdown or when waste calorific value is insufficient to maintain required combustion temperature.

Fuel storage and handling during operation will follow safety and environmental requirements, including:

- Storage in approved tanks or containers
- Impervious floor and bunded containment
- Fire detection and firefighting system
- No-smoking and hazard signage
- Spill response equipment
- Proper ventilation and separation from ignition sources
- Regular inventory and consumption monitoring
- Trained personnel for fuel handling

2.13.3 Earth Filling and Building Material Requirement

Earth filling and building materials will be required during site preparation and construction of the proposed facility. The quantity will depend on existing site level, drainage condition, flood protection requirement, foundation design and final layout.

Typical earth filling and construction materials may include:

Material	Purpose
Earth/sand filling material	Site leveling and platform development
Sand	Foundation, bedding, plastering and construction works
Bricks/blocks	Building construction and boundary wall
Cement	Concrete works, foundation and structural construction
Stone chips/aggregate	RCC works, roads and foundations
Reinforcement steel	RCC structures and equipment foundation
Structural steel	Shed, support frame and equipment structures
Concrete	Roads, floors, drains and foundations
HDPE/impervious lining, where required	Waste storage, leachate control and residue management areas
Roofing materials	Waste storage sheds and operational buildings

Pipes and drains	Water supply, wastewater and stormwater management
Electrical cables and fittings	Power supply and control system
Firefighting materials	Hydrant, firewater tank, extinguishers and alarm system

Environmental management measures for construction materials will include:

- Covered storage for cement and fine materials
- Water spraying for dust control
- Proper stacking of steel and construction materials
- Prevention of loose material runoff into drains
- Reuse of excavated soil where suitable
- Safe disposal of construction debris
- Controlled movement of material-carrying trucks

2.13.4 Water Requirement

Water will be required during both construction and operation phases. During construction, water will be used mainly for civil works, dust suppression and worker facilities. During operation, water will be required for incinerator support systems, scrubber/APCD operation, floor washing, vehicle washing, ash handling, ETP operation, fire safety, greenbelt maintenance and domestic use.

The water source may include approved groundwater, surface water, municipal supply or tanker supply.

2.13.4.1 Water Requirement during Construction

During construction, water will be required for:

- Concrete mixing and curing
- Dust suppression on roads and work areas
- Earthwork compaction
- Equipment washing
- Worker drinking and sanitation facilities
- Temporary firefighting arrangement
- Cleaning of construction areas

Water management during construction will include:

- Use of approved water source
- Avoidance of unnecessary water wastage
- Proper drainage of construction runoff
- Prevention of cement slurry entering natural drains
- Provision of sanitation facilities for workers
- Regular inspection of water storage tanks and pipelines
- Reuse of water where feasible for dust suppression

2.13.4.2 Water Requirement during Operation

During operation, water will be required for both process and non-process activities.

The main operational water uses may include:

Use Area	Purpose
APCD system	Flue gas cleaning and acid gas control
Incineration support	Equipment cooling or process support, depending on design
ETP operation	Treatment process, chemical preparation and cleaning
Floor washing	Cleaning of waste handling and processing areas
Vehicle washing	Decontamination of waste vehicles, where required
Ash handling	Dust suppression and residue conditioning, if applicable
Laboratory	Sampling, testing and cleaning
Fire safety	Firewater reserve and emergency use
Greenbelt	Plantation and landscaping
Domestic use	Drinking, sanitation and staff facilities

Water conservation measures during operation will include:

- Reuse of treated wastewater where feasible
- Low-flow fixtures in domestic facilities
- Regular leak detection and repair
- Separate stormwater and contaminated wastewater systems
- Use of covered drains in contaminated areas
- Metering and monitoring of water consumption
- Rainwater harvesting, if technically feasible

2.13.5 Manpower Requirement

The project will require manpower during both construction and operation phases. Construction manpower will include engineers, supervisors, skilled workers, semi-skilled workers and general laborers. Operational manpower will include technical, environmental, administrative, safety, maintenance, laboratory, waste handling and security personnel.

Preference may be given to local workers for suitable positions, subject to skill requirements and safety training. All workers will be provided with necessary orientation, PPE and health and safety instructions.

2.13.5.1 During Construction

During construction, manpower will be required for:

- Site preparation and earthwork
- Civil construction
- Mechanical installation
- Electrical installation
- Equipment erection
- Road and drainage construction

- Boundary wall and gate construction
- Utility installation
- Supervision and quality control
- Security and site administration

Indicative manpower categories during construction may include:

Category	Role
Project manager / site engineer	Construction supervision and coordination
Civil engineer	Civil works, foundation and structures
Mechanical engineer	Equipment installation and piping
Electrical engineer	Power supply, wiring and control systems
HSE officer	Safety and environmental compliance
Supervisors	Worksite supervision
Skilled workers	Mason, fitter, welder, electrician, plumber
Equipment operators	Excavator, crane, loader and truck operators
General workers	Site preparation, material handling and cleaning
Security personnel	Site access control and safety support

The number of construction workers will vary depending on work stage and construction schedule. Worker accommodation, sanitation, drinking water, first aid and safety facilities will be arranged as required.

2.13.5.2 During Operation

During operation, trained manpower will be required for safe and compliant operation of the TSDF and incineration facility. The facility will require technical personnel for waste acceptance, incineration operation, APCD management, ETP operation, ash handling, environmental monitoring, maintenance, safety and administration.

Indicative manpower categories during operation may include:

Category	Role
Facility Manager	Overall plant management and regulatory coordination
Operations Manager	Daily operational supervision
Environmental Manager / Officer	Monitoring, compliance reporting and EMP implementation
HSE Officer	Occupational safety, emergency response and training
Incinerator Operator	Operation of incineration system and process control
APCD/CEMS Technician	Emission control and monitoring system operation
ETP Operator	Wastewater and leachate treatment operation
Waste Receiving Officer	Waste documentation, manifest and acceptance control
Laboratory Technician	Waste sampling, testing and quality control
Segregation and Material Recovery Workers	Sorting, recovery and pre-treatment activities
Mechanical Technician	Equipment maintenance
Electrical Technician	Electrical and control system maintenance

Vehicle/Logistics Coordinator	Waste vehicle movement and transport records
Fire and Emergency Response Team	Fire safety, spill response and emergency control
Administrative and Accounts Staff	Documentation, procurement and finance
Security Personnel	Access control and site security
Cleaning and Support Staff	Housekeeping and facility support

All operational workers will receive training on:

- Waste acceptance criteria
- Hazard communication and labeling
- PPE use
- Fire safety
- Spill response
- Emergency evacuation
- Incinerator safety
- Chemical handling
- Ash and residue management
- Occupational health and hygiene
- Environmental monitoring and reporting

The final manpower requirement will be determined based on plant capacity, number of shifts, technology configuration and regulatory compliance obligations.

2.14 Technology Selection and Process Description

The proposed *Integrated TSDF and Incineration Facility of Sheam TSDF BD* will be developed using a combination of proven waste treatment, material recovery, pollution control and residue management technologies. The selection of technology will be based on the type and characteristics of waste to be received, environmental compliance requirements, operational safety, treatment efficiency, energy performance, residue management needs and long-term sustainability.

The facility will not be designed as a simple waste dumping or burning site. It will operate as a controlled waste management facility where incoming waste will be received, documented, inspected, segregated, pre-treated, recovered, incinerated where suitable, and the remaining residues will be managed through environmentally safe systems.

Technology selection for the proposed facility has been guided by the need to manage mixed solid, special, contaminated, non-recyclable and selected hazardous waste streams in a safe and environmentally responsible manner. Since the project will receive waste from municipal, commercial, institutional, healthcare, port, customs and selected industrial sources, a single treatment method will not be sufficient. Therefore, an *integrated treatment approach* has been proposed.

The technology package will include the following major systems:

Table 22: Technology Components

Technology Component	Purpose

Waste receiving and documentation system (Software Application)	To record waste source, quantity, type and acceptance status
Weighbridge system	Measuring incoming and outgoing waste quantity
Waste inspection and sampling system	To verify waste characteristics and suitability for treatment
Segregation and pre-treatment system	To separate recyclable, combustible, non-combustible and restricted waste
Material recovery system	To recover recyclable materials before final treatment
Quarantine storage	To temporarily hold unidentified, suspicious or incompatible waste
Controlled incineration system	To thermally destroy approved combustible waste
Secondary combustion chamber	To ensure complete destruction of organic pollutants, odor and pathogens
Air Pollution Control Devices	To control particulate matter, acid gases and other flue gas pollutants
Continuous Emission Monitoring System	To continuously monitor key stack emission parameters
Ash and residue handling system	To collect, cool, test and manage bottom ash, fly ash and APCD residues
Effluent Treatment Plant	To treat scrubber water, floor wash, vehicle wash, leachate and contaminated runoff
Fire safety and emergency system	To control fire, spill, chemical reaction and other emergency situations
Environmental monitoring system	To monitor air, water, soil, noise, stack emission and occupational exposure

The technology selection is based on the following principles:

Table 23: Technology Selection Principles

1	**Waste hierarchy** Priority will be given to waste reduction, segregation, reuse, recycling and material recovery before thermal treatment and final disposal.
2	**Controlled treatment instead of open burning** Incineration will be conducted only under controlled high-temperature conditions with proper combustion control, air pollution control and monitoring systems.
3	**Waste acceptance control** Only waste streams meeting defined **Waste Acceptance Criteria (WAC)** will be processed. Restricted, incompatible or unidentified waste will be isolated for further testing and decision.
4	**Pollution prevention and control** The facility will include APCD, CEMS, ETP, impervious flooring, drainage control, leachate collection and residue management to minimize environmental impacts.
5	**Safe residue management**

	Bottom ash, fly ash, sludge and other residues will be separately collected, tested and managed safely through stabilization, secured storage or approved disposal routes.
6	**Operational safety** The selected technology will include emergency shutdown, fire safety, spill response, worker protection and standard operating procedures.
7	**Scalability** The facility will be designed in a way that allows future expansion of incineration capacity, material recovery, laboratory testing, secured storage and additional treatment systems based on waste demand and regulatory approval.

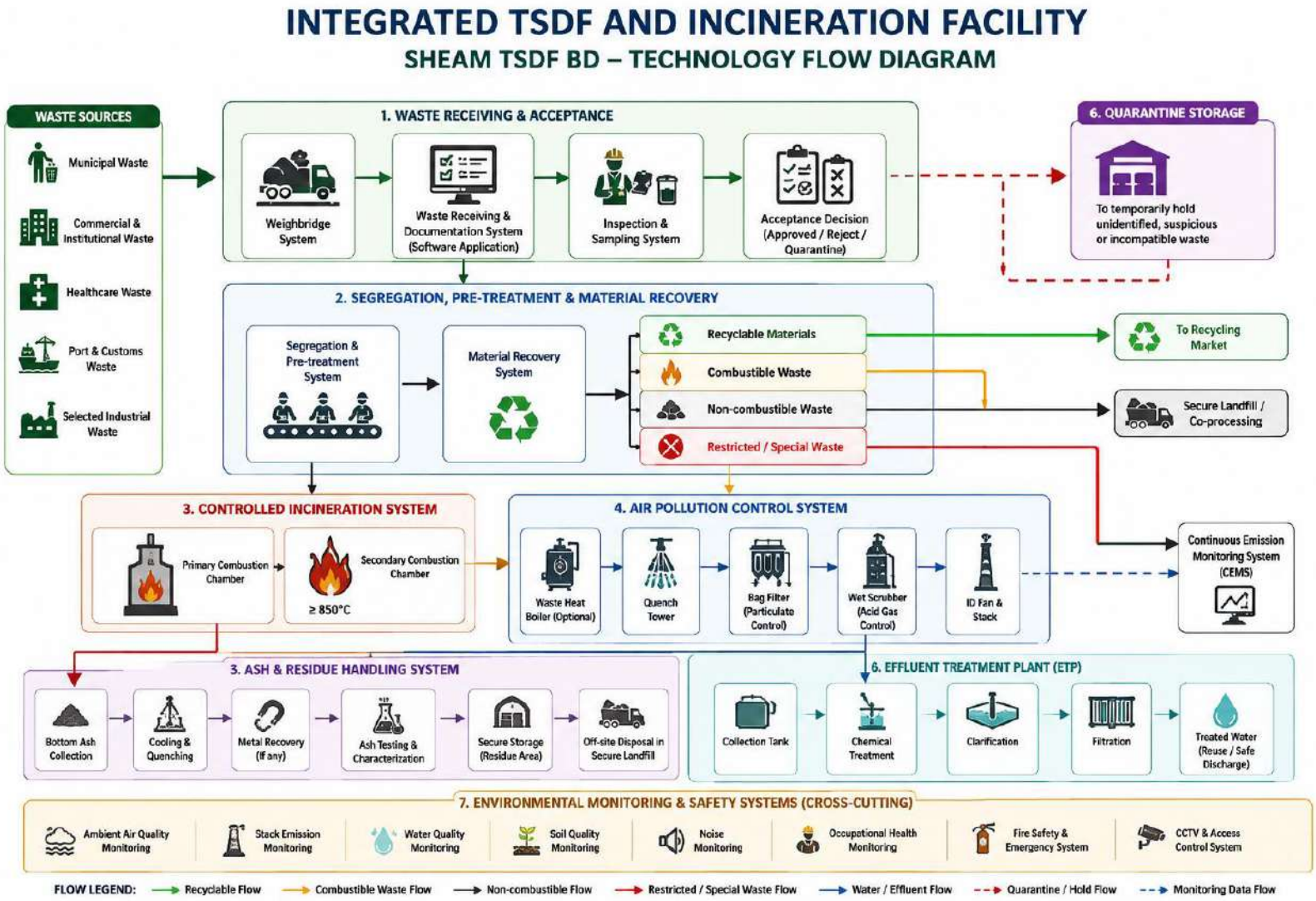


Figure 35: Technology Flow Diagram

2.14.1 Technology Selection

The core treatment technology proposed for combustible waste will be a *controlled high-temperature incineration system*. Depending on final design and waste characteristics, the incineration system may include a rotary kiln, fixed hearth, moving grate or other approved technology suitable for mixed solid and selected hazardous waste.

2.14.1.1 Overall TSDF Technology Framework

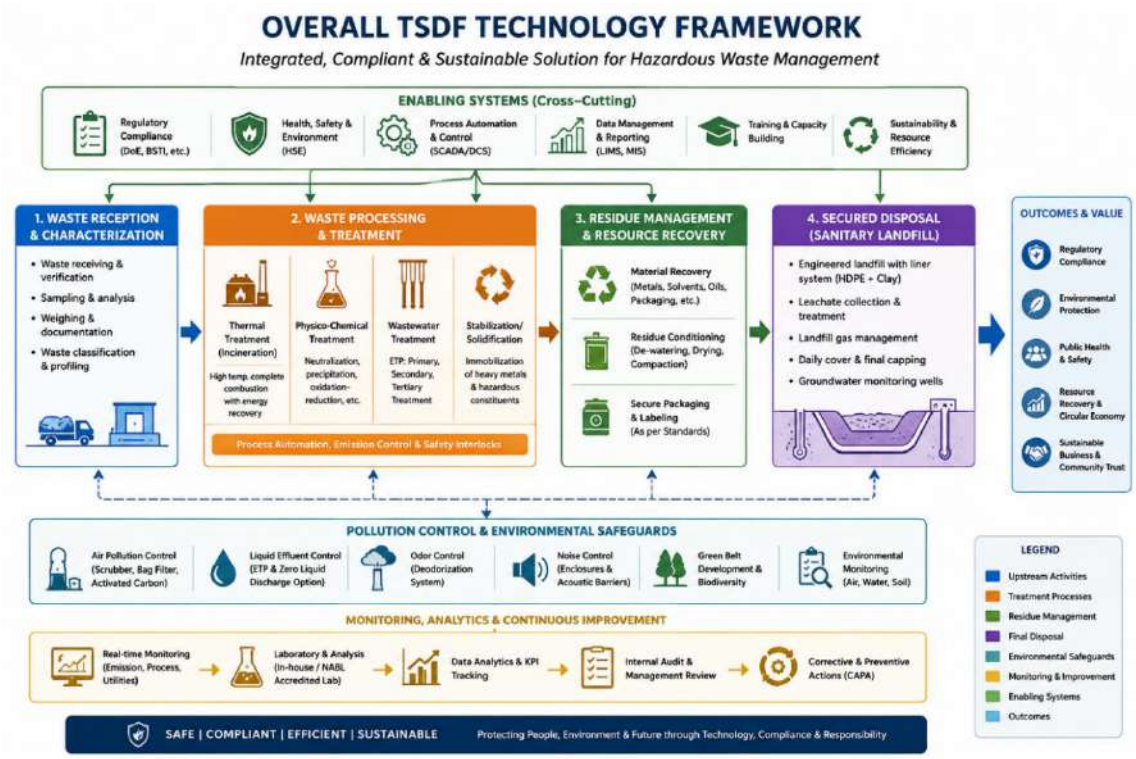


Figure 36: Technology Framework

The entire TSDF facility can be divided into the following main technology systems:

Sl.	Technology System	Purpose
1	Waste Receiving and Tracking Technology	To receive, verify, weigh and document incoming waste. *(Optional)*
2	Waste Identification and Laboratory Technology	To test, classify and decide treatment route.
3	Segregation and Pre-treatment Technology	To separate recyclable, combustible, non-combustible and hazardous fractions.
4	Material Recovery Technology	To recover reusable or recyclable materials.
5	Storage Technology	To safely store approved, unknown or incompatible waste.

6	Thermal Treatment Technology (Incineration)	To treat approved combustible waste through controlled incineration.
7	Air Pollution Control Technology	To clean flue gas before stack release.
8	Continuous Emission Monitoring Technology	To monitor stack emissions in real time.
9	Wastewater and Leachate Treatment Technology	To treat scrubber wastewater, floor wash, vehicle wash and leachate.
10	Ash and Residue Management Technology	To collect, test, stabilize and safely dispose of residues.
11	Secured Storage / Secured Landfill Technology	To contain treated hazardous residues safely.
12	Fire Safety and Emergency Response Technology	To manage fire, spill, explosion and chemical accident risks.

2.14.1.2 Laboratory Technology

The laboratory technology of the proposed TSDF will support waste identification, characterization, treatment-route selection, environmental monitoring and compliance verification. Since the facility may receive mixed, contaminated, expired, confiscated, industrial and special waste, laboratory testing is essential before final acceptance and treatment of unknown or suspicious waste streams.

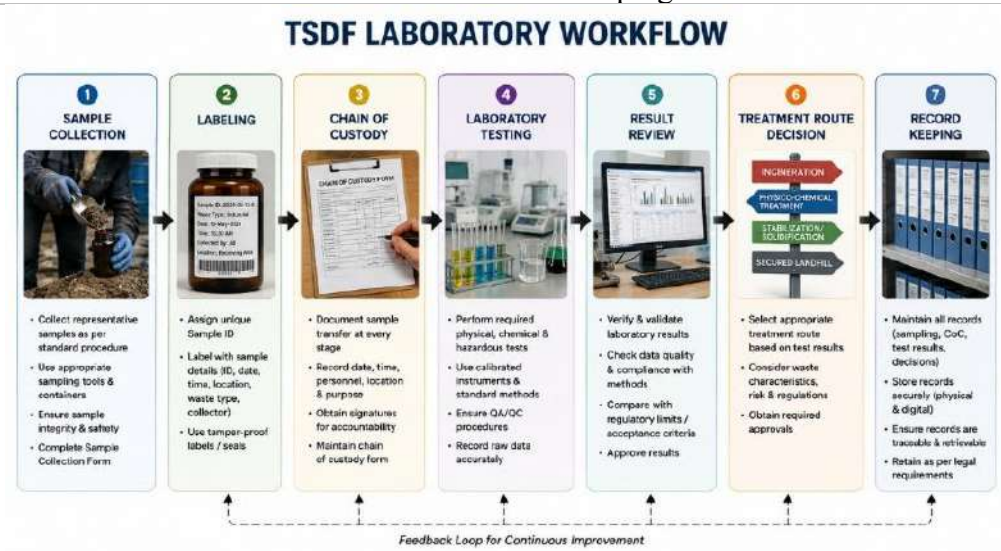
The laboratory will be used to assess the physical, chemical and hazardous characteristics of incoming waste. Waste samples may be tested for parameters such as pH, moisture content, calorific value, flash point, oil and grease, heavy metals, chloride, sulphur, COD, TDS, TSS and other relevant parameters depending on waste type. For ash, sludge and stabilized residue, leachability testing such as TCLP or equivalent testing may be carried out through an approved laboratory where required.

Items	Purpose
Laboratory Equipment List	pH meter, moisture analyzer, calorific value, flash point, COD, heavy metals, TCLP
Waste Testing Parameter Table	parameter, purpose, applicable waste
Sample Chain-of-Custody Table	sample ID, source, date, test, result, decision

The laboratory technology will support the following activities:

Function	Purpose
Waste sampling	Collection of representative samples from incoming waste batches
Waste characterization	Identification of physical and chemical properties of waste
Compatibility testing	Prevention of mixing incompatible waste streams

Incineration suitability	Assessment of calorific value, moisture, chlorine and ash content
Residue testing	Testing of bottom ash, fly ash, APCD residue and ETP sludge
Wastewater testing	Monitoring of scrubber wastewater, leachate, floor wash and ETP outlet
Environmental monitoring support	Testing of water, soil and selected environmental samples
Compliance documentation	Maintaining records for regulatory reporting and audit

Waste Sampling and Testing Flow
Sample Collection → Labeling → Chain of Custody → Laboratory Testing → Result Review → Treatment Route Decision → Record Keeping


2.14.1.3 Segregation and Pre-treatment Technology

Segregation and pre-treatment technology will be applied to separate different waste fractions before treatment or disposal. This is a critical step because mixed waste may contain recyclable materials, combustible materials, inert materials, contaminated packaging, restricted items, metals, glass, plastics, chemical containers or incompatible substances.

The purpose of segregation and pre-treatment is to improve treatment efficiency, reduce environmental risk, prevent unsafe incineration and recover useful materials where possible. Only approved and suitable waste fractions will be forwarded for incineration, material recovery, stabilization or secured storage.

The segregation and pre-treatment area should include controlled handling space, impervious flooring, covered working area, drainage to the contaminated water collection system, fire safety arrangements and occupational health and safety measures.

Typical pre-treatment activities may include:

Technology / Activity	Purpose
Manual sorting	Removal of visible recyclable, restricted or non-combustible materials
Conveyor-based sorting	Controlled movement and separation of waste fractions
Magnetic separation	Recovery of ferrous metals
Screening	Separation based on size and physical characteristics
Shredding / size reduction	Preparation of combustible waste for controlled feeding
De-packaging	Removal of packaging from expired or rejected goods
Drying, where required	Reduction of moisture content before treatment
Mixing / homogenization	Preparation of uniform feed for incineration
Removal of restricted items	Exclusion of cylinders, explosives, batteries, reactive chemicals or inert materials
Segregation Route Flow	
Accepted Waste → Sorting → Recyclable / Incinerable / Quarantine / Stabilization / Rejection	

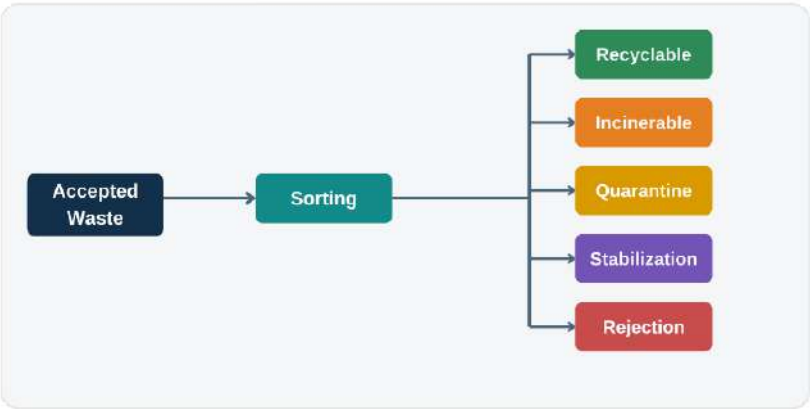


Figure 37: Segregation route flow

2.14.1.4 Material Recovery Technology

Material recovery technology will be used to recover reusable or recyclable materials from incoming waste before final treatment or disposal. This supports the waste hierarchy by reducing the quantity of waste requiring incineration or secured disposal.

Material recovery shall be applied only to materials that are safe, identifiable and suitable for recycling or reuse. Contaminated materials shall not be released without cleaning, verification and approval. Materials suspected to be chemically contaminated, infectious, reactive or unsafe shall be treated as waste and routed to appropriate treatment or disposal.

Material Recovery Flow
Segregated Waste → Recyclable Identification → Cleaning/Verification → Temporary Storage → Approved Recycler

Possible recoverable materials include:

Material	Recovery Method	Control Requirement
Ferrous metal	Manual sorting / magnetic separator	Cleaning and verification before release
Non-ferrous metal	Manual sorting	Separate storage and record keeping
Glass	Manual segregation	Only uncontaminated glass may be recovered
Selected plastic	Sorting and cleaning	Contaminated plastic to be treated separately
Paper / cardboard	Recovery if uncontaminated	Not allowed if soaked with chemicals
Packaging material	Inspection and segregation	Release only after safety confirmation
Reusable containers	Cleaning and verification	Must be free from hazardous residue

2.14.1.5 Storage Technology

Storage technology is an essential component of the TSDF because waste may need to be temporarily stored before inspection, laboratory testing, segregation, treatment, incineration, stabilization or final disposal. Storage areas shall be designed to prevent leakage, fire, odor, rainwater contact, soil contamination and groundwater pollution.

The proposed TSDF shall include separate storage arrangements based on waste type, hazard characteristics and treatment route. Incompatible waste shall not be stored together. Unknown or suspicious waste shall be placed in quarantine storage until test results and treatment decisions are available.

Recommended storage systems include:

Storage Type	Purpose	Design Requirement
General waste storage	Temporary storage of approved waste	Covered shed, impervious floor, drainage control
Quarantine storage	Storage of unknown or suspicious waste	Restricted access, labeling, secondary containment
Combustible waste storage	Waste waiting for incineration	Fire-safe area, ventilation, limited retention time
Chemical waste storage	Storage of chemical-containing waste	Bunded floor, compatibility-based segregation
Recyclable material storage	Temporary storage of recovered materials	Separate labeled bins and record keeping

Ash and residue storage	Storage of bottom ash, fly ash and APCD residue	Covered storage, dust control, testing before disposal
ETP sludge storage	Temporary storage of sludge	Leak-proof container, testing and approved disposal
Emergency storage	Temporary holding during incident response	Spill containment and emergency access

2.14.1.6 Incinerator

The proposed TSDF and Incineration Facility of Sheam Enterprise will utilize a shuttle kiln incinerator as the primary treatment technology for approved combustible, contaminated, special, and selected hazardous waste streams. This batch-operated, refractory-lined thermal treatment system enables controlled high-temperature destruction of waste, with technology selection based on waste characteristics, calorific value, moisture and ash content, environmental compliance, operational safety, and long-term maintainability. While suitable for small to medium-scale treatment of specific hazardous wastes, rotary kiln systems are generally advised for highly variable waste streams due to their greater flexibility and broader acceptance in hazardous waste management facilities for future expansion.

The incineration system included:

- Waste feeding system
- Primary combustion chamber
- Secondary combustion chamber
- Temperature control system
- Residence time control
- Auxiliary burner
- Combustion air control
- Ash discharge system
- Emergency shutdown system
- APCD and stack monitoring arrangement

The system is being designed to ensure high destruction efficiency for organic pollutants, odor-causing compounds, pathogens and other combustible hazardous constituents.

2.14.1.7 Air Pollution Control Technology

Air pollution control technology (APCD) System Flow Diagram
Secondary Chamber → Gas Cooling / Quencher → Cyclone → Scrubber → Activated Carbon Injection → Bag Filter → ID Fan → Stack → CEMS

The incineration process will generate flue gas that must be treated before release through the stack. Therefore, the facility will include an appropriate *Air Pollution Control Device system*. The final configuration will depend on the incinerator design and emission control requirements, but may include:

- Cyclone or multi-cyclone for coarse particulate removal
- Quencher or gas cooling system
- Dry or wet scrubber for acid gas control
- Bag filter for fine particulate control
- Activated carbon dosing for dioxins, furans, mercury and organic pollutants
- Lime or alkali dosing for acid gas neutralization
- Induced draft fan
- Stack with sampling platform
- Continuous Emission Monitoring System

The APCD system will be designed to control particulate matter, acid gases, heavy metals, organic pollutants and other combustion-related emissions in accordance with applicable standards and DoE requirements.

2.14.1.8 Continuous Emission Monitoring Technology

Continuous emission monitoring technology (CEMS) Data Flow
Stack Sensor → Analyzer → Data Logger → Control Room Dashboard → Alarm → Compliance Report

2.14.1.9 Wastewater Treatment Technology

Wastewater may be generated from scrubber operation, floor washing, vehicle washing, leachate collection, laboratory cleaning and contaminated runoff. An **Effluent Treatment Plant** will be installed to treat these wastewater streams before reuse or discharge, subject to regulatory approval.

ETP Process Flow
Collection Tank → Equalization → pH Correction → Coagulation/Flocculation → Clarifier → Sand Filter → Activated Carbon Filter → Treated Water Tank → Reuse/Discharge

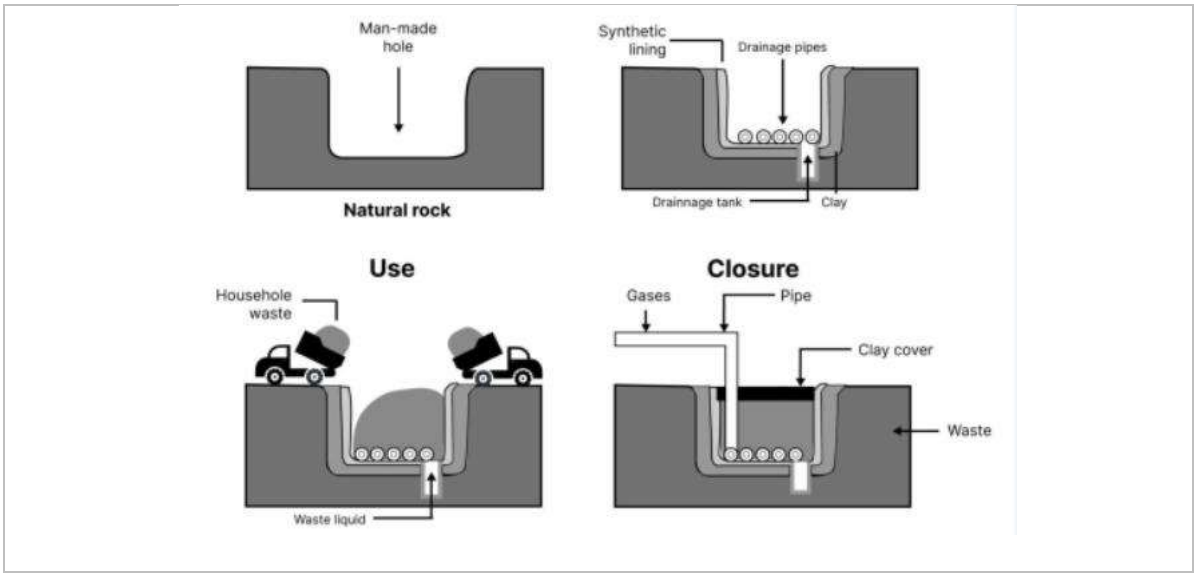
The ETP may include:

- Equalization tank
- pH correction
- Chemical dosing
- Coagulation and flocculation
- Sedimentation or clarification
- Filtration
- Activated carbon filtration, if required
- Sludge handling system
- Treated water tank
- Monitoring point before discharge or reuse

2.14.1.10 Ash and Residue Management Technology

Ash and Residue Management Flow
Bottom Ash / Fly Ash / APCD Residue / ETP Sludge → Collection → Cooling/Dewatering → Testing → Stabilization/Solidification → Secured Storage / Disposal

2.14.1.11 Secured Landfill Technology (in case landfill is required in future stages)



2.14.1.12 Fire Safety and Emergency Response Technology

Emergency Response Flow
Incident Detection → Alarm → Stop Operation → Evacuation → Fire/Spill Response → Medical Support → Authority Notification → Investigation → Corrective Action

2.14.2 Process Description

The project TSDF process will follow a controlled and sequential waste management flow, starting from waste receipt and ending with treatment, monitoring and final residue management. The process is designed to ensure that each waste consignment is traceable, properly classified and safely treated.

Step-1

Waste Source Approval and Pre-Acceptance

Before receiving waste, the facility will identify and approve waste generators or source institutions. Waste sources may include municipal bodies, commercial establishments, institutions, ports, customs facilities, healthcare-related sources and selected industries.

At the pre-acceptance stage, information will be collected on:

- Name and address of waste generator
- Type of waste
- Estimated quantity
- Physical condition of waste
- Hazardous characteristics, if any
- Packaging condition
- Expected frequency of delivery
- Required treatment method
- Transport arrangement

Where necessary, representative samples may be collected before acceptance to determine waste suitability for recycling, incineration, stabilization or rejection.

Step-2

Waste Transportation to the Facility

Approved waste will be transported to the facility using suitable vehicles. Waste-carrying vehicles should be covered, leak-proof and properly labeled where required. Hazardous, contaminated or odor-generating waste should be transported using controlled transport arrangements.

Transport requirements may include:

- Approved vehicle and driver
- Waste manifest or delivery document
- Covered or enclosed vehicle body
- Spill control materials
- Emergency contact information
- Route planning
- Vehicle maintenance
- GPS tracking, where feasible

The purpose of controlled transportation is to prevent spillage, odor, littering, leakage and unauthorized dumping during movement.

Step-3

Entry Control, Documentation and Weighing

At the facility gate, vehicles will pass through the security and documentation check. The following information will be verified:

- Waste source approval
- Vehicle identification
- Driver details
- Manifest or delivery challan
- Waste type and declared quantity

- Safety condition of vehicle
- Packaging and labeling condition

After documentation, the vehicle will move to the weighbridge. The gross weight will be recorded before unloading. After unloading, the vehicle may be weighed again to determine the net quantity of waste received.

Step-4

Waste Inspection, Sampling and Acceptance

Waste will be inspected at the receiving area. Visual inspection and, where required, sampling will be carried out to verify whether the waste matches the declared description.

Inspection may include:

- Physical appearance
- Odor
- Moisture condition
- Packaging condition
- Presence of restricted materials
- Combustibility
- Incompatibility risk
- Presence of recyclable fractions
- Need for laboratory testing

Waste that meets the approved criteria will be accepted for further processing. Waste that is unidentified, suspicious, incompatible or outside the approved acceptance criteria will be moved to the quarantine area for further investigation.

Step-5

Quarantine Storage for Unidentified or Special Waste

A dedicated quarantine storage area will be provided for waste requiring further verification. This may include:

- Unknown waste
- Confiscated or mixed cargo waste
- Chemically suspicious waste
- Damaged packaged goods
- Incompatible waste
- Waste requiring laboratory analysis
- Waste awaiting regulatory instruction

The quarantine area will have controlled access, impervious flooring, proper labeling, spill containment, fire safety and ventilation as required. No quarantined waste will be incinerated until it is properly identified and approved for treatment.

Stpe-6

Segregation and Pre-Treatment

Accepted waste will be sent to the segregation and pre-treatment area. The purpose of this step is to separate different waste fractions and prepare suitable waste for recovery or treatment.

Segregation may separate:

- Recyclable materials
- Combustible waste
- Non-combustible waste
- Metals
- Glass
- Plastics
- Inert materials
- Restricted materials
- Wet or high-moisture waste
- Oversized waste
- Hazardous residues

Pre-treatment activities may include:

- Sorting
- Size reduction
- Shredding
- Drying, where required
- Mixing or homogenization, if technically suitable
- Removal of non-combustibles
- Packaging adjustment
- Preparation for controlled feeding into incinerator

Pre-treatment will improve incineration efficiency, reduce operational problems and enhance material recovery.

Step-7

Material Recovery

Before incineration, recyclable or reusable materials will be recovered where feasible. Material recovery may include:

- Metals
- Glass
- Selected plastics
- Paper/cardboard, if uncontaminated
- Packaging materials
- Other recoverable fractions

Recovered materials will be temporarily stored in designated areas and transferred only to approved recyclers or authorized downstream users. Contaminated recyclable materials will not be released without proper cleaning, verification or approval.

Step-8

Incineration of Approved Combustible Waste:

Approved combustible waste will be fed into the incineration unit under controlled conditions. The incineration process will involve high-temperature combustion to destroy organic pollutants, pathogens and hazardous constituents.

The primary combustion chamber will burn the waste under controlled air supply and temperature. Flue gas from the primary chamber will pass into the secondary combustion chamber, where further high-temperature oxidation will occur to ensure destruction of unburnt gases, volatile organic compounds, odor and harmful organic constituents.

Key operating controls will include:

- Waste feed rate
- Combustion temperature
- Residence time
- Air supply
- Furnace pressure
- Auxiliary fuel use
- Flue gas condition
- Ash discharge
- Emergency shutdown

Only approved waste meeting WAC will be incinerated. Explosive, radioactive, highly reactive, pressurized containers or other restricted waste will not be accepted for direct incineration.

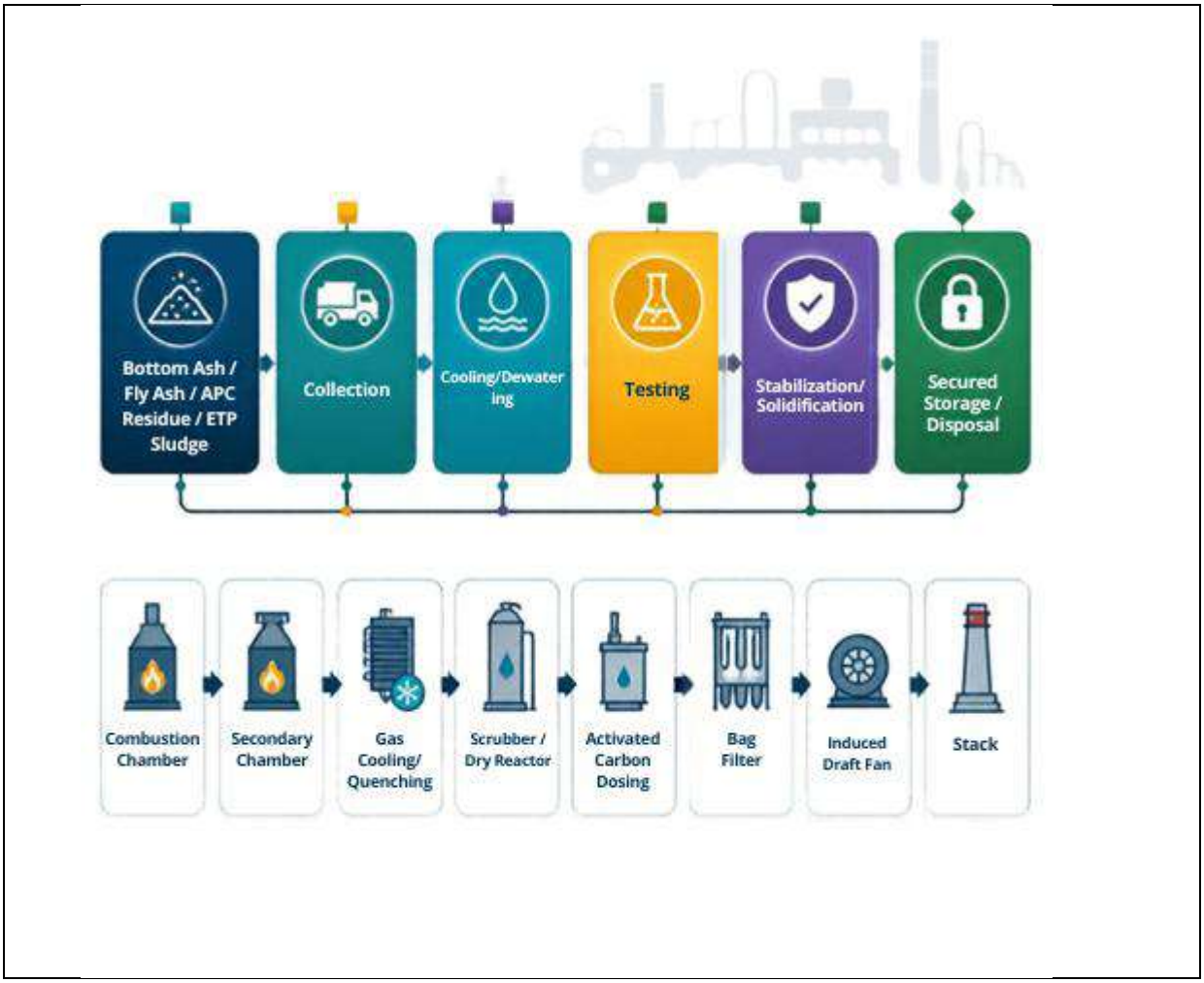
Step-9

Flue Gas Treatment through APCD

Flue gas from the incineration system will pass through the APCD system before being released through the stack. The APCD system will remove or reduce particulate matter, acid gases, toxic pollutants and other emissions.

A typical flue gas treatment sequence may include:

Combustion Chamber → Secondary Chamber → Gas Cooling/Quenching → Scrubber / Dry Reactor → Activated Carbon Dosing → Bag Filter → Induced Draft Fan → Stack



Stpe-10

Continuous Emission Monitoring and Stack Release

Treated flue gas will be discharged through a stack with appropriate height and sampling platform. A **Continuous Emission Monitoring System** will monitor key emission parameters on a real-time basis.

CEMS may monitor:

- Particulate matter
- CO
- CO_2
- SO_2
- NOx
- HCl, where applicable
- Oxygen
- Temperature
- Pressure

- Flow rate

Periodic third-party stack testing will also be conducted for parameters not continuously monitored, such as heavy metals, dioxins and furans, where applicable.

Step-11

Ash and Residue Management

Incineration will generate bottom ash, fly ash and APCD residues. These materials will be collected separately and managed carefully.

Ash management steps will include:

- Collection from ash discharge points
- Cooling and dust control
- Temporary storage in designated area
- Sampling and testing
- Stabilization or solidification, if required
- Safe storage or final disposal through approved route

Fly ash and APCD residue may contain concentrated pollutants and will be handled with special care. These residues will not be mixed with general waste.

Step-12

Wastewater and Leachate Management

Wastewater from scrubber operation, floor washing, vehicle washing, leachate and contaminated runoff will be collected through a dedicated drainage system and treated in the ETP.

The ETP process may include:

Collection Tank → Equalization → pH Adjustment → Chemical Treatment → Clarification → Filtration → Treated Water Tank → Reuse / Discharge

ETP sludge will be collected, dewatered and managed as per its characteristics and regulatory requirements.

Step-13

Final Residue Storage or Disposal

Treated residues, stabilized ash, ETP sludge and non-recyclable fractions will be managed through approved storage or disposal arrangements. If a secured disposal area is developed within the project, it will be designed with appropriate lining, leachate collection, drainage control, monitoring and closure provisions.

Final residue management will be based on:

- Waste classification

- Laboratory test results
- Leachability test, where required
- Regulatory approval
- Long-term environmental protection requirements

Stpe-14

Environmental Monitoring and Compliance Reporting

Environmental monitoring will be conducted throughout operation to ensure compliance and effectiveness of mitigation measures.

Monitoring will include:

- Stack emission monitoring
- CEMS data review
- Ambient air quality monitoring
- ETP outlet monitoring
- Surface water and groundwater monitoring
- Soil quality monitoring
- Noise monitoring
- Ash and residue testing
- Occupational health monitoring
- Waste manifest and inventory records
- Incident and non-compliance reporting

Monitoring records will be maintained and submitted to the relevant authority as required.

Overall Process Flow

The overall process flow of the proposed facility can be summarized as:

Waste Source Approval → Waste Transportation → Gate Entry and Documentation → Weighbridge → Waste Inspection and Sampling → Waste Acceptance / Quarantine → Segregation and Pre-treatment → Material Recovery → Incineration of Approved Waste → Flue Gas Treatment through APCD → Stack Monitoring through CEMS → Ash and Residue Handling → Wastewater Treatment through ETP → Final Residue Storage / Disposal → Environmental Monitoring and Reporting

2.15 Decision Tree for Incoming Lot

The Figure 1 presents a decision-making flowchart for the safe and legally compliant management of consignments, covering receipt, legal authorization, quarantine, assessment, reuse, recycling, incineration, and final disposal. The flowchart begins with the receipt and registration of a consignment, followed by verification of its legal release and the authority to manage it. A decision is then made on whether the consignment is confirmed as legally releasable. If confirmation is not

available, the consignment is placed in secure storage under customs or legal quarantine until written authorization is obtained.

Once authorization is established, the consignment undergoes an assessment to determine whether its identity and potential hazards are adequately known. If the available information is insufficient, the material is isolated in quarantine for specialist assessment. Where necessary, sampling, testing, and classification are conducted to establish its characteristics and determine the appropriate management route.

The subsequent decisions evaluate whether the material can be safely and legally reused. If it meets the relevant requirements, it may be directed toward authorized reuse or refurbishment. If reuse is unsuitable, the flowchart considers whether the material is recyclable through an approved route. Materials meeting this criterion are segregated and sent to an authorized recycler.

For materials that cannot be reused or recycled, the figure assesses their suitability for use as feedstock in a treatment, storage, and disposal facility (TSDF) incinerator. Where the material meets the required specifications and authorization conditions, it proceeds to approved feed storage, blending where permitted, and incineration. Materials unsuitable for this route are directed toward specialist treatment or approved final disposal. The process also includes the characterization of bottom ash and air pollution control (APC) residues generated during incineration to support their appropriate subsequent management.

Overall, the figure illustrates a hierarchical, decision-based waste and consignment management framework that prioritizes legal compliance, hazard identification, and the recovery of usable or recyclable materials while ensuring that unsuitable or hazardous materials are handled through authorized treatment and disposal routes. The sequential decisions points help prevent unauthorized handling and inappropriate reuse, recycling, or disposal.

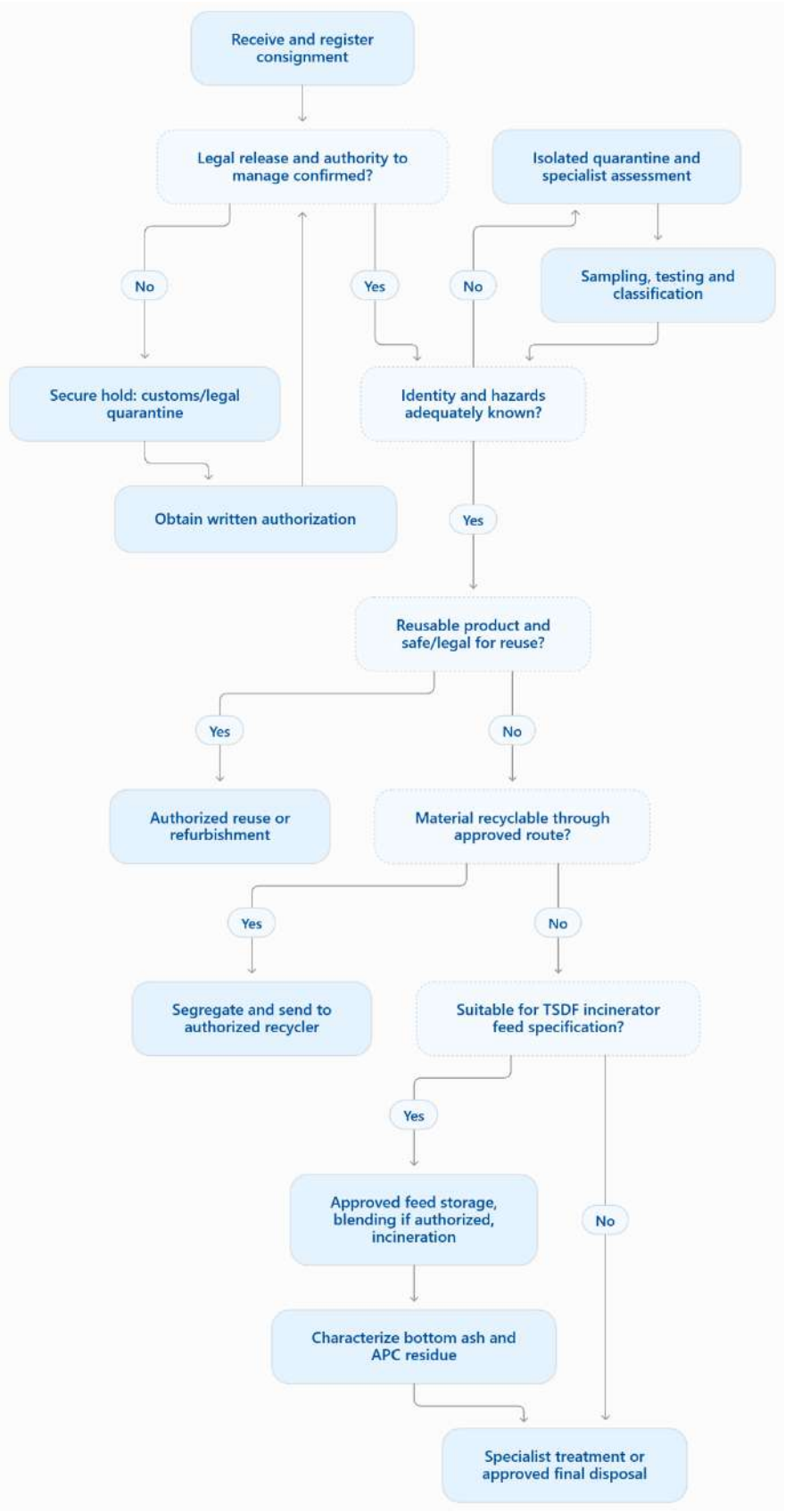


Figure 38: Decision-making flowchart for the safe and legally compliant management of consignments, covering receipt, legal authorization, quarantine, assessment, reuse, recycling, incineration, and final disposal

2.16 Description of Major Systems

The TSDF project comprises several integrated systems designed to ensure *safe waste reception, controlled incineration, efficient utility management, residue handling, pollution control, and environmentally sound disposal*. Each major system will be designed considering operational safety, environmental compliance, worker protection, and long-term sustainability of the facility.

2.16.1 Auxiliary Fuel System

The auxiliary fuel system will be provided to support start-up, temperature stabilization, and emergency operation of the incineration unit. The system will mainly be used to raise and maintain the required combustion temperature in the primary and secondary combustion chambers, particularly during start-up, low-calorific waste feeding, or process interruptions.

The auxiliary fuel may include diesel, furnace oil or other approved fuel depending on final design and availability.

Safety devices such as flame failure protection, pressure monitoring, emergency shut-off valves, leakage detection, fire-fighting arrangements, and grounding/earthing will be incorporated to minimize operational risks.

2.16.2 Air – Flue Gas System

The air and flue gas system will ensure proper supply of combustion air and safe extraction, cooling, treatment, and discharge of flue gases generated during incineration. The system will be designed to maintain suitable combustion conditions and prevent uncontrolled release of pollutants into the atmosphere.

Combustion air will be supplied to the primary and secondary chambers through forced draft fans. The volume of air will be controlled to ensure complete combustion of waste and to maintain adequate oxygen levels. Flue gas generated from combustion will pass through the secondary chamber, waste heat recovery section if applicable, gas cooling system, air pollution control devices, induced draft fan, and stack.

The flue gas treatment system will be designed to control particulate matter, acid gases, heavy metals, dioxins/furans, and other pollutants. Continuous monitoring arrangements may be provided for key parameters such as temperature, *oxygen, carbon monoxide, carbon dioxide, particulate matter, SO_2, NOx, HCl,* and other relevant emissions as required by regulatory authorities.

2.16.3 Combustion System

The combustion system is the core component of the TSDF incineration facility. It will be designed to thermally destroy hazardous and non-recyclable wastes under controlled operating conditions. The system will typically include a primary combustion chamber, secondary

combustion chamber, burners, refractory lining, waste feeding arrangement, combustion air supply, temperature monitoring, and automatic control system.

In the primary chamber, waste will be exposed to high temperature for drying, volatilization, and partial combustion. The secondary chamber will ensure complete oxidation of combustible gases generated from the primary chamber. The secondary chamber will be designed to maintain sufficient temperature, turbulence, and residence time to achieve effective destruction of hazardous organic compounds.

The combustion process will be controlled through automatic monitoring of temperature, air flow, pressure, oxygen level, and waste feed rate. Interlocks will be provided to stop waste feeding if the required operating conditions are not achieved. This will ensure safe operation and compliance with environmental standards.

2.16.4 Process Water System

The process water system will supply water required for different plant operations, including flue gas cooling, scrubber operation, equipment washing, floor washing, dust suppression, ash conditioning, and other process-related activities.

The system will include process water storage tanks, pumps, pipelines, valves, flow meters, and distribution networks. Water consumption will be optimized through recycling and reuse wherever technically feasible. Process water quality requirements will vary depending on the end use. For example, scrubber water may require specific chemical dosing, while cooling water may require treatment to prevent scaling and corrosion.

The facility will adopt water conservation measures to reduce fresh water dependency. Used process water will be collected, treated, and reused or discharged only after meeting applicable discharge standards.

2.16.5 Water Supply and Discharge System

The water supply system will be developed to meet the requirements of process operations, domestic use, fire-fighting, cleaning, landscaping, and other utility needs. Water may be sourced from groundwater, municipal supply, surface water, or approved external sources subject to regulatory permission and site-specific feasibility.

The discharge system will be designed to collect and manage wastewater from process areas, utility areas, administrative buildings, laboratories, and cleaning operations. Separate drainage networks will be provided for stormwater, domestic wastewater, and contaminated industrial wastewater to prevent cross-contamination.

Contaminated wastewater will be directed to the effluent treatment system before reuse or discharge. Stormwater from clean areas may be discharged through proper drainage channels after sediment removal. Stormwater from potentially contaminated areas, such as waste handling zones and residue storage areas, will be collected separately and treated if necessary.

2.16.6 Waste Reception and Segregation System

The waste reception and segregation system will be designed to ensure safe and controlled acceptance of waste at the facility. All incoming waste vehicles will be registered at the entrance gate and directed to the weighbridge for measurement. Waste documentation, manifest, source details, physical condition, and compatibility information will be verified before unloading.

After verification, waste will be transferred to the designated reception area. Waste will be segregated based on type, physical form, hazard characteristics, compatibility, treatment method, and incineration suitability. Segregation will help prevent incompatible waste mixing and improve operational efficiency.

The waste reception area will be provided with an impervious floor, leachate collection system, spill control materials, ventilation, fire protection, emergency shower/eyewash facilities, and appropriate signage. Incompatible waste categories will be stored separately in designated areas. Rejected waste, if any, will be recorded and returned to the generator or managed as per regulatory instruction.

2.16.7 Waste Sampling and Analysis

Waste sampling and analysis will be conducted to confirm waste characteristics and determine appropriate handling, storage, treatment, and disposal methods. Sampling will be performed by trained personnel following approved procedures and safety protocols.

The facility may include an on-site laboratory for basic testing such as pH, moisture content, calorific value, flash point, chlorine content, heavy metals, ash content, and other relevant parameters. For specialized analysis, samples may be sent to accredited laboratories or recognized institutions.

Sampling and analysis will support waste acceptance decisions, incineration feed planning, pollution control system operation, residue classification, and compliance reporting. Proper chain-of-custody records, sample labeling, test reports, and waste acceptance documentation will be maintained.

2.16.8 Dust Suppression

Dust suppression measures will be implemented in areas where dust generation may occur, including waste unloading zones, ash handling areas, residue storage areas, internal roads, and material handling points. The purpose of the dust suppression system is to protect workers, prevent fugitive emissions, and maintain good housekeeping within the facility.

Workers engaged in dust-prone operations will be provided with appropriate personal protective equipment such as dust masks or respirators, gloves, goggles, and protective clothing.

2.16.9 Incineration Residue Handling System

The incineration process will generate residues such as bottom ash, slag, fly ash, and air pollution control residues. These residues will be collected, cooled, stored, treated, and disposed of in an environmentally sound manner.

The residue handling system will include ash discharge equipment, cooling arrangements, conveyors or containers, covered storage areas, residue collection bins, and transfer systems. Residue handling areas will be provided with impervious flooring, leachate collection, dust suppression, and spill control measures.

Residues will be tested periodically to determine their hazardous characteristics. Based on test results, residues may be stabilized, solidified, recycled if suitable, or disposed of in a secured landfill cell within the TSDF facility or other approved disposal facility.

2.16.10Air Pollution Control Residue Handling

Air pollution control residues include fly ash, spent activated carbon, scrubber sludge, lime residue, filter dust, and other residues collected from flue gas treatment systems. These materials may contain concentrated pollutants such as heavy metals, salts, acid gas reaction products, and trace organic contaminants.

Such residues will be handled carefully as potentially hazardous materials. The system will include sealed collection hoppers, enclosed transfer systems, residue storage silos or drums, dust-tight containers, and dedicated handling procedures. Direct contact with workers and exposure to air will be minimized.

Air pollution control residues will be sampled and analyzed before final disposal.

2.16.11Bottom Residue Handling

Bottom residue refers to ash, slag, and non-combustible materials discharged from the primary combustion chamber. The bottom residue will be collected from the incinerator bottom after combustion and cooling.

The handling system may include wet ash discharge, water quenching, ash skips, or closed containers depending on the final plant design. The residue will be stored temporarily in a designated covered area with impervious flooring and leachate collection.

Bottom ash will be tested to determine whether it is hazardous or non-hazardous.

2.16.12Residue Treatment and Disposal

Residue treatment and disposal will be carried out based on the physical and chemical characteristics of the residues generated from the incineration and pollution control systems. The main objective is to reduce the environmental risk associated with residue storage and final disposal.

Treatment methods may include stabilization, solidification, neutralization, dewatering, encapsulation, or chemical treatment. Stabilization and solidification may be used to reduce the mobility of heavy metals and other contaminants. Treated residues will be tested to confirm compliance with disposal criteria.

2.16.13Water Treatment System

The water treatment system will be designed to treat wastewater generated from plant operations, including scrubber blowdown, floor wash water, equipment cleaning water, contaminated stormwater, laboratory wastewater, and domestic wastewater where applicable.

Depending on wastewater characteristics, the treatment system may include oil and grease trap, equalization tank, neutralization tank, chemical dosing, coagulation-flocculation, settling, filtration, activated carbon treatment, biological treatment, sludge dewatering, and final polishing units.

Treated water may be reused within the facility for dust suppression, ash conditioning, gardening, or other non-potable purposes, subject to quality requirements.

2.16.14Raw Water Treatment

Raw water treatment will be provided to improve the quality of water received from the selected source before its use in process, utility, and domestic applications. The level of treatment will depend on the source water quality and intended use.

The raw water treatment system may include screening, sedimentation, pressure sand filtration, activated carbon filtration, softening, disinfection, and chemical dosing. For boiler feed or sensitive equipment, additional treatment such as reverse osmosis, demineralization, or anti-scaling treatment may be required.

Treated raw water will be stored in dedicated tanks and distributed through separate pipelines for process use, domestic use, fire-fighting reserve, and other utility requirements.

2.16.15Potable Water

Potable water will be supplied for drinking, cooking, sanitation, washing, and other domestic uses within the facility. Potable water will be provided to administrative buildings, laboratory areas, control rooms, worker facilities, rest areas, and security posts.

The potable water system will include treated water storage tanks, disinfection units, pumps, pipelines, and distribution points. Water quality will be maintained in accordance with applicable drinking water standards. Regular testing of potable water will be conducted for basic parameters such as pH, turbidity, total dissolved solids, microbial quality, and residual chlorine, where applicable.

2.16.16Pollution Control Measures

The TSDF incineration project is equipped with an integrated pollution control system to minimize environmental impacts during waste handling, combustion, flue gas treatment, residue

management, wastewater handling, and final disposal. Pollution control measures will be incorporated at the design, construction, and operational stages.

The key objectives of the pollution control measures are to:

- Ensure controlled combustion of waste under designed temperature and residence time conditions.
- Minimize emissions of particulate matter, acid gases, heavy metals, dioxins, furans, volatile organic compounds, and other pollutants.
- Prevent fugitive dust and odor emissions from waste handling and residue management areas.
- Control wastewater generation and ensure treatment before reuse or discharge.
- Safely collect, store, treat, and dispose of incineration residues and air pollution control residues.
- Maintain continuous monitoring, inspection, and reporting for environmental compliance.

2.16.16.1 Air Emission Control System

The air emission control system will be designed to treat flue gas generated from the incineration process before discharge through the stack. The system will be integrated with the incinerator, secondary combustion chamber, gas cooling system, air pollution control devices, induced draft fan, continuous emission monitoring system, and stack.

The incineration process will be operated under controlled conditions to ensure complete combustion and reduce the formation of harmful pollutants. The primary combustion chamber will be used for drying, volatilization, and combustion of waste, while the secondary combustion chamber will ensure complete oxidation of combustible gases. Adequate temperature, turbulence, oxygen supply, and residence time will be maintained to achieve efficient destruction of organic pollutants.

The flue gas generated from the secondary chamber will pass through a gas cooling and treatment system. Rapid cooling of flue gas may be applied to reduce the possibility of reformation of dioxins and furans. Chemical dosing, activated carbon injection, lime dosing, filtration, scrubbing, or equivalent treatment technologies may be used depending on the final plant design.

The air emission control system will be designed to control the following major pollutants:

- Particulate matter and fly ash.
- Acid gases such as HCl, HF, SO_2, and other acidic components.
- Nitrogen oxides generated during high-temperature combustion.
- Heavy metals such as mercury, lead, cadmium, chromium, and other toxic metals.
- Dioxins, furans, and other trace organic pollutants.
- Carbon monoxide and unburned hydrocarbons resulting from incomplete combustion.

The system will be operated with proper pressure control to avoid fugitive release of flue gas from the combustion chambers and ducting. The induced draft fan will maintain negative pressure within the incineration and flue gas treatment system.

2.16.16.2 Air Pollution Control Device

The air pollution control device will be selected and designed based on the waste characteristics, incinerator capacity, expected emission load, regulatory requirements, and environmental performance targets. A multi-stage treatment arrangement will be adopted to ensure effective removal of different categories of pollutants.

A typical air pollution control system may include the following components:

Gas Cooling System:
The hot flue gas from the secondary combustion chamber will be cooled before entering the downstream pollution control units. This may be achieved through a waste heat boiler, quench tower, evaporative cooler, or heat exchanger. Rapid cooling will help reduce the risk of dioxin and furan reformation.

Dry or Semi-Dry Scrubber:
Lime or sodium-based reagent may be injected into the flue gas stream to neutralize acid gases such as HCl, HF, and SO_2. The reaction products will be collected along with fly ash in the particulate control system.

Activated Carbon Injection System:
Activated carbon may be injected to adsorb mercury, dioxins, furans, and other trace organic pollutants. The spent activated carbon will be collected as air pollution control residue and handled as hazardous waste.

Bag Filter / Fabric Filter:
A bag filter or fabric filter will be used to capture fine particulate matter, fly ash, spent reagent, and activated carbon particles. The collected dust will be discharged into sealed containers or silos to prevent fugitive emissions.

Wet Scrubber, if required:
A wet scrubber may be provided as an additional treatment stage for acid gas removal and final polishing of the flue gas. Scrubber blowdown will be collected and treated in the wastewater treatment system.

Induced Draft Fan:
The induced draft fan will draw the treated flue gas through the air pollution control system and maintain negative pressure in the incineration line. This will prevent leakage of untreated gas into the plant area.

Stack:
After treatment, the cleaned flue gas will be discharged through a stack of adequate height, designed to ensure safe dispersion of residual emissions into the atmosphere.

All air pollution control devices will be provided with inspection points, sampling ports, access platforms, pressure drop indicators, temperature monitoring, and maintenance arrangements. The collected air pollution control residues will be stored in covered, sealed, and labeled containers before treatment and disposal.

2.16.16.3 Stack Height

The stack will be designed to ensure proper dispersion of treated flue gas and to minimize ground-level concentration of pollutants. The final stack height will be determined based on plant capacity, emission characteristics, local meteorological conditions, nearby sensitive receptors, surrounding land use, building height, and regulatory requirements.

The stack will be constructed using suitable materials capable of withstanding flue gas temperature, moisture, and corrosive components. The stack will be provided with sampling ports, access ladder, working platform, lightning protection, aviation warning light if required, and structural support as per applicable standards.

The stack height will be 45m. The dispersion modeling will assess the potential impact of emissions on ambient air quality under different meteorological conditions. The design will ensure that predicted ground-level concentrations remain within applicable ambient air quality standards.

Key considerations for stack design will include:

- Adequate height for safe pollutant dispersion.
- Suitable internal diameter for proper gas velocity.
- Sampling platform and ports for manual monitoring.
- Compatibility with continuous emission monitoring system.
- Resistance to corrosion and high-temperature flue gas.

2.16.16.4 Pollution Monitoring

A comprehensive pollution monitoring program will be implemented during the operation of the TSDF facility to ensure regulatory compliance and effective environmental management. Monitoring will include continuous, periodic, and event-based monitoring of emissions, ambient air quality, wastewater, residues, noise, and workplace conditions.

For air emissions, the facility may install a Continuous Emission Monitoring System on the stack to monitor key parameters such as:

- Particulate matter.
- Carbon monoxide.
- Carbon dioxide.
- Oxygen.
- Sulfur dioxide.
- Nitrogen oxides.
- Hydrogen chloride.
- Flue gas temperature.
- Gas flow rate.
- Pressure and moisture, where applicable

Periodic manual stack monitoring will also be conducted through accredited laboratories for parameters not continuously monitored, such as heavy metals, dioxins, furans, total organic carbon, HF, and other specific pollutants as required by the regulatory authority.

Ambient air quality monitoring will be conducted at selected locations within and around the project site, particularly near the plant boundary and sensitive receptors. Parameters may include PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, VOCs, and other relevant pollutants.

Pollution monitoring will also include:

- Effluent quality monitoring before reuse or discharge.
- Groundwater monitoring through observation wells, if applicable.
- Surface water monitoring near discharge or drainage points.
- Residue testing, including bottom ash, fly ash, scrubber sludge, and stabilized waste.
- Noise level monitoring at plant boundary and work areas.
- Odor and fugitive dust monitoring in waste handling and storage areas.

2.16.17Control Measures for Residue Handling

Residues generated from the incineration process and air pollution control system will be handled through a controlled and environmentally safe management system. The main residue streams will include bottom ash, fly ash, slag, air pollution control residues, spent activated carbon, scrubber sludge, and other solid or semi-solid residues generated during plant operation.

The following control measures will be adopted for residue handling:

- Proper segregation of bottom ash, fly ash, scrubber sludge, and other residues.
- Collection of residues in closed or covered systems.
- Provision of impervious flooring and leachate collection drains.
- Dust suppression through water misting, ash conditioning, or enclosed transfer.
- Use of covered containers, sealed drums, or dedicated storage bays.
- Periodic residue sampling and laboratory analysis.
- Stabilization or solidification of hazardous residues before landfill disposal, where required.
- Use of personal protective equipment by workers handling residues.
- Maintenance of records for residue generation, testing, treatment, transport, and final disposal.

2.16.18Noise Control

Noise may be generated during construction and operation of the TSDF facility from equipment such as incinerator fans, blowers, pumps, compressors, generators, waste handling equipment, conveyors, vehicles, cranes, shredders, and other mechanical systems. Noise control measures will be incorporated in the plant design and operational management plan to protect workers and surrounding communities.

During the operational phase, major noise-generating equipment will be installed with appropriate engineering controls such as acoustic enclosures, silencers, vibration isolators, flexible connections, and noise barriers where required. Equipment will be selected with low-noise design features as far as practicable.

The plant layout will consider suitable separation between high-noise equipment and administrative buildings, laboratories, control rooms, worker rest areas, and site boundaries. Greenbelt development along the boundary will also support noise attenuation.

Noise control measures will include:

- Installation of silencers on fans, blowers, compressors, and DG sets.
- Provision of acoustic enclosures for high-noise equipment.
- Use of vibration pads and anti-vibration mounts.
- Regular preventive maintenance of rotating equipment.
- Lubrication and alignment of pumps, motors, and conveyors.
- Restriction of unnecessary horn use within the facility.
- Speed control of vehicles inside the plant premises.
- Scheduling of high-noise activities during daytime where possible.
- Use of personal protective equipment such as earplugs or earmuffs in high-noise work zones.
- Periodic workplace and boundary noise monitoring.

Noise levels will be monitored at plant boundary locations and near major equipment areas. If monitoring indicates exceedance of applicable limits, additional mitigation measures such as acoustic barriers, equipment replacement, enclosure improvement, or operational controls will be implemented.

2.16.19Effluent Treatment System

The effluent treatment system will be designed to treat wastewater generated from different plant activities before reuse, recycling, or discharge. Wastewater sources may include scrubber blowdown, floor washing water, vehicle washing water, contaminated stormwater, laboratory wastewater, equipment cleaning water, ash handling wastewater, and domestic sewage.	

Separate drainage systems will be provided for clean stormwater, contaminated process wastewater, and domestic wastewater to prevent cross-contamination. Wastewater generated from process and contaminated areas will be collected through properly designed drains and directed to the effluent treatment system. The effluent treatment system may include the following units depending on wastewater quality and final engineering design:	• Collection sump. • Oil and grease trap. • Equalization tank. • Neutralization tank. • Chemical dosing system. • Coagulation and flocculation unit. • Primary settling tank or clarifier. • Filtration system. • Activated carbon filter. • Sludge collection and dewatering system. • Final treated water tank. • Monitoring chamber before reuse or discharge.

Operational control of the effluent treatment system will include regular monitoring of flow, pH, total suspended solids, chemical oxygen demand, biological oxygen demand, oil and grease, heavy metals, total dissolved solids, and other relevant parameters. Records of effluent generation, treatment, reuse, discharge, and sludge disposal will be maintained.

2.16.20Other Waste Streams

In addition to incineration residues and wastewater, the TSDF facility will generate several other waste streams during construction, commissioning, operation, maintenance, laboratory activities, administrative activities, and worker support services. These waste streams will be managed through proper segregation, storage, treatment, recycling, and disposal practices.

Other waste streams may include:

- General waste from offices and worker facilities.
- Packaging materials such as cardboard, plastic, wooden pallets, drums, and containers.
- Used oil, lubricants, grease, and oily rags from equipment maintenance.
- Spent filters, used PPE, cleaning materials, and contaminated absorbents.
- Laboratory chemical waste and used sample containers.
- Empty reagent bags, lime bags, activated carbon bags, and chemical containers.
- Rejected or non-conforming waste received at the facility.
- Construction debris, scrap metal, concrete waste, and excavated materials.
- E-waste from office equipment.
- Domestic sewage and septic sludge, where applicable.

2.17 Standard Operating Procedure for Hazardous Waste Incinerator

2.17.1 Startup and establishment of combustion conditions

Before initiating combustion, the operator shall complete the pre-startup safety inspection and confirm the operational readiness of the incinerator, auxiliary burners, combustion-air system, induced-draft fan, temperature monitoring instruments, and air pollution control system.

The induced-draft and applicable pollution-control systems shall be established in accordance with the approved startup sequence. Adequate negative pressure shall be maintained within the combustion chamber to minimize the possibility of smoke and hazardous combustion gases escaping into the working environment.

The auxiliary burners shall be started through the approved automatic burner management sequence, including required furnace purging, ignition, and flame verification. The secondary combustion chamber shall be preheated to the validated operating temperature before waste combustion is initiated or permitted to proceed.

The primary chamber burner shall subsequently be operated in accordance with the approved startup sequence to initiate and maintain controlled combustion of the charged waste. The heating rate shall be controlled to prevent thermal shock and damage to refractory materials.

Operational safety requirements: Burner ignition shall not be attempted unless the required purge, airflow, draft, fuel-pressure, and flame-safeguard conditions are satisfied. Manual bypassing of safety interlocks, repeated ignition attempts without investigation, and operation with defective flame detectors or fuel shutoff devices are prohibited. Any abnormal pressure buildup, fuel leakage, flame failure, or uncontrolled temperature rise shall require immediate implementation of the applicable protective shutdown procedure.

2.17.2 Primary combustion and waste decomposition

Within the primary static combustion chamber, hazardous solid wastes undergo heating, moisture evaporation, thermal decomposition, gasification, and oxidation of combustible materials. The relative contribution of these processes depends on the waste composition, chamber temperature, combustion-air supply, and operating conditions.

The auxiliary burner and combustion-air system shall maintain the primary chamber within its approved operating temperature range. Combustion conditions shall be controlled to promote effective waste destruction while avoiding excessive heat release, incomplete combustion, refractory damage, and uncontrolled generation of smoke.

The operator shall monitor chamber temperature, combustion stability, burner performance, and furnace draft throughout the incineration cycle.

Operational safety requirements: The furnace charging and ash-removal doors shall remain securely closed during active combustion. Operators shall not open access doors to inspect burning waste or manually disturb the waste bed while combustion is in progress. Sudden increases in temperature, abnormal burner noise, visible smoke leakage, or indications of deflagration shall be treated as potentially hazardous operating conditions requiring immediate assessment and appropriate protective action.

2.17.3 Secondary combustion and burnout

Combustible gases, vapors, and entrained combustion products generated in the primary chamber are directed to the secondary combustion chamber, where additional combustion air and auxiliary burner heat support further oxidation.

The secondary chamber is intended to promote the destruction of residual combustible gases and organic compounds through adequate temperature, residence time, oxygen availability, and gas mixing. The operating conditions shall be established through equipment design verification, commissioning, and applicable regulatory requirements.

The secondary combustion chamber shall be maintained within its validated operating envelope throughout the period when combustible gases are being generated from the primary chamber.

Operational safety requirements: Waste combustion shall not proceed under conditions that compromise the required secondary chamber temperature, combustion-air supply, gas residence time, or furnace draft. Where automatic waste-feed cutoff or other protective interlocks are provided, these shall remain operational. For a preloaded batch furnace, stopping the burner or feed does not immediately stop the generation of combustible gases; therefore, emergency controls shall be designed to manage continuing heat release and gas generation safely.

2.17.4 Flue gas cooling and air pollution control

Following secondary combustion, the hot flue gases pass through the installed gas cooling and air pollution control systems before discharge through the stack.

Depending on the facility design, flue-gas cooling may be achieved using a quench system, heat exchanger, or other approved cooling arrangement. The cooled flue gases may subsequently pass through particulate collection equipment, acid-gas removal systems, wet scrubbers, adsorption media, or other pollution-control devices.

A typical wet treatment configuration may include a Venturi scrubber for particulate removal and gas cooling, a packed-bed scrubber for gas-liquid contact and acid-gas treatment, and a mist eliminator or cyclone separator for removal of entrained liquid droplets. Alternatively, dry or semi-dry systems may employ alkaline sorbents and particulate filtration. The actual process configuration shall be verified against approved engineering drawings and installed equipment.

The induced-draft fan maintains the required flue-gas flow through the system and supports negative-pressure operation of the combustion chambers.

Operational safety requirements: The incinerator shall not be operated when essential pollution-control equipment is unavailable or unable to maintain the approved operating conditions. Operators shall monitor relevant parameters, including flue-gas temperature, scrubber liquid flow, pH, pressure drop, water level, fan performance, and stack emission indicators, as

applicable. Loss of scrubber circulation, blocked gas passages, excessive pressure drop, fan failure, or abnormal stack emissions shall trigger the prescribed alarm and protective response.

Where wet scrubbers are installed, contaminated recirculating water and sludge shall be managed to prevent chemical exposure, overflow, corrosion, and uncontrolled discharge.

2.17.5 Controlled shutdown and cooling

Following completion of the batch incineration cycle, the operator shall verify that the waste has undergone the required combustion and burnout period. The auxiliary burners shall then be shut down according to the approved sequence, while maintaining the necessary combustion-air supply, induced draft, and pollution-control functions during the remaining burnout and cooling stages.

The furnace shall be allowed to cool gradually to a verified safe temperature before opening the combustion chamber or initiating ash removal.

Operational safety requirements: The main electrical supply, induced-draft fan, burner cooling systems, and essential pollution-control equipment shall not be switched off prematurely where continued operation is required for safe cooling and removal of residual combustion gases. Furnace doors shall remain closed until the prescribed safe-opening conditions are achieved. Water shall not be introduced directly into hot refractory-lined chambers unless specifically permitted by the equipment design and operating procedure.

2.17.6 Ash removal and residue management

After the combustion chamber has cooled to a safe condition, the remaining bottom ash shall be removed using designated tools and handling procedures. Ash removal shall be carried out carefully to minimize dust generation, thermal exposure, and contact with potentially toxic constituents.

Bottom ash, fly ash, spent sorbents, and scrubber sludge shall be collected separately, where applicable, and transferred to properly labeled containers or designated storage areas. These residues shall be characterized to determine their hazardous properties and appropriate treatment or disposal requirements.

Operational safety requirements: Personnel involved in ash handling shall wear suitable protective clothing, gloves, eye protection, and respiratory protection where required by the exposure assessment. Ash shall not be assumed to be nonhazardous solely because combustion is complete. Residual hot spots, sharp objects, toxic metals, and contaminated dust shall be considered during handling and disposal.

2.17.7 Process monitoring and operational safety management

Throughout the incineration cycle, the operator shall maintain continuous supervision of critical process parameters, including combustion chamber temperatures, burner operation, furnace draft, combustion-air availability, and the operating status of pollution-control equipment.

All operating conditions shall remain within the approved operating limits established through design verification, commissioning, performance testing, and applicable environmental permits.

The facility shall implement appropriate engineering safeguards, including emergency shutdown controls, burner flame-failure protection, temperature alarms, fuel isolation systems, and other interlocks identified through process hazard assessment.

Operational records shall include waste batch identification, quantity charged, startup and shutdown times, combustion temperature trends, abnormal operating conditions, corrective actions, ash generation, and relevant environmental monitoring data.

Any significant deviation from approved operating conditions shall be reported to the Shift Supervisor and EHS Officer. The incinerator shall not be restarted following a safety-critical failure until the cause has been investigated, corrective measures have been implemented, and formal authorization has been obtained.

2.17.8 Operating limits and safety-critical conditions

The incinerator shall be operated only within the approved operating limits established through engineering design, equipment verification, commissioning, performance testing, and applicable regulatory requirements.

The following limits shall be formally established before routine hazardous waste incineration:

Operating Parameter	Approved Limit
Maximum waste mass per batch	TBD
Maximum chamber filling fraction	TBD
Minimum waste clearance from burner	TBD
Maximum allowable batch thermal load	TBD
Primary chamber operating temperature range	TBD
Secondary chamber minimum operating temperature	TBD
Secondary chamber maximum operating temperature	TBD
Minimum secondary chamber gas residence time	TBD
Furnace negative-pressure operating range	TBD
Combustion-air operating range	TBD
Oxygen and CO operating criteria, where applicable	TBD
Flue-gas cooling and APCS operating limits	TBD
Minimum burnout acceptance criteria	TBD

Safe furnace door-opening temperature	TBD
Safe ash-removal temperature and conditions	TBD
Maximum allowable emission concentrations	As specified in applicable permits

TBD = To Be Determined through engineering verification, commissioning, performance testing, and formal approval.

No operating limit shall be adopted solely on the basis of a generic manufacturer's manual without confirming its suitability for the actual hazardous waste streams, equipment configuration, and regulatory requirements.

2.17.9 Abnormal operating conditions and stop-work requirements

The Operator shall immediately notify the Shift Supervisor and implement the prescribed protective response if any of the following conditions occur:

- Failure of an auxiliary burner, flame detector, or safety-critical fuel system component.
- Loss of induced draft or abnormal positive furnace pressure.
- Failure of essential combustion-air supply.
- Secondary chamber temperature falling below the approved minimum during active waste combustion.
- Uncontrolled increase in primary or secondary chamber temperature.
- Failure of essential air pollution control or flue-gas cooling equipment.
- Significant smoke leakage, abnormal stack emissions, or suspected toxic gas release.
- Fuel leakage, fire, explosion, or suspected deflagration.
- Failure of a critical safety interlock or emergency shutdown function.
- Any other condition presenting an immediate risk to personnel, equipment, or the environment.

The response shall be determined by the approved cause-and-effect matrix and emergency operating procedures. Protective actions may include preventing further charging, isolating burner fuel, maintaining essential draft or cooling, initiating controlled shutdown, or activating emergency shutdown.

Because combustible gases and residual heat may continue to be generated from a preloaded batch after burner shutdown, emergency shutdown shall not be assumed to mean simultaneous shutdown of all fans, cooling equipment, and pollution-control systems. The appropriate response shall be based on the identified hazard and validated protective logic.

2.17.10Operational records and authorization

The following records shall be maintained for each incineration batch:

1. Approved waste profile and batch release form.
2. Completed pre-startup inspection checklist.
3. Batch charging and operating log.
4. Temperature, draft, combustion, and environmental monitoring records.
5. Alarm, deviation, and incident reports, where applicable.
6. Shutdown, cooling, and ash-removal records.
7. Maintenance and equipment defect reports, where applicable.
8. Completed batch closeout and supervisory authorization.

All records shall be retained in accordance with the facility's document control procedure and applicable regulatory requirements.

2.18 Other Facility Infrastructure

2.18.1 Waste Vehicle Movement

The internal road network will be designed to allow smooth and safe movement of waste-carrying vehicles. Separate entry and exit arrangements may be provided where feasible. Vehicle movement will be managed to minimize congestion, prevent spillage and ensure safe maneuvering near waste unloading, incineration, residue handling and ETP areas.

Key design considerations include:

- Controlled vehicle entry and exit
- Adequate turning radius for trucks
- Separate pedestrian and vehicle movement, where possible
- Covered or paved internal roads
- Spill containment arrangements near unloading areas
- Vehicle washing facility before exit, where required
- Emergency access routes for fire service and rescue vehicles

2.18.2 Fire Protection System

A comprehensive fire protection system will be installed within the TSDF facility to prevent, detect, control, and respond to fire-related emergencies. As the facility will handle combustible, hazardous, and chemically reactive waste streams, fire safety will be considered a critical design and operational requirement.

The fire protection system will cover waste reception areas, waste storage zones, incinerator area, fuel storage area, chemical storage area, electrical rooms, control room, laboratory, administrative building, transformer area, DG set area, residue storage area, and other risk-prone locations.

The proposed fire protection system may include:

- Fire water storage tank with adequate reserve capacity.
- Fire hydrant network around major plant areas.
- Fire hose reels and landing valves at strategic locations.
- Portable fire extinguishers suitable for different fire classes.
- Fire alarm and smoke detection system.
- Heat detectors in high-risk areas.
- Manual call points and emergency sirens.
- Foam-based fire protection for fuel storage areas, if required.
- Automatic sprinkler or water spray system in selected areas.
- Fire pumps, including main pump, standby pump, and jockey pump.
- Emergency lighting and clearly marked evacuation routes.
- Fire access road for emergency vehicle movement.
- Dedicated assembly points and emergency response arrangements.

Fuel storage tanks will be provided with dyke/bund walls, earthing, flame arrestors, emergency shut-off valves, spill containment, and firefighting equipment. Chemical and waste storage areas will be segregated based on compatibility to reduce the risk of fire and chemical reaction.

The facility will prepare a Fire Safety and Emergency Response Plan. Workers will receive regular training on fire prevention, emergency evacuation, use of fire extinguishers, spill response, and safe handling of combustible materials. Fire drills will be conducted periodically in coordination with relevant local authorities, where applicable.

2.18.3 Electrical and I&C Systems

Key features of the electrical and I&C system will include:

- Reliable power distribution to all process and utility equipment.
- DG backup for emergency and essential loads.
- UPS support for control room, PLC/SCADA, CEMS, and safety systems.
- Emergency stop arrangement at critical locations.
- Interlocks for safe incinerator and pollution control operation.
- Automatic burner control and temperature regulation.
- Monitoring of pumps, fans, blowers, conveyors, and valves.
- Continuous emission monitoring interface.
- Alarm annunciation and event recording.
- Earthing and lightning protection system.
- Cable trays, conduits, and safe routing of electrical cables.
- Explosion-proof or flameproof fittings in hazardous areas, where required.

2.19 Significance of the Project

The proposed TSDF project is significant because it will provide a scientific, controlled, and environmentally sound solution for the treatment and disposal of hazardous, non-recyclable, confiscated, rejected, expired, contaminated, and special waste streams. At present, improper storage, uncontrolled dumping, open burning, and informal handling of such waste may create serious risks to public health, environmental quality, land resources, surface water, groundwater, and air quality.

The project will support Bangladesh's need for a dedicated hazardous waste treatment and disposal facility, particularly for waste generated from airports, ports, customs, industries, commercial activities, and public agencies. The facility will contribute to improved environmental governance, regulatory compliance, and safe waste management practices.

The major significance of the project includes:

- Scientific treatment and disposal of hazardous and special waste.
- Reduction of illegal dumping, open burning, and unsafe storage.
- Support to airport, port, customs, industrial, and institutional waste management.
- Protection of public health and environmental resources.
- Promotion of circular economy through segregation, recovery, and responsible disposal.
- Improved compliance with national environmental laws and ESIA commitments.
- Creation of skilled and semi-skilled employment opportunities.
- Introduction of modern waste treatment technology in Bangladesh.
- Strengthening of institutional capacity for hazardous waste management.

2.20 Project Schedule

The project schedule will be finalized during detailed engineering, procurement planning, regulatory approval, and financial closure. The implementation period may be divided into planning, approval, design, procurement, construction, installation, commissioning, and trial operation stages.

A tentative project implementation schedule is presented below:

The work plan for the Sheam Treatment, Storage and Disposal Facility (TSDF) project has been prepared to guide the overall ESIA study, project planning, design review, field investigation, stakeholder consultation, impact assessment, mitigation planning, and regulatory submission process. The work plan will help ensure that all environmental, social, technical, and regulatory requirements are addressed in a structured and timely manner.

The proposed work plan is indicative and may be revised based on the approved **Terms of Reference, site conditions, project design, technology selection, laboratory testing schedule, stakeholder feedback**, and requirements of the Department of Environment.

2.20.1 Indicative Project Implementation Work Plan

Sl. No.	Project Phase	Major Activities	Tentative Duration	Main Output

1	Regulatory Approval Phase	ESIA submission, DoE review, clarification response, approval process and clearance conditions review.	1–3 months	Environmental Clearance / approval conditions
2	Detailed Engineering Design	Final layout, civil design, mechanical design, electrical design, incinerator design, APCD, CEMS, ETP, fire safety and utility design.	2–3 months	Approved detailed design
3	Procurement Phase	Procurement of incinerator, APCD, CEMS, ETP, pumps, fans, fire safety system, laboratory equipment and construction materials.	1–3 months	Equipment supply contracts
4	Site Development	Boundary wall, site grading, earth filling, internal road, drainage and temporary facilities.	2–3 months	Prepared project site
5	Civil Construction	Construction of waste receiving area, storage shed, incinerator foundation, administrative building, laboratory, ETP, utility area and residue storage.	3–4 months	Completed civil infrastructure
6	Mechanical and Electrical Installation	Installation of incinerator, secondary chamber, APCD, stack, CEMS, ETP, fuel system, pipelines, electrical and control systems.	3–4 months	Installed plant and machinery
7	Fire Safety and Emergency System Installation	Fire hydrant, extinguishers, alarm system, emergency lighting, assembly point, spill kits and emergency response equipment.	1–2 months	Operational safety system
8	Laboratory and Monitoring Setup	Waste testing laboratory, sampling system, monitoring instruments, documentation system and waste manifest system.	1–2 months	Functional laboratory and monitoring setup
9	Trial Run and Commissioning	Equipment testing, cold trial, hot trial, emission testing, ETP testing, safety checks and operator training.	1–2 months	Commissioning report

10	Commercial Operation	Controlled waste acceptance, regular operation, environmental monitoring, compliance reporting and stakeholder communication.	Continuous	Operational TSDF facility

2.21 Future Expansion Provision

The layout will consider possible future expansion of the facility based on waste generation trends, regulatory approval and operational demand. Space may be reserved for additional incineration capacity, enhanced material recovery, laboratory expansion, secured landfill cell development, additional storage, renewable energy integration or advanced resource recovery systems.

