Government of the People's Republic of Bangladesh

Ministry of Environment, Forest and Climate Change

Department of Environment (DOE)

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

for

Dehara Residential Project, Dehara, Ashulia,
Upazila: Savar, District: Dhaka.

Submitted by

Eastern Housing Limited

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ABBREVIATIONS AND ACRONYMS

BBS	Bangladesh Bureau of Statistics
BOD	Biological Oxygen Demand
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
DO	Dissolved Oxygen
DOE	Department of Environment
DG	Director General
EC	Electrical Conductivity
ECA	Environmental Conservation Act
ECC	Environmental Clearance Certificate
ECR	Environmental Conservation Rules
EHS	Environment, Health and Safety
EES	Environmental Evaluation System
EIA	Environmental Impact Assessment
EIV	Environmental Impact Value
EQS	Environmental Quality Standards
EMAP	Environmental Management Action Plan
EMP	Environmental Management Plan
FGD	Focus Group Discussion
GoB	Government of Bangladesh
GIS	Geographic Information System
GPS	Global Positioning System
IEC	Important Environmental Components
IEE	Initial Environmental Examination
IPCC	Intergovernmental Panel on Climate Change
IWFM	Institute of Water and Flood Management
KII	Key Informants Interview

LGED	Local Government Engineering Department
MDL	Minimum Detectable Level
MoEF	Ministry of Environment and Forest
NCS	National Conservation Strategy
NEP	National Environment Policy
NEAMP	National Environmental Management Action Plan
NOC	No Objection Certificate
PRA	Participatory Rapid Appraisal
PWD	Public Works Department
SLR	Sea Level Rise
SRDI	Soil Resource Development Institute
SRES	Special Report on Emission Scenarios
TOR	Terms of Reference
VEC	Valued Environmental Components

EXECUTIVE SUMMARY

Under the Environment Conservation Rules (ECR), 2023, any Housing and Urbanization project that covers an area exceeding 25 acres falls into the red category, necessitating a mandatory Environmental Impact Assessment (EIA). This requirement ensures that projects of this scale integrate environmental mitigation measures right from the design phase, in alignment with the Department of Environment (DoE) policies. Eastern Housing Limited (EHL), the developer of the project, has commissioned Plan Plus Limited (PPL) to conduct a comprehensive EIA. This assessment is crucial for identifying and mitigating potential environmental impacts before the project's development commences.

The EIA process began with the collection of field data from various sources, followed by stages of screening, scoping, and bounding. The assessment was structured around two main scenarios: "future without the project" and "future with the project." This comparative analysis helps in understanding the environmental changes that the project would bring. Subsequently, the assessment identified potential environmental impacts arising from the construction activities of the proposed project. To address these impacts, the EIA team developed a set of feasible remedial measures, which have been detailed in the Environmental Management Plan (EMP).

The impacts were quantitatively and qualitatively evaluated using the Environmental Impact Values (EIV) methodology. This approach provided a structured framework to measure and mitigate the environmental consequences effectively. By integrating these findings into the project planning and design, EHL aims to not only comply with the stringent requirements set forth by the ECR, 2023, but also to promote sustainable development practices that minimize environmental degradation.

The Dehara Residential Project is strategically located at Dhamsona Union of Savar Upazila within Dhaka District. This Environmental Impact Assessment (EIA) report is structured to provide a comprehensive analysis of the project's environmental, social, and economic impacts. **Chapter 1** introduces the EIA report, outlining the background, objectives, scope, and methodology of the assessment. It sets the foundation for understanding the purpose and process of the EIA. **Chapter 2** discusses the relevant laws, regulations, and policies of the Government of Bangladesh that pertain to environmental and social issues. It emphasizes the project authority's commitment, led by the Local Government Engineering Department, to adhere to these legislative and policy frameworks. The environmental clearance procedures are

also detailed in this chapter. **Chapter 3** provides a detailed description of the Dehara Residential Project, including the surrounding environment, total land area, population served, existing developments, and the availability of utilities and facilities. The project aims to develop a vibrant and sustainable residential community, focusing on environmental preservation, modern amenities, and a diverse range of housing options. **Chapter 4** and **Chapter 5** describe the physical, biological, and socio-economic conditions of the project area. Notable geographical features include the proximity to the Dhaleswari River and a connected khal system. The area falls within the North Central Hydrological Region of Bangladesh, with specific ecological and agro-ecological zones noted. Baseline data on air, water, noise, and soil quality are presented, highlighting the transition from rural to urban economies characterized by industrial growth. **Chapter 6** outlines the solid waste management strategy for the project, adhering to the 3R policy (Reduce, Reuse, Recycle) of Bangladesh. It details the efforts to minimize waste generation, enhance reuse, and improve recycling practices. **Chapter 7** proposed sewage treatment involves an aerobic system, known for its efficiency in reducing Biological Oxygen Demand (BOD) and producing high-quality effluent. A Sewage Treatment Plant (STP) is detailed in this chapter, underscoring its importance in sustainable wastewater management. **Chapter 8** utilizes a screening matrix to evaluate potential environmental impacts during the construction and operational phases of the project. It discusses the the environmental impacts, mitigation measures and the Environmental Impact Value (EIV), which shows a significant potential for improvement through targeted environmental management strategies. Public consultation is acritical component of the EIA process. **Chapter 9** details the consultation held, capturing the stakeholders' knowledge, attitude and concerns regarding the project. Topics such as residential planning, communication facilities, land development, land pricing and utilities are discussed. **Chapter 10** represents the strategies for ongoing governmental management and monitoring throughout the project lifecycle. The final **Chapter 11** provides conclusions and actionable recommendations based on the findings of the eIA report, aiming to ensure that the project adheres to environmental standards and contributes positively to the local community and the environment.

The construction of the project has been evaluated and found to be technically viable, environmentally sound, and socially acceptable. The assessment indicates that the environmental and social benefits significantly outweigh any potential negative impacts associated with the project. Given these findings, it is strongly recommended that the Department of Environment (DoE) grant the necessary environmental clearance to this

important project. This clearance will not only affirm the project's compliance with environmental standards but also underscore its contribution to sustainable development. This endorsement will facilitate the initiation of a project poised to deliver substantial benefits to the community and the environment.

CHAPTER 1
BACKGROUND OF THE STUDY

1.1 Introduction

Environmental Impact Assessment (EIA) is now a mandatory study process to assess the environmental consequences of any proposed project and to delineate any environmental management measures that must be integrated into the plan to ensure that the project is technically, economically, socially and environmentally feasible. The EIA preparation led to the identification of potential environmental impacts due to proposed intervention and feasible remedial measures included in the Environmental Management Plan (EMP). As part of the EIA process, it is necessary to devise alternatives to avoid undesirable impacts. Besides the alternative, identification of impacts may also lead to the development of mitigation measures i.e. means of reducing the impacts. As a tool of environmental planning, EIA is therefore precautionary in nature. EIA is neither antidevelopment nor does it stop actions which impact the environment. It only requires that those impacts be considered. Most development activities impact the environment hence a "no impact" interpretation of environmental impact assessment could lead to no development. But a "considerable impact" interpretation of EIA will lead to better development. If environmental impacts are ignored, the project may not be sustainable in the long run, in which case the money invested in it will have been wasted. In this development proposal, the proponent intends to construct residential development at Dehara in Savar Upazila. It has been established that such projects have a potential of causing impacts on the environment. It is under this premise that the proponent deemed it necessary to carry out an Environmental Impact Assessment (EIA) for the proposed project.

With increasing population, demand for basic services like housing, education, administration, hospitals, transportation, etc. also increases. It is becoming very difficult to cope up with the rising demands and maintain a quality services to the residents of the city. In the upcoming future, the scenario will only get more complex and the demand will keep on growing. With a view to meet the demand, a more sustainable housing project is required. Considering the issue, Eastern Housing Limited initiated **Dehara Residential Project** in 1997. According to Environment Conservation Rules (ECR), 2023, Housing and Urbanization project of area more than 25 acre occupy **red category** and conducting EIA is mandatory for such type of project. In order to mitigate adverse impacts of the project and to comply with the requirements of

policy of DoE, the EIA has been taken up to integrate environmental mitigation measures in the project design. Location of proposed housing project is shown in **Figure 1.1**.

The environmental impact assessment on the proposed development will help the authorities concerned to take necessary steps to make city more livable, resilient and environment friendly. The development will obviously produce some adverse impacts particularly on solid waste management, traffic management and sewage management. Hence, the developer needs to carry out a detailed environmental study to investigate the potential impacts from the planned development project. **Eastern Housing Limited (EHL)** has been assigned **Plan Plus Limited (PPL)** to conduct Environmental Impact Assessment (EIA) prior to the development of the proposed project. The Contract for the EIA Consultancy Services was signed between EHL and PPL on 3 March, 2024.