CHAPTER 3

Policy, Legal and Administrative Framework

This chapter reviews the national policies, acts, rules, guidelines and environmental standards of Bangladesh that apply to the proposed TSDF and incineration facility, the administrative set-up and environmental clearance procedure of the Department of Environment, relevant international conventions and the international safeguard requirements and good practice guidelines considered in the assessment.

3 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

3.1 Overview

This chapter presents the administrative, legal, policy and institutional framework applicable to the proposed Integrated Treatment, Storage and Disposal Facility (TSDF) and Incineration Facility of Sheam TSDF BD at Telihati, Sreepur, Gazipur. The project involves waste receiving, segregation, storage, material recovery, controlled incineration, wastewater management, emission control, ash/residue handling and environmental monitoring; therefore, it is subject to environmental clearance, waste management, occupational health and safety, fire safety, land-use, transport and public health-related requirements.

The ESIA study has been prepared considering the regulatory requirements of the Department of Environment (DoE), Bangladesh, applicable national laws and policies, and relevant international good practices. The Environment Conservation Rules, 2023 were issued under the Bangladesh Environment Conservation Act, 1995 and regulate activities that may affect the environment and human health. They classify industrial units and projects into categories based on environmental risk and require environmental clearance for applicable projects.

For a TSDF and incineration facility, the legal framework is especially important because the project may involve handling solid waste, hazardous waste, healthcare-related waste, air emissions, effluent, residue, traffic movement and emergency risks. Therefore, the project must be designed and operated in compliance with national environmental standards and approval conditions.

3.2 National and International Framework

3.2.1 National Regulatory Frameworks

The following table enlists the available national regulatory framework related to the TSDF protocol.

Table 24: National regulatory frameworks related to the TSDF protocol

Reference	Application to the TSDF protocol
Bangladesh Environment Conservation Act 1995, as amended	Environmental protection, regulatory powers and environmental clearance framework
Environment Conservation Rules 2023	Environmental classification, clearance and applicable environmental requirements
Solid Waste Management Rules 2021	Solid waste management, segregation, collection, storage, recovery and disposal, as applicable
Hazardous Waste and Ship Breaking Waste Management Rules 2011	Hazardous waste classification and management requirements, as applicable
E-Waste Management Rules	Segregation and authorized management of electrical and electronic waste
Medical Waste (Management and Processing) Rules 2008	Applicable healthcare-related waste management

Applicable air-pollution control requirements	Incinerator emissions, air-pollution-control equipment and monitoring
Customs, import/export and port-specific legislation and orders	Legal release, confiscated goods, abandoned consignments, destruction approvals and controlled materials

Legal implementation

The TSDF's legal register should distinguish three categories:

- Binding legal requirements: Bangladesh legislation, applicable rules, license conditions, customs orders and other legally applicable directions.
- International obligations: treaty requirements applicable to Bangladesh, including relevant Basel Convention and MARPOL obligations.
- Technical good practice: ISO standards, Basel technical guidance, IMO guidance, and other engineering standards adopted in the project design.

An international guideline should not automatically be described as a Bangladesh statutory requirement unless it has been incorporated into applicable law, a permit, or an enforceable project condition.

3.2.1 International Technical References

The following table enlists the available international technical frameworks related to the TSDF protocol.

Table 25: International regulatory frameworks related to the TSDF protocol

Reference	Relevance
Basel Convention — hazardous-waste inventory methodology	Inventory, classification and tracking of hazardous and other wastes
Basel Convention — technical guidelines on incineration on land (D10) and specially engineered landfill (D5)	Incineration suitability, environmental controls and residue disposal
Basel Convention — technical guidelines on plastic wastes	Plastic identification, recovery and environmentally sound management
Basel Convention — mercury and persistent organic pollutant (POP) waste guidelines	Segregation and specialist treatment of high-risk materials
World Customs Organization (WCO) — SOPs for controls of waste shipments	Customs inspection, waste shipment controls and institutional coordination
International Maritime Organization (IMO) — MARPOL Annex V	Ship-generated garbage, port reception facilities, segregation and recordkeeping
ISO 14001	Environmental management system
ISO 45001	Occupational health and safety management

ISO 14040 and ISO 14044	Life-cycle assessment of waste-management alternatives
Applicable ISO/IEC 17025 requirements	Laboratory competence and quality assurance

3.3 Applicable National Legal Requirements

The following national legal instruments are applicable or relevant to the proposed project:

Law / Rule / Regulation	Relevance to the Project
Bangladesh Environment Conservation Act, 1995	Principal environmental law for conservation of environment, improvement of environmental standards and control/mitigation of pollution. (Bangladesh Laws)
Environment Conservation Rules, 2023	Provides environmental clearance process, project categorization, standards and environmental management requirements. (ECOLEX)
Solid Waste Management Rules, 2021	Relevant for solid waste handling, segregation, collection, storage, treatment and disposal; includes Extended Producer Responsibility concepts. (Sustainable Development Goals)
Medical Waste Management and Processing Rules, 2008	Relevant if the facility receives healthcare-related waste or infectious waste streams.
Bangladesh Labour Act, 2006 and amendments	Relevant for worker health, safety, working conditions, PPE, welfare and accident prevention.
Bangladesh Labour Rules, 2015	Provides supporting rules for occupational health and safety, workplace welfare and labor management.
Fire Prevention and Fire Fighting Act, 2003	Relevant for fire safety planning, fire license, fire prevention and emergency response.
Bangladesh National Building Code	Relevant for structural safety, fire safety, drainage, access, utility and building design.
Road Transport Act, 2018	Relevant for safe transportation of waste, vehicle operation, driver responsibility and road safety.
Disaster Management Act, 2012	Relevant for emergency preparedness, disaster risk reduction and response planning.
Water Act, 2013	Relevant for protection and use of surface water and groundwater resources.
The Embankment and Drainage Act, 1952	Relevant if the site affects drainage channels, embankments, water flow or flood protection structures.

3.4 Applicable Policies in Bangladesh

Several national policies are relevant to the proposed TSDF project because it supports pollution prevention, sustainable waste management, public health protection and environmental compliance.

These policies include:

Policy	Relevance

National Environment Policy	Provides policy direction for environmental protection, pollution control and sustainable development.
National 3R Strategy for Waste Management	Promotes reduce, reuse and recycle principles; relevant to material recovery and waste minimization. The Solid Waste Management Rules 2021 also reflect 3R and EPR-based waste management concepts. (Sustainable Development Goals)
National Industrial Policy	Supports environmentally responsible industrial development and compliance.
National Health Policy	Relevant to public health, healthcare waste and prevention of exposure to hazardous materials.
National Occupational Safety and Health Policy	Relevant to worker safety in waste handling, incineration, chemical exposure and emergency response.
Bangladesh Climate Change Strategy and Action Plan, 2009	Relevant to climate resilience, disaster preparedness, pollution reduction and adaptation planning.

3.5 Other Policies in Bangladesh

3.5.1 National Environmental Management Action Plan (NEMAP), 1995

The National Environmental Management Action Plan (NEMAP), 1995 provides a broad framework for environmental management in Bangladesh. It emphasizes environmental protection, pollution control, institutional strengthening, public awareness and integration of environmental considerations into development planning.

The proposed TSDF project is consistent with NEMAP objectives because it is objective to introduce a *scientific and centralized waste management facility* for controlling pollution from solid, special and hazardous waste streams.

3.5.2 The EIA Guidelines for Industry, 2021

The EIA *Guidelines for Industry*, 2021 provide guidance for preparing and reviewing Environmental Impact Assessment reports for industrial projects in Bangladesh. The guidelines identify key steps of the EIA process, including screening, scoping, baseline data collection, impact assessment, mitigation and environmental management planning.

For the Sheam TSDF project, these guidelines are directly relevant because the ESIA will assess the project's potential impacts on air, water, soil, noise, traffic, occupational health, community health and emergency risk.

3.5.3 National Conservation Strategy (NCS), 1992

The *National Conservation Strategy (NCS)*, 1992 promotes sustainable use of natural resources and conservation of the environment. The proposed project supports the principles of conservation by reducing unsafe waste disposal, controlling pollution and promoting material recovery where feasible.

3.5.4 National Land Transport Policy, 2004

The *National Land Transport Policy*, 2004 is relevant because the proposed facility will involve transportation of waste from different source areas to the project site. Waste transportation must be managed through approved vehicles, route planning, covered transport, spill prevention, driver training and emergency response measures.

3.5.5 National Water Management Plan, 2001 (approved in 2004

The *National Water Management Plan* is relevant to the protection of surface water, groundwater and drainage systems. For the TSDF project, wastewater, leachate, scrubber water, floor wash and contaminated runoff must be properly collected, treated and monitored to prevent pollution of water resources.

3.5.6 National Policy for Safe Water Supply & Sanitation (NPSWSS) 1998

This policy is relevant because the project must ensure *safe sanitation, worker hygiene, wastewater management* and prevention of contamination of water sources. The project's ETP, drainage design and water management systems should be planned to protect public health and environmental quality.

3.5.7 Open Space Protection

Open space protection is relevant where development activities may affect natural drainage, green areas, community open space or ecological buffers. The project should maintain appropriate internal open space, greenbelt, emergency access, drainage corridors and buffer areas to reduce environmental and social impacts.

3.5.8 Disaster Management Act, 2012

The *Disaster Management Act*, 2012 is relevant because TSDF operation involves potential emergency scenarios such as fire, explosion, chemical reaction, spill, leakage, incinerator upset condition, APCD failure and flood-related incidents. The project should include a Disaster Management Plan and Emergency Response Plan.

3.5.9 Road Transport Act, 2018

The *Road Transport Act*, 2018 is relevant to the movement of waste-carrying vehicles. The project should ensure safe vehicle operation, trained drivers, route control, speed control, traffic management, accident response and proper documentation for waste transport.

3.5.10 The Embankment and Drainage Act, 1952

This Act is relevant if the project site or access road affects natural drainage channels, embankments or water flow. The project should avoid obstruction of drainage and ensure that site development DoE's not increase local flooding or waterlogging.

3.5.11 Bangladesh Climate Change Strategy and Action Plan, 2009

The *Bangladesh Climate Change Strategy and Action Plan*, 2009 is relevant because the project should consider climate resilience, flood risk, extreme rainfall, heat stress, emergency preparedness and low-carbon resource recovery opportunities. The site design should include stormwater management, flood protection and resilient infrastructure planning.

3.6 Administrative Setup related to Environment in Bangladesh

3.6.1 Department of Environment (DOE)

The Department of Environment (DoE) is the main regulatory authority for environmental management in Bangladesh. It reviews environmental assessment documents, issues environmental clearance, sets conditions for project implementation, monitors compliance and takes enforcement action where necessary. The EIA Guidelines for Industry identify DoE as the formal authority responsible for reviewing and approving EIA reports.

3.6.2 Procedure for obtaining Environmental Clearance from DoE, Bangladesh

The environmental clearance process generally includes the following steps:

Project screening and categorization	The project is screened based on its nature, size, location and potential environmental risk.
Submission of application to DoE	The project proponent submits prescribed application forms, project documents and relevant supporting information.
Site clearance / location clearance, where applicable	For environmentally sensitive or higher-risk projects, DoE may require location clearance before full project implementation.
Preparation and submission of ESIA / EIA report	A detailed ESIA report is prepared covering baseline condition, impact assessment, mitigation measures, EMP, monitoring plan, risk assessment and stakeholder consultation.
Review by DoE	DoE reviews the report and may request additional information, clarification or revision.
Issuance of Environmental Clearance Certificate	If the project is found acceptable, DoE issues environmental clearance with conditions.
Implementation of EMP and monitoring	The project proponent implements mitigation measures and submits monitoring reports as required.
Renewal of clearance	Environmental clearance must be renewed as per applicable rules and DoE conditions.
Under the 2023 Rules, Bangladesh maintains project/industry categorization based on pollution potential; legal summaries note Green, Yellow, Orange and Red classifications, with Red category requiring stronger assessment and approval requirements. Given the nature of TSDF and incineration activities, the proposed project should be treated as a high-risk environmental project requiring detailed ESIA, risk assessment and strong EMP.	

3.7 International Legal Obligations

Bangladesh is party to several international conventions and declarations that are relevant to environmental protection, biodiversity, wetlands, cultural heritage, hazardous waste management and sustainable development. The proposed TSDF project should consider these obligations where applicable.

3.7.1 Rio Declaration

The *Rio Declaration on Environment and Development*, **1992** sets out principles for sustainable development, environmental protection, precautionary approach, public participation and environmental impact assessment. The proposed project aligns with the Rio principles by conducting ESIA, applying pollution control measures and promoting environmentally responsible waste management.

3.7.2 The Minamata Convention (Mercury)

The Minamata Convention on Mercury provides the global framework for protecting human health and the environment from anthropogenic emissions, releases, and wastes containing mercury and mercury compounds. The Convention requires Parties to ensure the environmentally sound management of mercury waste throughout its lifecycle, including collection, transportation, storage, treatment, and final disposal. In this context, Treatment, Storage, and Disposal Facilities (TSDFs) are essential for safely handling mercury-contaminated wastes generated from industrial processes, products, and pollution control systems. Properly designed TSDFs support compliance with the Convention by preventing mercury releases to air, water, and land, ensuring secure storage and treatment of mercury-bearing wastes, and facilitating their environmentally sound disposal in accordance with international best practices and national regulations.

3.7.3 The Hazardous Waste and Ship Breaking Waste Management Rules, 2011

The Hazardous Waste and Ship Breaking Waste Management Rules, 2011 of Bangladesh provide the national regulatory framework for the generation, collection, transportation, storage, treatment, recycling, and disposal of hazardous wastes, including wastes arising from ship-breaking and industrial activities. The Rules mandate environmentally sound management of hazardous wastes to protect human health and the environment and authorize the Department of Environment (DoE) to oversee compliance. In this context, the establishment of Treatment, Storage, and Disposal Facilities (TSDFs) is essential for ensuring the safe transportation, interim storage, treatment, recovery, and final disposal of hazardous and ship-breaking wastes. TSDFs serve as a critical infrastructure component for implementing the Rules by providing centralized facilities that minimize environmental contamination, enhance regulatory compliance, and support sustainable hazardous waste management practices nationwide.

3.7.4 The Basel Convention (Hazardous waste movement)

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal provides the international legal framework for the environmentally sound management (ESM) of hazardous wastes. Its primary role is to regulate and minimize the transboundary movement of hazardous wastes, particularly from developed to developing countries, and to ensure that such wastes are handled, transported, stored, treated, and disposed of in a manner that protects human health and the environment. Within this framework, the Convention encourages countries to establish adequate Treatment, Storage, and Disposal

Facilities (TSDFs) as an essential component of national hazardous waste management systems. TSDFs provide the infrastructure necessary for the safe collection, transportation, interim storage, treatment, recovery, and final disposal of hazardous wastes, thereby reducing reliance on cross-border waste movements and supporting compliance with the Convention's principles of self-sufficiency, proximity, and environmentally sound management.

3.7.5 The Stockholm Convention (POPs, including dioxins/furans)

The Stockholm Convention on Persistent Organic Pollutants (POPs) provides the global framework for eliminating or reducing the release of highly toxic and persistent chemicals, including unintentionally produced POPs such as dioxins and furans. The Convention requires Parties to identify, collect, transport, store, treat, and dispose of POP-containing wastes in an environmentally sound manner to prevent their release into the environment. In this context, Treatment, Storage, and Disposal Facilities (TSDFs) play a critical role by providing the infrastructure needed for the safe handling, temporary storage, destruction, and final disposal of POP-contaminated materials and hazardous wastes. Properly designed TSDFs help countries comply with Convention obligations by ensuring that POPs are irreversibly destroyed or transformed and do not re-enter the environment through improper waste management practices.

3.7.6 Convention on Biological Diversity, 1992

The *Convention on Biological Diversity (CBD),* 1992 is relevant where projects may affect flora, fauna, habitats or ecosystems. The ESIA will assess ecological conditions around the project site and recommend mitigation measures to avoid or minimize impacts on biodiversity.

3.7.7 Convention on Wetlands of International Importance Especially as Waterfowl Habitat, Ramsar, 1971

The *Ramsar Convention, 1971* is relevant if any wetland, water body or ecologically sensitive aquatic habitat is located within the project's influence area. The ESIA should confirm whether the project site has any connection to Ramsar sites or important wetlands and ensure that wastewater, leachate and runoff do not affect wetland resources.

3.7.8 UNESCO World Heritage Convention

The **UNESCO World Heritage Convention** is relevant where a project may affect any World Heritage Site or cultural/natural heritage area. The ESIA should confirm that the project DoEs not create direct or indirect impacts on any protected heritage site.

3.8 International Safeguard Requirements

3.8.1 IFC Performance Standards

The **IFC Performance Standards on Environmental and Social Sustainability** provide guidance for identifying, avoiding, mitigating and managing environmental and social risks. IFC states that the Performance Standards are directed toward clients and are intended to help avoid,

mitigate and manage risks and impacts through sustainable business practices, including stakeholder engagement and disclosure.

The eight IFC Performance Standards are:

IFC Performance Standard	Relevance to Sheam TSDF
PS1: Assessment and Management of Environmental and Social Risks and Impacts	ESIA, ESMP, monitoring and management system
PS2: Labor and Working Conditions	Worker safety, PPE, training and labor welfare
PS3: Resource Efficiency and Pollution Prevention	Incineration, APCD, ETP, ash management, waste minimization
PS4: Community Health, Safety and Security	Traffic, emergency response, public exposure and grievance
PS5: Land Acquisition and Involuntary Resettlement	Applicable only if land acquisition or displacement occurs
PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	Ecology, greenbelt and sensitive habitat protection
PS7: Indigenous Peoples	Applicable if Indigenous communities are affected
PS8: Cultural Heritage	Applicable if cultural heritage resources are affected
Recommended as good practice	

3.8.2 IFC Project Categorization

Under IFC's risk-based approach, projects are categorized based on the type, location, sensitivity and scale of risks and impacts. A TSDF and incineration facility may be considered a higher-risk project because it involves hazardous or special waste, thermal treatment, air emissions, wastewater, ash/residue handling, transport risk and community perception.

For the Sheam TSDF project, the ESIA should therefore apply a robust risk management approach, including stakeholder engagement, emergency planning, monitoring and grievance redress.

3.8.3 IFC EHS Guidelines

The World Bank Group / IFC Environmental, Health and Safety (EHS) Guidelines provide technical reference for pollution prevention, occupational health and safety, community safety, waste management, wastewater, air emissions, hazardous materials and emergency preparedness. These guidelines may be used as good international industry practice alongside Bangladesh's national standards.

For this project, relevant EHS areas include:

- Waste management facilities
- Hazardous materials management
- Air emissions and ambient air quality
- Wastewater and water quality

- Occupational health and safety
- Community health and safety
- Emergency preparedness and response
- Fire and explosion prevention

3.9 Applicable Environmental Standards

3.9.1 Flue Gas Emission Standard

Flue gas emissions from the incineration unit must be controlled through proper combustion design, secondary combustion chamber, Air Pollution Control Devices and Continuous Emission Monitoring System.

Relevant parameters may include:

- Particulate matter
- SO_2
- NOx
- CO
- HCl
- HF
- VOCs / TOC
- Heavy metals
- Dioxins and furans, where applicable
- Oxygen, temperature and flow rate
- Opacity, where applicable

3.9.2 Ambient Air Quality Standard

Ambient air quality monitoring should be conducted at the project boundary and selected sensitive receptors. Parameters may include:

- $PM_{2.5}$
- PM_{10}
- SO_2
- NOx
- CO
- Ozone, where applicable
- VOCs, where applicable
- HCl/HF or other project-specific pollutants, where required

3.9.3 Noise Level Standard

Noise levels must comply with applicable standards based on land-use category, such as industrial, commercial, mixed or residential areas. Monitoring should be conducted during both day and night periods.

Noise sources may include:

- Incinerator operation
- Blowers and fans
- Pumps
- Waste handling equipment
- Vehicle movement
- DG sets

3.9.4 Effluent Standard

Effluent from the ETP must comply with applicable DoE standards before discharge or reuse. The ETP should treat:

- Scrubber wastewater
- Floor wash
- Vehicle wash water
- Leachate
- Contaminated runoff
- Laboratory wastewater

Indicative monitoring parameters include:

- pH
- BOD
- COD
- TSS
- TDS
- Oil and grease
- Heavy metals
- Chloride
- Sulphate
- Phenolic compounds, where applicable
- Other project-specific pollutants

3.9.5 Sewage Discharge Standard

Domestic sewage generated from administrative buildings/offices, worker facilities and sanitation systems must be managed through septic tank/soak pit, sewage treatment system or connection to approved disposal facilities, depending on site condition and regulatory approval.

Monitoring parameters may include:

- pH
- BOD
- COD

- TSS
- Total coliform
- Oil and grease

3.9.6 Stack Height

The stack height of the incineration unit must be designed based on applicable DoE requirements, emission characteristics, plant capacity, local meteorology, surrounding land use and air dispersion considerations. Stack design should support effective dispersion of treated flue gas while ensuring compliance with ambient air quality standards and project-specific clearance conditions.

CHAPTER 4

Analysis of Alternatives

This chapter examines reasonable alternatives to the proposed project, including the no-project option, site, waste management approach, thermal treatment technology, air pollution control, auxiliary fuel, wastewater, residue disposal, layout and transport route alternatives, and explains the basis on which the preferred options were selected.

4 ANALYSIS OF ALTERNATIVES

4.1 Introduction

The analysis of alternatives is a central requirement of the ESIA process under the DoE EIA Guidelines for Industry (2021) and international good practice. Its purpose is to demonstrate that the proposed project represents the most appropriate option, having regard to environmental, social, technical, regulatory and economic considerations, and to show how the comparison of options has influenced the project design.

This chapter considers the following alternatives: (a) the no-project alternative; (b) site alternatives; (c) the overall waste management approach; (d) thermal treatment technology; (e) air pollution control systems; (f) auxiliary fuel; (g) wastewater management; (h) residue disposal; and (i) layout and waste transport routes.

4.2 Criteria for Comparison of Alternatives

Each alternative has been compared qualitatively against the criteria in the table below. The comparison uses the project information presented in Chapter 2 and the baseline information in Chapter 6.

Table 26: Criteria used for the analysis of alternatives

Criterion	Considerations
Environmental performance	Air emissions, wastewater, residues, risk to soil and groundwater, greenhouse gas emissions
Social acceptability	Distance to settlements and sensitive receptors, community concerns, traffic and safety, land acquisition
Technical suitability	Ability to treat the expected heterogeneous waste streams safely and reliably; proven track record
Regulatory compliance	Ability to meet ECR 2023 standards and DoE clearance conditions and to apply good international practice
Health and safety	Occupational and community risk, emergency response requirements
Economic and operational feasibility	Capital and operating cost, availability of skills, spare parts, utilities and reagents

4.3 No-Project Alternative

Under the no-project alternative the facility would not be built. The site would remain in its present condition and none of the construction or operational impacts described in Chapter 7 would occur at Telihati.

However, the national problem the project is designed to address would remain. Hazardous, confiscated, expired and contaminated waste from airports, ports, customs warehouses, industries and healthcare facilities would continue to be stored for long periods, disposed of in uncontrolled dumps, burnt in the open or mixed with municipal waste. These practices release uncontrolled emissions (including dioxins and furans from open burning), contaminate soil, surface water and groundwater, and expose waste workers and communities to chemical and biological hazards. Regulators and waste generators would also continue to lack an authorized outlet, which undermines enforcement of the Environment Conservation Rules, 2023 and related waste rules.

The no-project alternative would therefore avoid local impacts at the site but would perpetuate larger, more widespread and unmanaged environmental and public health risks elsewhere. It is not considered a preferable option.

4.4 Site Alternatives

4.4.1 Site Selection Criteria

Hazardous waste treatment facilities require careful siting. The criteria applied to the selection of the project site are listed below together with the status of the selected site at Telihati, Sreepur, on the basis of the information currently available.

Table 27: Site selection criteria and status of the selected site

Criterion	Requirement	Status of selected site	Remarks
Land use compatibility	Industrial or compatible land use; avoid residential zones	Located within an industrially developing area of Sreepur	Land classification to be confirmed with land documents (Annexure 2)
Distance to sensitive receptors	Adequate separation from settlements, schools, hospitals and religious institutions	Nearest features reported at approx. 1–2 km	Verified IEF distance matrix to be completed (Chapter 6)
Protected and ecologically sensitive areas	Outside national parks, reserved forests, ECAs and wetlands	No protected area identified within the immediate project area	Distance to the nearest protected area to be confirmed by GIS
Flood and waterlogging	Above high flood level; no history of prolonged inundation	Madhupur Tract terrace; low riverine flood risk	Site platform level to be set above highest recorded water level
Geology and groundwater	Low-permeability soils; adequate depth to groundwater	Madhupur Clay is generally of low permeability	Geotechnical and hydrogeological investigation required
Access	All-weather road access for heavy vehicles, avoiding congested settlements	Direct road access reported	Waste transport route assessment required
Proximity to waste sources	Reasonable haulage distance from major generators	Within the Dhaka–Gazipur industrial corridor	Favorable
Utilities	Availability of power, water and telecommunications	Reported available nearby	Water source and abstraction permission to be confirmed
Land availability	Sufficient area for facility, buffer and greenbelt without displacement	3 acres; no physical displacement reported	Adequacy for secured landfill and future expansion to be confirmed

4.4.2 Alternative Sites Considered

Good practice requires the ESIA to record the alternative sites that were considered by the proponent and the reasons for selecting the preferred site. The comparison should be presented in the format below.

Table 28: Comparison of alternative sites

Criterion	Site A (selected): Telihati, Sreepur	Site B	Site C
Location and land area	Telihati, Sreepur, Gazipur; 3 acres	Master Bari , Gazipur	Rajshahi
Distance to nearest settlement	1KM	2.5KM	3KM
Flood risk	Low	Low	High
Road access	Direct road access	No Direct Access	No Direct Access
Ecological sensitivity	Low (modified habitat)	Low (modified habitat)	Low (modified habitat)
Land acquisition / resettlement	None reported	None reported	None reported
Overall ranking	Preferred	Preferred	Moderate

4.4.3 Selection of the Site

On the basis of the criteria above, the Telihati site is considered suitable for the proposed facility, subject to confirmation of the site-specific geotechnical, hydrogeological and flood level data and the sensitive receptor distances. Its main advantages are its location within an industrially developed area, its road connectivity to the Dhaka–Gazipur industrial corridor, the generally low-permeability terrace soils and the absence of physical displacement. The main constraints are the limited land area (3 acres), which restricts the size of the secured landfill and buffer zone, and the presence of settlements and agricultural land in the surrounding area, which requires strict emission, odour, traffic and emergency controls.

4.5 Alternative Waste Management Approaches

Four overall approaches were considered for managing the target waste streams.

Table 29: Comparison of waste management approaches

Approach	Advantages	Disadvantages	Assessment
Landfill only (direct disposal in secured landfill)	Lower capital cost; simple operation	Not suitable for organic, liquid, infectious or reactive hazardous waste; long-term leachate liability; large land demand	Rejected
Incineration only	Destroys organic and infectious waste; large volume reduction	Unsuitable for non-combustible, metal-bearing or inorganic waste; no material recovery; residues still require secured disposal	Rejected as a stand-alone option
Off-site treatment (export or third-party facilities)	No local facility impacts	No licensed multi-sector TSDF in Bangladesh; export under the Basel Convention is costly and slow	Not feasible at scale
Integrated TSDF (acceptance control, segregation, recovery, incineration, stabilization, secured disposal)	Treats each waste stream by the most appropriate route; supports the waste hierarchy; traceability	Higher capital and operating cost; requires skilled operation and laboratory support	Preferred

The integrated TSDF approach is preferred because it applies the waste hierarchy (reduction, segregation, recovery, treatment and safe disposal) and allows each waste stream to be directed to the most appropriate route on the basis of laboratory characterization and the Waste Acceptance Criteria. Co-processing of suitable high-calorific waste (e.g. certain solvents, oily waste and sludges) in cement kilns is recognized as a complementary outlet that may be used where a kiln operator agrees and the DoE permits it, but it is not suitable for infectious, highly chlorinated or mercury-bearing waste and cannot replace a dedicated facility.

4.6 Thermal Treatment Technology Alternatives

The main thermal and non-thermal treatment technologies considered for the combustible and infectious fractions are compared below.

Table 30: Comparison of treatment technology alternatives

Technology	Description	Suitability for project waste	Assessment
Rotary kiln incinerator with secondary combustion chamber	Rotating refractory-lined kiln followed by a high-temperature secondary chamber	Handles heterogeneous solids, sludges, liquids, drums and packaged waste; widely proven for hazardous waste	Preferred (subject to capacity and cost)
Controlled-air (two-chamber) static hearth incinerator	Starved-air primary chamber and excess-air secondary chamber	Suitable for smaller capacities and relatively uniform solid waste; less suited to liquids and bulky drummed waste	Acceptable for the 6 t/day initial capacity if designed for the waste mix
Fluidised bed incinerator	Combustion in a fluidised sand bed	Requires homogeneous, pre-shredded feed; unsuitable for mixed hazardous waste	Rejected
Plasma arc / pyrolysis / gasification	High-temperature or oxygen-starved conversion	High capital and energy cost; limited commercial track record in the region	Rejected at this stage
Non-burn technologies (autoclave, microwave)	Steam or microwave disinfection	Suitable only for infectious healthcare waste; not for chemical waste	Possible complementary unit for infectious waste

Controlled high-temperature incineration is the preferred core technology. Whichever furnace type is finally selected, the design should achieve a secondary chamber temperature of at least 850°C with a gas residence time of at least 2 seconds, increasing to at least 1,100°C where waste containing more than 1% halogenated organic substances (as chlorine) is burnt, with automatic waste feed cut-off interlocks on low temperature, high CO or APCD failure. These requirements correspond to international good practice for hazardous waste incineration and should be confirmed against the applicable DoE standards in Chapter 3.

4.7 Air Pollution Control Alternatives

Table 31: Comparison of air pollution control alternatives

Option	Advantages	Disadvantages
Wet scrubbing	High removal of acid gases (HCl, HF, SO_2)	Generates scrubber blowdown requiring treatment; visible plume; higher water demand
Semi-dry (spray absorber with lime slurry) + bag filter	Good acid gas removal; no liquid effluent; combined with bag filter	More solid residue; requires careful temperature control
Dry sorbent injection (hydrated lime or sodium bicarbonate) + bag filter	Simple, robust, no liquid effluent	Higher reagent consumption; more residue
Activated carbon injection	Removes dioxins/furans and mercury	Spent carbon must be managed as hazardous residue
Rapid quench after secondary chamber	Minimises dioxin/furan re-formation (de novo synthesis window approx. 200–450°C)	Water demand; must be integrated with APC design

The preferred configuration is: secondary combustion chamber → rapid quench → dry or semi-dry acid gas reactor with activated carbon injection → bag filter → optional wet polishing scrubber → induced draft fan → 45 m stack with CEMS. This arrangement minimizes process wastewater while meeting emission limits. The process sequence described in Chapter 2 should be harmonized with this configuration.

4.8 Auxiliary Fuel Alternatives

Auxiliary fuel is required for start-up, shutdown and maintaining combustion temperatures. Chapter 2 indicates use of diesel (approx. 250 L/day) and furnace oil (approx. 1,200 L/day). The options are compared below.

Table 32: Comparison of auxiliary fuel alternatives

Fuel	Advantages	Disadvantages	Assessment
Furnace oil (heavy fuel oil)	Lower cost; available	Higher sulphur, PM and metal emissions; heating required; larger spill consequences	Least preferred
Diesel (light fuel oil)	Clean combustion; easy to handle; reliable supply	Higher cost than furnace oil; flammable liquid storage	Preferred liquid fuel
LPG	Very clean combustion; low SO_2 and PM	Pressurised storage; supply logistics	Acceptable alternative
Natural gas (pipeline)	Cleanest combustion; no on-site bulk liquid storage	Subject to availability of a new connection	Preferred if connection available

Use of diesel, LPG or natural gas in place of furnace oil is recommended to reduce SO_2 and particulate emissions and the consequences of fuel spills. If furnace oil is retained, its sulphur content, storage, bunding and emission implications must be assessed explicitly in Chapters 7 and 9.

4.9 Wastewater Management Alternatives

Three options were considered: (a) treatment in the ETP and discharge to an external drain; (b) treatment in the ETP and reuse within the facility for ash conditioning, dust suppression, floor washing and greenbelt irrigation; and (c) zero liquid discharge using evaporation. Option (b) is preferred because it minimises water abstraction and external discharge at moderate cost; any surplus discharge must meet the ECR 2023 effluent standards and be approved by the DoE. Zero liquid discharge is energy-intensive and is not considered necessary if a dry or semi-dry APC system is adopted.

4.10 Residue Disposal Alternatives

Incinerator bottom ash, fly ash, APC residues and ETP sludge may contain leachable heavy metals and must be tested before disposal. The options considered were: (a) disposal in an on-site secured landfill cell after testing and, where required, stabilization or solidification; (b) transfer to an external licensed hazardous waste landfill; and (c) long-term containerised storage. As no licensed external hazardous waste landfill is currently available in Bangladesh, option (a) is preferred, with stabilization of residues that fail leaching tests. Long-term storage is acceptable only as an interim measure. The available landfill area (about 11,000 sq ft in Chapter 2) should be checked against the projected residue generation over the facility life.

4.11 Layout and Transport Route Alternatives

Layout options were evaluated to separate clean and contaminated zones, keep the waste receiving, storage and incineration areas as far as practicable from the nearest receptors and the site boundary, place the stack downwind of the nearest settlements in the prevailing wind direction, provide one-way internal vehicle circulation with separate emergency access, and concentrate the greenbelt along the most sensitive boundaries.

For waste transport, routes using highways and main roads with minimum passage through settlements, markets and school zones are preferred, with deliveries scheduled outside school and peak hours where possible. The final route plan should be included in the Traffic Management Plan.

4.12 Summary of Preferred Alternatives

Table 33: Summary of preferred alternatives

Aspect	Preferred alternative	Main reason
Project need	Proceed with the project	No-project option perpetuates unsafe disposal of hazardous waste
Site	Telihati, Sreepur (subject to confirmation of site data)	Industrial setting, access, low flood risk, no displacement
Approach	Integrated TSDF	Treats each waste stream by the most suitable route; supports the waste hierarchy
Treatment technology	Controlled high-temperature incineration with secondary combustion chamber	Proven for heterogeneous hazardous waste

Aspect	Preferred alternative	Main reason
Air pollution control	Quench + dry/semi-dry reactor + activated carbon + bag filter (+ optional wet polishing)	Meets emission limits with minimal wastewater
Auxiliary fuel	Diesel, LPG or natural gas	Lower SO_2 and PM emissions than furnace oil
Wastewater	ETP with on-site reuse	Minimizes abstraction and discharge
Residues	Testing, stabilization and on-site secured landfill	No licensed external hazardous landfill available

CHAPTER 5

Approach and Methodology (Work Plan)

This chapter describes how the ESIA was carried out: the overall approach, screening and scoping, study area and assessment boundaries, baseline data collection methods, impact prediction and significance evaluation criteria, approach to mitigation, residual impact evaluation, consultation, and the work plan, assumptions and limitations of the study.

5 APPROACH AND METHODOLOGY (WORK PLAN)

This chapter describes the approach and methods used to prepare this ESIA, including the steps followed, the study area and assessment boundaries, baseline data collection, the criteria used to predict and evaluate impacts, and the work plan, assumptions and limitations of the study. The methodology follows the DoE EIA Guidelines for Industry (2021), the requirements of the Environment Conservation Rules, 2023 and international good practice, including the IFC Performance Standards and the World Bank Group EHS Guidelines.

5.1 Approach to ESIA Study

The ESIA study for the proposed Integrated TSDF and Incineration Facility of Sheam TSDF BD was carried out through a systematic, multidisciplinary and regulatory-compliant approach. The study approach is designed to identify the existing environmental and social baseline conditions, assess potential impacts, evaluate project risks, recommend mitigation measures and prepare a practical Environmental and Social Management Plan for safe project implementation.

The ESIA approach followed the requirements of the Department of Environment (DoE), Bangladesh, applicable national environmental laws and relevant good international practices for hazardous waste management, incineration, pollution control, occupational health and safety, and community protection.

The overall approach to the ESIA study will include the following key steps:

1	**Review of Project Information**
	At the initial stage, available project information was reviewed to understand the nature, size, location, technology and operational concept of the proposed TSDF facility. **This includes review of:** • Project concept and objectives • Site location and land information • Proposed plant layout • Waste sources and expected waste categories • Waste receiving and segregation process • Incineration technology and pollution control systems • Supporting infrastructure such as ETP, APCD, CEMS, ash handling and emergency response facilities • Construction and operation schedule
	This review will help define the technical boundary of the ESIA study and identify the major environmental and social issues requiring detailed assessment.
2	**Regulatory and Policy Review**
	A detailed review of applicable legal, regulatory and institutional requirements was conducted. The study was considering national environmental laws, rules, standards,

hazardous waste management requirements, occupational health and safety provisions, fire safety requirements and other relevant guidelines.

The regulatory review helps determine the project's compliance obligations, required approvals, environmental standards, monitoring requirements and reporting responsibilities. Where appropriate, relevant good international practices may also be considered to strengthen the assessment framework.

3 Scoping of Environmental and Social Issues

The scoping stage identifies the key environmental and social issues associated with the project.

This includes identification of potential impacts related to:

- Waste receiving and storage
- Waste segregation and pre-treatment
- Incineration and stack emission
- Air pollution control system
- Ash and residue management
- Wastewater, leachate and contaminated runoff
- Soil and groundwater protection
- Traffic and transportation
- Fire, explosion and emergency risk
- Worker health and safety
- Community health and safety
- Public perception and stakeholder concerns

The scoping process will help focus the ESIA on significant issues and avoid unnecessary assessment of low-risk or irrelevant matters.

4 Baseline Environmental and Social Data Collection

Baseline data was collected to establish the existing environmental and social condition of the project site and surrounding influence area. The baseline study covers the project site, immediate surrounding area and extended impact zone.

The baseline assessment will include:

Component	Study Approach
Air quality	Field monitoring and review of local pollution sources
Noise	Daytime and nighttime noise measurement
Surface water	Sampling and laboratory analysis of nearby water bodies or drainage channels
Groundwater	Sampling and analysis from representative sources
Soil	Soil sampling and contamination assessment
Land use	Field observation and mapping of surrounding land-use pattern
Ecology	Observation of vegetation, flora, fauna and sensitive habitats
Traffic	Review of access roads and vehicle movement pattern
Socio-economic condition	Community profile, livelihood, public facilities and stakeholder concerns

	The baseline information will provide the basis for impact prediction and comparison during future project monitoring.
5	**Field Survey and Site Reconnaissance**
	A field survey will be conducted to verify site conditions and surrounding environmental features. **The site reconnaissance will examine:** • Existing land use • Nearby settlements and sensitive receptors • Access roads and transport routes • Drainage pattern and water bodies • Industrial activities around the site • Topography and flood vulnerability • Utility availability • Buffer area and greenbelt opportunity • Environmental constraints and safety considerations
	The site survey will help validate project suitability and support development of appropriate mitigation measures.
6	**Waste Inventory and Characterization Approach**
	The ESIA assesses the expected waste streams proposed to be handled by the facility. The study reviews waste sources, approximate quantities, physical characteristics and treatment suitability. **The waste characterization approach considers:** • Source of waste • Type and composition of waste • Combustible and non-combustible fractions • Recyclable and recoverable fractions • Hazardous characteristics • Moisture content • Calorific value, where required • Compatibility and reactivity • Suitability for incineration, recycling, stabilization or secured disposal
	A clear **Waste Acceptance Criteria (WAC)** will be recommended to ensure that only approved and technically suitable waste is accepted for treatment.
7	**Impact Identification and Prediction**
	Potential impacts were identified and predicted for both construction and operation phases. The assessment will consider direct, indirect, cumulative, short-term, long-term, reversible and irreversible impacts. **The impact assessment covers:** • Air quality impacts • Stack emission impacts

	• Odor impacts • Wastewater and leachate impacts • Soil and groundwater contamination risks • Noise impacts • Traffic impacts • Ash and residue impacts • Occupational health and safety impacts • Community health and safety impacts • Emergency and accidental impacts • Socio-economic impacts
	The significance of impacts are evaluated based on magnitude, duration, extent, likelihood, sensitivity of receptors and effectiveness of mitigation measures.
8	**Risk Assessment Approach**
	A risk-based approach are adopted for hazardous waste handling and incineration-related hazards. The study identifies possible accident scenarios and evaluates their likelihood and consequences. **Risk assessment includes:** • Hazard identification • Fire and explosion risk assessment • Chemical incompatibility risk • Waste spill and leakage risk • Incinerator upset condition • APCD failure scenario • ETP failure scenario • Worker exposure risk • Emergency response capacity assessment
	A **5×5 risk matrix** may be used to classify risks as low, medium, high or extreme and to recommend appropriate control measures.
9	**Analysis of Alternatives**
	The ESIA evaluates reasonable alternatives to the proposed project. **This includes analysis of:** • No-project alternative • Site alternatives • Technology alternatives • Incineration-only versus integrated TSDF approach • Waste treatment and disposal alternatives • Layout alternatives • Transportation route alternatives • Pollution control alternatives
	The preferred option will be selected based on environmental performance, technical feasibility, regulatory compliance, operational safety and long-term sustainability.

10	**Development of Mitigation Measures**
	Based on the identified impacts and risks, suitable mitigation measures will be developed. The mitigation hierarchy will be followed in the sequence of: **Avoid → Minimize → Control → Treat → Monitor → Compensate, where applicable.** Mitigation measures will be proposed for air emissions, wastewater, leachate, soil and groundwater protection, waste storage, ash handling, noise, traffic, worker safety, community safety, emergency preparedness and environmental monitoring.
11	**Environmental and Social Management Plan**
	An Environmental and Social Management Plan were prepared to convert the ESIA findings into practical implementation measures. The ESMP defines: • Mitigation measures • Monitoring requirements • Institutional responsibilities • Implementation schedule • Reporting procedures • Training requirements • Emergency response actions • Documentation and recordkeeping • Budgetary provisions, where applicable
	The ESMP will serve as the main operational compliance tool for the construction and operation phases of the project.
11	**Stakeholder Engagement Approach**
	Stakeholder engagement was conducted to understand the views, concerns and expectations of relevant parties. **The stakeholder engagement approach includes:** • Identification of key stakeholders • Consultation meetings or interviews • Recording of concerns and suggestions • Integration of feedback into project planning • Development of grievance redress mechanism • Disclosure of relevant project information
12	**Preparation of ESIA Report**
	The final ESIA report compiles the project description, legal framework, baseline findings, impact assessment, risk assessment, alternatives analysis, mitigation measures, ESMP, monitoring plan, stakeholder consultation outcomes and conclusion. The report was prepared in a clear, evidence-based and regulatory-compliant format suitable for submission to the concerned authorities and use by the project proponent for project planning, implementation and compliance monitoring.

5.2 Methodology for the ESIA Study

The methodology for the ESIA study of the proposed Integrated TSDF and Incineration Facility of Sheam TSDF BD has been designed to ensure a systematic assessment of environmental, social, health, safety and regulatory issues associated with the project. The methodology follows a step-by-step approach covering project screening, scoping, baseline data collection, impact identification, impact prediction, mitigation planning, residual impact evaluation, environmental management planning, monitoring and stakeholder engagement.

The ESIA methodology will be applied to all relevant project phases, including site preparation, construction, commissioning, operation, emergency situations, closure and post-closure management.

5.2.1 Screening and Categorization

Screening is the first step of the ESIA process and is carried out to determine the environmental sensitivity, regulatory classification and level of assessment required for the proposed project.

The proposed project involves handling, storage, treatment, incineration and disposal of solid, special and hazardous waste streams. Due to the nature of the waste, thermal treatment process, potential emissions, wastewater generation, ash/residue management and associated health and safety risks, the project is considered an environmentally sensitive waste management facility.

Under the regulatory framework of Bangladesh, the project is expected to fall under a high environmental risk category requiring detailed environmental assessment and approval from the Department of Environment (DoE).

The screening process considers:

1	Nature and type of waste to be handled
2	Project location and surrounding land use
3	Incineration and emission control requirements
4	Wastewater, leachate and residue management
5	Proximity to settlements, industries, water bodies and sensitive receptors
6	Occupational and community health and safety risks
7	Need for detailed ESIA, EMP and monitoring plan
The outcome of screening confirms that a comprehensive ESIA study is required to assess potential impacts and define appropriate mitigation and monitoring measures.	

5.2.2 Scoping

Scoping is undertaken to identify the key environmental and social issues that require detailed assessment in the ESIA study. It helps define the study boundary, important receptors, likely impacts and required baseline data.

The scoping process for this project focuses on issues related to waste receiving, segregation, storage, pre-treatment, incineration, air pollution control, ash handling, wastewater treatment, emergency response and community concerns.

The major issues identified for detailed assessment include:

1	Air emissions from incineration
2	Odor from waste receiving and storage areas
3	Wastewater from scrubber systems, floor washing and vehicle washing
4	Leachate and contaminated runoff
5	Ash, fly ash and residue management
6	Soil and groundwater contamination risk
7	Noise from machinery, vehicles and plant operation
8	Traffic and road safety impacts
9	Fire, explosion and chemical incompatibility risks
10	Occupational health and safety risks
11	Community health and safety concerns
12	Stakeholder perception regarding hazardous waste and incineration
13	Emergency preparedness and disaster management requirements
The scoping stage will also define the spatial boundary of the study, including the project site, immediate impact zone and wider influence area around **Telihati, Sreepur, Gazipur**.	

5.2.3 Environmental and Social Baseline Data Collection

Baseline data collection carried out to establish the existing environmental and social conditions of the project area before implementation of the proposed facility. This baseline serves as the reference point for impact prediction, mitigation planning and future monitoring.

The baseline study includes both primary data collection through field surveys, site inspections, stakeholder consultations and environmental sampling, and secondary data review from published reports, maps, government records, meteorological data, land-use information and relevant regulatory documents.

The baseline data collection will cover the following components:

Component	Methodology
Ambient Air Quality	Field monitoring of $PM_{2.5}$, PM_{10}, SO_2, NOx, CO and other relevant parameters
Noise Level	Daytime and nighttime noise monitoring at representative locations
Surface Water	Sampling and analysis of nearby water bodies, canals or drainage channels
Groundwater	Sampling from tube wells or representative groundwater sources
Soil Quality	Soil sampling from project site and surrounding areas
Land Use	Field observation, mapping and review of local land-use pattern
Ecology	Observation of vegetation, flora, fauna and sensitive habitats

Traffic Condition	Assessment of access roads, vehicle movement and transport routes
Socio-economic Condition	Review of settlement pattern, livelihood, institutions and community facilities
Sensitive Receptors	Identification of nearby settlements, schools, mosques, health centers, markets and water bodies
The baseline data will be analyzed to identify existing environmental constraints, sensitive receptors and potential cumulative impacts from surrounding industrial activities.	

5.2.4 Impact Assessment and Mitigation Measures

Impact assessment conducted to identify, predict and evaluate the likely environmental and social impacts of the proposed project during construction and operation phases. The assessment considered both normal operating conditions and potential accidental or emergency scenarios.

The impact assessment examined:

1	Source of impact
2	Pathway of impact
3	Receptor sensitivity
4	Magnitude of impact
5	Duration and frequency
6	Spatial extent
7	Likelihood of occurrence
8	Reversibility
9	Significance before and after mitigation

For each identified impact, suitable mitigation measures are proposed. These measures follow the mitigation hierarchy:

The mitigation measures incorporated into the Environmental Management Plan to ensure practical implementation during project development and operation.



5.2.5 Potential Impact Prediction

Impact prediction estimated the likely changes to environmental and social conditions resulting from the proposed project activities. The prediction are based on project design information, baseline data, professional judgment, applicable standards, similar project experience and, where required, technical modeling.

Potential impacts to be predicted include:

Project Activity	Potential Impact
Site preparation and construction	Dust, noise, construction waste, traffic and worker safety risks
Waste transportation	Traffic movement, road safety, accidental spills and odor
Waste receiving and storage	Odor, leachate, pest attraction, occupational exposure
Segregation and pre-treatment	Worker exposure, noise, dust and waste handling risks
Incineration	Stack emissions, ash generation and thermal process risks
APCD operation	Scrubber wastewater, sludge and maintenance waste
Ash and residue handling	Soil and groundwater contamination risk
ETP operation	Treated effluent quality and sludge management
Emergency situations	Fire, explosion, spill, chemical reaction and public safety concern
Prediction will also consider cumulative impacts from nearby industrial activities, road traffic and existing environmental conditions in the Sreepur-Gazipur industrial cluster.	

5.2.6 Impact Evaluation

Impact evaluation determines the significance of each predicted impact. The evaluation considers the sensitivity of receptors, magnitude of impact, geographical extent, duration, frequency, probability and legal compliance requirements.

The following criteria are used for impact evaluation:

Criteria	Description
Magnitude	Degree of environmental or social change
Extent	Site-specific, local, regional or wider impact
Duration	Short-term, medium-term or long-term
Frequency	One-time, intermittent or continuous
Likelihood	Rare, unlikely, possible, likely or almost certain
Reversibility	Reversible, partly reversible or irreversible
Receptor Sensitivity	Low, medium or high sensitivity
Regulatory Importance	Compliance with applicable standards and permits
Based on these criteria, impacts may be classified as **low, moderate, high or significant**. High and significant impacts will require strong mitigation, engineering controls, management procedures and continuous monitoring.	

5.2.7 Mitigation and Enhancement Measures

Mitigation measures are developed to avoid, reduce or control adverse impacts identified during the ESIA. Enhancement measures are also recommended to improve positive project outcomes such as employment, environmental awareness, institutional compliance and community benefit.

Key mitigation measures may include:

Impact Area	Mitigation / Enhancement Measure
Air Emission	Controlled combustion, secondary chamber, APCD, CEMS and stack testing
Odor	Covered storage, quick processing, good housekeeping and ventilation control
Wastewater	ETP for scrubber water, floor wash, vehicle wash and leachate
Leachate	Impervious floor, drainage control, leachate collection and treatment
Ash and Residue	Segregated handling, stabilization, testing and secured disposal
Noise	Acoustic enclosure, equipment maintenance and greenbelt
Traffic	Route planning, covered vehicles, speed control and driver training
Fire Safety	Fire detection, hydrant system, extinguishers, emergency water and drills
Worker Safety	PPE, SOPs, training, medical checkup and exposure control
Community Safety	Buffer zone, grievance mechanism, disclosure and emergency coordination
Positive Impact	Local employment, skill development and environmental compliance support
Mitigation measures will be integrated into project design, construction contracts, operational SOPs and monitoring requirements.	

5.2.8 Residual Impact Evaluation

Residual impacts are the impacts that remain after applying mitigation measures. The ESIA evaluates whether the remaining impacts are acceptable, manageable and compliant with applicable standards.

Residual impact evaluation considers:

- Effectiveness of proposed mitigation measures
- Remaining risk after control measures
- Need for additional engineering or management controls
- Monitoring requirements
- Emergency preparedness requirements
- Regulatory compliance status

- Community acceptability

5.2.9 Environmental Management Plan (EMP) and Environmental Monitoring Plan

An Environmental Management Plan was prepared to translate the ESIA findings into practical actions for project implementation and operation. The EMP defines the mitigation measures, responsibilities, monitoring requirements, reporting system, training needs and institutional arrangements.

The EMP covers:

- Construction phase environmental management
- Operational phase environmental management
- Air emission management
- Wastewater and leachate management
- Ash and residue management
- Waste acceptance and storage management
- Odor and noise control
- Traffic and transport safety
- Occupational health and safety
- Fire safety and emergency response
- Community health and safety
- Documentation, recordkeeping and compliance reporting

An Environmental Monitoring Plan was also prepared to verify the effectiveness of mitigation measures and ensure continued compliance.

Indicative monitoring parameters include:

Monitoring Area	Parameters
Stack Emission	PM, SO_2, NOx, CO, HCl, HF, VOCs, heavy metals, dioxins/furans where applicable
CEMS	Continuous monitoring of key emission indicators
Ambient Air	$PM_{2.5}$, PM_{10}, SO_2, NOx, CO and other relevant parameters
ETP Outlet	pH, BOD, COD, TSS, TDS, oil & grease, heavy metals
Surface Water	pH, DO, BOD, COD, TDS, heavy metals
Groundwater	pH, TDS, iron, arsenic, chloride, heavy metals
Soil	pH, organic matter, heavy metals and contamination indicators
Noise	Daytime and nighttime noise levels
Ash and Residue	TCLP test, heavy metals and disposal suitability
Occupational Health	Worker exposure, PPE compliance and medical checkup records
The EMP and monitoring plan will also include corrective action procedures for any non-compliance or abnormal operating condition	

5.2.10 Consultation, Disclosure and Grievance Redress

Stakeholder consultation is an important part of the ESIA process. Consultation was conducted to understand concerns, expectations and suggestions from affected communities, government agencies, local administration, industrial stakeholders and other interested parties.

The consultation process involves:

- Identification of relevant stakeholders
- Disclosure of project information in understandable language
- Meetings or discussions with local communities and institutions
- Consultation with local government and regulatory authorities
- Engagement with waste generators and transport operators
- Documentation of comments, concerns and recommendations
- Integration of stakeholder feedback into project planning and EMP

A Grievance Redress Mechanism **(GRM)** will be developed to receive, record, review and resolve complaints or concerns related to the project.

The GRM will include:

- Complaint receiving channel
- Complaint registration and documentation
- Screening and assignment of responsibility
- Investigation and response
- Corrective action, where required
- Communication with complainant
- Closure and recordkeeping
- Periodic review of grievance trends

The consultation, disclosure and grievance process will help ensure transparency, improve community confidence and support responsible implementation of the proposed Sheam TSDF BD Facility.

5.3 Study Area and Assessment Boundaries

The spatial boundary of the assessment has been defined in three levels, as shown in the table below. The temporal boundary covers the pre-construction, construction, commissioning, operation, closure and post-closure phases of the project.

For the purpose of environmental assessment, the study area may be considered in three levels:

Table 34: ESIA Study Zone

Study Zone	Description
Project Site / Core Area	The land area proposed for the TSDF and incineration facility, including all treatment units, storage areas, internal roads, utilities and greenbelt.

Immediate Impact Zone	Surrounding area within approximately 1 km of the project boundary, covering nearby land use, receptors, access roads, drainage and local environmental features.
Extended Influence Zone	Wider study area within approximately 5 km, including industrial clusters, settlements, water bodies, traffic routes and cumulative environmental conditions.

5.4 Baseline Data Collection Methods

Baseline data were collected from primary field investigations and secondary sources. The methods and the scope of the baseline data collection are described below; the results are presented in Chapter 6. Baseline data study scope includes climate and meteorology, ambient air quality, noise level, surface water, groundwater, soil quality, land use, ecology, socio-economic condition, sensitive receptors, traffic, and disaster vulnerability

5.4.1 Primary Data Collection

Primary data collection was carried out to understand the existing environmental and social conditions of the project site and its surrounding area. The primary data provides site-specific information and helps validate the findings obtained from secondary sources. It also supports impact prediction, mitigation planning, and environmental management measures.

Primary data collection for the ESIA study may include the following activities:

Site Reconnaissance Survey:	A field visit was conducted to observe the proposed project site, access route, surrounding land use, nearby settlements, drainage pattern, vegetation, water bodies, and existing infrastructure. The survey helped identify environmentally sensitive locations and possible project influence areas.
Environmental Monitoring:	Baseline environmental monitoring may be conducted at representative locations within and around the project site. This may include ambient air quality, noise level, surface water quality, groundwater quality, soil quality, and meteorological observations. Monitoring locations should be selected based on wind direction, nearby receptors, drainage pattern, access routes, and expected project impact zones.
Soil and Land Condition Assessment:	Soil samples may be collected from selected locations to assess existing soil characteristics, contamination status, texture, pH, organic matter, heavy metals, and other relevant parameters. The assessment will help determine baseline soil quality and support planning for land development, drainage, and pollution prevention measures.
Water Quality Sampling:	Surface water and groundwater samples may be collected from nearby ponds, canals, tube wells, or other water sources. The samples should be analyzed for physical, chemical, and biological parameters to establish baseline water quality before project implementation.

Air Quality and Noise Monitoring:	Ambient air quality and noise level monitoring may be conducted near the project site boundary, nearby settlements, access road, and other sensitive receptors. These data will be used to compare future project-related changes and assess compliance with applicable standards.
Ecological Survey:	A rapid ecological survey may be conducted to identify existing vegetation, trees, aquatic features, wildlife presence, bird activity, and any sensitive habitat within the study area. The survey will help assess potential impacts on local ecology and determine mitigation measures such as greenbelt development.
Socio-Economic Survey and Consultation:	Consultations may be conducted with local community members, landowners, workers, local government representatives, nearby institutions, and other stakeholders. The consultation process will identify public concerns, expectations, livelihood conditions, local infrastructure, perceived risks, and potential benefits of the project.
Traffic and Access Assessment:	Existing road condition, vehicle movement, access suitability, and nearby traffic-sensitive locations may be assessed. This is important because waste transportation and construction material movement may increase traffic load during construction and operation.

5.4.2 Secondary Data Collection

Secondary data collection was carried out to supplement primary information and provide broader regional context for the ESIA study. Secondary data helps understand the existing environmental, social, administrative, legal, and planning conditions of the project area.

Secondary information may be collected from government agencies, published reports, maps, research documents, official statistics, environmental databases, regulatory documents, and previous studies relevant to Gazipur District and the proposed project area.

The key sources of secondary data includes:

- Department of Environment publications, environmental rules, standards, and clearance requirements.
- Bangladesh Bureau of Statistics data on population, demography, economy, and administrative profile.
- Bangladesh Meteorological Department data on rainfall, temperature, humidity, wind speed, and wind direction.
- Bangladesh Water Development Board information on rivers, flood levels, drainage, and hydrology.
- Geological Survey of Bangladesh information on regional geology, soil, and groundwater.
- Bangladesh Forest Department and relevant authorities for protected areas, forest land, and ecological sensitivity.
- Local government offices for land use, roads, drainage, infrastructure, and development plans.

- Published ESIA/EIA reports of similar industrial, waste management, or infrastructure projects.
- Satellite images, topographic maps, land use maps, and GIS-based information.
- National policies, laws, rules, guidelines, and international good practice documents related to hazardous waste management and incineration.

Secondary data collection will help establish the regional baseline for climate, geology, topography, hydrology, land use, biodiversity, socio-economic conditions, disaster risk, traffic network, and environmental sensitivity. These data will also support the assessment of cumulative impacts, alternative analysis, regulatory compliance, and preparation of the Environmental Management Plan.

5.5 Impact Significance Evaluation Criteria

The impact evaluation has been conducted through a structured assessment of project activities, environmental receptors and potential interaction pathways. The following criteria have been considered:

Criteria	Description
Nature of Impact	Positive or negative
Type of Impact	Direct, indirect or cumulative
Duration	Short-term, medium-term or long-term
Extent	Site-specific, local, regional or national
Magnitude	Low, medium or high
Sensitivity of Receptor	Low, medium or high
Probability	Unlikely, possible, likely or certain
Significance	Minor, moderate or major
Reversibility	Reversible or irreversible
Mitigation Potential	Easily mitigable, partially mitigable or difficult to mitigate

The significance of impacts has been evaluated based on the interaction between the magnitude of project activities and the sensitivity of environmental and social receptors.

5.6 Impact Significance Rating

Impact Significance	Description
Low / Minor	Limited impact, site-specific, temporary and easily manageable through standard mitigation measures.
Medium / Moderate	Noticeable impact requiring specific management, monitoring and mitigation measures.
High / Major	Significant impact requiring strict control, advanced mitigation, regulatory compliance and continuous monitoring.
Positive	Beneficial impact on environment, economy, employment, public health, compliance or national waste management system.

5.7 Assumptions and Limitations

The proposed work plan is based on the following assumptions:

a. required project information, layout and technical documents will be made available in time;
b. site access will be available for field survey and monitoring;
c. baseline monitoring can be conducted within the planned period;
d. laboratory test results will be available within the expected reporting time;
e. stakeholder consultation can be arranged with local support;
f. any additional requirement from DoE may require revision of the work plan.

In addition, the following limitations apply to this assessment:

- The project design is at a conceptual stage; final capacities, equipment specifications and layout may change during detailed engineering, and any significant change will require review of this ESIA.
- Baseline monitoring represents the season in which it was carried out and may not capture full seasonal variation; continued monitoring before commissioning is recommended.
- Impact predictions for air emissions depend on the final stack parameters and emission data supplied by the technology provider.
- The waste quantities and composition are estimates; the Waste Acceptance Criteria and laboratory characterization will govern the waste actually accepted.

CHAPTER 6

Environmental and Social Baseline

This chapter presents the existing physical, biological and socio-economic conditions of the project site and its study area, including topography, geology, climate, air quality, noise, water resources, soil, land use, agriculture, ecology, socio-economic profile, climate change context and the location of sensitive receptors and infrastructure.

6 ENVIRONMENTAL AND SOCIAL BASELINE

6.1 Study Area

The study area for the proposed TSDF/incineration project has been defined to assess the existing environmental and social baseline conditions and to identify the potential impacts arising from project construction, commissioning, operation, and associated activities. The study area includes the proposed project site, immediate surroundings, access roads, nearby settlements, water bodies, agricultural lands, industrial/commercial establishments, and other sensitive receptors that may be influenced by the project.

For the purpose of the ESIA study, the study area may be divided into two broad zones:

Core Zone:
The core zone includes the proposed project site and its immediate boundary area where direct project activities will take place. This includes land development, waste reception, storage, incineration, residue handling, air pollution control, effluent treatment, internal road development, utility installation, and other facility infrastructure.
Buffer Zone:
The buffer zone includes the surrounding area that may be indirectly affected by the project through air emissions, traffic movement, noise, stormwater runoff, wastewater discharge, land use change, employment generation, and community interaction. The buffer zone will be considered for baseline monitoring, receptor identification, impact assessment, and environmental management planning. The study area will be examined in terms of physical, biological, and socio-economic environmental components. The physical environment includes land use, topography, geology, soil quality, hydrology, drainage, groundwater, surface water, air quality, noise level, and climate. The biological environment includes vegetation, aquatic ecology, terrestrial ecology, wildlife presence, and any sensitive or protected habitat. The socio-economic environment includes population, settlement pattern, livelihood, land ownership, infrastructure, traffic, community facilities, occupational health and safety, and public perception.
The delineation of the study area will be supported by site visits, field observations, stakeholder consultation, environmental monitoring, GIS mapping, and review of relevant secondary information. Sensitive receptors such as houses, schools, mosques, markets, hospitals, ponds, canals, agricultural fields, industrial units, roads, and community facilities will be identified and mapped as part of the baseline assessment.

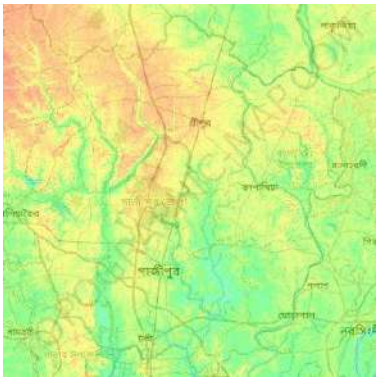
6.2 Topography

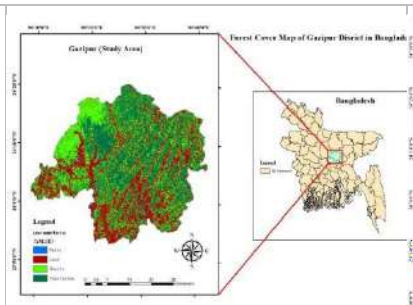
Gazipur District is located in the central part of Bangladesh and forms part of the greater Madhupur Tract physiographic region. The general topography of Gazipur is characterized by slightly elevated terraces, gently undulating landforms, low-lying floodplain areas, natural drainage channels, seasonal depressions, and localized wetland features. Compared to many floodplain districts of Bangladesh, Gazipur has relatively higher ground in several areas, although low-lying lands are also present along rivers, canals, and belt areas.

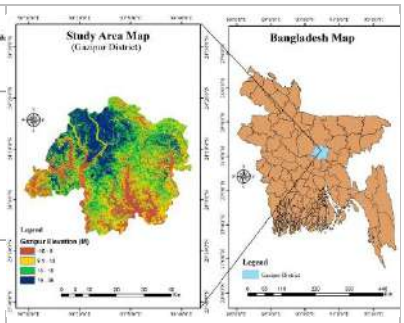
The landform of Gazipur is mainly influenced by the old alluvial terrace of the Madhupur Tract and the surrounding river systems. The terrain is generally flat to gently undulating, with gradual slopes toward natural drainage channels. The elevation varies from place to place depending on local

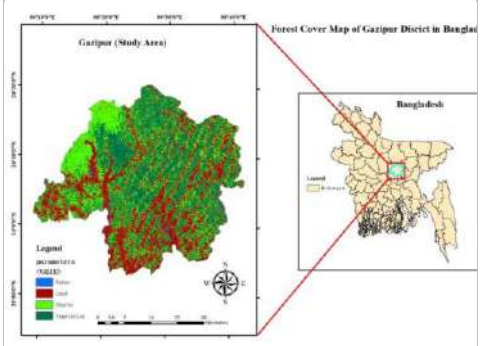
geomorphology, river proximity, and land development activities. Industrial, urban, agricultural, and semi-rural land uses are commonly observed across the district.

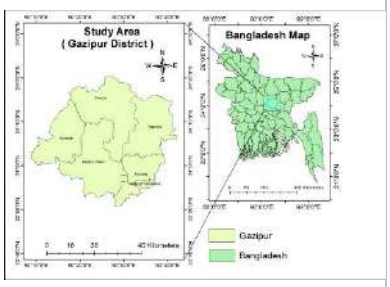
The project area in Gazipur should be assessed considering its local elevation, drainage pattern, flood susceptibility, nearby water bodies, existing land use, road access, and surrounding settlement pattern. Any low-lying portion of the site may require controlled land filling, proper compaction, stormwater drainage, and erosion protection measures before construction.





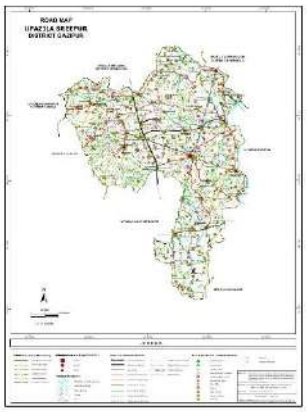


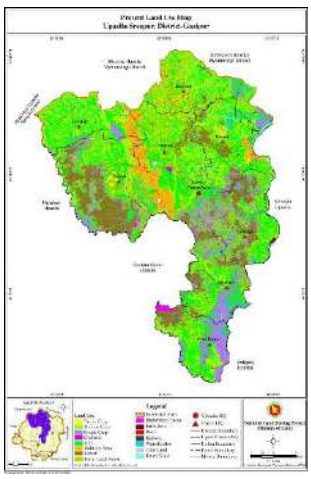


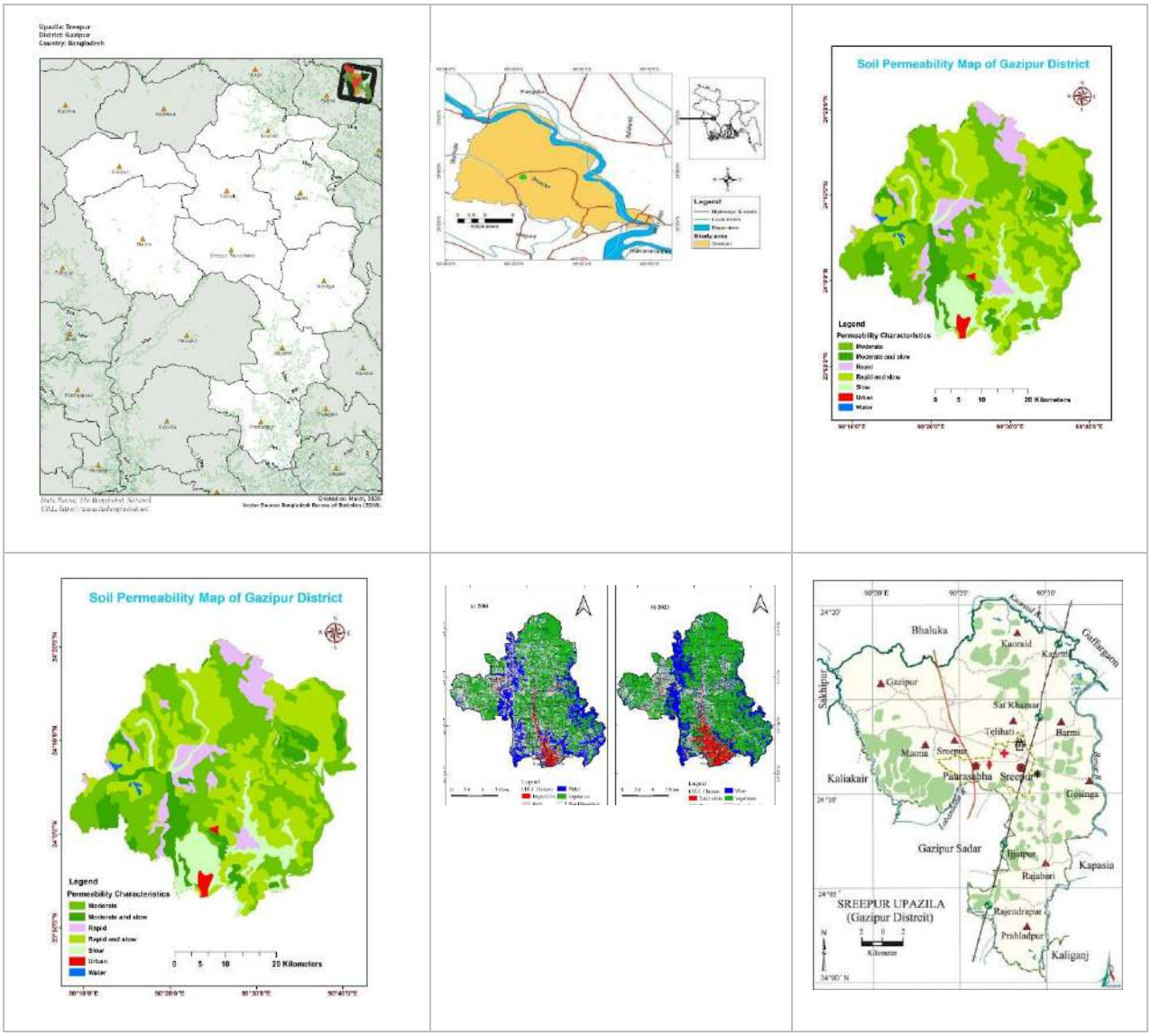












6.3 Geology of Gazipur

Gazipur District is located within the central part of Bangladesh and forms part of the **Madhupur Tract**, one of the major Pleistocene terrace regions of the country. The regional geology is mainly characterized by older terrace deposits, reddish-brown clayey soils, silty clay, fine sand, and alluvial sediments in low-lying floodplain areas. The Madhupur Tract is generally slightly elevated compared with the surrounding active floodplains and is geologically associated with Pleistocene-age terrace deposits.

The dominant geological formation in many parts of Gazipur is commonly associated with *Madhupur Clay*, which consists of highly weathered, oxidized, reddish-brown clay deposits. These deposits are generally firm to stiff in nature and may contain varying proportions of silt and fine sand. In lower areas near rivers, canals, wetlands, and floodplain zones, younger alluvial deposits may be present, consisting of soft clay, silt, silty sand, and recent floodplain sediments.

Gazipur's geological condition is important for the planning and design of the *TSDF/incineration* facility because subsurface soil characteristics influence foundation design, drainage planning,

landfill liner stability, leachate control, stormwater movement, and groundwater protection. The site-specific geology should therefore be confirmed through geotechnical investigation, borehole drilling, soil classification, groundwater level measurement, and laboratory testing.

Regional Geological Characteristics

- Gazipur is part of the Madhupur Tract, which is a Pleistocene terrace landform in central Bangladesh.
- The area commonly contains reddish-brown Madhupur Clay and terrace deposits.
- The terrace areas are generally more elevated than surrounding floodplain lands.
- Low-lying areas may contain recent alluvial deposits formed by river and floodplain processes.
- The soil profile may vary locally depending on elevation, drainage, erosion, filling, and land development.

6.4 Availability of Water

Gazipur District has access to different water sources, including groundwater, surface water bodies, ponds, canals, seasonal drainage channels, and municipal or local supply networks in developed areas. However, the actual availability of water at the proposed project site will depend on local hydrogeological condition, groundwater depth, seasonal variation, nearby surface water sources, and permission from relevant authorities.

For the proposed TSDF facility, the final water source shall be selected based on reliability, quality, sustainability, regulatory approval, and environmental safety. The project shall avoid excessive abstraction of groundwater and shall adopt water conservation, recycling, and reuse measures wherever feasible.

Existing Water Sources in the Study Area
The potential water sources in and around the project area may include: • Groundwater through deep tube well or approved bore well. • Nearby ponds, canals, or surface water bodies, subject to suitability and approval. • Rainwater collection during monsoon season. • Municipal or local water supply, if available. • Treated wastewater reuse within the facility. Among these sources, groundwater is commonly used in many parts of Gazipur for domestic, commercial, and industrial purposes. However, groundwater abstraction for the project should be assessed carefully through hydrogeological investigation and approval from the relevant authority.
Water Requirement During Construction Phase
During the construction phase, water will be required mainly for civil works, concrete mixing, curing, dust suppression, equipment washing, worker sanitation, and site housekeeping. Construction water demand will be temporary and will vary depending on the construction schedule, number of workers, weather condition, and type of construction activity. • Water conservation measures during construction will include:

- Controlled water use for curing and dust suppression.
- Use of treated or non-potable water where suitable.
- Prevention of water wastage from leakage or overflow.
- Temporary drainage to prevent waterlogging.
- Collection and proper disposal of wastewater from construction areas.
- Provision of separate drinking water for workers.

Water Requirement During Operation Phase

During operation, water will be required on a regular basis for both process and non-process activities. The major operational water uses may include:

- Process water for flue gas cooling or quenching, if applicable.
- Scrubber water for air pollution control system.
- Water for residue cooling, ash conditioning, and dust suppression.
- Equipment, floor, and vehicle washing.
- Effluent treatment plant operation.
- Domestic use by workers and administrative staff.
- Fire-fighting reserve.
- Greenbelt and landscaping.

6.5 Water Quality Considerations

The quality of available water shall be assessed before final selection of the water source. Water quality testing should include physical, chemical, and biological parameters depending on intended use. For process use, parameters such as pH, total dissolved solids, hardness, chloride, iron, turbidity, suspended solids, and microbial quality may be important.

For potable use, water must meet applicable drinking water standards. Potable water shall be treated, disinfected, and distributed through a separate pipeline network to avoid cross-contamination with process or non-potable water.

Water Conservation and Reuse

The TSDF facility will incorporate water conservation measures to reduce dependency on fresh water sources. Treated water from the effluent treatment system may be reused for non-potable applications such as dust suppression, ash conditioning, floor washing, greenbelt irrigation, and other suitable purposes.

Recommended water conservation measures include:

- Reuse of treated effluent within the facility.
- Rainwater harvesting from roof and paved areas, where feasible.
- Use of dry or semi-dry air pollution control technology, where technically suitable.
- Regular inspection and repair of leaks.
- Installation of flow meters for major water consumption points.
- Segregation of clean stormwater and contaminated wastewater.

- Use of water-efficient fixtures in administrative and worker facilities.

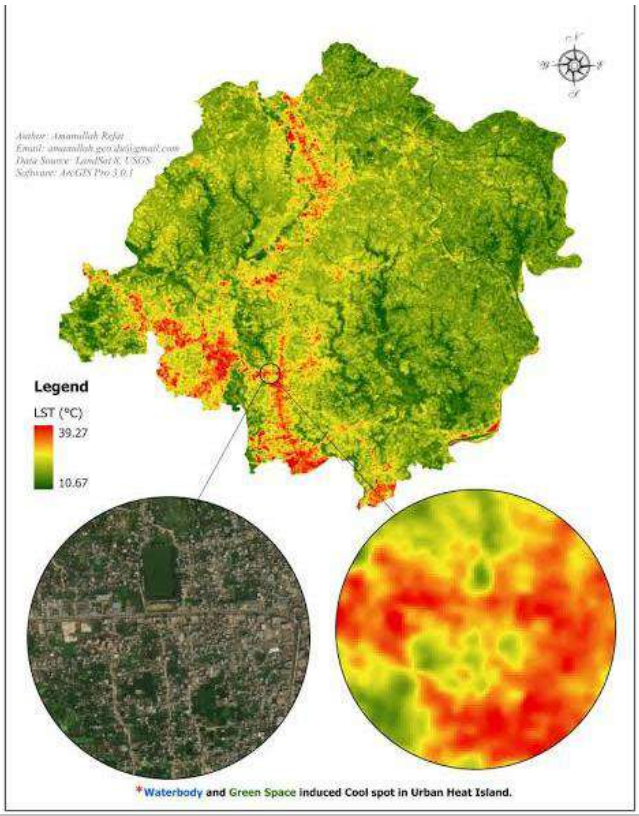
6.6 Potential Impacts on Water Availability

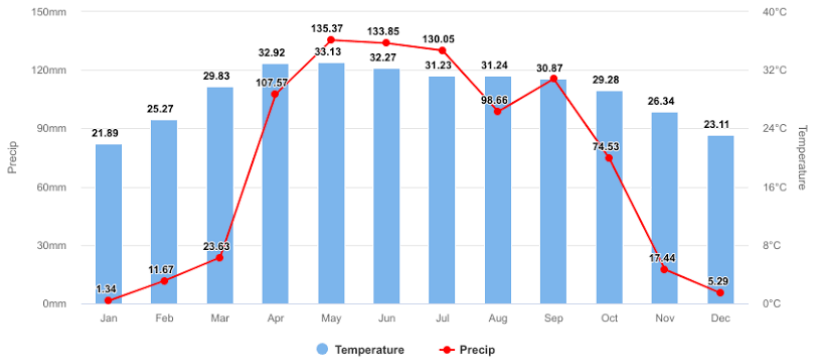
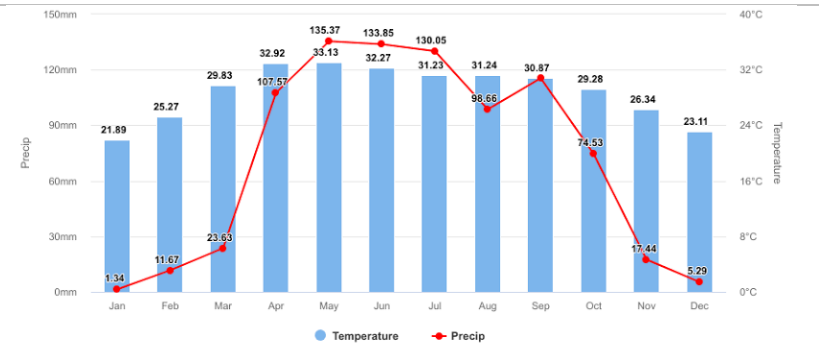
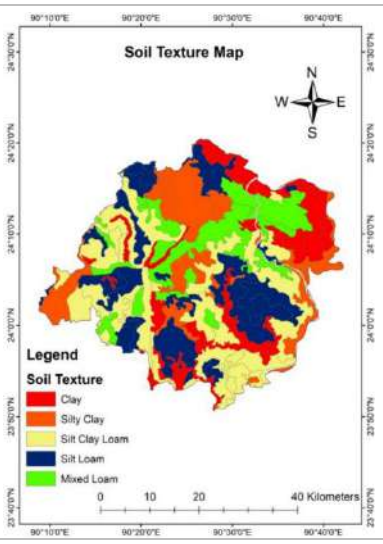
To minimize potential impacts, the project should:

- Conduct site-specific water availability and hydrogeological assessment.
- Obtain necessary permission for groundwater or surface water abstraction.
- Avoid over-extraction of groundwater.
- Monitor water consumption regularly.
- Maximize reuse of treated wastewater.
- Maintain records of water withdrawal, reuse, and discharge.
- Ensure that local community water sources are not affected.

6.7 Physical Environment

The physical environment of the project area includes climate, meteorology, ambient air quality, noise condition, seismicity, water resources, soil condition, land use and existing infrastructure. Since the project involves waste handling, incineration, wastewater generation, residue management and transport movement, a detailed understanding of the physical environment is essential for impact assessment and mitigation planning.

Temperature graph	

Rainfall graph	
Humidity graph	
Soil Texture	

6.7.1 Climate and Meteorology

The project site is located in Gazipur District, which experiences a tropical monsoon climate. The area generally has hot and humid summer, heavy rainfall during monsoon, and mild to cool winter. Seasonal variation in temperature, rainfall, humidity, wind speed and wind direction is important for the design and operation of the TSDF facility.

Included the following meteorological parameters:

Parameter	Relevance to TSDF Project
Temperature	Governs the design of flue gas cooling and cooling-water systems, heat-stress management for workers, storage-temperature control for reactive, flammable and putrescible wastes, and ventilation of enclosed waste-handling areas. High temperature also increases volatilisation and odour potential.
Rainfall	Determines the capacity of stormwater drains, first-flush collection and the emergency containment pond; controls the risk of waterlogging, leachate generation in the secured landfill and rainwater entry into waste storage areas; influences the scrubber and process water balance.
Relative humidity	Affects moisture content and degradation of stored waste, corrosion of equipment, stacks and tanks, visible plume formation at the stack, and dust-suppression requirements.
Wind speed	Controls the dispersion and dilution of stack emissions, fugitive dust and odour; is a key input for stack height design and air quality modelling; determines wind loading on the stack and tall structures.
Wind direction	Identifies the downwind receptors most likely to be exposed to emissions and odour; guides the location of ambient air monitoring stations, greenbelt orientation and placement of waste reception and storage areas.
Extreme weather	Nor'westers, cyclonic storms, lightning and intense rainfall may cause flooding, structural damage, power failure and release of waste or chemicals; relevant to structural design, lightning protection, emergency preparedness and business-continuity planning.

Monthly Climate Normals of the Nearest BMD Station

The study area has no long-term meteorological station of its own. The Bangladesh Meteorological Department (BMD) Dhaka station, located roughly 40–50 km to the south of the project area in the same climatic sub-region, has therefore been used as the representative station. Monthly normals of temperature, rainfall and humidity are given in the table below and are consistent with the graphs and Gazipur land-surface-temperature map presented above.

Month	Mean daily max. (°C)	Daily mean (°C)	Mean daily min. (°C)	Rainfall (mm)	Rainy days	Relative humidity (%)
Jan	25.4	19.1	12.7	7.7	2	71
Feb	28.1	21.8	15.5	28.9	3	64
Mar	32.5	26.5	20.4	65.8	5	62
Apr	33.7	28.7	23.6	156.3	10	71
May	32.9	28.7	24.5	339.4	15	76
Jun	32.1	29.1	26.1	340.4	14	82
Jul	31.4	28.8	26.2	373.1	17	83
Aug	31.6	29.0	26.3	316.5	16	82
Sep	31.6	28.8	25.9	300.4	13	83
Oct	31.6	27.7	23.8	172.3	7	78

Month	Mean daily max. (°C)	Daily mean (°C)	Mean daily min. (°C)	Rainfall (mm)	Rainy days	Relative humidity (%)
Nov	29.6	24.4	19.2	34.4	2	73
Dec	26.4	20.3	14.1	12.8	1	73
Annual	**30.6**	**26.1**	**21.5**	**2,148**	**105**	**75**

Source: Bangladesh Meteorological Department, Dhaka station (long-term normals).

Seasonal Meteorological Summary

The climate follows the four-season pattern of central Bangladesh: pre-monsoon (March–May), monsoon (June–September), post-monsoon (October–November) and a cool dry winter (December–February). The conditions that are important for the design and operation of the TSDF are summarised below.

Season	Months	Typical conditions	Implication for the TSDF
Pre-monsoon (hot)	Mar–May	Hottest part of the year (mean daily maximum 32.5–33.7 °C); humidity rising from about 62% to 76%; south and south-westerly winds; frequent thunderstorms, lightning and nor'westers.	Peak heat stress and odour/volatilisation potential; lightning protection and wind-resistant design of stack and tanks; first heavy showers can produce contaminated first-flush runoff.
Monsoon	Jun–Sep	Hot and very humid (82–83%); about 80% of annual rainfall (monthly 300–373 mm in May–Sep); winds mainly from the south and south-east; flash flooding and waterlogging are common.	Governs stormwater drainage, platform level, landfill leachate control and waste moisture; highest risk of runoff reaching ponds, khals and low-lying agricultural land.
Post-monsoon	Oct–Nov	Rainfall tapers off (172 mm in October, 34 mm in November); north-easterly and variable winds; late-season cyclonic storms are possible.	Cyclone and strong-wind preparedness; shift in dominant wind direction changes which receptors are downwind.
Dry (winter)	Dec–Feb	Cool and dry (mean daily minimum 12.7 °C in January); rainfall under 30 mm per month; humidity 64–73%; light westerly/north-westerly winds; morning fog and temperature inversions.	Poorest atmospheric dispersion and highest particulate loading of the year; priority season for dust suppression and for air quality monitoring.

Relative Humidity

Relative humidity is high throughout the year and highest in the monsoon. Monthly mean humidity for 2015–2021 varied between 52% (February 2020) and 84% (June 2021), with annual means of 70–74%.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	68	68	54	69	70	81	84	80	80	78	77	78	73
2016	69	61	67	64	70	80	83	81	81	77	69	79	73
2017	72	55	53	66	72	74	80	82	81	73	66	69	70
2018	71	56	59	67	71	79	77	78	79	74	68	66	70
2019	69	54	57	64	76	80	79	82	77	73	67	73	70
2020	66	52	57	69	74	75	78	80	79	77	69	75	70.9
2021	71	62	60	69	74	84	83	83	81	76	75	72	74.2
Mean	**69**	**58**	**58**	**67**	**72**	**79**	**81**	**81**	**80**	**75**	**70**	**73**	**71.6**

Source: BMD, Dhaka station, monthly mean relative humidity (%), 2015–2021.

Wind Speed and Direction

Wind records of the Dhaka station for 2016–2021 show light winds throughout the year, with a mean speed of about 3.2 knots (1.6 m/s). Winds blow mainly from the south and south-east during the warm season and from the west and north-west during winter. The low mean wind speed and the winter calm periods limit atmospheric dispersion, which is important for the stack height design and for the air quality assessment in Chapter 2.

Season	Months	Mean wind speed, knots (m/s)	Prevailing wind direction
Dry (winter)	Dec–Feb	3.0 (1.5)	West / North-West (some North)
Pre-monsoon	Mar–May	3.5 (1.8)	South (West / North-West in March)
Monsoon	Jun–Sep	3.0 (1.5)	South / South-East
Post-monsoon	Oct–Nov	3.5 (1.8)	North-East, variable (North, West)
Annual mean		**3.2 (1.6)**	**South in the warm season; West/North-West in winter**

Source: BMD, Dhaka station, monthly prevailing wind speed and direction, 2016–2021 (seasonal means calculated).