1.2 Objectives of the Study

The primary objectives of the Environmental Impact Assessment are to asses the impacts for the proposed development and to find out a way to overcome the adverse impacts. Furthermore, the EIA aims to facilitate the development's smooth, safe and efficient integration the development with matching with surroundings. By evaluating the potential impacts associated with the development, the EIA report provides insights for positive impacts, negative impacts, opinions from public consultations, detail traffic circulation plan, solid waste management plan, sewage treatment plan with others. These insights are vital for decision-making regarding the acceptance and implementation of the proposed housing projects. The specific objectives of this study are as follows-

- To carry out comprehensive environmental impact assessment;
- To prepare environmental management and monitoring plan, and
- To prepare the Sewege Treatment Plant (STP) for the project site.

1.3 Scope of the EIA Study

This report fulfils the requirements of the EIA under the ECR 2023 and has been prepared in accordance with the approved ToR by the DoE. The detailed scope of the EIA study is as outlined below:

- Review and analysis of environmental policy and legal requirement.
- Assessment of baseline conditions (Physical, Biological and Socio-economic condition).
- Assessment of environmental quality (Air, Water, Noise and soil).

- Formulation of a detail guideline for Sewage Treatment Plant (STP)
- Assessment of detailed ecological conditions in and around the project site.
- Identification, prediction, quantification and evaluation of potential aspects and impacts of the proposed project on the environment.
- Formulation of environmental management plan and specific mitigation plan for identified impacts.
- Mitigation measures and monitoring plan for effective implementation of mitigation measures of the project.
- Formulation of public and stakeholder consultation for the proposed project and.
- Preparation of the EIA report on the basis of DoE approved TOR for obtaining ECC from the DoE of Bangladesh.

1.4 Methodology

The methodology followed for the study is in line with the EIA procedure that has been recommended in the Environmental Assessment Guidelines published by DOE and other Govt agencies. The steps are as follows:

1.4.1 Preparatory Works

Detailed information on the proposed intervention, such as the housing project layout plan, proportion area of residential plot and utilities and community facilities including play ground, schools, katcha bazar etc. During the field visit special emphasis was on public consultation, progress of development and environmental baseline condition.

1.4.2 Scoping

Scoping is the process of identifying the key environmental issues. A scoping process was followed here for selecting Important Environmental and Social Components (IESCs) that are likely to be impacted by the proposed housing project. Scoping is performed in two stages. Individual professionals of the EIA study team made a preliminary list of the components of their disciplines, which could be impacted by the project. The second stage included stakeholders' perceptions of environmental and social components. The professional judgements of the EIA team members as well as the stakeholder's opinions obtained, were considered in selecting the IESCs.

1.4.3 Bounding

The areas likely to be impacted by the Dehara Residential Project were delineated in consultation with the Eastern Housing Limited authority with maps in addition to feedback received from the local people during the baseline consultations. GIS and RS tools have been used for this purpose. A project influence area/study area was selected considering the hydrological situation of the area. Steps of EIA processes are presented in Figure 1.1.

1.4.4 Data Collection

Data for the present environmental study were carried out for the proposed project through field reconnaissance as well as collection and analysis of secondary information from different relevant sources (e.g., LGED, DoE, BBS, EHL, etc.). The required reconnaissance surveys for the EIA took place at the beginning of the study by project team. Information from field reconnaissance, field sampling (air, water, noise, soil) and on-site public consultations were incorporated along with the secondary data to set the baseline condition. Satellite image of the area was processed to establish the present land use and settlement pattern. Water quality of the adjacent khal was established through laboratory analysis of some important parameters such as DO, pH, EC, BOD_5, etc. Air quality was established qualitatively based on location of project site. Noise level was established based on existing landscape and land use around the housing site.

1.4.5 Public Consultation

In order to generate qualitative and quantitative data and information on baseline and surveys were carried out by applying different PRA tools and techniques like transect walk, FGD and KII. Local knowledgeable persons including community representatives, traders, teachers, journalists and political leaders were interviewed individually. The EIA team members conducted face to face interview with beneficiaries to explore the need as well as suitable site location from technical and environmental consideration. The EIA team members also made professional observations during the field visits. Attendance of public consultation have been presented in **Appendix-E**.

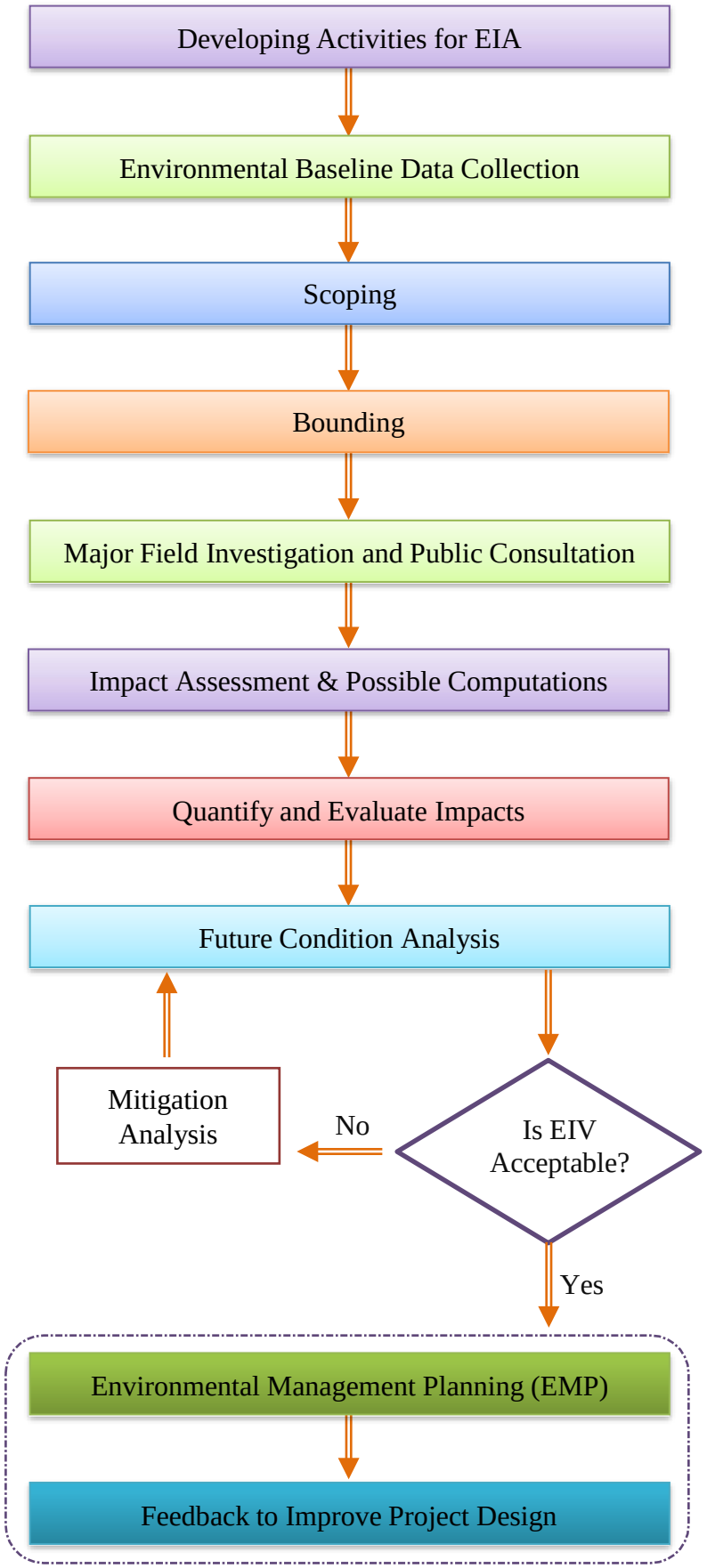

Figure 1.1: Steps used for EIA Process

1.4.6 Data Analysis

The baseline condition of the project influence area has been drawn according to information collected from primary and secondary data sources through literature review, field investigation and consultation with different stakeholders. The baseline condition has been established concerning physical environment, environmental quality, biological environment and socio-economic environment. The environmental impact of the proposed housing project on the IECs is assessed in three phases of the project (pre-construction, construction and post construction phases). Impacts are the results of the interaction of specific project activities with the existing environmental settings. The post-project impacts are estimated based on the differences in the changes between the Future with Project and Future without Project condition. The Future without Project conditions are generated through trend analysis and consultation with local people. The changes expected to be brought due to the proposed interventions are assessed to generate Future with Project condition. Comparisons and projection methods are used for predicting the impacts.