Extreme Rainfall and Storm Event Summary

Parameter	Observed value / event	Relevance to design
Annual rainfall	About 2,100–2,150 mm (BMD Dhaka normal 2,148 mm); nearly 80% falls in May–September	Basis for water balance, stormwater drainage and leachate management
Monsoon monthly rainfall	300–373 mm per month (May–September normals); individual wet months can exceed 600 mm	Peak drainage and containment load
Highest 24-hour rainfall	341 mm recorded in Dhaka on 13 September 2004; about 333 mm in 2009	Design-storm check for peripheral drains, first-flush tanks and the emergency containment pond
Cyclonic storms	Bay of Bengal cyclones weaken inland but bring strong winds and heavy rain to the Dhaka–Gazipur region, mainly in April–June and September–December	Structural safety of stack, tanks and buildings; securing of stored waste; emergency shutdown procedure
Nor'westers and lightning	Frequent in March–May with squalls and intense lightning	Lightning protection for the stack, tanks and electrical systems; worker safety
Flash flooding / waterlogging	Common during the monsoon in low-lying and poorly drained areas	Platform level, flood-protection of critical units and access-road drainage

Source: BMD, Dhaka station records; extreme-event records for Dhaka.

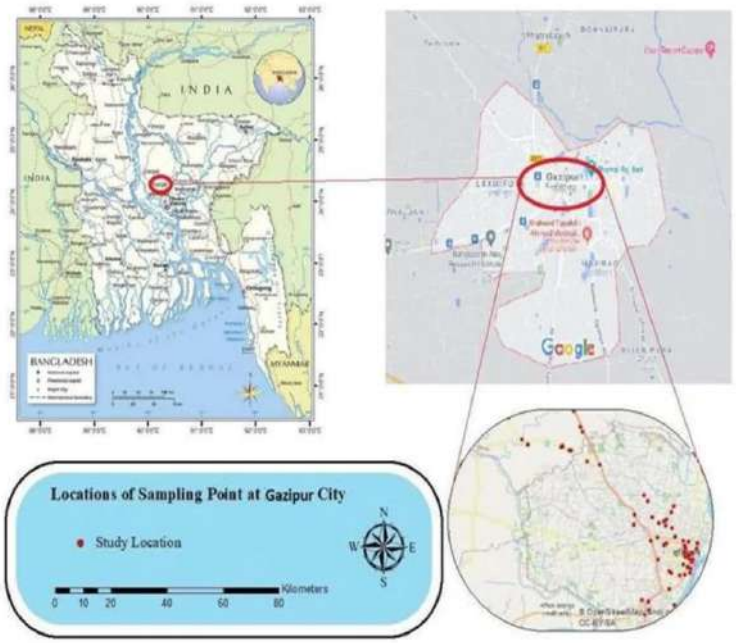
6.7.2 Ambient Air Quality

Ambient air quality monitoring should be conducted to establish the existing air quality condition around the project site before operation. The project is located in an industrially active region; therefore, existing air quality may already be influenced by industrial emissions, road dust, vehicle movement, brick kilns, construction activities and local burning practices.

S. N.	Sampling Location ID & Name	Concentration of Different Parameters in Ambient Air					
		$PM_{2.5}$	PM_{10}	SPM	SO_2	NO_2	CO
01	**AQ-01 In front of Project Main Gate Area**	**23**	**47**	**83**	**7.9**	**10.1**	**0.32**
02	Unit	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	PPM
03	Duration	24	24	8	24	24	8

04	Method of Analysis	Gravimetric			West-Gaeke	Jacob and Hochheiser	Electro-Chemical Sensor
05	Bangladesh (DoE) Standard for Ambient Air	65	150	200	80	80	5
06	**Remarks**	**Good**	**Good**	**Good**	**Good**	**Good**	**Good**

Ambient Air Monitoring Location Map



Interpretation of Ambient Air Quality Results

The baseline sample collected at AQ-01 (in front of the project main gate) shows that every measured parameter is well within the Bangladesh (DoE) ambient air quality standards. The 24-hour $PM_{2.5}$ (23 µg/m³) and PM_{10} (47 µg/m³) concentrations are about 35% and 31% of their standards (65 and 150 µg/m³), SPM (83 µg/m³, 8-hour) is about 42% of the 200 µg/m³ standard, and the gaseous pollutants are low: SO_2 7.9 µg/m³ (about 10% of 80 µg/m³), NO_2 10.1 µg/m³ (about 13% of 80 µg/m³) and CO 0.32 ppm (about 6% of 5 ppm).

Although the results comply with the national standards, the particulate fractions are above the more stringent WHO 2021 Air Quality Guideline values for 24-hour exposure ($PM_{2.5}$ 15 µg/m³; PM_{10} 45 µg/m³), which reflects the influence of regional industrial activity, road dust, brick kilns and construction in the Gazipur–Sreepur airshed. NO_2 and SO_2 are below the WHO 24-hour guideline values (25 and 40 µg/m³). The assimilative capacity of the airshed for fine particulates is therefore limited, which is an important consideration for the stack design and the emission limits of the incinerator.

The data represent a single monitoring location and sampling period and are indicative of the baseline. Seasonal monitoring, particularly in the dry winter season when particulate concentrations in the Dhaka–Gazipur region are highest, and additional stations at the nearest downwind receptors will be carried out under the Environmental Monitoring Plan. A baseline for incinerator-specific pollutants (HCl, HF, heavy metals, VOCs and dioxins/furans) shall also be established before commissioning.

6.7.3 Acoustic Environment

The acoustic environment describes existing noise conditions in and around the project site. Noise may currently originate from road traffic, industrial operations, construction activities, markets, local settlements and machinery.

Baseline noise monitoring should be conducted during both daytime and nighttime at representative locations.

Monitoring included:

- Project boundary
- Nearest settlement
- Access road
- Nearby industrial area
- Sensitive receptors such as schools, mosques, hospitals or community facilities, if present

Sample ID	Location Name	Concentration Present (dB)						Category	
		Day Time			Night Time				
		Leq	L_{max}	L_{min}	Leq	L_{max}	L_{min}		
NL - 01	East side of the project	46.67	55.9	34.3	35.21	50.4	31.6	Silent Area	
NL - 02	West side of the project	42.82	49.1	33.2	34.35	42.7	31.5		
NL - 03	North side of the project	42.10	50.6	36.4	33.58	37.7	31.2		
NL - 04	South side of the project	43.27	50.3	35.8	34.62	44.2	31.2		
Bangladesh Standard								**Day Time**	**Night Time**
Industrial Area								75	70
Commercial Area								70	60
Mixed Area								60	50
Residential Area								55	45
Silent Area								50	40
World Bank/IFC Standard								**Day Time**	**Night Time**
Industrial Area								70	70
Residential; Institutional; Educational								55	45

Interpretation of Noise Monitoring Results

Noise was measured at four locations on the east, west, north and south sides of the project boundary (NL-01 to NL-04). Daytime equivalent levels (Leq) ranged from 42.10 to 46.67 dB(A) and night-time levels from 33.58 to 35.21 dB(A). All values are below the Bangladesh Noise Pollution (Control) Rules 2006 limits for a Silent Area (50 dB(A) by day and 40 dB(A) at night) and below the World Bank/IFC EHS Guideline limits for residential, institutional and educational receptors (55 dB(A) by day and 45 dB(A) at night). The highest daytime and night-time levels were both recorded on the east side (NL-01), which may be associated with nearer local road and settlement activity.

The results indicate a quiet baseline acoustic environment. The most stringent category (Silent Area) has been used as a conservative reference for the project boundary. Noise from operation of the facility (induced-draft fans, blowers, pumps, compressors, generators and waste-carrying vehicles) shall be controlled by equipment selection, enclosures, silencers and the greenbelt so that boundary levels remain within the applicable standards and the increase over the background level at the nearest receptor does not exceed 3 dB(A), in line with the IFC EHS Guidelines.

6.7.4 Seismicity

Bangladesh is located in a seismically active region due to its proximity to major tectonic structures. The project site in Gazipur should be assessed for seismic risk in relation to structural design, fuel storage, chemical storage, incinerator foundation, stack stability, ETP tanks and waste storage structures.

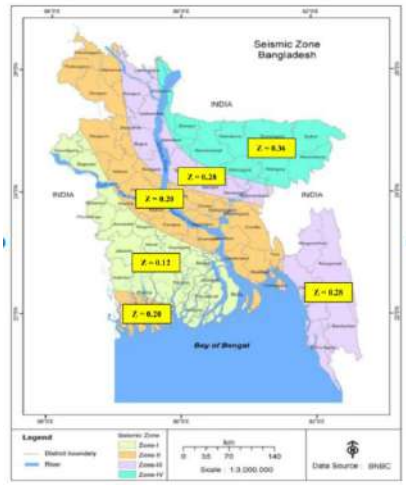
- Seismic zone classification of the project area
- Applicable Bangladesh National Building Code requirements
- Earthquake-resistant design consideration
- Emergency preparedness for earthquake-related incidents
- Structural safety requirement for stack, incinerator and storage tanks

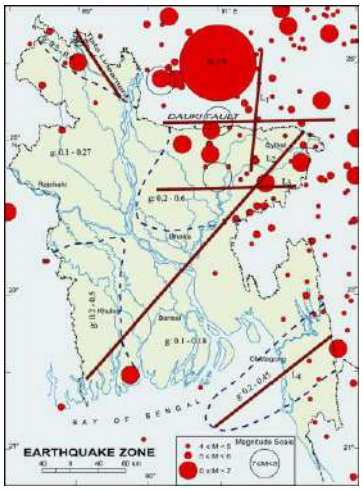
Seismic hazard in Bangladesh results from the northward subduction of the Indian Plate beneath the Eurasian and Burma plates. The Bangladesh National Building Code (BNBC 2020) divides the country into four seismic zones (Zone I to Zone IV) with zone coefficients (Z) of 0.12, 0.20, 0.28 and 0.36 respectively. Gazipur District, including Sreepur Upazila, is generally classified in Seismic Zone II (Z = 0.20), the same zone as Dhaka.

Seismic design parameter	Basis / value for the TSDF
Applicable code	Bangladesh National Building Code (BNBC) 2020
Seismic zone and coefficient	Zone II, Z = 0.20 (to be confirmed by the structural designer for the exact site)
Site class	To be determined from the geotechnical investigation (average N-SPT of the upper 30 m)
Importance factor	Higher importance category for facilities storing or treating hazardous waste, fuel and chemicals
Critical structures	Incinerator building and foundation, stack, ETP and storage tanks, chemical and fuel storage, secured landfill containment

Because the TSDF will handle and store hazardous waste, fuel and chemicals, the critical structures listed above will be designed so that the design earthquake does not cause a release of hazardous material. Anchored tanks, flexible pipe connections, secondary containment, automatic shut-off of fuel lines and an earthquake response procedure within the Emergency Preparedness and Response Plan (EPRP) will be provided.

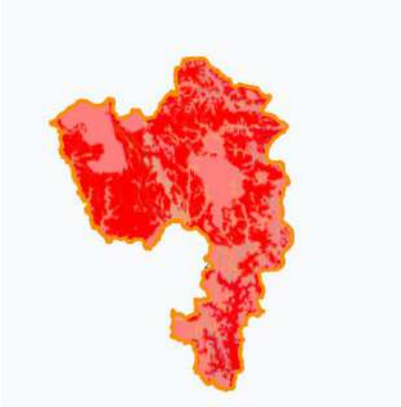
Bangladesh Seismic Zone





6.8 Surface Water Resource

Surface water resources include rivers, canals, ponds, drainage channels, wetlands and seasonal water bodies located within the project influence area. For a TSDF project, surface water is important because contaminated runoff, leachate, wastewater or accidental spills may affect nearby drainage or water bodies if not properly managed.

Surface water map	
Soil Drainage & Soil Reaction pH	 
Water sampling location map/ nearest pond	 
Canal/khal	

low-lying area	

6.8.1 Surface Water System

The assessment identified:

- Nearest canal, khal, pond, river or drainage channel
- Distance from project boundary
- Flow direction
- Seasonal water presence
- Existing use of water body
- Connection with downstream communities or agricultural land
- Pollution sensitivity

SN.	Sampling Location Name and ID
01	**SW – 01** Source from Nearby Pond

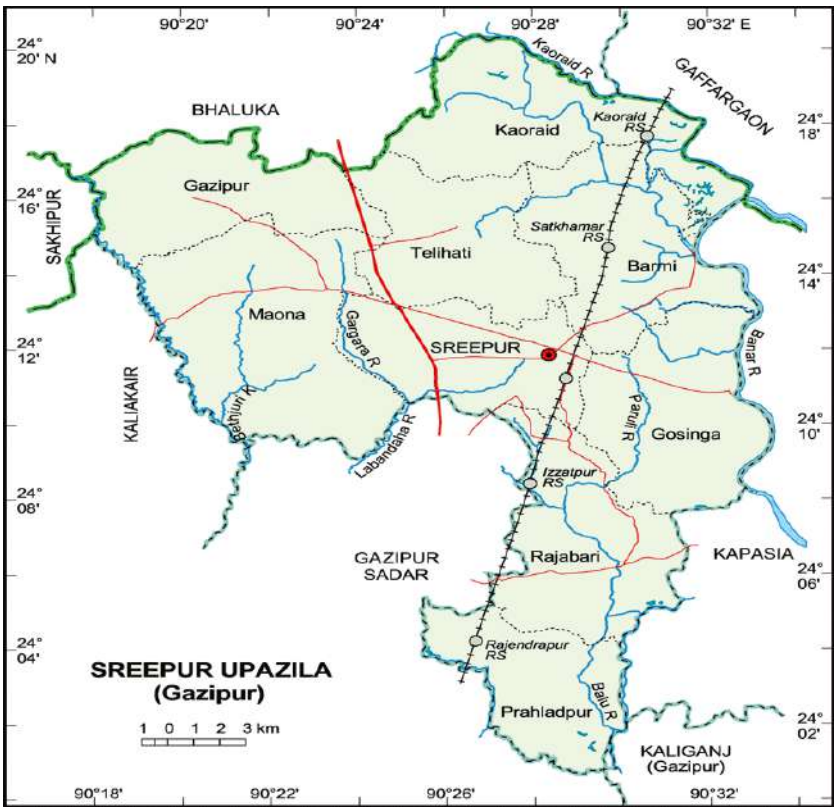
Analysis Result:

SN.	Name of Parameters	Concentration Present	Unit	Bangladesh Standard	Method of Analysis
01	pH	8.2	-	6.5-8.5	pH Meter
02	Total Dissolved Solid (TDS)	327	mg/l	2100	Gravimetric
03	Total Suspended Solids (TSS)	161	mg/l	150	Gravimetric
04	EC	474	µmohos/cm	1200	Multimeter
05	Dissolved Oxygen (DO)	5.5	mg/l	4.5-8.0	Azide modification
06	Biological Oxygen Demand BOD_5 at 20 ^0C	2.10	mg/l	50	Dilution
07	Chemical Oxygen Demand (COD)	19.4	mg/l	200	COD Refluction
08	Turbidity	0.25	NTU	10	Turbidity Meter
09	Salinity	Nil	g/l	0.6	Multimeter

The surface water system around the project site consists mainly of ponds, small seasonal khals and drainage channels, and low-lying depressions that fill during the monsoon. The larger rivers of Sreepur Upazila (the Banar, Kaoraid and Labandaha) are located away from the project boundary. A nearby pond was selected as the representative surface water receptor and sampled (SW-01), and the canal/khal and low-lying area closest to the site were documented during the field visit (see photographs above). Such water bodies are typically used by local people for domestic washing, irrigation, fishing and livestock watering and are therefore sensitive to any uncontrolled discharge.

Based on these observations, no process or contaminated water from the facility will be discharged to any pond, khal or drain. Clean stormwater will be drained separately through the peripheral drain,

while contaminated runoff, leachate and process wastewater will be collected and treated in the ETP and reused within the facility.



6.8.2 Hydrology

Hydrology describes the movement, availability and seasonal behavior of surface water in the project area. For the project, hydrology is important for drainage design, flood risk, stormwater management and leachate control.

The section covered:

- Local catchment condition
- Drainage flow direction
- Monsoon runoff pattern
- Waterlogging possibility
- Nearby floodplain or low-lying area
- Seasonal variation of surface water bodies

Separate drainage for:

- Clean stormwater

- Contaminated runoff
- Leachate and process wastewater

6.8.3 Surface Runoff During Rain

During rainfall, runoff may be generated from roofs, paved roads, waste handling areas, storage yards and open ground. In a TSDF facility, runoff from contaminated areas must not be mixed with clean stormwater.

The ESIA assess:

- Existing site slope
- Natural drainage path
- Rainfall intensity
- Potential waterlogging
- Runoff direction toward nearby receptors
- Risk of contaminated runoff during operation

Mitigation

- Peripheral drain
- Separate stormwater and contaminated water drains
- Oil and grease trap, where needed
- First-flush collection from contaminated areas
- Impervious floor in waste handling areas
- ETP connection for contaminated runoff
- Emergency containment pond or tank

6.8.4 Water Level

This section should describe seasonal surface water levels of nearby ponds, canals or drainage channels. If the project site is near a water body, the ESIA identified:

- Highest water level during monsoon
- Lowest water level during dry season
- Flood history
- Waterlogging duration
- Distance between project platform level and high flood level

6.8.5 River Bed Sediment

River bed sediment assessment is relevant only if a nearby river, canal or drainage channel may receive runoff or treated discharge. If applicable, sediment quality should be assessed for:

- pH
- Organic matter

- Texture
- Heavy metals
- Oil and grease
- Existing contamination indicators

6.8.6 Aquatic Monitoring

Aquatic monitoring should be conducted where nearby ponds, canals, wetlands or rivers may be affected. The study should identify aquatic flora and fauna, fish presence, aquatic vegetation and existing water use.

Parameters:

- Aquatic plants
- Fish species
- Plankton, where required
- Macroinvertebrates, where required
- Water body use
- Existing pollution signs

6.8.7 Water Quality

Surface water quality monitoring should be conducted at representative nearby water bodies or drainage channels.

Parameters:

Parameter	Relevance
pH	Acidity/alkalinity
DO	Aquatic life support
BOD	Organic pollution
COD	Chemical pollution
TSS	Suspended solids
TDS	Dissolved solids
Oil and grease	Industrial/vehicle contamination
Ammonia	Organic and wastewater pollution
Chloride	Salinity/industrial influence
Sulphate	Industrial/wastewater influence
Heavy metals	Hazardous waste relevance
Total coliform	Sanitation impact

Surface Water Quality Results (SW-01)

The sample from the nearby pond (SW-01) is slightly alkaline (pH 8.2, within the 6.5–8.5 range) and fresh (TDS 327 mg/L against 2,100 mg/L; EC 474 µmhos/cm against 1,200 µmhos/cm; salinity nil). Dissolved oxygen (5.5 mg/L) is within the 4.5–8.0 mg/L range, and the organic load is low (BOD_5 2.10 mg/L against 50 mg/L; COD 19.4 mg/L against 200 mg/L). Turbidity (0.25 NTU) is well below the 10 NTU limit.

Total suspended solids (161 mg/L) were slightly above the 150 mg/L reference value. This is common in shallow ponds that receive seasonal runoff and carry silt and algae, and it shows that the pond has little capacity to receive any additional suspended load. All other measured parameters comply with the standard.

The result is based on a single grab sample and is indicative only. The receiving pond, canal and nearby drains will be monitored in the pre-monsoon, monsoon and post-monsoon seasons, including oil and grease, ammonia, chloride, sulphate, heavy metals and total coliform, before construction and during operation.

6.8.8 Water Use

This section described how local surface water is used by nearby communities. Common uses included:

- Domestic washing
- Bathing
- Irrigation
- Fisheries
- Livestock watering
- Drainage
- Small-scale commercial activities

6.9 Ground Water Resource

Groundwater is an important environmental receptor for the proposed TSDF project. The project must prevent contamination of groundwater from waste storage, leachate, ash, ETP sludge, fuel storage and chemical handling areas.

Groundwater Sampling Location Map



6.9.1 Hydrogeology

Hydrogeology describes the groundwater-bearing formations, aquifer condition, soil permeability and groundwater vulnerability. The ESIA included:

- Aquifer type
- Depth to groundwater table
- Soil and subsoil condition
- Groundwater flow direction, where available

- Nearby tube wells
- Potential contamination pathways
- Need for groundwater monitoring wells

6.9.2 Ground Water Level

Groundwater level should be measured from representative tube wells or monitoring wells. Seasonal groundwater level should be considered because groundwater may rise during monsoon.

Ground Water Laboratory Report

Sl. No.	Sampling Location Name
01	Ground water (samples collected from the project deep tube well)

Analysis Result:

SN.	Name of Parameters	Concentration Present	Unit	ECR' 2023 Standard*	Method of Analysis
01	pH	7.6	-	6.5 – 8.5	pH Meter
02	Total Dissolved Solids (TDS)	261	mg/L	1000	Multimeter
03	Iron	0 .47	mg/L	0.3-1	UV-visible spectrophotometer
04	Alkalinity	43	mg/L	NYS	Titrimetric
05	Hardness	49	mg/L	200-500	Complexo-metric titration by EDTA
06	Chloride	57.1	mg/L	250	Titrimetric
07	Arsenic	0.002	mg/L	0.05	UV-visible spectrophotometer

Interpretation of Groundwater Quality Results

A groundwater sample was collected from the project deep tube well. The groundwater is slightly alkaline (pH 7.6) and fresh (TDS 261 mg/L against 1,000 mg/L; chloride 57.1 mg/L against 250 mg/L). Iron (0.47 mg/L) lies within the 0.3–1.0 mg/L range of the ECR 2023 standard. Hardness (49 mg/L) is below the 200–500 mg/L reference range, which means the water is soft and poses no health concern, and alkalinity (43 mg/L) has no prescribed limit. Arsenic (0.002 mg/L) is far below the Bangladesh limit of 0.05 mg/L and also below the WHO guideline of 0.01 mg/L.

The groundwater at the site is therefore currently of good quality and suitable for domestic and process use after appropriate treatment for iron. The parameters analysed form a basic baseline. Nitrate, ammonia, sulphate, manganese, lead, chromium, cadmium, mercury, oil and grease and coliform bacteria will be added and measured from dedicated up-gradient and down-gradient monitoring wells before waste disposal begins, so that any future change attributable to the facility can be detected.

Ground Water Use

Groundwater is an important water resource in the project influence area and is commonly used for domestic, commercial, institutional, and industrial purposes. In the surrounding settlements, groundwater is generally abstracted through shallow and deep tube wells for drinking, cooking, washing, sanitation, and other household requirements. Industrial establishments located within the broader Sreepur industrial area may also use groundwater as a supplementary or primary source of process and utility water.

For the TSDF facility, water will be required for domestic use, equipment and floor cleaning, dust suppression, firefighting reserve, greenbelt development, and selected process-related activities. The project authority will prioritize efficient water management and reuse of treated water, where technically feasible, to reduce pressure on groundwater resources.

The groundwater requirement of the TSDF project shall be determined based on the final plant design, operational capacity, workforce, and utility requirements. Controlled groundwater abstraction, water metering, leak detection, preventive maintenance, and water conservation practices shall be adopted during the operation phase.

6.9.3 Ground Water Quality

Groundwater quality is an important environmental consideration, particularly for a waste treatment, storage, and disposal facility. The principal potential sources of groundwater contamination may include accidental leakage of liquid waste, contaminated surface runoff, improper waste storage, fuel or chemical spills, leachate generation, and inappropriate handling of incineration residues.

Baseline groundwater quality shall be assessed through representative groundwater sampling from suitable tube wells located within and around the project influence area. Sampling locations should consider the project site, nearby settlements, groundwater flow conditions, and potentially sensitive receptors.

The collected groundwater samples shall be analyzed by an accredited laboratory for relevant physicochemical and, where necessary, biological parameters. Typical parameters may include pH, electrical conductivity, total dissolved solids, turbidity, hardness, alkalinity, chloride, sulphate, nitrate, ammonia, iron, manganese, arsenic, chromium, lead, cadmium, mercury, and other relevant heavy metals. Biological parameters such as total coliform and faecal coliform may also be assessed where groundwater is used for drinking purposes.

The analytical results shall be compared with applicable Bangladesh drinking water and environmental quality standards. Baseline results will provide a reference for future environmental monitoring and assessment of any project-related changes.

To protect groundwater quality, the proposed TSDF facility shall incorporate engineered concrete flooring, impervious waste storage areas, dedicated drainage systems, spill containment systems, covered waste storage, controlled residue handling, and proper wastewater treatment. Hazardous or potentially contaminated wastewater shall not be directly discharged onto land.

6.10 Components Scoped Out of the Baseline

The project is an inland, land-based facility. No major river, navigable channel or coastal water body passes through or adjoins the project site, and the project will not involve river abstraction, jetties, dredging, river crossings or discharge to a major river. The following components, which are normally relevant to river, coastal or port projects, have therefore been scoped out of the detailed baseline:

- **Waves and river bathymetry:** not applicable to an inland site with no large water body.
- **River morphology (plan form, erosion and accretion):** riverbank erosion or accretion risk is considered negligible on the Madhupur Tract terrace.
- **Navigation:** the area is served by road transport; the project will use authorised road vehicles only and will not affect inland water transport.

Small water bodies (ponds, khals and drainage channels) that could receive site runoff remain within the scope of the assessment and are described in the surface water sections of this chapter.

6.11 Transportation System

6.11.1 Road Communication System

Road communication is the principal transportation mode within the project area. The wider Sreepur area is connected with Gazipur and the national road network through regional highways, local roads, and industrial access roads.

The proposed project site is accessible by road, which will support transportation of construction materials, machinery, employees, waste collection vehicles, emergency vehicles, and operational supplies.

During the construction phase, temporary increases in traffic may occur due to movement of construction materials, equipment, and workers. During the operation phase, regular movement of waste transportation vehicles and service vehicles is expected.

The potential transportation impacts may include:

- Increase in local traffic volume;
- Temporary traffic congestion;
- Road safety risks;
- Noise and dust generation;
- Risk of waste spillage during transportation; and
- Potential deterioration of local access roads due to heavy vehicle movement.

6.12 Land Resource

6.12.1 Agro Ecological Region

Bangladesh has been divided into different Agro-Ecological Zones based on physiography, soil characteristics, hydrology, land level, and agro-climatic conditions. The project area falls within the broader agro-ecological characteristics of central Bangladesh.

The Sreepur area of Gazipur is generally influenced by terrace and adjoining floodplain environments. The regional landform, soil properties, drainage characteristics, and elevation influence agricultural practices and vegetation patterns within the project influence area.

Agricultural activities in the wider region may include seasonal crop cultivation, horticulture, homestead gardening, and plantation activities. However, industrialization and expansion of settlements have resulted in conversion of agricultural and open land into industrial and commercial uses.

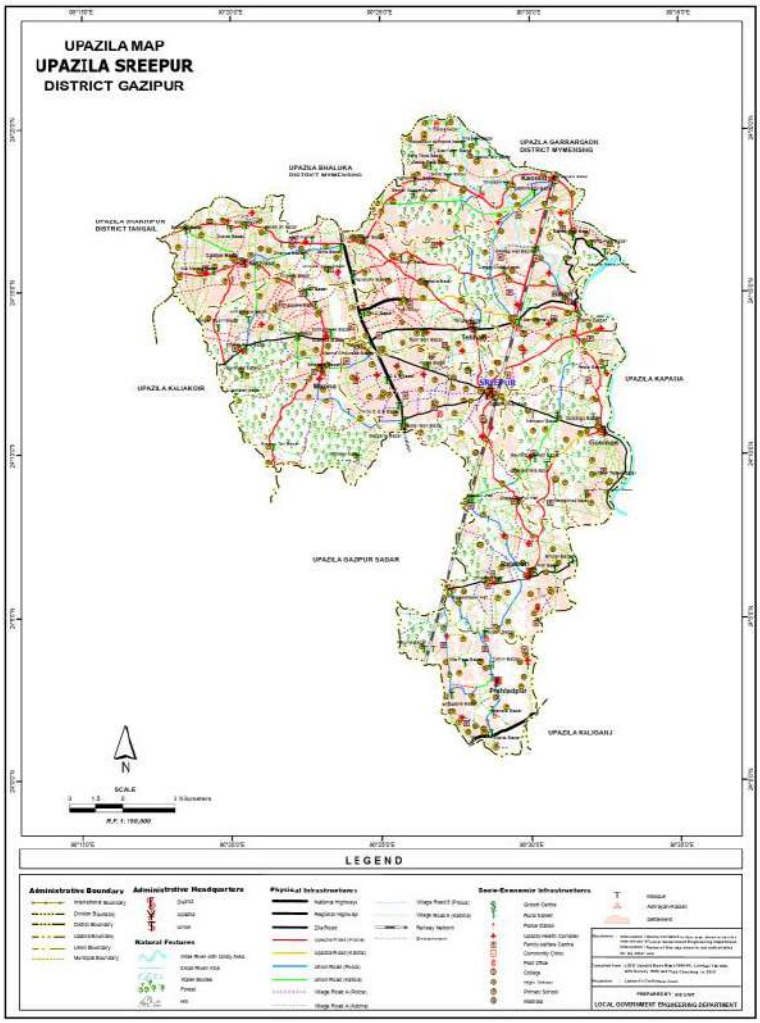
The proposed project site is located within an area experiencing significant industrial development. Therefore, the existing agro-ecological characteristics of the immediate project area have already been influenced by human activities and land use conversion.

The project is not expected to directly affect any designated ecologically critical agricultural zone. Nevertheless, appropriate pollution prevention and environmental management measures shall be implemented to prevent contamination of nearby soil and agricultural land.

Agricultural land map



Industrial and settlement map



6.12.2 Land Type

Land type is generally classified according to land elevation, seasonal inundation depth, drainage conditions, and hydrological characteristics. The land type of the project area has been assessed through field observation and review of local topographical and drainage conditions.

The proposed project site is situated on relatively developed and modified land. The site elevation and project platform shall be designed to minimize the risk of waterlogging and seasonal inundation.

The surrounding area contains a combination of elevated industrial land, settlement areas, low-lying land, agricultural plots, and natural or artificial drainage channels. Local depressions may experience temporary water accumulation during periods of intense rainfall.

Site preparation and land development activities shall consider the existing natural drainage pattern. Uncontrolled filling of drainage channels or low-lying areas shall be avoided to the extent practicable.

The final site grading plan shall ensure proper stormwater drainage and controlled runoff management. Finished ground levels of critical facilities, waste storage areas, electrical installations, and treatment units shall be maintained at suitable elevations based on detailed engineering and flood risk considerations.

6.12.3 Soil Texture

Soil texture refers to the relative proportion of sand, silt, and clay present in the soil. It influences soil permeability, water retention capacity, drainage characteristics, erosion potential, and contaminant migration.

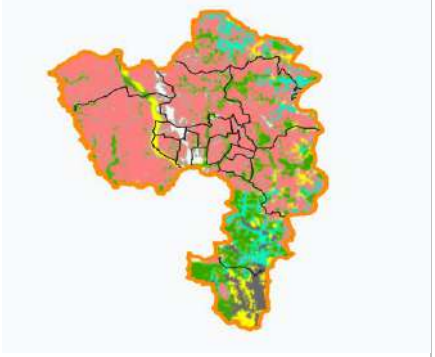
The soil texture within the project area is expected to reflect the regional geological and physiographic characteristics of the Gazipur and Sreepur area. Surface soils may exhibit varying proportions of clay, silt, and fine sand depending on site development, filling activities, and natural soil formation processes.

Representative soil samples shall be collected from selected locations within the project site and surrounding influence area. Laboratory analysis should determine the relative percentages of sand, silt, and clay and classify the soil texture using an accepted soil classification system.

Knowledge of soil texture is particularly important for the proposed TSDF facility because soil permeability may influence the movement of accidentally released contaminants. Areas containing more permeable soil may require additional engineering protection to prevent downward migration of pollutants.

Waste reception, hazardous waste storage, chemical storage, residue handling, and other potentially contaminating areas shall therefore be provided with impervious flooring and appropriate containment systems irrespective of the natural soil texture.

Soil Texture



Soil Salinity



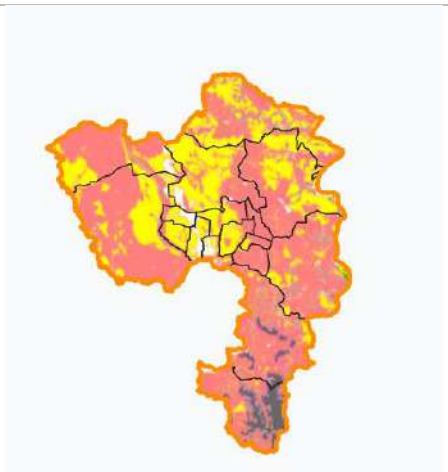
6.12.4 Soil Quality

Baseline soil quality assessment is required to establish the existing physicochemical condition of soil within and around the proposed project site. The baseline data will provide a reference for evaluating future changes that may occur during project construction and operation.

Representative soil samples shall be collected from selected locations considering the project boundary, proposed waste handling areas, surrounding land use, drainage direction, and sensitive receptors.

Soil samples should be analyzed for relevant parameters, which may include:

- pH;
- Electrical Conductivity;
- Moisture Content;
- Organic Matter;
- Total Organic Carbon;
- Nitrogen;
- Phosphorus;
- Potassium;
- Chloride;
- Sulphate;
- Oil and Grease; and
- Selected Heavy Metals.



Soil Moisture

Heavy metal analysis may include arsenic, lead, cadmium, chromium, mercury, nickel, copper, and zinc depending on the anticipated waste characteristics and laboratory assessment requirements.

The soil quality results shall be compared with applicable national standards or internationally recognized reference criteria where specific national soil quality standards are unavailable.

6.12.4.1 Landfill Site Soil Quality

The soil quality of any proposed landfill, secured disposal cell, or residue disposal area is particularly important for assessing the potential risk of contaminant migration into the surrounding environment.

For the proposed TSDF facility, incineration bottom ash, air pollution control residues, and other treatment residues shall be characterized before final disposal or further treatment. Residues shall not be indiscriminately deposited on open land.

Baseline soil samples from the proposed landfill or secured residue disposal area shall be collected prior to commencement of disposal activities. The samples shall be analyzed to establish the existing soil quality condition.

The assessment may include pH, electrical conductivity, organic content, oil and grease, and relevant metals such as arsenic, lead, cadmium, chromium, mercury, nickel, copper, and zinc.

The landfill or secured disposal area shall be designed based on the characteristics of the waste and residues proposed for disposal. Where required, engineered containment measures may include:

- Compacted low-permeability soil layer;
- Appropriate geomembrane liner;
- Leachate collection and drainage system;
- Leachate storage and treatment facilities;
- Surface water diversion system;
- Controlled waste placement;
- Daily or intermediate cover, where applicable;
- Groundwater monitoring arrangements; and
- Final closure and post-closure management measures.

6.12.5 Land Use

The existing land use pattern within the project influence area comprises a mixture of industrial facilities, residential settlements, agricultural land, vacant or undeveloped land, roads, commercial establishments, water bodies, and vegetation.

The broader Sreepur region has experienced substantial industrial growth due to its road connectivity and proximity to Gazipur and Dhaka. Establishment of factories, warehouses, commercial facilities, and residential developments has progressively modified the traditional rural and agricultural landscape.

The proposed project site is intended for development of an incineration-enabled Treatment, Storage and Disposal Facility. The facility will include waste reception and inspection areas, segregation and material recovery facilities, waste storage areas, incineration systems, air

pollution control facilities, residue handling areas, utility systems, internal roads, administrative facilities, greenbelt areas, and associated environmental infrastructure.

Development of the project will result in permanent conversion of the project land into industrial and waste management use. The proposed land use is consistent with the technical function of a centralized waste treatment and disposal facility, subject to applicable environmental and land-related approvals.

Potential land use impacts may include permanent alteration of the existing land surface, increased industrial activity, changes in local traffic movement, and indirect development pressure within the surrounding area.

6.13 Agriculture

6.13.1 Crop Production and Damages

Crop production within the broader project influence area depends on seasonal climatic conditions, land type, soil fertility, water availability, and irrigation facilities. Agricultural land may be used for the cultivation of paddy, vegetables, fruits, and other seasonal or locally suitable crops.

The detailed cropping pattern and annual crop production shall be established through agricultural surveys and consultation with local farmers. Information should include major crop types, cropping seasons, cropping intensity, cultivated area, average production, and prevailing agricultural practices.

Crop production may be affected by natural and human-induced factors such as:

- Excessive rainfall and waterlogging;
- Seasonal drought or inadequate irrigation;
- Pest and disease infestation;
- Soil fertility deterioration;
- Flooding and drainage congestion;
- Industrial dust and air pollution;
- Contaminated irrigation water;
- Unplanned land conversion; and
- Transportation and infrastructure development.

Secondary data for Sreepur Upazila (BBS Population Census 2011, as compiled in Banglapedia) describe the agricultural profile of the wider area as follows.

Indicator	Sreepur Upazila
Main crops	Paddy, wheat, potato, jute, mustard, ginger, turmeric and vegetables
Main fruits	Jackfruit, papaya, pineapple, banana, mango, litchi and guava
Principal agricultural exports	Paddy, mustard and jute
Agriculture as main source of income	54.62% of households
Ownership of agricultural land	Landowning households 65.8%; landless households 34.2%

6.13.2 Agriculture Input Use

Agricultural production within the project influence area may involve the use of various inputs, including seeds, fertilizers, pesticides, irrigation water, agricultural machinery, and human labour.

Common agricultural inputs generally include chemical fertilizers, organic manure, crop protection chemicals, improved seeds, and irrigation services. The actual type and quantity of agricultural inputs used within the study area shall be determined through field-level consultation and agricultural baseline surveys.

Farmers may apply fertilizers to improve soil nutrient conditions and increase crop yield. Pesticides, insecticides, herbicides, and fungicides may also be used for pest, weed, and disease management. Improper or excessive use of agricultural chemicals may contribute to deterioration of soil and surface water quality.

The agricultural baseline assessment should consider the following:

- Types of fertilizers used;
- Frequency and method of fertilizer application;
- Use of organic manure and compost;
- Types of pesticides and crop protection chemicals;
- Sources of seeds and planting materials;
- Agricultural machinery and equipment use;
- Labour requirements; and
- Agricultural input costs and accessibility.

6.13.3 Irrigation

Irrigation is an important supporting component of agricultural production, particularly during dry periods and for crops requiring controlled water supply.

Irrigation sources within the broader project influence area may include groundwater abstraction through shallow or deep tube wells, surface water bodies, canals, ponds, and other locally available water sources. The dominant irrigation source and irrigation coverage shall be identified during the agricultural and socioeconomic baseline surveys.

Groundwater-based irrigation may be influenced by groundwater availability, abstraction depth, energy costs, and seasonal water demand. Surface water irrigation depends on water availability and the condition of local drainage and water systems.

The proposed TSDF facility shall be designed to avoid adverse interference with existing irrigation systems. Existing irrigation channels, drainage paths, and water conveyance routes shall not be blocked or modified without appropriate technical assessment.

Potential risks to irrigation resources may arise from:

- Contaminated stormwater discharge;
- Accidental chemical or waste spillage;

- Improper wastewater disposal;
- Changes in local drainage patterns; and
- Excessive groundwater abstraction.

To minimize these risks, the project shall adopt controlled water abstraction, wastewater treatment, stormwater management, spill prevention, and water reuse measures.

Potentially contaminated water from waste reception, storage, equipment cleaning, or residue handling areas shall be collected and managed through dedicated drainage and treatment systems. Such water shall not be directly discharged into irrigation canals, agricultural fields, or nearby water bodies.

6.14 Livestock and Poultry





Livestock and poultry are important components of the rural and peri-urban economy in Bangladesh. Households within the broader project influence area may raise cattle, goats, sheep, chickens, ducks, and other domestic animals for household consumption, supplementary income, commercial production, and livelihood support.

The livestock and poultry baseline assessment shall identify the major types of animals and birds raised within the project influence area, approximate population, production practices, commercial farms, household-level rearing activities, and dependence of local communities on livestock resources.

Livestock farming may include small household-based rearing as well as organized commercial dairy and poultry farms. Poultry production may include broiler, layer, and traditional household poultry farming.

Potential interactions between the TSDF facility and livestock or poultry may arise from air emissions, noise, contaminated water, waste spillage, traffic movement, disease vectors, and improper handling of animal-related waste received at the facility.

The project shall implement strict waste acceptance, storage, treatment, housekeeping, pest control, wastewater management, and air emission control procedures to minimize potential adverse impacts.

Waste storage periods shall be minimized, particularly for putrescible and biologically degradable waste. Waste reception and storage areas shall be regularly cleaned and disinfected where required.

Access of stray animals, birds, and unauthorized livestock to waste storage and treatment areas shall be prevented through appropriate site fencing, security, and operational control.

6.14.1 Livestock/ Poultry Diseases

The proposed TSDF facility will adopt strict biosecurity and waste management controls. These shall include:

- Controlled entry and exit of waste transportation vehicles;
- Proper containment of animal and biological waste;
- Rapid treatment of putrescible waste;
- Regular cleaning and disinfection of designated areas;
- Vector, insect, and rodent control;
- Prevention of access by stray animals and birds;
- Appropriate personal protective equipment for workers;
- Proper wastewater and leachate management; and
- Emergency procedures for suspected infectious waste.

Animal carcasses, pathological waste, and other potentially infectious animal-derived waste shall be received only in accordance with the facility's approved Waste Acceptance Criteria and operational procedures.

Where such wastes are accepted, they shall be handled in designated areas and treated through an appropriate high-temperature treatment process without unnecessary storage or manual handling.

The facility shall maintain records of incoming specialized waste, including source, category, quantity, date of receipt, treatment method, and final residue management.

6.15 Fisheries

6.15.1 Fish Habitat

Fish habitat refers to aquatic environments that provide suitable conditions for fish feeding, breeding, shelter, growth, and movement. Fish habitats within the project influence area may include ponds, canals, seasonal wetlands, drainage channels, low-lying areas, and other permanent or temporary surface water bodies.

Aquatic habitats in the wider study area may be classified broadly as culture fisheries habitats and capture fisheries habitats. Culture fisheries are generally associated with managed ponds and commercial aquaculture facilities, whereas capture fisheries depend on naturally occurring fish populations in open or semi-open water bodies.

The quality and productivity of fish habitats are influenced by several environmental factors, including:

- Water depth and seasonal water availability;
- Dissolved oxygen;
- Water temperature;
- pH;
- Turbidity;
- Nutrient availability;
- Aquatic vegetation;
- Water flow and connectivity;
- Sediment quality; and
- Pollution levels.

6.15.2 Fish Production

Fish production within the project influence area may be derived from both aquaculture and capture fisheries. Household and commercial ponds may be used for cultivation of locally suitable freshwater fish species, while natural and seasonal water bodies may support capture fisheries.

The actual fish production level within the study area shall be determined through fisheries surveys and consultation with local fish farmers and fishermen. Information should include:

- Number and type of fish culture ponds;
- Major cultured fish species;
- Major naturally occurring fish species;
- Annual or seasonal fish production;
- Fishing seasons;
- Fish farming practices;
- Feed and fertilizer use;
- Fish disease occurrence;
- Fish marketing systems; and
- Dependence of local households on fisheries.

6.16 Ecosystem of the Study Area

Terrestrial vegetation photos	 

Homestead vegetation photos	 
Roadside vegetation photos	 
Pond/aquatic habitat photos	 
Common flora/fauna photos, if observed	 

6.16.1 Ecosystem Habitat and Biodiversity

The ecosystem baseline assessment has been undertaken to characterize the existing terrestrial and aquatic ecological conditions within the project site and surrounding study area. The assessment focuses on habitat types, biodiversity, vegetation, homestead forestry, roadside vegetation, aquatic ecosystems, and the potential presence of ecologically sensitive receptors.

The Sheam TSDF BD Ltd. facility is located at Telihati, Sreepur, Gazipur, within a landscape influenced by industrialization, settlement expansion, road infrastructure, agricultural activities, homestead vegetation, and scattered surface water bodies. Consequently, the natural ecological characteristics of the wider area have undergone various levels of modification due to human activities and land use changes.

6.16.2 Terrestrial and Aquatic Habitats

Ecosystem habitats within the project influence area consist of a combination of modified terrestrial and aquatic environments. Terrestrial habitats may include industrial land, vacant or

fallow land, homestead vegetation, roadside vegetation, agricultural land, scrub vegetation, and planted trees.

Aquatic habitats may include ponds, drainage channels, seasonal low-lying areas, canals, and other small water bodies. These aquatic environments may support fish, aquatic plants, amphibians, reptiles, insects, and other aquatic organisms.

The biodiversity of the study area is influenced by existing land use patterns and the degree of human disturbance. Due to industrial development, settlement expansion, transportation activities, and modification of natural habitats, the immediate project area is expected to support primarily common and disturbance-tolerant flora and fauna.

Terrestrial fauna potentially occurring within the wider study area may include common birds, small mammals, reptiles, amphibians, insects, and other invertebrates. Trees, shrubs, agricultural vegetation, and homestead gardens may provide feeding, nesting, resting, and shelter opportunities for local wildlife.

The ecological survey shall identify:

- Major habitat types;
- Dominant plant species;
- Common terrestrial fauna;
- Aquatic flora and fauna;
- Bird species;
- Amphibians and reptiles;
- Mammals, where observed or reported;
- Economically important species;
- Rare, threatened, or protected species; and
- Potential breeding or nesting locations.

6.16.3 Homestead Forestation

Homestead forestation is an important component of the rural and peri-urban landscape of Bangladesh. Trees and vegetation planted around residential properties provide economic, social, environmental, and ecological benefits.

Within the broader project influence area, homestead vegetation may consist of fruit trees, timber species, bamboo, shrubs, medicinal plants, and ornamental vegetation.

Common categories of homestead vegetation may include:

- Fruit-bearing trees;
- Timber-producing trees;
- Bamboo and cane;
- Medicinal plants;
- Ornamental vegetation;
- Household vegetables; and
- Naturally occurring shrubs and herbs.

Homestead forests provide fruits, timber, fuelwood, shade, and other household resources. They also contribute to local biodiversity by providing habitat, feeding areas, and nesting opportunities for birds, insects, and small terrestrial fauna.

The distribution and density of homestead vegetation within the study area shall be assessed through field observations and community consultations. Major plant species observed during the baseline ecological survey should be documented.

6.16.4 Roadside Vegetation

Roadside vegetation forms an important element of the ecological and visual landscape within the project influence area. Vegetation along roads may include planted trees, naturally occurring shrubs, grasses, herbs, and other plant species.

Roadside trees provide several environmental and ecological benefits, including:

- Dust interception;
- Noise attenuation;
- Shade provision;
- Carbon sequestration;
- Soil stabilization;
- Reduction of roadside erosion;
- Visual landscape improvement; and
- Habitat for birds and insects.

6.17 Bio Ecological Zone

Bio-ecological zoning provides a broad framework for understanding the relationship among physiography, hydrology, vegetation, wildlife, land use, and ecological processes of a particular geographical area. The bio-ecological characteristics of the project influence area have been considered as part of the ecological baseline assessment.

The proposed project is located at Telihati, Sreepur, Gazipur, within a rapidly developing industrial and peri-urban landscape. The broader area historically contained agricultural land, homestead vegetation, patches of natural and planted vegetation, low-lying areas, ponds, and seasonal aquatic habitats. Industrial development, road construction, settlement expansion, and conversion of land have progressively modified the original ecological characteristics.

The present ecological environment is therefore characterized mainly by modified terrestrial habitats and fragmented aquatic habitats. Common and disturbance-tolerant species are expected to dominate the project influence area.

Important ecological components within the study area may include:

- Homestead forests and gardens;
- Roadside vegetation;

- Agricultural vegetation;
- Scattered trees and shrubs;
- Ponds and small water bodies;
- Seasonal low-lying areas;
- Drainage channels;
- Aquatic vegetation; and
- Modified open or fallow land.

6.18 Socio Economic Condition

The socio-economic baseline assessment aims to understand the demographic, settlement, livelihood, employment, education, occupational, infrastructure, migration, and social characteristics of communities within the project influence area.





The project is located within Sreepur Upazila of Gazipur District, an area that has experienced considerable industrial, residential, and infrastructure development. The socio-economic characteristics of the broader area are influenced by industrial employment, agriculture, small businesses, transportation activities, service-sector occupations, and migration of workers from other parts of Bangladesh.







The socio-economic study should include both primary and secondary information. Primary information may be collected through household surveys, key informant interviews, focus group discussions, stakeholder consultation, and direct field observations. Secondary data should be obtained from relevant government agencies and published statistical sources.





The assessment shall pay particular attention to communities and sensitive receptors located close to the project boundary and along the proposed waste transportation routes.

6.18.1 Settlement of Urban and Rural Community

The project influence area represents a transitional rural, peri-urban, and industrial landscape. Traditional village settlements coexist with industrial establishments, commercial facilities, worker accommodation, and expanding residential development.

Rural settlements are generally characterized by clustered or dispersed homesteads, local roads, ponds, agricultural plots, homestead vegetation, religious institutions, and small commercial establishments.

Urban and peri-urban characteristics are increasingly visible within the broader Sreepur area due to industrial growth and improved transportation connectivity.

The settlement pattern around the project site shall be mapped using GIS and verified through field surveys. Residential clusters, educational institutions, healthcare facilities, religious establishments, markets, and other community facilities shall be identified.

The proposed TSDF facility will be developed within the designated project boundary. No uncontrolled extension of project activities into surrounding residential or community areas shall be permitted.

Potential project-community interactions may arise from vehicle movement, noise, dust, odour concerns, visual impacts, employment opportunities, and perceived environmental or health risks.

A Stakeholder Engagement Plan and Grievance Redress Mechanism shall be maintained throughout the project life cycle to ensure that community concerns are documented, investigated, and appropriately addressed.

6.18.2 Demographic Profile

The demographic profile of the project influence area shall be assessed to understand population size, household characteristics, age distribution, gender composition, population density, and other relevant demographic indicators.

Demographic information should be collected for the affected unions, villages, and settlements using the latest available official statistics and primary socioeconomic survey findings.

The assessment should consider:

- Total population;
- Number of households;
- Male and female population;
- Age structure;
- Household size;
- Population density;
- Working-age population;
- Dependent population;
- Literacy characteristics; and
- Population growth trends.

Official statistics for Sreepur Upazila, the administrative area of the project, and for Telihati Union, the union in which the project site is located, are presented below. They are taken from the Bangladesh Bureau of Statistics (BBS) Population and Housing Census 2022 and 2011, as published in the BBS national report, Banglapedia and the census-based union tables. Where a figure is not published at union level, it is shown as not available or as a clearly marked estimate, and it will be confirmed through the primary household survey and consultations.

Total population, households, household size and density

Sreepur Upazila had a total population of 855,263 in 2022, living in about 249,845 households. Telihati Union had 130,548 people, about 15.3% of the upazila population. Sreepur Municipality is the largest urban centre with 258,973 people (30.3% of the upazila). The project union is entirely rural in the census classification, but it is changing quickly into an industrial and peri-urban area.

Table 35: Total population, households, household size and population density, 2022

Indicator	Sreepur Upazila	Telihati Union (project union)
Total population (2022)	855,263	130,548
Population (2011)	492,792	45,271
Households (2022)	249,845	Not published separately; about 39,000 (estimate)
Households (2011)	122,872	Not available
Average household size (BBS, 2022)	3.34 persons	About 3.3 persons (upazila value assumed)
Total population per household (2011)	4.01 persons	Not available
Area	462.94 km²	39.90 km² (9,860 acres)
Population density (2022)	About 1,847 persons per km²	About 3,272 persons per km²
Population density (2011)	About 1,064 persons per km²	About 1,135 persons per km²

Source: BBS Population and Housing Census 2022 (National Report, Vol. I) and 2011; Banglapedia. Notes: the 2022 household size of 3.34 is the BBS-published value; total population divided by households gives 3.42. The Telihati household count is an estimate (130,548 ÷ 3.34) and the Telihati density uses the 2011 union area.

Household size has fallen from about 4.0 persons in 2011 to about 3.3–3.4 in 2022. This is typical of an area receiving many single workers and small migrant families who rent rooms near factories, and it is consistent with the very fast growth of the population. Persons living and eating together from the same kitchen are counted as one household.

Male and female population

Table 36: Male and female population and sex ratio

Indicator	Sreepur Upazila (2022)	Telihati Union (2022)
Male population	444,800 (52.0%)	68,118 (52.2%)
Female population	410,404 (48.0%)	62,415 (47.8%)
Hijra (third gender)	59	15
Total	855,263	130,548
Sex ratio (males per 100 females)	108.4	109.1
Females per 100 males	92.3	91.6
Sex ratio in 2011 (males per 100 females)	104.1	103.1

Source: BBS Population and Housing Census 2022 and 2011; census-based union tables (Telihati 2011: 22,980 males and 22,291 females).

Males outnumber females, and the gap widened between 2011 and 2022 (from 104 to 108 males per 100 females in the upazila). The ratio is slightly higher in Telihati Union (109 males per 100 females), which is consistent with in-migration of male workers for industry and construction. This matters for the labour-influx and community-health assessment in Chapter 2 and for the engagement with women described in Chapter 3.

Age structure

Table 37: Age structure of the population, 2022

Age group	Sreepur Upazila	Share	Telihati Union	Share
0–9 years	143,244	16.8%	22,722	17.4%
10–19 years	161,184	18.9%	26,119	20.0%
20–29 years	206,988	24.3%	33,370	25.6%
30–39 years	149,012	17.5%	22,816	17.5%
40–49 years	86,247	10.1%	12,451	9.5%
50–59 years	54,210	6.4%	6,736	5.2%
60–69 years	33,908	4.0%	3,983	3.1%
70–79 years	14,131	1.7%	1,615	1.2%
80 years and above	3,361	0.4%	736	0.6%

Source: BBS Population and Housing Census 2022 (age distribution as compiled in the census-based tables). Shares are calculated on the population with recorded age (upazila 852,285; Telihati 130,548).

The population is young. About 36% of the people in the upazila are below 20 years of age, and about 42% are aged 20–39, the age at which most factory and construction workers are employed. Only about 6% are 60 years or older. Telihati has the same pattern with an even higher share in the 20–29 group (25.6%).

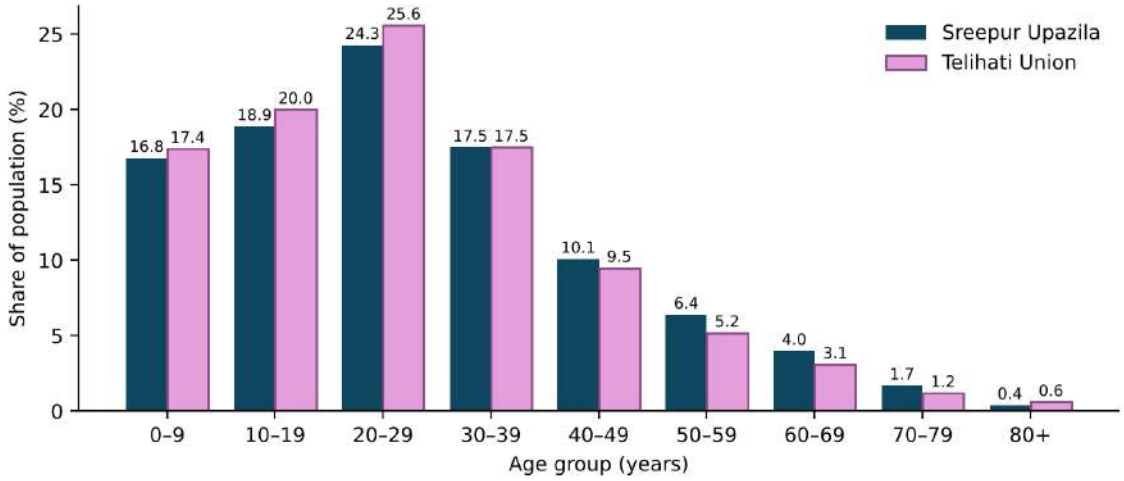


Figure 39: Age structure of Sreepur Upazila and Telihati Union, 2022 (share of population, %)

Working-age and dependent population

Table 38: Working-age and dependent population, 2022

Group	Sreepur Upazila	Share	Telihati Union	Share
Children, 0–14 years	216,472	25.3%	34,341	26.3%
Working-age population, 15–64 years	605,035	70.7%	92,383	70.8%
Elderly, 65 years and above	33,697	3.9%	3,824	2.9%
Total dependency ratio (dependants per 100 working-age persons)	41.3		41.3	
Child dependency ratio	35.8		37.2	
Old-age dependency ratio	5.6		4.1	

Source: BBS Population and Housing Census 2022 (broad age groups); ratios calculated. Dependants = children (0–14) plus elderly (65+). Shares for the upazila are on the 855,204 persons with recorded age group.

About 71% of the population is of working age (15–64 years), and there are about 41 dependants for every 100 working-age persons. This is a low dependency burden and a large labour pool. It explains the availability of semi-skilled and unskilled labour for the construction and operation of the project, and the pressure on local jobs, housing and transport that comes with a fast-growing workforce.

Literacy characteristics

Table 39: Literacy rate of the population aged 7 years and above

Area and year	Both sexes (%)	Male (%)	Female (%)
Sreepur Upazila, 1991	30.3	Not available	Not available
Sreepur Upazila, 2011	54.8	57.6	51.8
Sreepur Upazila, 2022	78.2	80.6	75.5
Telihati Union, 2011	56.6	Not available	Not available
Telihati Union, 2022	Not published in the sources reviewed	—	—

Source: BBS Population and Housing Census 2022 (National Report, Vol. I, upazila table: 78.15% total, 80.58% male, 75.50% female); BBS Census 2011 and Banglapedia; Wikipedia compilation of the 1991 census.

Literacy in the upazila rose from 54.8% in 2011 to 78.2% in 2022, a gain of about 23 percentage points. Men are more literate than women, but the gender gap is about 5 percentage points. Telihati Union had a literacy rate of 56.6% in 2011, slightly above the upazila average of that year. The 2022 literacy rate of the union will be confirmed in the household survey. High literacy among young workers supports training in the safe handling of hazardous waste, while the remaining non-literate adults should be reached through verbal and pictorial communication in the grievance and awareness programmes.

Population growth trends

Table 40: Population growth by census year

Census year	Sreepur Upazila	Telihati Union	Sreepur Municipality	Share of Telihati in upazila
1991	320,530	34,197	—	10.7%
2001	Not available	38,823	—	—
2011	492,792	45,271	126,249	9.2%
2022	855,263	130,548	258,973	15.3%
Annual growth 1991–2011	2.17%	1.41%	—	
Annual growth 2011–2022	5.14%	10.11%	6.75%	
Population increase 2011–2022	+362,471 (+73.6%)	+85,277 (+188%)	+132,724 (+105%)	

Source: BBS Population and Housing Census 1991, 2001, 2011 and 2022; annual growth rates calculated as compound rates.

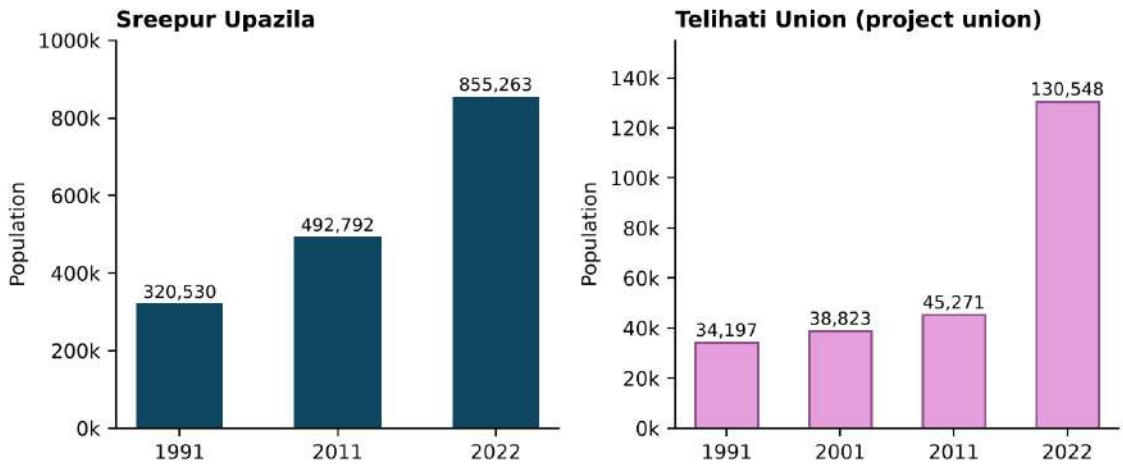


Figure 40: Population of Sreepur Upazila and Telihati Union by census year

Growth was moderate until 2011, at about 2% a year in the upazila and 1.4% a year in Telihati. It then accelerated sharply. Between 2011 and 2022 the upazila added about 362,000 people (+74%, or 5.1% a year) and Telihati Union nearly tripled, from 45,271 to 130,548, growing by about 10% a year. The growth is driven by industrial and commercial development along the Gazipur–Sreepur corridor and by labour in-migration, not by natural increase alone.

Table 41: Union-wise population of Sreepur Upazila, 2011 and 2022

Union / municipality	Population 2011	Population 2022	Annual growth	Share of upazila (2022)

Barmi	64,995	77,399	1.6%	9.0%
Gazipur	52,267	98,236	5.9%	11.5%
Gosinga	33,533	39,005	1.4%	4.6%
Kaoraid	50,204	63,457	2.2%	7.4%
Maona	51,110	88,103	5.1%	10.3%
Prahladpur	25,611	29,197	1.2%	3.4%
Rajabari	43,552	70,345	4.5%	8.2%
Sreepur Municipality	126,249	258,973	6.7%	30.3%
Telihati (project union)	45,271	130,548	10.1%	15.3%
Sreepur Upazila (total)	**492,792**	**855,263**	**5.1%**	**100.0%**

Source: BBS Population and Housing Census 2011 and 2022 (census-based union tables). The union figures add up to 855,263.

Telihati Union is the fastest-growing union of the upazila. Its density of about 3,270 persons per km² is already well above the upazila average of about 1,850, and it is expected to keep rising. The rapid growth means that the households closest to the project site are likely to be recent migrants as well as long-settled village families, and the household survey and stakeholder consultation should cover both groups.

Religion and ethnic composition.

In 2022 the upazila population was 96.6% Muslim (826,492), 3.2% Hindu (26,987) and about 0.2% Christian, Buddhist and others. Small indigenous communities (Santal, Koch, Rajbangshi, Mandi, Nunia and Bhangar) live in the upazila (BBS Census 2011). They are a small share of the population and will be covered in the vulnerability assessment and stakeholder engagement.

Overall, the demographic profile shows a young, mostly working-age, increasingly literate and fast-growing population with a male majority, in a union that is becoming dense and industrial. These features are used in Chapter 2 to rate the sensitivity of nearby residents and workers, and in Chapters 3 and 5 to plan consultation, local employment and community health and safety measures.

6.18.3 Employment Opportunity and Availability of Manpower

The Sreepur and Gazipur region has a considerable industrial workforce due to the concentration of manufacturing and industrial establishments. Skilled, semi-skilled, and unskilled workers are available in the broader regional labour market.

The proposed TSDF facility will require manpower during both construction and operation.

Construction-phase employment	Operation-phase manpower
• Civil construction workers; • Equipment installation personnel; • Electricians; • Welders; • Mechanical technicians; • Drivers; • Security personnel; • Supervisors; and	• Plant managers; • Environmental professionals; • Chemical or laboratory personnel; • Incinerator operators; • Mechanical and electrical technicians; • Waste handling personnel; • Health and safety personnel; • CEMS and control room operators;

• General labourers.	• Drivers; • Administrative staff; • Security personnel; and • Housekeeping staff.

6.18.4 Occupational Pattern

The occupational pattern within the project influence area reflects the mixed rural, industrial, and peri-urban characteristics of Sreepur.

Major occupational categories may include:

- Industrial employment;
- Agriculture;
- Small business and trading;
- Transportation services;
- Construction work;
- Government and private services;
- Livestock and poultry farming;
- Fisheries;
- Day labour;
- Technical occupations; and
- Household-based economic activities.

The main sources of household income in Sreepur Upazila (BBS Census 2011) are shown below. Industrial employment has increased since 2011 because of the growth of the Gazipur–Sreepur industrial belt.

Main source of income	Share of households (%)
Agriculture	54.62
Commerce	15.63
Service	8.52
Transport and communication	4.98
Non-agricultural labour	3.67
Rent and remittance	2.02
Construction	1.52
Industry	0.79
Religious service	0.19
Others	7.71

Source: Banglapedia, Sreepur Upazila (Gazipur District), based on BBS Population Census 2011.

6.18.5 Demand of Electricity

Electricity demand within the project influence area is associated with households, industries, commercial facilities, educational institutions, healthcare services, and public infrastructure.

Rapid industrial and residential development may contribute to increasing electricity demand in the broader Sreepur region.

The proposed TSDF facility will require electricity for:

- Waste reception and handling equipment;
- Segregation and material recovery systems;
- Incineration auxiliaries;
- Air Pollution Control Devices;
- Pumps and blowers;
- Process water systems;
- Wastewater treatment;
- Continuous Emission Monitoring System;
- Laboratory facilities;
- Lighting;
- Ventilation;
- Administrative facilities;
- Security systems; and
- Other utility systems

All unions of Sreepur Upazila are connected to the rural electrification network. The status of utility services and community facilities in the upazila (BBS Census 2011) is summarised below.

Item	Status in Sreepur Upazila
Access to electricity	All unions on the rural electrification network; 69.7% of dwelling households connected
Source of drinking water	Tube well 88.4%; tap water 8.6%; others 2.9%
Sanitation	Sanitary latrine 76.5%; non-sanitary latrine 20.8%; no latrine 2.6%
Educational institutions	164 primary schools, 50 secondary schools, 7 colleges, 56 madrasas, 44 NGO schools
Health facilities	1 Upazila Health Complex, 4 union health centres, 6 family welfare centres, 53 clinics, 1 hospital
Religious institutions	660 mosques, 12 temples, 2 churches
Markets	25 hats and bazaars

Source: Banglapedia, Sreepur Upazila (Gazipur District), based on BBS Population Census 2011.

6.18.6 Population Migration

Population migration is an important socioeconomic characteristic of industrialized areas. Employment opportunities associated with factories, construction projects, transportation, and service activities may attract workers from different parts of Bangladesh.

The broader Sreepur area may contain both permanent and temporary migrant populations associated with industrial employment.

The proposed project may result in limited labour in-migration during construction and operation. The magnitude of migration will depend on workforce requirements and the availability of qualified local manpower.

Potential effects of labour in-migration may include:

- Increased demand for housing;
- Increased demand for food and local services;
- Increased pressure on transportation;
- Demand for healthcare services;
- Changes in local commercial activities; and
- Increased interaction between local and migrant populations.

6.18.7 Social Diversity and Vulnerable Groups

The project influence area may include communities with different social, occupational, economic, and cultural backgrounds. Industrial development and labour migration have contributed to increased social diversity in the broader region.

The socioeconomic assessment shall consider whether any particularly vulnerable or disadvantaged population groups are located within the project influence area.

Potential vulnerable groups may include:

- Low-income households;
- Landless households;
- Elderly persons;
- Persons with disabilities;
- Female-headed households;
- Households dependent on natural resources;
- Informal workers; and
- Other socially or economically disadvantaged groups.

6.18.8 Social Solidarity

Social solidarity refers to the level of community cooperation, mutual support, collective decision-making, and social interaction among residents.

Communities within the project influence area may maintain social connections through family relationships, neighbourhood networks, religious institutions, local markets, educational institutions, and community organizations.

Industrialization and migration may introduce changes in traditional community relationships. However, local institutions and community leadership may continue to play an important role in social coordination.

The project shall maintain regular stakeholder engagement with local communities, community representatives, local administration, and other relevant stakeholders.

A transparent Grievance Redress Mechanism shall be established to receive and address project-related complaints.

6.18.9 Entities outside the 250 m Buffer

Entities located outside the 250 m buffer of the proposed project site shall be identified as part of the broader socioeconomic and environmental influence area assessment.

A GIS-based mapping exercise and field survey shall be conducted to identify sensitive and community facilities located outside the 250 m buffer that may have potential interaction with the project.

Such entities may include:

- Residential settlements;
- Schools and educational institutions;
- Healthcare facilities;
- Religious institutions;
- Markets;
- Industries;
- Agricultural land;
- Fish ponds;
- Community water sources; and
- Other sensitive receptors.

6.18.10 Entities inside the 200 m and 250 m Buffer

A detailed inventory of residential, commercial, institutional, industrial, agricultural, and other entities located within 200 m and 250 m of the project boundary shall be prepared.

The inventory shall be based on GIS mapping, physical field verification, and socioeconomic surveys.

The survey should identify:

- Households;
- Residential buildings;
- Industrial facilities;
- Commercial establishments;
- Educational institutions;
- Healthcare facilities;
- Religious institutions;
- Water bodies;
- Agricultural land;
- Livestock and poultry farms;
- Fish culture ponds; and
- Other sensitive receptors.

Potential project impacts within the buffer area may include:

- Noise;

- Dust;
- Odour concerns;
- Vehicle movement;
- Perceived health concerns;
- Visual impacts;
- Emergency risks; and
- Changes in local traffic conditions.

6.19 Climate Change Scenario

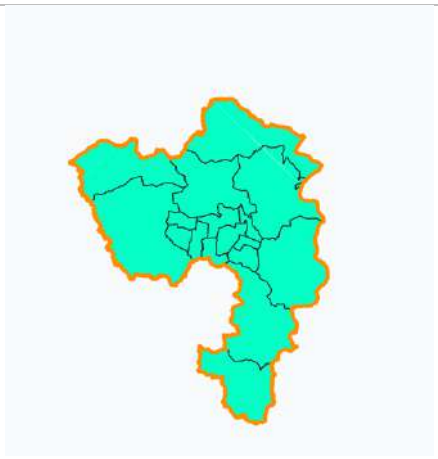
Climate change is an important environmental consideration for the planning, design, construction, and operation of major industrial and waste management facilities in Bangladesh.

Potential climate-related hazards relevant to the proposed project may include:

- Increased temperature;
- Extreme heat events;
- Intense rainfall;
- Waterlogging;
- Changes in rainfall patterns;
- Severe storms;
- Lightning;
- Strong winds; and
- Increased frequency of extreme weather conditions.



Cold winter zone <15



Hot summar zone <40

Climate change may influence project infrastructure, drainage systems, water demand, worker health, equipment performance, and emergency response arrangements.

Increased rainfall intensity may increase pressure on stormwater drainage systems. The project drainage network shall therefore be designed considering appropriate rainfall intensity and site runoff conditions.

Critical waste storage and treatment facilities shall be protected against uncontrolled stormwater entry.

Climate-related increases in temperature may affect working conditions and equipment cooling requirements. Appropriate ventilation, worker rest arrangements, drinking water, and heat stress management procedures shall be implemented.

The project shall also consider greenhouse gas emissions associated with fuel combustion, electricity consumption, waste transportation, and waste treatment activities.

Energy efficiency, waste recovery, controlled combustion, preventive maintenance, and optimization of vehicle movement shall be considered as part of the project's climate mitigation approach.

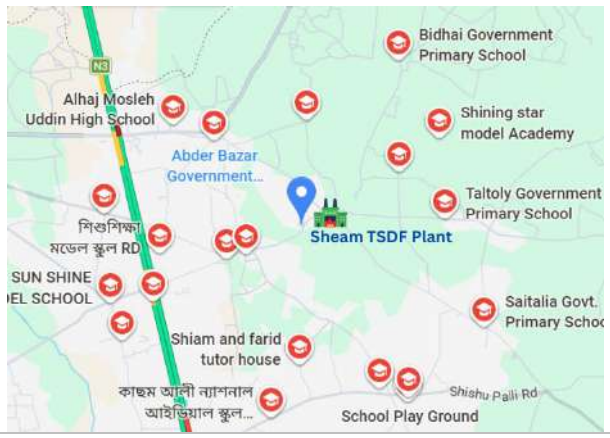
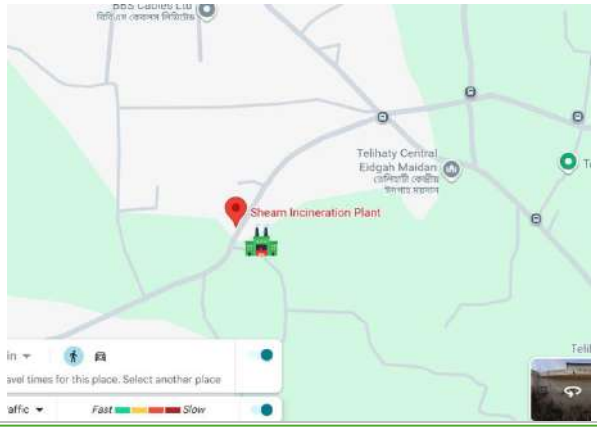
The Environmental and Social Management Plan shall include appropriate climate adaptation and resilience measures.

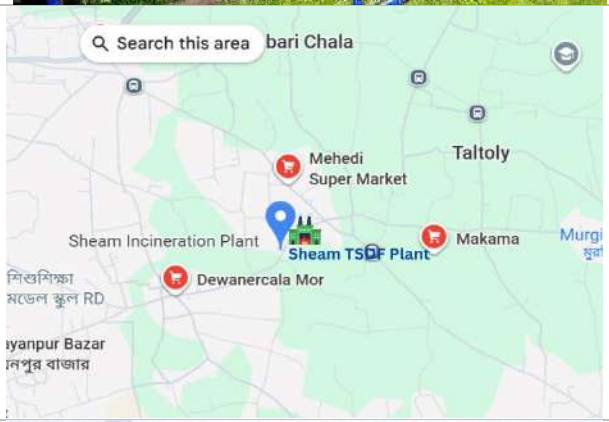
Periodic review of climate-related risks shall be undertaken during project operation to ensure that infrastructure and emergency procedures remain suitable for changing environmental conditions.

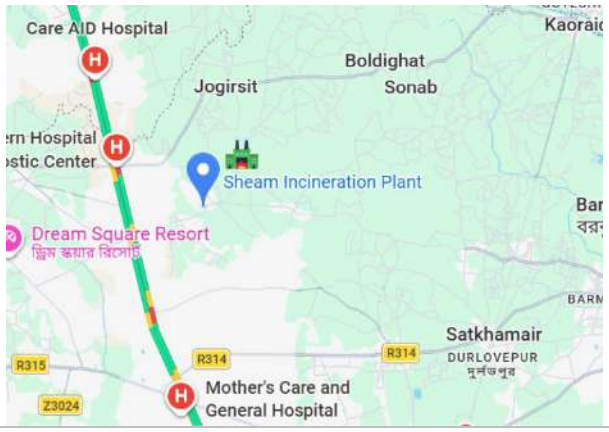
6.20 Distance to IEFs, Urban and Rural Communities

Important Environmental Features, hereafter referred to as IEFs, and nearby urban and rural communities shall be identified and mapped within the project study area.

IEFs may include:

Schools;	
Religious institutions;	

	
	
Markets	
	
Utility – Electric supply	

Hospitals and clinics;	

The distance of each identified IEF from the project boundary shall be determined through GIS analysis and verified during field surveys.

Urban, peri-urban, and rural settlements within the project influence area shall also be mapped. Particular attention shall be given to densely populated settlements and vulnerable communities.

The final ESIA provided an IEF distance matrix containing the following information:

- Name or identification of the IEF;
- Type of environmental or social feature;
- Direction from the project site;
- Approximate distance from the project boundary;
- Sensitivity of the receptor; and
- Potential interaction with project activities.

IEF Distance Matrix

IEF category	Features in the study area	Sensitivity	Potential interaction with the project	Distance and direction from boundary
Schools and educational institutions	Primary and secondary schools and madrasas of the surrounding villages (see map above)	High (children, long daytime exposure)	Dust, noise, traffic safety on the access road, odour	*1.6KM*
Religious institutions	Mosques and temples in nearby settlements	Medium–High (worship hours, gatherings)	Noise, traffic, perceived risk	*900M*
Markets and commercial centres	Local hats and bazaars	Medium	Traffic congestion, dust	*1.5KM*
Hospitals and clinics	Private hospitals and clinics shown on the map; Upazila Health Complex	High (vulnerable people)	Air emissions, noise, shared emergency access routes	*5KM*
Electricity supply infrastructure	Substation and distribution lines shown on the map	Medium (critical utility)	Fire or explosion hazard, line clearance near the stack	*1.7KM*
Residential settlements and worker housing	Clustered homesteads and worker accommodation of the industrial belt	High	Air emissions, noise, odour, traffic	*300M*

IEF category	Features in the study area	Sensitivity	Potential interaction with the project	Distance and direction from boundary
Ponds, khals and drains	Nearby pond (SW-01), canal/khal and low-lying areas	High (fisheries, domestic use)	Runoff, spills, accidental release	*700M*

The project shall consider the distance and sensitivity of IEFs when planning stack design, environmental monitoring locations, transportation routes, emergency response arrangements, and stakeholder engagement activities.

6.21 Distance to Existing Infrastructure Such as Roads, Ports, Rail

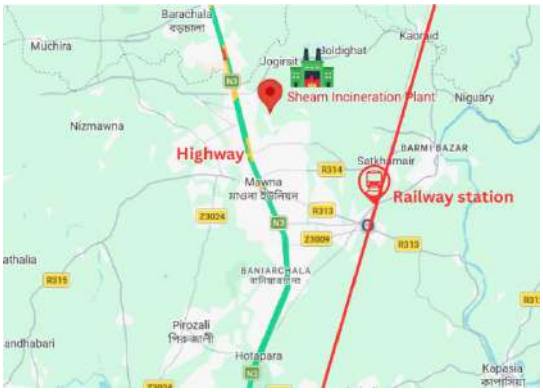
Existing transportation and utility infrastructure within the project influence area has been considered to assess project accessibility and potential interaction with regional infrastructure systems.

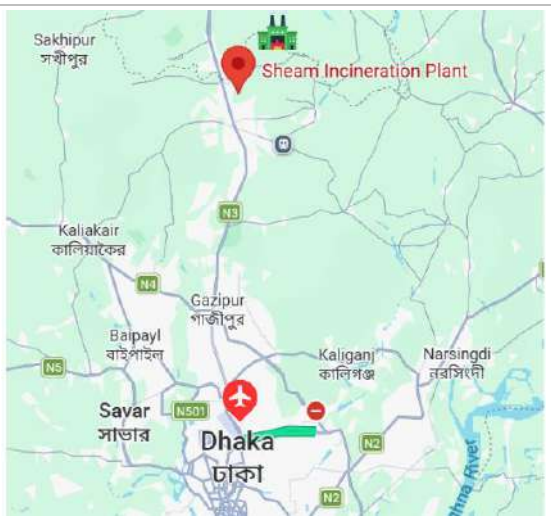
The proposed project is expected to depend primarily on road transportation for movement of waste, equipment, construction materials, workers, and treatment residues.

The distance from the project site to major roads, regional roads, highways, railway facilities, airports, inland water transport facilities, and other relevant infrastructure shall be determined through GIS mapping and field verification.

The infrastructure assessment shall consider:

- Nearest national highway;
- Nearest railway line;
- Nearest railway station;



• Nearest airport	

The project is located in Telihati Union of Sreepur Upazila, which is well connected by road to Gazipur, Dhaka and Mymensingh. The upazila has about 1,660 km of paved roads, 35 km of semi-paved roads, 952 km of earthen roads, 29 km of railway and 16 km of waterway (Banglapedia). Road transport will be the only mode used for the TSDF, and inland water transport will not be used.

Infrastructure	Relevance to the project	Distance and direction from site
National / regional highway	Main route for waste vehicles, equipment and workers	*3KM*
Local and industrial access roads	Final approach to the site; load capacity and width to be verified for heavy vehicles	*2KM*
Railway line and station	Not used for waste; relevant to workforce access and regional connectivity	*8km*
Airport	Hazrat Shahjalal International Airport, Dhaka; relevant only for specialist personnel and imported spares	*52KM*
Seaport	Chattogram Port; relevant only to imported equipment and spare parts	Outside the study area
Inland waterway	No navigable river adjoins the site; not used	Not applicable

6.22 Protected and Ecologically Sensitive Areas

The project site will be assessed in relation to nearby environmentally sensitive and legally protected areas. Protected areas may include national parks, wildlife sanctuaries, reserved forests, ecologically critical areas, wetlands, rivers, floodplains, cultural heritage sites, and other sensitive receptors.

Based on the site-specific ESIA study, the distance between the proposed project site and any protected or ecologically sensitive area will be identified and documented. If any sensitive area is located within the project influence zone, appropriate mitigation measures will be incorporated into the project design and environmental management plan.

The assessment will consider:

- Distance from protected forests, wetlands, rivers, canals, and water bodies.
- Presence of ecologically critical areas or biodiversity-sensitive locations.

- Distance from settlements, schools, hospitals, religious institutions, and markets.
- Possible impact pathways through air emissions, wastewater discharge, stormwater runoff, traffic, noise, and accidental release.
- Need for buffer zone, greenbelt, drainage control, and emergency response measures.

Findings of the Screening

Protected / sensitive area	Status	Relationship to the project site
Bhawal National Park	National park in the Madhupur Tract of Gazipur District; about 5,022 ha; declared in 1982	The project site is not inside the park. Distance: *25KM*
Madhupur National Park	National park in Tangail and Mymensingh	Outside the study area. Distance: *14KM*
Ecologically Critical Areas (ECA)	The Turag, Buriganga, Shitalakhya and Balu rivers around Dhaka were declared ECAs in 2009	No ECA has been identified within the project influence area. Nearest ECA: *Turag River 48KM*
Reserved and sal forest patches	Remnant sal forest of the Madhupur Tract under the Forest Department	No forest land identified within 1 km. Buriganga 70KM
Archaeological and heritage sites	Documented sites of Sreepur Upazila include the Chinashukhania palace remains, Kaoraid Kali Mandir and Sreepur Molla Mosque	None known within the immediate project area. *10KM*

On the basis of this screening, the project is not located within any declared protected area. The immediate area is a modified landscape of industrial land, settlements, homestead vegetation and fragmented aquatic habitats, so its ecological sensitivity is low to moderate. The pathways through which the facility could affect more distant sensitive areas (air emissions, runoff, noise and accidental release) are assessed in Chapter 2. A greenbelt and buffer will be developed around the site as described in the Environmental Management Plan.

6.23 Connectivity with Utilities and Emergency Services

The proposed TSDF facility will require connectivity with existing infrastructure such as access roads, electricity supply, water source, drainage system, communication network, emergency service routes, and nearby waste source locations. The ESIA will assess the distance and relationship of the project site with surrounding infrastructure to determine suitability, accessibility, and potential impact.

The proposed TSDF facility will require connectivity with existing infrastructure such as access roads, electricity supply, water source, drainage system, communication network, emergency service routes, and nearby waste source locations. The ESIA will assess the distance and relationship of the project site with surrounding infrastructure to determine suitability, accessibility, and potential impact.

Key infrastructure to be assessed includes:

Infrastructure / service	Existing connectivity and relevance to the TSDF	Distance
Main road and internal access road	The site is accessible by road. Waste vehicles will use designated routes, and internal roads will be paved and drained	*3KM*
Electricity	All unions of Sreepur are on the rural electrification network. The facility will connect to the nearest distribution line or substation, with standby generators or UPS for safe shutdown, the pollution control system and CEMS	*1.5KM*

Infrastructure / service	Existing connectivity and relevance to the TSDF	Distance
Water supply	A deep tube well exists at the site (groundwater sampled for this study). Abstraction is subject to approval, with metering and maximum reuse of treated water	On site
Drainage and surface water	Nearby pond and khal. No discharge of process or contaminated water to any water body	*700M*
Communication network	Mobile and broadband coverage is expected in the Sreepur industrial belt; needed for CEMS data transmission and emergency communication	In area
Settlements and community facilities	See the IEF distance matrix in Section 1.20	*400M*
Industrial area and waste sources	The Gazipur–Sreepur industrial belt (garments, glass, ceramics, textile and others) is the main source of industrial and hazardous waste, so transport distances are short	In area
Fire service and emergency healthcare	Fire Service and Civil Defence station serving Sreepur; Upazila Health Complex, clinics and private hospitals shown on the IEF map. National Emergency Service: 999	*4KM*

Key infrastructure to be assessed includes:

Nearest main road and internal access road.

- Nearest electricity distribution line or substation.
- Nearest water supply source.
- Nearest drainage canal, river, or surface water body.
- Nearest settlement or residential area.
- Nearest school, hospital, mosque, market, or community facility.
- Nearest industrial area, airport, port, customs facility, or waste generation source.
- Nearest fire service station and emergency healthcare facility.

6.24 Summary of Baseline Findings

The key findings of the environmental and social baseline are summarised below. They are the basis for the impact prediction and mitigation measures in Chapter 2 and for the Environmental and Social Management Plan.

Component	Key baseline finding	Implication for the TSDF
Topography and geology	Madhupur Tract terrace with gently undulating land; firm to stiff Madhupur clay with alluvial deposits in low areas	Suitable for foundations; site geotechnical and permeability testing needed for landfill and tank design
Climate	Tropical monsoon; about 2,150 mm annual rainfall, nearly 80% in May–September; mean wind speed about 3.2 knots; humidity 70–75%	Drainage and containment sized for extreme rainfall; stack design for light winds and winter inversions
Ambient air	All parameters within DoE standards; $PM_{2.5}$ and PM_{10} above WHO 2021 guideline values	Limited assimilative capacity; stringent air pollution control and CEMS
Noise	Day Leq 42.1–46.7 dB(A); night Leq 33.6–35.2 dB(A); below Silent Area limits	Quiet baseline; operational noise limited to within 3 dB(A) of background at receptors
Surface water	Pond SW-01 within limits except TSS (161 against 150 mg/L); ponds and khals are local receptors	No discharge to surface water; stormwater segregation and first-flush collection
Groundwater	Site tube well within ECR 2023 limits; arsenic 0.002 mg/L; fresh water (TDS 261 mg/L)	Protect with impervious floors, liners and monitoring wells; control abstraction
Land and soil	Modified land of industrial and settlement use; Madhupur soils	Impervious flooring, secured landfill design and soil baseline before disposal

Component	Key baseline finding	Implication for the TSDF
Agriculture, livestock and fisheries	Agriculture is the main income source of 54.6% of households; 772 poultry farms, 109 dairy farms, 35 fish farms in the upazila	Protect irrigation and pond water; dust and odour control
Ecology	Modified terrestrial and fragmented aquatic habitats with common species; no protected area identified at the site	Low–moderate sensitivity; greenbelt development
Socio-economy	Upazila population 855,263 (2022); Telihati Union grew from 45,271 to 130,548 in 2011–2022	Local employment opportunity; pressure on services; stakeholder engagement and GRM
Infrastructure and emergency services	Road-based access; grid electricity; fire and health services in the area	Traffic management; EPRP; standby power
Seismicity and climate hazards	BNBC 2020 Zone II (Z = 0.20); monsoon waterlogging and heat stress	Seismic-resistant design; platform level above flood level; climate adaptation measures

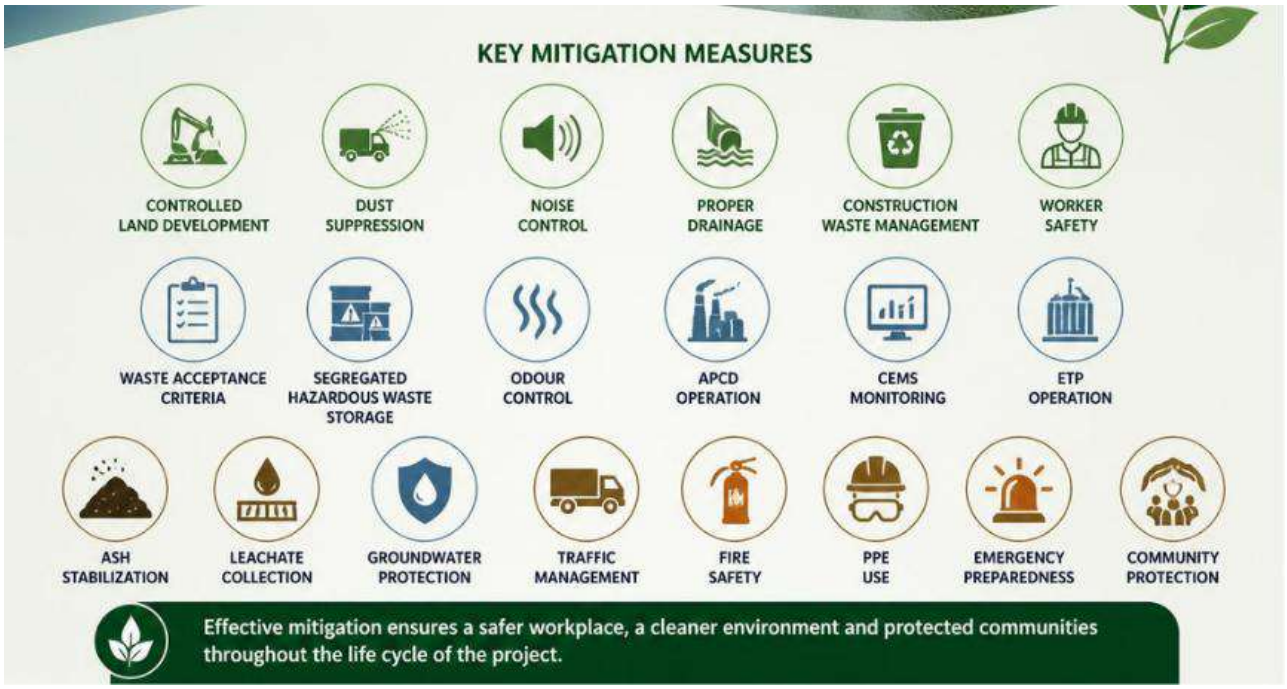
CHAPTER 7

Impact Assessment and Mitigation Measures

This chapter identifies and assesses the potential environmental and social impacts of the project during the pre-construction, construction and operation stages and, for each impact, presents the corresponding mitigation or enhancement measures. It concludes with the evaluation of impact significance, cumulative impacts, residual impacts after mitigation and a summary of the major impacts.

7 IMPACT ASSESSMENT AND MITIGATION MEASURES

This chapter identifies the potential environmental and social impacts of the proposed project and presents the corresponding mitigation and enhancement measures. Impacts are assessed stage by stage (pre-construction, construction and operation). For each impact, the description of the impact is followed immediately by the mitigation measures proposed to avoid, minimise or control it, so that each issue can be read in one place. The chapter closes with the evaluation of impact significance, cumulative impacts, residual impacts after mitigation and a summary of the major impacts. The significance criteria are described in Chapter 5 and the implementation arrangements in Chapter 10.



7.1 Impact Identification

Impact identification is an essential step of the ESIA process. It helps to identify the possible environmental, social, ecological, occupational health and community safety impacts that may arise from different stages of the proposed Sheam Treatment, Storage and Disposal Facility (TSDF) project.

The potential impacts have been identified considering the nature of the project activities, site condition, surrounding land use, project design, waste handling process, construction activities, operational activities, transportation requirements and environmental sensitivity of the project area.

The impacts have been assessed for the following project stages:

a. pre-construction stage;
b. construction stage;
c. operation stage;
d. emergency or accidental condition.

The major environmental and social components considered for impact identification include:

Environmental / Social Component	Possible Impact Area
Landform and land use	Site grading, filling, land development and land use change
Soil	Soil disturbance, erosion and contamination risk
Air quality	Dust, exhaust emission, odour and stack emission
Noise	Construction noise, machinery noise and vehicle movement
Surface water	Runoff, wastewater, sedimentation and contamination
Groundwater	Leakage, leachate and long-term contamination risk
Drainage	Change in runoff pattern and waterlogging
Ecology	Impact on flora, fauna and aquatic ecosystem
Occupational health and safety	Worker injury, exposure, accident and disease risk
Community health and safety	Traffic, dust, noise, odour, fire and emergency risk
Socio-economic condition	Employment, livelihood, land use and public concern

7.2 Pre-construction Stage Impacts and Mitigation

The pre-construction stage includes land-related activities, project planning, site survey, boundary demarcation, preliminary site clearing, resource planning, material sourcing, access preparation, baseline monitoring, stakeholder consultation and initial mobilization. Although major physical construction may not begin at this stage, certain preparatory activities may create environmental and social impacts if not properly managed.

The pre-construction stage impacts are generally temporary, localized and manageable through proper planning, engineering design, stakeholder consultation and environmental management measures.

7.2.1 Impact on Landform

The proposed project site may require land preparation, site grading, leveling, earth filling and boundary demarcation before construction. These activities may alter the existing surface profile and natural ground level of the site.

Potential impacts on landform may include:

a. change in existing ground elevation;
b. alteration of natural surface slope;
c. soil compaction due to machinery movement;
d. loss of natural surface cover;
e. creation of temporary uneven ground condition;
f. risk of erosion from exposed soil surface;
g. local waterlogging if site leveling is not properly designed.

The impact on landform is expected to be site-specific and permanent within the project boundary. However, it can be minimized through planned site grading, proper drainage design, controlled filling and use of approved filling materials.

Impact Aspect	Nature of Impact	Significance
Site grading and leveling	Change in existing surface profile	Moderate
Earth filling	Change in ground elevation	Moderate

Soil compaction	Reduced soil permeability	Low to Moderate
Exposed land surface	Dust and erosion risk	Low to Moderate

7.2.2 Mitigation Measures of Impact on Landform

During the pre-construction stage, landform may be affected due to site clearing, earth filling, grading, leveling, soil compaction, development of internal roads and preparation of foundations for the TSDF facility. These activities may change the existing ground profile, natural surface slope and local drainage pattern if not properly managed.

The following measures shall be implemented:

a) Land development shall be carried out only within the approved project boundary.
b) Unnecessary cutting, filling or disturbance outside the project area shall be strictly avoided.
c) Site grading and leveling shall be conducted according to the approved engineering design.
d) Earth filling shall be carried out in layers with proper compaction to avoid future settlement.
e) Existing natural drainage direction shall be considered during final site grading.
f) Low-lying areas shall be filled with approved and uncontaminated filling material.
g) Topsoil, where suitable, shall be removed and stored separately for future use in greenbelt and landscaping.
h) Side slopes and filled areas shall be stabilized to prevent erosion.
i) Temporary drainage channels shall be provided during land development to avoid waterlogging.
j) No municipal waste, industrial waste, sludge, ash or contaminated material shall be used for land filling.
k) The final site level shall be designed to reduce flood risk and ensure safe movement of vehicles.
l) Before and after photographs of land development activities shall be maintained for documentation.

7.2.3 Impact on the Site from Where Material would be Collected

During pre-construction and construction planning, materials such as earth, sand, bricks, stone chips, aggregates, cement, steel, water and fuel may be collected from external sources. If materials are collected from unauthorized or environmentally sensitive sources, impacts may occur at the collection sites.

Possible impacts may include:

a. land degradation at borrow areas;
b. erosion from unplanned soil or sand extraction;
c. disturbance to riverbanks, wetlands or low-lying areas;
d. dust generation during material loading and transportation;
e. pressure on local natural resources;
f. road damage due to heavy vehicle movement;

g. community disturbance near collection points;
h. possible use of contaminated or unsuitable filling material.

The significance of this impact depends on the source of materials, quantity required, extraction method and environmental condition of the source area. The impact can be reduced by procuring materials from approved and legally permitted suppliers only.

Material	Possible Source Impact
Earth / filling material	Land degradation, erosion, borrow pit formation
Sand	Riverbank erosion, aquatic habitat disturbance
Brick / aggregate	Dust, vehicle movement and resource consumption
Water	Pressure on local water source
Fuel	Spill, leakage and fire risk
Steel / cement	Energy use and transport-related impact

7.2.4 Mitigation Measures of Impact due to Resource Collection

During pre-construction, resources such as earth, sand, bricks, stone chips, cement, steel, water, fuel and construction materials will be required for site development and civil works. Improper collection of these resources may create environmental impacts at source locations, including land degradation, dust, erosion, waterlogging, road damage and community disturbance.

The following mitigation measures shall be adopted:

a) Construction materials shall be collected only from approved and legally permitted sources.
b) Soil and sand shall not be collected from environmentally sensitive areas, riverbanks, wetlands, protected areas or unauthorized borrow pits.
c) The project authority shall verify the source of filling material before use.
d) Contaminated soil, industrial sludge, municipal waste or mixed debris shall not be used for filling.
e) Material suppliers shall comply with applicable legal and environmental requirements.
f) Resource collection shall avoid damage to agricultural land, community land, water bodies and local drainage paths.
g) Material extraction sites shall be restored, graded and made safe after use, where applicable.
h) Trucks carrying loose materials shall be covered with tarpaulin.
i) Overloading of vehicles shall be prohibited to prevent road damage and material spillage.
j) Fuel and lubricants used for construction equipment shall be stored in a designated area with spill control measures.
k) Water abstraction for construction shall not affect local community water sources.
l) Records of material source, quantity and supplier details shall be maintained.

Resource Collection Management Table

Resource	Potential Impact	Mitigation Measure

Earth / filling material	Land degradation, erosion	Use approved source and clean material
Sand	Riverbank or land erosion	Procure from authorized supplier
Brick / aggregate	Dust and traffic	Covered transport and controlled storage
Water	Pressure on local source	Use approved source and avoid wastage
Fuel	Leakage and fire risk	Store in bunded area with fire protection
Steel / cement	Dust, storage risk	Store in covered and designated area

7.2.5 Drainage Pattern

Pre-construction site preparation, boundary development, land filling and temporary access development may affect the existing drainage pattern of the project area. If the natural runoff path is blocked, rainwater may accumulate within the site or adjacent areas.

Potential impacts on drainage pattern may include:

a. blockage of existing surface runoff routes;
b. temporary waterlogging within or near the project site;
c. increase in stormwater runoff from compacted surfaces;
d. sediment runoff during rainfall;
e. local erosion at drainage outlets;
f. disturbance to nearby drains, canals or low-lying land;
g. increased risk of contaminated runoff during later construction activities.

The impact on drainage pattern may become significant during monsoon if drainage is not properly planned. Therefore, drainage design should be considered at the earliest stage of site development.

Impact Source	Possible Impact
Earth filling	Blockage of natural flow
Site grading	Change in runoff direction
Soil stockpile	Sediment flow into drains
Temporary roads	Increased runoff and compaction
Boundary wall	Restriction of natural drainage if not designed properly

7.2.6 Mitigation Measures of Impact on Drainage Pattern

Site preparation, earth filling and grading may affect the natural drainage pattern of the project area. If surface runoff is not properly managed, it may cause waterlogging, erosion, sedimentation of nearby drains or flooding of adjacent land.

The following mitigation measures shall be implemented:

a. Existing natural drainage channels and flow directions shall be identified before site development.
b. Land filling shall not block existing drainage paths.
c. Temporary drains shall be constructed during site preparation to manage runoff.

d. Permanent stormwater drainage shall be designed based on site topography, rainfall intensity and surrounding drainage condition.
e. Peripheral drains shall be provided around the site boundary.
f. Clean stormwater shall be separated from contaminated runoff areas in the final design.
g. Silt traps and sedimentation pits shall be installed during construction to prevent sediment discharge.
h. Drain outlets shall be designed to avoid erosion at discharge points.
i. Drainage channels shall be kept free from construction debris, soil, waste and vegetation blockage.
j. Site grading shall ensure that surface runoff DoEs not flow toward waste storage, fuel storage, chemical storage or residue storage areas.
k. Regular inspection of drainage system shall be conducted, especially before and during monsoon.
l. Emergency pumping arrangement shall be kept available if waterlogging occurs.

7.2.7 Impact on Ambient Air

During the pre-construction stage, air quality may be affected mainly by dust generation from land clearing, site preparation, soil movement, earth filling, vehicle movement and material handling. Exhaust emissions may also be generated from trucks, generators and site equipment.

Potential impacts on ambient air may include:

a. increase in suspended dust particles;
b. localized increase in particulate matter;
c. exhaust emission from vehicles and equipment;
d. dust deposition on nearby vegetation, structures and roads;
e. temporary discomfort to workers and nearby receptors;
f. reduced visibility in active work areas during dry weather.

The impact is expected to be temporary and localized. It may be higher during dry and windy conditions and during movement of uncovered soil or sand-carrying vehicles.

Source	Possible Air Quality Impact
Site clearing	Dust generation
Earth filling	Suspended particulate matter
Soil stockpiling	Wind-blown dust
Vehicle movement	Road dust and exhaust emission
Material handling	Fine dust release
Generator / machinery	NOx, CO and smoke emission

7.2.8 Mitigation Measures of Impact on Ambient Air

During the pre-construction stage, ambient air quality may be affected by dust generation from land clearing, earth filling, soil stockpiling, truck movement, material handling and operation of construction machinery. Vehicle exhaust and generator emissions may also contribute to temporary air pollution.

The following mitigation measures shall be applied:

a. Water shall be sprayed regularly on exposed soil, access roads and active work areas.
b. Loose soil, sand and fine materials shall be covered during storage and transportation.
c. Vehicles carrying soil, sand or construction materials shall be covered with tarpaulin.
d. Vehicle speed inside the project area shall be controlled to reduce dust generation.
e. Unnecessary idling of construction vehicles and equipment shall be avoided.
f. Construction machinery shall be properly maintained to reduce smoke and exhaust emissions.
g. Cement and fine powder materials shall be stored in covered areas.
h. Open burning of waste, vegetation, packaging or construction debris shall be strictly prohibited.
i. Dust-generating activities shall be minimized during strong wind conditions.
j. Workers in dusty areas shall use dust masks or respirators.
k. Greenbelt development shall be initiated as early as practicable along the boundary.
l. Ambient air quality monitoring shall be conducted as per the Environmental Monitoring Plan.

Air Pollution Control Table

Source	Impact	Mitigation
Earthwork	Dust generation	Water spraying and phased work
Soil stockpile	Wind-blown dust	Covering and compaction
Truck movement	Road dust	Speed control and road watering
Machinery	Exhaust emission	Maintenance and no-idling practice
Material handling	Fine dust	Covered storage and careful handling

7.2.9 Impact on Ambient Noise

Noise may be generated during pre-construction activities such as site survey, land clearing, boundary marking, material delivery, equipment movement, temporary road preparation and preliminary earthwork. The main sources of noise are vehicles, generators, excavators, loaders, compactors and other mechanical equipment.

Potential impacts may include:

a. temporary increase in local noise level;
b. disturbance to workers and nearby receptors;
c. disturbance to birds and small fauna;
d. communication difficulty at active work areas;
e. discomfort due to continuous vehicle movement;
f. temporary vibration from heavy equipment movement.

The impact on ambient noise is expected to be temporary, intermittent and limited to the project site and nearby area. Noise impact may become more noticeable if work is conducted during night-time or near sensitive receptors.

Noise Source	Possible Impact
Trucks and vehicles	Traffic noise and horn use
Excavator / loader	Intermittent machinery noise
Generator	Continuous localized noise

Compactor	Noise and minor vibration
Material unloading	Short-term high noise

7.2.10 Mitigation Measures of Impact on Ambient Noise Level

Noise may be generated during the pre-construction stage from earthmoving equipment, trucks, compactors, generators, loading/unloading activities and general site preparation works. Although the impact is expected to be temporary, proper control measures shall be implemented to minimize disturbance to workers and nearby receptors.

The following mitigation measures shall be adopted:

a. Construction activities shall be carried out preferably during daytime.
b. High-noise activities shall be avoided during night-time unless absolutely necessary.
c. Construction equipment shall be fitted with silencers and maintained regularly.
d. Unnecessary use of vehicle horns shall be prohibited inside and near the project site.
e. Generators shall be placed away from sensitive receptors and provided with acoustic enclosure where required.
f. Equipment shall not be kept running when not in use.
g. Workers exposed to high noise shall be provided with earplugs or earmuffs.
h. Noise-generating activities shall be scheduled to avoid continuous disturbance.
i. Temporary noise barriers shall be used near sensitive receptors, if required.
j. Vehicle movement shall be controlled through speed limits and designated routes.
k. Boundary noise monitoring shall be conducted periodically.
l. Complaints related to noise shall be recorded and addressed promptly.

7.2.11 Impact on Waterbody

Nearby water bodies, drains, canals, ponds or low-lying areas may be affected during the pre-construction stage if soil, silt, construction debris, wastewater, oil, grease or fuel enters the drainage system. Although major wastewater generation is not expected at this stage, uncontrolled site preparation may create sediment-laden runoff during rainfall.

Potential impacts on water bodies may include:

a. increase in turbidity due to soil runoff;
b. siltation of nearby drains or ponds;
c. contamination from oil, fuel or lubricant leakage;
d. blockage of drainage channels by soil or debris;
e. reduction of water quality near discharge points;
f. impact on aquatic organisms if runoff enters water bodies;
g. temporary disturbance to local water use.

The impact is expected to be low to moderate, depending on rainfall, site slope, proximity of water bodies and effectiveness of runoff control measures.

Source	Possible Impact on Waterbody

Exposed soil	Sediment runoff
Material storage	Washout of fine materials
Fuel handling	Oil and grease contamination
Drain blockage	Waterlogging and overflow
Vehicle movement	Mud and pollutant runoff

7.2.12 Mitigation Measures of Impact on Waterbody

Pre-construction activities may affect nearby water bodies, ponds, canals, drains or low-lying areas through sediment runoff, construction waste discharge, oil leakage, fuel spill, washing wastewater or uncontrolled drainage flow. Therefore, waterbody protection measures shall be implemented from the beginning of site development.

The following mitigation measures shall be applied:

a. No construction waste, soil, sludge, oil, fuel or wastewater shall be discharged into nearby water bodies.
b. Temporary drains, silt traps and sedimentation pits shall be installed to control sediment-laden runoff.
c. Fuel, oil and chemical storage areas shall be located away from water bodies and drains.
d. Refueling and equipment maintenance shall be conducted only in designated areas.
e. Spill kits shall be available at fuel storage and equipment operation areas.
f. Construction runoff shall be controlled before leaving the site.
g. Washing of vehicles or equipment near ponds, canals or open drains shall be prohibited.
h. Stockpiles of soil, sand and construction materials shall be kept away from drainage channels.
i. Drainage routes shall be inspected after rainfall.
j. Any accidental spill near a waterbody shall be immediately contained and cleaned.
k. Surface water quality monitoring shall be conducted before construction and during major site development activities.
l. Workers shall be trained not to dispose of waste or wastewater into natural drainage or water bodies.

7.2.13 Impact on Soil

Soil may be affected during the pre-construction stage due to site clearing, earth filling, excavation, compaction, material storage, fuel handling and accidental spillage. Soil contamination may occur if fuel, oil, lubricants, chemicals or waste materials are not properly managed.

Potential impacts on soil may include:

a. disturbance of natural soil profile;
b. compaction of soil due to vehicle and equipment movement;
c. erosion from exposed soil surface;
d. contamination from oil, fuel or chemical leakage;
e. mixing of clean soil with unsuitable filling material;
f. loss of topsoil from site preparation activities;
g. poor soil quality for future greenbelt development.

The impact on soil is expected to be localized within the project boundary. However, improper handling of fuel, waste and filling materials may create long-term contamination risk.

Impact Source	Soil Impact
Site clearing	Topsoil disturbance
Earth filling	Change in soil structure
Vehicle movement	Soil compaction
Fuel and oil handling	Soil contamination
Waste dumping	Land pollution
Exposed surface	Soil erosion

7.2.14 Mitigation Measures of Impact on Soil

Soil may be affected during the pre-construction stage due to land clearing, earth filling, material storage, fuel handling, equipment leakage, waste disposal, soil compaction and accidental spillage. Since the proposed project is a TSDF facility, soil protection is especially important to prevent future contamination and ensure safe site development.

The following mitigation measures shall be implemented:

a. Only clean and approved filling material shall be used for site development.
b. Topsoil shall be preserved separately where suitable for future greenbelt development.
c. Fuel, oil, lubricant and chemical storage shall be placed on impervious surface with secondary containment.
d. Equipment and vehicles shall be inspected regularly for leakage.
e. Any oil, fuel or chemical spill shall be cleaned immediately using absorbent materials.
f. Used oil, oily rags, empty chemical containers and contaminated materials shall be stored separately and disposed of through approved channels.
g. Construction debris shall not be dumped randomly on soil.
h. Soil stockpiles shall be protected from erosion and runoff.
i. Open defecation by workers shall be prohibited; proper sanitation facilities shall be provided.
j. Waste bins shall be placed at the worksite for proper collection of domestic and construction waste.
k. Soil quality monitoring shall be conducted at representative locations as part of baseline and compliance monitoring.

Soil Protection Table

Potential Source	Possible Impact	Mitigation Measure
Earth filling	Soil quality alteration	Use approved clean filling material
Fuel storage	Soil contamination	Bunded storage and spill control
Equipment leakage	Oil and grease contamination	Regular inspection and maintenance
Construction waste	Land pollution	Segregated collection and proper disposal

Soil stockpile	Erosion and runoff	Covering, compaction and drainage
Worker activities	Sanitation impact	Provide toilets and waste bins

7.2.15 Social Impact

Pre-construction activities may create social impacts related to land ownership, land use change, local access, public perception, employment opportunity and stakeholder concern. Social impacts may be both adverse and beneficial.

Potential social impacts may include:

a. concern about land use conversion;
b. public concern about waste management facility operation;
c. temporary disturbance from survey and site preparation activities;
d. possible concern regarding odour, pollution, traffic and safety;
e. expectation of local employment;
f. possible conflict if recruitment is not transparent;
g. concern from nearby land users and communities;
h. increased interest from local administration and regulatory agencies.

7.2.15.1 Land Loss

Land loss may occur if private, agricultural, commercial or community land is acquired or converted for project development. If the project is developed within legally owned or approved project land, direct land loss impact is expected to be limited. However, land-related issues must be carefully verified before construction.

Potential impacts may include:

a. permanent conversion of existing land use;
b. loss of agricultural or vacant land, if applicable;
c. boundary-related dispute with adjacent landowners;
d. temporary use of nearby land for access, material storage or construction support;
e. concern among local people regarding future land value or land use compatibility.

7.2.15.2 Livelihood Loss

Livelihood loss may occur if project activities affect agricultural activities, small businesses, informal income sources, access routes, transport movement or use of local resources. At the pre-construction stage, livelihood impact is usually limited unless land acquisition, access restriction or resource disturbance occurs.

Potential impacts may include:

a. temporary disturbance to local movement;
b. restricted access to nearby agricultural land or shops;
c. disruption of local income activities due to site preparation;
d. concern among local workers or land users;
e. loss of crops, trees or temporary structures if affected;

f. reduced access to natural resources if any are used by local people.

7.2.15.3 Physical Displacement

Physical displacement refers to relocation of households, shops, community structures or other occupied establishments due to project development. Based on project planning, physical displacement is not expected if the facility is developed within available and legally controlled project land.

However, possible concerns may include:

a. removal of any temporary structure within the project boundary;
b. relocation of informal users, if present;
c. disturbance to nearby houses or shops during site preparation;
d. concern regarding future operational safety and pollution;
e. requirement for access management if any nearby structure is close to the project boundary.

7.2.16 Mitigation Measures of Social Impact

The proposed Sheam TSDF BD Ltd. project may create both temporary and long-term social impacts during the pre-construction, construction and operation phases. Potential social impacts may relate to land use change, temporary disturbance to local movement, traffic movement, employment opportunity, community perception, public safety concerns and interaction with nearby communities.

The project authority shall implement appropriate mitigation measures to minimize adverse social impacts and enhance positive social benefits. The social management approach shall be based on transparency, consultation, fair compensation where applicable, local employment preference, community safety, grievance redress and continuous communication with relevant stakeholders.

The key social mitigation measures shall include:

a. conduct consultation with affected and interested stakeholders before major site development activities;
b. verify land ownership, land use and boundary demarcation before construction;
c. avoid disturbance to land outside the approved project boundary;
d. maintain access to nearby roads, land, water sources and community facilities;
e. minimize disturbance from construction traffic, dust, noise and worker movement;
f. prioritize local employment for suitable skilled and unskilled jobs;
g. ensure fair wage, safe working condition and non-discriminatory recruitment;
h. establish a Grievance Redress Mechanism for receiving and resolving community complaints;
i. maintain regular communication with local representatives, community leaders and nearby stakeholders;
j. ensure that project activities do not create unsafe conditions for nearby communities.

7.2.16.1 Mitigation Measures of Land Loss

Land loss may occur if private, agricultural or community land is acquired or converted for project development. Based on the project planning, the TSDF facility shall be developed within the legally owned or approved project land. However, land-related impacts must be carefully verified through land documents, boundary survey and field consultation.

The following mitigation measures shall be implemented:

a. project development shall be limited to the approved project boundary only;
b. land ownership documents, plot records, mouza map and boundary demarcation shall be verified before construction;
c. no additional land shall be occupied temporarily or permanently without legal permission;
d. access to adjacent land shall not be blocked during land development;
e. any temporary use of nearby land for material storage, vehicle parking or construction support shall be done with written consent of the landowner;
f. if any land acquisition or transfer is required, it shall be completed through lawful, transparent and documented procedures;
g. compensation, if applicable, shall be provided based on legal requirement and mutually agreed terms;
h. damage to crops, trees, boundary structures or access roads shall be avoided; where damage occurs, restoration or compensation shall be arranged;
i. the project boundary shall be fenced or marked to prevent accidental encroachment;
j. grievances related to land shall be recorded and resolved through the project GRM.

Table 42: Land loss mitigation table

Potential Issue	Mitigation Measure	Responsibility
Unauthorized land use	Work only within approved boundary	Project Authority
Boundary dispute	Conduct boundary survey and demarcation	Project Authority
Temporary land use	Obtain written permission from landowner	Contractor / Project Authority
Damage to adjacent land	Restore or compensate as applicable	Project Authority
Community complaint	Record and resolve through GRM	GRM Focal Person

7.2.16.2 Mitigation Measures of Livelihood Loss

Livelihood loss may occur if project activities affect agricultural activities, small businesses, local access, transport routes, informal income activities, or use of local natural resources. Although the project is proposed within an industrially compatible area, livelihood-related risks shall be assessed and managed carefully.

The following mitigation measures shall be adopted:

a. baseline socio-economic survey shall identify any livelihood activity within or near the project influence area;
b. construction activities shall not block access to shops, houses, agricultural land, workplaces or community facilities;
c. local roads shall remain usable during construction, except for temporary and well-managed interruptions;
d. construction material transport shall be planned to avoid unnecessary disruption to local trade, markets and movement;
e. if any livelihood activity is temporarily affected, the project authority shall consult the affected person and provide appropriate restoration support;
f. preference shall be given to local workers for suitable employment opportunities during construction and operation;
g. local suppliers, transporters and service providers may be engaged where technically and commercially feasible;
h. worker recruitment shall be transparent and shall not create conflict among local groups;
i. community grievances related to livelihood disturbance shall be recorded and addressed promptly;
j. livelihood restoration measures, if required, shall be documented and monitored until completion.

Livelihood Protection Measures

Possible Livelihood Impact	Mitigation / Enhancement Measure
Temporary access disruption	Maintain alternative access and signage
Impact on small shops or roadside business	Schedule transport and avoid blocking frontage
Loss of temporary income opportunity	Provide local employment preference
Disturbance from dust/noise	Implement dust and noise control measures
Complaint from affected person	Resolve through GRM with documentation

7.2.16.3 Mitigation Measures of Physical Displacement

Physical displacement refers to relocation of households, structures, shops or community facilities due to project development. Based on the current project concept, physical displacement is not expected if the facility is developed within legally available project land. However, this shall be confirmed through site survey, land ownership verification and consultation with local stakeholders.

The following mitigation measures shall be implemented:

a. project design shall avoid physical displacement of households, shops, religious structures, schools, community facilities or other occupied structures;
b. site boundary shall be finalized after field verification to ensure that no occupied structure is affected;
c. no eviction or removal of structure shall be carried out without proper legal process, consultation and approval;

d. if any structure is found within the project boundary, the project authority shall assess ownership, use, occupancy status and possible alternatives;
e. project layout shall be adjusted, where technically feasible, to avoid displacement;
f. if physical displacement becomes unavoidable, a proper resettlement and compensation plan shall be prepared before displacement;
g. affected persons shall be consulted and informed in advance;
h. assistance shall be provided to restore shelter, access, utility connection and livelihood where applicable;
i. vulnerable affected persons shall receive special attention during any relocation process;
j. all displacement-related grievances shall be handled through the GRM.

Physical Displacement Control Table

Issue	Required Action
Household displacement	Avoid through layout planning
Shop or business displacement	Avoid; otherwise compensate and restore
Community facility impact	Avoid completely or redesign layout
Vulnerable person affected	Provide special support
Dispute or complaint	Resolve through GRM before construction

7.2.16.4 Employment Generation

The proposed TSDF project is expected to create positive social impacts through employment generation during construction and operation phases. Employment opportunities may include civil construction work, site preparation, equipment installation, security, transportation, waste handling, plant operation, laboratory support, ETP operation, maintenance, administration, housekeeping, greenbelt development and emergency response support.

The project authority shall maximize local employment benefits while ensuring safety, competency and fair working conditions.

Following enhancement measures shall be implemented:

a. local people shall be given preference for suitable unskilled, semi-skilled and support service jobs;
b. skilled technical positions shall be filled based on qualification, training and competency;
c. recruitment shall be transparent and non-discriminatory;
d. workers shall receive job-specific safety induction before starting work;
e. training shall be provided for waste handling, PPE use, fire safety, emergency response and occupational health;
f. fair wages and working hours shall be maintained as per applicable labour requirements;
g. child labour shall be strictly prohibited;
h. contractors shall follow worker safety, welfare and labour compliance requirements;
i. women may be considered for suitable administrative, laboratory, monitoring, documentation and support roles where feasible;
j. local suppliers and service providers may be engaged for food, transport, maintenance, plantation, cleaning and other support services;

k. employment records shall be maintained by the project authority or contractor.

Employment Generation Plan

Employment Area	Possible Local Opportunity
Site preparation	Labour, security, transport support
Construction	Mason, helper, electrician assistant, fitter assistant
Greenbelt development	Plantation, nursery support, maintenance
Operation	Waste handling, segregation, housekeeping, security
Transport	Driver, helper, logistics support
Administration	Office support, documentation assistant
Environmental management	Sampling assistant, monitoring support
Maintenance	Mechanical and electrical support staff

Table 43: Summary of social mitigation matrix

Social Aspect	Potential Impact	Mitigation / Enhancement Measure	Responsibility
Land loss	Loss of land or boundary dispute	Legal verification, boundary demarcation, compensation if applicable	Project Authority
Livelihood loss	Temporary disturbance to income or access	Maintain access, local employment, livelihood support if needed	Project Authority / Contractor
Physical displacement	Relocation of household or structure	Avoid through layout planning; prepare plan if unavoidable	Project Authority
Employment	Positive income opportunity	Local recruitment, training, fair wage, safe workplace	Project Authority / Contractor
Community concern	Fear about pollution, traffic and safety	Consultation, disclosure and GRM	Project Authority / HSE Officer

7.2.17 Impact on Ecosystem and Biodiversity

Pre-construction activities may affect local ecosystem and biodiversity through vegetation clearing, noise, dust, human movement, soil disturbance and runoff. The impact is expected to be limited if the project site DoEs not contain protected area, critical habitat, major forest or sensitive wetland. However, local ecological features such as trees, shrubs, birds, insects, reptiles, small mammals, ponds, drains and aquatic organisms may be affected.

7.2.17.1 Impacts on Terrestrial Flora

Terrestrial flora may be affected due to vegetation clearing, tree removal, dust deposition and soil disturbance during pre-construction activities. The impact will depend on the existing vegetation cover within the project site.

Potential impacts include:

a. removal of grasses, shrubs or small plants;
b. cutting of trees, if required;
c. damage to roadside or boundary vegetation;
d. dust deposition on leaves;
e. reduced plant growth due to soil compaction;
f. loss of topsoil supporting vegetation;
g. visual reduction of greenery.

7.2.17.2 Impact on Terrestrial Fauna

Terrestrial fauna such as birds, insects, reptiles, rodents and small mammals may be temporarily disturbed during site preparation. Noise, vibration, vegetation removal, worker movement and vehicle movement may cause local fauna to move away from the project site.

Potential impacts include:

a. disturbance to birds and small animals;
b. temporary loss of shelter for insects and reptiles;
c. displacement of small fauna from cleared areas;
d. risk of injury to small animals during clearing;
e. disturbance from noise and vehicle movement;
f. attraction of rodents or stray animals due to improper waste handling.

7.2.17.3 Impact on Aquatic Ecosystem

Aquatic ecosystems may be affected if sediment, soil, oil, fuel, construction waste or wastewater enters nearby ponds, canals, drains or low-lying water bodies during the pre-construction stage. Increased turbidity and contamination may affect fish, aquatic plants, plankton and other aquatic organisms.

Potential impacts include:

a. increase in turbidity due to sediment runoff;
b. siltation of small drains or ponds;

c. contamination from oil, grease or fuel leakage;
d. reduction in dissolved oxygen if polluted runoff enters water bodies;
e. disturbance to aquatic organisms;
f. blockage of water flow due to soil or debris;
g. degradation of local aquatic habitat quality.

7.2.18 Mitigation Measures of Impact on Ecosystem and Biodiversity

7.2.18.1 Mitigation Measures of Impact on Terrestrial Flora

Site clearance shall be limited to the area required for the facility. Existing trees within the boundary shall be surveyed before clearance and retained wherever the layout allows; trees that must be removed shall be compensated by planting native species within the greenbelt at a ratio to be agreed with the local authority (at least two trees for each tree felled is recommended). Clearance by burning is prohibited.

7.2.18.2 Mitigation Measures of Impact on Terrestrial Fauna

Vegetation clearance shall be carried out progressively and, where practicable, outside the main bird nesting season. Any nests, burrows or animals found shall be relocated by trained staff. Workers shall be prohibited from hunting, trapping or harming wildlife, and night lighting shall be directed downward and kept to the minimum needed for safety.

7.2.18.3 Mitigation Measures of Impact on Aquatic Ecosystem

No pond, khal or drainage channel shall be filled or blocked without technical assessment and approval. Silt fences and sediment traps shall be installed before earthworks to prevent turbid runoff reaching nearby water bodies, and fuel, oil and construction chemicals shall be stored on bunded, impermeable surfaces away from drainage paths.

7.2.19 Impact on Occupational health and safety

During the pre-construction stage, workers may be exposed to occupational health and safety risks associated with site survey, land clearing, boundary demarcation, material handling, vehicle movement, earthwork, equipment operation and working in outdoor environmental conditions.

Potential occupational health and safety impacts may include:

a. injury from sharp objects, tools or uneven ground;
b. slips, trips and falls;
c. dust exposure during clearing and earthwork;
d. heat stress and dehydration during outdoor work;
e. noise exposure from machinery and vehicles;
f. injury from vehicle or equipment movement;
g. snakebite, insect bite or contact with harmful plants;
h. minor cuts, bruises or musculoskeletal strain;
i. exposure to fuel, oil or chemicals during preliminary site activities;
j. lack of sanitation or drinking water facilities for workers.

7.2.20 Mitigation Measures of Impact on Occupational Health and Safety

The contractor shall prepare a site-specific Health, Safety and Environment Plan before mobilisation. Workers shall be provided with appropriate PPE and induction training; the site shall be fenced and access controlled; first aid facilities, drinking water and sanitation shall be provided; and all incidents shall be recorded and investigated. Detailed occupational health and safety measures for the construction stage are presented in Section 7.3.

7.3 Construction Stage Impacts and Mitigation

The construction stage of the proposed Sheam TSDF BD Ltd. project will include site development, earthwork, civil construction, installation of incinerator and auxiliary systems, construction of waste receiving area, storage sheds, residue storage area, ETP, laboratory, administrative facilities, internal roads, drainage system, utility lines, fire safety system and other supporting infrastructure.

During this stage, environmental and social impacts may occur due to excavation, filling, material handling, construction vehicle movement, machinery operation, wastewater generation, waste disposal, worker presence and temporary disturbance to surrounding communities. Most construction-stage impacts are expected to be temporary, localized and manageable through proper implementation of the Environmental Management Plan.

7.3.1 Impact on Land use

Construction activities will convert the project site into an environmental infrastructure facility. Temporary land use changes may also occur within the project boundary due to material storage, equipment parking, worker facilities, temporary access roads and construction support areas.

Potential impacts include:

a. permanent conversion of the project land for TSDF development;
b. temporary occupation of space for construction material storage and machinery;
c. disturbance to adjacent land users if activities extend beyond the approved boundary;
d. visual change of the local landscape due to construction works;
e. risk of unplanned dumping of construction debris on open land;
f. temporary access disturbance to nearby land or local roads.

7.3.2 Mitigation Measures of Impact on Land Use

During the construction phase, land use within the project boundary will be changed from its existing condition to an industrial environmental infrastructure facility. Construction activities may include site development, civil works, internal road construction, storage area preparation, utility installation, drainage works, ETP construction, incinerator foundation works and development of supporting facilities. If not properly managed, these activities may temporarily affect surrounding land use through dust, traffic movement, noise, material storage, runoff and disturbance to nearby land users.

The following mitigation measures shall be implemented:

a. Construction activities shall be restricted within the approved project boundary.

b. No temporary occupation of adjacent private, agricultural or community land shall be allowed without written permission.
c. The project boundary shall be clearly marked and secured before construction begins.
d. Construction materials, machinery, vehicles and waste shall be stored only in designated areas.
e. Access to adjacent land, houses, agricultural plots, roads and community facilities shall not be blocked.
f. Temporary facilities such as worker rest area, storage yard, fuel storage and equipment parking shall be planned to avoid disturbance to surrounding land users.
g. Dust, noise and runoff from construction areas shall be controlled to prevent nuisance to nearby land use.
h. Construction waste shall not be dumped on open land, agricultural land, roadside or drainage channels.
i. The site layout shall maintain adequate setback, internal circulation, emergency access and greenbelt area.
j. After construction, all temporary storage areas and construction support areas shall be cleaned and restored.
k. Greenbelt development shall be initiated along the boundary to improve land use compatibility and visual screening.
l. Any complaint related to land use disturbance shall be recorded and resolved through the project Grievance Redress Mechanism.

Table 44: Land use impact mitigation table

Potential Impact	Mitigation Measure	Responsibility
Change in site land use	Develop only approved TSDF project area	Project Authority
Disturbance to adjacent land	Avoid encroachment and maintain boundary control	Contractor / Site Engineer
Temporary access blockage	Maintain local access and provide alternative route if required	Contractor
Unplanned material storage	Use designated storage area only	Contractor
Construction waste on open land	Collect and dispose through approved method	Contractor / HSE Officer
Visual impact	Develop boundary wall and greenbelt	Project Authority

7.3.3 Impact on Natural Resources

Construction of the TSDF facility will require natural resources such as soil, sand, aggregate, water, fuel, steel, cement and other construction materials. Improper use or sourcing of these resources may create environmental pressure at source locations and within the project area.

Potential impacts include:

a. consumption of earth filling materials, sand and aggregates;
b. pressure on local water resources during construction;
c. increased fuel consumption by construction machinery and vehicles;

d. generation of construction waste from inefficient material use;
e. disturbance at borrow areas or material collection sites;
f. indirect impact from transportation of construction materials.

7.3.3.1 Impact on Agricultural Resources

If agricultural land exists near the project area, construction activities may temporarily affect agricultural resources through dust deposition, access disturbance, surface runoff, drainage blockage and accidental spillage of construction materials.

Potential impacts include:

a. dust deposition on nearby crops;
b. temporary disturbance to agricultural access roads;
c. blockage of irrigation or drainage channels;
d. contamination risk from oil, fuel, cement slurry or construction wastewater;
e. crop damage due to uncontrolled movement of vehicles or workers;
f. reduced soil productivity if construction waste is dumped on agricultural land.

7.3.3.2 Impact on Fisheries

Fisheries may be affected if nearby ponds, canals, drains or water bodies receive construction runoff, sediment, cement slurry, wastewater, fuel or oil. Increased turbidity and contamination may affect aquatic habitat and fish health.

Potential impacts include:

a. siltation of nearby ponds, canals or drains;
b. increased turbidity due to runoff from exposed soil;
c. contamination from oil, grease or fuel leakage;
d. reduction of water quality due to construction wastewater;
e. temporary disturbance to fish habitat;
f. possible impact on local fish culture if contaminated runoff enters fish ponds.

7.3.3.3 Impact on Forest

No major forest impact is anticipated if the project is implemented within the approved project boundary. However, construction activities may affect existing trees, roadside vegetation, shrubs or homestead vegetation if clearing is required.

Potential impacts include:

a. removal of small trees, shrubs or vegetation within the construction area;
b. dust deposition on nearby vegetation;
c. physical damage to trees due to machinery movement;
d. loss of local greenery;
e. disturbance to small habitats supported by vegetation;
f. temporary visual impact due to removal of vegetation.

7.3.3.4 Impact on Livestock

Livestock such as cattle, goats, poultry or domestic animals in nearby areas may be affected by construction noise, dust, vehicle movement, worker activity and accidental access to construction areas. If the site is not properly fenced, livestock may enter the construction area and face injury risk.

Potential impacts include:

a. disturbance from construction noise and vehicle movement;
b. exposure to dust from construction activities;
c. risk of injury if livestock enter excavation or construction zones;
d. possible contamination of grazing areas if waste is improperly disposed;
e. disturbance to local movement routes used by livestock;
f. risk of drinking contaminated water if runoff enters local ponds or drains.

7.3.4 Mitigation Measures of Impact on Natural Resources

Agricultural resources may be affected if construction activities disturb nearby agricultural land, irrigation channels, soil quality, access roads or drainage systems. Dust deposition, construction runoff, material spillage and traffic movement may also affect crops or agricultural productivity if not properly controlled.

Although the proposed TSDF facility will be developed within the approved project land, precautionary measures shall be taken to prevent adverse impacts on agricultural resources in the surrounding area.

The following mitigation measures shall be implemented:

a. Construction activities shall be confined within the project boundary.
b. Agricultural land outside the project area shall not be used for material storage, vehicle parking, waste dumping or worker camps without written permission.
c. Existing field access roads shall not be blocked by construction vehicles or materials.
d. Drainage and irrigation channels used by nearby agricultural land shall not be obstructed.
e. Dust generation from earthwork, material transport and site roads shall be controlled by water spraying.
f. Trucks carrying soil, sand and loose materials shall be covered to prevent dust deposition on crops.
g. Construction runoff shall be controlled through temporary drains and silt traps.
h. Fuel, oil, cement slurry, chemicals and construction wastewater shall not be discharged onto agricultural land.
i. Any accidental spill affecting agricultural land shall be cleaned immediately.
j. If crops, trees or agricultural structures are damaged due to project activities, restoration or compensation shall be considered as per applicable requirement.
k. Local farmers shall be consulted if construction activities may temporarily affect access or drainage.
l. Complaints from farmers or land users shall be recorded and addressed through the GRM.

Table 45: Agricultural resource protection table

Potential Impact	Mitigation Measure
Dust deposition on crops	Water spraying, covered transport and speed control
Blockage of farm access	Keep access routes open or provide temporary alternative
Drainage or irrigation obstruction	Maintain existing flow and provide temporary drains
Soil contamination	Prevent fuel, oil, cement slurry and waste discharge
Crop damage	Avoid disturbance; restore or compensate if damage occurs
Community complaint	Record and resolve through GRM

7.3.4.1 Mitigation Measures of Impact on Fisheries

Construction activities may affect fisheries resources if sediment, construction waste, oil, fuel, cement slurry or wastewater enters nearby ponds, canals, drains, wetlands or surface water bodies. Increased turbidity and contamination may affect aquatic life, fish habitat and water quality.

The following mitigation measures shall be adopted to protect fisheries and aquatic resources:

a. No construction waste, soil, cement slurry, oil, fuel or wastewater shall be discharged into ponds, canals, drains or other water bodies.
b. Temporary drainage shall be designed to prevent sediment-laden runoff from entering surface water.
c. Silt traps, sedimentation pits and check barriers shall be provided near drainage outlets.
d. Fuel and chemical storage shall be located away from water bodies and drainage channels.
e. Refueling and maintenance of machinery shall be conducted only in designated areas.
f. Vehicle and equipment washing shall not be allowed near ponds, canals or open drains.
g. Stockpiles of soil, sand and construction materials shall be kept away from water bodies.
h. Construction activities near drainage channels shall be carried out carefully, especially during rainfall.
i. Any accidental spill near a water body shall be immediately contained and reported.
j. Surface water quality shall be monitored before and during construction, where applicable.
k. Natural water flow to nearby aquatic habitats shall not be blocked.
l. Workers shall be trained not to dump waste or wastewater into water bodies.

Table 46: Fisheries protection table

Potential Impact	Mitigation Measure	Monitoring Indicator
Sedimentation of pond/canal	Silt trap and sediment control	Turbidity / visual inspection
Water contamination	No discharge of oil, fuel or wastewater	Water quality test
Fish habitat disturbance	Maintain natural drainage and water flow	Drainage inspection

Construction waste entry	Proper waste collection and disposal	Housekeeping checklist
Fuel spill	Spill kit and designated refueling area	Spill record

7.3.4.2 Mitigation Measures of Impact on Forest

Trees, roadside vegetation, homestead vegetation or forest-like vegetation exist within or near the project influence area, construction activities may cause vegetation removal, dust deposition, physical damage to trees, habitat disturbance and reduction of local greenery. Although no major forest impact is expected if the project is developed within the approved boundary, tree and vegetation protection measures shall be implemented.

The following mitigation measures shall be adopted:

a. Tree cutting shall be avoided as far as practicable.
b. Vegetation removal shall be limited to the approved construction area only.
c. No clearing shall be conducted outside the project boundary.
d. Existing mature trees shall be preserved where they do not conflict with safety or engineering design.
e. If tree cutting is unavoidable, compensatory plantation shall be carried out.
f. Native, pollution-tolerant and locally suitable species shall be used for greenbelt development.
g. Construction material shall not be stored against trees or vegetation.
h. Machinery movement shall be controlled to avoid damage to tree roots, trunks and branches.
i. Open burning of vegetation or construction waste shall be prohibited.
j. Dust control measures shall be implemented to reduce dust deposition on nearby vegetation.
k. Greenbelt development shall be included as part of the project design.
l. Tree plantation and survival rate shall be monitored periodically.

Table 47: Forest and vegetation protection table

Potential Impact	Mitigation Measure
Tree removal	Avoid cutting; compensate through plantation if unavoidable
Damage to nearby vegetation	Control machinery movement and material storage
Dust deposition	Water spraying and covered transport
Loss of greenery	Develop boundary greenbelt
Burning of vegetation	Strictly prohibit open burning
Poor plantation survival	Maintain watering, fencing and replacement planting

Recommended Greenbelt Measures

The project should develop a greenbelt around the facility boundary and suitable internal areas. The greenbelt will help reduce dust, noise, visual impact and improve environmental

quality. Recommended species should be locally available, fast-growing, pollution-tolerant and low-maintenance.

The greenbelt plan should include:

a. plantation along boundary wall;
b. plantation near administrative area and internal roads;
c. buffer plantation near waste handling and residue areas, where feasible;
d. regular watering and maintenance;
e. replacement of dead plants;
f. annual survival rate monitoring.

7.3.5 Impact on Ambient Air Quality

Construction activities may affect ambient air quality mainly through dust generation and exhaust emission. Dust may be generated from earthwork, excavation, filling, stockpiling, concrete mixing, material handling, vehicle movement and road surface disturbance. Exhaust emissions may be generated from trucks, generators, excavators, loaders and other diesel-powered equipment.

Potential impacts include:

a. increase in suspended particulate matter;
b. dust deposition on nearby vegetation, structures and roads;
c. exhaust emission from vehicles and equipment;
d. temporary reduction of local air quality;
e. discomfort to workers and nearby receptors;
f. increased air pollution during dry and windy weather.

7.3.6 Mitigation Measures of Impact on Ambient Air Quality

During the construction phase, ambient air quality may be affected due to dust generation from site clearing, earthwork, backfilling, excavation, material handling, vehicle movement, stockpiling of soil and sand, concrete mixing, cutting, grinding and operation of diesel-powered machinery. Exhaust emissions from trucks, generators and construction equipment may also contribute to temporary air pollution.

The following mitigation measures shall be implemented:

a. Water shall be sprayed regularly on exposed soil, internal roads, active construction areas and material handling zones.
b. Trucks carrying soil, sand, cement, aggregate and other loose materials shall be covered with tarpaulin.
c. Vehicle speed inside the project site and on access roads near the site shall be controlled.
d. Construction materials such as cement, sand and fine aggregates shall be stored in covered or designated areas.
e. Dust-generating activities shall be minimized during dry and windy conditions.
f. Unnecessary idling of construction vehicles and machinery shall be prohibited.
g. Construction equipment and vehicles shall be maintained regularly to reduce smoke and exhaust emissions.

h. Open burning of waste, vegetation, packaging materials or construction debris shall be strictly prohibited.
i. Wheel washing or road cleaning shall be arranged where mud or dust is carried from the site to public roads.
j. Workers exposed to dusty conditions shall be provided with dust masks or respirators.
k. Temporary barriers or screens may be used near sensitive receptors, where required.
l. Ambient air quality shall be monitored periodically during major construction activities.

Table 48: Air quality mitigation table

Source / Activity	Potential Impact	Mitigation Measures	Responsibility
Earthwork and excavation	Dust generation	Water spraying and phased excavation	Contractor / HSE Officer
Soil and sand stockpile	Wind-blown dust	Covering, compaction and proper storage	Contractor
Truck movement	Road dust and exhaust emission	Speed control, covered trucks and vehicle maintenance	Contractor / Security
Cement handling	Fine dust emission	Covered storage and careful handling	Contractor
Diesel machinery	Exhaust emission	Regular maintenance and no-idling policy	Contractor
Construction waste burning	Smoke and toxic emission	Strict prohibition of open burning	HSE Officer

7.3.7 Impact on Ambient Noise Level

Noise will be generated from construction machinery, vehicles, generators, concrete mixers, compactors, cutting machines, welding machines, loading and unloading activities. Noise may affect workers and nearby receptors if not properly controlled.

Potential impacts include:

a. temporary increase in ambient noise level;
b. disturbance to nearby residents or workplaces;
c. discomfort to workers at construction areas;
d. communication difficulty in high-noise zones;
e. minor vibration from heavy machinery;
f. disturbance to birds and small animals.

7.3.8 Mitigation Measures of Impact on Ambient Noise Level

Construction activities may generate noise from excavators, loaders, concrete mixers, compactors, cranes, generators, welding machines, grinders, cutters, trucks and other machinery. Noise may affect workers and nearby receptors if construction activities are not properly managed.

The following mitigation measures shall be adopted:

a. High-noise construction activities shall preferably be carried out during daytime.
b. Construction machinery shall be properly maintained and fitted with silencers where applicable.
c. Diesel generators shall be provided with acoustic enclosures or placed away from sensitive receptors.
d. Unnecessary operation of equipment shall be avoided.
e. Vehicle horns shall be restricted inside the project area and near nearby settlements.
f. Noise-generating equipment shall be located as far as practicable from site boundary and sensitive receptors.
g. Workers exposed to high noise shall be provided with earplugs or earmuffs.
h. Temporary noise barriers shall be installed if high-noise work is conducted near sensitive receptors.
i. Construction traffic shall follow designated routes and speed limits.
j. Night-time construction shall be avoided unless required for safety or technical reasons.
k. Noise complaints shall be recorded and addressed through the project grievance mechanism.
l. Noise monitoring shall be conducted at the site boundary and near major noise-generating equipment.

Table 49: Noise management table

Noise Source	Potential Impact	Mitigation Measures	Responsibility
Excavator / loader / compactor	Worker and community disturbance	Regular maintenance and daytime operation	Contractor
Generator	Continuous noise	Acoustic enclosure and suitable placement	Contractor
Cutting / grinding	High intermittent noise	PPE and controlled working hours	Contractor / HSE Officer
Truck movement	Traffic noise	Speed control and restricted horn use	Security / Contractor
Concrete mixer	Localized noise	Equipment maintenance and placement control	Contractor
Night work	Community disturbance	Avoid unless essential	Project Authority

7.3.9 Impact on Water Bodies

Water bodies may be affected if construction runoff, sediment, soil, cement slurry, oil, grease, wastewater or solid waste enters nearby ponds, canals, drains or low-lying areas. Construction during rainfall may increase the risk of sediment-laden runoff.

Potential impacts include:

a. increased turbidity in nearby water bodies;
b. siltation of drains, canals or ponds;
c. contamination from oil, fuel and lubricants;

d. pollution from cement slurry and concrete wash water;
e. blockage of drainage channels;
f. impact on aquatic organisms and fish habitat.

7.3.10 Mitigation Measures of Impact on Water Bodies

Construction activities may affect nearby ponds, canals, drains, low-lying areas or surface water bodies if sediment runoff, construction waste, wastewater, fuel, oil, cement slurry or other pollutants enter the drainage system. Therefore, proper waterbody protection measures shall be implemented throughout the construction phase.

The following mitigation measures shall be applied:

a. No construction waste, soil, cement slurry, oil, fuel, wastewater or domestic waste shall be discharged into ponds, canals, drains or nearby water bodies.
b. Temporary drainage channels shall be developed to control stormwater runoff from the construction site.
c. Silt traps, sedimentation pits and check barriers shall be installed at drainage outlets.
d. Soil, sand, cement and other loose materials shall be stored away from drainage channels and water bodies.
e. Fuel, oil and chemical storage areas shall be located on impervious surfaces with secondary containment.
f. Equipment maintenance and refueling shall be carried out only in designated areas.
g. Vehicle and equipment washing shall not be allowed near ponds, canals or open drains.
h. Concrete wash water shall be collected in a designated pit and shall not be discharged directly into drainage channels.
i. Construction work near drainage paths shall be carefully managed during rainfall.
j. Drains shall be inspected regularly and kept free from waste, soil and construction debris.
k. Any accidental spill shall be contained immediately and cleaned using appropriate spill control materials.
l. Surface water quality shall be monitored before construction and during major site development activities, where applicable.

Table 50: Waterbody protection table

Potential Source	Possible Impact	Mitigation Measures	Monitoring Indicator
Sediment runoff	Siltation of drains or ponds	Silt trap, sedimentation pit and temporary drainage	Visual inspection / turbidity
Cement slurry	Water contamination	Collect in designated pit	Site inspection
Fuel and oil leakage	Surface water pollution	Bunded storage and spill kit	Spill record
Construction waste	Drain blockage and pollution	Segregated collection and proper disposal	Housekeeping checklist
Equipment washing	Oil, grease and sediment discharge	Washing only in designated area	Site inspection

Rainfall runoff	Contaminated runoff	Drainage control and covered material storage	Drain inspection

7.3.11 Impact on Soil

Soil may be affected during construction due to excavation, filling, soil compaction, storage of materials, fuel handling, oil leakage, chemical storage, waste disposal and accidental spills.

Potential impacts include:

a. disturbance of natural soil profile;
b. compaction due to vehicle and machinery movement;
c. erosion from exposed soil surfaces;
d. contamination from oil, fuel, paint, chemicals or cement slurry;
e. mixing of clean soil with construction waste;
f. reduction of soil quality in temporary work areas;
g. loss of topsoil suitable for plantation.

7.3.12 Mitigation Measures of Impact on Soil

Soil quality may be affected during construction due to excavation, backfilling, material storage, fuel and oil leakage, improper disposal of construction waste, chemical handling, cement slurry discharge, equipment maintenance and accidental spills. Soil contamination must be prevented from the construction stage because the proposed project will later operate as a controlled waste treatment and disposal facility.

The following mitigation measures shall be implemented:

a. Only approved, clean and uncontaminated filling materials shall be used for site development.
b. Excavated soil shall be reused for backfilling and landscaping where technically suitable.
c. Topsoil shall be preserved separately for future greenbelt development, where applicable.
d. Fuel, oil, lubricants and chemicals shall be stored in designated areas with impervious flooring and secondary containment.
e. Drip trays shall be used during fuel transfer, equipment maintenance and oil handling.
f. Construction vehicles and equipment shall be inspected regularly for leakage.
g. Any oil, fuel or chemical spill shall be cleaned immediately using absorbent materials.
h. Used oil, oily rags, filters, empty chemical containers and contaminated materials shall be collected separately and disposed of through approved channels.
i. Construction debris shall not be dumped randomly on open soil.
j. Cement slurry and concrete wash water shall be collected in designated pits.
k. Domestic waste from workers shall be collected in bins and removed regularly.
l. Open defecation shall be strictly prohibited; proper sanitation facilities shall be provided.
m. Soil stockpiles shall be protected from erosion and runoff.
n. Areas for future waste storage, residue handling, fuel storage, chemical storage and ETP shall be developed with impervious flooring and proper drainage.
o. Soil quality monitoring shall be conducted at representative locations before construction and during operation as required.

Table 51: Soil protection table

Source / Activity	Potential Impact	Mitigation Measures	Responsibility
Excavation and backfilling	Soil disturbance and erosion	Controlled excavation, reuse and compaction	Contractor / Site Engineer
Fuel storage	Soil contamination	Bunded storage and spill kit	Contractor / HSE Officer
Equipment leakage	Oil and grease contamination	Regular inspection and maintenance	Contractor
Construction waste	Land pollution	Segregated collection and approved disposal	Contractor
Cement slurry	Soil hardening and contamination	Collection in designated pit	Contractor
Worker activities	Sanitation-related soil pollution	Toilets, bins and regular cleaning	Contractor
Soil stockpile	Erosion and sediment runoff	Covering, slope control and drainage	Contractor

7.3.13 Impact on Workers Health, Sanitation and Safety

Construction workers may be exposed to occupational health and safety risks during excavation, civil works, material handling, equipment operation, welding, cutting, lifting, electrical works and working under environmental conditions such as heat, dust and noise.

Potential impacts include:

a. physical injury from tools, machinery and vehicles;
b. slips, trips and falls;
c. exposure to dust and noise;
d. heat stress and dehydration;
e. poor sanitation-related illness;
f. exposure to cement, chemicals, oil and fuel;
g. fire and electrical hazards;
h. injury from falling objects or working at height.

7.3.13.1 Accidents and Injuries from General Construction Activities

General construction activities may cause accidents and injuries if safety procedures are not followed. High-risk activities include excavation, lifting, working at height, welding, cutting, electrical work, heavy vehicle movement and handling of sharp or heavy materials.

Potential accidents and injuries include:

a. fall from height;
b. fall into excavation;
c. injury from falling objects;

d. cuts and puncture wounds;
e. burn injuries from welding or hot work;
f. electric shock;
g. crushing injury from vehicle or equipment movement;
h. musculoskeletal injury from manual handling;
i. eye injury from dust, sparks or flying particles;
j. fire-related injury.

7.3.13.2 Health Impact associated with Environmental Conditions

Workers may face health impacts due to environmental conditions at the construction site, including dust, heat, noise, poor sanitation, unsafe drinking water, stagnant water and exposure to cement or chemicals.

Potential health impacts include:

a. respiratory irritation from dust exposure;
b. skin irritation from cement, lime or chemicals;
c. eye irritation from dust and construction particles;
d. hearing stress from high noise exposure;
e. dehydration and heat stress;
f. waterborne disease from poor sanitation;
g. vector-borne disease due to stagnant water;
h. fatigue from long working hours or poor rest facilities.

7.3.14 Mitigation Measures of Impact on Workers Health, Sanitation and Safety

7.3.14.1 Accidents and Injuries from General Construction Activities.

During the construction phase of the proposed TSDF facility, workers may be exposed to accident and injury risks from excavation, earthwork, material handling, heavy equipment movement, welding, cutting, grinding, electrical work, lifting operations, working at height, vehicle movement, sharp materials, falling objects and unsafe housekeeping. These risks shall be controlled through a site-specific Health, Safety and Environment management system.

The following mitigation measures shall be implemented:

a. A site-specific Construction Health and Safety Plan shall be prepared before commencement of construction work.
b. All workers shall receive safety induction before entering the construction site.
c. Personal Protective Equipment such as safety helmet, safety shoes, reflective vest, gloves, goggles, dust mask and ear protection shall be provided as per work requirement.
d. Excavation areas shall be barricaded, marked with warning signs and provided with safe access.
e. Deep excavation shall be protected through proper slope, shoring or support arrangement.
f. Working at height shall be allowed only with safe scaffolding, guardrails, full-body harness and lifeline.

g. Lifting operations shall be conducted by trained personnel using certified lifting tools and equipment.
h. Crane, hoist, chain block, sling and lifting accessories shall be inspected before use.
i. Welding, cutting and grinding works shall be controlled through hot work permit, fire extinguisher and trained operator.
j. Electrical work shall be performed by competent electricians only.
k. Temporary electrical connections shall be properly insulated, grounded and protected from water exposure.
l. Lockout/tagout procedure shall be followed during maintenance of electrical or mechanical equipment.
m. Construction vehicles and equipment shall follow designated routes and speed limits.
n. Reverse alarms, signal persons or flagmen shall be used for heavy vehicle movement.
o. Fire extinguishers and first aid boxes shall be available at active work locations.
p. Unsafe tools, damaged cables, defective ladders and faulty equipment shall be removed from service immediately.
q. Good housekeeping shall be maintained to avoid slips, trips, falls and fire hazards.
r. Emergency contact numbers shall be displayed at visible locations.
s. All accidents, near misses and unsafe conditions shall be reported, recorded and investigated.
t. Corrective actions shall be implemented to prevent recurrence of similar incidents.

Table 52: Construction accident prevention table

Activity / Source	Possible Accident or Injury	Mitigation Measures
Excavation work	Fall, collapse, trapped worker	Barricade, safe slope, shoring and warning sign
Working at height	Fall from height	Safety harness, guardrail, scaffold inspection
Lifting operation	Falling object, crane accident	Certified lifting gear, trained operator, exclusion zone
Welding and cutting	Burn, fire, eye injury	Hot work permit, fire extinguisher, welding shield
Electrical work	Electric shock, fire	Competent electrician, earthing, insulation, lockout/tagout
Vehicle movement	Collision, crushing injury	Speed control, traffic route, flagman and reverse alarm
Manual handling	Muscle strain, back injury	Mechanical handling, team lifting and training
Sharp materials	Cut and puncture injury	Gloves, safe storage and proper disposal
Poor housekeeping	Slip, trip and fall	Daily cleaning and clear access routes

Emergency Response for Construction Accidents

a. work shall be stopped immediately in the affected area;
b. the injured person shall be moved only if it is safe to do so;
c. first aid shall be provided by a trained first aider;

d. serious injuries shall be referred to the nearest hospital or clinic;
e. the Site Engineer and HSE Officer shall be informed immediately;
f. the accident area shall be secured for investigation;
g. an incident report shall be prepared;
h. corrective actions shall be implemented before work resumes.

7.3.14.2 Health Impact associated with Environmental Conditions

Construction workers may face health impacts from dust, noise, heat stress, poor sanitation, unsafe drinking water, stagnant water, vector breeding, exposure to cement, chemical contact, poor hygiene, inadequate rest facilities and contaminated food. These impacts shall be prevented through proper workplace hygiene, sanitation, health surveillance, environmental control and worker welfare facilities.

The following mitigation measures shall be implemented:

a. Safe drinking water shall be provided to all workers at the construction site.
b. Temporary sanitation facilities shall be provided and maintained in hygienic condition.
c. Open defecation shall be strictly prohibited.
d. Handwashing facilities with soap shall be provided near toilet, eating and rest areas.
e. Waste bins shall be placed at worker areas and emptied regularly.
f. Food waste shall be collected daily to prevent odour, pests and disease vectors.
g. Dust control measures such as water spraying and covered material storage shall be implemented.
h. Workers exposed to dust shall use dust masks or respirators.
i. Workers exposed to cement, lime, chemicals or wet concrete shall use gloves, boots and eye protection.
j. Noise-exposed workers shall use earplugs or earmuffs.
k. Adequate rest breaks shall be provided during hot weather.
l. Shaded rest areas shall be arranged for workers.
m. First aid facilities shall be available at the construction site.
n. Workers shall be trained on heat stress, dehydration, dust exposure, hygiene and safe material handling.
o. Stagnant water shall be removed to prevent mosquito breeding.
p. Construction camp or worker rest area shall be kept clean and well ventilated.
q. Workers with illness, injury or symptoms of exposure shall be referred for medical treatment.
r. Medical records and first aid records shall be maintained by the contractor or HSE Officer.
s. Pest and vector control measures shall be implemented where required.
t. Health and hygiene inspections shall be conducted regularly.

Table 53: Health impact mitigation table

Environmental Condition	Possible Health Impact	Mitigation Measures
Dust from earthwork and materials	Respiratory irritation, eye irritation	Water spraying, dust mask, covered storage

Excessive noise	Hearing stress, headache, fatigue	Ear protection, equipment maintenance, work scheduling
Heat and sun exposure	Dehydration, heat stress	Drinking water, shade, rest breaks
Poor sanitation	Waterborne disease, infection	Clean toilets, handwashing, waste disposal
Stagnant water	Mosquito breeding and vector disease	Drainage, removal of stagnant water
Cement and chemicals	Skin irritation, eye injury	Gloves, boots, goggles, safe handling
Poor housekeeping	Injury, pest attraction, hygiene problem	Daily cleaning and waste removal
Unsafe drinking water	Stomach illness and dehydration risk	Safe drinking water supply
Food waste	Odour, insects and rodents	Covered bins and daily disposal

Table 54: Worker welfare and health monitoring

Facility	Requirement
Drinking water	Safe and adequate supply
Toilet facilities	Clean, separate where practical and regularly maintained
Handwashing point	Soap and water available
Rest area	Shaded and safe location
First aid	First aid box and trained first aider
Waste bins	Covered bins for domestic waste
PPE storage	Clean and dry PPE storage
Emergency contact	Displayed at visible locations

7.3.15 Impact on Key Point Installations and Others

The project will include construction and installation of key facilities such as incinerator foundation, APCD, stack, ETP, waste receiving area, residue storage area, laboratory, fuel storage, electrical room, generator, firewater tank, internal drainage and control room. Improper construction of these key installations may create future operational risks.

Potential impacts include:

a. structural failure or settlement of heavy equipment foundations;
b. leakage from ETP, drains or wastewater collection systems;
c. unsafe fuel storage and fire risk;
d. electrical hazards from poor installation;
e. poor access for emergency response and maintenance;
f. future air emission control problem due to improper APCD or stack installation;
g. unsafe waste receiving or residue storage area due to poor flooring and drainage;
h. operational failure during commissioning.

7.3.16 Mitigation measures of impact on Key Point Installation

During the construction phase of the proposed TSDF facility, different key point installations may be developed or installed, including the incinerator foundation, Air Pollution Control Device area, stack foundation, ETP, electrical substation, generator room, fuel storage area, laboratory, firewater tank, hydrant system, control room, waste receiving area, residue storage area, internal drainage and utility systems. These installations are critical for safe operation of the facility and must be protected from design, construction, safety and environmental risks.

Improper construction or installation of these key facilities may create future operational hazards such as equipment failure, fire risk, leakage, poor drainage, emission control failure, electrical hazards, wastewater overflow or unsafe worker movement. Therefore, strict engineering supervision, quality control and safety management shall be ensured during construction.

The following mitigation measures shall be implemented:

a. All key installations shall be constructed according to approved engineering drawings, design specifications and safety requirements.
b. The incinerator, APCD, CEMS, stack, ETP, fuel storage, electrical room and fire protection system shall be installed under supervision of qualified engineers.
c. Foundations for heavy equipment shall be designed considering equipment load, vibration, soil bearing capacity and long-term settlement risk.
d. Electrical installations shall follow proper earthing, cable routing, circuit protection, emergency shutdown and fire safety requirements.
e. Fuel storage areas shall be provided with impervious flooring, dyke/bund wall, spill containment, fire extinguisher and warning signage.
f. ETP, wastewater channels and leachate collection systems shall be constructed as leak-proof systems to prevent soil and groundwater contamination.
g. Stack foundation and structure shall be designed for wind load, vibration, corrosion resistance and safe access for monitoring.
h. Waste receiving, storage and residue handling areas shall be constructed with impervious floors, drainage collection and covered arrangement where required.
i. Firewater tank, hydrant network and emergency access routes shall be installed before trial operation.
j. Safety clearance shall be obtained before energizing electrical, mechanical or fuel-related systems.
k. Hot work, lifting work, confined space work and electrical work shall be controlled through permit-to-work system.
l. Critical installation areas shall be barricaded during construction to prevent unauthorized entry.

m. Testing and commissioning records shall be maintained for all major equipment and systems.
n. Any design change during construction shall be reviewed by the engineering team and documented.
o. Defective installation, leakage, cracks, poor alignment or unsafe condition shall be corrected before commissioning.

Table 55: Key point installation mitigation table

Key Installation	Potential Impact / Risk	Mitigation Measures	Responsibility
Incinerator foundation	Settlement, vibration, structural failure	Proper design, soil investigation, quality concrete and supervision	Engineering Team / Contractor
APCD area	Future emission control failure, leakage	Proper installation, access platform, inspection points	Engineering Team
Stack	Structural risk, unsafe monitoring access	Wind-load design, sampling platform, ladder, lightning protection	Engineering Team
ETP	Leakage, overflow, poor treatment performance	Leak-proof tanks, proper slope, testing before operation	Contractor / ETP Engineer
Fuel storage	Fire, leakage, soil contamination	Bund wall, impervious floor, fire protection, signage	Contractor / HSE Officer
Electrical room	Shock, fire, equipment damage	Earthing, circuit protection, cable management, restricted access	Electrical Engineer
Fire system	Poor emergency readiness	Hydrant network, fire pump, water reserve, inspection	Fire Safety Contractor
Waste receiving area	Leachate, odour, soil contamination	Impervious floor, drainage, covered unloading area	Contractor
Residue storage	Dust, leachate, worker exposure	Covered area, sealed floor, drainage collection	Contractor / HSE Officer
Control room	Operational disruption	Safe location, backup power, ventilation, access control	Engineering Team

Quality Control Requirements

Quality Control Item	Requirement
Drawing approval	Construction shall follow approved drawings
Material quality	Cement, steel, pipe, cable and equipment shall meet specification
Foundation inspection	Check reinforcement, formwork and concrete quality before casting
Leak testing	ETP tanks, drains and pipelines shall be checked for leakage
Electrical testing	Insulation, earthing and protection system shall be tested

Fire system testing	Hydrant, pump and extinguisher system shall be tested
Equipment alignment	Mechanical equipment shall be checked before commissioning
Documentation	Inspection checklist and test reports shall be maintained

7.3.17 Solid Waste Disposal

Construction activities will generate solid waste such as excavated soil, broken bricks, concrete debris, steel scrap, wood waste, cement bags, plastic packaging, paint containers, welding waste, domestic waste and food waste from workers.

Potential impacts include:

a. land pollution due to uncontrolled dumping;
b. blockage of drains and waterlogging;
c. dust and visual nuisance from debris;
d. fire risk from combustible waste;
e. injury from sharp materials;
f. odour and pest attraction from food waste;
g. contamination from oily rags, paint containers or chemical waste;
h. community disturbance if waste is dumped outside the project site.

7.3.18 Mitigation Measures of Impact due to Solid Waste Disposal

During the construction phase, solid waste will be generated from site clearing, excavation, civil construction, equipment installation, packaging, worker activities and temporary facilities. If not properly managed, construction solid waste may cause land pollution, blocked drains, dust, pest attraction, fire risk, visual nuisance, worker injury and contamination of soil or water bodies.

The main construction-stage solid waste may include excavated soil, broken bricks, concrete debris, wood pieces, steel scrap, welding rods, packaging materials, plastic, cement bags, paint containers, empty chemical containers, used oil filters, oily rags, domestic waste and food waste from workers.

The following mitigation measures shall be implemented:

a. A Construction Solid Waste Management Plan shall be prepared before starting major construction work.
b. Waste shall be segregated at source into reusable, recyclable, general, hazardous and contaminated waste categories.
c. Excavated soil shall be reused for backfilling, leveling or landscaping where technically suitable.
d. Broken bricks, concrete debris and aggregate waste may be reused as sub-base material where acceptable.
e. Steel scrap, metal pieces, packaging materials and reusable wood shall be collected separately for recycling or reuse.
f. Cement bags, plastic packaging and general construction waste shall be stored in designated waste collection areas.
g. Hazardous waste such as used oil, oily rags, spent filters, paint containers, chemical containers and contaminated absorbents shall be stored separately in labeled containers.

h. Construction waste shall not be dumped on agricultural land, roadside, drains, water bodies or outside the approved project boundary.
i. Waste storage areas shall be kept away from drainage channels and water bodies.
j. Open burning of construction waste, plastic, packaging, wood or domestic waste shall be strictly prohibited.
k. Domestic waste from workers shall be collected in covered bins and removed regularly.
l. Food waste shall be disposed of daily to prevent odour, insects and rodents.
m. Sharp waste such as glass, metal offcuts and nails shall be collected safely to prevent injury.
n. Waste shall be transported by covered vehicles to approved disposal or recycling locations.
o. Disposal records shall be maintained, including waste type, quantity, date and destination.
p. The HSE Officer shall inspect waste storage and housekeeping conditions regularly.

Construction Solid Waste Management Table

Waste Type	Source	Management / Disposal Method
Excavated soil	Excavation and foundation work	Reuse for backfilling or landscaping where suitable
Concrete debris	Civil works	Reuse as sub-base or dispose at approved location
Broken bricks	Masonry works	Reuse for filling or dispose properly
Steel scrap	Reinforcement and fabrication	Collect and sell to authorized recycler
Wood waste	Formwork and packaging	Reuse where possible or dispose safely
Cement bags	Cement use	Collect separately and recycle/dispose
Plastic packaging	Material packaging	Segregate and send for recycling
Paint containers	Painting works	Store separately and dispose safely
Used oil / oily rags	Equipment maintenance	Store in sealed container and hand over to approved handler
Welding rod waste	Welding works	Collect as metal waste
Domestic waste	Worker activities	Covered bins and regular disposal
Food waste	Worker dining area	Daily collection and disposal

Solid Waste Storage Requirements

Requirement	Description
Designated waste area	Waste shall be stored only in approved temporary storage zones
Segregated bins	Separate bins for recyclable, general and hazardous waste
Covered storage	Waste shall be protected from rain and wind where required
Labeling	Hazardous and contaminated waste shall be clearly labeled
Drainage protection	Waste storage shall not block drains or create runoff pollution
Fire safety	Combustible waste shall be kept away from ignition sources
Housekeeping	Waste storage area shall be cleaned regularly
Record keeping	Waste generation and disposal records shall be maintained

Hazardous Construction Waste Control

Some construction waste may be hazardous or contaminated, such as used oil, paint residue, chemical containers, oily rags, spent filters, solvent-contaminated materials and contaminated absorbents. These materials shall be handled with special care.

The following measures shall be followed:

a. Hazardous construction waste shall be stored separately from general waste.
b. Containers shall be leak-proof, labeled and placed on impervious surface.
c. Used oil and lubricant waste shall not be discharged onto soil or drains.
d. Empty chemical containers shall not be reused for drinking water, food storage or domestic purposes.
e. Workers handling hazardous waste shall use gloves, masks, goggles and safety shoes.
f. Hazardous waste shall be handed over only to approved recyclers or disposal handlers.
g. Spill kits shall be available near hazardous waste storage areas.

Monitoring Requirements

Monitoring Item	Frequency	Responsibility
Waste segregation condition	Daily	HSE Officer / Site Supervisor
Construction waste storage area	Daily	Contractor
Hazardous waste storage	Weekly	HSE Officer
Drain blockage by waste	Daily and after rainfall	Site Supervisor
Domestic waste removal	Daily	Contractor
Recycling / disposal record	Monthly	Contractor / Project Authority
Complaint related to waste	Continuous	GRM Focal Person

7.3.19 Social Impact due to Industrial Set up

7.3.19.1 Impacts on Local Resources and Infrastructures

Construction activities may create temporary pressure on local roads, drainage systems, water supply, electricity, markets and service facilities due to material transportation, worker presence and construction support activities.

Potential impacts include:

a. increased traffic on local roads;
b. road damage from heavy vehicles;
c. temporary road congestion;
d. pressure on local water sources;
e. blockage or disturbance of local drainage;
f. increased demand for local services;
g. dust and mud on public roads;
h. disturbance to nearby access routes.

7.3.19.2 Impact on Community Health and Safety

Community health and safety may be affected by dust, noise, heavy vehicle movement, unsafe construction access, falling materials, traffic accidents, construction waste, fuel storage and worker-community interaction.

Potential impacts include:

a. increased risk of road accidents;
b. dust exposure to nearby receptors;
c. noise disturbance;
d. risk of public entry into construction areas;
e. injury from open excavation or construction materials;
f. fire or spill risk near community areas;
g. disturbance from worker movement;
h. concern regarding future operation of the TSDF facility.

7.3.19.3 Impact on Demography

During construction, temporary labour influx may occur if workers are brought from outside the local area. This may create temporary changes in local population movement, demand for accommodation, food, transport and services.

Potential impacts include:

a. temporary increase in worker population;
b. increased demand for local goods and services;
c. pressure on local housing or rental facilities if outside workers stay nearby;
d. possible social interaction issues between workers and local people;
e. increased movement around the project area;
f. temporary pressure on sanitation and local facilities

7.3.19.4 Economic Growth

The construction phase may support local economic growth by increasing demand for labour, construction materials, transport, food supply, equipment rental, local services and small businesses.

Positive impacts include:

a. increased cash flow in the local economy;
b. business opportunity for local suppliers;
c. income opportunity for transport providers;
d. growth of small service businesses;
e. temporary increase in demand for food and basic goods;
f. contribution to local employment and income generation.

7.3.19.5 Capacity Building

Construction of the TSDF facility can contribute to capacity building through training of workers, contractors and supervisors on environmental management, occupational safety, waste handling, fire safety, emergency response and pollution control.

Positive impacts include:

a. improved construction safety awareness;
b. skill development of local workers;
c. training on PPE use and safe work practices;
d. awareness on waste segregation and pollution prevention;
e. improved emergency response knowledge;
f. exposure to technical installation works related to environmental infrastructure.

7.3.20 Mitigation Measures of Social Impact

7.3.20.1 Impacts on Local Resources and Infrastructures

During the construction phase, local resources and infrastructures may experience temporary pressure due to movement of construction vehicles, use of access roads, demand for construction materials, water use, electricity use, labour movement and temporary site activities. Local roads, drainage channels, water sources, community access routes and nearby service facilities may be affected if construction activities are not properly managed.

The following mitigation measures shall be implemented:

a. Construction vehicle movement shall be planned through approved access routes.
b. Heavy vehicles shall avoid weak local roads, narrow community roads and congested areas where possible.
c. Construction material delivery shall be scheduled to avoid peak traffic hours.
d. Access to houses, shops, agricultural lands, institutions and community facilities shall not be blocked.
e. Internal roads and temporary access roads shall be maintained in good condition.
f. Any road damage caused by project-related heavy vehicle movement shall be repaired by the project authority or contractor.
g. Water shall be collected only from approved sources and shall not affect local community water supply.
h. Electricity use during construction shall be arranged through authorized connection or approved generator system.
i. Local drainage channels shall not be blocked by soil, construction materials, waste or temporary structures.
j. Construction materials shall not be stored on public roads, drains or community access points.
k. Dust, mud and construction debris from project vehicles shall be controlled to protect local roads and settlements.
l. Regular communication shall be maintained with local representatives regarding construction schedule and traffic movement.

Local Resources and Infrastructure Mitigation Table

Potential Impact	Mitigation Measure	Responsibility
Pressure on local roads	Use approved route, avoid overloading, repair damage	Contractor / Project Authority
Road congestion	Schedule transport and avoid peak hours	Contractor
Blockage of local access	Keep access roads open and provide alternative access if needed	Contractor
Pressure on water source	Use approved source and monitor water use	Project Authority
Drainage obstruction	Keep drains free from soil, waste and construction materials	Contractor
Dust and mud on road	Wheel cleaning, water spraying and road sweeping	Contractor
Community inconvenience	Advance communication and grievance mechanism	Project Authority / GRM Focal Person

7.3.20.2 Impact on Community Health and Safety

Construction activities may create temporary community health and safety risks due to dust, noise, increased traffic, heavy vehicle movement, construction waste, open excavation, unsafe material storage, fire risk, worker-community interaction and accidental spills. These impacts shall be controlled through preventive safety measures, traffic management, site security and community communication.

The following mitigation measures shall be adopted:

a. The construction site shall be properly fenced or barricaded to prevent unauthorized public access.
b. Warning signs shall be displayed near construction areas, entry points, excavation zones and vehicle movement routes.
c. Flagmen or traffic marshals shall be assigned at the site entry and exit during heavy vehicle movement.
d. Vehicle speed shall be controlled near settlements, schools, markets, mosques and other sensitive receptors.
e. Construction vehicles shall be covered to prevent dust, falling materials and road contamination.
f. Dust suppression shall be carried out regularly on access roads and exposed construction areas.
g. High-noise construction activities shall be limited to daytime as far as practicable.
h. Open excavation, pits, stored materials and sharp objects shall be barricaded.
i. Construction waste shall not be dumped in community areas, roadsides, drains or water bodies.
j. Fire extinguishers and spill control materials shall be available at construction material and fuel storage areas.
k. Workers shall be instructed to maintain respectful behaviour with local communities.
l. No worker camp or labour activity shall create disturbance to nearby communities.
m. Emergency contact numbers shall be displayed at the site gate.

n. Any community complaint regarding dust, noise, traffic, waste, safety or worker behaviour shall be recorded and addressed through the project GRM.

Community Health and Safety Mitigation Table

Risk / Impact	Mitigation Measure
Traffic accident	Speed limit, flagman, route control and driver training
Dust exposure	Water spraying, covered trucks and road cleaning
Noise disturbance	Daytime work and equipment maintenance
Unauthorized entry	Boundary fencing, security and warning signs
Injury from excavation	Barricade and night lighting
Fire or spill	Fire extinguisher, spill kit and safe storage
Waste nuisance	Regular waste collection and disposal
Community complaint	GRM and quick corrective action

7.3.20.3 Impact on Demography

During the construction phase, temporary labour influx may occur due to the engagement of skilled, semi-skilled and unskilled workers. If a large number of workers come from outside the local area, it may create temporary pressure on local services, housing, markets, transport, sanitation and community relations. However, the demographic impact is expected to be limited and temporary if local employment is prioritized and worker management is properly implemented.

The following mitigation measures shall be implemented:

a. Local workers shall be prioritized for suitable unskilled and semi-skilled jobs. b. Labour recruitment shall be transparent and non-discriminatory. c. The contractor shall maintain a worker register with name, address, job category and contact details. d. Worker accommodation, if required, shall be managed in a safe and hygienic manner. e. Workers shall be provided with sanitation, drinking water, rest area and waste disposal facilities. f. Workers shall receive orientation on local culture, community respect, safety and code of conduct. g. Child labour shall be strictly prohibited. h. Forced labour or exploitative labour practices shall not be allowed. i. Worker movement shall be managed to avoid disturbance to nearby communities. j. Any conflict between workers and local people shall be addressed immediately through project management and local coordination. k. Temporary labour presence shall not affect local access, public safety or community facilities. l. The project shall monitor labour influx and community concerns during the construction period.

Demographic Impact Management Table

Potential Issue	Mitigation Measure
Temporary labour influx	Prioritize local employment and maintain worker register
Pressure on local services	Provide site-based sanitation, water and rest facilities

Community conflict	Worker code of conduct and local coordination
Unsafe worker behaviour	Safety induction and supervision
Child labour risk	Strict prohibition and contractor compliance
Social disturbance	GRM and immediate corrective action

7.3.20.4 Capacity Building

The proposed TSDF project can contribute to capacity building by creating awareness and practical knowledge on safe construction practices, environmental management, occupational health and safety, waste handling, fire safety, emergency response and pollution prevention. Capacity building during construction will also prepare the workforce for future operation of the TSDF facility.

The following capacity-building measures shall be implemented:

a. All construction workers shall receive safety induction before starting work.
b. Toolbox meetings shall be conducted regularly at active work areas.
c. Workers shall be trained on PPE use, housekeeping, waste segregation and emergency reporting.
d. Supervisors shall receive training on construction safety, environmental compliance and incident reporting.
e. Selected workers shall be trained in first aid and fire extinguisher use.
f. Contractors shall be oriented on ESIA commitments and EMP implementation requirements.
g. Local workers engaged in construction shall receive basic skill development through on-the-job training.
h. Environmental awareness shall be provided on dust control, noise control, wastewater prevention, solid waste management and spill response.
i. Training attendance records shall be maintained.
j. Capacity building shall continue during transition from construction to commissioning and operation.

Capacity Building Plan

Training / Capacity Area	Target Participants	Frequency
Site safety induction	All workers and visitors	Before site entry
PPE use	Construction workers	Initial and refresher
Toolbox meeting	Active work teams	Daily / weekly
Fire safety	Workers, supervisors, security	Periodic
First aid	Selected workers and supervisors	Periodic
Waste management	Workers and contractors	Monthly / as needed
Spill response	Fuel handlers and maintenance workers	Periodic
EMP compliance	Contractor and supervisors	Before major work
Community safety	Drivers, security and supervisors	Periodic
Emergency response	Site team and contractor	Drill-based

7.3.21 Impacts due to Wastewater Generation and Disposal

Construction wastewater may be generated from concrete works, curing, vehicle washing, equipment washing, worker sanitation, cleaning activities and stormwater runoff from exposed surfaces. If not managed properly, wastewater may pollute soil, drains and water bodies.

Potential impacts include:

a. sediment-laden runoff from construction areas;
b. cement slurry entering drains or soil;
c. oil and grease contamination from equipment washing;
d. wastewater from temporary sanitation facilities;
e. waterlogging from poor drainage;
f. contamination of nearby ponds, canals or low-lying areas;
g. odour and hygiene problems near worker facilities.

7.3.22 Mitigation Measures of Wastewater Generation and Disposal

During the construction phase, wastewater may be generated from concrete works, curing activities, equipment washing, vehicle washing, domestic use by workers, temporary sanitation facilities, construction camp activities, cleaning activities and stormwater runoff from exposed surfaces. If not properly managed, construction wastewater may carry suspended solids, cement slurry, oil, grease, fuel residue, soil particles and other contaminants into nearby drains, ponds, canals, low-lying areas or groundwater recharge zones.

The following mitigation measures shall be implemented:

a. No untreated construction wastewater shall be discharged into nearby ponds, canals, drains, agricultural land or open low-lying areas.
b. Temporary drainage channels shall be provided to collect and divert construction runoff safely.
c. Silt traps, sedimentation pits and temporary settling tanks shall be installed to remove suspended solids from runoff before discharge.
d. Concrete wash water and cement slurry shall be collected in a designated lined pit and shall not be discharged directly into natural drains.
e. Vehicle and equipment washing shall be carried out only in designated washing areas.
f. Washing areas shall be provided with oil and grease traps where fuel, oil or lubricant contamination is possible.
g. Fuel storage, lubricant storage and equipment maintenance areas shall be placed on impervious surfaces with spill containment.
h. Spill kits shall be available near fuel handling, equipment maintenance and washing areas.
i. Domestic wastewater from workers shall be managed through temporary toilets, septic tank/soak pit or approved sanitary arrangement.
j. Open defecation shall be strictly prohibited at the construction site.
k. Wastewater from worker rest areas, kitchen or washing points shall not be allowed to flow untreated into surrounding land or water bodies.
l. During rainfall, construction materials, cement, chemicals and waste shall be covered to prevent contaminated runoff.
m. Temporary drains shall be cleaned regularly to prevent blockage and waterlogging.
n. Wastewater discharge points, if any, shall be inspected regularly by the HSE Officer.

o. Any complaint related to water pollution, drainage blockage or wastewater discharge shall be recorded and resolved immediately.