1.4.7 Alternative Analysis

Different alternatives of the project were critically studied in this section on the basis of data collected from the field level. Quantitative values of different environmental parameters were compared to find out the best possible alternative and grading of the alternatives was studied to help the decision makers to attain a logical solution.

1.4.8 Impact Evaluation

The impact on existing physicochemical setting (either positive or negative) was evaluated with the EIA team. Impact on environmental quality (air, water, noise, soil) was evaluated by the EIA team considering baseline condition, project activities and expected changes to the natural settings. The socio-economic changes were evaluated on the basis of project documents, local public consultation and expert judgment. The importance values assign to parameters included in the EIA were assigned using expert judgment on the expected impacts. Environmental Impacts have been assessed by Environmental Evaluation System (ESS) developed by Battelle Columbus Laboratories in the United States. In this study, an overall Environmental Impact Values (EIV) defined mathematically as following equation (1.1) to know the environmental degradation (negative change) or environmental gain (positive change) for the proposed project in a single quantitative term.

$$EIV = \sum_{1}^{m} Vi * Wi$$

$$= \sum_{1}^{m} (Vi)_1 * Wi - \sum_{1}^{m} (Vi)_2 * Wi \longrightarrow \text{Equation (1.1)}$$

Where,

EIV	=	Environmental Impact Values
$(Vi)_1$	=	Value in environmental quality of parameter i with project
$(Vi)_2$	=	Value in environmental quality of parameter i without project
Wi	=	Relative weight (importance) of parameter i
m	=	Total number of parameters
Vi	=	Net change in environmental quality of parameter i

Upon the gathering of the environmental data and the response of the environmental parameter to the project activities, value in environmental quality of parameters and their relative importance in the project have been determined and EIV has been calculated. The beneficial and adverse changes in environmental parameters resulting from any project usually expressed in quantitative terms have been plotted in a scale to quantify the environmental alterations as shown in **Figure 1.2**. The figure shows the correlation between quantitative statement and proposed quantitative values of environmental changes resulting from a project.

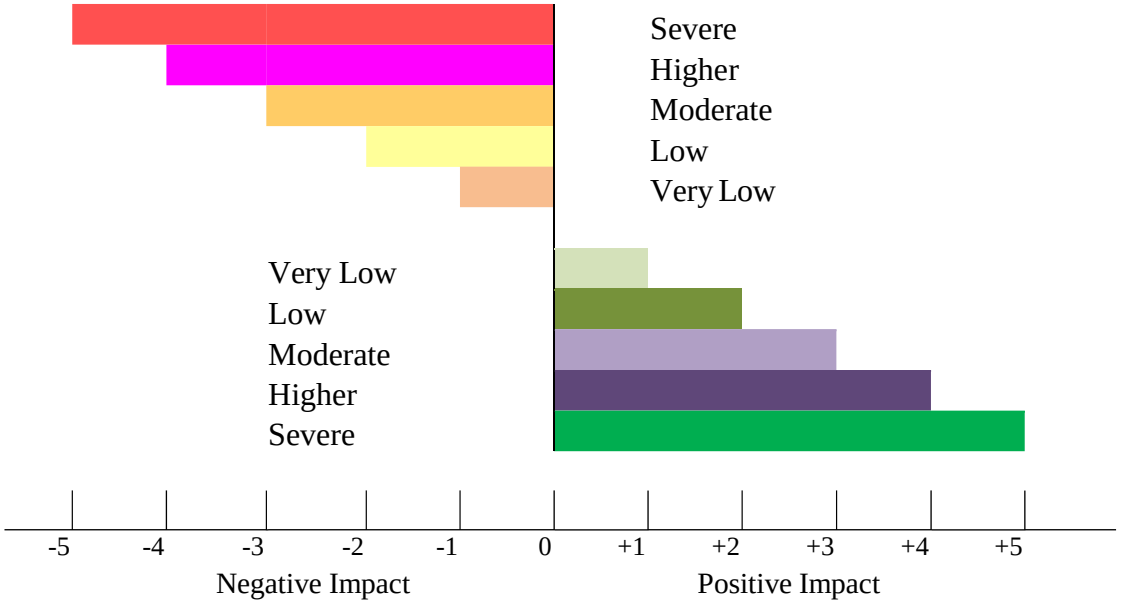

Figure 1.2: Quantification of Environmental Impact (Source: LGED, 2008)

Since the changes of environmental parameters are measured with respect to existing condition, no change has 0 (Zero) values. Benefits or positive impacts are graded from +1 to +5, and negative impacts are scored from -1 to -5. Impacts are assessed quantitatively wherever possible. A value from the scale representing effect of the project on each parameter has been taken to compute the EIV of the project.

All environmental parameters influenced by the project are not of equal importance or weight. The importance of a parameter varies from country to country depending on the environmental concerns of the country. Generally, in Bangladesh flood, employment, agriculture, fisheries, etc. carry more importance than many other countries. The importance may also vary in different regions within the country. So, the same parameter may have different values for subprojects located in different regions.

The parameters related to infrastructure projects have been given different values based on prevailing environmental concerns in Bangladesh and presented in **Figure 1.4**. These values have been arrived at after considering of all probable impacts due to the project during its construction and post-construction stages. These are average values only based on normal conditions, which should be modified in case the projects are located in special locations having significant environmental concerns. The values representing importance or weight of the parameters can be used to compute the relative impacts of the parameters which are then summed up to obtain the total EIV of the project (**Table 1.1**). Relative Importance Values of Environmental Parameters are shown in **Figure 1.3**.

1.4.9 Environmental Management Plan

A comprehensive environmental management plan (EMP) was prepared by the EIA team. Potential negative impacts, were assessed and mitigation measures were suggested for minimizing their effects. Likewise positive impacts were assessed and enhancement measures were suggested for increasing their benefits. Where appropriate, compensation measures were suggested for the negative impacts.

Table 1.1: Checklist of Environmental Parameters

ENVIRONMENTAL PARAMETERS	Relative Importance value	Degree of Impact	Relative Impact		EIV
			Positive	Negative	
I. PHYSICAL IMPACT ▪ Hydrology and Flooding ▪ Water Pollution ▪ Drainage ▪ Air Quality ▪ Noise Pollution ▪ Ground Water Table ▪ Soil Characteristics/ Soil Fertility					
II. ECOLOGICAL IMPACT ▪ Fisheries ▪ Forest/ Green Cover ▪ Wildlife & Biodiversity ▪ Soild Waste ▪ Eutrofication ▪ Wetland and Wetland Habitat ▪ Terrestrial Habitat ▪ Trees and Vegetation ▪ Heat Island ▪ Waste Water					
III. IMPACT ON HUMAN INTEREST ▪ Land Use/ Land value ▪ Housing and Amenities ▪ Commercial/Industrial Activities ▪ Employment Opportunities ▪ Transport & Communication ▪ Landscape ▪ Agricultural growth					
IV. QUALITY OF LIFE VALUES ▪ Travel safety ▪ Health ▪ Education & literacy ▪ Water Supply & Sanitation ▪ Cultural Heritiage & Recreation					
Total Environmental Impact Value (EIV)					