Construction Wastewater Management Table

Wastewater Source	Possible Pollutants	Mitigation / Disposal Measures	Responsibility
Concrete wash water	High pH, cement slurry, suspended solids	Collect in lined pit; reuse/neutralize/dispose safely	Contractor
Equipment washing	Oil, grease, mud, sediment	Use designated washing area with oil trap	Contractor
Vehicle washing	Mud, oil, grease, soil particles	Washing only in controlled area; collect runoff	Contractor
Construction runoff	Silt, soil, debris	Temporary drains, silt traps and sedimentation pits	Contractor / HSE Officer
Worker sanitation	BOD, pathogens, odour	Temporary toilets, septic/soakage arrangement	Contractor
Kitchen/rest area wastewater	Organic matter, grease	Controlled collection and disposal	Contractor
Fuel storage runoff	Oil and hydrocarbon contamination	Bunded area and spill control	Contractor / HSE Officer

Wastewater Monitoring Requirements

Monitoring Item	Location	Frequency	Responsibility
Temporary drainage condition	Construction site and boundary	Weekly and after rainfall	HSE Officer
Silt trap / sediment pit	Drainage outlet	Weekly	Contractor
Concrete wash pit condition	Concrete work area	Daily during concrete work	Site Supervisor
Sanitation facility condition	Worker facility area	Daily	Contractor
Oil and grease spill signs	Fuel/equipment area	Daily	HSE Officer
Waterlogging	Low-lying construction areas	After rainfall	Site Engineer
Complaint related to water discharge	Project office / GRM register	Continuous	GRM Focal Person

7.3.23 Mitigation Measures for Impact due to Transportation of Raw Materials

During the construction phase, transportation of raw materials such as soil, sand, bricks, cement, stone chips, aggregate, steel, pipes, structural materials, machinery, fuel, chemicals and construction equipment may create environmental and social impacts. These impacts may include dust generation, road congestion, traffic accident risk, noise, vibration, material spillage, damage

to local roads, mud tracking, fuel consumption, vehicle emission and disturbance to nearby communities.

The following mitigation measures shall be implemented:

a. Transportation routes shall be selected in consultation with site management, considering road width, traffic condition, settlement areas, schools, markets, hospitals, mosques and other sensitive receptors.
b. Heavy vehicle movement shall be scheduled to avoid peak traffic hours, school opening/closing times and market congestion periods where feasible.
c. Trucks carrying soil, sand, cement, aggregate and other loose materials shall be covered with tarpaulin.
d. Overloading of trucks shall be strictly prohibited.
e. Vehicles shall follow designated access routes and shall not use unauthorized local roads.
f. Speed limits shall be enforced near the project site, settlements and internal construction roads.
g. Drivers shall be trained on safe driving, defensive driving, community safety, spill prevention and emergency response.
h. Vehicle fitness, brakes, lights, horn, tires and exhaust condition shall be checked regularly.
i. Vehicles shall not be allowed to create excessive smoke or visible emissions.
j. Mud and dust carried by vehicles from the construction site shall be controlled through wheel cleaning, road sweeping and water spraying.
k. Materials shall be loaded and secured properly to prevent falling objects or spillage during transportation.
l. Cement, chemicals, fuel and other sensitive materials shall be transported in sealed or properly packed condition.
m. Fuel and chemical transportation shall follow proper safety precautions and emergency response arrangements.
n. Flagmen or traffic marshals shall be posted at the site entry and exit during heavy vehicle movement.
o. Warning signs, speed limit boards and traffic direction signs shall be installed at the site entrance and internal roads.
p. Any spilled material on public roads shall be cleaned immediately.
q. Vehicle movement records shall be maintained at the site gate.
r. Community complaints regarding traffic, dust, road damage or unsafe driving shall be recorded and resolved through the project GRM.

Raw Material Transportation Mitigation Table

Transport Activity / Material	Potential Impact	Mitigation Measures	Responsibility
Soil and sand transport	Dust, spillage, road dirt	Covered trucks, no overloading, wheel cleaning	Contractor
Cement transport	Fine dust emission	Sealed bags, covered transport, careful unloading	Contractor
Aggregate and brick transport	Road dust, falling material	Covered load, secured stacking, speed control	Contractor

Steel and pipes	Road safety risk, falling objects	Proper binding, safe loading/unloading	Contractor
Heavy machinery transport	Traffic disruption, road damage	Route planning, escort/flagman where needed	Contractor / Site Engineer
Fuel and chemicals	Spill, fire, soil/water contamination	Sealed containers, spill kit, safe handling	Contractor / HSE Officer
Vehicle movement	Accident, noise, emission	Driver training, fitness check, speed control	Contractor / Security

7.3.24 Impact on Ecology

Construction activities may affect local ecology through vegetation removal, dust deposition, noise, human movement, wastewater runoff, waste disposal and disturbance to small habitats. If nearby water bodies or vegetation areas are present, ecological impacts may occur on terrestrial and aquatic species.

Potential impacts include:

a. removal of vegetation within the project boundary;
b. disturbance to birds, insects, reptiles and small animals;
c. dust deposition on plants;
d. runoff entering aquatic habitats;
e. disturbance to soil organisms;
f. increased human presence and vehicle movement;
g. attraction of pests due to improper waste management.

7.3.24.1 Impact on Terrestrial Flora

Terrestrial flora may be affected by site clearing, vegetation removal, soil compaction, dust deposition and accidental damage from machinery or material storage.

Potential impacts include:

a. loss of grasses, shrubs and small plants;
b. cutting of trees if required;
c. damage to roadside or boundary vegetation;
d. dust deposition on leaves;
e. reduced growth due to soil compaction;
f. loss of topsoil suitable for vegetation;
g. temporary reduction in local greenery.

7.3.24.2 Impact on Terrestrial Fauna

Terrestrial fauna may include common birds, reptiles, insects, rodents and small mammals. These may be disturbed by construction noise, vibration, vegetation removal, lighting, vehicle movement and worker presence.

Potential impacts include:

a. temporary displacement of small animals;
b. disturbance to birds and nesting areas;
c. loss of shelter from vegetation removal;
d. injury risk to small animals during site clearing;
e. disturbance from night lighting and noise;
f. attraction of rodents or stray animals due to food waste.

7.3.24.3 Impact on Aquatic Flora and Fauna

Aquatic flora and fauna may be affected if sediment, cement slurry, oil, fuel, wastewater or construction waste enters nearby ponds, drains, canals or low-lying water bodies.

Potential impacts include:

a. increased turbidity of water;
b. siltation of aquatic habitat;
c. contamination from oil, grease or fuel;
d. reduction in water quality;
e. stress on fish and aquatic organisms;
f. reduced sunlight penetration affecting aquatic plants;
g. blockage of natural drainage flow.

7.3.25 Mitigation Measures of Impact on Ecology

7.3.25.1 Mitigation Measures of Impact on Terrestrial Flora

During the construction phase, terrestrial flora may be affected due to site clearing, vegetation removal, dust deposition, soil compaction, movement of construction vehicles, material storage and accidental damage to trees or roadside vegetation. Although major forest or sensitive vegetation impact is not anticipated if construction is limited within the approved project boundary, precautionary measures shall be implemented to protect existing vegetation and improve green coverage.

The following mitigation measures shall be implemented:

a. Vegetation clearing shall be limited to the approved construction area only.
b. Unnecessary cutting of trees, shrubs and roadside vegetation shall be avoided.
c. Existing mature trees shall be retained where they do not interfere with project design or safety requirements.
d. No vegetation outside the project boundary shall be removed or damaged.
e. Construction materials, machinery and waste shall not be stored near tree roots or against tree trunks.
f. Vehicle and machinery movement shall be restricted to designated routes.
g. Dust control measures such as water spraying and covered transportation shall be implemented to reduce dust deposition on nearby plants.
h. Open burning of vegetation, leaves, wood, packaging or construction waste shall be strictly prohibited.
i. If any tree cutting is unavoidable, compensatory plantation shall be carried out using native and locally suitable species.

j. Greenbelt development shall be initiated along the project boundary as early as practicable.
k. Plantation areas shall be protected from grazing, trampling and construction damage.
l. Watering, mulching and replacement planting shall be carried out to ensure survival of planted trees.
m. The survival rate of planted trees shall be monitored periodically.

Terrestrial Flora Mitigation Table

Potential Impact	Mitigation Measures	Responsibility
Removal of vegetation	Limit clearing within approved boundary only	Contractor / Site Engineer
Damage to existing trees	Protect trees and restrict machinery movement	Contractor
Dust deposition on leaves	Water spraying and covered material transport	Contractor / HSE Officer
Soil compaction near trees	Avoid parking and material storage near trees	Contractor
Loss of greenery	Compensatory plantation and greenbelt development	Project Authority
Poor plant survival	Regular watering, fencing and replacement planting	Project Authority / HSE Officer

7.3.25.2 Mitigation Measures of Impact on Terrestrial Fauna

Terrestrial fauna such as birds, small mammals, reptiles, insects and other common wildlife may be temporarily disturbed during construction due to vegetation clearing, noise, lighting, vehicle movement, dust, worker activity and habitat disturbance. The project area is not expected to contain critical wildlife habitat; however, mitigation measures shall be implemented to avoid unnecessary harm to local fauna.

The following mitigation measures shall be adopted:

a. Vegetation clearing shall be carried out gradually to allow small animals and birds to move away safely.
b. Unnecessary disturbance to birds, nests, burrows or small wildlife habitats shall be avoided.
c. Workers shall be instructed not to hunt, trap, disturb or harm birds, reptiles or other wildlife.
d. No wildlife shall be captured or kept by workers.
e. Construction activities shall be limited to the approved project area.
f. Construction noise shall be controlled through proper equipment maintenance and daytime work scheduling.
g. Night-time construction and excessive lighting shall be avoided as far as practicable.
h. Open waste and food waste shall not be left at the site, as it may attract rodents, stray animals and pests.
i. Domestic waste shall be stored in covered bins and removed regularly.
j. Hazardous materials, fuel and chemicals shall be stored safely to prevent exposure to animals.

k. Site fencing shall be designed to prevent entry of livestock and stray animals into construction areas.
l. Any injured wildlife found at the site shall be reported to the HSE Officer and handled with support from relevant local authority if required.

Terrestrial Fauna Mitigation Table

Potential Impact	Mitigation Measures
Habitat disturbance	Limit clearing and avoid unnecessary vegetation removal
Noise disturbance	Maintain equipment and restrict night work
Harm to birds or small animals	Prohibit hunting, trapping or disturbance
Attraction of pests	Manage food waste and domestic waste properly
Animal entry into site	Maintain fencing and controlled access
Exposure to chemicals	Store fuel and chemicals securely
Disturbance from lighting	Avoid unnecessary night lighting

7.3.25.3 Mitigation Measures of Impact on Aquatic Ecosystem

The aquatic ecosystem may be affected if construction runoff, sediment, oil, fuel, cement slurry, wastewater or solid waste enters nearby ponds, canals, drains, wetlands or low-lying water bodies. Increased turbidity, reduced water quality and contamination may affect fish, aquatic plants, plankton, benthic organisms and other aquatic life. Therefore, strict pollution prevention measures shall be implemented during construction.

The following mitigation measures shall be implemented:

a. No construction waste, soil, cement slurry, oil, fuel, chemical or wastewater shall be discharged into any pond, canal, drain or surface water body.
b. Temporary drainage systems shall be developed to safely divert runoff from construction areas.
c. Silt traps, sedimentation pits and check barriers shall be installed at runoff discharge points.
d. Soil, sand, cement and loose construction materials shall be stored away from water bodies and drainage channels.
e. Fuel, oil and chemical storage areas shall be located on impervious surfaces with secondary containment.
f. Equipment refueling and maintenance shall be carried out only in designated areas away from water bodies.
g. Vehicle and equipment washing shall not be carried out near ponds, canals or open drains.
h. Concrete wash water shall be collected in a designated lined pit and shall not be discharged into drainage channels.
i. Construction activities near drainage paths shall be carefully managed during rainfall.
j. Drains shall be kept free from soil, waste, packaging materials and construction debris.
k. Any accidental spill near a water body shall be immediately contained, cleaned and reported.

l. Workers shall be trained not to throw waste, food residue, oil, chemical containers or wastewater into water bodies.
m. Surface water quality shall be monitored where applicable, especially during major site development and monsoon periods.
n. Natural drainage flow to nearby aquatic habitats shall not be blocked.

Aquatic Ecosystem Mitigation Table

Potential Impact	Source	Mitigation Measures	Monitoring Indicator
Increased turbidity	Soil runoff and excavation	Silt trap, sedimentation pit and runoff control	Visual inspection / turbidity
Water contamination	Oil, fuel and chemicals	Bunded storage, spill kit and safe handling	Spill record
Cement pollution	Concrete wash water	Collection in lined pit	Site inspection
Drain blockage	Construction waste and debris	Regular cleaning and waste collection	Drain inspection
Impact on fish and aquatic life	Polluted runoff	No untreated discharge into water bodies	Surface water quality
Loss of natural flow	Poor drainage management	Maintain existing drainage flow	Drainage inspection

7.3.26 Impact on Groundwater

Groundwater may be affected during construction if contaminants such as oil, fuel, chemicals, cement slurry, wastewater or domestic sewage seep into the ground. Excessive groundwater extraction for construction use may also affect local groundwater availability.

7.3.26.1 Ground Water Quality

Groundwater quality may be affected if pollutants infiltrate through soil and reach the aquifer. The main potential sources are fuel storage, chemical storage, equipment maintenance areas, wastewater disposal points, sanitation facilities and waste storage areas.

Potential impacts include:

a. oil and grease contamination;
b. increased dissolved solids from cement slurry;
c. bacterial contamination from poor sanitation;
d. chemical contamination from paints, solvents or construction chemicals;
e. seepage from contaminated runoff;
f. contamination from unmanaged hazardous construction waste.

7.3.26.2 Groundwater Availability

Groundwater may be required during construction for concrete works, curing, dust suppression, cleaning, sanitation and worker use. Excessive groundwater abstraction may affect local water availability if uncontrolled.

Potential impacts include:

a. pressure on local groundwater resources;
b. temporary lowering of groundwater level near the abstraction point;
c. reduced availability for nearby users if the same aquifer is used;
d. increased energy use for pumping;
e. possible conflict with local water users during dry season.

7.3.27 Mitigation Measures of Impact on Groundwater

7.3.27.1 Mitigation Measures of Impact on Ground Water Quality

Groundwater quality protection is important during construction because contamination may occur through infiltration of polluted water, oil, grease, chemical residue, sewage, cement slurry or waste leachate. Once groundwater is contaminated, restoration becomes difficult and costly. Therefore, preventive control measures shall be applied from the beginning of construction activities.

The following mitigation measures shall be adopted:

a. All fuel, oil and chemical storage areas shall be located on impervious surfaces.
b. Secondary containment shall be provided for fuel drums, lubricant containers and chemical storage.
c. Refueling shall not be carried out near drains, ponds, open soil or water bodies.
d. Used oil, oily rags, spent filters and contaminated absorbents shall be stored separately in sealed containers.
e. Temporary toilets shall be provided with proper septic or sanitary arrangement.
f. Sanitation facilities shall be inspected regularly to prevent leakage or overflow.
g. Concrete washout water shall be collected in a lined pit and allowed to settle before safe disposal.
h. Equipment washing wastewater shall be collected and shall not be allowed to infiltrate into soil.
i. Hazardous construction waste shall not be mixed with general waste.
j. Soil contaminated by oil, fuel or chemicals shall be excavated and disposed of through safe method.
k. Construction materials shall be stored away from drainage channels and low-lying areas.
l. Groundwater quality monitoring shall be conducted at representative locations before construction and during construction, if required by the monitoring plan.
m. Borewell(s) shall be installed to monitor groundwater quality on a regular basis.

Ground Water Quality Protection Measures

Risk Area	Control Measure	Monitoring Indicator

Fuel storage	Bund wall, impervious floor, spill kit	No leakage/spill record
Chemical handling	Labeling, covered storage and trained handling	Storage inspection
Sanitation	Proper septic/temporary toilet facility	No overflow or odour
Cement washout	Lined washout pit	No direct discharge
Waste storage	Segregated and covered storage	Housekeeping checklist
Equipment maintenance	Designated maintenance area	No oil stain on soil
Drainage	Silt trap and controlled runoff	Drain inspection
Groundwater monitoring	Baseline and periodic testing	Test report

Suggested Groundwater Quality Parameters

Parameter Group	Parameters
General quality	pH, EC, TDS, turbidity
Organic pollution	BOD, COD
Nutrients	Ammonia, nitrate, phosphate
Salinity / ions	Chloride, sulphate
Oil contamination	Oil and grease
Metals	Iron, manganese, lead, chromium, cadmium, arsenic, mercury where relevant
Microbiological	Total coliform, faecal coliform if sanitation impact is suspected

7.3.27.2 Mitigation Measures of Impact on Ground Water Availability

Groundwater availability may be affected if large quantities of groundwater are extracted for construction works. Water may be required for concrete mixing, curing, dust suppression, equipment cleaning, sanitation, drinking water and general construction use. Excessive abstraction may reduce local groundwater level, particularly during dry season.

The following mitigation measures shall be implemented:

a. Construction water demand shall be estimated before major construction activities.
b. Groundwater abstraction shall be minimized as far as practicable.
c. Water shall be collected only from approved and permitted sources.
d. Uncontrolled pumping from shallow tube wells shall be avoided.
e. Water use shall be recorded regularly during construction.
f. Treated or non-potable water may be used for dust suppression where suitable.
g. Water wastage during curing, washing and cleaning shall be avoided.
h. Hoses and taps shall be checked regularly to prevent leakage.
i. Rainwater storage may be considered for non-potable construction use where feasible.
j. Dry construction methods shall be adopted where technically possible.
k. Local community water sources shall not be affected by project water use.

Ground Water Availability Management Table

Construction Water Use	Potential Impact	Mitigation Measure

Concrete mixing	Increased water demand	Controlled batching and planned use
Curing	Continuous water use	Use efficient curing method
Dust suppression	Frequent water use	Use treated/non-potable water where possible
Equipment washing	Water wastage	Designated washing area and controlled use
Worker sanitation	Water demand	Efficient fixtures and regular monitoring
Drinking water	Pressure on local source	Use approved safe supply source
Leakage from taps/hoses	Unnecessary wastage	Regular inspection and repair

Water Conservation Measures

Measure	Expected Benefit
Water-use record keeping	Controls unnecessary abstraction
Reuse of suitable water	Reduces freshwater demand
Leak repair	Prevents wastage
Controlled dust suppression	Reduces excess water use
Proper curing method	Saves construction water
Rainwater use where feasible	Reduces pressure on groundwater
Worker awareness	Promotes responsible water use

7.4 Operation Stage Impacts and Mitigation

7.4.1 Impact on Natural Resources

7.4.1.1 Impact on Agricultural Resources

Agricultural resources around the project area may be affected if emissions, dust, contaminated runoff, wastewater discharge, residue mismanagement or traffic-related disturbance are not properly controlled. Although the TSDF facility will operate within its approved boundary, surrounding agricultural land, crops, irrigation channels and soil quality may be sensitive receptors.

Potential impacts on agricultural resources may include:

a. dust deposition on crops from vehicle movement or residue handling;
b. possible effect on crop quality if contaminated runoff reaches agricultural land;
c. soil contamination risk from accidental spill, leachate or wastewater overflow;
d. disturbance to irrigation or drainage channels due to poor stormwater management;
e. concern among local farmers regarding air emission, odour or waste transportation;
f. reduced productivity if agricultural land is affected by uncontrolled pollution;
g. temporary access disturbance due to waste transport vehicles.

The impact on agricultural resources is expected to be low to moderate if the facility is properly operated with controlled drainage, air pollution control, paved internal roads, covered storage and environmental monitoring.

Potential Impact on Agricultural Resources

Source	Possible Impact on Agriculture
Stack emission, if uncontrolled	Concern regarding crop exposure and deposition
Fugitive dust	Dust deposition on crops and leaves
Contaminated runoff	Soil and irrigation water contamination
Waste transport	Access disturbance and dust
Residue handling	Dust or ash deposition if not controlled
Wastewater overflow	Soil and crop contamination risk

7.4.1.2 Impact on Livestock

Livestock in nearby areas may include cattle, goats, poultry, ducks and other domestic animals. Operation of the TSDF facility may affect livestock indirectly through noise, traffic movement, odour, dust, accidental spill, contaminated water or unsafe access if animals enter the facility area.

Potential impacts on livestock may include:

a. disturbance from vehicle movement and operational noise;
b. exposure to dust or odour if fugitive emissions are not controlled;
c. risk of injury if livestock enter the facility boundary or transport route;
d. contamination risk if livestock drink from water bodies affected by polluted runoff;
e. reduced grazing safety if waste, ash or contaminated materials are improperly stored;
f. concern among livestock owners regarding facility operation and waste transportation.

The impact on livestock is expected to be low and localized, provided that the site remains fenced, waste is stored safely, runoff is controlled and community access routes are properly managed.

Potential Impact on Livestock

Impact Source	Possible Effect
Waste transport vehicles	Disturbance and accident risk
Operational noise	Temporary stress or disturbance
Fugitive dust or odour	Discomfort in nearby areas
Contaminated runoff	Risk to drinking water sources
Uncontrolled waste storage	Attraction or exposure risk
Open site access	Injury risk to animals

7.4.2 Mitigation Measures of Impact on Natural Resources

Impacts on agricultural resources and livestock during operation will arise mainly through air emissions, contaminated runoff or accidental releases. They will be controlled through the air emission, water, soil and agriculture, and waste management measures presented in the following sections, in particular strict emission control and monitoring, segregation of contaminated runoff, prevention of any untreated discharge to agricultural land or irrigation channels, and exclusion of stray animals from waste handling areas.

7.4.3 Impact on Air Quality

Air quality impact is one of the most important potential impacts during the operation of an incineration-enabled TSDF facility. Air emissions may be generated from waste handling, waste storage, waste preparation, waste feeding, incineration, air pollution control system, stack emission, residue handling, vehicle movement and generator operation.

Potential Air Emission Sources during Operation

Source	Possible Pollutants / Impact
Waste receiving area	Odour, dust, bioaerosol, VOCs
Waste storage area	Odour and fugitive emissions
Waste preparation and feeding	Dust, odour and worker exposure
Incinerator stack	PM, CO, NOx, SO_2, acid gas, heavy metals
APCD residue handling	Fine dust and hazardous residue exposure
Vehicle movement	Dust, smoke and exhaust emission
Generator operation	NOx, SO_2, CO and particulate emission
Residue storage	Fugitive dust if not covered

7.4.3.1 Waste Handling, Transportation and Storage

Waste handling, transportation and storage may generate air quality impacts due to odour, dust, fugitive emission, vehicle exhaust and accidental release of waste materials. Since the TSDF will receive different types of waste, air quality impact may vary depending on waste type, moisture content, organic content, contamination level, packaging condition and duration of storage.

Potential impacts from waste handling, transportation and storage include:

a. odour generation from decomposable or contaminated waste;
b. dust generation from dry waste, packaging waste, powdery waste or broken materials;
c. release of vapour or volatile compounds from chemical-contaminated waste;
d. bioaerosol risk from organic or healthcare-related waste, if accepted;
e. vehicle exhaust from incoming and outgoing waste transport vehicles;
f. fugitive emission during unloading, sorting and temporary storage;
g. public nuisance if waste vehicles are uncovered or leaking;
h. worker exposure to odour, dust and airborne contaminants;
i. increased air pollution during high traffic periods at the facility.

Impact from Waste Handling, Transportation and Storage

Activity	Possible Air Quality Impact
Waste unloading	Odour, dust and fugitive emission
Manual handling / sorting	Dust, odour and worker exposure
Temporary storage	Odour and vapour release
Waste vehicle movement	Dust and exhaust emission
Leaking or uncovered vehicles	Odour nuisance and public concern
Dry waste handling	Particulate matter generation
Chemical-contaminated waste	Vapour or volatile compound release

Long storage duration	Increased odour and decomposition risk

7.4.3.2 Waste Preparation and Feeding

Waste preparation and feeding are critical operational steps before incineration. These activities may include segregation, size reduction, mixing, removal of unsuitable materials, temporary transfer, loading into feed system and controlled feeding into the incinerator. If not properly managed, waste preparation and feeding may create air quality impacts, odour, dust, worker exposure and combustion instability.

Potential impacts from waste preparation and feeding include:

a. dust generation during cutting, shredding, mixing or handling of dry waste;
b. odour release during preparation of organic or contaminated waste;
c. fugitive emission from open handling areas;
d. worker exposure to airborne contaminants;
e. accidental feeding of unsuitable or incompatible waste;
f. poor combustion condition due to irregular feeding or high-moisture waste;
g. increase in smoke, CO or odour if waste feed rate is not controlled;
h. increased emission load on APCD during unstable operation;
i. release of fine particles during transfer of prepared waste;
j. fire risk from combustible materials if waste preparation is not controlled.

The impact from waste preparation and feeding may be moderate to high if the system is poorly managed. Proper waste characterization, controlled feeding, trained operators, covered handling, ventilation, PPE and operational monitoring are required to reduce the impact.

Impact from Waste Preparation and Feeding

Activity	Possible Impact
Waste segregation	Dust, odour and worker exposure
Waste size reduction	Dust and noise
Waste mixing	Odour and fugitive emission
Transfer to feed system	Spillage, dust and odour
Feeding to incinerator	Combustion instability if uncontrolled
Feeding unsuitable waste	Abnormal emission and safety risk
Handling high-moisture waste	Poor combustion and increased smoke risk
Handling dry powdery waste	Particulate release

7.4.4 Mitigation Measures of Impact on Air Quality

Air quality impacts during operation may arise from waste receiving, waste handling, storage, incineration, fuel combustion, APCD operation, residue handling, vehicle movement and generator operation. The facility shall apply engineering controls, process controls, monitoring and good housekeeping to minimize air emissions and odour.

The following measures shall be implemented:

a. Waste acceptance shall follow approved Waste Acceptance Criteria.
b. Unknown, incompatible, explosive, radioactive or prohibited waste shall not be accepted.
c. Waste shall be received, unloaded and stored in designated covered areas.
d. Odour-generating waste shall not be stored for long periods.
e. Dry and dusty waste shall be handled in covered or enclosed systems where practicable.
f. Incinerator shall be operated under controlled combustion conditions.
g. Air Pollution Control Device shall operate continuously during incineration.
h. Continuous Emission Monitoring System shall be maintained for key stack parameters.
i. Stack emission shall be monitored periodically through approved laboratory.
j. Ash and APCD residue shall be handled in covered containers to reduce fugitive dust.
k. Internal roads shall be paved, cleaned and sprinkled as required.
l. Vehicle idling shall be restricted inside the facility.
m. Greenbelt shall be developed and maintained along the project boundary.

Air Quality Control Matrix

Source	Potential Impact	Mitigation Measures
Waste receiving	Odour, dust, vapour	Covered unloading, quick processing, ventilation
Waste storage	Odour and fugitive emission	Segregated covered storage and limited storage time
Incinerator stack	PM, CO, NOx, SO_2, acid gas, metals	Controlled combustion, APCD, CEMS, stack monitoring
Residue handling	Fine dust	Covered handling, misting, PPE, sealed containers
Vehicle movement	Dust and exhaust	Paved roads, speed control, no-idling policy
DG set	Exhaust emission	Stack, maintenance, limited operation

7.4.4.1 Mitigation Measures of Impact due to Waste Handling, Transportation and Storage

Waste handling, transportation and storage shall be managed carefully to prevent dust, odour, leakage, vapour release, spillage, worker exposure and community nuisance.

The following measures shall be implemented:

a. All incoming waste shall be accompanied by proper documentation and manifest.
b. Waste shall be inspected at the gate and receiving area before acceptance.
c. Waste transport vehicles shall be covered, leak-proof and properly labeled where required.
d. Waste unloading shall be conducted only in designated receiving areas.
e. Waste shall be segregated according to type, compatibility, treatment requirement and hazard characteristics.
f. Incompatible waste shall not be stored together.
g. Liquid or semi-liquid waste shall be stored in leak-proof containers or tanks with secondary containment.
h. Odour-generating waste shall be processed as early as possible.
i. Waste storage areas shall have impervious floors, proper drainage and leachate collection.
j. Storage areas shall be covered or enclosed as required.
k. Emergency spill kits shall be available near receiving, storage and loading areas.

l. Workers shall use appropriate PPE during waste unloading, sorting and storage.
m. Waste storage inventory shall be maintained and updated regularly.
n. Regular housekeeping shall be maintained to prevent odour, pest attraction and dust generation.

Waste Handling and Storage Control Table

Activity	Control Measure
Waste transportation	Covered, leak-proof and documented vehicles
Waste receiving	Inspection, weighing, manifest verification
Waste unloading	Designated unloading bay with impervious floor
Waste storage	Covered, labeled and segregated storage
Odorous waste	Reduced storage time and quick treatment
Liquid waste	Leak-proof container and secondary containment
Dusty waste	Covered handling and dust suppression
Accidental spill	Spill kit, containment and immediate cleanup

7.4.4.2 Mitigation Measures of Impact due to Fuel Combustion

Fuel combustion may occur from auxiliary fuel used in the incinerator, diesel generator operation and vehicle movement. Improper combustion may result in smoke, carbon monoxide, particulate matter, nitrogen oxides, sulphur oxides and greenhouse gas emissions.

The following mitigation measures shall be implemented:

a. Auxiliary fuel shall be used efficiently and only as required for start-up, shutdown or combustion stabilization.
b. Incinerator burners shall be maintained regularly for efficient combustion.
c. Fuel quality shall be monitored and low-sulphur fuel shall be preferred where feasible.
d. Combustion temperature, oxygen level and residence time shall be maintained as per design requirement.
e. Waste feed rate shall be controlled to avoid incomplete combustion.
f. DG set shall be operated only during power failure or emergency requirement.
g. DG set shall be provided with proper stack height and acoustic enclosure.
h. All fuel storage areas shall be provided with spill containment and fire protection.
i. Vehicle idling shall be restricted.
j. Regular preventive maintenance shall be carried out for burners, pumps, valves, generators and fuel lines.
k. Smoke, abnormal odour or visible emission shall be investigated immediately.

7.4.5 Green House Gas Emission

During the operation phase of the proposed TSDF facility, greenhouse gas emissions may be generated from incineration activities, auxiliary fuel consumption, electricity use, waste transportation, operation of generators, and handling of waste and residues. The major greenhouse gases of concern may include carbon dioxide, methane and nitrous oxide, depending on the type of waste, fuel consumption, combustion efficiency and energy use.

The proposed TSDF facility may also provide indirect environmental benefits by preventing uncontrolled dumping, open burning and unmanaged decomposition of waste, which may otherwise generate methane, odour and other pollutants. However, controlled incineration itself

will generate carbon dioxide and other combustion-related emissions, which need to be managed through efficient operation and energy/resource optimization.

Potential sources of greenhouse gas emission include:

a. combustion of waste in the incinerator;
b. use of auxiliary fuel during start-up, shutdown or low-calorific waste operation;
c. electricity consumption for fans, pumps, blowers, APCD, CEMS, ETP, laboratory and lighting;
d. operation of diesel generator during power failure;
e. fuel consumption by waste collection and residue transportation vehicles;
f. decomposition of stored organic waste if storage time is prolonged;
g. use of chemicals and consumables in treatment processes.

Potential Greenhouse Gas Emission Sources

Source	Possible GHG Impact
Incineration of waste	CO_2 emission from combustion
Auxiliary fuel use	CO_2 emission from fuel burning
Electricity consumption	Indirect GHG emission from grid power use
Diesel generator	CO_2 and other combustion emissions
Waste transportation	Vehicle-related fuel emission
Waste storage	Methane/odour risk if organic waste is stored for long periods
Chemical use	Indirect emission from production, transport and use of chemicals

The impact from greenhouse gas emission is considered **moderate** during normal operation. The impact can be reduced through proper waste segregation, optimized combustion, reduced auxiliary fuel use, energy-efficient equipment, preventive maintenance, route optimization, reduced vehicle idling and timely processing of biodegradable or odour-generating waste.

7.4.6 Mitigation Measures for Greenhouse Gas Emissions

Greenhouse gas emissions from the facility arise mainly from the combustion of fossil carbon in the waste, auxiliary fuel use, electricity consumption and vehicle movements. The following measures shall be adopted:

- Maximise recovery of recyclable materials before incineration so that only waste requiring thermal treatment is burnt.
- Optimise combustion control and burner management to minimise auxiliary fuel consumption, and prefer lower-carbon fuels (natural gas or LPG) where available.
- Evaluate the feasibility of heat recovery from the flue gas for internal use during detailed design.
- Use energy-efficient motors, drives, pumps and lighting, and consider rooftop solar power for administrative and utility loads.
- Plan waste collection routes and loads to minimise vehicle kilometres travelled.
- Record fuel, electricity and waste throughput data and report greenhouse gas emissions annually.

7.4.7 Impact on Ambient Noise Level

During the operation phase, noise may be generated from incinerator operation, fans, blowers, pumps, compressors, waste handling equipment, shredders, conveyors, air pollution control system, ETP machinery, generators, loading/unloading activities and vehicle movement. Continuous operation of mechanical equipment may increase occupational noise exposure inside the facility and may also contribute to boundary noise if not properly controlled.

Potential impacts on ambient noise level include:

a. increased noise level within plant operation areas;
b. occupational exposure of workers near high-noise equipment;
c. disturbance to nearby receptors if noise travels beyond the project boundary;
d. intermittent noise from waste vehicles, loading/unloading and material handling;
e. noise from DG set operation during power failure;
f. vibration and mechanical noise from rotating equipment;
g. disturbance to nearby fauna and livestock, if present.

Operational Noise Sources

Noise Source	Possible Impact
Incinerator fans and blowers	Continuous mechanical noise
Pumps and compressors	Localized noise and vibration
Waste handling equipment	Intermittent operational noise
Shredder / size reduction equipment	High intermittent noise
DG set	Continuous noise during operation
ETP machinery	Localized mechanical noise
Vehicle movement	Traffic noise, horn and loading noise
Residue handling	Short-term handling noise

The impact on ambient noise is expected to be **low to moderate** if equipment is properly enclosed, maintained and operated. Noise impact may become significant near high-noise zones without PPE or acoustic control. Boundary noise is expected to remain manageable with equipment maintenance, greenbelt development, acoustic enclosure for DG set, speed control and restricted horn use.

7.4.8 Mitigation Measures of Impact on Ambient Noise Level

Operational noise may arise from incinerator fans, blowers, pumps, compressors, shredders, conveyors, ETP equipment, DG set, loading/unloading activities and vehicle movement.

The following mitigation measures shall be implemented:

a. High-noise equipment shall be installed with silencers, vibration pads or acoustic enclosure where required.
b. DG set shall be provided with acoustic enclosure.
c. Rotating equipment shall be maintained regularly.
d. Equipment foundations shall be designed to reduce vibration.
e. Unnecessary horn use shall be prohibited inside the facility.

f. Speed limits shall be maintained for internal vehicle movement.
g. High-noise areas shall be marked with warning signs.
h. Workers in high-noise areas shall use earplugs or earmuffs.
i. Boundary greenbelt shall be maintained to reduce noise propagation.
j. Noise monitoring shall be conducted at equipment areas and site boundary.
k. Noise complaints from nearby communities shall be recorded and addressed.

Noise Mitigation Table

Noise Source	Mitigation Measure
Fans and blowers	Silencer, enclosure and maintenance
DG set	Acoustic enclosure and limited operation
Pumps and compressors	Vibration pads and maintenance
Shredder / conveyors	Enclosure and controlled operation
Vehicle movement	Speed control and no horn policy
Loading/unloading	Controlled timing and supervision

7.4.9 Impact on Water Bodies

During the operation phase, nearby water bodies may be affected if untreated wastewater, contaminated runoff, leachate, chemical spills, fuel leakage, scrubber wastewater, ETP overflow or residue-contaminated water enters surface drains, ponds, canals, low-lying areas or other receiving water bodies.

The proposed TSDF facility will generate different types of wastewater from waste handling, floor washing, vehicle washing, scrubber system, ETP operation, laboratory activities, domestic use, residue handling area and contaminated stormwater. Therefore, proper wastewater collection, segregation, treatment and reuse/discharge control are essential.

7.4.9.1 Impacts on Surface Water Quantity

Surface water quantity may be affected if the project uses nearby surface water sources for operation or if stormwater drainage is not properly managed. During operation, water may be required for floor washing, vehicle washing, scrubber system, ETP operation, dust suppression, greenbelt maintenance, domestic use and emergency firefighting reserve.

Potential impacts on surface water quantity include:

a. reduction in available water if surface water is abstracted from local ponds, canals or nearby sources;
b. pressure on local water resources during dry season;
c. increased stormwater runoff due to paved and impervious surfaces;
d. reduced natural infiltration within the developed site;
e. localized waterlogging if stormwater drainage is insufficient;
f. change in runoff volume entering nearby drains during heavy rainfall;
g. possible overflow from storage or treatment areas during extreme rainfall.

Surface Water Quantity Impact Table

Operational Issue	Possible Impact

Water use for washing and process	Pressure on water source
Scrubber and ETP water demand	Increased operational water requirement
Paved surface	Increased stormwater runoff
Poor drainage	Waterlogging and overflow
Dry season water demand	Stress on local water availability
Heavy rainfall	Increased runoff to external drains

7.4.9.2 Impacts on Surface Water Quality

Surface water quality may be affected if contaminated wastewater, leachate, stormwater runoff, fuel spill, chemical spill, ash residue or untreated effluent reaches nearby drains, ponds, canals or low-lying water bodies. This is one of the major environmental risks during operation of a TSDF facility.

Potential surface water quality impacts include:

a. increase in suspended solids and turbidity;
b. increase in COD and BOD from contaminated wash water;
c. increase in TDS, chloride, sulphate and dissolved salts from scrubber wastewater;
d. change in pH due to acidic or alkaline wastewater;
e. presence of oil and grease from vehicle washing and machinery areas;
f. heavy metal contamination from ash, APCD residue or leachate;
g. chemical contamination from laboratory wastewater or ETP chemicals;
h. odour and visual pollution from contaminated discharge;
i. impact on aquatic organisms and fisheries;
j. public concern if water bodies show visible pollution.

Surface Water Quality Impact Table

Pollutant / Parameter	Possible Source	Possible Impact
Suspended solids	Floor wash, runoff, ash handling	Turbidity and siltation
COD / BOD	Waste storage, wash water, domestic wastewater	Organic pollution
Oil and grease	Vehicle washing, machinery maintenance	Surface film and aquatic stress
pH	Scrubber wastewater, chemicals	Acidic/alkaline impact
TDS / salts	Scrubber blowdown, ETP discharge	Increased dissolved solids
Heavy metals	Ash, APCD residue, leachate	Toxicity risk
Chemical residues	Laboratory and ETP chemicals	Water quality degradation
Pathogens	Domestic wastewater	Health risk if untreated

The impact on surface water quality may be **high** in case of untreated discharge, ETP failure or accidental spill. However, the impact can be controlled through complete wastewater collection, treatment, reuse, monitoring and emergency containment.

7.4.9.3 Discharge of Treated Process Water

Treated process water may be generated from the Effluent Treatment Plant after treatment of scrubber wastewater, floor washing water, vehicle washing water, contaminated runoff, leachate and other process wastewater. The quality of treated water will depend on the influent characteristics, ETP design, chemical dosing, operational control and monitoring.

If treated process water is discharged without meeting applicable standards, it may affect surface water, soil, aquatic life and public health. Therefore, treated process water discharge must be carefully controlled and monitored.

Potential impacts from treated process water discharge include:

a. contamination of surface water if treated water DoEs not meet standards;
b. increased TDS, suspended solids or chemical load in receiving drains;
c. change in pH of receiving water;
d. accumulation of pollutants if discharge is continuous;
e. aquatic ecosystem stress if residual pollutants are present;
f. odour or colour problem if treatment is inadequate;
g. regulatory non-compliance and public complaint;
h. long-term soil or water quality impact if discharged to land without control.

Treated Process Water Discharge Impact Table

Discharge Issue	Possible Impact
Inadequate treatment	Pollution of receiving water
High TDS	Salinity and dissolved solids increase
High suspended solids	Turbidity and sedimentation
pH fluctuation	Stress on aquatic organisms
Heavy metal residue	Toxicity and accumulation risk
Oil and grease residue	Surface film and reduced oxygen transfer
Continuous discharge	Long-term pollutant loading
ETP bypass or overflow	Serious surface water contamination

The impact from treated process water discharge is considered **moderate to high** without proper treatment and compliance monitoring. If treated water is reused within the facility for dust suppression, floor washing, greenbelt or other non-potable uses, the discharge impact can be reduced. Any final discharge shall meet applicable DoE standards and shall be monitored regularly.

Summary of Operation Stage Water Impact

Component	Main Impact	Significance Without Control
Surface water quantity	Pressure on water source and increased runoff	Low to Moderate

Surface water quality	Contamination from wastewater, leachate and runoff	Moderate to High
Treated process water discharge	Pollution risk if treatment is inadequate	Moderate to High
Stormwater runoff	Transport of pollutants to drains or ponds	Moderate
ETP failure or overflow	Untreated wastewater release	High
Chemical/fuel spill	Acute water contamination	Moderate to High

7.4.10 Mitigation Measures of Impact on Water Bodies

7.4.10.1 Mitigation Measures of Impact on Surface Water Quantity

Operation of the TSDF facility may require water for washing, ETP, scrubber system, dust suppression, greenbelt, domestic use and emergency fire reserve. Surface water quantity impact shall be minimized through efficient use and reuse.

The following measures shall be adopted:

a. Water demand shall be estimated and monitored regularly.
b. Water shall be collected only from approved sources.
c. Water reuse shall be maximized where technically suitable.
d. Treated wastewater may be reused for dust suppression, floor washing or greenbelt irrigation if quality permits.
e. Rainwater harvesting may be considered where feasible.
f. Water wastage from taps, hoses and washing points shall be prevented.
g. High-water-use activities shall be controlled and supervised.
h. Water consumption records shall be maintained.
i. Community water sources shall not be affected by project operation.

7.4.10.2 Mitigation Measures of Impact on Surface Water Quality

Surface water quality may be affected due to untreated effluent, contaminated runoff, leachate, residue washout, oil leakage or chemical spill. Strict preventive measures shall be maintained.

The following measures shall be implemented:

a. All process wastewater shall be collected and treated.
b. ETP shall be operated by trained operator.
c. ETP inlet and outlet quality shall be monitored regularly.
d. Wastewater pipelines, tanks and drains shall be inspected for leakage.
e. Waste storage and residue areas shall be covered to prevent rainwater contact.
f. Surface runoff from contaminated areas shall be collected separately.
g. Fuel and chemical spills shall be contained immediately.
h. Laboratory wastewater shall be segregated and neutralized where required.
i. No ash, sludge, residue or chemical shall be washed into storm drains.
j. Treated water discharge shall comply with applicable standards.

Surface Water Quality Protection Table

Source	Mitigation Measure

Process wastewater	Collection and ETP treatment
Leachate	Collection tank and treatment
Residue storage runoff	Covered storage and drainage control
Fuel/chemical spill	Secondary containment and spill response
Laboratory wastewater	Segregation and neutralization
Stormwater	Separate clean and contaminated drains

7.4.10.3 Mitigation Measures of Impact due to Discharge of Treated Process Water

Treated process water shall be discharged only after meeting applicable regulatory standards. Reuse shall be prioritized to reduce discharge volume.

The following measures shall be adopted:

a. Treated effluent quality shall be tested before discharge.
b. Online or periodic monitoring shall be conducted for critical parameters.
c. ETP shall not be bypassed under any condition.
d. Emergency holding tank shall be provided for off-spec treated water.
e. Off-spec treated water shall be recycled back to ETP.
f. Treated water reuse shall be maximized for non-potable purposes.
g. Discharge point shall be clearly identified and monitored.
h. Flow meter shall be installed to record discharge quantity.
i. Treated effluent records shall be maintained.
j. Any non-compliance shall be reported internally and corrective action shall be taken immediately.

7.4.11 Impact due to Waste Generation and Disposal

7.4.11.1 Solid Waste Disposal

During the operation phase of the proposed TSDF facility, different types of solid waste and residues will be generated from waste receiving, segregation, incineration, air pollution control, wastewater treatment, laboratory activities, office activities, maintenance works and housekeeping. Proper management of these solid wastes is essential because some residues may contain hazardous constituents and may pose risk to soil, groundwater, surface water, air quality, workers and surrounding communities.

The main solid waste and residue streams during operation may include:

a. rejected and non-incinerable waste;
b. recyclable materials separated during waste sorting;
c. bottom ash from incineration;
d. fly ash and Air Pollution Control Device residue;
e. spent activated carbon, filter media and scrubber residue;
f. ETP sludge;
g. laboratory waste and chemical-contaminated materials;
h. used PPE, contaminated absorbents and cleaning materials;
i. used oil filters, oily rags and maintenance waste;
j. packaging waste, plastic, paper, carton and office waste;
k. domestic waste from workers and administrative areas.

Potential impacts from improper solid waste disposal include:

a. soil contamination from ash, sludge or contaminated waste;
b. groundwater contamination through leachate generation;
c. surface water pollution due to runoff from waste storage areas;
d. fugitive dust from dry ash and APCD residue;
e. odour and pest attraction from decomposable waste;
f. worker exposure to hazardous residue;
g. fire risk from combustible waste;
h. visual nuisance and poor housekeeping;
i. regulatory non-compliance due to improper disposal;
j. public concern regarding unsafe residue handling.

Solid Waste and Residue Impact Table

Waste / Residue Type	Possible Impact
Bottom ash	Dust, heavy metal presence, soil contamination if unmanaged
Fly ash / APCD residue	Fine hazardous dust, heavy metal and toxic residue risk
ETP sludge	Concentrated pollutants and odour risk
Rejected waste	Storage burden and odour if not managed
Recyclable materials	Littering and fire risk if stored poorly
Used PPE and absorbents	Contamination and worker exposure risk
Laboratory waste	Chemical contamination risk
Maintenance waste	Oil, grease and chemical contamination
Domestic waste	Odour, pests and hygiene problem

The impact from solid waste disposal during operation may be **moderate to high** if residues are not segregated, tested, stored and disposed of properly. The impact can be controlled through residue characterization, covered storage, impervious flooring, leachate collection, dust suppression, secure disposal, recordkeeping and regular monitoring.

Special attention shall be given to bottom ash, fly ash, APCD residue and ETP sludge. These materials shall not be disposed of as general waste unless proper laboratory analysis confirms their classification and suitability for disposal or reuse.

7.4.11.2 Impacts due to Wastewater Generation and Disposal

During operation, wastewater will be generated from different process and non-process activities of the TSDF facility. Wastewater generation is one of the major potential environmental impacts because the facility will handle contaminated waste, residues, chemicals and process water from air pollution control and cleaning systems.

The major wastewater sources may include:

a. scrubber blowdown from air pollution control system;
b. floor washing water from waste receiving and processing areas;
c. vehicle washing wastewater;
d. contaminated runoff from waste storage and residue handling areas;

e. leachate from waste storage area, if any;
f. wastewater from ash and residue handling areas;
g. laboratory wastewater;
h. ETP chemical preparation and cleaning wastewater;
i. domestic wastewater from toilets, washrooms and staff facilities;
j. stormwater mixed with contaminated materials during rainfall.

Potential impacts due to wastewater generation and disposal include:

a. surface water pollution if untreated wastewater enters nearby drains, ponds or canals;
b. groundwater contamination through seepage from unlined or damaged drainage systems;
c. soil contamination from wastewater overflow or leakage;
d. increase in COD, BOD, TSS, TDS, oil and grease in receiving water;
e. pH imbalance from acidic or alkaline wastewater;
f. presence of heavy metals or hazardous constituents from ash, leachate or scrubber wastewater;
g. odour generation from stagnant wastewater;
h. sludge generation from ETP operation;
i. public complaint if discharge creates visible pollution or odour;
j. regulatory non-compliance if treated effluent fails to meet standards.

Wastewater Source and Potential Impact Table

Wastewater Source	Possible Pollutants	Potential Impact
Scrubber blowdown	TDS, salts, pH variation, dissolved pollutants	Surface water and soil contamination
Floor washing	Suspended solids, organic matter, waste particles	Drain pollution and odour
Vehicle washing	Oil, grease, mud, contaminated particles	Water and soil pollution
Waste storage runoff	Leachate, COD, BOD, heavy metals	High contamination risk
Residue handling area	Ash particles, heavy metals, alkaline runoff	Soil and water contamination
Laboratory wastewater	Chemical residues, acids, alkalis	Toxicity and pH impact
Domestic wastewater	BOD, pathogens, nutrients	Hygiene and water pollution
ETP sludge water	Concentrated pollutants	Secondary contamination risk

The impact due to wastewater generation and disposal may be **moderate to high** without proper control. However, the impact can be reduced significantly through separate drainage systems, wastewater collection tanks, leachate control, ETP operation, treated water reuse, monitoring and emergency storage arrangement.

The facility shall ensure that no untreated process wastewater is discharged outside the project boundary. Treated wastewater may be reused for dust suppression, floor washing, greenbelt development or other non-potable purposes, subject to quality suitability. Any final discharge shall comply with applicable regulatory standards.

Wastewater Impact Significance

Impact Aspect	Nature of Impact	Significance Without Control
Process wastewater	Continuous operational impact	High
Scrubber wastewater	Chemical and dissolved pollutant impact	High
Contaminated runoff	Rainfall-dependent pollution risk	Moderate to High
Domestic wastewater	Hygiene and organic pollution	Moderate
Laboratory wastewater	Chemical contamination	Moderate to High
ETP failure or overflow	Untreated discharge risk	High
Treated wastewater discharge	Compliance-dependent impact	Moderate

7.4.12 Mitigation Measures of Impact due to Waste Generation and Disposal

7.4.12.1 Mitigation Measures of Impact due to Solid Waste Disposal

Solid waste during operation may include rejected materials, packaging waste, office waste, used PPE, contaminated absorbents, used filters, maintenance waste and domestic waste.

The following measures shall be adopted:

a. Separate bins shall be provided for recyclable, general, contaminated and hazardous waste.
b. Office and domestic waste shall be collected daily.
c. Food waste shall be stored in covered bins to prevent odour and pests.
d. Used PPE and contaminated absorbents shall be treated as contaminated waste.
e. Used oil, oily rags and filters shall be stored in sealed containers.
f. Empty chemical containers shall be decontaminated or disposed of safely.
g. Recyclable waste shall be transferred to approved recyclers.
h. Open burning of waste shall be strictly prohibited.
i. Solid waste storage areas shall be cleaned regularly.
j. Records of waste generation and disposal shall be maintained.

7.4.12.2 Mitigation Measures of Impact of Wastewater Generation and Disposal

Wastewater generation shall be controlled through segregation, collection, treatment, reuse and monitoring.

The following measures shall be implemented:

a. Process wastewater shall be collected through dedicated drains.
b. Domestic wastewater shall be managed through septic/STP or approved system.
c. Scrubber blowdown shall be collected and treated in ETP.
d. Vehicle washing water shall pass through oil and silt trap before treatment.

e. Floor washing water from contaminated areas shall be treated.
f. Laboratory wastewater shall be segregated based on chemical characteristics.
g. ETP sludge shall be collected, dewatered and safely disposed of.
h. Wastewater flow and quality shall be monitored regularly.
i. Treated wastewater shall be reused where suitable.
j. No untreated wastewater shall be discharged to land or water bodies.

7.4.13 Soil and Agriculture

During the operation phase of the proposed TSDF facility, soil and agricultural resources may be affected if waste handling, wastewater management, residue storage, chemical storage, fuel storage and stormwater control systems are not properly managed. Soil is an important receiving environment because contamination may occur through spills, leakage, leachate, ash deposition, contaminated runoff or accidental discharge.

Potential impacts on soil may include:

a. contamination from waste leakage or leachate from waste storage areas;
b. contamination from bottom ash, fly ash, APCD residue or ETP sludge if stored improperly;
c. oil and grease contamination from vehicle movement, maintenance and fuel handling;
d. chemical contamination from laboratory chemicals, ETP chemicals, scrubber chemicals or cleaning agents;
e. soil quality degradation due to untreated wastewater overflow;
f. deposition of fugitive dust or ash on exposed soil;
g. reduced soil productivity if contaminated runoff reaches nearby agricultural land;
h. accumulation of heavy metals or other pollutants if residues are not properly managed;
i. public concern regarding possible impact on crops, vegetation and agricultural productivity.

Agricultural resources near the project area may be indirectly affected by dust deposition, contaminated runoff, wastewater discharge, residue mismanagement, traffic movement or accidental release of pollutants. If agricultural fields, irrigation channels or ponds are located near the facility, they may be sensitive to any uncontrolled discharge or surface runoff.

Potential Impacts on Soil and Agriculture

Source / Activity	Possible Impact on Soil and Agriculture
Waste storage	Leachate generation and soil contamination risk
Waste handling	Spillage of contaminated materials
Residue storage	Ash dust, heavy metals and contaminated runoff
ETP sludge handling	Soil contamination if improperly stored
Fuel and chemical storage	Leakage, spill and localized contamination
Vehicle movement	Oil, grease and dust deposition
Wastewater overflow	Soil and crop contamination risk
Stack or fugitive dust	Deposition on soil, vegetation and crops
Stormwater runoff	Transport of pollutants to nearby land

The impact on soil and agriculture may be **moderate** during normal operation if waste and residues are handled properly. However, the impact may become **high** in case of accidental spill,

leachate leakage, wastewater overflow, ash mismanagement or uncontrolled discharge to agricultural land.

7.4.14 Mitigation Measures of Impact on Soil and Agriculture

Soil and agricultural resources may be affected by spills, leachate, residue dust, contaminated runoff, wastewater overflow or improper storage of waste and chemicals.

The following measures shall be implemented:

a. Waste handling areas shall have impervious flooring.
b. Chemical and fuel storage shall have secondary containment.
c. Waste and residue storage shall be covered and protected from rainfall.
d. Contaminated runoff shall be collected and treated.
e. Regular inspection shall be conducted for cracks, leakage and spills.
f. Any contaminated soil shall be removed and safely disposed of.
g. Dust from ash or residue handling shall be controlled.
h. Agricultural land outside the project boundary shall not be used for waste storage or disposal.
i. Wastewater shall not be discharged onto agricultural land unless permitted and quality-approved.
j. Complaints from farmers or land users shall be addressed through GRM.

7.4.15 Impact on Ground Water

Groundwater may be affected during operation if contaminated liquid, leachate, wastewater, chemicals, fuel, oil, ETP sludge or residue-contaminated runoff infiltrates into the soil and reaches the aquifer. Since the proposed facility will handle different types of waste and residues, groundwater protection is an important environmental concern.

Potential sources of groundwater impact include:

a. leakage from waste storage areas;
b. seepage from leachate collection tanks or drains;
c. leakage from ETP tanks, pipelines or wastewater channels;
d. overflow of untreated or partially treated wastewater;
e. seepage from residue storage area;
f. accidental spill of fuel, oil, chemicals or laboratory reagents;
g. improper storage of bottom ash, fly ash, APCD residue or ETP sludge;
h. poor sanitation system or leakage from domestic wastewater facilities;
i. infiltration of contaminated stormwater from unpaved or cracked surfaces;
j. failure of impervious flooring in waste handling or chemical storage areas.

Potential groundwater quality impacts may include increase in TDS, COD, BOD, chloride, sulphate, oil and grease, heavy metals, ammonia, suspended solids, pH variation and chemical contamination. The level of impact will depend on soil permeability, groundwater depth, drainage design, containment system, waste characteristics and emergency response effectiveness.

Potential Groundwater Impact Table

Source	Possible Pollutants	Potential Impact
Waste storage area	Leachate, COD, BOD, heavy metals	Groundwater contamination

Residue storage	Ash, heavy metals, alkaline runoff	Long-term contamination risk
ETP leakage or overflow	TSS, TDS, chemicals, sludge particles	Aquifer quality degradation
Fuel storage	Oil, grease, hydrocarbon	Localized groundwater pollution
Chemical storage	Acid, alkali, reagents	Toxicity and pH impact
Domestic wastewater	BOD, nutrients, pathogens	Sanitation-related contamination
Contaminated stormwater	Mixed pollutants	Infiltration through soil

7.4.16 Mitigation Measures of Impact on Ground Water

Groundwater protection shall be ensured through containment, leak prevention, monitoring and controlled water use.

The following measures shall be adopted:

a. All waste storage, chemical storage, residue storage and wastewater areas shall have impervious floors.
b. Leachate and contaminated wastewater shall be collected through closed or lined systems.
c. ETP tanks and pipelines shall be tested for leakage.
d. Fuel tanks and chemical containers shall be placed within bunded areas.
e. Groundwater monitoring wells may be established at suitable locations.
f. Groundwater quality shall be monitored periodically.
g. Groundwater abstraction shall be controlled and recorded.
h. Water reuse shall be encouraged to reduce groundwater demand.
i. Any sign of groundwater contamination shall be investigated immediately.
j. Emergency containment shall be maintained for major spills or leakage.

7.4.17 Impact due to Residue Disposal

Residue disposal is one of the major environmental issues during operation of the proposed incineration-enabled TSDF facility. Incineration and associated pollution control systems will generate different types of residues, some of which may contain concentrated pollutants. These residues may include bottom ash, fly ash, APCD residue, scrubber sludge, spent activated carbon, spent filter media, ETP sludge and contaminated absorbents.

The quantity and characteristics of residues will depend on waste composition, incineration efficiency, air pollution control system, wastewater treatment process and operational practices. Residues, especially fly ash and APCD residue, may contain fine particulate matter, heavy metals, salts, unburnt carbon and other hazardous constituents. Therefore, improper residue disposal may create significant environmental and health impacts.

Potential impacts due to residue disposal include:

a. soil contamination from improper storage or disposal of ash and sludge;
b. groundwater contamination due to leachate from residue storage or disposal areas;
c. surface water contamination from residue-contaminated runoff;
d. fugitive dust emission from dry ash and APCD residue;
e. worker exposure to fine ash, heavy metals and hazardous residues;

f. odour or chemical exposure from sludge or wet residues;
g. long-term accumulation of pollutants in disposal areas;
h. fire or reaction risk if incompatible residues are mixed;
i. public concern regarding disposal of hazardous residues;
j. regulatory non-compliance if residues are not tested, classified and disposed of properly.

Residue Types and Potential Impacts

Residue Type	Source	Potential Impact
Bottom ash	Incinerator grate / chamber	Dust, heavy metals, leachate risk
Fly ash	Flue gas stream / APCD	Fine hazardous dust and toxic constituent risk
APCD residue	Bag filter, scrubber, dry/semi-dry system	Heavy metals, salts and chemical contamination
Scrubber sludge	Wet scrubbing system	High TDS, pH and sludge disposal issue
ETP sludge	Wastewater treatment	Concentrated pollutants and odour
Spent activated carbon	Air pollution control	Adsorbed pollutants and hazardous residue risk
Used filter media	APCD / wastewater treatment	Contaminated solid waste
Contaminated absorbents	Spill response and cleaning	Hazardous waste handling risk

Residue disposal impact may be **moderate to high** depending on residue characteristics and disposal method. The impact will be higher if residues are stored in open areas, exposed to rainwater, mixed with general waste, transported uncovered or disposed of without testing.

Special attention shall be given to:

a. segregation of bottom ash and fly ash;
b. laboratory testing of residues;
c. identification of hazardous characteristics;
d. covered and impervious storage;
e. prevention of rainwater contact;
f. leachate collection from residue storage areas;
g. dust control during residue handling;
h. safe transportation to approved disposal site;
i. proper documentation of quantity, test results and final disposal.

Residue Disposal Impact Significance

Impact Aspect	Nature of Impact	Significance Without Control
Bottom ash disposal	Soil and water contamination risk	Moderate
Fly ash / APCD residue	Hazardous dust and heavy metal risk	High
ETP sludge	Concentrated pollutant disposal risk	Moderate to High

Residue storage runoff	Surface water and soil contamination	High
Residue handling dust	Worker exposure and air impact	Moderate to High
Long-term disposal	Accumulation of pollutants	High

7.4.18 Mitigation Measures of Impact due to Residue Disposal

Residues from incineration and pollution control systems may include bottom ash, fly ash, APCD residue, scrubber sludge, spent activated carbon, filter media and ETP sludge. These residues may contain concentrated pollutants and must be handled safely.

The following measures shall be implemented:

a. Bottom ash, fly ash and APCD residue shall be collected separately.
b. Residues shall be tested for hazardous characteristics and leachability.
c. Fly ash and APCD residue shall be treated as potentially hazardous unless proven otherwise.
d. Residues shall be stored in covered and impervious storage areas.
e. Dry ash shall be handled in closed or covered containers.
f. Dust suppression shall be used during residue handling.
g. Workers shall use respirator, gloves, goggles and protective clothing.
h. Residue storage area shall have drainage and leachate collection.
i. Hazardous residue shall be stabilized or solidified before secured disposal where required.
j. Residues shall not be dumped in open land, drains, ponds or municipal disposal areas.
k. Residue generation, test results, storage and disposal records shall be maintained.

Residue Management Table

Residue	Required Control
Bottom ash	Cooling, testing, covered storage and safe disposal
Fly ash	Sealed container, PPE and hazardous handling
APCD residue	Separate storage, testing and stabilization
ETP sludge	Dewatering, testing and approved disposal
Spent activated carbon	Hazardous storage and controlled disposal
Scrubber sludge	Chemical handling and safe disposal

7.4.19 Impact on Ecology

During operation of the proposed TSDF facility, ecological impacts may occur due to air emission, odour, dust, noise, artificial lighting, traffic movement, wastewater discharge, contaminated runoff, residue handling and accidental release of pollutants. If proper pollution control and environmental management measures are not implemented, nearby vegetation, common wildlife, aquatic organisms and local ecological balance may be affected.

The project site is not expected to cause major ecological disturbance if the facility operates within the approved boundary and maintains proper pollution control systems. However, ecological receptors such as trees, shrubs, birds, insects, reptiles, small mammals, ponds, drains and aquatic organisms may be sensitive to long-term exposure to dust, noise, polluted runoff or wastewater.

Potential ecological impacts may include:

a. dust deposition on nearby vegetation;
b. disturbance to birds and small fauna due to noise and traffic;
c. attraction of pests, rodents or stray animals due to poor waste housekeeping;
d. contamination of aquatic habitats if wastewater or runoff enters water bodies;
e. stress on aquatic flora and fauna due to poor surface water quality;
f. reduction of local ecological quality if greenbelt is not maintained;
g. ecological disturbance during accidental spill, fire or emergency discharge.

The impact on ecology is expected to be **low to moderate** during normal operation, provided that air emission, wastewater, residue and waste handling systems are properly controlled.

7.4.19.1 Impact on Terrestrial Flora

Terrestrial flora may include trees, shrubs, grasses, roadside vegetation, homestead vegetation and planted greenbelt species around the project area. During operation, terrestrial flora may be affected by dust, air emissions, residue handling, wastewater overflow, chemical spill or poor stormwater management.

Potential impacts on terrestrial flora include:

a. dust deposition on leaves from vehicle movement and residue handling;
b. reduced photosynthetic activity if dust accumulates on vegetation;
c. stress to plants from polluted runoff or contaminated soil;
d. damage to greenbelt if wastewater, ash or chemicals are improperly disposed;
e. change in vegetation health due to long-term exposure to air pollutants;
f. loss of visual greenery if greenbelt is not maintained properly;
g. accidental damage to plantation due to vehicle movement or poor site management.

The impact on terrestrial flora is expected to be **low to moderate**. Greenbelt development and regular maintenance will help reduce dust, noise and visual impacts and improve ecological value of the project boundary.

Potential Impact on Terrestrial Flora

Source / Activity	Possible Impact
Vehicle movement	Dust deposition on leaves
Residue handling	Ash dust deposition
Stack emission, if uncontrolled	Stress on nearby vegetation
Wastewater overflow	Soil and root zone contamination
Chemical or fuel spill	Localized plant damage
Poor greenbelt maintenance	Reduced ecological and visual benefit

7.4.19.2 Impact on Terrestrial Fauna

Terrestrial fauna may include common birds, insects, reptiles, rodents, small mammals, domestic animals and other locally available species. Operation of the TSDF facility may affect terrestrial fauna mainly through noise, traffic movement, lighting, waste storage, odour, pest attraction and accidental exposure to contaminated materials.

Potential impacts on terrestrial fauna include:

a. disturbance to birds and small animals due to operational noise;
b. temporary avoidance of the project area by common fauna;
c. attraction of rodents, insects, stray dogs or birds if food waste or organic waste is not managed properly;
d. injury risk to small animals or livestock if they enter operational areas;
e. exposure risk from waste, ash, chemicals or contaminated water;
f. disturbance from night lighting and vehicle movement;
g. reduced habitat quality if greenbelt and vegetation are not maintained.

The impact on terrestrial fauna is expected to be **low** during normal operation because the project activities will be confined within the facility boundary. However, poor housekeeping and open waste storage may increase pest and stray animal problems.

Potential Impact on Terrestrial Fauna

Source / Activity	Possible Impact
Operational noise	Disturbance to birds and small animals
Vehicle movement	Risk to small animals and livestock
Open waste storage	Attraction of pests and stray animals
Artificial lighting	Disturbance to night-active species
Chemical or residue exposure	Health risk to animals
Poor boundary control	Entry of livestock or stray animals

7.4.19.3 Impacts on Aquatic Flora and Fauna

Aquatic flora and fauna may include aquatic plants, algae, plankton, fish, amphibians, benthic organisms and other aquatic life in nearby ponds, canals, drains or low-lying water bodies. During operation, aquatic ecology may be affected if contaminated wastewater, treated effluent not meeting standards, leachate, ash-contaminated runoff, chemical spill or fuel leakage enters surface water bodies.

Potential impacts on aquatic flora and fauna include:

a. increased turbidity due to contaminated runoff;
b. reduction of dissolved oxygen due to organic pollution;
c. toxicity to fish and aquatic organisms from chemicals, metals or oil;
d. change in pH due to acidic or alkaline wastewater;
e. stress on aquatic plants due to poor water quality;
f. siltation of drains or ponds from residue-contaminated runoff;
g. accumulation of pollutants in aquatic sediments;
h. reduction of habitat quality for fish and other aquatic organisms.

The impact on aquatic flora and fauna may be **moderate to high** in case of untreated discharge, ETP failure, leachate leakage or accidental spill. Under controlled operation with

proper ETP, drainage segregation and treated water monitoring, the impact is expected to remain low.

Potential Impact on Aquatic Ecology

Source	Possible Ecological Impact
Untreated wastewater	Organic pollution and aquatic stress
ETP failure	Poor water quality and toxicity risk
Residue runoff	Heavy metal and suspended solid contamination
Fuel or chemical spill	Toxicity to aquatic organisms
Leachate	COD, BOD and chemical pollution
High TDS discharge	Stress on aquatic plants and organisms
pH variation	Harmful condition for aquatic life

7.4.20 Mitigation Measures of Impact on Ecology

7.4.20.1 Mitigation Measures of Impact on Terrestrial Flora

Ecological impacts during operation may arise from air emission, dust, noise, traffic, contaminated runoff, wastewater discharge, residue mismanagement and lighting. Mitigation shall focus on pollution prevention, greenbelt development and ecological monitoring.

The following measures shall be implemented:

a. Existing vegetation outside the project boundary shall not be disturbed.
b. Greenbelt plantation shall be maintained throughout operation.
c. Dust deposition on vegetation shall be minimized through road cleaning and water spraying.
d. No ash, sludge or wastewater shall be disposed of near plantation areas.
e. Dead plants shall be replaced regularly.
f. Plantation survival rate shall be monitored.
g. Native, pollution-tolerant and low-maintenance species shall be preferred.
h. Chemical or fuel storage shall not be located near greenbelt areas without containment.

7.4.20.2 Mitigation Measures of Impact on Terrestrial Fauna

The following measures shall be adopted:

a. Boundary fencing shall be maintained to prevent entry of livestock and stray animals.
b. Food waste shall be stored in covered bins and removed regularly.
c. Workers shall not harm, trap or disturb birds or small animals.
d. Noise and lighting shall be controlled to reduce disturbance.
e. Chemical, fuel and waste storage areas shall be secured.
f. Pest control shall be carried out in an environmentally safe manner.
g. Any injured animal found inside the facility shall be reported to HSE Officer.
h. Greenbelt shall be maintained as a buffer habitat for common local species.

7.4.20.3 Mitigation Measures of Impact on Aquatic Flora and Fauna

The following measures shall be implemented:

a. No untreated wastewater shall be discharged into drains, ponds, canals or water bodies.
b. Treated water discharge shall meet applicable standards.

c. Contaminated stormwater shall be collected and treated.
d. Ash, sludge, residue and chemicals shall not be stored near drainage outlets.
e. Oil and grease traps shall be maintained.
f. Surface water monitoring shall be conducted periodically.
g. Any spill near drainage channels shall be contained immediately.
h. Drainage channels shall be kept free from waste and sludge.
i. Emergency containment shall be available for major wastewater or chemical release.

7.4.21 Impact on Occupational Health

Operation of the TSDF facility may expose workers to different occupational health risks due to waste handling, incinerator operation, ash and residue handling, chemical use, wastewater treatment, laboratory activities, vehicle movement, heat, noise, dust, odour and emergency situations.

Workers involved in waste receiving, sorting, storage, incineration, APCD operation, ETP operation, laboratory testing, maintenance and residue disposal may be exposed to physical, chemical, biological and ergonomic hazards.

Potential occupational health impacts include:

a. exposure to dust, fumes, vapour and odour during waste handling;
b. respiratory irritation from ash, residue and fine particulate matter;
c. exposure to chemicals used in ETP, scrubber and laboratory;
d. heat stress near incinerator and boiler-related areas;
e. noise exposure from fans, blowers, pumps, shredders and generator;
f. skin and eye irritation from chemical contact;
g. injury risk from sharp objects, broken materials or contaminated waste;
h. exposure to biological contaminants from certain waste streams;
i. fatigue and physical strain from manual handling;
j. fire, burn or emergency exposure risk during abnormal operation;
k. long-term occupational disease risk if PPE and monitoring are not properly maintained.

The impact on occupational health may be **moderate to high** without proper safety control. However, with SOPs, PPE, training, medical surveillance, ventilation, housekeeping and emergency preparedness, the impact can be effectively reduced.

Occupational Health Risk Table

Work Area	Possible Health Impact
Waste receiving and sorting	Dust, odour, sharp object injury, biological exposure
Waste storage	Odour, vapour and accidental exposure
Incinerator operation	Heat stress, emission exposure and fire risk
APCD and ash handling	Fine dust, heavy metal and respiratory exposure
ETP operation	Chemical exposure and odour
Laboratory	Chemical handling and sample contamination risk
Maintenance	Electrical, mechanical and chemical exposure
Vehicle movement area	Accident, dust and exhaust exposure

7.4.22 Mitigation Measures of Impact on Occupational Health and Safety

Operation of a TSDF facility involves occupational risks from hazardous waste, chemicals, dust, fumes, heat, noise, fire, machinery, waste transportation, ash handling and emergency events. A strong occupational health and safety system shall be implemented.

The following measures shall be adopted:

a. Site-specific Occupational Health and Safety Plan shall be implemented.
b. Workers shall receive job-specific training before work assignment.
c. PPE shall be provided according to work area and exposure risk.
d. Safety Data Sheets shall be available for all chemicals.
e. Permit-to-work system shall be used for hot work, confined space, electrical work and work at height.
f. Incinerator, APCD, ETP and residue handling areas shall be operated by trained personnel.
g. Fire detection, firefighting and emergency response equipment shall be maintained.
h. First aid, eyewash and emergency shower facilities shall be available.
i. Periodic medical check-up shall be conducted for exposed workers.
j. Incident, accident and near-miss reporting shall be maintained.
k. Emergency drills shall be conducted periodically.
l. Hygiene facilities, drinking water and sanitation shall be maintained.

Occupational Safety Control Table

Work Area	Main Risk	Required Control
Waste receiving	Exposure, sharp objects	PPE, training, supervision
Incinerator	Heat, fire, emission	SOP, PPE, temperature control
Ash handling	Dust, heavy metals	Respirator, sealed storage, dust control
Chemical storage	Spill, burn, reaction	SDS, labeling, containment
ETP	Chemical exposure	PPE, training, eyewash
Maintenance	Electrical/mechanical injury	Permit-to-work and lockout/tagout

7.4.23 Impact on Public Health and Safety

Public health and safety impacts during operation may arise from waste transportation, odour, air emission, traffic movement, accidental spill, fire, explosion, wastewater release, residue mismanagement, pest attraction and community concern. Nearby residents, road users, local workers, farmers, institutions and other receptors may be affected if operational controls fail.

Potential public health and safety impacts include:

a. odour nuisance from waste storage or handling;
b. concern regarding stack emission and air quality;
c. dust impact from vehicle movement or residue handling;
d. traffic accident risk from waste and material transport vehicles;
e. risk from accidental spill or leakage during waste transportation;
f. fire or emergency incident risk;
g. contamination of water bodies from wastewater or runoff;
h. pest, rodent or vector attraction due to poor housekeeping;

i. public concern regarding handling of hazardous or contaminated waste;
j. psychological discomfort or perception of health risk among nearby communities.

The impact on public health and safety may be **moderate** during normal operation and may become **high** during accidental events if emergency response is weak. Proper boundary control, environmental monitoring, traffic management, emergency planning, stakeholder communication and grievance redress are essential.

Public Health and Safety Impact Table

Source / Activity	Possible Public Impact
Waste transportation	Traffic accident, spill and odour
Waste storage	Odour and pest attraction
Stack emission	Air quality concern
Wastewater discharge	Surface water pollution risk
Residue disposal	Dust and contamination concern
Fire or emergency	Public safety risk
Traffic movement	Road safety concern
Poor communication	Community fear and complaint

7.4.24 Mitigation Measures of Impact on Public Health and Safety

Public health and safety risks may arise from waste transport, odour, dust, traffic, fire, spill, wastewater release, air emission or emergency incidents. These risks shall be managed through boundary control, pollution control, communication and emergency preparedness.

The following measures shall be implemented:

a. The facility shall be secured with boundary wall, gate control and security.
b. Unauthorized public entry shall be prohibited.
c. Waste vehicles shall be covered, leak-proof and route-controlled.
d. Odour, dust, wastewater and residue shall be controlled through operational measures.
e. Emergency contact numbers shall be displayed at the facility entrance.
f. Fire safety and emergency response systems shall be maintained.
g. Community grievance mechanism shall remain active.
h. Local administration, Fire Service and nearby health facilities shall be informed during major emergencies.
i. Regular environmental monitoring results shall be maintained for compliance.
j. Public complaints shall be investigated and corrective action shall be taken.

7.4.25 Social Impact

The operation of the TSDF facility will create both positive and adverse social impacts. Positive impacts may include employment generation, improved waste management services, local business opportunity, skill development and contribution to environmental protection. Adverse impacts may include public concern regarding pollution, traffic, odour, health risk, waste transport, safety and possible disruption to nearby activities.

7.4.25.1 Impact on Demographic Pattern

Operation of the TSDF facility may require skilled and semi-skilled workers, including plant operators, engineers, laboratory personnel, ETP operators, maintenance staff, environmental officers, safety officers, drivers, security staff and administrative personnel. Some skilled workers may come from outside the immediate local area.

Potential impacts on demographic pattern include:

a. minor increase in local worker population;
b. temporary or permanent presence of skilled workers from outside;
c. increased demand for housing, food, transport and local services;
d. limited change in local occupational structure;
e. increased interaction between local community and project workforce;
f. possible social concern if outside labour is preferred over local labour.

The impact on demographic pattern is expected to be **low to moderate** because the facility workforce size is likely to be limited compared to the local population. The impact can be positive if local employment is prioritized.

7.4.25.2 Impact on Economic Enhancement

The TSDF facility may support local and national economic enhancement by creating employment, improving industrial waste management services, supporting regulatory compliance, reducing environmental liability and creating demand for local goods and services.

Potential positive economic impacts include:

a. income generation for workers and service providers;
b. business opportunity for local suppliers and transporters;
c. improved waste management support for industries and institutions;
d. contribution to environmental compliance of waste generators;
e. reduction of costs associated with unmanaged waste, illegal dumping and environmental damage;
f. development of technical service market related to waste treatment and environmental monitoring;
g. increased local economic activity due to facility operation;
h. improved investment confidence in environmental infrastructure.

The impact on economic enhancement is considered **positive and moderate to high**, particularly if the facility operates sustainably and maintains compliance.

7.4.25.3 Improved Waste Management Services

The proposed TSDF facility is expected to provide an important positive impact by improving organized waste management services. It will create a controlled platform for receiving, testing, treating, incinerating and managing waste that may otherwise remain

unmanaged, illegally dumped, openly burned or stored without proper environmental safeguards.

Potential positive impacts include:

a. improved treatment and disposal option for contaminated and non-recyclable waste;
b. reduction of uncontrolled dumping and open burning;
c. improved traceability through waste manifest and documentation;
d. support to industries, institutions, healthcare-related sources and customs/confiscated waste management;
e. reduction of environmental and public health risks from unmanaged waste;
f. improvement in compliance with environmental requirements;
g. creation of technical capacity for hazardous and special waste management;
h. contribution to cleaner and safer waste management practices in Bangladesh.

This is considered a **major positive impact** of the project. However, the benefit depends on proper operation, regulatory compliance, monitoring and transparent waste acceptance procedures.

7.4.25.4 Disruption and Loss of Livelihood

Operation of the facility may cause disruption or livelihood-related concerns if traffic movement, odour, dust, public perception or access restriction affects nearby land users, small businesses, farmers or transport users. In general, major livelihood loss is not expected if the facility operates within its boundary and DoEs not restrict access to surrounding areas.

Potential impacts may include:

a. temporary disturbance to nearby businesses or road users due to waste transport vehicles;
b. concern among farmers regarding impact on crop quality or land value;
c. reduced comfort of nearby residents due to odour or traffic, if uncontrolled;
d. concern among informal waste handlers or recyclers if waste flow is reorganized;
e. access disturbance during emergency events or traffic congestion;
f. possible reputational concern for nearby land use due to association with waste facility.

The impact on livelihood is expected to be **low to moderate** under normal operation. It may become significant if complaints are not addressed or if operational impacts affect nearby economic activities.

Livelihood Impact Table

Possible Livelihood Issue	Potential Cause
Access disturbance	Waste vehicle movement
Concern of farmers	Dust, runoff or public perception
Small business disturbance	Traffic, odour or public concern
Informal waste sector impact	Shift to controlled waste handling
Local land use concern	Perception of pollution risk
Community complaint	Poor communication or weak GRM

7.4.26 Mitigation Measures of Social Impact

7.4.26.1 Mitigation Measures of Creation of Direct, Indirect and Induced Employment

Employment generation is a positive social impact of the project. The facility will create direct employment in plant operation, waste handling, laboratory, ETP, maintenance, administration, security, housekeeping and HSE activities. Indirect employment may be created in transport, supply chain, maintenance, PPE supply, recycling and service sectors.

The following enhancement measures shall be implemented:

a. Local people shall be prioritized for suitable jobs.
b. Recruitment shall be transparent and non-discriminatory.
c. Workers shall receive training before assignment.
d. Fair wage and safe working conditions shall be ensured.
e. Contractors shall follow labour and safety requirements.
f. Women may be considered for suitable administrative, laboratory, monitoring and support roles.
g. Worker grievance mechanism shall be maintained.
h. Skill development training shall be provided to improve long-term employability.

7.4.26.2 Mitigation Measures of Economic Growth

The project may contribute to local and national economic growth by creating employment, improving waste management infrastructure, reducing unmanaged waste risks, supporting industries, generating service demand and promoting environmental compliance.

The following enhancement measures shall be adopted:

a. Local suppliers and service providers shall be considered where technically feasible.
b. Local transport and maintenance service providers may be engaged subject to compliance.
c. Timely payment shall be ensured to workers and service providers.
d. Local businesses shall be encouraged to participate in non-critical supply chains.
e. Training and capacity building shall be provided for local workers.
f. Environmental compliance shall be maintained to ensure sustainable economic benefit.
g. The project shall support safe waste management services for industries and institutions.

7.4.27 Impact due to Transportation of Waste and Materials

During operation, transportation activities will include incoming waste vehicles, outgoing residue vehicles, chemical supply vehicles, fuel supply vehicles, maintenance material transport, recyclable material transport, staff vehicles and emergency vehicles. Transportation may create environmental, safety and social impacts along access roads and near the project site.

Potential impacts include:

a. increased traffic movement near the project site;
b. dust generation from vehicle movement;
c. exhaust emissions from transport vehicles;
d. odour nuisance from waste-carrying vehicles if not properly covered;

e. leakage or spillage of waste, residue, fuel or chemicals during transport;
f. road accident risk involving waste transport vehicles;
g. road damage due to heavy vehicle movement;
h. noise from trucks, horns and loading/unloading activities;
i. community concern regarding movement of hazardous or contaminated waste;
j. emergency risk during transport accident or spill.

The impact due to transportation of waste and materials is expected to be **moderate** during normal operation. The impact may become **high** in case of road accident, hazardous waste spill, fuel leakage or uncontrolled transport practice.

Transportation Impact Table

Transport Activity	Possible Impact
Incoming waste transport	Odour, spill, traffic and public concern
Residue transport	Dust, leakage and contamination risk
Chemical transport	Spill, fire and safety risk
Fuel transport	Fire, leakage and accident risk
Recyclable material transport	Traffic and dust
Staff and service vehicles	Local traffic increase
Emergency vehicles	Temporary traffic control requirement

7.4.28 Mitigation Measures of Impact due to Transportation of Waste and Materials

Waste and material transportation may create risks related to traffic accident, spill, leakage, odour, dust, road damage and public concern. Therefore, a dedicated transportation safety system shall be maintained.

The following measures shall be implemented:

a. Waste transport vehicles shall be covered, leak-proof and suitable for the type of waste.
b. Each waste consignment shall have proper manifest and documentation.
c. Vehicles carrying hazardous or contaminated waste shall have emergency contact information.
d. Drivers and helpers shall be trained in waste transport safety and spill response.
e. Transportation routes shall be planned to avoid sensitive receptors where feasible.
f. Vehicles shall be inspected before dispatch and after arrival.
g. Waste shall be properly packed, sealed and labeled.
h. Incompatible waste shall not be transported together.
i. Spill kits, PPE and emergency instructions shall be available in vehicles where required.
j. Vehicle speed shall be controlled.
k. Accident or spill during transportation shall be reported immediately.
l. Transport records shall be maintained including waste type, quantity, source, destination and date.

Waste Transportation Mitigation Table

Transport Risk	Mitigation Measure
Waste leakage	Leak-proof container and covered vehicle
Odour	Sealed packaging and timely delivery
Accident	Trained driver, speed control and route planning
Spill	Spill kit, PPE and emergency procedure
Public concern	Proper documentation and safe transport practice
Traffic congestion	Scheduled transport and approved route
Incompatible waste	Segregated transport and manifest control

7.5 Evaluation of Impact Significance



The proposed facility is intended for the safe, scientific and environmentally compliant management of hazardous, industrial, airport, port, customs-confiscated, biomedical, chemical, laboratory, commercial and other regulated waste streams.

The impact evaluation considers the full project lifecycle, including:

- Pre-construction stage;
- Construction stage;
- Operation stage;
- Emergency and accidental scenarios;
- Decommissioning or closure stage, where applicable.

The evaluation has been prepared considering the proposed project components such as *waste receiving, transportation, segregation, storage, laboratory testing, incineration, air pollution control, continuous emission monitoring, residue and ash handling, wastewater treatment, leachate management, secured disposal and emergency response systems*. The project data sheet identifies the TSDF as an integrated facility with *waste collection, transportation, secure storage, laboratory testing, segregation, treatment, recycling, secured landfill and biomedical waste treatment* components.

7.5.1 Positive Impacts of the Project

The proposed TSDF project is expected to generate several positive environmental, social, economic and institutional impacts.

a) Improvement of Hazardous Waste Management System
b) National Environmental Benefit

c) Support to Regulatory Compliance
d) Reduction of Environmental Pollution
e) Employment and Skill Development
f) Institutional Knowledge Development

7.5.2 Negative Impacts During Pre-Construction Stage

During land preparation, earth filling, grading and site development, there may be temporary impacts on soil, drainage, vegetation and local access.

Potential impacts include	• Soil disturbance; • Dust generation; • Temporary change in surface runoff; • Noise from machinery; • Temporary disturbance to nearby communities; • Risk of improper disposal of construction debris.
Significance	Moderate
Duration	Short-term
Mitigation	Proper site drainage, dust suppression, controlled earthwork, designated spoil disposal, boundary fencing and good construction practices.

7.5.3 Impact on Local Drainage

Earth filling and site preparation may alter existing drainage patterns if proper stormwater management is not designed.

Significance	Moderate
Mitigation	Peripheral drains, stormwater channels, silt traps, proper site grading and avoidance of blockage of natural drainage paths.

7.5.4 Vegetation and Land Use Impact

Vegetation exists within the project boundary, site preparation may result in localized removal of trees or shrubs.

Significance	Low to Moderate
Mitigation	Greenbelt development, plantation around boundary, preservation of existing trees where possible.

7.5.5 Potential Impacts During Construction Stage

Particulars	Significance	Mitigation Measures
Air Quality Impact	Moderate	• Regular water spraying; • Covered transportation of soil and sand; • Speed control inside project area; • Proper maintenance of vehicles and machinery; • Use of dust masks by workers; • Avoiding unnecessary idling of vehicles
Noise and Vibration Impact	Moderate	• Use of low-noise equipment; • Restriction of high-noise work to daytime; • Provision of ear protection for workers; • Regular equipment maintenance; • Temporary noise barriers where necessary.
Soil Contamination Impact	Moderate	• Designated chemical and fuel storage area; • Impervious flooring; • Spill kits at site; • Immediate cleanup of spills; • Proper collection and disposal of construction waste.
Water Quality Impact	Moderate or high	• Silt traps and sedimentation pits; • Proper drainage system; • No direct discharge of wastewater; • Controlled vehicle washing; • Separate storage of hazardous materials.

Occupational Health and Safety Impact	Moderate to High	• Site-specific Health, Safety and Environment Plan; • Mandatory PPE; • Safety training; • Fire extinguishers; • First-aid facility; • Work permit system for welding, cutting and electrical work; • Emergency response plan.
Traffic and Road Safety Impact	Moderate	• Traffic management plan; • Scheduled delivery time; • Trained drivers; • Speed limits; • Flagmen at entry/exit points; • Covered trucks.

7.5.6 Potential Impacts During Operation Stage

Particulars	Potential impacts	Significance	Mitigation Measures
Impact from Waste Transportation	• Leakage of hazardous liquid; • Spillage of contaminated materials; • Odor nuisance; • Traffic safety risk; • Community concern.	Moderate to High	• Use of covered and dedicated waste transport vehicles; • Manifest and tracking system; • Emergency spill kits in vehicles; • Trained drivers and handlers; • Route planning; • Vehicle decontamination; • Compliance with waste transportation protocol.