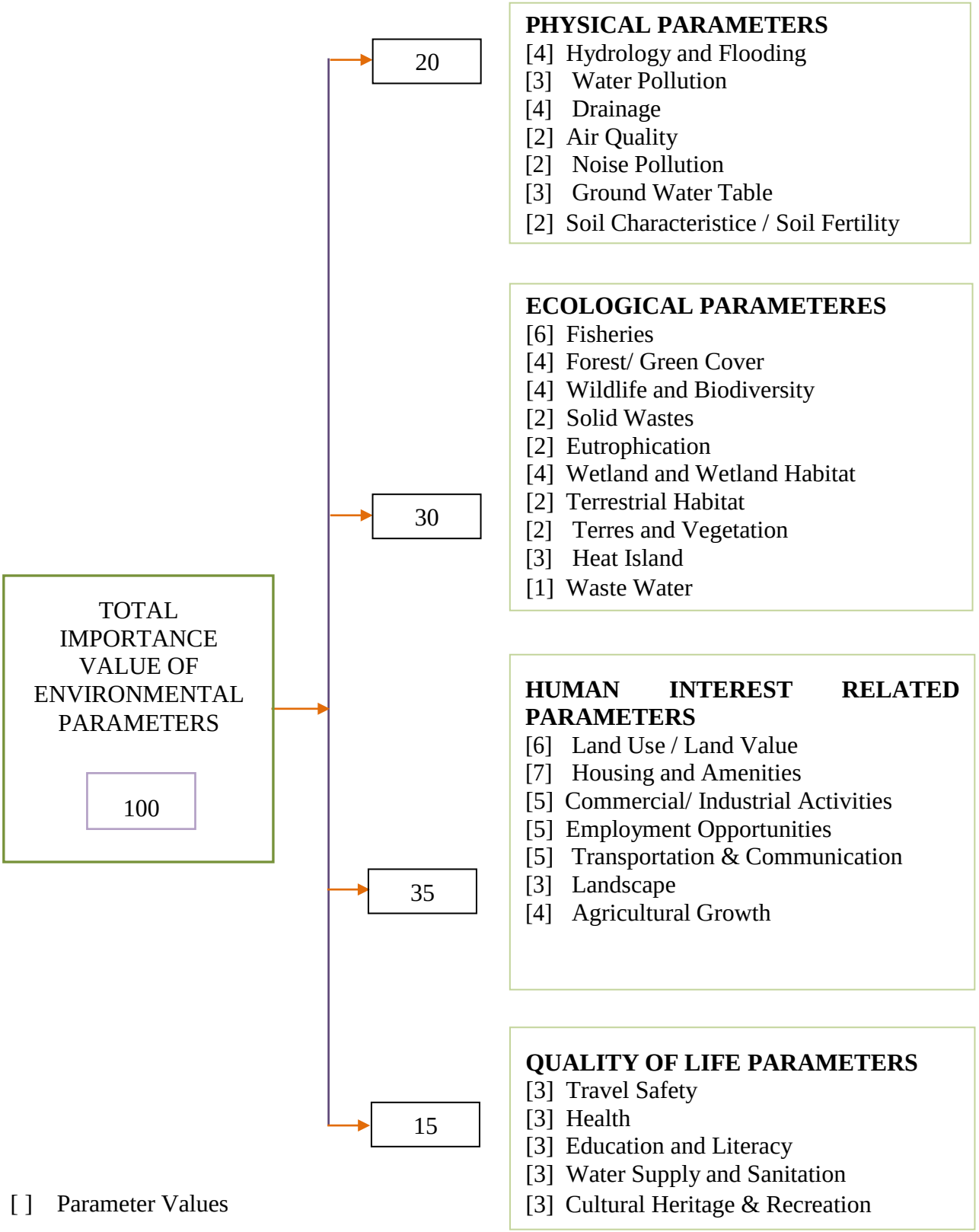

Figure 1.3: Typical Relative Importance Values of Environmental Parameters

1.5 Limitation

In this assessment, the baseline of the project area in the pre-project condition was observed partially because around 75% of the land has already been developed. Important relevant data such as water quality, hydrological analysis and other seasonal baseline data have been collected for study period only. Seasonal variation in terms of flooding, temperature, water level could not be assessed.

1.6 EIA Team

The consultants' team consist the following multidisciplinary professionals:

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1.7 Structure of the Report

The rest of the report is organized as follows:

- **Chapter 2** discusses policy and legal framework, which are relevant to the present study.
- **Chapter 3** describes the project area, highlighting details of interventions.
- **Chapter 4** provides environmental baseline conditions to facilitate potential impact assessment due to proposed intervention.
- Social and economic profile of the study area are presented in **Chapter 5**.
- **Chapter 6** describes solid waste management in line with 3R concept.
- Detailed description & design of Sewage Treatment Plant are presented in **Chapter 7**.
- **Chapter 8** is devoted to environmental impacts and mitigation measures.
- Findings through public consultation meeting are presented in **Chapter 9**.
- Environmental management and monitoring plan are presented in **Chapter 10**.
- Conclusions and Recommendations of the EIA study are presented in **Chapter 11.**

Figure 1.4: Location of Project Site

CHAPTER 2
POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1 Introduction

This chapter provides a comprehensive overview of the environmental and social governance framework as established by the Government of Bangladesh. It specifically focuses on the laws, regulations, and policies that are pertinent to the project at hand. The content herein is curated to ensure relevance and applicability to the project's objectives and operational scope. It is imperative to note that the legislative and policy landscape is dynamic; therefore, this section will be regularly updated to reflect the latest developments. New enactments or amendments to existing laws, regulations and policies will be incorporated as they are promulgated and come into force. The project authority bears the responsibility of adhering to all applicable legal and policy requirements. This includes, but is not limited to, legislation, policies, strategies and regulatory matters that directly impact the project's execution and sustainability.

The relevant national legislative, regulatory and policy instruments are meticulously outlined to ensure that the Environmental Health and Safety (EHS) team and policymakers are well-informed. This awareness is crucial for their cognizance and compliance, particularly for those involved in the review process of environmental documentation necessary for obtaining environmental clearance.

Additionally, this chapter sheds light on the environmental clearance procedure, delineating the steps and requirements involved in securing the necessary approvals. This process is critical to the project's legitimacy and must be navigated with due diligence and adherence to the stipulated guidelines. By maintaining a clear and updated understanding of these frameworks, the project can proceed with the confidence that it operates within the legal confines and with a commitment to environmental stewardship and social responsibility.

2.2 Applicable Environmental Legislation in Bangladesh

2.2.1 National Environmental Policy, 1992

The National Environment Policy of 1992 sets out the basic framework for environmental action, together with a set of broad sector action guidelines. The Policy provides the broader framework of sustainable development in the country. It also stated all major undertakings, which will have a bearing on the environment; must undertake an IEE and EIA before initiation of the project. Key elements of the policy are:

- Maintaining ecological balance;
- Protection from natural disasters;
- Regulate all activities harming the environment;
- Promote environment friendly development;
- Ensure sustainable management of natural resources;
- Support international environmental initiatives.

2.2.2 National Environmental Management Plan, 1995

The National Environment Management Action Plan (NEMAP) is a wide ranging and multi-faceted plan, which builds on and extends the statements set out in the National Environment Policy (NEP). NEMAP has the following issues:

- Identification of key environmental issues affecting Bangladesh;
- Identification of actions to reduce environmental degradation;
- Improvement of the natural and built environment;
- Conservation of habitats and biodiversity;
- Promotion of sustainable development; and
- Improvement in the quality of life.

2.2.3 Bangladesh Environmental Conservation Act, 1995

The Bangladesh Environment Conservation Act of 1995 is the key legislation in relation to environment protection in Bangladesh. This Act is promulgated for environment conservation, standards, development, pollution control, and abatement. The main strategies of the Act can be summarized as:

- Provide regulatory power for environmental monitoring and enforcement;
- Declaration of ecologically critical areas (ECA);
- Set standard for air, water, noise and soil quality;
- Regulate vehicle emission and industrial discharges;
- Amendments:
  - 2000: Focus on compensation for ecosystem damage;
  - 2002: Additional restrictions and legal support;
  - 2010: Further definitions and regulations including penalties.

2.2.4 Environmental Conservation Rules (ECR), 2023

The ECR is a set of rules, promulgated under the Environmental Conservation Act, which specifies environmental approvals processes for various project types and provides allowable

limits for environmental disturbance or pollution discharge / emissions. The ECR 2023 provides categorization of industries and projects and identifies types of environmental assessments required against respective categories of industries or projects. The rules set:

- Fixation of National Environmental Quality Standards;
- Detail procedures for obtaining Environmental Clearance;
- Require IEE/EIAs for certain project categories;
- Project Categorization: Green, Yellow, Orange, Red based on environmental impact.

The proposed project, according to the ECR 2023 falls under the **Red Category** (Item 33: Development of Land of more than 25 Acres).

2.2.5 Requirement for Environmental Clearance

According to ECR 2023 depending upon location, size and severity of pollution loads, projects and industries have been classified into four categories Green, Yellow, Orange and Red respectively, to indicate nil, minor, medium and severe impacts on Important Environmental Components (IECs).

Figure 2.1 presents steps to be followed for environmental clearance for red category project.

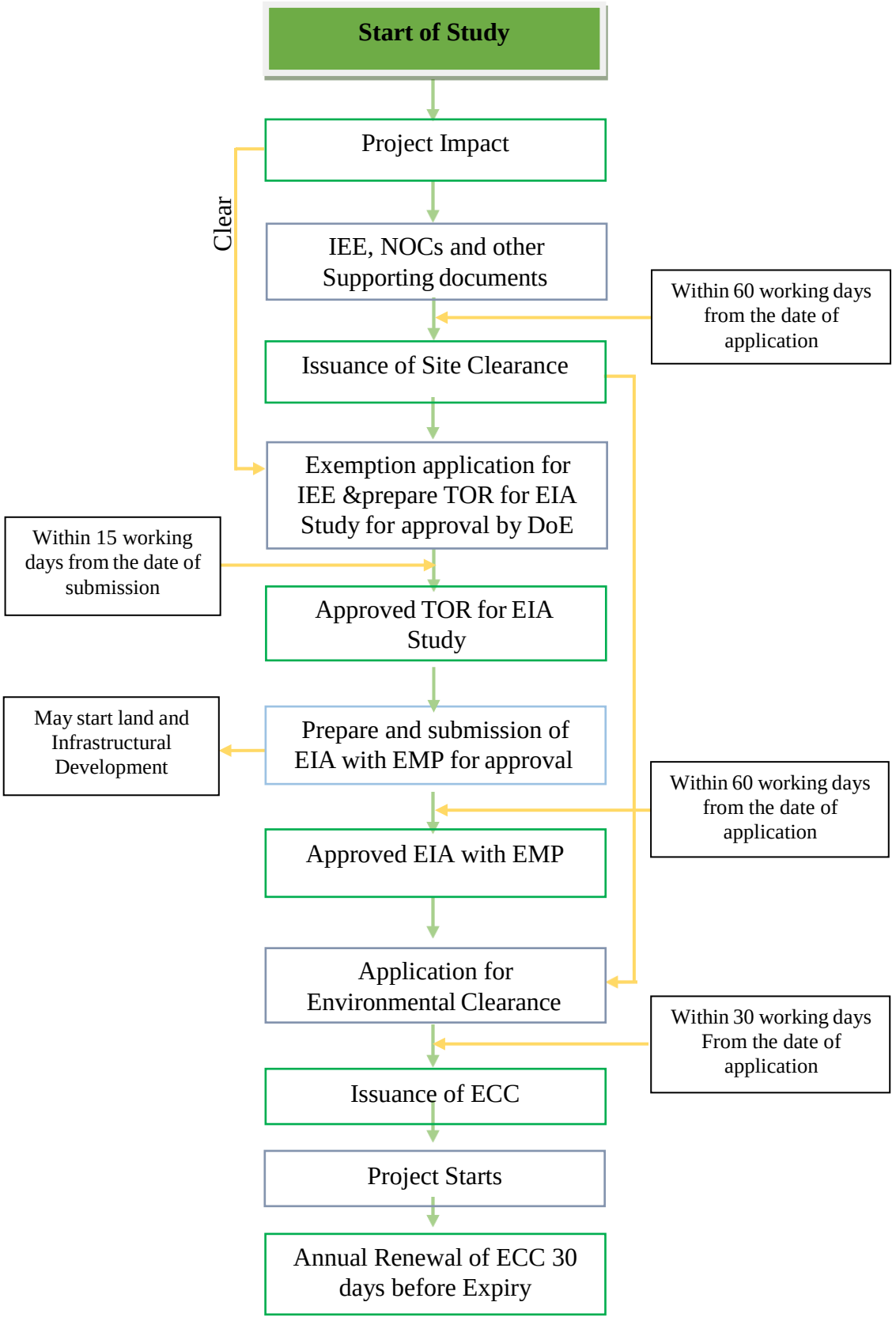


Figure 2.1: Steps to be followed for Environmental Clearance Certificate (LGED, 2008)

2.3 Acquisition and Requisition of Immovable Property Act, 2017

Whenever it appears to the Deputy Commissioner that any property in any locality is needed or is likely to be needed for any public purpose or in the public interest, he shall cause a notice to be published at convenient places on or near the property in the prescribed form and manner stating that the property is proposed to be acquired.

This Law provides the framework that should be followed for all acquisition, resettlement or compensation for the Project. Except in the case of emergency requirement for the purpose of maintenance of transport or communication system, no property which is bona fide used by the owner thereof as the residence of himself or his family or which is used either for religious worship by the public or as an educational institution or orphanage or as a hospital, public library, graveyard or cremation ground shall be requisitioned.

2.4 Waste Management and 3R Strategy in Bangladesh

Being a land hungry country with high growth of population, urbanization and economy Bangladesh needs to adapt a very efficient waste management system. As of 2017 Bangladesh generated more than 0.5 kg/day per capita of municipal waste every day which is projected to increase to 0.75 kg/capita/day by 2025 (Ashikuzzaman and Hawlader, 2019). However, managing this huge amount of municipal waste is a mammoth task and due to continued population growth, urbanization and increase in per capita waste generation this will intensify more with time. However, the government has taken a number of significant measures to make a notable progress in this area. Formulation of **National 3R Strategy in 2010** with support from UNCRD is a major step forward in this regard. Some of the salient features of the 3R strategies are the following:

- There should be a shift of thinking from the conventional wisdom that waste has no value and based on that the **3R** will encourage extraction of highest possible value from the waste. The **3R** comprises of:
  - **Reduce**: choosing to use items with care to reduce the amount of waste generated.
  - **Reuse**: Repeated use of items or parts of items which still have usable aspects.
  - **Recycling**: use of waste itself as resources.
- Based on the **waste hierarchy** there are various levels in waste value chain. They include prevention, minimization, reuse, recycling, energy recovery and disposal. These levels in

the hierarchy are in decreasing order of preference, with prevention as most desired and disposal as the lease desired option.

- The **goals** of the **3R** strategy include complete elimination of waste disposal in open dumps, rivers and flood plains, promote recycling through mandatory segregation at source, creation of a market for recycled products and providing incentives to recycling. The **objectives** included addressing barriers to implementation, defining roles of various actors.
- The **3R** strategy also provided guiding principles, identified related policies and guidelines, highlighted a good number of best practice examples, formulated strategies for 3R adoption, defined the role of various stakeholders and devised an action plan for 3R adoption.

As an aftermath of the **3R** strategy the government has promulgated the Solid Waste Manamgement Rule 2021 which clearly spearheaded the **3R** strategy, defined the role of different stakeholders and specified various standards related to solid waste management.

Bangladesh, particularly Dhaka city, lags far behind the developed world in terms of solid waste management. However, the government has recently prioritized the **3R** model for solid waste management. This will save expenditures on the one hand while also preventing environmental pollution. At Dehara Residential Project, the **3R** concept for Solid Waste Management is being planned for the project with the utmost consideration. Effective solid waste management for Dehra Residential Project is crucial for maintaining cleanliness, hygiene, healthy environment and environmental sustainability for its residents.

Through the concept, encourage residents to adopt a minimalist lifestyle, reducing disposable products and packaging waste. Promote reusable alternatives like cloth bags and water bottles. Organize swap meets or donation drives for unwanted items in good condition. Implement a clear recycling program. Provide color-coded bins for different materials (paper, plastic, metal, glass) and educate residents on proper sorting. Provide sufficient, well-maintained bins with clear signage for waste categories. Designate convenient collection points throughout the housing project. Establish a regular collection schedule for different waste types. Consider separate pickups for recyclables and organic waste. Explore environmentally friendly disposal options. Look into composting facilities for organic waste and recycling plants for processed recyclables.

2.5 Bangladesh's Engagement in Global Environmental Governance

Bangladesh, as a country profoundly affected by environmental challenges such as climate change, biodiversity loss, and pollution, has taken significant steps on the international stage to address these issues. The nation's commitment is evident through its ratification and participation in several pivotal international treaties, conventions, and protocols aimed at environmental protection, pollution control, biodiversity conservation, and climate change mitigation. Below, we explore some of these key agreements and Bangladesh's role in them.

Ramsar Convention on Wetlands

The Ramsar Convention, formally known as the Convention on Wetlands of International Importance, especially as Waterfowl Habitat, is an international treaty for the conservation and sustainable use of wetlands. Bangladesh became a party to the Ramsar Convention in 1992, recognizing the critical role that its wetlands play in biodiversity conservation, flood mitigation, and as a source of livelihood for millions of its citizens. By designating several sites as Wetlands of International Importance (Ramsar Sites), Bangladesh has committed to preserving the ecological character of these areas.

Bonn Convention on Migratory Species

Also known as the Convention on the Conservation of Migratory Species of Wild Animals (CMS), the Bonn Convention aims to conserve terrestrial, marine, and avian migratory species throughout their range. Bangladesh's accession to the CMS underscores its recognition of the importance of safeguarding migratory species that cross its borders, many of which are threatened or endangered. This commitment is crucial for maintaining ecological balance and ensuring the survival of migratory birds that use Bangladesh as a transit or wintering site.

Convention on Biological Diversity (CBD)

The Earth Summit in Rio de Janeiro in 1992 saw the birth of the Convention on Biological Diversity (CBD), a comprehensive, multilateral treaty with three main goals: the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from genetic resources. Bangladesh, as a signatory to the CBD, has taken steps to integrate biodiversity conservation into its national development and sectoral planning, recognizing the intrinsic value of biodiversity and the ecological services it provides.