Impact from Waste Receiving and Storage	Improper receiving and storage of hazardous waste may cause odor, fire risk, leakage, chemical reaction, pest attraction, worker exposure and soil/water contamination.	High before mitigation; Moderate after mitigation.	• Dedicated waste receiving bay; • Weighing, inspection and documentation; • Waste compatibility assessment; • Separate storage for incompatible waste; • Impervious floor with containment; • Secondary containment for drums and liquids; • Ventilation and odor control; • Fire detection and suppression system; • Restricted access; • Maximum storage time control.
Impact from Waste Segregation and Pre-Treatment	Waste segregation may expose workers to sharp objects, chemicals, infectious materials, fumes, dust and unknown hazardous substances.	High	• Waste characterization before handling; • Mechanized handling where possible; • PPE including gloves, mask, face shield, apron and safety shoes; • Segregation table with ventilation; • Training on hazardous waste identification; • Emergency eyewash and shower; • Prohibition of manual handling of unknown high-risk materials.
Air Emission Impact from Incineration	• Particulate matter; • Acid gases; • Carbon monoxide; • Nitrogen oxides; • Sulfur oxides; • Volatile organic compounds; • Heavy metals;	High before mitigation; Moderate to Low after proper control.	• Dual-chamber incinerator; • Controlled waste feeding; • Proper temperature control; • Adequate secondary chamber retention time; • Avoidance of incompatible or unsuitable waste; • Quenching system; • Scrubber system; • Bag filter or equivalent particulate control;

	• Dioxins and furans, depending on waste composition and combustion control.		• Activated carbon dosing, where required; • Stack height as per regulatory requirement; • Continuous Emission Monitoring System; • Regular stack emission testing; • Preventive maintenance of APCD.
Odor Impact	Odor may arise from waste receiving, storage, biomedical waste, organic waste, contaminated packaging, expired products, wastewater and sludge.	Moderate	• Covered storage; • Negative pressure in critical areas; • Proper ventilation; • Timely treatment of odor-generating waste; • Disinfection where required; • Odor control system; • Good housekeeping; • No long-term open storage.
Wastewater Impact	Wastewater may be generated from scrubber blowdown, floor washing, vehicle washing, laboratory activities, leachate, domestic use and contaminated stormwater.	High before treatment; Low to Moderate after treatment.	• Separate drainage for contaminated and non-contaminated water; • Effluent Treatment Plant; • pH adjustment; • Chemical treatment; • Oil and grease trap; • Sludge dewatering; • Treated water monitoring; • No untreated discharge; • Reuse of treated water where possible; • Regular testing of ETP outlet.
Leachate Impact	Leachate from waste storage, residue storage or secured landfill may	High	• Impervious flooring; • HDPE lining in secured landfill;

	contaminate soil and groundwater if not properly collected and treated.		• Leachate collection network; • Leachate storage tank; • Leachate treatment through ETP; • Groundwater monitoring wells; • Regular inspection of liner and drainage system; • Prevention of rainwater entry into hazardous waste storage area.
Ash and Residue Impact	Incineration will generate bottom ash, fly ash and air pollution control residues. These residues may contain hazardous constituents depending on the waste composition.	High	• Separate collection of bottom ash and fly ash; • Covered ash storage; • Laboratory testing of ash; • Stabilization/solidification if required; • Disposal in secured landfill; • Dust control during handling; • PPE for workers; • Record keeping of ash generation and disposal.
Soil and Groundwater Impact	Potential soil and groundwater contamination may occur due to leakage from waste storage, chemical storage, wastewater channels, ETP, leachate system or ash storage.	High before mitigation; Low to Moderate after mitigation.	• Impervious flooring; • Secondary containment; • Leak detection; • Proper drainage; • Secured landfill lining; • Groundwater monitoring; • Emergency spill response; • Routine inspection and maintenance.
Noise Impact	Noise may be generated from incinerator operation, ID fan,	Moderate	• Acoustic enclosure for DG set; • Silencer for blowers and fans;

	blowers, pumps, shredders, compressors, DG set, vehicles and material handling equipment.		• Equipment foundation and vibration control; • PPE for workers; • Greenbelt around boundary; • Regular noise monitoring.
Occupational Health and Safety Impact	Workers may be exposed to hazardous waste, chemicals, fumes, heat, noise, fire risk, sharp materials, biological hazards and confined-space risks.	High	• Occupational Health and Safety Plan; • PPE matrix by work activity; • Hazard communication and labeling; • Safety Data Sheet availability; • Worker medical check-up; • Training and competency certification; • Work permit system; • Confined space procedure; • Heat stress management; • Fire safety training; • Emergency drills; • Incident reporting system.
Fire and Explosion Risk	Hazardous waste, chemicals, aerosols, solvents, batteries, contaminated packaging and flammable materials may create fire or explosion risks.	High	• Waste compatibility screening; • Segregated storage of flammable and reactive waste; • Fire detection system; • Fire hydrant and extinguisher network; • Foam/dry chemical extinguishers; • Explosion-proof electrical fittings in high-risk areas; • No-smoking policy; • Hot work permit; • Emergency response team;

			• Coordination with local fire service.
Community Health and Safety Impact	Nearby communities may be concerned about emissions, odor, traffic, fire risk, waste transport and accidental releases.	Moderate	• Boundary wall and controlled access; • Greenbelt; • Community awareness; • Grievance redress mechanism; • Emergency communication plan; • Safe transportation routes; • Regular environmental monitoring disclosure; • Compliance reporting to regulatory authority
Impact on Public Infrastructure and Traffic	Waste vehicles and operational traffic may affect local roads.	Low to Moderate	• Defined vehicle routes; • Transport scheduling; • Vehicle fitness; • Driver training; • Speed control; • Avoidance of school/community peak hours where possible.
Impact from Laboratory Activities	Laboratory testing may generate chemical waste, used reagents, contaminated glassware, wastewater and sample residues.	Moderate	• Laboratory waste management procedure; • Chemical storage cabinet; • Fume hood; • Labeling and inventory control; • Neutralization and safe disposal; • PPE; • Emergency shower and eyewash; • Proper sample chain-of-custody.

Impact from Power Failure or Equipment Failure	Failure of incinerator, APCD, CEMS, ETP, scrubber or ID fan may lead to uncontrolled emissions, wastewater issues or operational safety risks.	High	• Automatic shutdown interlock; • Standby power; • Preventive maintenance; • Critical spare parts; • Operator training; • Alarm system; • Emergency bypass prohibition unless approved for safety; • Immediate reporting and corrective action.

7.6 Cumulative Impacts

Cumulative impacts if nearby industrial activities, traffic, waste storage or emissions are not properly managed. However, the project is also expected to generate positive cumulative benefits by reducing uncontrolled disposal of hazardous and regulated waste in Bangladesh.

Potential cumulative concerns:	• Increased local traffic; • Combined air emission load; • Pressure on local drainage; • Community concern regarding hazardous waste transport; • Industrial activity concentration.
Mitigation Measures	• Integrated monitoring; • Coordination with local authorities; • Traffic management; • Greenbelt development; • Emission monitoring; • Periodic environmental audit.

7.7 Risk-Based Evaluation of Residual Impacts

Project Activity	Potential Impact	Receptor	Significance Before Mitigation	Mitigation	Residual Significance
Land development	Dust, noise, runoff	Air, community, soil	Moderate	Water spraying, drainage, controlled earthwork	Low
Construction work	Noise, waste, accident	Workers, community	Moderate	PPE, safety plan, waste management	Low
Waste transportation	Spill, leakage, accident	Road users, soil, water	High	Covered vehicles, manifest, spill kit, trained drivers	Moderate
Waste receiving	Odor, exposure, leakage	Workers, air, soil	High	Covered bay, inspection, containment	Moderate
Waste storage	Fire, leakage, reaction	Workers, soil, water	High	Segregated storage, compatibility control, fire system	Moderate
Segregation	Worker exposure	Workers	High	PPE, training, mechanical handling	Moderate
Incineration	Air emission	Air, community	High	Dual chamber, APCD, CEMS, stack monitoring	Low to Moderate
Scrubber/ETP	Wastewater pollution	Water, soil	High	ETP, monitoring, no untreated discharge	Low
Ash handling	Hazardous residue exposure	Workers, soil	High	Testing, stabilization, secured landfill	Moderate
Leachate	Soil/groundwater contamination	Soil, groundwater	High	Liner, collection, treatment, monitoring	Low to Moderate
Laboratory testing	Chemical exposure	Workers, water	Moderate	Fume hood, PPE, chemical waste management	Low
Emergency event	Fire/spill/explosion	Workers, community	High	Emergency plan, fire system, drills	Moderate
Greenbelt	Visual and air quality improvement	Community, environment	Positive	Plantation and maintenance	Positive
Employment	Job creation	Local economy	Positive	Local recruitment and training	Positive

7.8 Summary of Major Impacts

Major Positive Impacts	• Establishment of a scientific hazardous waste treatment and disposal system; • Reduction of unsafe dumping and uncontrolled burning; • Support to customs, airport, port and industrial waste disposal; • Employment generation; • Development of national technical capacity; • Support to environmental compliance; • Improvement of public health and environmental protection.
Major Negative Impacts Requiring Strict Control	• Air emissions from incineration; • Hazardous waste storage and handling risk; • Fire and explosion risk; • Wastewater and leachate generation; • Ash and residue disposal; • Worker exposure to hazardous materials; • Community concern and traffic safety.

CHAPTER 8

Stakeholder Engagement

This chapter identifies and maps project stakeholders, describes the information disclosure and consultation carried out for the ESIA, including the focus group discussion and the public consultation meeting held on 1 September 2026, and sets out the Stakeholder Engagement Plan and the Grievance Redress Mechanism for the project life cycle.

8 STAKEHOLDER ENGAGEMENT

Stakeholder engagement is an essential component of the Environmental and Social Impact Assessment process for the proposed Incineration-Enabled Treatment, Storage and Disposal Facility of Sheam TSDF BD Ltd. at Telihati, Sreepur, Gazipur. The project involves handling, storage, segregation, treatment, incineration, residue management and disposal of hazardous, special, contaminated, expired, confiscated, commercial, institutional and selected industrial waste streams. Therefore, effective consultation with relevant stakeholders is necessary to ensure transparency, social acceptability, regulatory compliance and responsible project implementation.

The purpose of stakeholder engagement is to identify the concerns, expectations, suggestions and potential risks perceived by affected and interested parties. Since TSDF and incineration projects may create public concerns regarding air emissions, odour, traffic movement, hazardous waste transportation, fire risk, public health and environmental safety, early and meaningful consultation is important to build confidence and reduce misunderstanding.

The stakeholder engagement process for this project shall include identification of relevant stakeholders, disclosure of project information, consultation with local communities and authorities, documentation of concerns, integration of feedback into the project planning process and establishment of a Grievance Redress Mechanism. The engagement process shall continue throughout the project lifecycle, including planning, construction, commissioning, operation and emergency response stages.

The consultation process shall be conducted in a language and format understandable to the stakeholders. Information shall be shared regarding the nature of the project, waste management process, environmental control measures, air pollution control system, wastewater treatment, emergency preparedness, traffic management, community safety measures, employment opportunities and complaint handling procedure.

The stakeholder engagement process will help Sheam TSDF BD Ltd. to:

a. understand local concerns and expectations;
b. improve project planning and design;
c. enhance public awareness about scientific waste management;
d. strengthen coordination with regulatory and emergency response agencies;
e. reduce social risk and misinformation;
f. ensure that mitigation measures reflect local realities;
g. promote transparent and responsible implementation of the project.

8.1 Scope and Specific Objectives

The scope of stakeholder analysis and engagement covers all individuals, groups, institutions, government agencies, local communities, service providers, waste generators, transporters, emergency responders and other interested parties who may be directly or indirectly affected by the proposed TSDF project or may have an interest in the project.

The stakeholder engagement process shall cover both the project site and the surrounding influence area. It shall include the local community near the project site, nearby industries, local

administration, regulatory authorities, waste source organizations, transport operators, workers, contractors, emergency service providers and other relevant institutions.

Scope of Stakeholder Engagement

a. identification of all relevant stakeholders;
b. classification of stakeholders based on influence, interest and level of impact;
c. disclosure of project-related environmental and social information;
d. consultation with affected and interested stakeholders;
e. recording of opinions, concerns, objections and recommendations;
f. assessment of stakeholder expectations regarding environmental protection and public safety;
g. incorporation of stakeholder feedback into mitigation measures and management plans;
h. development of a Grievance Redress Mechanism;
i. establishment of communication procedures during construction and operation;
j. continuous engagement during project implementation.

Specific Objectives

Objective	Description
Identify stakeholders	Identify individuals, groups, authorities and institutions that may be affected by or interested in the project
Understand concerns	Collect stakeholder views regarding odour, air emission, traffic, public health, waste transportation, emergency risk and environmental safety
Share project information	Provide clear information about the project purpose, process, pollution control systems and mitigation measures
Improve project design	Use stakeholder feedback to strengthen environmental and social management measures
Build public confidence	Promote transparency and awareness regarding scientific waste treatment and disposal
Ensure regulatory coordination	Maintain communication with DoE, local administration, Fire Service and relevant authorities
Reduce social risk	Prevent misunderstanding, misinformation and conflict through early engagement
Promote community safety	Inform communities about safety measures, emergency response and grievance channels
Develop GRM	Establish a formal system for receiving, recording and resolving complaints
Support long-term engagement	Maintain communication throughout construction and operation phases

8.2 Stakeholder Identification Approach

Stakeholders have been identified based on their relationship with the proposed project, their possible exposure to project impacts, their role in project approval and implementation, and their interest in environmental and social performance. The stakeholders may include directly affected people,

indirectly affected people, regulatory agencies, local institutions, emergency service providers, waste generators, transport contractors, employees, nearby industries and other concerned groups.

For the proposed TSDF project, stakeholder identification is particularly important because the project will handle sensitive waste streams and may create concerns related to hazardous waste, incineration, air emissions, traffic and emergency risks.

8.3 Identification of Stakeholders

Stakeholder Group	Examples / Members	Interest or Concern
Regulatory Authority	Department of Environment	Environmental clearance, compliance, monitoring and reporting
Local Administration	local government representatives	Land use, public safety, local coordination and law and order
Local Community	Nearby residents, landowners, shopkeepers, local workers	Odour, traffic, health and safety, employment, emergency risk
Nearby Industries	Industrial units, factories, warehouses in Gazipur/Sreepur area	Waste disposal opportunity, traffic, environmental compliance
Waste Generators	Industries, ports, airports, customs warehouses, healthcare-related sources, commercial facilities	Safe waste treatment, documentation, compliance and service reliability
Emergency Service Providers	Fire Service and Civil Defence, hospitals, ambulance service, police	Emergency preparedness, firefighting, medical response and accident control
Waste Transporters	Drivers, helpers, logistics contractors, vehicle owners	Route safety, spill response, waste handling and documentation
Project Employees	Plant workers, operators, engineers, supervisors, laboratory staff	Occupational health and safety, PPE, training and working conditions
Contractors and Suppliers	Construction contractors, equipment suppliers, chemical suppliers, maintenance contractors	Construction safety, environmental compliance and work permits
Local Institutions	Schools, mosques, markets, clinics and community facilities near the project area	Public safety, traffic, noise and emergency awareness
Vulnerable Groups	Elderly people, women, children, low-income households and persons with disabilities near the influence area	Health, safety, access, awareness and emergency communication
Media / Civil Society	Local media, environmental groups, community organizations	Transparency, environmental performance and public information

Directly Affected Stakeholders

Directly affected stakeholders are those who may experience direct project-related impacts during construction or operation. These may include nearby households, land users, local workers, adjacent industries, road users, waste transport workers and people living near access roads.

Potential concerns of directly affected stakeholders may include:

a. odour from waste receiving and storage;
b. dust and noise during construction;
c. traffic movement of waste vehicles;
d. risk of waste spillage during transportation;
e. air emissions from incineration;
f. fire or emergency incident;
g. employment opportunity for local people;
h. impact on local drainage and road condition.

8.4 Stakeholder Mapping

Stakeholder mapping has been carried out to understand the relative level of interest, influence and potential impact associated with each stakeholder group. This mapping helps determine the appropriate level of engagement required for each group.

Stakeholders may be categorized based on two key dimensions:

a. Level of Influence: the ability of the stakeholder to affect project approval, implementation or operation.

b. Level of Interest / Impact: the extent to which the stakeholder is affected by or interested in the project.

Stakeholder Mapping Matrix

Stakeholder Category	Level of Influence	Level of Interest / Impact	Engagement Strategy
Department of Environment	High	High	Close coordination, formal submission, compliance reporting
Local Administration	High	High	Regular consultation and emergency coordination
Local Community	Medium	High	Public consultation, disclosure, grievance mechanism
Nearby Industries	Medium	Medium to High	Consultation, waste service coordination, environmental awareness
Fire Service and Civil Defence	High	Medium	Emergency planning, site familiarization, drill coordination
Hospitals / Ambulance Services	Medium	Medium	Medical emergency coordination

Police / Traffic Authority	Medium	Medium	Road safety and emergency traffic control coordination
Waste Generators	Medium to High	High	Service agreement, waste acceptance criteria, manifest system
Waste Transport Contractors	Medium	High	Training, route control, emergency response instruction
Project Employees and Workers	Medium	High	Training, PPE, toolbox meeting, safety communication
Contractors and Suppliers	Medium	Medium	Contractual ESMP compliance and work permit system
Vulnerable Groups	Low	High	Targeted communication and emergency awareness
Local Institutions	Low to Medium	Medium	Information disclosure and emergency awareness
Media / Civil Society	Medium	Medium	Transparent information sharing, where required

Key Issues to be Discussed During Stakeholder Consultation

The following issues shall be discussed with stakeholders during consultation:

Issue	Stakeholder Concern
Air emission	Control of smoke, gas, particulate matter, dioxins/furans and stack monitoring
Odour	Waste storage, receiving and transportation-related odour
Traffic	Increase in waste vehicles and road safety
Waste transport	Covered vehicles, spill prevention and emergency response
Public health	Protection from hazardous exposure and environmental pollution
Fire safety	Fire detection, firefighting and emergency response readiness
Water pollution	ETP, leachate control, surface water and groundwater protection
Employment	Local job opportunities and skill development
Emergency response	Alarm system, evacuation, Fire Service coordination and public safety
Complaint handling	Grievance receiving, response time and responsible person

8.5 Information Disclosure, Consultation and Participation

8.5.1 Focus Group Discussion

A Focus Group Discussion (FGD) was conducted as part of the stakeholder consultation process to obtain the views, concerns, expectations, and recommendations of people living and working in and around the proposed project area. The FGD provided an opportunity for local stakeholders to discuss the proposed project openly and to share their perceptions regarding its potential environmental, social, economic, health, and safety implications.

The discussion focused on providing participants with clear information about the Sheam TSDF project, its major activities, anticipated benefits, and potential adverse impacts. Participants were encouraged to express their concerns and provide suggestions regarding appropriate mitigation and management measures.

The key objectives of the FGD were to:

- Inform local stakeholders about the proposed project and its major components;
- Understand the existing socio-economic and environmental conditions from the community's perspective;
- Identify potential environmental and social concerns associated with project implementation and operation;
- Assess community perceptions regarding potential health, safety, traffic, waste management, air quality, noise, and other impacts;
- Identify potential benefits, including local employment and economic opportunities;
- Obtain recommendations from community members regarding environmental protection and community safety;

8.5.2 Public Consultation Meeting/Stakeholder Consultation Meeting

A Public Consultation Meeting/Stakeholder Consultation Meeting was conducted as an integral part of the Environmental and Social Impact Assessment (ESIA) process to ensure meaningful engagement with relevant stakeholders and communities potentially affected by the sheam TSDF project. The meeting provided a platform for stakeholders to receive information about the project, understand its potential environmental and social implications, and provide their views, concerns, expectations, and recommendations.

The meeting brought together relevant stakeholders, including local community representatives, nearby residents, local government representatives, community leaders, land users, and other interested parties.

Public consultation meeting	Date and time
Telihati, Sreepur, Gazipur	Date: 01-09-2026 , Tuesday 11.00 AM

The participants were briefed on the project objectives, major components, proposed activities, expected benefits, and potential environmental and social risks associated with the construction and operation of the facility.

8.5.3 Overview of the Meeting

The key objectives of the consultation meeting were to:

- Disclose relevant information about the TSDF project to stakeholders in a transparent manner;
- Obtain stakeholder views regarding the TSDF project and its potential impacts;
- Identify environmental, social, health, and safety concerns from the perspective of local communities;

- Understand community expectations regarding employment, local economic opportunities, and other potential project benefits;
- Discuss potential impacts related to air quality, odor, noise, traffic movement, waste transportation and handling, occupational health and safety, and community health and safety;
- Identify appropriate mitigation measures and management practices based on stakeholder recommendations;
- Provide stakeholders with an opportunity to ask questions and seek clarification regarding the project; and
- Establish a framework for continued stakeholder engagement and communication throughout the project life cycle.

8.5.4 Opening of the Meeting

Public Consultation Meeting

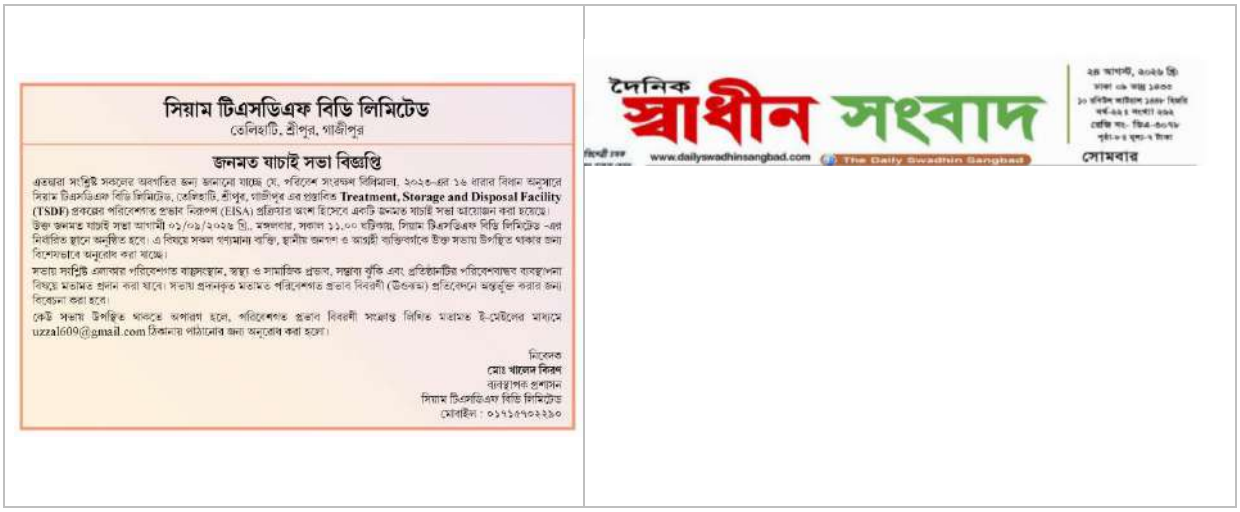
A public consultation meeting for the SHEAM TSDF Project was successfully conducted on 1 September 2026 at Telihati, Sreepur, Gazipur. The consultation was organized by the Project Management Department of the SHEAM TSDF Project as part of its commitment to stakeholder engagement and transparent communication throughout the project development process.

Prior to the meeting, extensive awareness and notification activities were undertaken to ensure broad participation from affected and interested stakeholders. Announcements regarding the consultation meeting were published in both national and local newspapers. In addition, project representatives conducted direct outreach through one-to-one communications with key stakeholders and community members to encourage their participation and gather their views on the TSDF project.

The consultation meeting was attended by a diverse group of stakeholders, including local residents from the surrounding communities, landowners, social influencers, educational professionals, community leaders, and elected representatives such as Union Parishad (UP) members. Representatives from various social and economic groups were present to express their opinions, concerns, expectations, and recommendations regarding the project.

Public consultation newspaper notice photos





সিয়াম টিএসডিএফ বিডি লিমিটেড
তেলিহাটি, শ্রীপুর, গাজীপুর

জনমত যাচাই সভা বিজ্ঞপ্তি

এতদ্বারা সংশ্লিষ্ট সকলের অবগতির জন্য জানানো যাচ্ছে যে, পরিবেশ সংরক্ষণ বিধিমালা, ২০২৩-এর ১৬ ধারার বিধান অনুসারে সিয়াম টিএসডিএফ বিডি লিমিটেড, তেলিহাটি, শ্রীপুর, গাজীপুর এর প্রস্তাবিত **Treatment, Storage and Disposal Facility (TSDF)** প্রকল্পের পরিবেশগত প্রভাব নিরূপণ (EISA) প্রক্রিয়ার অংশ হিসেবে একটি জনমত যাচাই সভা আয়োজন করা হয়েছে।

উক্ত জনমত যাচাই সভা আগামী ০২/০৯/২০২৫ খ্রি., মঙ্গলবার, সকাল ১১.০০ ঘটিকায়, সিয়াম টিএসডিএফ বিডি লিমিটেড -এর নির্ধারিত স্থানে অনুষ্ঠিত হবে। এ বিষয়ে সকল গণ্যমান্য ব্যক্তি, স্থানীয় জনগণ ও আগ্রহী ব্যক্তিবর্গকে উক্ত সভায় উপস্থিত থাকার জন্য বিশেষভাবে অনুরোধ করা যাচ্ছে।

সভায় সংশ্লিষ্ট এলাকার পরিবেশগত বাড়লসংস্থান, স্বাস্থ্য ও সামাজিক প্রভাব, সম্ভাব্য ঝুঁকি এবং প্রতিষ্ঠানটির পরিবেশব্যবস্থাপনা বিষয়ে মতামত প্রদান করা যাবে। সভায় প্রদানকৃত মতামত পরিবেশগত প্রভাব বিবরণী (উওঅ) প্রতিবেদনে অন্তর্ভুক্ত করার জন্য বিবেচনা করা হবে।

কেউ সভায় উপস্থিত থাকতে অপারগ হলে, পরিবেশগত প্রভাব বিবরণী সংক্রান্ত লিখিত মতামত ই-মেইলের মাধ্যমে uzzal609@gmail.com ঠিকানায় পাঠানোর জন্য অনুরোধ করা হলো।

নিবেদক
মোঃ খালেদ বিন্নাশ
ব্যবস্থাপক প্রশাসন
সিয়াম টিএসডিএফ বিডি লিমিটেড
মোবাইল : ০১৭১৫৭০২২৯০

দৈনিক স্বাধীন সংবাদ
www.dailyswadhinsangbad.com
The Daily Swadhin Sangbad
সোমবার

During the meeting, project officials presented an overview of the TSDF facility, including its objectives, expected environmental and socio-economic benefits, waste management processes, pollution control measures, occupational health and safety provisions, and compliance with applicable environmental regulations. Participants were encouraged to openly discuss potential environmental and social impacts, seek clarifications, and provide feedback on issues relevant to the local community.

The consultation process provided an important platform for constructive dialogue between the project proponents and stakeholders. The comments, concerns, and recommendations received during the meeting were duly recorded and will be considered in the project planning and environmental management process. The active participation of local stakeholders demonstrated significant community interest in the project and contributed to ensuring that local perspectives are incorporated into project decision-making and mitigation planning.

During the meeting, participants were encouraged to express their opinions freely and raise any concerns regarding the proposed development. Particular attention was given to issues that may directly affect the surrounding communities, including environmental pollution, waste transportation, odor control, traffic congestion, occupational and community safety, emergency preparedness, and potential impacts on local livelihoods and natural resources.

8.5.5 Presentation

As part of the stakeholder consultation and public participation process, a presentation on the proposed project was delivered to the participants to provide a clear and comprehensive understanding of the project and its potential environmental and social implications.

The presentation covered the key aspects of the proposed project, including the project background and objectives, site location, major project components, proposed activities, process and operational arrangements, and anticipated environmental and social impacts. Particular emphasis was placed on potential impacts related to air quality, odor, noise, waste transportation

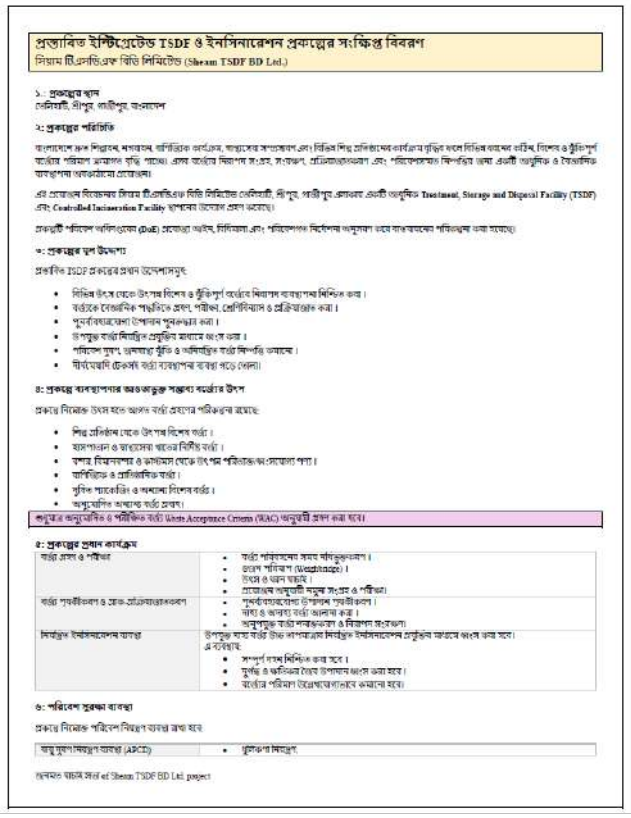
and handling, traffic, occupational health and safety, community health and safety, emergency preparedness, and environmental protection.

The presentation also highlighted the measures proposed to prevent, minimize, or control potential adverse impacts. Participants were informed about the proposed environmental management and monitoring measures, occupational and community health and safety provisions, emergency response arrangements, and the mechanisms for receiving and addressing stakeholder concerns and grievances.

The presentation was followed by an interactive question-and-answer session, during which participants were encouraged to seek clarification, express their concerns, and provide recommendations. The issues and suggestions raised by the participants were documented and considered in the preparation of the ESIA and Environmental and Social Management Plan (ESMP).




COMBINATION OF ENGINEERED SYSTEMS
TECHNICAL CAPABILITY
ENVIRONMENTAL MANAGEMENT
SAFETY IS ONE OF THE CORE PILLARS
HEALTH, SAFETY AND EMERGENCY PREPAREDNESS
SAFETY FIRST
ABOUT US
We enable industries and organizations to move beyond conventional waste management by delivering advanced hazardous waste treatment and disposal solutions. Our focus is on building safe, compliant, and sustainable treatment ecosystems that empower stakeholders to manage waste efficiently, minimize environmental impact, and achieve long-term operational and environmental sustainability.
TSDF stands for Treatment Storage Disposal Facility
Safe, Sustainable, Compliant Waste Solutions
Vision
Mission
Values
Transforming Waste into Safe Solutions



প্রস্তাবিত ইন্টিগ্রেটেড TSDF ও ইনসিনারেশন প্রকল্পের সংক্ষিপ্ত বিবরণ
শিয়াম টিএসডিএফ বিডি লিমিটেড (Sheam TSDF BD Ltd.)

১. প্রকল্পের স্থান
মৌজাবাড়ী, শ্রীপুর, গাজীপুর, বাংলাদেশ

২: প্রকল্পের পরিচিতি

বাংলাদেশে শক্ত শিল্পবর্জ্য, স্বাস্থ্যসেবা বর্জ্য, ইলেকট্রনিক বর্জ্য, ব্যাটারি ও অন্যান্য বিপজ্জনক বর্জ্যের পরিমাণ দ্রুত বৃদ্ধি পাচ্ছে। এসব বর্জ্যের নিরাপদ সংগ্রহ, সংরক্ষণ, প্রক্রিয়াকরণ এবং পরিবেশসম্মত নিষ্পত্তির জন্য একটি আধুনিক ও বৈজ্ঞানিক ব্যবস্থাপনা অবকাঠামো প্রয়োজন।

এই প্রয়োজন বিবেচনায় শিয়াম টিএসডিএফ বিডি লিমিটেড মৌজাবাড়ী, শ্রীপুর, গাজীপুর এলাকায় একটি আধুনিক Treatment, Storage and Disposal Facility (TSDF) এবং Controlled Incineration Facility স্থাপনের উদ্যোগ গ্রহণ করেছে।

প্রকল্পটি পরিবেশ অধিদপ্তরের (DoE) প্রযোজ্য আইন, নির্দেশিকা এবং পরিবেশগত বিধিমালা অনুসরণ করে বাস্তবায়নের পরিকল্পনা করা হয়েছে।

৩: প্রকল্পের মূল উদ্দেশ্য

প্রস্তাবিত TSDF প্রকল্পের প্রধান উদ্দেশ্যসমূহ:

- বিভিন্ন উৎস থেকে উৎপন্ন বিশেষ ও ঝুঁকিপূর্ণ বর্জ্যের নিরাপদ ব্যবস্থাপনা নিশ্চিত করা।
- বর্জ্যকে বৈজ্ঞানিক পদ্ধতিতে গ্রহণ, পরীক্ষা, শ্রেণিবিন্যাস ও প্রক্রিয়াজাত করা।
- পুনর্ব্যবহারযোগ্য উপাদান পুনরুদ্ধার করা।
- চূড়ান্ত বর্জ্য নিয়ন্ত্রিত প্রযুক্তির মাধ্যমে অপসারণ করা।
- পরিবেশ দূষণ, স্বাস্থ্যঝুঁকি ও অনিয়ন্ত্রিত বর্জ্য নিষ্পত্তি কমানো।
- দীর্ঘমেয়াদি টেকসই বর্জ্য ব্যবস্থাপনা ব্যবস্থা গড়ে তোলা।

৪: প্রকল্পে ব্যবস্থাপনার অন্তর্ভুক্ত সম্ভাব্য বর্জ্যের উৎস

প্রকল্পে নিম্নোক্ত উৎস হতে আসন্ন বর্জ্য গ্রহণের পরিকল্পনা রয়েছে:

- শিল্প প্রতিষ্ঠান থেকে উৎপন্ন বিশেষ বর্জ্য।
- হাসপাতাল ও স্বাস্থ্যসেবা খাতের বিশেষ বর্জ্য।
- তেলসহ বিষাক্ত পদার্থ ও ভাঙ্গাচোরা থেকে উৎপন্ন পরিত্যক্ত/অপ্রচলিত পণ্য।
- ব্যাটারিজাত ও প্রক্রিয়াজাত বর্জ্য।
- দূষিত প্যাকেজিং ও অন্যান্য বিশেষ বর্জ্য।
- অনুমোদিত অন্যান্য বর্জ্য প্রবাহ।

গ্রহণযোগ্য বর্জ্যের অনুমোদিত ও পরীক্ষিত বর্জ্য (Waste Acceptance Criteria (WAC) অনুযায়ী গ্রহণ করা হবে।

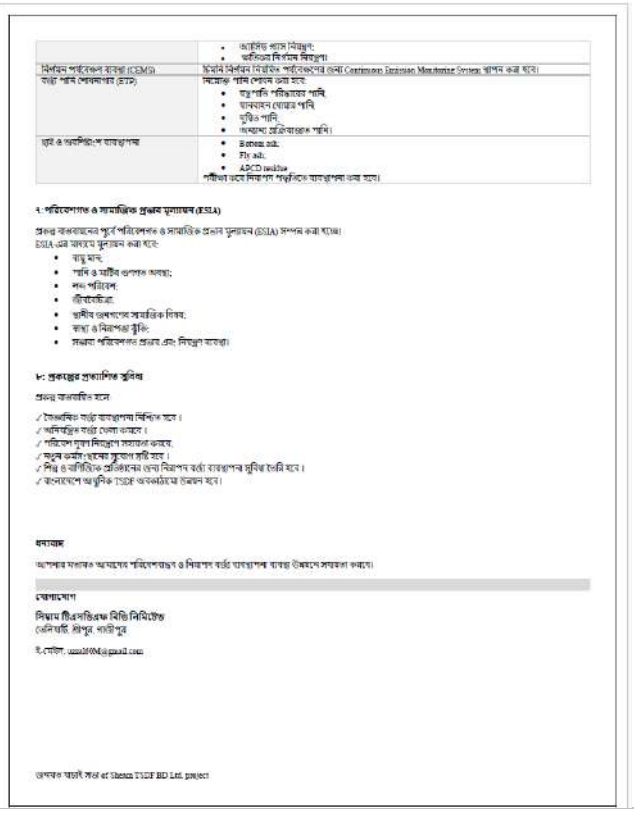
৫: প্রকল্পের প্রধান কার্যক্রম

বর্জ্য গ্রহণ ও পরীক্ষা	• বর্জ্য পরিবহনের সময় দায়িত্বহস্তান্তর। • ওজন পরিমাপ (Weighbridge)। • নমুনা ও তথ্য যাচাই। • গ্রহণযোগ্য/অনুমতি সমূহ সংগ্রহ ও পরীক্ষা।
বর্জ্য পৃথকীকরণ ও প্রাক-প্রক্রিয়াজাতকরণ	• পুনর্ব্যবহারযোগ্য উপাদান পৃথকীকরণ। • দাহ্য ও অদাহ্য বর্জ্য আলাদা করা। • অনুপযুক্ত বর্জ্য শনাক্তকরণ ও নিরূপণ প্রক্রিয়া।
নিয়ন্ত্রিত ইনসিনারেশন ব্যবস্থা	উপযুক্ত দাহ্য বর্জ্য উচ্চ তাপমাত্রায় নিয়ন্ত্রিত ইনসিনারেশন প্রযুক্তির মাধ্যমে ধ্বংস করা হবে। এ ব্যবস্থায়: • সম্পূর্ণ দাহ নিশ্চিত করা হবে। • যুক্তি ও ভলিউম হ্রাস উপযোগ ঘটানো হবে। • মানোত্তীর্ণ পরিমাণ ছাইয়ের ব্যবস্থাপনা করানো হবে।

৬: পরিবেশ সুরক্ষা ব্যবস্থা

প্রকল্পে নিম্নোক্ত পরিবেশ নিয়ন্ত্রণ ব্যবস্থা রাখা হবে:

বায়ু দূষণ নিয়ন্ত্রণ ব্যবস্থা (APCD)	• ফ্লু গ্যাস নিয়ন্ত্রণ;



	• অক্সিডাইজার নিয়ন্ত্রণ; • অক্সিজেন নিয়ন্ত্রণ ব্যবস্থা।
নির্গমন পর্যবেক্ষণ ব্যবস্থা (CEMS)	চিমনীতে নির্গমন নিয়ন্ত্রিত পর্যবেক্ষণের জন্য Continuous Emission Monitoring System স্থাপন করা হবে।
বর্জ্য পানি শোধনাগার (ETP)	নিম্নোক্ত পানি শোধন করা হবে: • ফ্লু-গ্যাস পরিষ্কারের পানি; • যানবাহন ধোয়ার পানি; • গুদামের পানি; • অন্যান্য প্রক্রিয়াজাত পানি।
ছাই ও অবশিষ্টাংশ ব্যবস্থাপনা	• Bottom ash; • Fly ash; • APCD residue পরীক্ষা করে নিরাপদ পদ্ধতিতে ব্যবস্থাপনা করা হবে।

৭: পরিবেশগত ও সামাজিক প্রভাব মূল্যায়ন (ESIA)

প্রকল্প বাস্তবায়নের পূর্বে পরিবেশগত ও সামাজিক প্রভাব মূল্যায়ন (ESIA) সম্পন্ন করা হবে।
ESIA-এর মাধ্যমে মূল্যায়ন করা হবে:

- বায়ু মান;
- পানি ও মাটির গুণগত অবস্থা;
- শব্দ পরিবেশ;
- জীববৈচিত্র্য;
- স্থানীয় জনগণের সামাজিক বিষয়;
- স্বাস্থ্য ও নিরাপত্তা ঝুঁকি;
- সম্ভাব্য পরিবেশগত প্রভাব এবং নিয়ন্ত্রণ ব্যবস্থা।

৮: প্রকল্পের প্রত্যাশিত সুবিধা

প্রকল্প বাস্তবায়নে হবে:

✓ বৈজ্ঞানিক বর্জ্য ব্যবস্থাপনা নিশ্চিত হবে।
✓ অনিয়ন্ত্রিত বর্জ্য ফেলা কমবে।
✓ পরিবেশ দূষণ নিয়ন্ত্রণে সহায়তা করবে;
✓ অনুমত অর্থনীতিতে সুযোগ সৃষ্টি হবে।
✓ শিল্প ও বাণিজ্যিক প্রতিষ্ঠানের জন্য নিরাপদ বর্জ্য ব্যবস্থাপনা সুবিধা তৈরি হবে।
✓ জাতীয়ভাবে আধুনিক TSDF অবকাঠামোর উন্নয়ন হবে।

ধন্যবাদ

আপনার মূল্যবান অংশগ্রহণে পরিবেশবান্ধব ও নিরাপদ বর্জ্য ব্যবস্থাপনা ব্যবস্থা উন্নয়নে সহায়তা করবে।

যোগাযোগ

শিয়াম টিএসডিএফ বিডি লিমিটেড
মৌজাবাড়ী, শ্রীপুর, গাজীপুর

ই-মেইল: [illegible]@gmail.com

8.5.6 Public Consultation Program Photos








8.6 Stakeholder Engagement Plan

Stakeholder engagement is an essential component of the Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP) process. The purpose of the Stakeholder Engagement Plan (SEP) is to establish a systematic, transparent, inclusive, and continuous process through which relevant stakeholders are informed about the project, consulted on matters that may affect them, and provided with opportunities to express their views, concerns, and recommendations.

The Stakeholder Engagement Plan for the proposed project has been developed to facilitate effective communication between the Developer, relevant government authorities, local communities, project workers, contractors, and other interested stakeholders throughout the project life cycle.

The engagement process will be implemented during the **pre-construction, construction, operation, and decommissioning/closure phases**, as applicable. The level and frequency of engagement will be adjusted according to the nature and significance of project activities and stakeholder concerns.

The key objectives of the Stakeholder Engagement Plan are to:

- Identify and understand stakeholder concerns, expectations, and interests;
- Provide appropriate opportunities for stakeholders to participate in the project decision-making process;
- Identify potential environmental and social risks from the stakeholders' perspective;
- Maintain transparent and constructive communication with affected communities;
- Ensure that vulnerable and potentially disadvantaged groups are appropriately considered;
- Establish an accessible mechanism for receiving and resolving grievances;

- Incorporate relevant stakeholder feedback into project design and environmental and social management measures; and
- Maintain a documented record of stakeholder engagement activities and responses.

8.6.1 Stakeholder Engagement Program

The Stakeholder Engagement Program will be implemented as a continuous process throughout the project life cycle.

The principal stakeholder groups.

- Relevant government ministries, departments, and regulatory authorities;
- Local government institutions;
- Local community representatives and community leaders;
- Residents and households surrounding the project area;
- Landowners, land users, and other potentially affected persons;
- Local businesses and service providers;
- Project employees and workers;
- Transporters and suppliers;
- Emergency service providers;
- Environmental, health, and safety institutions;

8.6.2 Monitoring and Reporting

8.6.2.1 Monitoring

The stakeholder engagement monitoring program will assess whether engagement activities are being implemented effectively and whether stakeholder concerns are being appropriately addressed.

8.6.2.2 Reporting

The Sheam TSDF operation department will maintain a documented record of stakeholder engagement activities and prepare periodic reports as part of the project's environmental and social management system.

8.7 Grievance Redress Mechanism

A Grievance Redress Mechanism (GRM) will be established to provide an accessible, transparent, predictable, and effective means for stakeholders to raise concerns or complaints associated with the project.

The GRM is intended to provide a structured process through which project-related grievances can be received, registered, assessed, investigated, resolved, and closed within a reasonable timeframe.

The mechanism will apply to grievances raised by:

- Local communities;
- Project-affected persons;

- Workers and employees;
- Contractors and subcontractors;
- Suppliers and service providers; and
- Other legitimate stakeholders.

8.7.1 Process involved in Effective Grievance Management

The grievance management process will generally consist of the following stages:

1. Receive the grievance → 2. Register the grievance → 3. Acknowledge receipt → 4. Screen and assess → 5. Investigate → 6. Develop resolution → 7. Communicate response → 8. Implement corrective action → 9. Follow up → 10. Close the grievance → 11. Appeal, if required

CHAPTER 9

Hazard and Risk Assessment

This chapter assesses natural disaster risks (earthquake, cyclone and flood) and operational hazards such as fire, explosion, flammable liquid storage, toxic release, waste spillage and incinerator upset conditions. It presents the risk assessment process and results, the Emergency Response Plan, risk management and mitigation measures, and the procedures for abnormal operating conditions.

9 HAZARD AND RISK ASSESSMENT

9.1 Disaster Impact Assessment

Disaster Impact Assessment is an important component of the Environmental and Social Impact Assessment for the proposed *TSDF Project*. The objective of this assessment is to identify potential natural and human-induced disaster risks that may affect the project site, project infrastructure, workers, surrounding communities, environmental protection systems, waste storage areas, treatment facilities, and emergency response capacity.

The Disaster Impact Assessment has been carried out using a risk-based approach. The assessment considers the probability of disaster occurrence, possible severity of impact, vulnerability of project components, exposure of workers and surrounding communities, and the capacity of the project to prevent, respond to, and recover from disaster events.

9.1.1 Approach and Methodology

The methodology includes the following steps:

Step	Description
Hazard identification	Identification of relevant natural and man-made disaster risks for the project area
Baseline review	Review of national and regional disaster profile of Bangladesh
Site vulnerability assessment	Assessment of project location, land condition, drainage, access, surrounding receptors, and facility layout
Impact assessment	Evaluation of possible impacts on project infrastructure, environment, workers, and community
Risk ranking	Classification of disaster risk based on likelihood and severity
Mitigation planning	Development of preventive, preparedness, response, and recovery measures
Emergency planning	Integration of disaster response into the project emergency response plan

The major disaster hazards considered for this assessment include:

Disaster Type	Relevance to Project
Earthquake and seismic activity	May affect structures, storage areas, tanks, pipelines, electrical systems, and emergency facilities
Cyclone and strong wind	May damage roofing, stack, lightweight structures, trees, utility lines, and communication systems
Storm surge	Generally more relevant to coastal areas; low relevance to inland Gazipur area
Flood and heavy rainfall	May affect drainage, access roads, storage areas, wastewater systems, and surface runoff
Tornado / local storm	May cause sudden localized damage to structures and utilities
Fire and explosion	Important operational risk due to waste, fuel, chemicals, electrical systems, and hot work

Lightning	May affect electrical systems, stack, communication, and worker safety
Industrial accident	May result from equipment failure, chemical spill, waste incompatibility, or process malfunction

For each hazard, the following impact pathways have been considered:

Impact Pathway	Example
Physical damage	Damage to buildings, storage sheds, incinerator, stack, tanks, roads, drains
Environmental release	Release of waste, chemicals, fuel, wastewater, ash, or contaminated runoff
Occupational risk	Injury to workers due to collapse, fire, electric shock, exposure, or accident
Community risk	Dust, smoke, odour, contaminated runoff, traffic disruption, emergency evacuation
Operational disruption	Shutdown of treatment system, utilities, monitoring systems, and waste receiving
Regulatory risk	Non-compliance due to uncontrolled emission, discharge, or waste release

9.1.2 Disasters in Bangladesh

Bangladesh is one of the most disaster-prone countries in the world due to its geographic location, dense population, river systems, low-lying floodplains, monsoon climate, coastal exposure, and seismic setting. The country regularly experiences different types of natural disasters including floods, cyclones, storm surges, riverbank erosion, torna DoEs, lightning, drought, landslides, and earthquakes.

Although the proposed TSDF project site is located in **Gazipur District**, which is an inland area and not directly exposed to coastal storm surge, the project area may still be affected by heavy rainfall, localized flooding, drainage congestion, strong wind, lightning, tornado-like local storms, and earthquake risk.

Major Disasters Relevant to Bangladesh

Disaster Type	General Characteristics in Bangladesh
Flood	Common during monsoon due to heavy rainfall, river overflow, and drainage congestion
Cyclone	Mainly affects coastal districts, but associated wind and heavy rain may influence inland areas
Storm surge	Major risk for coastal belt; low direct relevance for inland Gazipur
Earthquake	Potential risk due to regional tectonic setting and active fault systems
Lightning	Frequent during thunderstorm season and may affect workers and electrical systems

Riverbank erosion	Common along major rivers; relevance depends on site proximity to river
Drought / heat stress	Seasonal heat may affect workers and water demand
Fire hazard	Human-induced disaster risk in industrial and storage facilities

Disaster Relevance to the TSDF Project

Disaster	Relevance to TSDF Project	Overall Concern
Earthquake	Moderate to significant depending on structural design and seismic zone	Structural safety and hazardous material containment
Cyclone / strong wind	Moderate	Roof, stack, utility line, tree damage
Storm surge	Low	Inland location reduces direct risk
Flood / waterlogging	Moderate	Drainage, contaminated runoff, access disruption
Tornado	Moderate	Sudden localized wind damage
Lightning	Moderate	Electrical damage, fire risk, worker safety
Fire / explosion	Significant operational concern	Waste, fuel, chemical and process safety
Heavy rainfall	Significant seasonal concern	Drainage, runoff, erosion, wastewater management

9.1.3 Disaster Impact Assessment in the Project Area

The proposed project area in Gazipur is generally characterized by inland terrain, industrial expansion, semi-urban and rural land use, local road networks, seasonal rainfall, and drainage-dependent surface runoff. The site is not located in the coastal belt; therefore, direct storm surge risk is low. However, the project must be designed considering earthquake resistance, heavy rainfall, stormwater drainage, strong wind, lightning protection, fire safety, and emergency access.

The TSDF facility contains sensitive project components that require disaster-resilient planning, including:

Project Component	Disaster Vulnerability
Waste receiving area	Spill, traffic disruption, stormwater contamination
Hazardous waste storage	Leakage, fire, structural damage, incompatible waste reaction
Incinerator unit	Operational shutdown, emission risk, equipment damage
Stack and APC system	Wind, lightning, structural vibration, operational malfunction
ETP/STP	Overflow, treatment failure, contaminated discharge
Ash/residue storage	Contaminated runoff, dust release, storage damage
Chemical/fuel storage	Spill, fire, explosion, leakage
Internal roads	Flooding, access obstruction, emergency delay
Electrical system	Short circuit, lightning damage, fire risk
Greenbelt	Storm damage, fallen trees blocking access
Worker facilities	Injury risk during storm, earthquake, fire, or flood

9.1.3.1 Earthquake and Seismic Activity

Bangladesh lies near a seismically active region influenced by the interaction of the Indian, Eurasian, and Burmese tectonic plates. Although major earthquakes are not frequent, the risk of seismic activity exists in different parts of the country. Gazipur and the surrounding region may experience seismic shaking from regional earthquakes.

For a TSDF facility, earthquake risk is important because seismic vibration may affect structural stability, storage areas, tanks, pipelines, incinerator foundation, stack, electrical systems, and containment structures.

Potential Earthquake Impacts

Affected Component	Potential Impact
Buildings and sheds	Cracking, collapse, structural damage
Waste storage racks	Falling containers, leakage, mixing of incompatible waste
Incinerator and stack	Foundation stress, misalignment, structural vibration
Pipelines and tanks	Leakage, rupture, joint failure
ETP/STP structures	Cracking, overflow, treatment disruption
Electrical system	Short circuit, fire, power failure
Internal roads	Cracking, access disruption
Workers	Injury from falling objects, panic, evacuation difficulty
Environment	Release of waste, chemicals, fuel, or wastewater

Earthquake Risk Assessment

Criteria	Assessment
Likelihood	Low to moderate, but possible
Severity	High if hazardous storage or structures are affected
Reversibility	Moderate to difficult depending on release
Significance	Moderate to significant
Required Control	Seismic-resistant design, emergency planning, secure storage

Mitigation Measures for Earthquake Risk

Risk Area	Mitigation Measures
Structural design	All structures shall be designed following Bangladesh National Building Code and applicable seismic design requirements
Waste storage	Containers shall be stored securely with stable stacking and anti-fall arrangement
Tanks and vessels	Tanks shall be installed on stable foundation with anchoring and flexible joints
Stack structure	Stack shall be designed considering seismic and wind load
Pipelines	Provide flexible connections and emergency shut-off valves
Electrical system	Install circuit protection, emergency shut-off, and fire protection
Emergency response	Prepare earthquake emergency response procedure
Evacuation	Mark safe evacuation routes and muster points
Training	Conduct earthquake response drills for workers

Post-earthquake inspection	Inspect structures, storage, tanks, pipelines, incinerator, ETP/STP before restart

9.1.3.2 Cyclone and Storm Surges

Cyclones and storm surges are major hazards in the coastal belt of Bangladesh. Since the proposed project site is located in Gazipur, direct storm surge risk is considered low. However, cyclone-associated heavy rainfall, strong wind, stormy weather, and regional power disruption may still affect the project area.

Strong wind may damage roofs, lightweight structures, stack components, fencing, trees, signage, communication systems, and utility lines.

Potential Cyclone / Strong Wind Impacts

Affected Component	Potential Impact
Roofing and sheds	Damage to roof sheets and cladding
Stack and tall structures	Wind load stress, vibration
Electrical lines	Power failure, short circuit
Waste storage area	Water entry, container damage, leakage
Chemical/fuel storage	Leakage or spill due to structural damage
Greenbelt	Fallen trees blocking road or damaging boundary
Internal roads	Waterlogging and traffic disruption
Workers	Injury from flying objects or falling materials
Operations	Temporary shutdown due to power or weather condition

Storm Surge Relevance

Aspect	Assessment
Coastal exposure	Low
Direct storm surge risk	Low
Indirect cyclone impact	Moderate through wind and rainfall
Main concern	Heavy rainfall, strong wind, drainage, power failure

Mitigation Measures for Cyclone / Strong Wind

Risk Area	Mitigation Measures
Building design	Design roofing and structures to withstand local wind load
Stack safety	Design stack considering wind pressure and structural stability
Drainage	Provide adequate stormwater drainage and regular cleaning
Waste storage	Keep waste containers covered, sealed, and stored above flood-prone level
Emergency shutdown	Stop waste handling and incineration during severe storm warning if necessary
Power backup	Maintain standby generator and emergency lighting
Tree management	Prune weak branches and avoid unsafe trees near buildings
Loose materials	Secure loose sheets, drums, tools, and construction materials
Worker safety	Suspend outdoor work during storm warning

Communication	Maintain storm warning communication and emergency contact list

9.1.3.3 Floods

Flooding is a common disaster in Bangladesh, especially during monsoon season. Although the project site in Gazipur is not located in the major coastal flood zone, localized flooding or waterlogging may occur due to heavy rainfall, inadequate drainage, blocked drains, low-lying land, poor site grading, or obstruction of natural runoff.

Potential Flood and Waterlogging Impacts

Affected Component	Potential Impact
Waste storage area	Water entry, container floating, leakage
Chemical/fuel storage	Spill or contamination of runoff
Incinerator area	Operational shutdown and equipment damage
ETP/STP	Overflow, treatment failure, contaminated discharge
Ash/residue area	Contaminated runoff and dust after drying
Internal roads	Vehicle movement disruption
Electrical rooms	Short circuit and fire risk
Boundary drains	Overflow and erosion
Workers	Slip, fall, electric shock, waterborne disease risk
Community	Road flooding, contaminated drainage concern

Flood Risk Assessment

Criteria	Assessment
Likelihood	Moderate during heavy monsoon rainfall
Severity	Moderate to high if waste storage is affected
Reversibility	Moderate depending on contamination
Significance	Significant for TSDF operation
Required Control	Elevated design, drainage, containment, emergency response

Mitigation Measures for Flood and Waterlogging

Risk Area	Mitigation Measures
Site elevation	Maintain finished ground level above expected local flood level where feasible
Drainage design	Provide properly designed stormwater drainage network
Waste storage	Construct covered and raised storage areas with impervious flooring and bunding
Hazardous material storage	Store chemicals and fuel in bunded and elevated areas
ETP/STP	Provide overflow prevention and emergency holding capacity
Stormwater control	Separate clean stormwater from contaminated runoff
Drain maintenance	Clean drains before and during monsoon season
Emergency pump	Keep portable pumps available for water removal

Electrical safety	Keep electrical panels above expected water level
Access road	Maintain all-weather access for emergency vehicles
Monitoring	Inspect drainage after heavy rainfall
Contaminated water	Collect and treat contaminated runoff before discharge

9.1.4 Mitigation Measures for the Significant Disaster

Based on the disaster impact assessment, the most significant disaster risks for the proposed TSDF project are:

Disaster / Hazard	Significance for Project
Earthquake	Significant due to structural and hazardous material storage risk
Flood / waterlogging	Significant due to potential contaminated runoff
Cyclone-associated strong wind and rainfall	Moderate to significant
Tornado / severe local storm	Moderate
Fire and explosion	Significant operational disaster risk
Lightning	Moderate to significant for electrical and worker safety
Chemical spill / hazardous release	Significant due to nature of TSDF operation

General Disaster Mitigation Measures

Risk Area	Mitigation Measures
Site planning	Locate high-risk facilities away from drainage paths and low-lying areas
Structural design	Follow BNBC and relevant engineering codes for seismic and wind load
Elevation	Raise critical equipment, storage, electrical rooms, and control rooms above flood-prone level
Drainage	Provide adequate stormwater drainage, silt traps, and emergency pumping
Waste storage	Use covered, bunded, impervious, and well-ventilated storage areas
Chemical/fuel storage	Provide secondary containment, spill kits, fire protection, and ventilation
Incinerator safety	Provide safe shutdown system, emergency control, and backup power
APC system	Maintain preventive maintenance and alarm system
ETP/STP	Provide emergency holding capacity and no direct discharge during abnormal condition
Fire protection	Install hydrant, extinguishers, alarms, firewater tank, and emergency response system
Lightning protection	Install lightning arresters and earthing system for tall structures and electrical systems
Emergency access	Maintain clear internal roads and emergency vehicle access
Communication	Maintain emergency contact list and warning system
Training	Conduct regular disaster preparedness and emergency drills
Monitoring	Inspect critical systems before and after disaster events

Community coordination	Coordinate with local fire service, health facility, local administration, and community representatives

Disaster-Specific Mitigation Matrix

Disaster	Key Impact	Mitigation Measures	Responsibility
Earthquake	Structural damage, waste release, injury	Seismic design, secured storage, emergency shutdown, evacuation drill	Project Authority
Flood	Waterlogging, contaminated runoff, access disruption	Elevated storage, drainage, bunding, emergency pump, contaminated runoff treatment	Project Authority
Cyclone / storm	Roof damage, power failure, wind damage	Wind-resistant design, secure loose materials, backup power, storm warning system	Project Authority
Tornado / nor'wester	Sudden wind damage, worker injury	Strong roof fixing, safe shelter, weather warning, post-storm inspection	Project Authority
Lightning	Electrical damage, fire, worker injury	Lightning protection, earthing, surge protection, stop outdoor work	Project Authority
Fire	Injury, emission, hazardous release	Fire detection, hydrant, extinguisher, segregation, no smoking, hot work permit	Project Authority
Chemical spill	Soil/water contamination	Spill kit, bunding, PPE, emergency cleanup, waste compatibility control	Project Authority
ETP failure during disaster	Untreated discharge	Emergency holding tank, standby pump, stop discharge	Project Authority
Access disruption	Delay in emergency response	Maintain all-weather access road and alternative route	Project Authority

9.2 Hazard and Risk Assessment

Hazard and Risk Assessment is an essential component of the Environmental and Social Impact Assessment for the proposed Sheam TSDF BD Ltd. TSDF Project. The purpose of this assessment is to identify potential hazards associated with project activities, evaluate the likelihood and consequences of accidental events, and recommend appropriate prevention, control, emergency response, and risk reduction measures.

Since the proposed facility will involve receiving, handling, temporary storage, treatment, and disposal of controlled, hazardous, industrial, and confiscated waste streams, several potential hazards may arise during pre-construction, construction, operation, and decommissioning phases.

9.2.1 RA Study Objective

The main objective of the Risk Assessment study is to systematically identify, analyze, evaluate, and control potential risks associated with the proposed TSDF project.

The specific objectives are:

Objective	Description
Hazard identification	Identify possible sources of fire, explosion, toxic release, chemical spill, occupational accident, and environmental contamination
Risk analysis	Assess likelihood and consequence of identified hazards
Consequence assessment	Evaluate possible impact zones for selected credible accident scenarios
Risk ranking	Classify risks into low, medium, high, or extreme categories
Control measures	Recommend engineering, operational, and emergency control measures
Worker protection	Reduce occupational exposure to hazardous materials and unsafe conditions
Community safety	Minimize off-site risk to nearby communities and receptors
Environmental protection	Prevent contamination of air, water, soil, and groundwater
Emergency preparedness	Support preparation of emergency response and disaster management plan
Regulatory compliance	Assist compliance with DoE requirements, ESIA commitments, and applicable safety standards

The RA study focuses on credible worst-case and most-likely accident scenarios related to:

- Flammable liquid storage;
- Fuel storage and handling;
- Chlorine or chlorine-containing chemical handling, if applicable;
- Chemical storage;
- Hazardous waste storage;
- Incinerator operation;
- Air pollution control system;
- Wastewater treatment system;
- Transportation and unloading activities;
- Occupational health and safety risks.

9.2.2 Risk Assessment Process

The risk assessment process follows a structured approach involving hazard identification, frequency estimation, consequence analysis, risk evaluation, and risk control.

Risk Assessment Steps

Step	Description
Step 1: Activity review	Review project activities, plant layout, process flow, storage areas, utilities, and waste handling system
Step 2: Hazard identification	Identify possible hazardous events and sources of risk
Step 3: Scenario selection	Select credible accident scenarios for detailed assessment

Step 4: Frequency analysis	Estimate likelihood of occurrence based on operational conditions and historical experience
Step 5: Consequence analysis	Assess possible impact from fire, explosion, toxic release, spill, or exposure
Step 6: Risk ranking	Rank risks using likelihood and consequence matrix
Step 7: Mitigation planning	Recommend prevention, control, response, and recovery measures
Step 8: Residual risk assessment	Assess remaining risk after implementing mitigation measures
Step 9: Monitoring and review	Update risk assessment periodically during operation

Risk Assessment Matrix:

The risk level is determined based on the combination of likelihood and consequence.

Likelihood Criteria

Likelihood Level	Description	Indicative Frequency
1 - Rare	May occur only in exceptional circumstances	Once in more than 10 years
2 - Unlikely	Could occur but not expected under normal control	Once in 5–10 years
3 - Possible	May occur at some time during project life	Once in 1–5 years
4 - Likely	Expected to occur occasionally	Several times during project life
5 - Almost Certain	Expected to occur frequently	Multiple times per year

Consequence Criteria

Consequence Level	Description	Example
1 - Insignificant	No injury, negligible environmental impact	Minor housekeeping issue
2 - Minor	First aid injury, minor spill, localized impact	Small contained spill
3 - Moderate	Medical treatment injury, limited environmental release	Localized fire/spill requiring response
4 - Major	Serious injury, major equipment damage, significant pollution	Tank fire, toxic release within site
5 - Catastrophic	Fatality, off-site impact, major environmental damage	Major fire/explosion/toxic release

Risk Rating Matrix

Likelihood / Consequence	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
1 Rare	Low	Low	Low	Medium	Medium
2 Unlikely	Low	Low	Medium	Medium	High
3 Possible	Low	Medium	Medium	High	High
4 Likely	Medium	Medium	High	High	Extreme
5 Almost Certain	Medium	High	High	Extreme	Extreme

Risk Acceptability Criteria

Risk Level	Acceptability	Required Action
Low	Acceptable	Maintain routine controls
Medium	Tolerable with control	Implement mitigation and monitor
High	Not acceptable without reduction	Immediate control measures required
Extreme	Unacceptable	Stop activity until risk is reduced

9.2.3 Potential Hazard and Risk During Different Stages

Different hazards may occur during different project stages. The risk profile changes from land development and construction-related safety risks to operational hazards associated with waste handling, incineration, chemical storage, fuel use, and pollution control systems.

Potential Hazards during Pre-construction Phase

Activity	Potential Hazard	Possible Impact
Land development	Dust, unstable ground, equipment movement	Worker injury, air pollution
Soil transport	Vehicle accident, spillage	Public safety risk, road pollution
Material sourcing	Borrow pit instability	Land degradation, accident
Site clearing	Snake/insect bite, falling vegetation	Worker injury

Potential Hazards during Construction Phase

Activity	Potential Hazard	Possible Impact
Excavation	Collapse, falling into trench	Serious injury
Working at height	Fall from structure/scaffold	Serious injury or fatality
Welding/cutting	Fire, burn, eye injury	Worker injury, fire
Electrical work	Electric shock, short circuit	Injury, fire
Heavy equipment	Collision, overturning, crushing	Injury, property damage
Fuel storage	Leakage, fire	Soil contamination, fire

Concrete work	Skin burn, wash water pollution	Worker injury, water pollution
Lifting operation	Falling load, crane failure	Serious injury

Potential Hazards during Operation Phase

Activity	Potential Hazard	Possible Impact
Waste receiving	Unknown or incompatible waste	Fire, toxic release, incorrect treatment
Waste storage	Leakage, reaction, fire	Worker exposure, environmental contamination
Incineration	High temperature, flame failure, high emission	Fire, emission exceedance
Air pollution control	Scrubber/filter failure	Air pollution, regulatory non-compliance
Fuel storage	Spill, pool fire	Fire, soil/water contamination
Chemical storage	Spill, toxic release, reaction	Worker/community health risk
Chlorine handling, if applicable	Toxic gas release	Respiratory hazard, emergency evacuation
ETP/STP operation	Overflow, chemical exposure	Water pollution, worker exposure
Ash/residue handling	Dust exposure, heavy metal contamination	Worker exposure, soil contamination
Maintenance	Confined space, hot work, mechanical injury	Worker injury
Transportation	Road accident, leakage	Community safety risk

Potential Hazards during Decommissioning Phase

Activity	Potential Hazard	Possible Impact
Dismantling	Falling objects, structural instability	Worker injury
Equipment removal	Residual chemical/waste exposure	Worker exposure
Tank cleaning	Confined space, toxic vapour	Serious injury
Waste removal	Spill, improper disposal	Environmental contamination
Demolition waste	Dust, noise, debris	Air/noise impact

9.2.4 Hazard Identification

Hazard identification has been conducted considering the proposed TSDF process, material handling, chemical and fuel storage, waste characteristics, mechanical systems, utility systems, and emergency situations.

Major Hazard Categories

Hazard Category	Possible Source
Fire hazard	Flammable liquid, fuel storage, combustible waste, electrical fault, hot work
Explosion hazard	Vapour accumulation, incompatible waste reaction, pressurized container
Toxic release	Chlorine, acidic gases, chemical spill, incompatible waste reaction
Chemical burn	Acid/alkali handling, scrubber chemicals, laboratory chemicals
Environmental contamination	Spill, leakage, untreated wastewater, contaminated runoff
Air emission hazard	Incinerator malfunction, APC failure, stack emission exceedance
Occupational injury	Equipment, height work, confined space, lifting, electrical work
Biological hazard	Putrescible waste, contaminated material, wastewater/sludge
Ergonomic hazard	Manual handling, repetitive movement
Physical hazard	Heat, noise, vibration, dust, radiation from hot surfaces
Natural hazard	Flood, earthquake, storm, lightning

Hazard Identification Matrix

Facility / Activity	Hazard	Possible Cause	Consequence	Existing / Proposed Control
Waste receiving	Unknown waste	Incomplete documentation	Fire, reaction, exposure	Manifest verification, inspection, sampling
Waste storage	Container leakage	Damaged drum or poor handling	Spill, soil contamination	Bunded floor, daily inspection
Flammable storage	Pool fire	Leakage and ignition	Thermal radiation, fire spread	Bund, fire system, no smoking
Fuel transfer	Spill/fire	Hose failure, overfill	Fire, contamination	SOP, spill kit, earthing
Chlorine/chemical storage	Toxic release	Cylinder/container leak	Respiratory hazard	Ventilation, detector, PPE
Incinerator	Incomplete combustion	Low temperature, overfeeding	Smoke, CO, odour	Temperature control, automatic interlock
APC system	Emission exceedance	Scrubber/filter failure	Air pollution	Preventive maintenance, monitoring
ETP/STP	Overflow	Pump failure, hydraulic overload	Water pollution	Standby pump, holding tank

Ash handling	Dust exposure	Dry handling, poor PPE	Worker exposure	Moist handling, PPE, sealed container
Generator	Fire/noise	Fuel leak, poor maintenance	Fire, noise nuisance	Acoustic enclosure, inspection
Electrical room	Short circuit	Overload, poor wiring	Fire, shutdown	Earthing, breaker, inspection
Maintenance	Confined space exposure	Poor ventilation	Serious injury	Permit system, gas test
Internal transport	Accident	Speeding, poor route	Injury, spill	Speed limit, signage, trained driver

9.2.4.1 Hazards from Flammable Liquid Storage

Flammable liquids may be stored at the facility for fuel use, auxiliary operation, maintenance, laboratory use, or waste treatment support. The main hazards associated with flammable liquid storage are vapour release, pool fire, flash fire, tank overfilling, leakage, spill, ignition, and fire spread.

Flammable liquid storage must be designed and operated with strict fire prevention and containment measures.

Possible Hazards from Flammable Liquid Storage:

Hazard	Description	Potential Impact
Leakage from tank	Failure of tank shell, valve, pipe, or flange	Soil contamination, fire risk
Overfilling	Filling beyond safe capacity	Spill, vapour release
Pool fire	Ignition of spilled flammable liquid	Thermal radiation, injury, property damage
Flash fire	Ignition of vapour cloud	Burn injury
Vapour accumulation	Poor ventilation or confined area	Fire/explosion risk
Static electricity	During fuel transfer	Ignition source
Fire spread	Fire reaching nearby storage	Escalation of emergency
Tank rupture	Mechanical damage or fire exposure	Large spill and fire

Causes of Flammable Storage Incidents

Cause	Preventive Control
Poor tank condition	Regular inspection and maintenance

Valve/flange leakage	Routine leak check and replacement
Overfilling	Level indicator, overfill alarm, SOP
Ignition source	No smoking, hot work permit, flameproof electrical fittings
Static charge	Earthing and bonding during transfer
Poor housekeeping	Remove combustible materials nearby
Inadequate bunding	Provide secondary containment
Operator error	Training and supervision

Control Measures for Flammable Liquid Storage

Control Area	Required Measures
Tank design	Use approved tank design suitable for stored liquid
Secondary containment	Provide bund with adequate capacity
Fire protection	Provide foam/dry chemical extinguisher, hydrant, fire alarm
Separation distance	Maintain safe distance from buildings, waste storage, and ignition sources
Earthing/bonding	Provide during loading and unloading
Ventilation	Ensure adequate ventilation and vapour control
Signage	Display “No Smoking”, “Flammable”, and emergency contact signs
Spill response	Keep spill kit, sand, absorbent, and drain covers
Operating procedure	Prepare SOP for filling, unloading, transfer, and emergency response
Inspection	Conduct daily visual and periodic technical inspection
Training	Train operators in fuel handling and fire response

9.2.5 Frequency Analysis

Frequency analysis estimates the likelihood of occurrence of identified hazardous events. The frequency depends on equipment design, storage quantity, operating procedure, maintenance quality, worker training, safety system reliability, inspection frequency, and emergency preparedness.

In absence of detailed process-specific failure rate data at the ESIA stage, a qualitative frequency analysis has been applied using likelihood categories: Rare, Unlikely, Possible, Likely, and Almost Certain.

Frequency Classification:

Frequency Category	Description	Indicative Occurrence
Rare	Highly unlikely under normal control	May occur only in exceptional cases
Unlikely	Not expected but possible	Could occur during project life
Possible	May occur occasionally	Possible during operation
Likely	Expected to occur if control is weak	May occur several times
Almost Certain	Expected frequently	Repeated occurrence likely

General Frequency Analysis of Hazard Events:

Hazard Event	Frequency Without Control	Frequency With Control
Small fuel spill	Possible	Unlikely
Major tank leakage	Unlikely	Rare
Pool fire	Unlikely	Rare
Waste container leakage	Possible	Unlikely
Incompatible waste reaction	Possible	Rare / Unlikely
Chlorine release	Unlikely	Rare
Incinerator high CO event	Possible	Unlikely
APC system malfunction	Possible	Unlikely
ETP overflow	Possible	Unlikely
Worker injury	Possible	Unlikely
Electrical fire	Unlikely	Rare
Road accident during waste transport	Possible	Unlikely

9.2.6 Consequence Analysis

Consequence analysis evaluates the possible impact of hazardous events on people, property, environment, and operation. The analysis considers fire, thermal radiation, chemical release, toxic exposure, spill contamination, equipment damage, and off-site impact potential.

Consequence Categories:

Consequence Level	Description	Example
Insignificant	No injury or environmental impact	Small contained leak
Minor	First aid injury or minor localized spill	Small spill cleaned immediately
Moderate	Medical treatment, localized fire or pollution	Contained pool fire
Major	Serious injury, major equipment damage, significant release	Storage tank fire
Catastrophic	Fatality, off-site impact, major environmental damage	Major explosion or toxic release

Main Consequence Types:

Hazard Event	Main Consequence
Fuel spill	Soil contamination, fire risk
Pool fire	Thermal radiation, burn injury, equipment damage
Flash fire	Burn injury to exposed workers
Chlorine release	Respiratory exposure, evacuation
Chemical spill	Soil/water contamination, chemical burn
Incompatible waste reaction	Heat, gas release, fire, toxic fumes
Incinerator malfunction	High emission, smoke, odour

APC failure	Air pollution and regulatory non-compliance
ETP overflow	Water pollution and contaminated runoff
Ash/residue spill	Dust exposure and heavy metal contamination
Electrical fire	Injury, equipment damage, operational shutdown

9.2.7 Risk Evaluation

Risk evaluation combines the likelihood and consequence of identified hazards to determine overall risk ranking. The purpose of risk evaluation is to prioritize hazards requiring additional control measures.

Risk Evaluation Matrix for Major Hazards:

Hazard	Likelihood with Control	Consequence	Risk Rating	Required Action
Minor fuel spill	Unlikely	Minor	Low	Maintain spill control
Major fuel tank leakage	Rare	Major	Medium	Maintain bunding, inspection, emergency response
Pool fire from flammable liquid	Rare	Major	Medium	Fire protection and ignition control
Chlorine leak	Rare	Major	Medium	Leak detection, ventilation, emergency response
Incompatible waste reaction	Unlikely	Major	Medium	Waste compatibility check and segregation
Waste container leakage	Unlikely	Moderate	Medium	Daily inspection and secondary containment
Incinerator low temperature	Unlikely	Moderate	Medium	Automatic control and operator training
High stack emission	Unlikely	Major	Medium	APC maintenance and monitoring
ETP overflow	Unlikely	Moderate	Medium	Standby pump and holding capacity
Worker fall from height	Unlikely	Major	Medium	Height work permit and fall protection
Electrical fire	Rare	Major	Medium	Electrical inspection and fire protection
Road accident during waste transport	Unlikely	Major	Medium	Route control and driver training
Dust exposure during ash handling	Possible	Moderate	High	PPE, enclosed handling, dust suppression
Fire in waste storage	Unlikely	Major	Medium	Segregation, fire detection, storage control

Risk Reduction Priority

Priority	Hazard Group
High priority	Ash/residue dust exposure, waste compatibility, fire prevention, stack emission control
Medium priority	Fuel storage, chemical storage, chlorine handling, ETP failure, transport accident
Routine priority	General housekeeping, minor spills, noise, worker PPE compliance

9.3 Emergency Response Plan

An Emergency Response Plan is an essential component of the disaster risk management and operational safety system for the proposed Sheam TSDF BD Ltd. TSDF Project. The facility will involve receiving, handling, temporary storage, treatment, and disposal of controlled, industrial, hazardous, confiscated, and disposal-listed waste streams. Therefore, emergency preparedness is required to protect workers, surrounding communities, environment, project assets, and regulatory compliance.

The Emergency Response Plan provides a structured system for prevention, preparedness, response, control, communication, evacuation, medical support, reporting, and recovery during emergency situations. The plan shall be implemented during construction and operation phases and shall be reviewed periodically based on site conditions, operational experience, audit findings, drill outcomes, and regulatory requirements.

The plan shall cover emergencies related to fire, explosion, chemical spill, hazardous waste release, toxic gas release, flammable liquid storage, chlorine release where applicable, incinerator abnormal operation, air pollution control system failure, wastewater overflow, fuel leakage, road accident, worker injury, natural disaster, and community-related emergency.

9.3.1 Types of Possible Emergency

The following emergency scenarios may occur at the proposed TSDF facility:

Emergency Type	Possible Cause	Possible Impact
Fire	Flammable liquid, combustible waste, electrical fault, hot work	Injury, smoke, property damage, emission
Explosion	Vapour accumulation, incompatible chemical reaction, pressurized container	Severe injury, structural damage
Chemical spill	Container rupture, poor handling, transfer failure	Soil/water contamination, worker exposure
Fuel spill	Tank leakage, overfilling, pipe or hose failure	Fire risk, soil contamination
Fire risk, soil contamination	Chlorine leak, incompatible waste reaction, acid gas release	Respiratory hazard, evacuation

Waste leakage	Damaged container, improper storage, accident	Soil contamination, odour, exposure
Incinerator malfunction	Low temperature, flame failure, overfeeding	Smoke, high CO, emission exceedance
APC system failure	Scrubber failure, bag filter damage, ID fan trip	Air pollution and regulatory non-compliance
ETP/STP failure	Pump failure, overflow, poor treatment	Water pollution and odour
Road accident	Vehicle movement, poor visibility, speeding	Injury, spill, traffic disruption
Worker injury	Fall, burn, electric shock, equipment accident	Injury or fatality
Natural disaster	Earthquake, storm, lightning, flood	Structural damage, spill, power failure
Community emergency	Odour, smoke, traffic accident, off-site concern	Public complaint and response requirement

9.3.2 Emergency Classification

Emergency Level	Description	Response Requirement
Level 1 – Minor Emergency	Small incident confined to immediate work area; no serious injury or off-site impact	Controlled by trained site personnel using local resources
Level 2 – Site Emergency	Incident affecting a larger area within the facility; may require partial evacuation and emergency team response	Emergency Response Team activated; management informed
Level 3 – Major Emergency	Major fire, toxic release, explosion, serious injury, or potential off-site impact	Full emergency plan activated; external agencies informed
Level 4 – Off-site Emergency	Emergency has crossed or may cross project boundary and affect community or environment	External emergency services, local administration, and regulatory authority involvement required

9.3.3 Risks Associated with Project Activities

The purpose of this section is to identify the major risks associated with project activities during the construction and operation phases, as well as risks arising from external and meteorological emergencies. Special attention has been given to toxic gas release, fire and explosion risk, seismic vulnerability, and high-risk zones within the facility.

Risk identification has been carried out considering:

Consideration	Description
Project activity	Construction, operation, maintenance, waste handling, transport

Hazard source	Chemical, fuel, waste, equipment, electrical, weather, seismic
Receptor	Workers, contractors, visitors, surrounding community, environment
Impact pathway	Air emission, spill, runoff, fire, explosion, exposure, accident
Control requirement	Prevention, preparedness, emergency response, monitoring

9.3.3.1 Construction Phase

During the construction phase, the major risks will be related to civil works, land development, backfilling, excavation, structural works, equipment movement, material storage, welding, electrical work, working at height, and construction traffic. These risks are generally temporary but may become significant if not properly controlled.

Major Construction Phase Risks

Activity	Potential Risk	Possible Impact
Site clearing and grading	Dust generation, uneven ground, vegetation removal	Air pollution, worker slip/trip, soil erosion
Backfilling and compaction	Dust, noise, vibration, equipment movement	Worker exposure, community disturbance
Excavation and trenching	Collapse, fall into trench, water accumulation	Serious injury or fatality
Foundation work	Open pits, rebar injury, concrete handling	Worker injury
Structural work	Work at height, falling object	Serious injury
Welding and cutting	Fire, burn, eye injury, fumes	Worker injury, fire hazard
Electrical installation	Electric shock, short circuit, fire	Injury, equipment damage
Crane and lifting work	Falling load, crane instability	Serious injury, property damage
Heavy vehicle movement	Collision, reversing accident, road damage	Injury, traffic disturbance
Construction material storage	Collapse, obstruction, dust	Worker injury, site disorder
Fuel storage for equipment	Spill, leakage, fire	Soil contamination, fire risk
Concrete mixing/washing	Alkaline wash water, sediment runoff	Water pollution
Temporary worker facility	Poor sanitation, waste accumulation	Health risk, odour
Hot work near combustible material	Ignition and fire	Fire damage and injury

Construction Phase Emergency Risk Matrix

Hazard	Likelihood	Consequence	Risk Level	Control Measures
Dust from earthwork	Likely	Minor / Moderate	Medium	Water spraying, covering materials, speed control
Excavation collapse	Unlikely	Major	Medium / High	Shoring, barricading, safe slope, permit system
Fall from height	Possible	Major	High	Scaffold inspection, full body harness, guardrails
Welding fire	Possible	Major	High	Hot work permit, fire watch, extinguisher
Electrical shock	Unlikely	Major	Medium	Licensed electrician, lockout/tagout, proper earthing
Vehicle accident	Possible	Major	High	Speed limit, flagman, traffic route, reverse alarm
Fuel spill	Possible	Moderate	Medium	Bunded storage, spill kit, trained handling
Concrete wash discharge	Possible	Moderate	Medium	Wash pit, sediment control, no direct discharge
Poor sanitation	Possible	Minor / Moderate	Medium	Toilets, drinking water, waste collection
Noise exposure	Likely	Minor / Moderate	Medium	Equipment maintenance, PPE, restricted work hours

Construction Phase Mitigation Measures

Risk Area	Mitigation Measures
Site access	Provide controlled entry, security gate, vehicle log and visitor register
Excavation	Barricade all trenches, provide safe access and avoid edge loading
Work at height	Use certified scaffold, lifeline, safety harness and fall protection
Hot work	Apply hot work permit, keep fire extinguisher and appoint fire watch
Equipment operation	Use trained operators and maintain daily equipment checklist
Traffic movement	Install speed limit, signage, flagman and designated internal route
Fuel and chemical use	Store in bunded area with spill kit and no smoking sign
Electrical safety	Ensure proper earthing, circuit protection and isolation before repair
Worker safety	Provide PPE, toolbox meeting, first aid and emergency contact
Waste and wastewater	Segregate construction waste and control wash water discharge
Community safety	Maintain road cleanliness, traffic control and complaint register

9.3.3.2 Operation Phase

The operation phase will involve the most significant risk elements of the TSDF project because of the nature of activities such as hazardous waste receiving, storage, segregation, treatment, incineration, air pollution control, wastewater treatment, ash handling, residue management, laboratory analysis, chemical storage, fuel storage, and internal transportation.

Operational risks may affect workers, facility infrastructure, the surrounding community, and the environment if not properly controlled.

Major Operation Phase Risks

Activity / Area	Potential Risk	Possible Impact
Waste receiving	Arrival of unknown, undocumented or incompatible waste	Fire, toxic release, wrong treatment
Waste unloading	Container damage, leakage, spill	Worker exposure, soil contamination
Waste segregation	Contact with hazardous material, sharp objects, reactive waste	Injury, exposure, reaction
Waste storage	Leakage, odour, incompatible reaction, fire	Environmental contamination, emergency
Flammable waste storage	Vapour release, ignition, pool fire	Thermal radiation, injury, property damage

Chemical storage	Spill, toxic exposure, corrosion	Worker injury, contamination
Chlorine or chlorine-containing chemical, if applicable	Toxic gas release	Respiratory hazard, evacuation
Incinerator operation	High temperature, flame failure, incomplete combustion	Fire, smoke, high CO, emission exceedance
Air Pollution Control System	Scrubber/filter failure, ID fan trip	Air pollution, stack emission exceedance
Ash and residue handling	Dust, heavy metal exposure, spill	Worker exposure, soil contamination
ETP/STP operation	Overflow, poor treatment, chemical dosing failure	Water pollution, odour
Fuel storage and transfer	Spill, leakage, fire	Soil contamination, fire
DG generator operation	Fire, noise, exhaust	Worker/community disturbance
Laboratory work	Chemical spill, glass breakage, exposure	Injury, contamination
Maintenance work	Confined space, hot work, mechanical injury	Serious occupational accident
Internal vehicle movement	Collision, waste spill	Injury, release of hazardous material

Operation Phase Emergency Risk Matrix

Hazard	Likelihood	Consequence	Risk Level	Required Control
Waste container leakage	Possible	Moderate	Medium	Inspection, secondary containment, overpack drum
Incompatible waste reaction	Unlikely	Major	Medium / High	Waste compatibility check, segregation, lab testing
Fire in waste storage	Unlikely	Major	Medium / High	Fire detection, segregation, fire extinguishers, no ignition
Fuel pool fire	Rare / Unlikely	Major	Medium	Bunding, fire protection, ignition control
Toxic gas release	Rare / Unlikely	Major	Medium / High	Ventilation, detector, PPE, emergency response
Incinerator high CO	Possible	Moderate / Major	Medium / High	Temperature control, feed control, monitoring
APC failure	Possible	Major	High	Preventive maintenance, interlock, backup system
Stack emission exceedance	Possible	Major	High	CEMS/manual monitoring, shutdown procedure
ETP overflow	Possible	Moderate	Medium	Standby pump, holding tank, alarm system
Ash dust exposure	Possible	Moderate	Medium	Enclosed handling, PPE, dust suppression
Worker chemical exposure	Possible	Moderate / Major	Medium / High	PPE, SDS, training, eyewash/shower
Road accident inside facility	Possible	Moderate / Major	Medium / High	Traffic route, speed control, trained drivers

Operation Phase Mitigation Measures

Risk Area	Mitigation Measures
Waste acceptance	Accept only approved waste with manifest, source details and inspection
Waste characterization	Conduct laboratory testing where required before treatment
Compatibility control	Maintain waste compatibility chart and separate incompatible waste
Storage design	Use covered, ventilated, bunded and impervious storage areas
Fire protection	Install extinguishers, hydrants, alarms, firewater system and emergency access
Incinerator safety	Maintain temperature control, feed control, interlock and safe shutdown procedure
APC system	Maintain scrubber, bag filter, activated carbon dosing, ID fan and monitoring system
Stack monitoring	Conduct continuous or periodic stack emission monitoring
Wastewater control	Operate ETP/STP with monitoring, holding capacity and no uncontrolled discharge
Chemical safety	Maintain SDS, PPE, eyewash, emergency shower, ventilation and labeling
Ash/residue handling	Store in sealed containers and test before final disposal
Worker safety	Provide training, PPE, permit-to-work, first aid and health monitoring
Emergency response	Maintain fire, spill, toxic release and evacuation procedures
Documentation	Maintain waste manifest, incident register, maintenance log and monitoring reports

9.3.3.3 External and Meteorological Emergencies

External and meteorological emergencies are events that may originate outside the direct control of the facility but can affect project operations, worker safety, infrastructure, waste containment, emergency response and environmental protection. These may include heavy rainfall, flooding, storm, strong wind, tornado, lightning, extreme heat, road accident outside the facility, community unrest, nearby fire, utility failure and external security threats.

Although the project site is located inland and is not directly exposed to coastal storm surge, seasonal heavy rainfall, localized waterlogging, lightning, strong wind and severe local storms may be relevant to the project area.

External and Meteorological Emergency Risks

Emergency Type	Possible Impact on Project
Heavy rainfall	Waterlogging, contaminated runoff, drainage overflow
Flooding / local waterlogging	Waste storage impact, road access disruption, electrical risk
Strong wind / storm	Roof damage, fallen trees, loose material movement
Tornado / nor'wester	Sudden structural damage, flying objects, worker injury
Lightning	Electrical damage, fire, worker injury

Extreme heat	Worker heat stress, dehydration
External road accident	Waste transport interruption, spill, traffic problem
External fire nearby	Smoke, access restriction, emergency escalation
Utility failure	Power loss, pump failure, APC/ETP interruption
Security threat / unauthorized entry	Safety and waste control risk

Mitigation and Preparedness Measures

Emergency	Preparedness / Response Measures
Heavy rainfall	Clean drains before monsoon, maintain stormwater system and emergency pumps
Waterlogging	Keep waste storage elevated and protected; isolate contaminated water
Strong wind	Secure loose materials, strengthen roof and stop outdoor work during warning
Tornado / local storm	Provide safe shelter area and emergency communication
Lightning	Install lightning protection and earthing system; stop outdoor work during storm
Extreme heat	Provide drinking water, shaded rest area and work-rest schedule
Road accident	Emergency transport plan, driver training and spill response kit
Utility failure	Standby generator, UPS for critical control and safe shutdown procedure
External fire	Coordinate with Fire Service and restrict access if required
Security threat	Maintain boundary control, CCTV, gate security and emergency contact

Meteorological Monitoring

Parameter	Purpose
Rainfall	Drainage and flood preparedness
Wind speed	Dust, odour, smoke and storm risk
Wind direction	Emergency plume direction and evacuation planning
Temperature	Worker heat stress monitoring
Relative humidity	Dust control and comfort condition
Lightning warning	Outdoor work safety

9.3.3.4 Release of toxic gases, blasting and explosion and potential sources of fire

The TSDF facility may face risk of toxic gas release, explosion or fire due to chemical handling, flammable liquid storage, incompatible waste reaction, incinerator malfunction, electrical faults, hot work, and fuel storage. These hazards require strict prevention and emergency response planning.