Kyoto Protocol

The Kyoto Protocol is an international treaty that extends the 1992 United Nations Framework Convention on Climate Change (UNFCCC) and commits its parties by setting internationally binding emission reduction targets. Bangladesh ratified the Kyoto Protocol, acknowledging the critical need to address the causes and consequences of climate change. As a developing country, Bangladesh is primarily focused on adaptation strategies to cope with the impacts of climate change, such as rising sea levels, increased cyclone frequency, and salinity intrusion, while also exploring sustainable development pathways that contribute to global mitigation efforts.

2.6 Conclusions

The project at Dehara, Savar, Dhaka, necessitates a comprehensive Environmental Impact Assessment (EIA) in accordance with Bangladesh's stringent environmental legislation and policies. The National Environmental Policy (1992), National Environmental Management Plan (1995) and the Bangladesh Environmental Conservation Act (1995) with its subsequent amendments, form the core legal framework mandating EIAs for significant undertakings like housing projects. The Environmental Conservation Rules (ECR) of 2023 categorize the Dehra project under the **'Red'** category due to its scale, requiring a detailed environmental clearance process. This process is guided by the principles of sustainable development, ecological balance, and conservation of natural resources, with a specific emphasis on the **'3R'** strategy (reduce, reuse, recycle) for waste management. The project must also align with international environmental treaties to which Bangladesh is a signatory, ensuring global environmental standards are met. The goal is to minimize environmental degradation while promoting a healthy and sustainable living environment for the residents of **Dehra Residential Project**.

CHAPTER 3
DESCRIPTION OF THE PROJECT AREA

3.1 Project Location

Dehara Residential Project is located at Dhamsona Union of Savar Upazila under Dhaka District. The Dehara Residential Project boasts a strategic location in Ashulia, Savar. This promising development is positioned to the west of the bustling Nabinagar-Chandra Highway, offering convenient access to one of the region's key transportation arteries.

3.2 Description of Project Surrounding

Enveloped by the natural beauty of the Dhalleshwari river to the east and the economic hub of the Dhaka Export Processing Zone (DEPZ) to the south, the Dehara Residential Project is a harmonious blend of tranquility and industrial vibrancy. The northern and southern peripheries are graced with seasonal wetlands, adding to the area's ecological diversity. Within a one-kilometer radious, the project is encircled by a mosaic of undeveloped land, presenting a canvas of potential for future growth and development. The immediate vicinity is marked by notable landmarks:

- To the North: The BKSP Cricked Ground, a center of sporting excellence and recreation.
- To the East: The Nabinagar-Chandra Highway, a vital conduit that connects the area with the broader region.
- To the South: The DEPZ, a cornerstone of the nation's industrial prowess, alongside the Atomic Energy Research Establishment, a testament to the country's scientific advancement.
- To the West: The serene flow of the Dhaleswari river, a natural treasure that enhances the locale's aesthetic and environmental value.

3.3 Total Land Area and Population Served

The Dehara Residential Project spans an impressive 125.28 acres. In alignment with the Private Housing Land Development Act of 2004 (RAJUK 2004, Amended in 2012 & 2015), the stipulated population density is set at 350 individuals per acre. Adhering to these guidelines, the project is poised to serve a total population of approximately 44,000 residents. This strategic planning ensures a balanced community development, fostering a vibrant and sustainable living environment for its inhabitants.

3.4 Existing Condition of Land

The project showcases significant progress in land development with over eighty percent (80%) of the total area already developed. Residential housing has been successfully completed on about twenty percent (20%) of this developed land, marking a milestone in the project's journey towards creating a thriving community. The development includes well-planned road networks within the developed sections, enhancing accessibility and connectivity for residents.

Source: Study Team, Project Area on 10 March, 2024

3.5 Mouza within the Project Area

Nestled in a region of high potential, the Dehara Residential Project is a beacon of sustainable living. It is strategically situated to offer unparallel accessibility and connectivity. The project stands out for its commitment to providing a pollution-free environment amidst natural surroundings, coupled with modern amenities, making it an ideal solution to address the pressing housing shortage.

3.6 Utility Facility Allocation

The Dehara Residential Project has meticulously allocated space for essential civic amenities in line with the stringent standards set forth by the Private Housing Project Land Development Rule of 2004, with subsequent reviews in 2012 and 2015. The thoughtful planning ensures that the project not only meets but exceeds the expectations for a modern, community-oriented living space. Below is an elaborated and improved presentation of the allocation for various facilities:

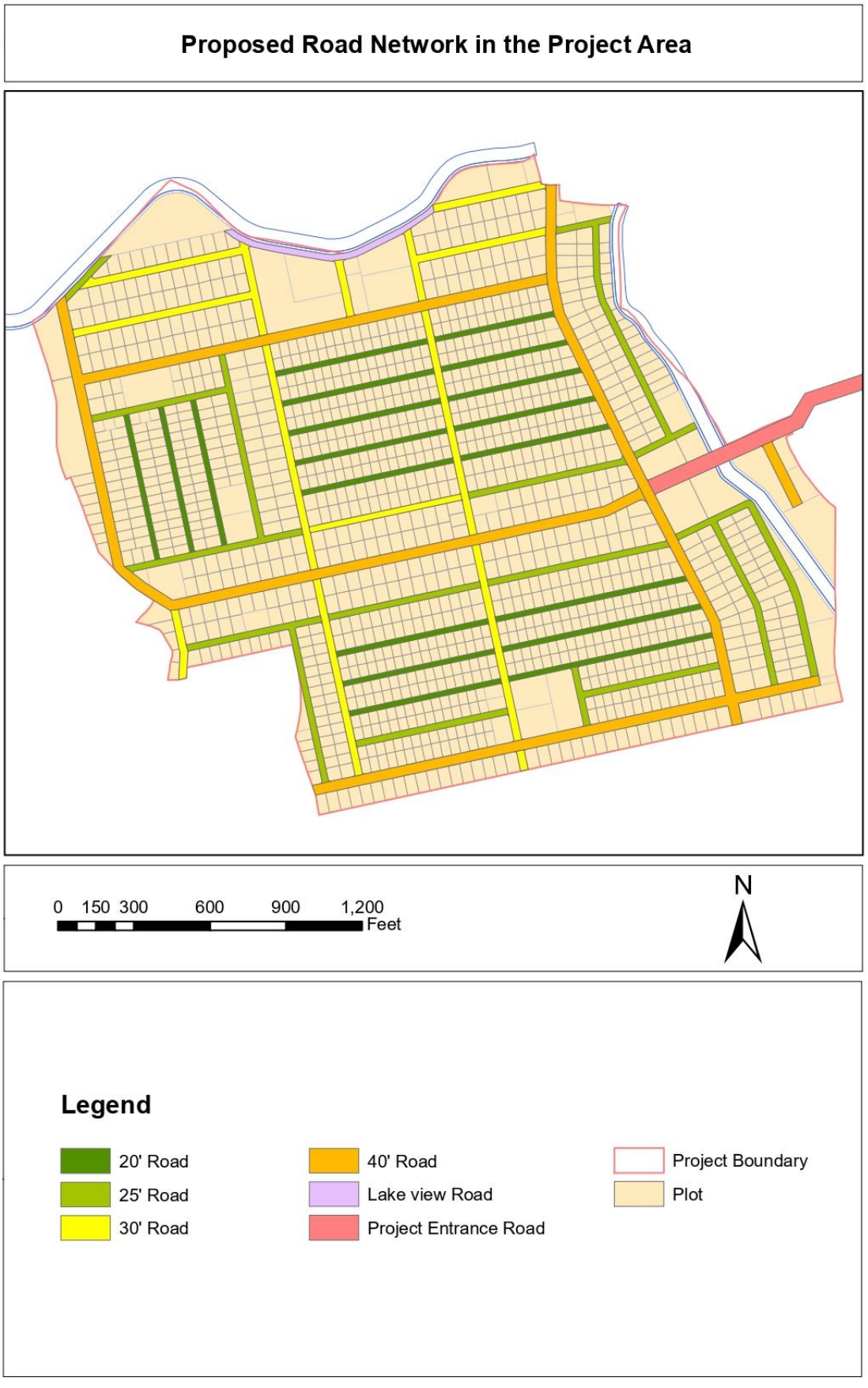


Figure 3.1: Road Network Plan for Dehara Residential Project

Education

In the Dehara Residential Project area, educational institutes like nursery schools, primary schools, secondary schools and colleges will be provided as per instruction provided by the Private Housing Project Land Development Rule of 2004, with subsequent reviews in 2012 and 2015.

Health

Healthcare in terms of clinic and hospitals will be provided as per instruction provided by the Private Housing Project Land Development Rule of 2004, with subsequent reviews in 2012 and 2015.