The term **blasting** in this section refers to sudden pressure release, explosion-like event, or explosive reaction caused by incompatible substances, pressurized containers, aerosol cans,

gas cylinders, or flammable vapour ignition. No deliberate blasting activity is expected during normal TSDF operation.

Potential Toxic Gas Release Sources

Source	Possible Gas / Emission	Cause
Chlorine or chlorine-containing chemicals	Chlorine gas	Cylinder/container leak, reaction with acids
Acid and incompatible waste	Acid fumes, chlorine or other toxic gases	Mixing with reactive substances
Organic waste decomposition	Odour, ammonia, hydrogen sulphide in limited cases	Poor storage, anaerobic decomposition
Incinerator malfunction	CO, smoke, acid gases, VOCs	Incomplete combustion, low temperature
APC system failure	Particulate and acid gas release	Scrubber/filter malfunction
Chemical storage	Toxic vapour	Container damage, poor ventilation
ETP/STP	Odour, gas generation	Poor treatment, sludge accumulation
Laboratory	Chemical vapour	Spill, reaction, poor handling

Potential Explosion / Blasting Sources

Source	Possible Cause	Possible Impact
Flammable liquid storage	Vapour ignition	Flash fire, pressure wave, burn injury
Aerosol cans	Heating or incineration without proper control	Bursting or explosion
Pressurized cylinders	Mechanical damage, fire exposure	Cylinder rupture
Incompatible waste	Chemical reaction	Heat, gas generation, explosion
Waste feed to incinerator	Unknown explosive/reactive material	Furnace disturbance, equipment damage
Fuel system	Leakage and ignition	Fire/explosion
Electrical room	Short circuit	Fire and equipment damage
Dusty combustible material	Dust ignition in confined condition	Fire or explosion risk

Potential Fire Sources

Fire Source	Cause
Flammable liquid tank	Spill and ignition
Fuel unloading area	Hose leakage, static electricity
Combustible waste storage	Heat generation, incompatible mixing
Incinerator fuel system	Burner fault, fuel leak

Electrical panels	Short circuit, overload
Generator room	Fuel leakage, overheating
Welding/hot work	Sparks near combustible material
Laboratory	Chemical reaction, flame or heating equipment
Vehicle area	Engine fire, fuel leak
Smoking	Unauthorized smoking near hazardous areas

Control Measures for Toxic Gas, Explosion and Fire

Risk Area	Control Measures
Toxic gas release	Ventilation, gas detector where required, chemical segregation, PPE, emergency evacuation
Chlorine hazard	Secure cylinder, leak kit, detector, emergency respirator and SDS
Incompatible waste	Waste compatibility chart, laboratory screening and separate storage
Aerosol cans	Segregate and handle separately; avoid uncontrolled incineration
Flammable liquid	Bunding, earthing, bonding, no smoking and fire protection
Fuel transfer	SOP, trained operator, spill kit and emergency shut-off
Electrical system	Earthing, circuit breaker, inspection and restricted access
Hot work	Hot work permit, fire watch and extinguisher
Incinerator	Feed control, temperature monitoring, emergency shutdown
APC system	Preventive maintenance, alarm and stack monitoring
Emergency response	Fire drill, spill drill, toxic release drill and evacuation plan

Emergency Response to Toxic Gas Release

Step	Action
Step 1	Raise alarm and stop work immediately
Step 2	Evacuate personnel from affected and downwind areas
Step 3	Move workers upwind and away from low-lying areas
Step 4	Isolate source only by trained personnel with proper PPE
Step 5	Inform Plant Manager, HSE Officer and Emergency Response Team
Step 6	Call external emergency services if release is significant
Step 7	Provide medical support to exposed persons
Step 8	Monitor air quality before declaring safe
Step 9	Investigate root cause and implement corrective action

Emergency Response to Fire / Explosion

Step	Action
Step 1	Raise alarm and activate emergency response
Step 2	Stop waste feed, fuel transfer, electrical supply or chemical handling if safe
Step 3	Evacuate non-essential personnel to muster point
Step 4	Use correct extinguisher/fire system by trained team only
Step 5	Call Fire Service for major or uncontrolled fire
Step 6	Prevent firewater from entering drains or outside areas

Step 7	Account for all personnel
Step 8	Inspect damaged area and control remaining hazards
Step 9	Collect contaminated firewater and fire residue for treatment/disposal
Step 10	Restart only after safety and environmental clearance

9.3.3.5 Seismic Vulnerability

Seismic vulnerability refers to the potential impact of earthquake or ground shaking on project structures, equipment, storage systems, utilities, pipelines, tanks and safety systems. Although earthquake events are not frequent, Bangladesh has regional seismic risk due to its tectonic setting. For a TSDF facility, seismic vulnerability is important because structural damage may lead to secondary hazards such as waste leakage, chemical spill, fuel release, fire, wastewater overflow, stack damage or worker injury.

Seismically Vulnerable Components

Project Component	Possible Seismic Impact
Waste storage shed	Structural damage, container fall, leakage
Chemical storage	Container damage, spill, toxic release
Flammable liquid storage	Tank movement, pipe rupture, leakage
Incinerator foundation	Alignment problem, equipment stress
Stack	Structural vibration, cracking, collapse risk
APC ducting	Joint failure, leakage, misalignment
ETP/STP tanks	Cracking, overflow, pipe damage
Electrical room	Short circuit, fire, shutdown
Laboratory	Chemical container fall, glass breakage
Internal roads	Cracks, access difficulty
Boundary wall	Collapse and security risk
Worker areas	Falling objects and evacuation risk

Seismic Risk Controls

Risk Area	Control Measures
Structural design	Follow Bangladesh National Building Code and seismic design requirements
Stack and tall structures	Design considering seismic and wind load
Tanks and vessels	Provide anchoring, stable foundation and flexible pipe connection
Waste storage	Avoid unstable stacking; use racks and anti-fall measures
Chemical storage	Secure shelves and containers; separate incompatible chemicals
Electrical safety	Install emergency shut-off, proper earthing and fire protection
Emergency evacuation	Mark evacuation routes and muster points
Training	Conduct earthquake response training and drills
Post-earthquake inspection	Inspect buildings, tanks, pipes, incinerator, APC, ETP/STP before restart

Emergency stock	Maintain spill kit, first aid, emergency lighting and communication

9.3.3.6 High Risk Zones and Locations

High-risk zones are areas within the project where the probability or consequence of emergency events is comparatively higher due to hazardous materials, high temperature, fuel, chemicals, electrical systems, heavy equipment, confined space, or pollution control operations. These zones shall be clearly identified in the site layout, marked with signage, access-controlled, monitored and included in emergency response planning.

Proposed High Risk Zones

Zone / Location	Key Risk	Control Requirement
Waste receiving area	Unknown waste, leakage, vehicle accident	Inspection, manifest verification, spill kit
Waste segregation area	Sharp object, exposure, incompatible waste	PPE, segregation protocol, supervision
Hazardous waste storage	Fire, leakage, toxic release, reaction	Bunding, ventilation, labeling, fire control
Flammable liquid storage	Spill, pool fire, thermal radiation	Bund, no smoking, fire protection, earthing
Chemical storage	Spill, toxic vapour, chemical burn	Segregation, SDS, PPE, eyewash, ventilation
Chlorine storage, if applicable	Toxic gas release	Detector, ventilation, leak kit, restricted access
Incinerator area	High temperature, fire, emission, equipment failure	Interlock, monitoring, PPE, shutdown system
Fuel feeding/burner area	Fuel leak and fire	Leak check, isolation valve, fire protection
APC system area	Dust, chemical exposure, equipment failure	Maintenance, PPE, monitoring
Stack and duct area	Hot surface, emission, height risk	Restricted access, insulation, fall protection
Ash/residue handling area	Dust, heavy metal exposure	Sealed handling, PPE, dust control
ETP/STP area	Chemical exposure, overflow, sludge	Bunding, PPE, drainage control
Laboratory	Chemical exposure, glass breakage	SDS, PPE, eyewash, controlled access
DG generator/electrical room	Fire, shock, noise	Earthing, fire extinguisher, restricted access
Workshop/maintenance area	Hot work, mechanical injury	Permit system, guarding, fire watch
Internal roads and gate	Vehicle accident, spill	Speed control, signage, traffic management
Confined spaces	Oxygen deficiency, toxic gas	Permit, gas testing, standby rescue

High Risk Zone Management

Management Requirement	Description
Signage	Display hazard signs, PPE requirement and emergency instructions
Access control	Allow only authorized and trained personnel
PPE requirement	Provide area-specific PPE
Emergency equipment	Place fire extinguisher, spill kit, eyewash or gas detector as required
Inspection	Conduct routine HSE inspection
Monitoring	Monitor air, noise, emission, leakage or gas where applicable
Housekeeping	Keep high-risk areas clean and free from obstruction
Permit-to-work	Apply for hot work, confined space, electrical work and height work
Emergency route	Keep access road and evacuation route clear
Training	Provide job-specific and emergency response training
Documentation	Maintain inspection, maintenance and incident records

High Risk Zone Emergency Control Matrix

High Risk Zone	Main Emergency	Immediate Response
Waste receiving	Unknown waste spill	Isolate vehicle, stop unloading, apply spill control
Waste storage	Fire or reaction	Evacuate area, isolate waste, activate fire response
Flammable storage	Pool fire	Raise alarm, isolate fuel, use foam/dry chemical, call Fire Service if needed
Chemical storage	Spill or toxic vapour	Evacuate, wear PPE, contain spill, ventilate area
Chlorine storage	Gas leak	Evacuate downwind area, move upwind, trained response only
Incinerator	Abnormal combustion	Stop waste feed, maintain safe shutdown and inspect
APC system	Emission exceedance	Stop/reduce feed, inspect scrubber/filter/fan
ETP/STP	Overflow	Stop discharge, divert to holding, repair pump
Ash area	Dust release	Stop handling, suppress dust, collect safely
Electrical room	Fire/shock	Isolate power, use CO_2/DCP extinguisher
Internal road	Accident/spill	Stop traffic, rescue, contain spill
Confined space	Worker emergency	Do not enter without rescue plan and PPE

Summary Risk Control Measures

Risk Type	Key Control
Construction accident	PPE, training, supervision, permit system
Operational waste hazard	Manifest, testing, segregation and controlled storage

Toxic gas release	Ventilation, detector, PPE, evacuation and emergency response
Fire and explosion	Bunding, fire system, ignition control and hot work permit
Chemical spill	Secondary containment, SDS, spill kit and trained handlers
Incinerator emergency	Temperature control, interlock, feed control and safe shutdown
APC failure	Preventive maintenance, alarm and emission monitoring
Seismic risk	BNBC-compliant design, anchoring and post-event inspection
Meteorological emergency	Drainage, lightning protection, storm preparedness
High-risk zones	Signage, access control, monitoring and emergency equipment

9.3.4 Risk Management Plan

The Risk Management Plan for the **Sheam TSDF BD Ltd. TSDF Project** has been developed to prevent, control, respond to, and recover from potential emergency situations during construction, operation, maintenance, waste transportation, and abnormal operating conditions. The plan focuses on the protection of workers, surrounding communities, environment, project assets, and regulatory compliance.

The Risk Management Plan covers emergency warning systems, surveillance, training, response procedures, logistics, manpower, PPE, chain of command, reporting, evacuation, fire and hazard fighting, ammonia leakage response, waste transportation emergency response, organizational setup, communication network, and verification of emergency preparedness activities.

The plan shall be implemented by Sheam TSDF BD Ltd. through the Plant Manager, HSE Officer, Environmental Officer, Waste Management Officer, Emergency Response Team, Security Team, Maintenance Team, Fire Fighting Team, First Aid Team, and trained workers.

9.3.4.1 Warning alarm systems

A reliable warning alarm system shall be installed to alert workers, visitors, contractors, drivers, and emergency response teams during fire, toxic gas release, chemical spill, explosion risk, major injury, flood, earthquake, or other emergency conditions.

The alarm system shall cover critical areas such as waste receiving, hazardous waste storage, chemical storage, flammable liquid storage, incinerator area, APC system, ETP/STP, laboratory, electrical room, generator area, administrative building, security gate, and worker facilities.

9.3.4.2 Surveillance

Surveillance is a key component of the Risk Management Plan for the proposed Sheam TSDF BD Ltd. project. The purpose of surveillance is to detect abnormal conditions, unsafe acts, unauthorized access, equipment malfunction, waste leakage, fire risk, chemical spill, toxic gas release, emission abnormality, wastewater overflow, and other emergency indicators at an early stage.

Surveillance shall be maintained continuously during the operation phase and regularly during the construction phase. High-risk zones such as waste receiving area, hazardous waste storage, chemical storage, flammable liquid storage, incinerator area, air pollution control system, ETP/STP, laboratory, ash/residue handling area, electrical room, generator room, internal roads, and main gate shall be brought under surveillance.

Surveillance Area	Monitoring Requirement
Main gate and security post	Vehicle entry, visitor entry, waste transport movement, unauthorized access
Waste receiving area	Waste manifest, container condition, leakage, odour, spill, unknown waste
Hazardous waste storage	Container integrity, labeling, segregation, fire risk, leakage
Chemical storage	Spill, ventilation, compatibility, SDS availability, container condition
Flammable liquid storage	Leakage, bund condition, no-smoking compliance, fire protection
Incinerator area	Abnormal temperature, smoke, fuel leakage, unsafe operation
APC system	Scrubber, bag filter, ID fan, ducts, reagent dosing, CEMS alarm
Stack area	Visible smoke, abnormal emission, plume condition
ETP/STP	Overflow, odour, chemical dosing, pump failure, abnormal discharge
Ash/residue area	Dust release, spillage, container condition, worker PPE
Electrical and generator room	Fire risk, overheating, fuel leak, unauthorized entry
Laboratory	Chemical spill, exposure risk, glass breakage, fire risk
Internal roads	Speeding, collision risk, waste transport safety
Boundary area	Unauthorized entry, external fire, community interface issues

9.3.4.3 Training Programs

Training programs shall be conducted to ensure that all workers, supervisors, contractors, drivers, operators, emergency response team members and security personnel understand the hazards associated with TSDF activities and are capable of responding effectively during normal, abnormal and emergency conditions.

Training shall be provided before deployment and refreshed periodically. Special training shall be provided for workers involved in waste handling, incinerator operation, chemical storage, flammable liquid handling, ETP/STP operation, laboratory work, transportation and emergency response.

Training Program	Participants	Frequency
General HSE induction	All	Before site entry

Waste handling and segregation	Waste handlers, supervisors, operators	
Hazardous waste compatibility	Waste management team, laboratory team	
Fire safety and firefighting	Fire team, operators, security, supervisors	
Spill response training	Waste team, chemical handlers, HSE team	
Chemical handling and SDS awareness	Chemical handlers, lab staff, ETP/STP operators	
Ammonia leakage response	Emergency team and relevant operators	
Toxic gas release response	Emergency response team	
Incinerator emergency shutdown	Incinerator operators and maintenance team	
APC system emergency response	Operators, maintenance and environmental team	
First aid training	Selected workers and supervisors	
PPE use and maintenance	All relevant workers	
Working at height	Construction and maintenance workers	
Confined space safety	Maintenance and HSE team	
Electrical safety and lockout/tagout	Electrical and maintenance workers	
Waste transportation emergency	Drivers, transport supervisor, waste team	
Evacuation drill	All site personnel	
Emergency mock drill	Emergency response team and workers	

9.3.4.4 Response (Contingencies)

Emergency response contingencies shall be prepared for all credible emergency scenarios. The purpose of contingency response is to control the emergency at source, protect life, prevent environmental release, minimize property damage and restore safe conditions.

Each contingency procedure shall clearly define the emergency type, alarm method, immediate response, responsible personnel, required PPE, equipment, evacuation requirements, external communication and reporting procedure.

Emergency Scenario	Immediate Response

Fire	Raise alarm, isolate fuel/electricity if safe, evacuate, use suitable extinguisher
Chemical spill	Stop source, wear PPE, contain spill, prevent drain entry, collect contaminated material
Fuel spill	Stop transfer, isolate ignition sources, use absorbent, close drains
Ammonia leakage	Evacuate affected area, move upwind, isolate leak by trained personnel only
Toxic gas release	Evacuate downwind area, use respiratory protection by trained responders
Waste container leakage	Isolate container, overpack or transfer safely, clean area
Incompatible waste reaction	Stop handling, isolate area, consult technical team
Incinerator malfunction	Stop waste feeding, stabilize operation, initiate safe shutdown if required
APC failure	Stop or reduce feed, inspect scrubber/filter/fan, conduct emission check
ETP/STP overflow	Stop discharge, divert to holding tank, repair system
Ash/residue spill	Stop handling, suppress dust, collect in sealed container
Worker injury	Provide first aid, call ambulance if required, report incident
Storm/lightning	Stop outdoor work, secure materials, move personnel to safe shelter
Earthquake	Evacuate after shaking, inspect facility before restart

9.3.4.5 Support (Logistics and Manpower)

Effective emergency response at the proposed TSDF facility shall depend on the availability of adequate logistics, trained manpower, equipment, communication support, and coordination arrangements. The facility management shall ensure that sufficient resources are available at all times to respond promptly to fire, chemical leakage, waste spillage, explosion risk, occupational accident, natural disaster, or emergency during waste transportation.

The following logistical arrangements shall be maintained within the facility:

a. **Emergency Vehicles and Transport Support**
b. First Aid and Medical Support
c. Firefighting Logistics
d. Spill Control and Containment Materials
e. Communication Equipment
f. Emergency Power and Lighting
g. Evacuation and Assembly Support
h. Incident Controller

9.3.4.6 Personal Protective Equipment

Personal Protective Equipment (PPE) shall be provided to all workers, operators, emergency response personnel, waste handlers, maintenance staff, laboratory personnel, and visitors, as applicable, to protect them from occupational hazards associated with waste handling,

chemical exposure, fire, heat, dust, fumes, biological contamination, sharp materials, noise, and accidental spills.

The TSDF facility shall ensure that appropriate PPE is selected based on the nature of work, type of waste handled, exposure risk, and emergency scenario. Use of PPE shall be mandatory in all designated operational and hazardous areas.

Purpose of PPE

a. protect workers from direct contact with hazardous, infectious, corrosive, toxic, flammable, or contaminated waste;

b. reduce exposure to dust, smoke, fumes, vapours, aerosols, and odour;

c. prevent injury from sharp objects, hot surfaces, moving equipment, falling materials, and splashes;

d. support safe emergency response during fire, leakage, spillage, rescue, evacuation, and waste transportation incidents;

e. ensure compliance with occupational health and safety requirements.

Types of PPE Required

PPE Type	Application
Safety helmet	Protection from falling objects and head injury
Safety shoes/gum boots	Protection from sharp objects, chemicals, slippery surfaces, and waste contact
Chemical-resistant gloves	Handling hazardous waste, chemicals, contaminated containers, and spill materials
Heat-resistant gloves	Incinerator operation, hot surfaces, ash handling, and maintenance
Safety goggles	Protection from chemical splash, dust, and flying particles
Face shield	Chemical handling, spill response, and high splash-risk activities
Respiratory mask/N95 mask	Protection from dust, fumes, odour, and particulate matter
Half-face/full-face respirator	Chemical vapour, toxic gas, and high exposure work areas
Fire-resistant clothing	Firefighting, incinerator area, and high-temperature work
Chemical-resistant apron/suit	Chemical spill response and hazardous liquid handling
Reflective vest	Traffic movement, waste transportation, loading/unloading areas
Ear plug/ear muff	High noise areas such as generator, blower, compressor, and mechanical rooms
Safety harness	Work at height, tank maintenance, roof work, and stack-related activities

Disposable coverall	Handling infectious, contaminated, or unknown waste
SCBA set	Toxic gas, confined space, fire, smoke, or oxygen-deficient emergency situations

PPE Requirement by Work Area

- Waste Reception and Segregation Area
- Hazardous Waste and Chemical Storage Area
- Incinerator and Ash Handling Area
- Air Pollution Control Device and Stack Area
- Laboratory Area
- Fire and Emergency Response
- Waste Transportation Emergency

9.3.4.7 Chain of Commands

For the TSDF facility to ensure quick decision-making, proper coordination, and effective emergency response. During any emergency, all workers, contractors, visitors, and emergency response personnel shall follow the instructions of the designated emergency management team.

The chain of command shall define authority, responsibility, communication flow, and reporting obligations during fire, waste spillage, chemical leakage, ammonia leakage, accident, explosion risk, natural disaster, or emergency during waste transportation.

Emergency Chain of Command

Position	Key Responsibility
Plant Head	Overall command during emergency, declaration of emergency, external coordination
Operation Manager	Immediate control at incident location and supervision of response activities
Safety Officer / EHS Officer	Risk assessment, PPE compliance, evacuation support, incident documentation
Fire and Hazard Fighting Team Leader	Firefighting and hazard control operation
Spill Response Team Leader	Waste spill, chemical leakage and containment response
First Aid and Rescue Team Leader	Rescue, first aid and medical coordination
Security Team Leader	Access control, traffic control and emergency vehicle movement
Communication Officer	Internal and external communication and emergency contact activation
Department Supervisors	Headcount, worker control and area-wise emergency response

General Workers / Operators	Follow emergency instructions and report to assembly point

9.3.4.8 Reporting System

A structured reporting system will maintained to ensure that all emergencies, incidents, near misses, unsafe conditions, injuries, spills, leakages and fire events are reported, recorded, investigated and corrected.

a) Internal Reporting

Any worker or visitor who observes an emergency or unsafe condition shall immediately inform the nearest supervisor, control room, security post or Safety Officer. The supervisor shall immediately notify the Incident Controller and Emergency Coordinator.

The following incidents shall be reported immediately:

- Fire or smoke generation;
- Explosion or risk of explosion;
- Waste spill or leakage;
- Chemical release or ammonia leakage;
- Injury, illness or accident;
- Equipment failure creating safety risk;
- Abnormal emission, odour or noise;
- Vehicle accident during waste transportation;
- Natural disaster impact;
- Unauthorized entry or security breach.

b) External Reporting

Depending on the severity of the incident, the facility management shall inform relevant external authorities and agencies, including:

- Fire Service and Civil Defence;
- Department of Environment, where applicable;
- Local administration;
- Police station;
- Nearby hospital or ambulance service;
- Utility service providers;
- Waste generator or client, if related to transported waste;
- Other regulatory authorities as required.

9.3.4.9 Evacuation

An emergency evacuation system shall be established to ensure safe and orderly movement of workers, visitors, contractors and other personnel from hazardous areas to designated safe assembly points.

Evacuation may be required during fire, explosion risk, toxic gas release, ammonia leakage, major waste spill, structural failure, earthquake, cyclone, flood, or any other emergency situation that may endanger life and safety.

When the emergency alarm is activated, all personnel shall stop work immediately, shut down equipment if safe to do so, and move toward the nearest emergency exit or evacuation route. No person shall return to the affected area until clearance is given by the Emergency Coordinator.

The evacuation process shall include:

a. activation of alarm, siren or public announcement system;
b. immediate movement through marked evacuation routes;
c. assistance to injured, disabled or trapped persons by trained rescue personnel;
d. headcount at designated assembly points;
e. restriction of entry into affected areas;
f. communication with emergency services, if required;
g. declaration of all-clear after verification of safety.

Assembly Points:

Safe assembly points shall be selected at locations away from:

- waste storage area;
- chemical storage area;
- fuel storage area;
- incinerator and boiler area;
- emission stack and APCD area;
- potential fire or explosion zone.

Evacuation Route and Signage

Evacuation routes shall be kept free from obstruction at all times. Emergency exit signs, directional arrows, emergency lights, layout maps and assembly point signs shall be displayed at visible locations.

Evacuation maps shall be installed at:

- main entrance;
- administrative building;

- waste reception area;
- laboratory;
- incinerator control room;
- chemical storage area;
- worker rest area;
- security gate.

9.3.4.10 Fire/ Hazard Fighting

Fire and hazard fighting arrangements shall be established to control fire, smoke, explosion risk, chemical hazard, fuel hazard, electrical fire and waste-related combustion incidents. The TSDF facility shall maintain appropriate firefighting systems and trained personnel to respond to emergencies.

Possible Fire and Hazard Sources

Potential fire and hazard sources at the facility may include:

- combustible waste storage;
- flammable liquid or fuel storage;
- incinerator and high-temperature equipment;
- electrical panels and cables;
- generator room;
- chemical storage;
- waste transport vehicles;
- hot ash and residue handling;
- welding, cutting or maintenance work.

Firefighting Equipment

Equipment	Application
ABC dry powder extinguisher	General fire involving solid, liquid and electrical sources
CO_2 extinguisher	Electrical panels, control rooms and sensitive equipment
Foam extinguisher	Flammable liquid and fuel-related fire
Fire hose reel and hydrant	Larger fire control and cooling support
Sand bucket	Small fuel or chemical spill-related fire control
Fire blanket	Small localized fire and emergency use
Fire alarm and smoke detector	Early warning
Emergency lighting	Safe movement during power failure
Fire pump and water storage	Continuous firefighting support

Fire Response Procedure

In case of fire or visible smoke, the person identifying the incident shall raise the alarm immediately. Trained firefighting personnel shall respond using suitable firefighting

equipment, only when it is safe to do so. Non-essential personnel shall evacuate to the assembly point.

The fire response system shall include:

Alarm activation;

b. immediate shutdown of nearby equipment, if safe;
c. isolation of electrical supply, fuel line or chemical source, if required;
d. use of appropriate fire extinguishing equipment by trained personnel;
e. evacuation of non-essential persons;
f. calling Fire Service and Civil Defence for major fire;
g. prevention of fire spread to waste storage, fuel storage and chemical storage;
h. post-fire inspection before restart of operation.

Hazard Fighting

Hazard fighting shall include response to chemical spill, gas leakage, waste leakage, abnormal emission, toxic exposure and equipment failure. Only trained personnel with proper PPE shall enter hazardous zones. Hazardous areas shall be isolated using barricades and warning signs.

Fire and hazard response activities shall be documented and reviewed by the EHS team.

9.3.4.11 Emergency Response during Waste Transportation

Emergency response during waste transportation is essential to manage accidents, spills, leakage, fire, road incident or exposure during movement of waste from the source to the TSDF facility.

All waste transportation vehicles shall follow approved routes, safe driving practices, proper labeling, documentation and emergency preparedness requirements.

Possible Transportation Emergencies:

Potential emergencies during transportation may include:

- vehicle accident;
- waste container leakage;
- chemical spill;
- fire in vehicle;
- exposure of driver or helper;
- unauthorized opening of waste container;
- road blockage or traffic incident;
- vehicle breakdown;
- natural disaster during transport.

9.3.4.12 Organizational Set up

An emergency organizational setup shall be established to ensure effective implementation of the emergency response plan. The organization shall include management, operation, EHS, security, maintenance, medical support and communication personnel.

Proposed Emergency Organization:

Emergency Role	Assigned Department / Person
Site Emergency Controller	Plant Head / Facility Manager
Deputy Emergency Controller	Operation Manager
Incident Controller	Shift In-Charge / Area Supervisor
Safety and EHS Coordinator	EHS Officer
Fire Response Team	Trained operation and maintenance personnel
Spill Response Team	Waste handling and EHS personnel
First Aid Team	Trained first aid personnel
Rescue and Evacuation Team	Department supervisors and security personnel
Communication Officer	Admin / Control Room Officer
Security and Traffic Control	Security team
Utility Isolation Team	Electrical and mechanical maintenance team
Documentation Team	EHS / Admin representative

Responsibilities of the Emergency Organization

a. emergency preparedness;
b. training and mock drills;
c. maintenance of emergency equipment;
d. incident response;
e. evacuation management;
f. communication with external agencies;
g. incident reporting and investigation;
h. corrective action implementation;
i. review and improvement of emergency procedures.

9.3.4.13 Communication Network

A reliable communication network shall be maintained to support emergency response, internal coordination and external reporting. Communication failure during an emergency may delay response and increase risk; therefore, multiple communication channels shall be available.

Internal Communication

- emergency alarm and siren;
- public address system;
- mobile phone;

- walkie-talkie;
- control room telephone;
- CCTV monitoring;
- emergency signage;
- shift supervisor communication chain.

External Communication

Agency	Purpose
Fire Service and Civil Defense	Fire, explosion, rescue and hazardous emergency
Hospital / Ambulance	Medical emergency
Police Station	Security, traffic and accident support
Department of Environment	Environmental incident reporting
Local Administration	Public safety and emergency coordination
Utility Providers	Electricity, gas, water or service isolation
Waste Generator / Client	Waste-specific information and coordination
Nearby Industries	Mutual emergency support, if applicable

Communication Flow During Emergency:

Incident Observer → Area Supervisor → Incident Controller → Emergency Coordinator → Internal Response Teams / External Agencies

- type of emergency;
- exact location;
- material involved;
- number of injured persons, if any;
- immediate support required;
- contact person at site.

9.3.4.14 Verification of Activities

Verification of emergency preparedness and response activities shall be conducted to ensure that all planned measures are functional, effective and ready for implementation. Verification shall include inspection, testing, drills, record review, corrective action tracking and management review.

Verification Areas:

Activity	Verification Method
Fire extinguishers and hydrants	Physical inspection and pressure check
Emergency alarms and sirens	Functional testing
Emergency lighting	Operational check
Spill kits	Inventory and condition check
PPE	Availability, condition and expiry check
First aid boxes	Medicine and material inspection

Evacuation routes	Obstruction-free condition check
Assembly points	Signage and accessibility check
Emergency contact list	Updated phone number verification
Training records	Review of attendance and competency
Mock drills	Performance evaluation
Incident reports	Corrective action tracking
Waste transport vehicles	Emergency kit and document inspection
Communication devices	Mobile, walkie-talkie and PA system check

9.3.5 Organizational Set up

An effective organizational set up shall be established for the TSDF facility to ensure proper preparedness, quick decision-making, safe emergency response, and coordinated recovery during any emergency situation. The emergency organization shall function under the direct supervision of the facility management and shall include trained personnel from operation, maintenance, EHS, security, administration, medical support, and communication units.

The organizational set up shall be designed to respond to emergencies related to fire, explosion risk, waste spillage, chemical leakage, ammonia leakage, toxic gas release, occupational injury, equipment failure, natural disaster, and emergency during waste transportation.

The emergency organization shall follow a clear command structure so that responsibilities are well defined and response activities are implemented without confusion.

9.3.5.1 Emergency Response Team (ERT)

An Emergency Response Team shall be formed at the TSDF facility to respond immediately to any emergency situation. The ERT shall consist of trained personnel who will be responsible for emergency control, firefighting, evacuation, first aid, communication, spill control, rescue, utility isolation, and coordination with external agencies.

The ERT shall remain prepared during all operational hours. For night shift, holiday, or off-hour operation, a minimum emergency response arrangement shall be maintained with clearly assigned responsibilities.

Composition of ERT

ERT Position	Main Function
Site Incident Controller	Overall control of emergency response at site
Fire / Safety Officer	Firefighting, safety control, hazard assessment and PPE compliance
Evacuation Officer	Safe evacuation and headcount at assembly point
Communication / Liaison Officer	Internal and external emergency communication
Medical Officer / First Aid Leader	First aid, casualty handling and medical coordination
Spill Response Team Leader	Waste, chemical, fuel or hazardous material spill control

Security Team Leader	Access control, crowd control and emergency vehicle movement
Maintenance / Utility Officer	Isolation of electricity, fuel, equipment and utilities
Transport Coordinator	Response support during waste transportation emergency
Documentation Officer	Incident record, photographs, report and corrective action follow-up

General Duties of ERT

a. responding immediately after emergency alarm or notification;
b. assessing the nature and severity of the emergency;
c. controlling fire, spill, leakage, exposure or unsafe condition;
d. ensuring safe evacuation of personnel;
e. providing first aid and arranging medical support;
f. communicating with Fire Service, hospital, police, Department of Environment and local authority, where required;
g. protecting workers, visitors, nearby community, property and environment;
h. preventing escalation of the incident;
i. supporting incident investigation and corrective actions;
j. participating in regular training, drills and emergency preparedness inspections.

9.3.5.2 Roles and Responsibilities of ERT

9.3.5.2.1 Site Incident Controller (SIC)

The Site Incident Controller shall be the main responsible person for controlling emergency response activities at the facility. The SIC shall normally be the Plant Manager, Facility Manager, Operation Manager, or any senior authorized person nominated by the management.

Responsibilities of Site Incident Controller

a. take immediate command after receiving emergency information;
b. assess the type, location, scale and potential impact of the emergency;
c. activate the Emergency Response Team;
d. declare emergency level and decide whether partial or full evacuation is required;
e. instruct shutdown of plant, equipment, utilities, fuel supply or electrical system, where necessary;
f. ensure that only trained and authorized personnel enter the affected area;
g. coordinate with Fire / Safety Officer, Evacuation Officer, Medical Officer and Communication Officer;
h. arrange external support from Fire Service, hospital, police, local administration, Department of Environment or other relevant agencies;
i. ensure that emergency response actions do not create additional risk to workers or community;
j. approve re-entry into the affected area after confirmation of safety;
k. initiate incident investigation after emergency control;
l. ensure preparation of incident report and corrective action plan;

m. report major incidents to the management and relevant authority as per requirement.

9.3.5.2.2 Fire/ Safety Officer

Key Focus Areas

The Fire / Safety Officer shall give special attention to:

- incinerator area;
- waste storage and segregation area;
- fuel storage area;
- chemical storage area;
- electrical panel room;
- generator room;
- ash and residue handling area;
- laboratory;
- waste transportation vehicle parking area.

9.3.5.2.3 Evacuation Officer

The Evacuation Officer shall be responsible for safe, systematic and timely evacuation of workers, visitors, contractors and other persons from affected or high-risk areas to designated assembly points.

Responsibilities of Evacuation Officer

a. guide personnel through safe evacuation routes;
b. ensure that evacuation routes and emergency exits remain clear;
c. assist elderly, injured, disabled or trapped persons, where possible and safe;
d. prevent panic during evacuation;
e. ensure that no person uses unsafe shortcuts or enters the affected area;
f. conduct headcount at assembly points through supervisors or department representatives;
g. identify missing persons and immediately report to the Site Incident Controller;
h. ensure visitors and contractors are also accounted for;
i. keep people at assembly points until further instruction;
j. coordinate with Security Team to restrict unauthorized entry;
k. support evacuation drills and training activities;
l. maintain evacuation records and drill observations.

Assembly Point Management

- located away from fire, smoke, chemical storage, fuel storage and waste storage areas;
- clearly marked with signage;
- accessible through safe routes;
- large enough for workers and visitors;
- known to all employees and contractors.

9.3.5.2.4 Communication/Liaison Officer

The Communication / Liaison Officer shall be responsible for maintaining clear, accurate and timely communication during emergency situations. This role is essential for coordination among internal response teams, facility management, external emergency agencies and relevant authorities.

Responsibilities of Communication / Liaison Officer

a. receive emergency information and inform the Site Incident Controller immediately;
b. activate emergency contact chain as instructed by the SIC;
c. communicate with Fire Service and Civil Defence, hospital, ambulance, police, local administration, Department of Environment and other agencies, as required;
d. provide accurate information about emergency type, location, material involved, number of injured persons and support required;
e. maintain communication with security gate for emergency vehicle access;
f. inform waste generator or client if the emergency involves transported or received waste;
g. maintain communication records during emergency;
h. avoid spreading unverified information;
i. support public communication only as authorized by facility management;
j. update emergency contact list regularly;
k. assist in post-incident reporting and documentation.

9.3.5.2.5 Medical Officer

The Medical Officer or designated First Aid Leader shall be responsible for providing immediate medical support to injured or exposed persons until professional medical assistance is available. Where a full-time Medical Officer is not available, trained first aiders shall be assigned for each shift.

Responsibilities of Medical Officer

a. provide immediate first aid to injured, exposed or sick persons;
b. assess the condition of casualties and prioritize treatment;
c. arrange ambulance or hospital transfer, where required;
d. coordinate with nearby hospital, clinic or emergency medical service;
e. maintain first aid boxes, stretcher, eyewash, emergency shower and medical supplies;

f. guide workers on first aid for burn, cut, chemical exposure, inhalation, eye splash, heat stress and physical injury;
g. maintain medical and injury records;
h. advise the Site Incident Controller regarding health risk and medical evacuation requirement;
i. support emergency drills related to injury and casualty handling;
j. ensure contaminated clothing is removed safely during chemical or waste exposure cases;
k. follow up on injured workers after the incident.

Medical Support Facilities

- first aid box at key locations;
- stretcher;
- emergency eyewash and shower;
- burn dressing materials;
- disposable gloves and masks;
- emergency contact list of hospitals and ambulance services;
- drinking water and basic recovery support;
- injury and treatment register.

9.3.6 Control Structure

A well-defined emergency control structure shall be established at the TSDF facility to ensure effective command, coordination, decision-making, and implementation of emergency response actions. The control structure shall operate under the leadership of the Site Incident Controller and shall include representatives from operation, EHS, maintenance, security, medical support, communication, transportation, and administration.

The purpose of the control structure is to ensure that emergency actions are taken in a disciplined, timely, and coordinated manner without confusion or duplication of responsibility.

Emergency Control Structure

Facility Head / Plant Manager
↓
Site Incident Controller
↓
Fire / Safety Officer
↓
Evacuation Officer | Communication / Liaison Officer | Medical Officer | Security Officer | Spill Response Team | Maintenance Team | Transport Coordinator

Main Functions of Control Structure

a. receiving emergency information and verifying the situation;
b. activating the Emergency Response Team;
c. declaring emergency level based on severity;
d. ensuring shutdown of affected plant or equipment, where required;
e. arranging evacuation of workers, visitors, contractors and nearby exposed persons;
f. coordinating firefighting, spill control, rescue and first aid activities;
g. communicating with external agencies and authorities;
h. ensuring access control and traffic management;
i. maintaining incident records and reporting;
j. declaring all-clear after verification of safety.

9.3.7 Assembly Point

Designated assembly points shall be established within the TSDF facility premises to ensure safe gathering of workers, visitors and contractors during emergency evacuation. The assembly points shall be located in safe areas away from major risk sources.

Selection Criteria for Assembly Point

a. safe distance from incinerator area, waste storage area, chemical storage, fuel storage, electrical room and emission stack;
b. easy access from all operational zones;
c. clear signage and visibility;
d. sufficient open space for all workers, contractors and visitors;
e. safe access for emergency vehicles;
f. location away from smoke, toxic gas release, fire spread or explosion impact zone;
g. no obstruction from vehicle movement or waste handling activities.

Assembly Point Management

The assembly point shall have:

- assembly point signage;
- emergency contact board;
- basic first aid support;
- drinking water, where possible;
- visitor and contractor attendance checking system;
- clear access for ambulance and emergency support.

9.3.8 Responsibility Matrix

A responsibility matrix shall be maintained to define the duties of each emergency response role. This matrix shall help avoid confusion during emergency situations and ensure quick action.

Activity / Function	SIC	Fire / Safety Officer	Evacuation Officer	Communication Officer	Medical Officer	Security Team	Maintenance Team
Emergency declaration	Lead	Support	Support	Support	Support	Support	Support
Emergency alarm activation	Approve / Direct	Support	Support	Support	-	Support	-
Firefighting	Monitor	Lead	Support	Inform external agency	Medical support	Access control	Utility isolation
Waste / chemical spill control	Monitor	Lead	Support	Inform authority if required	Medical support	Area restriction	Equipment support
Evacuation	Approve	Safety support	Lead	Announcement support	Casualty support	Route control	Utility shutdown
First aid and medical support	Monitor	Support	Support	Arrange ambulance	Lead	Access control	Support
External communication	Approve	Provide technical info	Provide headcount info	Lead	Medical info	Gate coordination	Utility info
Access control	Direct	Support	Support	Support	-	Lead	Support
Utility isolation	Direct	Safety verification	-	-	-	Support	Lead
Incident documentation	Approve	Provide details	Provide evacuation records	Lead	Medical records	Security records	Technical records
All-clear declaration	Lead	Safety confirmation	Headcount confirmation	Communicate	Medical clearance	Access reopening	System readiness

9.3.9 Onsite Emergency Response Initiation

Onsite emergency response shall be initiated immediately after identification of any abnormal, unsafe or emergency condition within the facility. Any worker, contractor, visitor or security personnel who notices an emergency shall immediately raise alarm and inform the nearest supervisor or control room.

Emergency response may be initiated for:

- fire or smoke;
- explosion risk;
- chemical leakage;
- ammonia leakage;
- hazardous waste spill;
- fuel spill;
- injury or occupational accident;
- toxic gas, odour or abnormal emission;
- equipment failure creating safety risk;
- vehicle accident inside the facility;
- natural disaster impact;
- security breach or unauthorized entry.

Response Initiation Procedure

a. identify the emergency condition;
b. raise alarm immediately;
c. inform area supervisor, control room or security post;
d. notify Site Incident Controller and Fire / Safety Officer;
e. activate Emergency Response Team;
f. isolate the affected area;
g. stop operation or equipment, if safe to do so;
h. evacuate non-essential personnel;
i. provide first aid to injured persons;
j. control fire, spill or leakage using trained personnel only;
k. call external support, if required;

l. record the incident and initiate investigation after control.

9.3.10 Physical Barrier, Alarm System and Access Controls

Physical barriers, alarm systems and access control arrangements shall be established to prevent unauthorized entry, reduce exposure to hazards and support emergency response.

Physical Barriers

a. waste storage area;
b. hazardous chemical storage area;
c. incinerator and APCD area;

d. fuel storage area;
e. ash and residue handling area;
f. electrical panel and generator room;
g. laboratory chemical storage area;
h. restricted emergency response zone.

Alarm System

The facility shall maintain suitable alarm and warning systems such as:

- emergency siren;
- fire alarm;
- smoke detector;
- gas detector, where required;
- public address system;
- manual call point;
- emergency lighting;
- warning signboards;
- control room notification system.

Access Control

Access control shall be maintained to prevent unauthorized entry into hazardous or emergency areas. The security team shall control entry and exit during normal operation and emergency conditions.

Access control measures shall include:

a.visitor registration system;
b. restricted access to hazardous areas;
c. entry permission for authorized workers only;
d. PPE compliance check before entering operational zones;
e. control of vehicle movement;
f. emergency gate opening for ambulance and fire service;
g. isolation of affected area during emergency.

9.3.11 Public Safety and Education Programme

A public safety and education programme shall be developed to create awareness among workers, contractors, visitors, nearby communities and relevant stakeholders about emergency preparedness, safe conduct and environmental protection.

Objectives of Public Safety Programme

a. create awareness about TSDF safety measures;
b. inform workers and visitors about emergency alarms, evacuation routes and assembly points;
c. educate nearby community about emergency communication and safety precautions;

d. reduce panic during any emergency;
e. improve coordination with local authorities and surrounding stakeholders;
f. promote responsible waste management and environmental protection.

Awareness Topics

Topic	Target Group
Emergency alarm meaning	Workers, visitors and contractors
Evacuation route and assembly point	Workers and visitors
Fire safety and prevention	Workers and contractors
Waste handling risks	Workers and transport personnel
Spill and leakage reporting	Workers and drivers
Community emergency contact	Nearby community and local stakeholders
Do's and don'ts during emergency	All relevant stakeholders
Environmental protection and hygiene	Workers and nearby community

9.3.12 External Support Requirements

As the TSDF facility may receive waste from external sources including industrial premises, healthcare units, commercial sources, customs warehouses, airports, seaports, land ports or transport routes, emergency support arrangements shall also cover external locations and off-site areas.

External Areas Covered

a. waste generator premises;
b. airport cargo or customs warehouse;
c. seaport or land port area;
d. waste loading and unloading points;
e. transportation routes;
f. temporary storage or transfer points;
g. surrounding community areas affected by transport incident.

9.3.13 External Events Perceived

External events are incidents or conditions occurring outside the TSDF facility that may affect facility operation, worker safety, waste transportation, public safety or environmental compliance. These events shall be considered in emergency planning.

Possible External Events

a. road accident involving waste transport vehicle;
b. fire or explosion at nearby industry;
c. chemical release from neighboring facility;
d. flood or waterlogging affecting access road;
e. cyclone, storm or heavy rainfall;
f. earthquake;
g. traffic blockage or road closure;
h. public unrest or security disturbance;

i. power grid failure;
j. interruption of fuel or water supply;
k. disease outbreak or public health emergency;
l. natural disaster affecting waste collection or delivery;
m. aircraft, port or customs warehouse emergency involving waste consignment.

Response to External Events

- temporary suspension of waste transport;
- route diversion;
- securing waste storage;
- additional inspection of drainage and stormwater system;
- emergency stock of fuel, water and critical materials;
- coordination with local administration and emergency agencies;
- communication with waste generators and transport contractors;
- protection of workers and nearby community.

9.3.14 Rehearsal

Regular rehearsal or mock drill shall be conducted to test the effectiveness of the emergency response plan, preparedness of personnel, functionality of equipment and adequacy of communication systems.

Purpose of Rehearsal

a. test emergency response readiness;
b. improve coordination among ERT members;
c. evaluate response time;
d. check alarm and communication systems;
e. verify evacuation routes and assembly points;
f. identify gaps in training, equipment or procedure;
g. improve confidence of workers and emergency responders.

Types of Rehearsal

- fire emergency;
- hazardous waste spill;
- chemical leakage;
- ammonia leakage;
- evacuation;
- injury and first aid;
- waste transport accident;
- power failure;
- natural disaster scenario;
- emergency communication with external agencies.

9.3.15 Safety training

Safety training shall be provided to all employees, contractors, drivers, security personnel, laboratory staff, operators, maintenance personnel and emergency response team members. Training shall ensure that all personnel understand workplace hazards, safe operating practices, emergency procedures and use of safety equipment.

Objectives of Safety Training

a. improve awareness of TSDF operational hazards;
b. ensure safe waste handling and segregation;
c. reduce accident, injury, fire and environmental risk;
d. ensure correct use of PPE;
e. prepare workers for emergency response;
f. improve compliance with legal and environmental requirements;
g. build a safety culture within the facility.

Training Topics

Training Topic	Target Participants
General safety induction	All workers, visitors and contractors
Hazardous waste handling	Waste reception, segregation and operation team
Incinerator safety	Incinerator operators and maintenance team
Fire safety and extinguisher use	All workers and ERT
Chemical handling and spill response	EHS, laboratory, storage and operation team
PPE use and maintenance	All operational workers
Emergency evacuation	All workers, visitors and contractors
First aid and casualty handling	First aid team and selected staff
Ammonia leakage response	ERT and relevant operational staff
Waste transportation emergency	Drivers, helpers and transport coordinator
Electrical safety and lockout/tagout	Maintenance and electrical team
Confined space and work at height	Relevant trained personnel
Incident reporting and near-miss reporting	All workers
Environmental compliance and pollution control	Operation, EHS and management team

Training Method

Training may be conducted through classroom sessions, toolbox meetings, practical demonstrations, mock drills, posters, safety briefings, on-the-job training and refresher courses.

Training Records

The facility shall maintain records of:

- training schedule;
- attendance sheet;
- training material;

- competency evaluation;
- drill participation;
- refresher training;
- contractor safety orientation;
- training effectiveness review.

9.3.16 Risk Mitigation Measure

Risk mitigation measures shall be implemented at the TSDF facility to prevent, minimize and control risks associated with waste handling, incineration, auxiliary fuel use, chemical storage, fire, explosion, toxic exposure, equipment failure, occupational accidents and environmental incidents. The mitigation measures shall be applied during design, construction, commissioning, operation, maintenance and emergency response phases.

The objective of risk mitigation is to ensure safe operation of the facility, protect workers and surrounding communities, prevent environmental pollution, reduce property damage and maintain regulatory compliance.

The risk mitigation approach shall include:

a. identification of hazards and risk sources;
b. elimination or reduction of hazards through engineering and administrative control;
c. use of safe operating procedures;
d. installation of fire protection and emergency systems;
e. use of proper PPE;
f. periodic training and mock drills;
g. regular inspection, monitoring and maintenance;
h. incident reporting, investigation and corrective action.

9.3.16.1 Auxiliary Fuel System

The auxiliary fuel system shall be designed and operated with proper safety controls, as fuel storage and handling may create fire, explosion, leakage and occupational safety risks. Auxiliary fuel may be required for start-up, temperature control, stable combustion and emergency operation of the incinerator.

Potential Risks from Auxiliary Fuel System

The main risks associated with the auxiliary fuel system may include:

- fuel leakage from tank, pipeline, valve or connection;
- fire due to ignition source near fuel storage or handling area;
- vapour accumulation in poorly ventilated areas;
- overfilling of fuel tank;
- accidental spill during fuel unloading or transfer;
- electrical spark or hot work near fuel system;
- failure of burner control system;
- uncontrolled fuel flow to combustion chamber;

- inadequate firefighting arrangement near fuel storage area.

Mitigation Measures for Auxiliary Fuel System

Safe Location of Fuel Storage	Fuel storage tanks shall be located at a safe distance from waste storage area, chemical storage area, incinerator building, electrical room, office area and public access points. The area shall be clearly marked as a restricted zone.
Secondary Containment	Fuel storage tanks shall be provided with suitable secondary containment or bunding arrangement to contain accidental leakage or spill. The containment capacity shall be adequate to prevent fuel from spreading to soil, drain or waterbody.
Leak Prevention and Detection	Fuel tanks, pipelines, valves and joints shall be inspected regularly for leakage, corrosion, damage or loose fittings. Any leakage shall be repaired immediately. Drip trays shall be used at likely leakage points, where applicable.
Fire Protection Arrangement	Appropriate fire extinguishers such as foam, dry powder and CO_2 type shall be available near the fuel storage and burner area. Fire hydrant or hose reel coverage shall be ensured where required.
No Smoking and Ignition Control	"No Smoking", "No Open Flame" and "Flammable Material" signboards shall be displayed in the fuel storage and fuel handling areas. Hot work shall not be permitted near fuel systems without formal work permit and safety clearance.
Safe Fuel Transfer Procedure	Fuel unloading and transfer shall be carried out by trained personnel only. The transfer operation shall be supervised to prevent overflow, spillage and unsafe handling. Transfer hoses and connections shall be checked before use.
Emergency Shut-off System	Emergency fuel shut-off valves shall be provided at suitable locations. Operators shall be trained to isolate fuel supply during emergency, fire, leakage, burner malfunction or abnormal operating condition.
Ventilation	Fuel storage and fuel handling areas shall be adequately ventilated to prevent vapour accumulation. Enclosed areas containing fuel-related equipment shall not be allowed to accumulate flammable vapour.
Electrical Safety	Electrical fittings near the fuel storage or handling area shall be suitable for the risk condition. Loose wiring, temporary electrical connection and spark-generating activities shall be strictly controlled.
Spill Control Materials	Spill kits, absorbent materials, sand, collection containers and PPE shall be available near the fuel storage area. Spilled fuel shall be collected safely and disposed of according to facility waste management procedures.
Routine Inspection and Maintenance	Fuel storage tanks, transfer pumps, pipelines, burners, valves, level indicators and safety interlocks shall be inspected and maintained periodically. Records of inspection and maintenance shall be preserved.

Training of Operators	Operators and maintenance staff shall be trained on fuel handling, fire prevention, emergency isolation, spill response, PPE use and reporting procedure.

9.3.16.2 General Control Measures

General control measures shall be implemented throughout the TSDF facility to reduce operational, environmental, occupational and emergency risks. These measures shall apply to waste reception, storage, segregation, incineration, residue handling, laboratory operation, maintenance, transportation and emergency response.

Waste Acceptance and Segregation Control	a. Waste shall be accepted only after proper documentation, inspection and identification. b. Incompatible waste shall not be mixed. c. Waste shall be segregated based on physical, chemical, hazardous, non-hazardous, recyclable, infectious, combustible and non-combustible characteristics. d. Unknown or suspicious waste shall be kept separately for verification before treatment. e. Waste containers shall be properly labeled and stored in designated areas.
Storage Control	a. Waste storage areas shall be clearly marked and access-controlled. b. Hazardous waste shall be stored in compatible containers. c. Storage areas shall have impervious flooring, drainage control and spill containment arrangement. d. Storage time shall be minimized as far as practicable. e. Combustible waste shall be stored away from ignition sources, fuel storage and electrical rooms.
Incineration Process Control	a. Incinerator operation shall be carried out by trained operators only. b. Operating temperature, waste feed rate, combustion condition and residence time shall be controlled as per design requirement. c. Overloading of incinerator shall be avoided. d. Waste shall not be fed into the incinerator if safe operating conditions are not achieved. e. Emergency shutdown procedure shall be available and known to operators. f. Air pollution control devices shall be operated together with the incinerator system. g. Stack emission monitoring and operational parameter monitoring shall be maintained.
Air Pollution Control and Monitoring	a. Air Pollution Control Device shall be maintained in operational condition.

	b. Continuous Emission Monitoring System, where applicable, shall be used to monitor key emission parameters. c. Stack emission testing shall be conducted as per regulatory requirement. d. Any abnormal emission, smoke, odour or equipment failure shall be reported immediately. e. Preventive maintenance shall be carried out for scrubber, bag filter, ID fan, ducting, stack and related equipment.
Fire and Explosion Control	a. Fire detection and firefighting equipment shall be installed at risk-prone areas. b. Fire extinguishers shall be inspected regularly. c. Flammable materials shall be stored separately and safely. d. Hot work permit system shall be implemented for welding, cutting and grinding works. e. Electrical panels shall be kept clean, dry and accessible. f. Emergency exits and firefighting access routes shall remain unobstructed.
Occupational Health and Safety Control	a. Workers shall use required PPE before entering operational areas. b. Toolbox meetings shall be conducted regularly. c. Safety signboards shall be displayed at hazardous areas. d. Work permit system shall be followed for high-risk jobs such as confined space work, hot work, electrical work and work at height. e. First aid facilities, eyewash stations and emergency showers shall be maintained. f. Workers shall be trained on hazard identification, emergency response and safe work procedure.
Spill and Leakage Control	a. Spill kits shall be available at waste reception, storage, fuel area, laboratory and transport vehicle parking area. b. Drainage systems shall be designed to prevent contaminated runoff from leaving the facility untreated. c. Spill-prone areas shall have containment arrangement. d. Spill response shall be carried out by trained personnel with appropriate PPE. e. All spills shall be reported, recorded and investigated.
Vehicle and Traffic Control	a. Vehicle movement inside the facility shall be controlled through designated routes. b. Speed limits shall be displayed and enforced. c. Loading and unloading areas shall be supervised. d. Waste transport vehicles shall carry emergency kits. e. Drivers and helpers shall be trained on emergency response during transportation.

Maintenance Control	a. Preventive maintenance schedule shall be maintained for all critical equipment. b. Lockout/tagout procedure shall be followed during maintenance of electrical or mechanical equipment. c. Defective equipment shall not be operated. d. Maintenance records shall be preserved. e. Critical spares shall be available to reduce unsafe downtime.
Environmental Control	a. Wastewater, contaminated runoff and leachate shall be collected and treated properly. b. Ash and residues shall be handled, stored and disposed of safely. c. Noise, dust, odour and emission control measures shall be implemented. d. Greenbelt development shall be maintained around the facility boundary where feasible. e. Environmental monitoring shall be carried out as per EMP requirement.

9.3.16.3 Other Safety Measures

In addition to specific and general control measures, the TSDF facility shall implement the following safety measures to strengthen overall risk prevention and emergency preparedness.

Emergency Preparedness	a. Emergency Response Plan shall be prepared, displayed and communicated to all relevant personnel. b. Emergency contact numbers shall be displayed at control room, security gate, administrative office, waste reception area, incinerator control room and storage areas. c. Emergency Response Team shall be formed and trained. d. Mock drills shall be conducted periodically for fire, spill, evacuation, chemical leakage, ammonia leakage and transportation emergency. e. Emergency equipment shall be inspected regularly.
Access Control and Security	a. Unauthorized entry into operational and hazardous areas shall be prohibited. b. Visitor entry shall be controlled through registration and safety briefing. c. Security personnel shall monitor entry, exit and vehicle movement. d. Restricted areas shall be marked with warning signs. e. CCTV surveillance shall be maintained at critical locations, where applicable.
Safety Signage and Labeling	a. Safety signs shall be installed for PPE requirement, restricted area, fire equipment, emergency exit, assembly point, chemical hazard, flammable material and high voltage. b. Waste containers and chemical containers shall be labeled properly.

	c. Emergency route maps shall be displayed at important locations.
Housekeeping	a. Good housekeeping shall be maintained in all operational areas. b. Waste shall not be scattered outside designated storage areas. c. Access routes, emergency exits and firefighting points shall remain clear. d. Oil, fuel, chemical or waste spill shall be cleaned immediately. e. Scrap materials and unused items shall be removed from work areas.
Personal Protective Equipment	a. PPE shall be provided according to job hazard and work area requirement. b. Workers shall be trained on proper use, cleaning and storage of PPE. c. Damaged or contaminated PPE shall be replaced immediately. d. Emergency PPE such as chemical suit, fire-resistant clothing and respirator shall be available for trained responders.
Health Surveillance	a. Workers exposed to hazardous waste, dust, fumes, heat, noise or chemicals shall be included in occupational health surveillance, where required. b. Medical check-up records shall be maintained. c. Any work-related illness or exposure shall be reported and investigated.
Incident Reporting and Corrective Action	a. All incidents, near misses, unsafe acts and unsafe conditions shall be reported. b. Incident investigation shall identify root causes. c. Corrective and preventive actions shall be assigned with responsible persons and completion dates. d. Closure of corrective actions shall be verified by the EHS team.
Documentation and Review	**The following documents shall be maintained:** • risk assessment records; • inspection checklist; • maintenance records; • training records; • PPE issuance records; • incident reports; • mock drill reports; • emergency equipment inspection records; • environmental monitoring records; • corrective action register.

9.4 Action during Abnormal Operating Condition

9.4.1 Introduction

Abnormal operating conditions may occur during the operation of the proposed **Sheam TSDF BD Ltd.** facility due to equipment malfunction, power failure, improper waste feed, air pollution control system failure, high stack emission, fire risk, wastewater treatment failure, spill or leakage, excessive noise, accident, or natural events. Since the project involves treatment, storage, and disposal of controlled and hazardous waste streams, any abnormal condition must be handled immediately through a defined emergency and corrective action procedure.

The purpose of this section is to establish a systematic response mechanism for identifying abnormal situations, controlling the source, protecting workers and the surrounding community, preventing environmental pollution, and restoring normal operating conditions safely.

All abnormal operating conditions shall be recorded, investigated, corrected, and reported to the responsible authority where required.

Objectives of Abnormal Condition Management:

Objective	Description
Immediate control	Stop or control the abnormal activity before it creates major impact
Worker protection	Ensure safety of workers, operators, visitors, and emergency responders
Environmental protection	Prevent release of pollutants to air, water, soil, and surrounding areas
Equipment safety	Protect plant machinery, air pollution control system, ETP/STP, and utilities
Regulatory compliance	Maintain compliance with DoE conditions and ESIA commitments
Incident documentation	Record incident details, causes, actions taken, and follow-up measures
Prevent recurrence	Identify root cause and implement preventive measures

9.4.2 General Response Procedure during Abnormal Condition

The following step-by-step procedure shall be followed during any abnormal operating condition.

Step	Action
Step 1	Identify the abnormal condition immediately
Step 2	Inform the Shift Supervisor, Plant Manager, HSE Officer, and Environmental Officer
Step 3	Stop or isolate the affected operation, if required
Step 4	Protect workers through evacuation, PPE, barricading, or restricted access
Step 5	Control the source of pollution, leakage, emission, fire, or unsafe condition
Step 6	Use emergency equipment such as spill kit, fire extinguisher, emergency pump, standby generator, or containment system

Step 7	Conduct immediate inspection and initial investigation
Step 8	Resume operation only after safety and environmental clearance
Step 9	Record incident details in the abnormal operation register
Step 10	Conduct root cause analysis and implement corrective and preventive actions

9.4.3 Abnormal Condition in Incinerator Operation

The incinerator shall be operated only under approved operating conditions. Abnormal incinerator conditions may result in incomplete combustion, high emission, equipment damage, odour, smoke, or unsafe working conditions.

Possible Incinerator Abnormalities:

Abnormal Condition	Possible Cause
Low primary chamber temperature	Insufficient fuel, wet waste, burner problem
Low secondary chamber temperature	Burner failure, high waste feed, poor combustion
High CO level	Incomplete combustion
Visible black smoke	Overfeeding, poor combustion, wet waste
Flame failure	Burner malfunction or fuel supply problem
Excessive ash	High inorganic content in waste
Abnormal vibration/noise	Mechanical fault
High furnace pressure	Draft control issue or blockage
Waste feed jam	Feeding mechanism problem
Sudden odour	Incomplete combustion or poor air control

Required Actions:

Abnormal Condition	Immediate Action	Responsibility
Low chamber temperature	Stop waste feeding and stabilize temperature	Plant Operator
High CO	Reduce feed rate and improve air/fuel control	Plant Operator
Visible smoke	Stop or reduce feed, check combustion and APC system	Plant Operator / Environmental Officer
Flame failure	Stop feeding and inspect burner system	Maintenance Team
High furnace pressure	Stop feeding and inspect draft system	Plant Operator
Feed jam	Stop feeding system and clear blockage safely	Maintenance Team
Abnormal noise/vibration	Stop affected equipment and inspect	Maintenance Team
Temperature sensor failure	Shift to safe shutdown and repair instrument	Plant Operator

Safe Restart Conditions:

Requirement	Confirmation
Combustion temperature	Restored to approved range
APC system	Fully operational
Burner system	Checked and functional
Monitoring instruments	Working properly
Waste feed system	Cleared and controlled
HSE clearance	Given by HSE Officer
Environmental clearance	Given by Environmental Officer / Plant Manager

CHAPTER 10

Environmental and Social Management Plan

This chapter presents the Environmental and Social Management Plan (ESMP): institutional arrangements and responsibilities, management measures for the pre-construction, construction and operation phases, specific management plans, the environmental and social monitoring plan, the closure and post-closure management plan, training, reporting and the indicative ESMP implementation budget.

10 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

10.1 Purpose and Scope of the ESMP

The Environmental and Social Management Plan (ESMP) translates the findings of the environmental and social impact assessment (Chapter 7) and the hazard and risk assessment (Chapter 9) into specific, actionable, and verifiable management measures. It establishes the mitigation measures, implementation responsibilities, schedules, monitoring requirements, and compliance verification procedures necessary to prevent, minimize, control, or otherwise manage potential environmental and social impacts throughout the project lifecycle. The ESMP shall be incorporated into relevant construction contracts and facility operating procedures and shall be reviewed and updated following detailed design, prior to commissioning, and whenever significant changes occur in project activities, operational processes, waste characteristics, or applicable regulatory requirements.

The ESMP comprises: (a) institutional arrangements and responsibilities (Section 10.2); (b) environmental and social management measures for the pre-construction, construction, and operation phases (Sections 10.3–10.5); (c) specific environmental and social management plans (Section 10.6); (d) the environmental and social monitoring plan, including compliance criteria, action levels, and corrective action procedures (Section 10.7); (e) closure and post-closure management requirements (Section 10.8); (f) training and capacity-building measures (Section 10.9); (g) reporting, documentation, and periodic review procedures (Section 10.10); and (h) the indicative ESMP implementation budget (Section 10.11).

The term “shall” is used throughout this chapter to indicate mandatory commitments and implementation requirements. The specified monitoring frequencies, performance criteria, and environmental limits represent minimum project requirements, except where more stringent provisions are established under applicable laws, regulations, or conditions of the Environmental Clearance Certificate (ECC) issued by the Department of Environment (DoE). In such cases, the more stringent applicable requirements shall prevail. Procedures for managing abnormal operating conditions involving the incinerator, Air Pollution Control Device (APCD), and Effluent Treatment Plant (ETP) are addressed in Chapter 9 and are cross-referenced in this ESMP to ensure consistency and avoid unnecessary duplication.

10.2 Institutional Arrangements and Responsibilities

Sheam TSDF BD Ltd. (STBL), as the project proponent, has overall responsibility for implementing the Environmental and Social Management Plan (ESMP) and ensuring compliance with the conditions of the Environmental Clearance Certificate (ECC) and applicable regulatory requirements. An Environmental, Social, Health and Safety (ESHS) unit shall be established before the commencement of construction activities to coordinate, supervise, and monitor ESMP implementation throughout the construction, operation, and closure phases of the project. The ESHS unit shall report directly to STBL's senior management to ensure effective oversight, accountability, and timely implementation of corrective actions.

The institutional arrangements define responsibilities for environmental management, occupational health and safety, waste acceptance and handling, pollution control, laboratory testing, community

engagement, emergency preparedness, and regulatory reporting. During construction, the appointed Engineering, Procurement and Construction (EPC) contractor shall implement the applicable construction-phase ESMP measures under the supervision of STBL. During operation, designated facility personnel shall implement the relevant environmental, social, and safety management measures in accordance with approved operating procedures and applicable regulatory requirements.

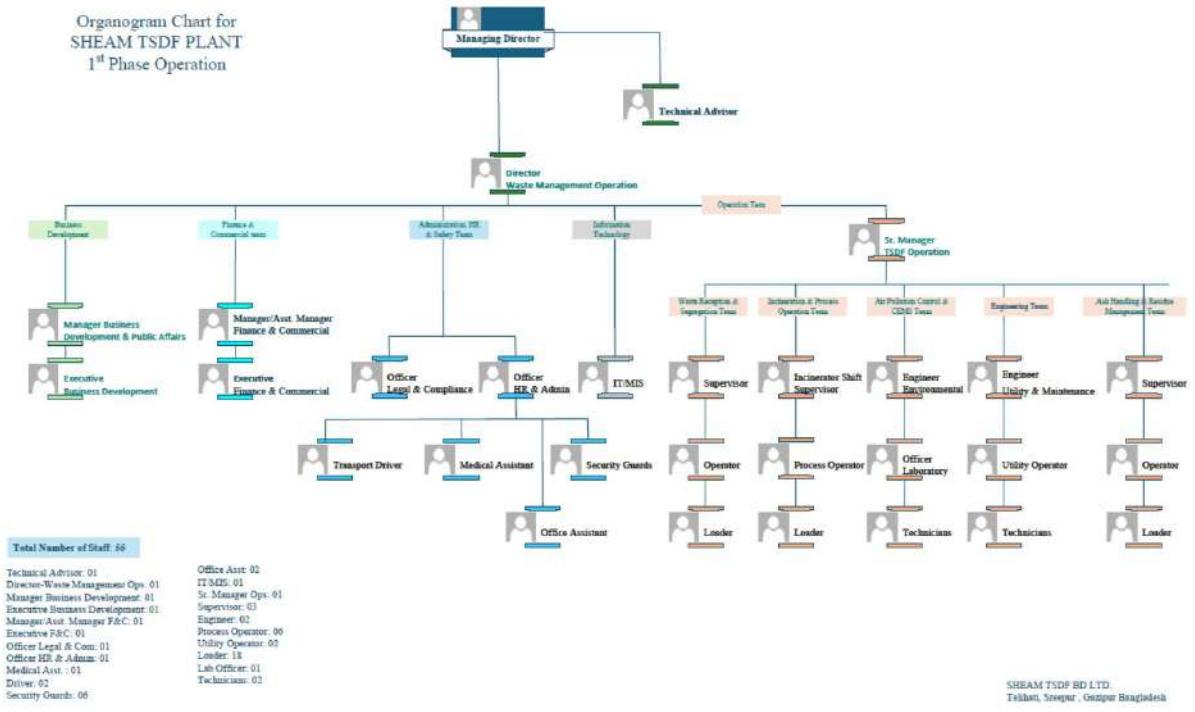
The roles and responsibilities for ESMP implementation are presented in Table 10.1. The corresponding abbreviations are used consistently in the responsibility columns of the subsequent ESMP and monitoring tables.

Table 56: Roles and responsibilities for ESMP implementation

Role (Abbreviation)	Key Responsibilities
STBL Management (MGT)	Overall accountability for ESMP implementation and ECC compliance; allocation of necessary financial and human resources; approval of ESHS policies and procedures; oversight of environmental and social performance; and submission of required compliance reports to the DoE.
ESHS Manager (ESHSM)	Leads the ESHS unit; coordinates ESMP implementation, environmental and social monitoring, and compliance reporting; oversees permits, inspections, audits, corrective actions, and periodic ESMP reviews and updates.
Environmental Officer (EO)	Supervises environmental monitoring and sampling; reviews Continuous Emission Monitoring System (CEMS) data; monitors Effluent Treatment Plant (ETP) and Air Pollution Control Device (APCD) performance; oversees residue management and secured landfill monitoring records; and maintains environmental monitoring data and compliance records.
Health and Safety Officer (HSO)	Implements the Occupational Health and Safety (OHS) Plan; ensures appropriate use of Personal Protective Equipment (PPE); supervises permit-to-work procedures, workplace safety inspections, occupational exposure monitoring, incident investigations, and emergency preparedness drills.
Community Liaison Officer (CLO)	Implements the Stakeholder Engagement Plan (SEP) and Grievance Redress Mechanism (GRM); serves as the focal person for community grievances; coordinates stakeholder consultations, community communication, information disclosure, and local recruitment initiatives; and maintains stakeholder engagement and grievance records.
Waste Acceptance Officer (WAO)	Conducts waste pre-acceptance reviews, incoming waste inspections, manifest verification, weighing, and waste classification; supervises quarantine and rejection of non-conforming waste; and maintains waste acceptance, inventory, and tracking records.
Laboratory In-charge (LI)	Supervises waste characterization and verification testing; conducts or coordinates residue leaching tests, including the Toxicity Characteristic Leaching Procedure (TCLP), where applicable; oversees stabilization quality assurance testing and in-house effluent analysis; and maintains laboratory quality control and sample chain-of-custody records.
Plant Operations Manager (POM)	Supervises the operation and maintenance of the incinerator, APCD, ETP, stabilization unit, and secured landfill within approved operating parameters; implements standard operating procedures and abnormal operating condition management measures; and maintains operational and maintenance records.
Logistics Officer (LO)	Coordinates waste transportation and associated logistics; supervises transport fleet management, vehicle inspections, driver training, route compliance, and transportation documentation; maintains transport incident records; and coordinates responses to transportation-related emergencies.
Site Engineer (SE)	Supervises construction activities, earthworks, drainage systems, soil compaction, and construction quality control; oversees secured landfill cell construction and associated quality assurance measures; and ensures appropriate rehabilitation of temporary construction areas and borrow areas, where applicable.

Role (Abbreviation)	Key Responsibilities
EPC/Construction Contractor (EPC)	Implements construction-phase ESMP measures, the Contractor ESHS Plan, and applicable labor management requirements; ensures compliance with construction-related environmental and occupational safety requirements; conducts inspections and monitoring; reports incidents and non-compliance; and submits monthly ESHS performance reports to STBL.
Accredited Laboratory (AL)	Conducts independent environmental sampling and testing, including stack emissions, ambient air quality, noise, water, soil, and waste residues, as applicable; follows recognized analytical methods and quality assurance procedures; and provides monitoring reports. The laboratory shall hold ISO/IEC 17025 accreditation for relevant testing parameters and satisfy applicable DoE recognition or acceptance requirements.
Department of Environment (DoE)	Provides regulatory oversight in accordance with applicable environmental legislation; reviews environmental monitoring and compliance reports; conducts regulatory inspections; evaluates compliance with ECC conditions; and undertakes ECC renewal and other regulatory actions, as applicable.
Fire Service, Hospitals, and Local Administration	Provide external emergency response and coordination within their respective mandates; support firefighting, emergency medical assistance, evacuation, and public safety measures; and participate in emergency preparedness consultations and drills, where appropriate.

Proposed organogram of SHEAM TSDF BD Ltd:



10.3 EMP during Pre-construction Stage

The pre-construction phase includes site boundary demarcation, land development, sourcing and transportation of fill materials, and preparation of site access. These activities may cause temporary

impacts on land, drainage, air quality, community movement, occupational health and safety, and the surrounding environment. The following management measures shall be implemented to prevent or minimize these impacts. The corresponding monitoring requirements are presented in Section 10.7.4.

The pre-construction phase includes site boundary demarcation, land development, sourcing and transportation of fill materials, and preparation of site access. These activities may cause temporary impacts on land, drainage, air quality, community movement, occupational health and safety, and the surrounding environment. The following management measures shall be implemented to prevent or minimize these impacts. The corresponding monitoring requirements are presented in Section 10.7.4.

10.3.1 Land Development

Land development activities include site clearing, grading, earth filling, leveling, temporary drainage arrangements, access preparation, and demarcation of the project boundary. As the facility will accommodate hazardous waste treatment and storage operations and a secured landfill, earth filling and compaction shall be carried out in accordance with the approved engineering design and applicable technical specifications to ensure adequate ground stability and minimize the risk of differential settlement affecting foundations, containment structures, bunded areas, and landfill cells. The mitigation and management measures for land development activities are presented in Table 10.2.

Table 57: Mitigation and Management Measures for Land Development

Issue	Mitigation / Management Measures	Responsibility
Vegetation removal	Demarcate the approved project boundary before commencing site clearing; restrict vegetation removal to designated areas; prevent encroachment on adjoining land and unnecessary removal of vegetation.	SE / EPC
Topsoil loss	Strip and stockpile reusable topsoil separately in designated areas; protect stockpiles from erosion and contamination; reuse suitable topsoil for greenbelt development and landscaping.	SE / EPC
Dust generation	Spray water on exposed soil surfaces, earthwork areas, and unpaved access routes at least twice daily during dry weather, with additional spraying as necessary to control visible dust emissions.	EPC
Soil erosion and runoff	Provide temporary slope protection, silt traps, and drainage channels before the monsoon; stabilize exposed surfaces and stockpiles; prevent sediment-laden runoff from entering adjoining land and drainage channels.	SE / EPC
Drainage obstruction	Maintain existing natural drainage paths; provide suitable temporary drainage diversions where necessary; prevent obstruction of natural drains, adjoining agricultural land, and surrounding drainage systems.	SE / EPC
Noise and vibration	Use properly maintained construction machinery and equipment; minimize unnecessary idling and excessive noise; restrict heavy construction activities to 06:00–21:00, subject to applicable regulatory requirements and any stricter site-specific restrictions.	EPC
Worker safety	Provide site-specific safety induction, appropriate Personal Protective Equipment (PPE), first-aid facilities, and adequate supervision; implement safe working procedures for earthmoving machinery, excavation, and material handling.	HSO / EPC

Issue	Mitigation / Management Measures	Responsibility
Community disturbance	Install warning signs and safety barriers; maintain safe access routes for nearby communities; provide advance notice of activities likely to cause significant disturbance; and address community concerns through the established Grievance Redress Mechanism (GRM).	CLO / EPC

10.3.2 Source, Extraction and Transport of Fill Material

Fill material shall be obtained only from legally authorized and environmentally acceptable sources that meet the selection criteria presented in Table 10.3. STBL shall ensure that the necessary permits, approvals, and landowner agreements, where applicable, are verified and documented before material extraction or collection begins. The suitability of fill material shall be assessed to ensure compliance with the approved engineering specifications and to prevent the introduction of contaminated or unsuitable materials to the project site.

Table 58: Selection Criteria for Fill Material Sources

Criterion	Requirement
Legal approval	The source shall have valid permits, leases, or other authorizations from the competent authority, as applicable.
Environmental suitability	Fill material shall not be extracted from protected areas, wetlands, riverbanks, or other ecologically sensitive locations where extraction is prohibited or may cause significant environmental damage.
Material quality	Fill material shall be free from contamination, waste, and unsuitable organic matter and shall meet the approved engineering specifications. Material suitability shall be verified through inspection and appropriate testing before use.
Agricultural land	Extraction from productive agricultural land shall be avoided. Where unavoidable, extraction shall be undertaken only with the required legal permissions and documented landowner consent, subject to applicable restrictions.
Transport distance and route	Transport routes shall be selected to minimize travel distance, traffic disruption, dust, and community safety risks. Routes passing through schools, markets, hospitals, and religious establishments shall be avoided where practicable.
Social acceptability	Written landowner consent or other evidence of lawful access shall be obtained, where applicable. Potential community concerns and disputes shall be addressed before extraction activities commence.
Site restoration	Extraction sites shall be suitable for safe rehabilitation, including grading, drainage restoration, slope stabilization, and revegetation, as applicable, in accordance with approved restoration requirements.

Table 59: Mitigation and Management Measures for Fill Material Extraction and Transport

Issue	Mitigation / Management Measures	Responsibility
Illegal or unsafe extraction	Obtain fill material only from legally authorized and approved sources; prohibit deep or unstable excavation cuts and uncontrolled riverbank extraction; ensure extraction activities comply with applicable permits and safety requirements.	MGT / SE
Dust and material spillage during transport	Use properly covered trucks with secured tarpaulins; prevent overloading; clean up spilled materials promptly; implement wheel washing or equivalent measures at the site exit to prevent soil and sediment tracking onto public roads.	EPC
Traffic and accident risks	Use designated transport routes; avoid peak traffic hours and sensitive locations where practicable; enforce appropriate speed limits; employ trained and licensed drivers; and provide trained traffic marshals at the site entrance and exit during heavy vehicle movements.	EPC / HSO

Issue	Mitigation / Management Measures	Responsibility
Road damage	Use roadworthy vehicles suitable for the carrying capacity and condition of access roads; avoid excessive axle loads; inspect frequently used transport routes; and promptly repair road damage attributable to project-related transportation activities.	EPC
Fuel and oil leakage	Conduct routine refueling and maintenance in designated areas equipped with appropriate secondary containment; provide spill response kits at relevant work sites; and ensure prompt containment, clean-up, and proper disposal of contaminated materials.	EPC / HSO
Equipment emissions and noise	Use properly maintained vehicles and machinery with functional exhaust and noise-control systems; minimize unnecessary engine idling; and ensure compliance with applicable emission and noise requirements.	EPC

10.3.3 Closure of Borrow Areas

Upon completion of material extraction, borrow areas shall be rehabilitated to ensure long-term stability, safety, and environmental protection. No unsafe excavation pits, unstable slopes, loose material stockpiles, or construction waste shall remain at the extraction sites. Disturbed areas shall be graded to achieve stable landforms, provided with adequate drainage to prevent waterlogging and erosion, and revegetated with suitable grasses or locally adapted plant species, as appropriate. Where borrow areas are privately owned, rehabilitation and closure activities shall be undertaken in consultation with the respective landowners and in accordance with applicable agreements and regulatory requirements. Before-and-after photographic records shall be maintained, and completion of rehabilitation measures shall be verified by the Site Engineer (SE) using a closure checklist and formally approved by the ESHS Manager (ESHSM).

10.3.4 Summary ESMP Matrix for Pre-construction Phase

Table 60: Summary ESMP Matrix – Pre-construction Phase

Activity	Potential Impact	Mitigation Measures	Monitoring Indicator	Responsibility
Land clearing	Vegetation loss, soil exposure, and topsoil degradation	Restrict clearing to the approved project boundary; minimize vegetation removal; strip and preserve reusable topsoil for landscaping and greenbelt development.	Cleared area within approved boundary; topsoil stockpile condition.	SE / EPC
Earth filling	Dust generation, soil erosion, sediment runoff, and ground settlement	Implement water spraying, controlled filling and layer-wise compaction; provide temporary drainage and erosion-control measures in accordance with approved engineering specifications.	Visible dust levels; signs of erosion and sediment runoff; compaction test records; drainage condition.	SE / EPC
Material sourcing	Illegal extraction, land degradation, and environmental disturbance	Obtain fill materials only from legally authorized and environmentally acceptable sources meeting the approved selection criteria.	Valid source permits and approval documents; material inspection and suitability records.	MGT / SE

Activity	Potential Impact	Mitigation Measures	Monitoring Indicator	Responsibility
Material transport	Dust, material spillage, traffic disturbance, accidents, and road damage	Use covered trucks; prevent overloading; follow designated transport routes and speed limits; implement traffic safety and spill-cleanup measures.	Truck covering and loading condition; transport inspection records; road condition; traffic incident records.	EPC / HSO
Equipment operation	Noise, exhaust emissions, fuel and oil leakage, and soil contamination	Maintain machinery and vehicles; minimize unnecessary idling; implement appropriate noise-control measures and spill prevention procedures.	Equipment maintenance and inspection records; visible emissions; evidence of leakage or spills.	EPC / HSO
Borrow area closure	Unsafe excavation pits, unstable slopes, waterlogging, erosion, and land degradation	Grade and stabilize disturbed areas; provide adequate drainage; remove waste and loose stockpiles; and revegetate with suitable local species.	Completed closure checklist; before-and-after photographs; evidence of slope stability, drainage, and revegetation.	SE / ESHSM
Worker activities	Occupational injuries, accidents, and exposure to construction-related hazards	Provide safety induction, appropriate Personal Protective Equipment (PPE), first-aid facilities, and adequate supervision; implement safe working procedures.	PPE compliance; safety induction and training records; inspection findings; incident and near-miss records.	HSO / EPC
Community interface	Traffic congestion, access restrictions, safety risks, and community disturbance	Provide warning signs, traffic marshals, and safe access routes; implement transport route planning; communicate disruptive activities in advance; and address grievances through the established mechanism.	Warning signs and traffic-control arrangements; community complaints and grievance register; corrective action records.	CLO / EPC

10.4 ESMP during Construction Phase

The construction phase includes civil works for waste receiving and storage sheds, incineration and Air Pollution Control Device (APCD) structures, the stabilization unit, secured landfill cells, the Effluent Treatment Plant (ETP), internal roads, drainage systems, utilities, fire safety infrastructure, and administrative buildings. The Engineering, Procurement and Construction (EPC) contractor shall implement the measures specified in this section through a Contractor Environmental, Social, Health and Safety (ESHS) Plan approved by the ESHS Manager before mobilization. Compliance with the ESMP shall be incorporated into construction contracts as a mandatory requirement, with appropriate contractual provisions for addressing non-compliance, including corrective actions and penalties where applicable.

The objectives of the construction-phase ESMP are to:

- Minimize dust, noise, vibration, and traffic-related disturbances;
- Prevent soil and water contamination;
- Ensure safe handling, storage, and disposal of construction waste;
- Protect workers and surrounding communities and ensure fair labor and working conditions;
- Maintain effective site drainage and prevent waterlogging;

- Ensure compliance with applicable Department of Environment (DoE) requirements, Environmental Clearance Certificate (ECC) conditions, and ESIA commitments; and
- Ensure that critical containment structures, including bunds, impervious floors, and secured landfill liner systems, are constructed in accordance with approved engineering designs and quality assurance requirements to support safe facility operation.

10.4.1 Site Preparation and Backfilling

Site preparation shall be carried out in phases to minimize exposed soil surfaces and associated environmental impacts. Backfilling shall be undertaken using only approved, uncontaminated materials that meet the specified engineering requirements. Fill material shall be placed and compacted in successive layers in accordance with the approved design and technical specifications. Organic waste, sludge, contaminated soil, municipal waste, industrial residues, and construction debris shall not be used as fill material. The mitigation and management measures for site preparation and backfilling are presented in Table 10.6.

Table 61: Mitigation and Management Measures for Site Preparation and Backfilling

Issue	Mitigation / Management Measures	Responsibility
Unauthorized land disturbance	Demarcate the approved project boundary before commencing work; install temporary fencing and appropriate warning signs; restrict land disturbance to designated construction areas.	SE / EPC
Dust from filling and roads	Spray water on exposed surfaces and unpaved access roads during dry conditions; enforce a maximum vehicle speed of 15 km/h within the construction site; cover loose materials where necessary.	EPC
Contaminated or unsuitable fill	Inspect and conduct appropriate testing of fill materials before placement; verify compliance with approved material specifications; reject contaminated or otherwise unsuitable materials.	SE / LI
Settlement risk	Place and compact fill material in successive layers in accordance with approved engineering specifications; conduct and document compaction tests; rectify areas that do not meet the specified requirements.	SE / EPC
Erosion and sediment runoff	Stabilize exposed slopes and disturbed surfaces promptly; install temporary silt traps, sedimentation pits, and erosion-control measures to prevent sediment-laden runoff from leaving the site.	SE / EPC
Waterlogging	Maintain temporary drainage channels and appropriate site gradients; prevent obstruction of drainage routes; remove accumulated water where necessary to maintain safe working conditions.	SE / EPC
Public access disturbance	Maintain safe access along adjoining public roads; install appropriate warning signs and traffic-control measures; provide alternative access arrangements where temporary restrictions are unavoidable; inform affected communities in advance.	EPC / CLO

10.4.2 Construction Site Management

The construction site shall be organized into designated functional zones to ensure safe and efficient operations and minimize environmental and occupational risks. These shall include construction work areas, material storage areas, equipment parking and maintenance areas, construction waste

storage areas, worker welfare facilities (rest areas, drinking water, sanitation, and first aid), bunded fuel and chemical storage areas, and clearly designated emergency access routes.

The following site management measures shall be implemented:

- Control site entry and exit through designated access points with appropriate security arrangements, vehicle routes, and speed limits.
- Store construction materials in designated areas and cover loose or dust-generating materials to prevent dispersion and runoff.
- Maintain daily housekeeping and ensure regular collection, segregation, and appropriate disposal of construction waste.
- Provide adequate sanitation facilities, washing facilities, safe drinking water, and rest areas for workers, including separate sanitation facilities for male and female workers.
- Ensure adequate site lighting, temporary fencing, safety barriers, and warning signs around excavations, hazardous work areas, and other locations presenting safety risks.
- Maintain unobstructed emergency access routes and ensure the availability of appropriate emergency response equipment.
- Maintain site activity logs, inspection records, waste management records, and incident registers to support monitoring, reporting, and corrective actions.

10.4.3 Construction Waste Management

Construction activities shall generate different types of waste, including excavated soil, concrete debris, metal scrap, packaging materials, chemical containers, used oil, and domestic waste. These wastes shall be segregated at source, stored in designated areas, and managed through reuse, recycling, treatment, or disposal, as appropriate, to prevent environmental contamination and minimize waste generation. Hazardous and non-hazardous wastes shall be stored separately, and waste handling and disposal shall comply with applicable regulatory requirements. The management methods for different construction waste streams are presented in Table 10.7.

Table 62: Construction Waste Management

Waste Type	Source	Management Method
Excavated soil	Foundation excavation and site grading	Reuse suitable, uncontaminated excavated soil for backfilling and site leveling in accordance with approved engineering specifications; dispose of surplus or unsuitable material at authorized locations.
Concrete debris and brick chips	Civil construction and demolition-related activities	Segregate and reuse as sub-base or other suitable construction applications where technically acceptable; otherwise, transport to an approved disposal facility.
Steel scrap	Reinforcement works and metal fabrication	Collect and store separately; reuse where practicable or transfer to authorized scrap dealers or recycling facilities.
Wood, cement bags, and plastic packaging	Formwork, construction materials, and packaging	Segregate at source; reuse suitable materials and transfer recyclable waste to approved recycling vendors; dispose of non-recyclable residues through authorized arrangements.
Paint and chemical containers	Painting, finishing, and chemical handling activities	Store separately in designated areas; return reusable containers to suppliers where practicable; manage containers containing hazardous residues as hazardous waste and transfer them to authorized handlers.

Waste Type	Source	Management Method
Used oil and oily rags	Equipment operation and maintenance	Collect in properly labeled, sealed containers; store in designated areas with secondary containment; transfer to authorized waste handlers for recovery, treatment, or disposal.
Food and general waste	Worker activities and site facilities	Provide designated waste bins; collect waste regularly, preferably daily; prevent littering and pest infestation; and dispose of waste through an authorized local collection and disposal system.

Open burning, uncontrolled dumping, and burial of construction waste within the project site shall be prohibited. Waste quantities, storage arrangements, reuse and recycling activities, and final disposal destinations shall be documented in a construction waste register. The EPC contractor shall maintain these records and submit them to the ESHS Manager for periodic review.

10.4.4 Occupational Health and Safety

A construction-specific Occupational Health and Safety (OHS) Plan shall be implemented to prevent workplace injuries, accidents, and exposure to occupational hazards. The plan shall address excavation, working at height, lifting operations, welding and cutting, electrical work, equipment movement, manual handling, confined-space entry, concrete works, and other construction-related activities. The EPC contractor shall implement the OHS measures under the supervision of the Health and Safety Officer (HSO). The principal construction OHS requirements are presented in Table 10.8.

Table 63: Construction Occupational Health and Safety Measures

Safety Area	Required Measures
Induction	Provide mandatory safety induction to all workers before commencing work; conduct task-specific safety briefings and toolbox meetings; maintain induction and training records.
Personal Protective Equipment (PPE)	Provide safety helmets, safety footwear, and high-visibility vests as minimum requirements; ensure task-specific PPE, including full-body harnesses, welding shields, appropriate respirators, chemical-resistant gloves, and hearing protection, in accordance with the PPE matrix (Annexure 9).
Excavation	Provide appropriate shoring, benching, or sloping for excavations; install barricades and warning signs; maintain safe access and egress; prevent excessive loading near excavation edges; and inspect excavations regularly.
Working at height	Provide suitable guardrails, inspected scaffolding, safe access arrangements, and fall-arrest systems where required; ensure proper use of full-body harnesses and maintain scaffold inspection records.
Lifting operations	Prepare lifting plans for relevant operations; use inspected and appropriately certified lifting equipment; employ competent crane operators, riggers, and signal persons; and establish exclusion zones around lifting activities.
Hot work	Implement a hot-work permit system; remove or protect combustible materials; provide suitable fire extinguishers; assign a fire watch where required; and ensure appropriate ventilation and PPE.
Electrical safety	Implement lockout/tagout procedures during electrical maintenance; ensure proper earthing and electrical protection using Earth Leakage Circuit Breakers (ELCBs) or Residual Current Circuit Breakers (RCCBs), as appropriate; and restrict electrical work to authorized personnel.
Confined-space entry	Implement a confined-space entry permit system; conduct atmospheric testing before and during entry as required; provide suitable ventilation, standby personnel, communication arrangements, and emergency rescue procedures.

Safety Area	Required Measures
First aid and emergency preparedness	Provide adequately stocked first-aid facilities and trained first-aid personnel; maintain an emergency response plan, designated assembly points, emergency contact information, and unobstructed ambulance and emergency vehicle access.
Incident management	Record and investigate all occupational incidents, injuries, and near misses; identify root causes; implement corrective and preventive actions; and maintain incident investigation and follow-up records.

10.4.5 Air Quality and Noise Management

Construction activities may generate dust, exhaust emissions, noise, and vibration from earthworks, material handling, transportation, construction machinery, and temporary power generation. Appropriate control measures shall be implemented to minimize impacts on workers, nearby communities, and sensitive receptors. The mitigation and management measures for construction-related air quality and noise impacts are presented in Table 10.9.

Table 64: Construction Air Quality and Noise Management Measures

Issue	Mitigation / Management Measures	Responsibility
Dust from exposed soil, stockpiles, and roads	Apply water spraying to exposed surfaces and unpaved roads during dry conditions; cover or moisten stockpiles as necessary; maintain low vehicle speeds; and minimize unnecessary soil disturbance.	EPC
Dust from material transport	Transport soil, sand, and other loose materials in properly covered trucks; prevent overloading and material spillage; and clean affected roads promptly.	EPC
Cement dust	Store cement in covered or enclosed areas; minimize dust generation during handling and transfer; and provide appropriate respiratory protection to exposed workers.	EPC / HSO
Equipment exhaust emissions	Use properly maintained vehicles and construction machinery; conduct regular inspections and servicing; minimize unnecessary engine idling; and avoid operating equipment with excessive visible emissions.	EPC
Open burning	Prohibit open burning of construction waste, packaging materials, vegetation, and other waste within the project site.	EPC / HSO
Equipment and generator noise	Use properly maintained machinery with functional silencers; provide acoustic enclosures or other suitable noise-control measures for generators where necessary; and locate stationary noise-generating equipment away from sensitive receptors where practicable.	EPC
Working hours	Restrict high-noise construction activities to 06:00–21:00, subject to applicable regulatory requirements and any stricter site-specific restrictions; provide advance notice to nearby communities before unusually noisy activities.	EPC / CLO
Worker exposure	Provide appropriate respiratory and hearing protection in designated high-exposure areas; conduct occupational exposure assessments where necessary; and implement suitable administrative and engineering controls.	HSO / EPC
Impacts on sensitive receptors	Monitor noise and dust conditions at relevant sensitive receptors; install temporary screens, dust barriers, or noise barriers where monitoring or site conditions indicate the need for additional controls.	EPC / EO

10.4.6 Water Resources Management

Construction activities may affect surface water and groundwater quality through sediment runoff, concrete wash water, fuel and oil spills, equipment washing, and domestic wastewater generation. Water management measures shall be implemented to prevent contamination, maintain site drainage, and promote efficient water use. Particular attention shall be given to drainage and erosion control during the monsoon season. The mitigation and management measures for construction-related water resources are presented in Table 10.10.

Table 65: Construction Water Resources Management Measures

Issue	Mitigation / Management Measures	Responsibility
Sediment runoff	Install and maintain temporary drainage channels, silt traps, sediment barriers, and other suitable erosion-control measures; prevent sediment-laden runoff from entering surrounding drainage channels and water bodies.	EPC
Concrete wash water	Collect concrete wash water in designated, contained settling or treatment facilities; allow solids to settle and manage the resulting sludge appropriately; reuse treated water where feasible; and prohibit direct discharge into drains or water bodies. Any discharge shall meet applicable regulatory requirements, including pH limits.	EPC
Oil and fuel spills	Store fuel and oil in designated areas with appropriate secondary containment, generally not less than 110% of the largest container capacity; provide spill response kits and trained personnel; and ensure prompt containment and clean-up of spills.	EPC / HSO
Equipment washing	Conduct equipment and vehicle washing only in designated areas with appropriate drainage, sediment collection, and oil separation facilities; prevent uncontrolled discharge of wash water.	EPC
Domestic wastewater	Provide adequate sanitation facilities, including appropriately designed septic tanks and soak pits or other approved wastewater management systems, sized according to the peak construction workforce and site conditions; ensure regular inspection and maintenance.	EPC
Water wastage	Promote efficient water use; inspect water supply systems regularly; repair leaks promptly; and maintain records of water abstraction and consumption through appropriate metering arrangements.	EPC
Monsoon-related risks	Establish and maintain temporary drainage, erosion-control, and sediment management measures before the monsoon; inspect drainage facilities regularly and after heavy rainfall; and promptly remove obstructions or accumulated sediment.	SE / EPC

10.4.7 Labor and Working Conditions

The Engineering, Procurement and Construction (EPC) contractor and all subcontractors shall comply with the Bangladesh Labor Act, 2006, the Bangladesh Labor Rules, 2015, and their applicable amendments, and shall follow the relevant provisions of IFC Performance Standard 2 (Labor and Working Conditions) as good international industry practice. Labor management requirements shall be incorporated into construction contracts and verified through monthly contractor audits under the supervision of the ESHS Manager.

The following minimum requirements shall apply:

- **Child and forced labor:** Child labor and forced labor shall be prohibited. No person under 18 years of age shall be employed in hazardous construction activities. Age verification shall be conducted during recruitment.
- **Employment conditions and wages:** Workers shall receive written terms of employment, and wages shall be paid regularly and on time, in accordance with applicable legal requirements and prescribed minimum wage rates.
- **Working hours and overtime:** Working hours, rest periods, overtime, and associated compensation shall comply with applicable labor laws and regulations.
- **Worker welfare:** Adequate drinking water, sanitation, washing facilities, rest areas, and first-aid arrangements shall be provided. Worker accommodation, where provided, shall meet appropriate health, safety, hygiene, and welfare standards.
- **Worker grievance mechanism:** A confidential and accessible worker grievance mechanism shall be established separately from the community Grievance Redress Mechanism (GRM), with procedures for recording, investigating, and resolving complaints without retaliation.
- **Code of conduct:** All workers shall comply with a worker code of conduct addressing workplace behavior, non-discrimination, prevention of sexual exploitation, abuse and harassment, and disciplinary procedures.
- **Local employment:** Priority shall be given to qualified local workers where the required skills and experience are available, consistent with applicable labor requirements and fair recruitment practices.

10.4.8 Summary ESMP Matrix for Construction Phase

Table 66: Summary ESMP Matrix for Construction Phase

Activity	Potential Impact	Mitigation Measures	Monitoring Indicator	Responsibility
Site preparation and backfilling	Dust generation, erosion, settlement, and drainage alteration	Restrict activities to designated areas; use approved fill materials; ensure layer-wise compaction; maintain temporary drainage and erosion-control measures.	Fill material inspection and test records; compaction test results; drainage condition; evidence of erosion.	EPC / SE
Material storage	Dust generation, runoff contamination, and obstruction of work areas	Store materials in designated areas; cover loose materials; maintain appropriate drainage and housekeeping arrangements.	Storage area inspection records; material covering; drainage and housekeeping conditions.	EPC
Construction waste management	Soil contamination, blocked drains, improper disposal, and environmental degradation	Segregate waste at source; maximize reuse and recycling; store hazardous waste separately; ensure disposal through authorized facilities or handlers.	Construction waste register; disposal records; waste segregation and storage conditions; site cleanliness.	EPC / EO
Construction of containment structures	Potential future leakage and contamination of soil and groundwater	Construct secured landfill liner systems, bunds, and impervious floors in accordance with approved engineering designs; implement construction quality assurance and quality control procedures.	Material specifications and test records; liner installation and integrity testing records; construction QA/QC documentation; independent Construction Quality Assurance (CQA) verification and sign-off.	SE / ESHSM

Activity	Potential Impact	Mitigation Measures	Monitoring Indicator	Responsibility
Equipment operation	Noise, exhaust emissions, fuel and oil spills, and soil contamination	Maintain machinery and vehicles; minimize unnecessary idling; implement spill prevention and response measures; provide appropriate noise-control arrangements.	Equipment maintenance and inspection records; spill records; visible emissions; noise observations.	EPC / HSO
Lifting and working at height	Occupational accidents, falls, injuries, and equipment-related hazards	Implement permit-to-work procedures; provide appropriate fall protection, inspected scaffolding, lifting plans, and competent operators; establish exclusion zones.	Work permits; lifting equipment inspection records; PPE compliance; safety inspection and incident records.	HSO / EPC
Dust and noise generation	Deterioration of air quality, worker exposure, and disturbance to nearby communities	Apply water spraying; use covered transport vehicles; maintain equipment silencers; restrict high-noise activities to designated working hours; provide additional controls near sensitive receptors where necessary.	Particulate matter (PM) and noise monitoring results; dust-control inspection records; community grievances.	EPC / EO
Water use and runoff	Waterlogging, sediment runoff, water contamination, and excessive water consumption	Maintain temporary drains and silt traps; control equipment washing and concrete wash water; prevent uncontrolled discharge; promote efficient water use.	Drainage inspection records; runoff and discharge quality where applicable; water consumption records; evidence of waterlogging.	EPC / EO
Fuel and chemical storage	Soil and water contamination, fire hazards, and occupational exposure	Store fuel and chemicals in designated areas with appropriate secondary containment; maintain spill kits, fire safety equipment, and safe handling procedures.	Storage area inspection records; containment condition; spill and incident records; availability of emergency equipment.	EPC / HSO
Workforce and labor management	Labor rights violations, occupational health risks, inadequate sanitation, and worker grievances	Implement labor management requirements; prohibit child and forced labor; provide appropriate worker welfare facilities; maintain a worker grievance mechanism and code of conduct.	Monthly contractor labor audit reports; employment and training records; sanitation inspections; worker grievance records.	EPC / ESHSM
Community interface	Traffic disturbance, restricted access, accidents, and community safety risks	Install warning signs and traffic-control measures; provide trained traffic marshals; enforce speed limits; maintain safe public access; communicate disruptive activities and address grievances.	Traffic and safety inspection records; community grievance register; incident records; corrective action documentation.	EPC / CLO

10.5 ESMP during Operation Phase

The operation phase will involve waste receiving, verification, weighing, segregation, storage, pre-treatment, material recovery, incineration, air pollution control, wastewater treatment, residue stabilization, disposal in the secured landfill, laboratory testing, and waste transportation. As the facility will handle hazardous, special, contaminated, and non-recyclable wastes, the operational

ESMP shall be implemented through written Standard Operating Procedures (SOPs) for each operational unit and associated waste management activity.

The objectives of the operation-phase ESMP are to:

- Accept only waste that the facility is authorized and technically equipped to manage, and ensure traceability of each consignment from receipt to final treatment, recovery, or disposal;
- Control air emissions, odor, wastewater, leachate, noise, and residues in accordance with applicable environmental standards and regulatory requirements;
- Protect workers, surrounding communities, and the environment from operational hazards and potential adverse impacts;
- Ensure compliance with Environmental Clearance Certificate (ECC) conditions, applicable regulatory requirements, and ESIA commitments; and
- Establish clear responsibilities for operational monitoring, recordkeeping, reporting, and implementation of corrective actions.

10.5.1 Waste Acceptance and Tracking

Waste acceptance is the first line of environmental and operational control at a Treatment, Storage and Disposal Facility (TSDF). No waste shall be accepted for treatment, recovery, storage, or disposal without prior verification and approval in accordance with the facility's Waste Acceptance Criteria (WAC, Annexure 10) and waste manifest system (Annexure 11). The waste acceptance and tracking procedure is presented in Table 10.12.

Table 67: Waste Acceptance and Tracking Procedure

Step	Requirement	Responsibility
Pre-acceptance	The waste generator shall submit a waste profile containing information on the source, composition, hazardous properties, and Safety Data Sheet (SDS), where available, together with a representative sample where required. The Laboratory In-charge (LI) shall verify compliance with the WAC and suitability for the intended treatment or disposal route before approval.	WAO / LI
Transport and manifest	Each waste consignment shall be accompanied by a manifest signed by the generator and transporter. Waste transport vehicles shall be appropriately covered or enclosed, leak-proof where applicable, and labeled according to the characteristics of the waste.	LO / WAO
Gate inspection	Each incoming consignment shall undergo visual inspection, weighing, and verification of manifests, labels, and container conditions. Damaged or leaking containers shall be isolated and managed in accordance with the applicable spill response and quarantine procedures.	WAO
Verification sampling	Fingerprint testing, including relevant parameters such as pH, flash point, reactivity, and halogen content, shall be conducted for every bulk consignment and at least 10% of containerized consignments. Additional testing shall be undertaken where waste characteristics, documentation, or inspection findings indicate potential non-compliance.	LI
Non-conforming waste	Unidentified or non-conforming waste shall be isolated in the designated quarantine area pending assessment. The generator shall be notified within 24 hours. Rejected waste shall be returned to the generator or transferred to another authorized facility under appropriate manifest documentation and applicable regulatory requirements.	WAO / LI

Step	Requirement	Responsibility
Registration and storage	Accepted waste shall be recorded in the electronic waste tracking register, assigned a unique identification reference, and transferred to a designated storage area according to waste characteristics, compatibility, and the approved treatment or disposal route.	WAO / POM
Mass balance	Monthly reconciliation shall be conducted for waste received, stored, treated, recovered, transferred, residues generated, and waste disposed of in the secured landfill. The reconciliation shall account for changes in waste inventory and the capacities of individual treatment and disposal units.	EO / POM

The electronic waste tracking system shall maintain records of waste generators, consignment identification, waste categories, quantities, laboratory verification results, storage locations, treatment or recovery routes, residue generation, and final disposal destinations. These records shall support waste traceability, inventory control, regulatory reporting, and verification of compliance with the facility's approved waste-handling capacity.

10.5.2 Air Emission Management

Potential sources of air emissions during facility operation include the incinerator stack, waste receiving and storage areas, ash and Air Pollution Control Device (APCD) residue handling, internal roads, vehicle exhaust, the diesel generator (DG) set, and fugitive odor emissions. Appropriate emission prevention and control measures shall be implemented to minimize impacts on ambient air quality, workers, and surrounding communities.

The incinerator shall be operated under the following minimum conditions:

- The secondary combustion chamber shall maintain a gas temperature of at least 850 °C, with a gas residence time of at least 2 seconds under the specified operating conditions. The minimum temperature shall be increased to 1,100 °C when incinerating waste containing more than 1% halogenated organic substances, expressed as chlorine, subject to the applicable regulatory requirements and approved incinerator design.
- Waste feeding shall not commence until the secondary combustion chamber has reached the required operating temperature using auxiliary fuel, and the necessary combustion and emission-control systems are fully operational.
- Automatic waste-feed cut-off interlocks shall be provided and maintained for critical operating conditions, including secondary chamber temperature below the required set point, carbon monoxide (CO) concentration above the specified alarm threshold, APCD malfunction (including bag filter differential pressure outside the permissible range or interruption of reagent dosing), loss of induced-draft (ID) fan operation or required negative pressure, and failure of critical Continuous Emission Monitoring System (CEMS) functions.
- The APCD system, comprising rapid quenching, acid gas neutralization, activated carbon injection, and bag filtration, together with the ID fan, shall be operational before waste feeding begins and throughout the waste-feeding period.
- The waste feed rate shall be controlled according to waste characteristics, including calorific value, moisture content, and compatibility with the incinerator's approved operating specifications. Unknown, pressurized, explosive, radioactive, and highly reactive wastes shall not be introduced into the incinerator.
- The CEMS shall continuously monitor and record particulate matter (PM), CO, sulfur dioxide (SO_2), nitrogen oxides (NOx), hydrogen chloride (HCl), oxygen (O_2), temperature, moisture,

and flue gas flow, in accordance with the approved monitoring specifications. Periodic third-party stack emission testing shall be conducted to verify emission-control performance and applicable CEMS measurements, as specified in Section 10.7.6.

- All interlock trips, start-ups, shutdowns, emission exceedances, and abnormal operating events shall be recorded, investigated, and addressed through appropriate corrective actions in accordance with the abnormal operating condition and emergency response procedures described in Chapter 9.

Table 68: Operational Air Emission Sources and Control Measures

Source	Potential Impact	Control Measures
Incinerator stack	Emissions of PM, SO_2, NOx, CO, acid gases, heavy metals, and dioxins/furans; deterioration of ambient air quality.	Maintain appropriate combustion temperature and residence time; implement automatic waste-feed interlocks; operate the APCD and CEMS; discharge treated flue gas through the designed 45 m stack; and conduct periodic third-party stack emission testing.
Waste receiving and storage areas	odor, volatile organic compounds (VOCs), bioaerosols, and fugitive emissions; potential worker and community exposure.	Maintain enclosed or covered receiving and storage areas; segregate incompatible wastes; implement first-in-first-out waste handling where appropriate; provide adequate ventilation and odor-control measures; and ensure prompt spill containment and housekeeping.
Ash and APCD residue handling	Fugitive dust emissions, exposure to hazardous particulates, and potential contamination of surrounding work areas.	Use enclosed or controlled residue transfer systems; store residues in sealed and labeled containers; provide local exhaust ventilation and suitable dust-suppression measures where appropriate; and ensure the use of task-specific PPE.
Internal roads and vehicles	Fugitive dust, vehicle exhaust emissions, and deterioration of local air quality.	Maintain paved internal roads; enforce site speed limits; minimize unnecessary engine idling; use covered or enclosed waste transport vehicles; and maintain vehicles in proper operating condition.
Diesel generator (DG) set	Exhaust emissions, including PM, NOx, SO_2, and CO, and associated local air quality impacts.	Provide an appropriately designed exhaust stack; use suitable fuel meeting applicable specifications; maintain the generator regularly; and provide an acoustic enclosure to minimize associated noise.

10.5.3 Transport and Handling of Waste and Materials

Waste and material transportation, loading, unloading, and handling activities shall be conducted in accordance with approved operating procedures to prevent spills, leakage, incompatible waste mixing, occupational exposure, and risks to surrounding communities.

The following measures shall be implemented:

- All waste transport vehicles shall enter through the designated controlled gate and undergo inspection for leakage, odor, uncovered loads, damaged containers, and compliance with waste transport documentation.
- Solid waste shall be transported in appropriately covered or enclosed vehicles, while liquid and semi-liquid wastes shall be transported in suitable leak-proof containers or tankers compatible with the waste characteristics.

- Waste transport vehicles shall carry the required manifest documentation and emergency contact information. Drivers and helpers shall receive appropriate training in safe waste handling, spill response procedures, and the use of Personal Protective Equipment (PPE).
- Designated transport routes shall be followed, avoiding sensitive community areas where practicable. Vehicle speed limits shall be enforced within the facility, and appropriate traffic safety measures shall be implemented during loading, unloading, and vehicle movement.
- Loading and unloading operations shall be supervised by designated personnel. Incompatible wastes and materials shall be segregated and handled separately to prevent hazardous reactions, spills, and cross-contamination.
- Fuel, lime, activated carbon, caustic chemicals, and other treatment reagents shall be stored in designated, appropriately labeled areas with suitable secondary containment and segregation according to their chemical compatibility and hazard characteristics.
- Waste transport vehicles and associated equipment shall be inspected and decontaminated before leaving the facility where necessary to prevent the transfer of hazardous residues or contaminated materials outside the project boundary.

10.5.4 Wastewater and Stormwater Management

The facility shall maintain three separate drainage and wastewater management systems for clean stormwater, contaminated process water and runoff, and domestic wastewater. These systems shall be designed and operated to prevent cross-contamination and uncontrolled discharge into the surrounding environment.

In accordance with the preferred alternative identified in Chapter 4, treated effluent from the Effluent Treatment Plant (ETP), with a design capacity of 50 m³/day, shall be reused within the facility for suitable applications, including ash conditioning, dust suppression, floor washing, and greenbelt irrigation, subject to compliance with the water quality requirements for each intended use. Any surplus treated effluent shall be discharged only with the necessary approval from the Department of Environment (DoE) and in compliance with the applicable effluent discharge standards under the Environment Conservation Rules (ECR), 2023, and the conditions of the Environmental Clearance Certificate (ECC).

The principal wastewater sources, potential pollutants, and corresponding management measures are presented in Table 10.14.

Table 69: Wastewater Sources and Management Measures

Source	Possible Pollutants	Management Measures
Scrubber/quench blowdown (if wet APCD is used)	Total Dissolved Solids (TDS), chloride, sulfate, heavy metals, and extreme pH.	Collect separately and treat through appropriate neutralization, chemical precipitation, and other necessary treatment processes before discharge to the ETP or subsequent treatment stages.
Floor and vehicle washing	Suspended solids, oil and grease, and hazardous waste residues.	Collect through designated contaminated-water drainage systems; provide sediment and oil separation where appropriate; and direct wastewater to the ETP for treatment.

Source	Possible Pollutants	Management Measures
Landfill leachate and contaminated storage-area runoff	Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), ammonia, heavy metals, and hazardous organic compounds.	Collect through dedicated leachate collection systems, sumps, and covered storage tanks; transfer to the ETP for appropriate treatment.
Laboratory wastewater	Chemical residues, acids, alkalis, and potentially hazardous substances.	Segregate incompatible and concentrated chemical wastes; apply appropriate pretreatment, including neutralization where suitable; and transfer compatible wastewater to the ETP.
Domestic wastewater	BOD, COD, suspended solids, and pathogens.	Collect and treat through a properly designed septic tank system or Sewage Treatment Plant (STP), as applicable, with appropriate maintenance and compliant final disposal or discharge.
ETP sludge	Concentrated pollutants, including heavy metals and other hazardous constituents.	Dewater and test sludge to determine its hazardous characteristics; stabilize or solidify where required; and dispose of residues meeting the landfill acceptance criteria in the secured landfill or another authorized facility.

The following operational requirements shall apply:

- **Wastewater treatment and emergency storage:** No untreated wastewater shall be discharged from the facility. The ETP shall be operated whenever wastewater requiring treatment is generated or received. Emergency wastewater storage capacity equivalent to at least two days of peak wastewater generation shall be maintained to accommodate temporary ETP shutdowns, maintenance, or abnormal operating conditions.
- **Flow measurement and recordkeeping:** ETP influent, treated effluent, and reuse volumes shall be measured and recorded daily. Operational records shall include wastewater generation, treatment performance, reuse, discharge where authorized, and relevant monitoring results.
- **Drainage and containment:** Peripheral drains, silt traps, and oil traps shall be provided and maintained where required. Paved operational areas handling hazardous wastes or chemicals shall be graded towards designated contaminated-water collection drains to prevent uncontrolled runoff.
- **Rainwater segregation:** Clean stormwater shall be diverted away from hazardous waste storage areas, residue storage areas, and active landfill cells. Contaminated runoff, including first-flush runoff from relevant operational areas, shall be collected and directed to the ETP or designated containment facilities for appropriate treatment.
- **Monsoon preparedness:** Stormwater drainage systems shall be inspected before and during the monsoon season and cleaned regularly to prevent blockages. Emergency pumping arrangements shall be maintained for areas susceptible to waterlogging.
- **Stormwater discharge:** Stormwater discharged beyond the project boundary shall be free from contamination by hazardous waste, ash, oil, sludge, and chemicals and shall comply with applicable environmental requirements. Any stormwater suspected of contamination shall be diverted to the contaminated-water collection and treatment system.

10.5.5 Noise Management

Noise and vibration generated by operational equipment, including fans, blowers, compressors, diesel generators, and vehicle movements, shall be controlled to minimize occupational exposure and disturbance to surrounding communities. The following measures shall be implemented:

- Install and maintain silencers on fans, blowers, compressors, and diesel generator (DG) sets; provide acoustic enclosures for the DG set and other high-noise equipment where required.
- Provide suitable vibration isolators for rotating equipment and undertake regular inspection and preventive maintenance to minimize noise and vibration.
- Enforce vehicle speed limits and restrict unnecessary horn use within the facility.
- Provide appropriate hearing protection and warning signs in areas where noise levels exceed 85 dB(A), supported by occupational noise exposure assessments and applicable safety requirements.
- Maintain a greenbelt along the project boundary to provide supplementary noise attenuation and environmental screening.
- Conduct periodic workplace and boundary noise monitoring in accordance with the monitoring requirements specified in Section 10.7.

10.5.6 Residue Management

Incineration and pollution control processes generate residues in which hazardous constituents may become concentrated. The principal residue streams include bottom ash and slag, fly ash and Air Pollution Control Device (APCD) dust, spent activated carbon, scrubber sludge where applicable, Effluent Treatment Plant (ETP) sludge, and contaminated absorbents and filter media. Fly ash, APCD residues, spent activated carbon, and scrubber sludge shall be managed as hazardous waste unless appropriate testing and applicable regulatory requirements establish otherwise. Other residues shall be characterized and classified before treatment, reuse, or disposal.

All residues shall be collected, segregated, stored, tested, treated, and disposed of in accordance with approved operating procedures and the applicable waste acceptance criteria. The residue management procedure is presented in Table 10.15.

Table 70: Residue Management Procedure

Step	Action	Responsibility
Generation	Record the quantity, source, and type of each residue stream daily to support waste tracking and mass balance reconciliation.	POM
Collection and cooling	Collect residues separately using designated, closed or enclosed handling systems and suitable containers. Allow hot residues to cool safely before handling. Avoid uncontrolled open handling of dry ash and dust-generating materials.	POM
Segregation	Keep bottom ash and slag separate from fly ash, APCD residues, and other waste streams; prevent mixing of incompatible residues.	POM / EO
Storage	Store residues in designated, covered areas with impervious floors, appropriate secondary containment, controlled drainage, labeling, restricted access, and suitable dust and spill-control arrangements.	POM

Step	Action	Responsibility
Testing and classification	Conduct appropriate residue characterization, including heavy metal analysis and leachability testing using the Toxicity Characteristic Leaching Procedure (TCLP) or other applicable methods, to determine hazardous characteristics and disposal suitability.	LI / AL
Stabilization	Stabilize or solidify hazardous residues where required before landfilling. Conduct batch quality assurance testing, including leachability and compressive strength testing, as applicable, to verify compliance with the approved landfill acceptance criteria.	POM / LI
Disposal	Dispose of residues only in the secured landfill where the applicable acceptance criteria are met, or transfer them to another DoE-authorized facility. Disposal on open land or into drains, ponds, water bodies, or municipal waste disposal sites shall be prohibited.	POM
Beneficial reuse	Permit beneficial reuse of bottom ash only where testing confirms its suitability, applicable environmental requirements are satisfied, and the necessary DoE approval has been obtained. Fly ash and APCD residues shall not be reused.	EO / MGT
Documentation	Maintain a residue management register documenting residue quantities, sources, classification and test results, treatment records, storage locations, final disposal destinations, and relevant approvals.	EO

10.5.7 Secured Landfill Management

The secured landfill shall receive only stabilized residues and other wastes that meet the approved landfill acceptance criteria. The landfill shall be designed, constructed, operated, and maintained in accordance with approved engineering specifications and applicable environmental requirements. The following measures shall be implemented:

- Provide an engineered composite liner system comprising compacted clay and a High-Density Polyethylene (HDPE) geomembrane, together with appropriate leachate collection and leak detection layers. Liner installation and associated containment structures shall be subject to independent Construction Quality Assurance (CQA) verification.
- Collect leachate through the designated collection system and sump, transfer it to a covered leachate storage tank, and treat it in the Effluent Treatment Plant (ETP). The leachate head above the liner shall be maintained below the maximum level specified in the approved engineering design.
- Implement cell-by-cell waste placement, with appropriate daily or operational cover and temporary rain covers over active cells, to minimize rainfall infiltration, odor, litter, and leachate generation.
- Accept only wastes that satisfy the approved landfill acceptance criteria, including leachability testing using the Toxicity Characteristic Leaching Procedure (TCLP) following stabilization, where applicable. Record waste quantities and placement locations using a designated landfill cell grid map.
- Provide final capping of completed landfill cells using an approved low-permeability cover system, drainage layer, and vegetated topsoil to minimize infiltration and maintain long-term stability.
- Maintain perimeter drainage systems to divert uncontaminated stormwater away from active landfill cells and prevent uncontrolled runoff into surrounding areas.

- Conduct routine inspections of landfill cells, leachate collection systems, drainage arrangements, and containment infrastructure, with inspection findings and corrective actions documented in the operational records.

10.5.8 Housekeeping

Good housekeeping practices shall be maintained throughout the facility to minimize environmental contamination, occupational hazards, fire risks, and operational disturbances. The following measures shall be implemented:

- Store waste only in designated, appropriately labeled storage areas; prevent the accumulation or scattering of waste on floors, roads, and open ground.
- Clean up spills promptly using appropriate containment and decontamination procedures; clean waste receiving and processing floors daily or more frequently where necessary.
- Keep drainage channels free from waste, sludge, and other obstructions; remove empty containers, scrap materials, and unnecessary equipment from operational areas.
- Keep fire exits, emergency access routes, evacuation pathways, and firefighting equipment unobstructed at all times.
- Complete daily housekeeping inspections using designated checklists, with identified deficiencies recorded and corrective actions implemented by the responsible area supervisors.

10.5.9 Occupational Health and Safety

Workers may be exposed to hazardous wastes, dust, fumes, heavy metals, chemicals, heat, noise, sharps, biological agents, and moving equipment during facility operations. Appropriate occupational health and safety measures shall be implemented to prevent accidents, injuries, occupational illnesses, and hazardous exposures. The following measures shall be implemented:

- Establish and implement Standard Operating Procedures (SOPs) for each operational area, together with permit-to-work systems for hot work, confined-space entry, electrical maintenance, and working at height.
- Provide and enforce the use of task-specific Personal Protective Equipment (PPE) in accordance with the PPE matrix (Annexure 9), including appropriate respiratory protection for ash and residue handling and Self-Contained Breathing Apparatus (SCBA) for designated emergency response activities.
- Prioritize engineering controls, including mechanical handling, enclosed material transfer, local exhaust ventilation, and other appropriate exposure-control measures, before relying on administrative controls and PPE.
- Maintain Safety Data Sheets (SDS) for all chemicals and treatment reagents, together with an updated chemical inventory and appropriate chemical handling and storage procedures.
- Provide adequately equipped first-aid facilities, eyewash stations, and emergency showers at locations where chemical exposure risks exist.
- Provide adequate washing, showering, and changing facilities; prohibit eating, drinking, and smoking in waste handling and other designated hazardous work areas.
- Conduct pre-employment and periodic occupational medical examinations, including appropriate biological monitoring for workers with potential heavy metal exposure, based on occupational risk assessment and the monitoring requirements specified in Section 10.7.6.

- Provide hepatitis B and tetanus vaccination, as appropriate, for workers handling healthcare-related waste, sharps-containing waste, or other materials presenting relevant biological hazards, in accordance with occupational health advice.
- Implement suitable work-rest schedules, job rotation, and other exposure-control measures for workers in high-temperature or high-exposure areas.
- Maintain records of occupational incidents, near misses, and work-related illnesses; conduct regular emergency drills, workplace inspections, safety training, and occupational health and safety audits.

10.5.10 Community Health and Safety

Community health and safety measures shall be implemented to minimize potential risks associated with hazardous waste transportation, facility operations, emissions, odor, traffic, and emergency incidents. The following measures shall be implemented:

- Maintain a secure boundary wall, controlled entry and exit points, and appropriate security arrangements to prevent unauthorized access to the facility.
- Establish and maintain a greenbelt along the project boundary to provide environmental screening and supplementary mitigation of dust, noise, and visual impacts.
- Ensure that waste transport vehicles are appropriately covered or enclosed and leak-proof where required; enforce suitable speed limits and traffic safety measures near settlements, schools, markets, and other sensitive locations.
- Maintain emergency communication arrangements with the local administration, Fire Service and Civil Defence, and nearby healthcare facilities; display emergency contact information prominently at the facility entrance.
- Operate a community Grievance Redress Mechanism (GRM) under the supervision of the Community Liaison Officer (CLO), with complaints acknowledged within two working days and responded to within 15 working days. Complaints and corresponding corrective actions shall be documented.
- Prevent and minimize odor through enclosed waste storage, timely waste processing, appropriate ventilation, and regular housekeeping. Complaints relating to odor, smoke, traffic, spills, or other operational disturbances shall be investigated promptly and addressed through appropriate corrective measures.
- Maintain an off-site emergency communication and response procedure for major incidents, consistent with the emergency preparedness and response arrangements described in Chapter 9.
- Provide public access to real-time Continuous Emission Monitoring System (CEMS) data through an electronic display at the facility entrance, in accordance with the monitoring and disclosure requirements specified in Section 10.7.8.

10.5.11Summary ESMP Matrix for Operation Phase

The principal environmental and social risks associated with facility operations, together with the corresponding mitigation measures, monitoring indicators, and responsible personnel, are summarized in Table 10.16. The measures shall be implemented throughout the operation phase in accordance with the approved Standard Operating Procedures (SOPs), applicable regulatory requirements, and the monitoring program described in Section 10.7.

Table 71: Summary ESMP Matrix for Operation Phase

Activity	Potential Impact	Mitigation Measures	Monitoring Indicator	Responsibility
Waste acceptance and storage	Acceptance of unsuitable or unidentified waste; incompatible waste mixing; spills and contamination.	Implement Waste Acceptance Criteria (WAC), pre-acceptance verification, fingerprint testing, waste segregation, and quarantine procedures.	Waste acceptance and rejection records; verification test results; inventory and monthly mass balance.	WAO / LI
Incinerator operation	Stack emissions, incomplete combustion, and potential release of hazardous pollutants.	Maintain specified combustion temperature and residence time; operate automatic waste-feed interlocks, Air Pollution Control Device (APCD), and Continuous Emission Monitoring System (CEMS).	CEMS records; combustion temperature and operating logs; interlock records; periodic stack emission test reports.	POM / EO
Waste transportation and handling	Spills, leakage, odor, traffic accidents, and potential community exposure.	Use covered or enclosed vehicles, manifest documentation, approved transport routes, supervised handling, and trained drivers.	Vehicle inspection records; manifests; spill and transport incident records.	LO / WAO
Wastewater and stormwater management	Surface water and groundwater contamination; uncontrolled wastewater discharge.	Maintain separate drainage systems, operate the Effluent Treatment Plant (ETP), maximize suitable treated water reuse, and prevent untreated discharge.	ETP influent and effluent flow records; treated effluent test results; reuse records; drainage inspection records.	POM / EO
Residue management	Fugitive dust, hazardous exposure, and soil or water contamination.	Segregate residues; provide covered storage; undertake appropriate testing, including Toxicity Characteristic Leaching Procedure (TCLP); and stabilize hazardous residues where required.	Residue generation and disposal register; laboratory test results; stabilization quality assurance records.	POM / EO
Secured landfill operation	Leachate generation, liner leakage, and potential groundwater contamination.	Maintain engineered composite liner and leachate collection systems; apply operational cover; control stormwater; and implement final capping of completed cells.	Leachate quantity and quality; leak detection records; groundwater monitoring results; landfill inspection and placement records.	POM / EO
Noise management	Occupational noise exposure and disturbance to surrounding communities.	Provide silencers, acoustic enclosures, vibration isolation, appropriate hearing protection, and boundary greenbelt.	Workplace and boundary noise monitoring results; equipment maintenance records.	HSO / EO
Occupational health and safety	Workplace injuries, hazardous exposure, and occupational illnesses.	Implement SOPs, permit-to-work systems, engineering controls, appropriate Personal Protective Equipment (PPE), medical surveillance, and emergency preparedness measures.	Workplace inspection records; exposure monitoring and occupational health records; incidents, near misses, and lost-time injuries (LTIs).	HSO
Community health and safety	Community exposure, traffic hazards, public concern, and off-site emergency risks.	Maintain access control, safe waste transportation, community Grievance Redress Mechanism (GRM), public disclosure, and emergency coordination arrangements.	Community grievance register and response records; traffic incident records; emergency drill and communication records.	CLO / HSO

10.6 Specific Management Plans

10.6.1 Greenbelt Development

A greenbelt shall be developed along the project boundary, internal roads, administrative area, and suitable non-operational open spaces to intercept dust, provide supplementary noise attenuation, improve visual screening, stabilize soil, and support local biodiversity. Plantation activities shall commence during the construction phase and continue throughout the operation phase, using predominantly native, pollution-tolerant species suitable for the climatic and soil conditions of Gazipur.

The proposed greenbelt development zones and plantation arrangements are presented in Table 10.17.

Table 72: Greenbelt Development Zones

Zone	Plantation Type	Purpose
Project boundary	Three-row plantation belt, comprising an outer row of dense shrubs and medium-height trees, a middle row of tall pollution-tolerant trees, and an inner row of medium-height trees and ground cover, where adequate space is available.	Dust interception, visual screening, and supplementary environmental buffering.
Internal roads	Avenue plantation using suitable native or locally adapted trees.	Shade, dust interception, and landscape improvement.
Entrance and administrative area	Ornamental trees, shrubs, and grass, with preference for suitable native species.	Visual amenity and landscape improvement.
Drainage channels	Grass and shallow-rooted erosion-control vegetation along suitable drain embankments and adjoining areas.	Soil stabilization and erosion control without obstructing drainage.
Non-operational open spaces	Mixed native trees, shrubs, and ground cover.	Biodiversity enhancement, soil protection, and microclimate improvement.

The following requirements shall apply:

- Plantation locations shall be selected to avoid obstruction of emergency access, firefighting routes, CCTV sightlines, drainage channels, and utility corridors. Appropriate separation distances shall be maintained from fuel, chemical, and hazardous waste storage areas.
- Deep-rooted species shall not be planted over underground utilities, foundations, landfill liner systems, or final landfill caps. Vegetation established on completed landfill caps shall be compatible with the approved capping design.
- Treated ETP effluent may be used for irrigation only where its quality is suitable for the intended application and does not pose unacceptable risks to soil, groundwater, or vegetation.
- Plantation areas shall be maintained through appropriate watering, mulching, pruning, weed control, and replacement planting, particularly during the establishment period.
- A minimum plant survival target of 80% shall be maintained. Dead or unhealthy plants shall be replaced during the next suitable planting season.
- Plantation progress, survival rates, replacement activities, and maintenance requirements shall be monitored and documented periodically by the responsible environmental personnel.

10.6.2 Rainwater Harvesting

Rainwater from clean roof areas, including the administrative building, workshops, and other uncontaminated roofs, shall be collected through gutters and downpipes, screened, passed through a first-flush diversion system, and stored in a covered tank for suitable non-potable applications. Potential uses include greenbelt irrigation, cleaning of paved areas, toilet flushing where water quality permits, and supplementation of the fire-water reserve where technically suitable and consistent with fire protection requirements.

Runoff from waste receiving, storage, treatment, residue handling, and landfill areas shall not be used for rainwater harvesting. Potentially contaminated runoff from these areas shall be collected separately and directed to the designated contaminated-water collection system for treatment in the Effluent Treatment Plant (ETP), as required.

Rainwater harvesting gutters, screens, first-flush diverters, filters, and storage tanks shall be inspected and cleaned before each monsoon season and maintained regularly during operation to prevent blockage, sediment accumulation, and water contamination.

10.6.3 Thermal Pollution Management

Thermal emissions and heat-related risks associated with incineration, residue handling, and other high-temperature operations shall be controlled through appropriate engineering and operational measures. The following measures shall be implemented:

- Hot flue gases from the incinerator shall pass through the rapid quench system and subsequent Air Pollution Control Device (APCD) components before discharge through the stack. Rapid cooling shall be maintained in accordance with the approved incinerator design to minimize the potential for dioxin and furan re-formation.
- Cooling water, where used, shall be managed through a closed-loop or appropriately controlled system. Heated cooling water shall not be discharged directly into surface water bodies.
- Hot bottom ash and slag shall be cooled using controlled procedures before transfer to designated residue handling and storage areas, with appropriate measures to prevent steam, dust, and contaminated runoff.
- Workers operating near hot equipment, surfaces, and residues shall be protected through suitable insulation, guarding, restricted access, task-specific Personal Protective Equipment (PPE), and heat-stress management measures.

10.6.4 Surface Water and Fisheries Protection

Nearby ponds, canals, and agricultural drainage channels may support fisheries, irrigation, and other local water uses. Facility operations shall therefore be managed to prevent contamination of surrounding surface water bodies and associated aquatic environments.

No untreated wastewater, landfill leachate, or contaminated runoff shall be discharged into ponds, canals, drainage channels, or other surface water bodies. Clean stormwater and contaminated drainage systems shall be maintained separately, while hazardous waste storage, chemical handling,

and residue management areas shall be provided with appropriate containment and controlled drainage arrangements.

Vegetated buffers shall be maintained between operational areas and adjacent drainage channels, where site conditions permit, without obstructing drainage or compromising facility safety. Surface water quality shall be monitored at the designated locations and frequencies specified in Section 10.7.6. Any identified contamination attributable to facility operations shall be investigated promptly, and appropriate corrective measures shall be implemented.

10.6.5 Land, Resettlement and Livelihood

The project will be implemented on land owned by Sheam TSDF BD Ltd. (STBL), as documented in Annexure 2. Based on the land ownership review and socio-economic survey, no physical or economic displacement is anticipated, and a Resettlement Action Plan (RAP) is therefore not considered necessary, subject to confirmation that no tenants, informal occupants, land users, or livelihood activities will be adversely affected. The following safeguards shall be implemented:

- No adjoining land shall be occupied or used without the necessary authorization and agreement.
- Advance notice shall be provided to affected persons regarding any temporary restriction of access or disruption to existing land uses.
- Areas temporarily affected by project activities shall be restored to their previous condition, as far as practicable.
- Any unforeseen damage to crops, property, or livelihood assets attributable to project activities shall be documented, assessed, and appropriately compensated, with grievances addressed through the established Grievance Redress Mechanism (GRM).
- If physical or economic displacement is identified at any stage, the impacts shall be assessed and an appropriate site-specific resettlement or livelihood restoration plan shall be prepared and implemented, as required, in accordance with applicable Bangladesh laws and the principles of IFC Performance Standard 5, before the displacement occurs.

10.6.6 Contingency and Emergency Preparedness

The hazard and risk assessment, Emergency Response Plan (ERP), Emergency Response Team (ERT), and abnormal operating condition procedures are presented in Chapter 9. The ESMP shall incorporate these arrangements to ensure prompt response to equipment failures, accidental releases, fires, extreme weather events, and other operational emergencies.

The minimum contingency actions to be implemented during facility operation are presented in Table 10.18.

Table 73: Minimum Contingency Actions

Contingency	Immediate Action
Incinerator, APCD, or critical interlock failure	Automatically stop waste feeding; maintain safe combustion and necessary emission-control functions during controlled burnout using auxiliary fuel, as required; investigate and rectify the fault before restarting waste feeding.

Contingency	Immediate Action
CEMS failure	Notify the Environmental Officer (EO) immediately; implement approved backup monitoring arrangements where permitted; suspend waste feeding when required by the approved interlock logic, ECC conditions, or DoE-approved operating procedures. Resume feeding only after the required monitoring functions are restored or operation is otherwise authorized.
ETP failure	Immediately stop treated effluent discharge and reuse where treatment performance cannot be verified; divert incoming wastewater to designated emergency storage; suspend wastewater-generating activities if storage capacity becomes insufficient.
Power failure	Activate emergency power supply for critical safety, control, monitoring, and emission-control equipment, including the induced-draft (ID) fan and necessary APCD components, in accordance with the approved emergency operating procedures.
Chemical spill or leakage	Isolate the affected area; restrict access; identify the substance and associated hazards; contain the spill using suitable response materials; and collect contaminated materials for appropriate treatment or disposal.
Unknown or reactive waste	Stop handling and isolate the affected consignment in a safe location; prevent contact with incompatible materials; undertake appropriate identification and hazard assessment before any further movement or treatment. Transfer to the designated quarantine area only where safe to do so.
Fire	Raise the alarm; activate the ERT and applicable emergency response procedures; evacuate affected personnel; and notify the Fire Service and Civil Defence and other relevant authorities as required.
Flood or extreme rainfall	Protect hazardous waste storage areas and active landfill cells; maintain stormwater diversion and containment systems; isolate contaminated runoff; and implement emergency pumping or other protective measures where necessary.
Transport accident	Activate the transport emergency response procedure; notify relevant authorities and emergency services as required; secure the affected area; and contain and recover spilled waste using appropriately trained personnel and equipment.

All contingency events shall be recorded and investigated, with appropriate corrective and preventive actions implemented. Following incidents affecting critical treatment, containment, monitoring, or safety systems, operations shall resume only after the necessary safety checks have been completed and documented restart approval has been obtained from the Plant Operations Manager (POM) and ESHS Manager.

10.6.7 Community Investment

In addition to the mandatory mitigation measures specified in this ESMP, Sheam TSDF BD Ltd. (STBL) may undertake voluntary community investment and Corporate Social Responsibility (CSR) activities to support the well-being of surrounding communities. Such activities may include environmental and road-safety awareness programs, community health camps, support for safe drinking water, and educational initiatives in local schools.

These voluntary activities shall not substitute for, or be counted as, the environmental and social mitigation measures required under the ESMP. Where implemented, the activities and their outcomes shall be documented and reported under the social monitoring program described in Section 10.7.6.

10.7 Environmental and Social Monitoring Plan

10.7.1 Objectives and Principles

The Environmental and Social Monitoring Plan shall verify the implementation and effectiveness of ESMP measures, demonstrate compliance with applicable national environmental standards and Environmental Clearance Certificate (ECC) conditions, identify unexpected environmental and social impacts at an early stage, and initiate timely corrective actions. The monitoring requirements for the pre-construction, construction, and operation phases are consolidated in the following sections to ensure consistency and avoid duplication. The following principles shall apply:

- Each monitoring parameter shall have a defined monitoring location, frequency, method, applicable compliance criterion or performance indicator, and responsible party.
- Baseline environmental and social data presented in Chapter 6 shall be used as reference information for evaluating changes and trends. At least one complete round of pre-operational environmental monitoring shall be conducted before facility commissioning.
- Monitoring locations shall be identified using Global Positioning System (GPS) coordinates and presented on a monitoring location map. Consistent monitoring locations shall be maintained to support comparison of results over time, with any necessary changes documented.
- Monitoring results shall be assessed against applicable Bangladesh environmental standards, ECC conditions, and relevant international guidelines or project commitments. Where different criteria apply to the same parameter, the more stringent requirement shall be adopted where legally applicable or committed to under the ESMP.
- Monitoring results shall be evaluated against the compliance criteria and action levels specified in Section 10.7.7. Exceedances or significant adverse trends shall trigger investigation, appropriate corrective actions, and documented follow-up verification.

10.7.2 Compliance Criteria

The compliance criteria presented in the following monitoring tables shall be applied to assess the environmental performance of the facility. Applicable national standards shall be based on the Environment Conservation Rules, 2023 (ECR 2023), other relevant Bangladesh regulations, and the conditions of the Environmental Clearance Certificate (ECC), as summarized in Chapter 3.

For incinerator stack emissions, the World Bank Group Environmental, Health and Safety (EHS) Guidelines for Waste Management Facilities, with reference to relevant European Union industrial emission standards, shall be adopted as the international performance benchmark. Where national and adopted international criteria differ for the same parameter, the more stringent applicable or project-committed requirement shall be used for performance assessment and corrective action.

Table 74: Compliance Criteria and Benchmark Limits

Parameter	Benchmark limit	Basis / averaging	Parameter	Benchmark limit	Basis / averaging
Stack emissions: reference conditions 273 K, 101.3 kPa, dry gas, 11% O_2					
Total particulate matter	10 mg/Nm³	Daily average	Hydrogen fluoride (HF)	1 mg/Nm³	Daily average
Total organic carbon (TOC)	10 mg/Nm³	Daily average	Mercury (Hg)	0.05 mg/Nm³	Sampling period 30 min–8 h
Hydrogen chloride (HCl)	10 mg/Nm³	Daily average	Cd + Tl	0.05 mg/Nm³	Sampling period 30 min–8 h
Sulfur dioxide (SO_2)	50 mg/Nm³	Daily average	Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V	0.5 mg/Nm³	Sampling period 30 min–8 h
Nitrogen oxides (as NO_2)	200 mg/Nm³	Daily average	Dioxins and furans	0.1 ng I-TEQ/Nm³	Sampling period 6–8 h
Carbon monoxide (CO)	50 mg/Nm³	Daily average	Combustion	≥850 °C / ≥2 s (≥1,100 °C if >1% halogenated organics as Cl)	Continuous
Other media					
Ambient air ($PM_{2.5}$, PM_{10}, SO_2, NO_2, CO, O_3)	National Ambient Air Quality Standards	As per standard averaging periods	Effluent (pH, BOD, COD, TSS, TDS, O&G, metals, etc.)	ECR 2023 standards for industrial effluent (inland surface water / irrigation)	Grab or composite sample
Noise (Noise Pollution (Control) Rules, 2006)	Industrial 75/70; mixed 60/50; residential 55/45 dB(A)	Day (06:00–21:00) / night LAeq	Noise (WBG EHS, at receptor)	Residential 55/45 dB(A); industrial 70/70 dB(A); and ≤3 dB increase over background	1-hour LAeq, day/night
Groundwater	Bangladesh drinking water standards (ECR 2023) and site baseline	Trend against upgradient wells and baseline	Leached residues before landfilling	TCLP regulatory levels (US EPA 40 CFR 261.24) pending a national criterion	Per batch

Sources:

- Incinerator stack emissions: EU Directive 2010/75/EU, Annex VI, supported by the WBG EHS Guidelines for Waste Management Facilities.
- Ambient air, effluent, and national noise limits: Applicable Bangladesh regulations.
- International receptor noise limits: WBG General EHS Guidelines, Section 1.7.
- TCLP: US EPA 40 CFR §261.24 and Method 1311.

10.7.3 Quality Assurance and Quality Control

A Quality Assurance and Quality Control (QA/QC) program shall be implemented to ensure the accuracy, reliability, traceability, and comparability of environmental monitoring results. The following requirements shall apply:

- Compliance sampling and laboratory analysis shall be undertaken by laboratories recognized or accepted by the Department of Environment (DoE) and accredited to ISO/IEC 17025 for the relevant parameters and methods, where such accreditation is available and applicable. Laboratory accreditation status and scope shall be verified before engagement.
- Recognized sampling and analytical methods shall be used, including US EPA Method 5 for particulate matter (PM), Method 26A for hydrogen chloride (HCl) and hydrogen fluoride (HF), Method 29 for metals, and Method 23 or EN 1948 for dioxins and furans, as applicable to stack emission testing. Water and wastewater analysis shall follow appropriate US EPA or APHA Standard Methods, while residue leachability testing shall follow US EPA SW-846 Method 1311 (Toxicity Characteristic Leaching Procedure, TCLP), where specified.
- Appropriate sample identification, preservation, handling, transport, and chain-of-custody procedures shall be maintained. Field blanks, duplicate samples, and other relevant QA/QC checks shall be included according to the sampling program and analytical methods. Duplicate samples shall represent at least 10% of applicable environmental samples.
- The Continuous Emission Monitoring System (CEMS) shall undergo routine calibration, functional checks, and maintenance in accordance with the manufacturer's specifications and applicable QA/QC requirements. CEMS performance shall be independently verified through appropriate parallel stack testing at least annually. A minimum target of 95% valid hourly monitoring data per month shall be maintained, subject to applicable regulatory and equipment-specific requirements.
- Environmental monitoring equipment, including noise meters, sampling instruments, and meteorological monitoring equipment, shall be calibrated or verified at the intervals specified by the manufacturer and applicable monitoring methods, with formal calibration conducted at least annually where required. Calibration certificates and maintenance records shall be retained.
- Environmental monitoring results, laboratory reports, calibration records, and QA/QC documentation shall be maintained in a central monitoring database. The Environmental Officer (EO) shall review monitoring results and trend charts at least monthly, identify abnormal trends or exceedances, and initiate appropriate corrective actions in accordance with Section 10.7.7.

10.7.4 Pre-construction and Baseline Monitoring

Table 75: Pre-construction and Baseline Monitoring

Aspect	Parameter / indicator	Location	Frequency	Method	Responsibility
Groundwater baseline	Full suite as in Table 10.26 plus water level	All monitoring wells once installed	Two rounds (dry and wet season) before commissioning	Sampling by AL	EO / AL
Soil baseline	Heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn), dioxins/furans, TPH, pH	6 points: storage, residue, landfill, downwind max-GLC point, 2 off-site	Once before commissioning	Composite samples by AL	EO / AL
Land development	Boundary compliance, vegetation removal	Project site	Daily during activity	Inspection	SE
Fill material source	Approval documents, material quality	Source location	Before use of each source	Document check; testing	MGT / SE
Soil transport	Truck covering, spillage, route compliance	Access roads and gate	Daily	Inspection	EPC / HSO
Dust	Visual dust; water spraying record	Site and access road	Daily	Inspection	HSO
Noise	LAeq dB(A)	Site boundary	Weekly during major work	Sound level meter	HSO
Drainage and erosion	Waterlogging, erosion, silt trap condition	Site and slopes	Weekly and after heavy rain	Inspection	SE
Borrow area closure	Grading, drainage, revegetation	Source sites	At closure	Checklist and photographs	SE
Worker safety	PPE use, induction records	Work areas	Daily	Inspection	HSO
Community	Grievances and access disturbance	Project office	Continuous	GRM register	CLO

10.7.5 Construction Phase Monitoring

Table 76: Construction Phase Monitoring

Aspect	Parameter / indicator	Location	Frequency	Criterion	Responsibility
Ambient air	$PM_{2.5}$, PM_{10} (24 h)	Site boundary (downwind) and nearest settlement	Monthly; daily visual dust check	NAAQS	EO / AL
Noise	LAeq day and night	Boundary and nearest receptor	Monthly; after complaint	Noise Rules 2006	HSO / AL
Runoff and wash water	pH, TSS, oil and grease	Site discharge point; concrete wash pit	Monthly and after heavy rain	ECR 2023 effluent	EO / AL

Aspect	Parameter / indicator	Location	Frequency	Criterion	Responsibility
Drainage	Waterlogging, blockage	Site drains	Weekly and after rain	No waterlogging	SE
Construction waste	Segregation, quantities, disposal records	Waste storage zone	Weekly	100% recorded; no open burning	EPC
Fuel and chemicals	Bund condition, spills	Fuel/chemical store	Daily	Zero uncontained spills	HSO
Containment QA	Liner and bund construction QA	Landfill cells, storage bays	Each stage of construction	Design specification; CQA sign-off	SE
Worker safety	PPE, permits, incidents, LTIs	Work areas	Daily; monthly summary	Zero fatalities; all incidents investigated	HSO
Labor conditions	Age records, contracts, wages, hours, accommodation, worker grievances	Contractor records and camp	Monthly audit	Labour Act 2006; Section 10.4.7	ESHSM
Traffic	Speed, routes, spillage, accidents	Gate and access road	Daily	Zero project-related road accidents	LO / EPC
Community	Grievances received and closed	Project office	Continuous; monthly summary	Response within 15 working days	CLO

10.7.6 Operation Phase Monitoring

(a) Stack Emissions and Combustion Conditions

Table 77: Stack Emission and Combustion Monitoring

Parameter	Location	Frequency	Method	Criterion	Responsibility
PM, CO, SO_2, NOx, HCl, O_2, temperature, moisture, flow	Incinerator stack	Continuous (CEMS)	CEMS, 30-min and daily averages	Table 10.19	POM / EO
PM, SO_2, NOx, CO, HCl (verification)	Stack sampling ports	Quarterly	Isokinetic/manual stack sampling	Table 10.19	AL
HF, TOC	Stack	Quarterly	Stack sampling	Table 10.19	AL
Hg, Cd+Tl, other metals	Stack	Quarterly in year 1; then half-yearly	US EPA Method 29	Table 10.19	AL
Dioxins and furans	Stack	Twice in first 12 months (incl. commissioning); then half-yearly	US EPA Method 23 / EN 1948	0.1 ng I-TEQ/Nm^3	AL
Secondary chamber temperature and residence time	Secondary chamber	Continuous	Thermocouples; DCS log	≥850 °C (≥1,100 °C halogenated), ≥2 s	POM

Parameter	Location	Frequency	Method	Criterion	Responsibility
Waste feed rate; interlock trips	Feed system / DCS	Continuous; daily review	DCS log	All trips logged and investigated	POM
Bag filter differential pressure; reagent and activated carbon dosing	APCD	Continuous	DCS log	Within design range	POM
Visible smoke / opacity	Stack outlet	Daily	Visual check / opacity meter	No visible smoke	POM

(b) Ambient Air and Meteorology

Table 78: Ambient Air and Meteorological Monitoring

Parameter	Location	Frequency	Method	Criterion	Responsibility
$PM_{2.5}$, PM_{10}, SO_2, NO_2, CO (24 h)	4 fixed stations: upwind; point of maximum predicted ground-level concentration (dispersion model); nearest settlement; access road	Monthly in first year of operation; quarterly thereafter if compliant	Gravimetric / standard methods	NAAQS	AL
HCl, VOCs, heavy metals on PM_{10} (Pb, Cd, As, Hg)	Max-GLC point and nearest settlement	Quarterly	Standard methods	NAAQS / WHO guidelines	AL
H_2S, NH_3, odor	Waste receiving/storage area and downwind boundary	Monthly; after any odor complaint	Portable analyzer; odor survey	No off-site odor nuisance	EO
Wind speed and direction, temperature, humidity, rainfall, pressure	On-site weather station	Continuous (hourly records)	Automatic weather station	Used to interpret air results and update wind rose	EO

(c) Noise

Table 79: Noise Monitoring

Parameter	Location	Frequency	Method	Criterion	Responsibility
LAeq day and night	4 boundary points and nearest sensitive receptor	Quarterly; after any complaint	Class 1/2 sound level meter, 1-hour readings	Table 10.19	AL / HSO
Workplace noise (LAeq 8 h)	Incinerator hall, ID fan, compressor, DG set, shredder	Quarterly	Dosimetry / area survey	85 dB(A) action level for hearing protection	HSO

(d) Wastewater, Stormwater and Surface Water

Table 80: Wastewater, Stormwater and Surface Water Monitoring

Parameter	Location	Frequency	Method	Criterion	Responsibility
Flow	ETP inlet, outlet and reuse lines	Daily	Flow meters	Within design capacity	POM
pH, TSS, COD (in-house)	ETP outlet	Daily	In-house laboratory	ECR 2023 effluent	LI
pH, temperature, TSS, TDS, BOD, COD, O&G, NH_3-N, chloride, sulfate, phenol, cyanide, metals (As, Cd, Cr^{6+}, total Cr, Cu, Hg, Ni, Pb, Zn)	ETP inlet and outlet	Monthly	Composite sample by AL	ECR 2023 effluent	AL
pH, BOD, COD, TSS, O&G, total and fecal coliform	Septic tank/STP outlet	Quarterly	Grab sample	ECR 2023 sewage	AL
pH, TSS, O&G, metals	Stormwater outfall	Monthly during monsoon (May–Oct)	Grab sample during flow	ECR 2023 effluent	EO / AL
pH, DO, BOD, COD, TSS, TDS, O&G, NH_3-N, metals	Nearby water bodies: upstream and downstream (as in Chapter 6 baseline)	Quarterly	Grab sample	ECR 2023 inland surface water; trend vs baseline	AL

(e) Groundwater

At least three monitoring wells shall be installed before operation: one upgradient and two downgradient of the waste storage area and secured landfill, with locations and screen depths confirmed by the hydrogeological assessment. The two baseline rounds (Table 10.20) set the reference values.

Table 81: Groundwater Monitoring

Parameter	Location	Frequency	Method	Criterion	Responsibility
Water level	All wells	Monthly	Dip meter	Flow direction confirmed annually	EO
pH, EC, TDS, chloride, sulfate, nitrate, ammonia	All wells	Quarterly	Purged sample by AL	Drinking water standard and baseline trend	AL
Metals (As, Cd, Cr, Hg, Pb, Ni, Fe, Mn), phenol, cyanide, TPH	All wells	Half-yearly (dry and wet season)	Purged sample by AL	Drinking water standard and baseline trend	AL
Total and fecal coliform	Downgradient wells	Half-yearly	Purged sample by AL	Drinking water standard	AL

(f) Soil

Table 82: Soil Monitoring

Parameter	Location	Frequency	Method	Criterion	Responsibility
Heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn), pH, TPH	Same 6 points as baseline (Table 10.20)	Annually	Composite samples by AL	Trend against baseline	AL
Dioxins and furans	Max-GLC point and nearest agricultural land	Every 2 years	Composite samples by AL	Trend against baseline	AL

(g) Waste Acceptance, Residues and Secured Landfill

Table 83: Waste, Residue and Secured Landfill Monitoring

Parameter	Location	Frequency	Method	Criterion	Responsibility
Manifest completeness; consignments received, rejected and quarantined	Gate / WAO office	Each consignment; monthly summary	Tracking register	100% manifested; no unidentified waste in general storage	WAO
Verification (fingerprint) tests	Laboratory	Every bulk load; ≥10% of containerized loads	In-house laboratory	Matches pre-acceptance profile	LI
Waste mass balance	Facility-wide	Monthly	Register reconciliation	Unaccounted difference <2%	EO
Storage condition: labels, containers, leaks, segregation	Storage bays	Daily	Inspection checklist	Zero leaks; 100% labeled; incompatibles separated	HSO
Bottom ash, fly ash, APCD residue: quantity	Residue area	Daily	Weighing	Recorded	POM
Residue TCLP and total metals; loss on ignition (bottom ash)	Each residue stream	Monthly	AL	TCLP levels; LOI <5%	AL
Stabilized residue: TCLP and compressive strength	Stabilization unit	Each batch (TCLP monthly composite by AL)	In-house / AL	Passes landfill acceptance criteria	LI / AL
Leachate volume; head on liner	Leachate sump	Daily volume; weekly head	Meter / level gauge	Below design maximum	POM
Leachate quality (pH, COD, BOD, NH_3-N, chloride, metals)	Leachate tank	Quarterly	AL	Input to ETP design range	AL
Leak detection layer flow	Leak detection sump	Weekly	Inspection / volume	Below action leakage rate	POM
Cell placement records; daily cover; cap integrity	Landfill	Daily; cap quarterly	Inspection; grid map	All placements recorded	POM / EO

(h) Occupational Health and Safety

Table 84: Occupational Health and Safety Monitoring

Parameter	Location / group	Frequency	Method	Criterion	Responsibility
Respirable dust, metals in workplace air, VOCs	Ash/residue handling, receiving, shredding, laboratory	Quarterly	Personal sampling	ACGIH TLVs / national OEL	HSO / AL
Heat stress (WBGT)	Incinerator area	Daily in hot season	WBGT meter	Work–rest regime applied	HSO
Pre-employment and periodic medical examination incl. lung function and audiometry	All operational workers	Pre-employment; annually	Occupational physician	Fitness for work recorded	HSO
Biological monitoring (blood lead, urinary metals as relevant)	Ash, residue and APCD workers	Annually	Accredited clinical laboratory	ACGIH BEIs	HSO
PPE compliance; permits; inspections	All work areas	Daily	Inspection	100% compliance	HSO
Incidents, near misses, LTIs, occupational illness	Facility-wide	Continuous; monthly summary	Incident register	Zero fatalities; all incidents investigated	HSO
Fire and spill drills; emergency equipment readiness	Facility-wide	Quarterly drills; monthly equipment checks	Drill records	Drill objectives met	HSO

(i) Social, Community and Ecology

Table 85: Social, Community and Ecological Monitoring

Parameter	Location	Frequency	Method	Target	Responsibility
Grievances received, resolved and outstanding; resolution time	GRM register	Monthly	Register review	Acknowledged ≤2 working days; resolved ≤15 working days	CLO
Odor, smoke, noise and traffic complaints	Surrounding community	Continuous	GRM and site inspection	Each complaint investigated	CLO / EO
Transport incidents and route compliance	Transport routes	Monthly	Fleet records	Zero serious incidents	LO
Local employment (number and % of workforce; women employed)	HR records	Quarterly	HR data	As per local recruitment plan	ESHSM
Community consultation and disclosure meetings	Neighboring communities	Half-yearly	Meeting records	Held as scheduled	CLO
Community investment activities and beneficiaries	Program sites	Annually	Program records	Reported annually	CLO
Greenbelt survival, plant health, dust on foliage	Greenbelt zones	Quarterly	Survey	Survival ≥80%	EO
Birds and other fauna; invasive species	Greenbelt and adjoining open land	Half-yearly	Survey	Trend recorded	EO

10.7.7 Action Levels and Corrective Action

Monitoring results shall be compared against two thresholds. An alert level gives early warning so that controls can be adjusted before a limit is breached; an action level represents non-compliance and requires immediate response and notification.

Table 86: Action Levels, Corrective Action and Notification

Medium	Alert level	Action level	Required response	Notification
Stack (CEMS)	30-min average >80% of the daily limit, or rising trend	Daily average > limit; 30-min average >2× daily limit	Alert: adjust combustion/APCD. Action: stop waste feed, burn out residual waste, investigate root cause, correct, document restart approval	DoE within 24 h of a confirmed exceedance; written report within 7 days
Stack (periodic test)	Result >80% of limit	Result > limit	Repeat test within 30 days after corrective action; review APCD and feed	DoE within 24 h of receipt of result
Ambient air	Project contribution >50% of NAAQS headroom, or upward trend	Exceedance attributable to project	Check stack and fugitive sources; increase monitoring frequency; corrective action report	DoE in next quarterly report (action level: within 7 days)
ETP effluent	Any parameter >80% of limit	Any parameter > limit	Stop discharge/reuse; recirculate to ETP; investigate and correct	DoE within 24 h if discharged off-site
Groundwater	Downgradient value significantly above upgradient/baseline (two consecutive rounds)	Exceeds drinking water standard and attributable to project	Confirmatory resampling; inspect liner, leak detection, storage bunds and drains; contamination assessment; remediation plan	DoE within 7 days of confirmation
Leak detection (landfill)	Flow above normal operating range	Flow above action leakage rate	Identify the leaking cell; stop placement; repair liner; increase groundwater monitoring	DoE within 7 days
Noise	Within 3 dB(A) of limit	Above limit at boundary/receptor	Identify source; maintenance, enclosure or barrier	Quarterly report
Workplace exposure	>50% of OEL	>OEL or BEI exceeded	Engineering controls; PPE review; medical follow-up; removal from exposure where indicated	Internal; Labor inspectorate as required
Community grievance	Repeat complaint on the same issue	Complaint indicating health or safety risk	Site investigation within 24 h; corrective action; feedback to complainant	Monthly GRM summary; DoE if environmental

10.7.8 Public Disclosure

STBL shall ensure public access to relevant environmental and social monitoring information to promote transparency and accountability. The following disclosure measures shall be implemented:

- Real-time Continuous Emission Monitoring System (CEMS) readings shall be displayed on an electronic board at the facility gate and published on the company website. Daily average values shall also be presented alongside the applicable emission limits, with the monitoring period and data validity status clearly indicated.
- A non-technical summary of quarterly environmental and social monitoring results shall be shared with the local Union Parishad and made available at the facility site office.
- The annual environmental and social performance report shall be made publicly available through the company website and at the facility site office.

10.8 Closure and Post-Closure Management Plan

The Closure and Post-Closure Management Plan shall ensure that the facility is closed in an environmentally sound, safe, and socially responsible manner at the end of its operating life or following permanent cessation of operations. The plan shall cover all project components, including waste receiving and storage areas, treatment units, the secured landfill, utilities, drainage systems, buildings, and equipment.

STBL shall review and update the plan at least once every five years and following significant changes in facility operations or regulatory requirements. A detailed Final Closure Plan shall be prepared and submitted to the Department of Environment (DoE) for approval at least two years before planned closure, based on actual site conditions, waste inventories, environmental monitoring results, and applicable regulatory requirements. In the event of unplanned permanent closure, STBL shall notify DoE and prepare a closure plan in accordance with regulatory directions.

10.8.1 Objectives

The objectives of the Closure and Post-Closure Management Plan shall be to:

- Stop facility operations safely and systematically while protecting workers, surrounding communities, and the public.
- Remove, treat, or appropriately dispose of residual waste, hazardous materials, and contaminated equipment.
- Prevent contamination of soil, surface water, groundwater, and air during and after closure.
- Properly cap and maintain the secured landfill and prevent unauthorized access.
- Restore or stabilize disturbed areas for an approved future land use.
- Maintain post-closure environmental monitoring, maintenance, and institutional responsibility for the required period.

10.8.2 Decommissioning and Demobilization

Decommissioning shall be planned and undertaken by trained personnel under a dedicated Closure Health and Safety Plan. The plan shall include job safety analysis, permit-to-work procedures, lockout/tagout, confined-space entry procedures, exposure monitoring, and emergency response arrangements. Decommissioning activities shall include:

- Ceasing waste acceptance and treating or transferring all remaining waste in storage.
- Emptying, cleaning, and decontaminating tanks, pipelines, process equipment, and contaminated surfaces.
- Removing fuels, chemicals, and hazardous materials for appropriate treatment or disposal at authorized facilities.
- Disconnecting and isolating utilities, dismantling equipment, and removing structures not required for post-closure management.
- Segregating dismantled materials for reuse, recycling, authorized treatment, or disposal, in order of preference, subject to contamination status and applicable requirements.

10.8.3 Waste and Hazardous Material Management during Closure

All wastes generated during closure, including hazardous waste, chemical residues, used oils, contaminated soil and equipment, wastewater and sludge, batteries, electronic waste, and any healthcare-related waste, shall be characterized, segregated, and stored according to their hazardous properties and compatibility.

Waste transportation shall be undertaken using appropriate containment and manifest documentation, where applicable. All closure wastes shall be treated, recovered, or disposed of at authorized facilities in accordance with applicable regulatory requirements. Waste transfer and final disposal records shall be retained as part of the closure documentation.

10.8.4 Site Investigation, Remediation and Restoration

Following decommissioning, a closure site investigation shall be undertaken to assess potential contamination of soil and groundwater, using the pre-operational baseline and relevant monitoring results as reference information.

Where contamination requiring remediation is identified, a site-specific remediation plan shall be developed based on the nature and extent of contamination, potential exposure pathways, hydrogeological conditions, intended future land use, and applicable environmental standards. The remediation plan shall be submitted to DoE for approval before implementation.

Following completion of the required remediation activities, disturbed areas shall be appropriately graded, drained, stabilized, and revegetated, consistent with the approved future land use. Remediation completion and site restoration shall be documented and verified.

10.8.5 Secured Landfill Closure

Secured landfill cells shall be progressively closed and capped as they reach their approved final waste levels. Final closure shall include installation of an engineered low-permeability capping system incorporating appropriate drainage, protective, and vegetated topsoil layers, in accordance with the approved landfill design.

The final closure arrangements shall include perimeter drainage, permanent fencing, warning signage, and measures to prevent erosion, infiltration, and unauthorized access.

The leachate collection and treatment system shall remain operational for as long as leachate management is required. Post-closure inspection, maintenance, and environmental monitoring shall continue in accordance with the approved Post-Closure Management Plan and applicable regulatory requirements.

10.8.6 Community Health and Safety during Closure

STBL shall implement appropriate community health and safety measures throughout closure activities. These shall include:

- Restricting unauthorized access and maintaining perimeter fencing and warning signage.
- Controlling dust, noise, and heavy vehicle movements associated with decommissioning and waste transportation.
- Preventing accidental releases of hazardous substances and maintaining appropriate emergency response arrangements.
- Providing advance notice to surrounding communities and relevant local authorities before major closure activities.
- Maintaining the Grievance Redress Mechanism (GRM) throughout the closure period and ensuring that community complaints are recorded, investigated, and addressed.

10.8.7 Post-Closure Monitoring and Maintenance

Post-closure monitoring and maintenance shall continue for the period required by the Department of Environment (DoE) and the approved Final Closure Plan. In line with international practice for

hazardous waste landfills, a period of up to 30 years after landfill closure is assumed for planning purposes. The actual monitoring and maintenance period shall be determined by DoE based on site conditions, environmental performance, and residual risks.

Monitoring frequencies may be reduced after the initial five years where results demonstrate stable environmental conditions, subject to DoE approval. Monitoring and maintenance shall continue or be intensified where contamination, structural deterioration, or other adverse conditions are identified.

The minimum post-closure monitoring and maintenance requirements are presented in Table 10.32.

Table 10.87: Post-Closure Monitoring and Maintenance

Element	Parameter	Frequency (Years 1–5)	Frequency (After Year 5, if Stable)	Responsibility
Groundwater	Parameters specified in Table 10.26	Half-yearly	Annually	STBL / AL
Leachate	Leachate generation volume and quality parameters specified in Table 10.28	Monthly volume measurement; half-yearly quality analysis	Quarterly volume measurement; annual quality analysis	STBL / AL
Leak detection layer	Leakage detection flow and abnormal changes	Monthly	Quarterly	STBL
Landfill cap and drainage	Settlement, erosion, cracking, vegetation condition, and drainage performance	Quarterly and following heavy rainfall	Half-yearly and following significant rainfall or extreme weather events	STBL
Surface water	Parameters specified in Table 10.25 for nearby surface water bodies	Half-yearly	Annually	STBL / AL
Site security	Perimeter fencing, warning signage, and evidence of unauthorized access	Monthly	Quarterly	STBL

10.8.8 Financial Provision

STBL shall establish and maintain a dedicated closure and post-closure fund, or an equivalent financial assurance mechanism acceptable to the Department of Environment (DoE), such as a bank guarantee. Financial provisions shall be established through appropriate contributions or arrangements during the operating life of the facility and shall be sufficient to cover decommissioning, waste removal, site investigation and remediation, secured landfill capping, and post-closure monitoring and maintenance.

The estimated closure and post-closure costs shall be reviewed and updated at least every five years, in conjunction with the periodic review of the Closure and Post-Closure Management Plan, and adjusted where necessary to reflect changes in facility conditions, regulatory requirements, and anticipated costs.

10.8.9 Closure Completion Report

Following completion of closure activities, STBL shall prepare and submit a Closure Completion Report to DoE for review and approval. The report shall document the closure activities undertaken; final waste inventories and disposal destinations; decommissioning, decontamination, and remediation records; environmental monitoring results; photographic evidence; incident, stakeholder consultation, and grievance records; and any outstanding environmental or social issues.

The report shall also describe the arrangements for continued post-closure monitoring, maintenance, institutional responsibility, and financial assurance. Post-closure obligations shall remain in effect until formally released by DoE.

10.9 Training and Capacity Building

All personnel, including contractors and subcontractors, shall receive environmental, social, health, and safety (ESHS) training appropriate to their assigned responsibilities before commencing work and at regular intervals thereafter. Training shall cover relevant ESMP requirements, safe operating procedures, occupational health and safety, waste handling, emergency preparedness, incident reporting, and grievance management, as applicable to individual roles.

The ESHS unit shall maintain training records, including attendance, training topics, and refresher training requirements. Training effectiveness shall be evaluated through periodic inspections, audits, practical assessments, and emergency drills, with additional training provided where deficiencies are identified.

Table 88: Training and Capacity Building Program

Training Topic	Target Group	Frequency
ESHS induction, site rules, worker and community grievance mechanisms, and code of conduct	All staff and contractors; visitors (relevant site safety induction)	Before commencing work or entering operational areas; visitor briefing before site entry
Construction-phase ESMP and Contractor ESHS Plan requirements	EPC contractor managers, supervisors, and subcontractors	Before mobilization; refresher every six months
Hazardous waste identification, Waste Acceptance Criteria (WAC), manifest documentation, and waste tracking system	Waste receiving, laboratory, and operations staff	Before undertaking assigned duties; annual refresher
Safe handling, segregation, and storage of incompatible wastes	Waste handlers and supervisors	Before undertaking assigned duties; refresher every six months
Incinerator, Air Pollution Control Devices (APCD), Continuous Emission Monitoring System (CEMS), Effluent Treatment Plant (ETP), stabilization, and secured landfill operation, including abnormal operating conditions and safety interlocks	Relevant operators and maintenance personnel	Before commissioning or assignment to relevant duties; annual refresher
Personal Protective Equipment (PPE), respiratory protection, confined-space entry, and hot-work safety	Relevant operations and maintenance personnel	Before undertaking relevant duties; annual refresher
Firefighting, spill response, first aid, and emergency evacuation	Emergency Response Team (ERT); all staff (relevant emergency awareness and evacuation procedures)	Quarterly emergency drills; annual refresher training
Defensive driving and transport emergency response	Waste transport drivers and helpers	Before undertaking transport duties; annual refresher
Environmental sampling, Quality Assurance and Quality Control (QA/QC), CEMS data review, and environmental recordkeeping	ESHS and laboratory personnel	Before undertaking assigned duties; annual refresher
Stakeholder engagement, community communication, and grievance handling	Community Liaison Officer (CLO) and relevant security personnel	Before undertaking assigned duties; annual refresher

10.10 Reporting, Documentation and Review

STBL shall maintain a reporting and documentation system to monitor ESMP implementation, demonstrate regulatory compliance, track environmental and social performance, and ensure timely corrective action. The reporting requirements are summarized in Table 10.34.

Table 89: Reporting Requirements

Report	Prepared by	Submitted to	Frequency / Reporting Deadline
Daily operation, CEMS, and safety interlock log	POM / EO	ESHSM	Daily
Contractor ESHS and labor compliance report (construction phase)	EPC	ESHSM	Monthly
Waste receipt, treatment, residue generation, disposal register, and mass balance	WAO / EO / POM	MGT; DoE upon request or as required	Monthly
Environmental exceedance notification	EO / ESHSM	MGT; DoE as required	Within 24 hours of a confirmed stack emission or effluent exceedance, with a written follow-up report within seven days, or earlier where required by applicable regulations or ECC conditions
Incident and emergency report	HSO / ESHSM	MGT; DoE and other relevant authorities, as required	Within 24 hours of a major incident, or earlier where required by applicable regulations or emergency reporting procedures
Grievance log summary	CLO	ESHSM	Monthly
ESMP implementation and environmental and social monitoring report	ESHSM	MGT; DoE as required	Quarterly, or as specified in the ECC
Annual environmental and social performance report, including a publicly disclosed version	ESHSM	MGT; DoE as required for compliance reporting or ECC renewal	Annually
Independent environmental and social audit report	Independent third-party auditor	MGT; DoE as required	Annually

Notes: POM = Plant Operations Manager; EO = Environmental Officer; ESHSM = ESHS Manager; EPC = Engineering, Procurement and Construction Contractor; WAO = Waste Acceptance Officer; MGT = STBL Management; HSO = Health and Safety Officer; CLO = Community Liaison Officer; CEMS = Continuous Emission Monitoring System; ECC = Environmental Clearance Certificate; DoE = Department of Environment.

The ESMP shall be reviewed at least annually and following any major incident, repeated environmental exceedance, significant process modification, change in accepted waste streams, or new regulatory requirement. Revisions shall be documented, approved by STBL Management, and communicated to relevant personnel and contractors.

All monitoring data, waste registers, inspection records, incident reports, audit findings, corrective action records, and regulatory correspondence shall be maintained in an organized and retrievable format. Records relevant to facility operations, closure, and post-closure obligations shall be retained throughout the operating life and applicable post-closure period, or longer where required by law or ECC conditions.

10.11 ESMP Implementation Budget

The costs of pollution control and environmental protection infrastructure incorporated into the facility design, including Air Pollution Control Devices (APCD), Continuous Emission Monitoring System (CEMS), Effluent Treatment Plant (ETP), stabilization unit, secured landfill liner, and leachate collection and treatment systems, are included in the overall project capital cost presented in Chapter 2.

The ESMP implementation budget presented in Table 10.35 covers additional environmental, social, health, and safety management measures, including staffing, monitoring, training, community engagement, independent audits, and contingency provisions. The budget distinguishes between one-time capital expenditure and recurring annual costs during construction, operation, and post-closure management.

STBL shall allocate sufficient financial resources for ESMP implementation and review the budget annually to reflect actual expenditure, monitoring requirements, regulatory obligations, and changes in project activities.

Table 90: Indicative ESMP Implementation Budget

Item	Phase	Estimated Cost (BDT)	Basis
ESHS unit staffing	Construction and operation	30,00000	Annual
Construction-phase mitigation, including dust suppression, noise barriers, drainage, and sanitation	Construction	20,00000	Lump sum
Groundwater monitoring wells (minimum three) and on-site meteorological monitoring station	Construction	500,000	Lump sum
Pre-operational baseline monitoring, including groundwater and soil quality	Pre-commissioning	12,00000	Lump sum
Stack emission testing, including dioxins/furans and heavy metals	Operation	690,000	Annual
Ambient air, noise, surface water, groundwater, soil, leachate, and residue monitoring by accredited laboratories	Construction and operation	17,00000	Annual
CEMS calibration, maintenance, and public monitoring display system	Operation	976,000	Annual
Personal Protective Equipment (PPE), first aid, occupational health surveillance, and exposure monitoring	Construction and operation	136,5000	Annual
ESHS training and emergency response drills	Construction and operation	300,000	Annual
Greenbelt development and maintenance	Construction and operation	768,000	Initial establishment cost and annual maintenance
Stakeholder engagement, Grievance Redress Mechanism (GRM), and public disclosure	All phases	10,00000	Annual
Independent environmental and social audit	Operation	12,00000	Annual
Closure and post-closure financial provision	Operation	50,000000	Annual contribution or equivalent financial assurance
Contingency provision	All phases	300,000	10% of applicable ESMP implementation costs

CHAPTER 11

Conclusions and Recommendations

This chapter presents the overall conclusions of the ESIA regarding the environmental and social acceptability of the proposed project and the key recommendations and conditions that should be fulfilled before and during construction and operation.

11 CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusion

The Environmental and Social Impact Assessment (ESIA) has been undertaken to identify, assess, and evaluate the potential environmental and social impacts associated with the proposed project and to establish appropriate measures for managing those impacts throughout the project life cycle.

Based on the assessment, the proposed project is expected to generate significant socio-economic and developmental benefits, including employment opportunities, local economic activity, improved waste management practices, development of associated infrastructure, and contribution to sustainable environmental management. The project may also support improved resource utilization and reduce the potential environmental risks associated with inappropriate handling, storage, treatment, and disposal of waste.

At the same time, the implementation and operation of the project may result in potential adverse environmental and social impacts. These may include impacts associated with construction activities, air emissions, noise and vibration, wastewater and drainage, waste handling and transportation, traffic movement, occupational health and safety, community health and safety, hazardous materials, emergency situations, and other operational activities.

The assessment indicates that most of the identified adverse impacts can be **avoided, minimized, controlled, or mitigated** through appropriate engineering controls, good operating practices, effective environmental and social management, regular monitoring, and compliance with applicable laws, regulations, standards, and approval conditions.

Particular importance has been placed on:

- Environmental pollution prevention and control;
- Safe handling, storage, transportation, treatment, and disposal of waste;
- Air emission and odor management;
- Surface water, groundwater, and soil protection;
- Occupational health and safety;
- Community health and safety;
- Traffic and transportation management;
- Emergency preparedness and response;
- Stakeholder engagement and information disclosure;
- Worker welfare and labor management;
- Environmental and social monitoring; and
- Closure and post-closure management.

On the basis of the assessment presented in this report, the proposed Integrated TSDF and Incineration Facility is considered environmentally and socially acceptable, provided that the design commitments in Chapter 2, the preferred alternatives in Chapter 4, the mitigation measures in Chapter 7, the risk controls in Chapter 9 and the ESMP in Chapter 10 are fully implemented, and that the recommendations below are fulfilled.

11.2 Recommendations

The following recommendations are made for the proponent, the design team and the regulatory authority.

Before submission of the final ESIA and the ECC application

- Complete the site-specific baseline monitoring (ambient air, noise, surface water, groundwater and soil) and incorporate the laboratory results, monitoring location maps and compliance comparison in Chapter 6.
- Carry out air dispersion modelling for the 45 m stack using site meteorological data and present predicted ground-level concentrations of NO_2, SO_2, CO, PM_{10}, $PM_{2.5}$ and HCl, individually and cumulatively with the baseline, in Chapter 7.
- Reconcile the stated waste handling capacity (100 t/day) with the incinerator capacity (6 t/day), the storage areas and the secured landfill area, and present a mass balance of waste, residues and recovered materials.
- Revise the project cost in Bangladeshi Taka and replace references to Indian guidance (e.g. CPCB) with DoE standards or international guidance where appropriate.
- Document the alternative sites considered and complete the sensitive receptor (IEF) distance matrix.
- Add the records of the public consultation meeting (attendance, issues raised and responses) to Chapter 8 and Annexures 7 and 8.

Design and construction

- Design the incinerator to achieve at least 850°C (1,100°C for halogenated waste) with 2 seconds residence time in the secondary chamber, with automatic waste feed cut-off interlocks.
- Adopt a dry or semi-dry APCD with activated carbon injection and bag filter, rapid quench and CEMS for at least PM, CO, SO_2, NOx, HCl, O_2 and temperature.
- Provide impermeable, bunded and covered storage with segregation of incompatible wastes, secondary containment for liquids and a lined secured landfill with leachate collection.
- Install at least three groundwater monitoring wells (one upgradient and two downgradient) before operation begins.
- Implement the construction-phase ESMP through contract clauses and a contractor HSE plan.

Operation

- Accept waste only in accordance with written Waste Acceptance Criteria, a manifest system and laboratory verification; reject or quarantine unknown waste.
- Implement the monitoring plan, make the key monitoring results available to the public, and report them to the DoE as required by the ECC.
- Maintain a trained Emergency Response Team, conduct regular drills with the Fire Service and keep emergency contacts up to date.
- Operate the Grievance Redress Mechanism and continue stakeholder engagement throughout the project life.
- Conduct an annual independent environmental audit and update the ESMP and closure plan as necessary.

APPENDIX

Appendix

The appendix contains the supporting documents referred to in this report, including the approved ToR, land documents, technical specifications, laboratory reports, consultation records, management procedures and plans.

APPENDIX

Annexure	Content
Annexure 1	ToR approved copy
Annexure 2	Land ownership documents
Annexure 3	Technical Data Sheets – Advanced Incineration & Waste Treatment System
Annexure 4	APCD and CEMS specification
Annexure 5	ETP design concept
Annexure 6	Baseline monitoring laboratory reports
Annexure 7	Stakeholder consultation attendance sheet
Annexure 8	Public Consultation minutes and photographs
Annexure 9	PPE matrix
Annexure 10	Waste Acceptance Criteria
Annexure 11	Fire safety layout