Utility & Community Services

In the Dehara Residential Project area, utility and community services like water pumps, mosques, graveyard, parking, community centers will be provided as per instruction provided by the Private Housing Project Land Development Rule of 2004, with subsequent reviews in 2012 and 2015.

3.7 Detailed Description of Utility Facility Allocation

The Dehara Residential Project has been designed with a comprehensive utility and facility plan that adheres to the Private Housing Project Land Development Rule of 2004 including its revisions in 2012 and 2015. The following sections provide an enhanced description of the utility facilities and community services that have been incorporated into the project.

3.7.1 Internal Roads Infrastructure

The project features an extensive network of internal roads, ensuring seamless connectivity within the community. Major roads within the development will vary in width, with the broadest being 60 ft and others at a substantial 40 feet. This infrastructure is a key component of the proposed satellite township, designed to meet and exceed current standards for residential developments.

3.7.2 Provision of Utility Services

A high-quality urban lifestyle is supported by robust utility services, which include:

- **Electricity**: The Dhaka Palli Bidyut Samity-1 (DPBS-1) is the authority responsible for providing electricity to the project area. Both completed buildings and those under construction are utilizing power supplied by DPBS-1.
- **Gas**: TITAS GAS has provided connections to a number of households, with approximately 20 currently using natural gas for domestic purposes. Although new gas connections for domestic use are currently on hold by the government, provisions have been made for future connections should policies change, allowing residents to potentially use natural gas. In the interim, residents are encouraged to use LPG for their domestic needs.
- **Water**: Eastern Housing has established Deep Tube Wells (DTWs) to supply water to the project. Additionally, residents have the option to use submersible pumps to fulfill their water requirements.

3.7.3 Community Services and Recreational Spaces

The project places a strong emphasis on community and recreational facilities

- **Community Center**: A community center has been planned to serve as a hub for social and cultural activities.
- **Parking Lot**: Parking area is designated to accommodate vehocles, enhancing convenience for residents.
- **Graveyard**: Respecting cultural and religious practices, area has been allocated for a graveyard.
- **Mosques**: Adequate number of mosques are planned dedicated to providing spiritual spaces for the community.
- **Parks and Green Spaces**: Recognizing the importance of greenery, two parks have been proposed, aimed at enriching the community's environmental quality.
- **Playgrounds**: To promote active lifestyles, four playgrounds are planned to be developed.

3.7.4 Educational Facilities and Market Access

Education is a priority within the Dehara Residential Project:

- **Nursery Schools**: Four nursery schools are planned to foster early childhood education.
- **Primary Schools**: Three primary schools will provide foundational learning experiences.

- **Secondary Schools**: Two secondary schools are included to continue educational opportunities for older children.
- **College**: One college is proposed to offer higher education within the community.

Additionally, marketplaces are strategically located to be within easy reach of all residents, ensuring convenience and accessibility for daily necessities.

3.8 Current Status of the DEHARA Residential Project

The DEHARA Residential Project, situated in the Dehara Mouza of Ashulia Thana within the Dhaka District, spans an impressive **125.28 acres**. Spearheaded by Eastern Housing Limited, the initiative aims to alleviate the housing shortage by offering a variety of housing plots. Positioned in a region of high potential, the project is distinguished by its excellent accessibility, connectivity and the provision of a pollution-free environment amidst natural surroundings, all complemented by modern amenities. This strategic combination positions the Dehara Residential Project as a sustainable solution to the pressing need for housing.

Environmental and Developmental Highlights

The project area is flanked by seasonal wetlands to the north and south, contributing to its ecological diversity and appeal. Within a one-kilometer radius, the majority of the land remains undeveloped, presenting vast opportunities for future expansion and development.

Plot Diversity and Population Estimation

The Dehara Residential Project offers a diverse range of plot sizes to cater to varying preferences and needs. Specifically, the project features five (5) distinct types of plots, ranging from 2.5 katha to 5 katha. These plots are designed to accommodate both single-unit and double-unit apartments. Based on an average occupancy of five (5) individuals per unit, the project has carefully estimated the total population for both apartment types, ensuring that the development can adequately meet the community's needs.

3.9 Summary of the Project

The Dehara Residential Project is making significant strides towards creating a vibrant and sustainable residential community. With a focus on environmental preservation, modern amenities and diverse range of housing options, the project is well-positioned to contribute positively to the region's development and meet the housing needs of its future residents.

CHAPTER 4
BASELINE ENVIRONMENTAL CONDITION

4.1 Physical Environment

4.1.1 Geology

The project under consideration is situated within Unit 20, which is characterized by Deep Red-Brown Terrace Soils, as depicted in **Figure 4.1**. This relatively small area is found along the northeastern fringes of the Barind Tract. The soil composition here bears a resemblance to that of the level terraces within the Madhupur Tract, albeit with a distinct distribution ratio. Predominantly, the soil profile in this region consists of a loamy surface layer, under which lies a layer of friable clay at a subsurface level. The red soils of this unit are elevated above the typical flood zones, thereby remaining unaffected by normal flooding events. In contrast, the brown and grey upland soils are subject to seasonal wetness or shallow flooding due to the rise in the groundwater table during the monsoon period. Additionally, certain valleys within this unit experience more profound flooding during the monsoon, resulting in their lower sections remaining saturated throughout the majority of the dry season, if not its entirety.

4.1.2 Topography and Physiography

The Dhaka lies on the lower reaches of the Ganges Delta and covers a total area of 306.38 square kilometres. Tropical vegetation and moist soils characterize the land, which is flat and close to sea level. This leaves Dhaka susceptible to flooding during the monsoon seasons owing to heavy rainfall and cyclones. Due to its location on the lowland plain of the Ganges Delta, the city is fringed by extensive mangroves and tidal flat ecosystems. Dhaka District is bounded by the districts of Gazipur, Tangail, Munshiganj, Rajbari, Narayanganj, Manikganj.

A wide range of land use occurs across this unit. On high floodplain ridges, the main cropping pattern is aus or jute followed by dryland rabi crops (especially pulses, oilseeds, spices and wheat); sugarcane, tobacco, cotton and bananas are also grown in some areas. Soils of the region are silt loams and silty clay loams on the ridges and silty clay loams to heavy clays on lower sites. General soil types predominantly include Calcareous Dark Grey and Calcareous Brown Floodplain soils. Organic matter content is low in ridges and moderate in the basins. Soils are calcareous in nature and general fertility level is medium.

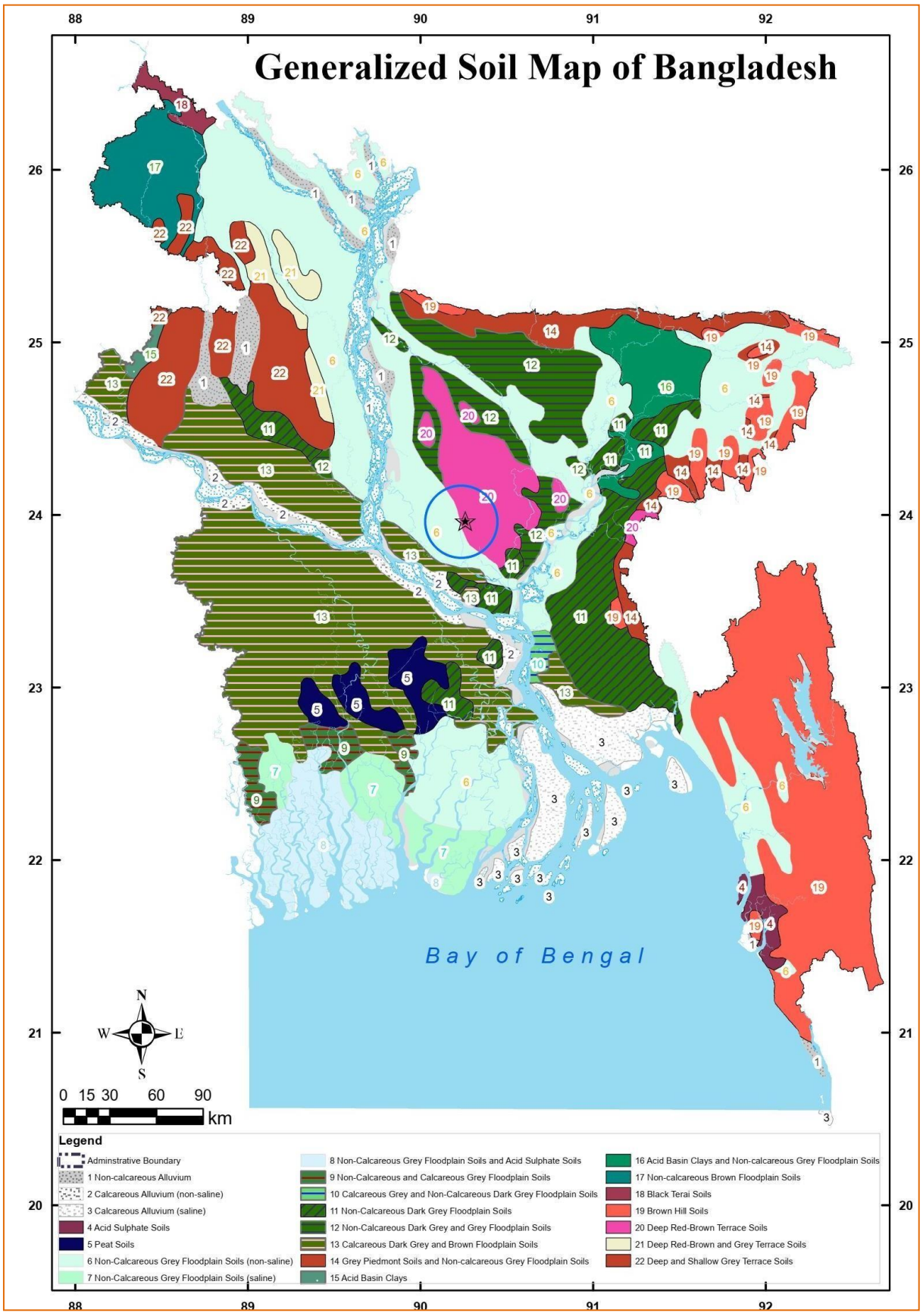


Figure 4.1: General Soil Map of Bangladesh and location of proposed project

4.1.3 Seismology

On the basis of earthquake epicenters and morphotectonic characteristics under Bangladesh National Building Code 2020, Bangladesh is divided into four seismic zones, namely zone-1, zone-2, zone-3 and zone-4. The seismic zones of Bangladesh are presented in **Table 4.1**.

Table 4.1: Seismic Zones of Bangladesh

Seismic Zone	Location	Seismic Intensity	Seismic Zone Coefficient, Z
1	Southwestern part including Barisal, Khulna, Jashore, Rajshahi	Low	0.12
2	Lower Central and Northwestern part including Noakhali, **Dhaka**, Naogaon, Pabna, Dinajpur as well as Southwestern corner including Sundarbans	**Moderate**	**0.20**
3	Upper Central and Northwestern part including Brahmanbaria, Sirajganj, Rangpur	Severe	0.28
4	Northeastern part including Sylhet, Mymensingh, Kurigram.	Very Severe	0.36

The project site is located in Zone-2 which is a zone of very moderate intensity with a basic seismic coefficient of 0.20. During seismic or earthquake delineation in Bangladesh, ground condition (firm or soft) has not been taken into consideration. Hence special precaution is needed in considering the risk from earthquakes to any structure in floodplain formation.

4.1.4 River System near to the Project

Dhaleshwari River a distributary of the jamuna, takes off in the northwestern part of tangail district. It is a meandering river having two branches. The main stream flows north of Manikganj and joins the other branch, the Kaliganga, south of Manikganj. The Kaliganga again joins with the Dhaleshwari. The Buriganga was once a distributary of the Dhaleshwari and used to discharge its flow again into the Dhaleswari. It meets the Shitalakshya river near Narayanganj and flows south to meet the Meghna near Shaitnol and then loses its separate identity. Total length of the river is about 160 km. Average depth of river is 122 feet and maximum depth is 265 feet according to River of Bangladesh published by BWDB.

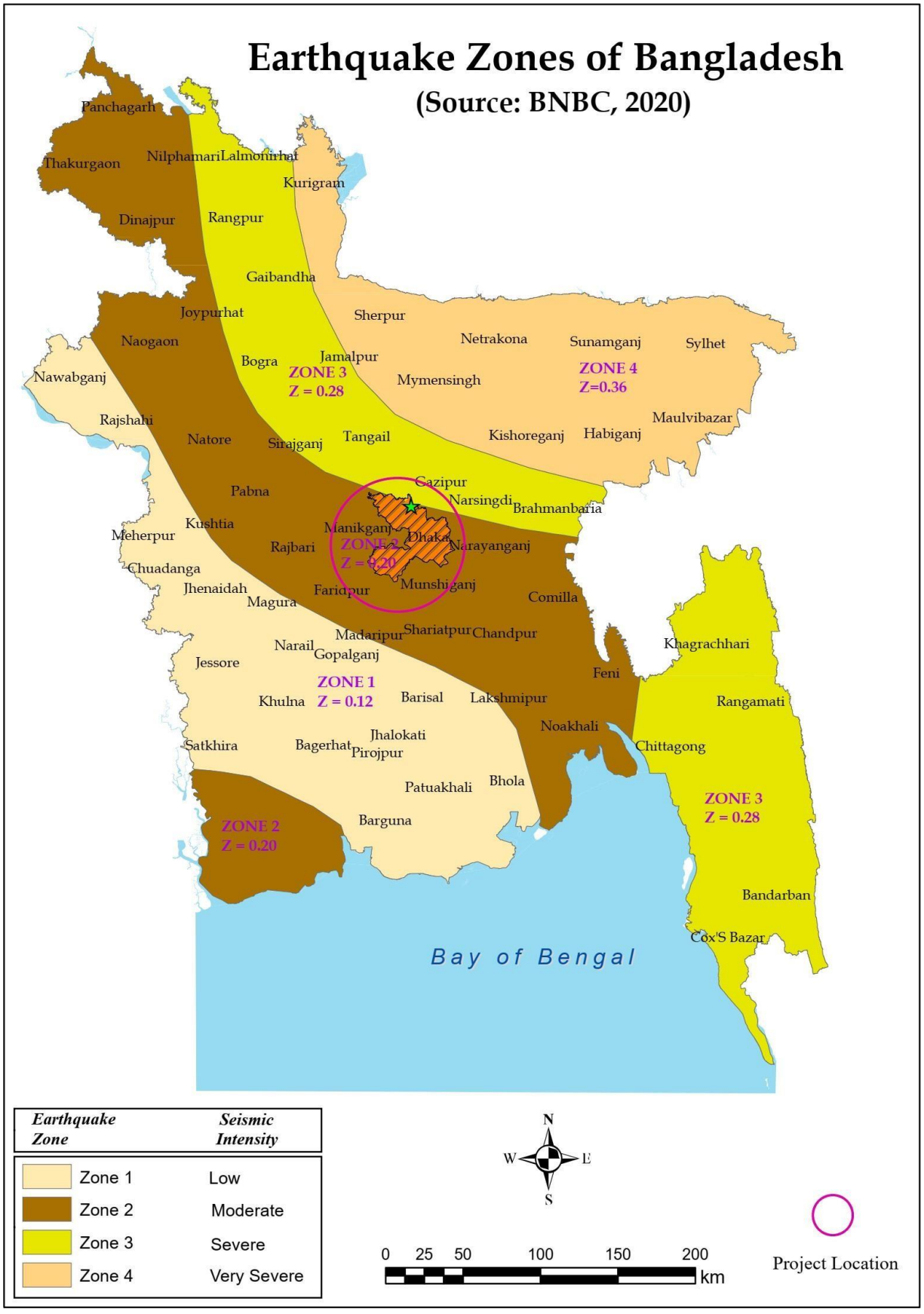


Figure 4.2: Seismic Zones of Bangladesh

4.1.5 Climate

Savar Upazila is located within North Central Hydrological region of Bangladesh. There is a climate station of BMD at Dhaka. The mean annual rainfall in Dhaka is about 2148 mm which is lower than the national average of 2300 mm. Annual rainfall, however, shows considerable variability from year to year. Approximately 78% of rainfall occurs in May to September. The maximum temperature varies from 25.4^{0}C to 33.9^{0}C and it is experienced during the pre-monsoon period (April-May). Average monthly minimum temperature ranges from 12.7^{0}C to 26.3^{0}C.

Table 4.2: Climatic Information for BMD Dhaka Station

Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max. Temp (^{0}C)	25.4	28.1	32.5	33.7	32.9	32.1	31.4	31.6	31.8	31.6	29.6	26.4
Min. Temp (^{0}C)	12.7	15.5	20.4	23.6	24.5	26.1	26.2	26.3	25.9	23.8	19.2	14.1
Rainfall (mm)	7.7	28.9	65.8	156.3	339.4	340.4	373.1	316.5	300.4	172.3	34.4	12.8
Relative Humidity (%)	71	64	62	71	76	82	83	82	83	78	73	73
Wind Speed (m/s)	1.23	1.60	2.59	4.21	3.80	3.70	3.64	3.21	2.24	1.28	0.93	0.92

Source: Bangladesh Meteorological Department, 2024

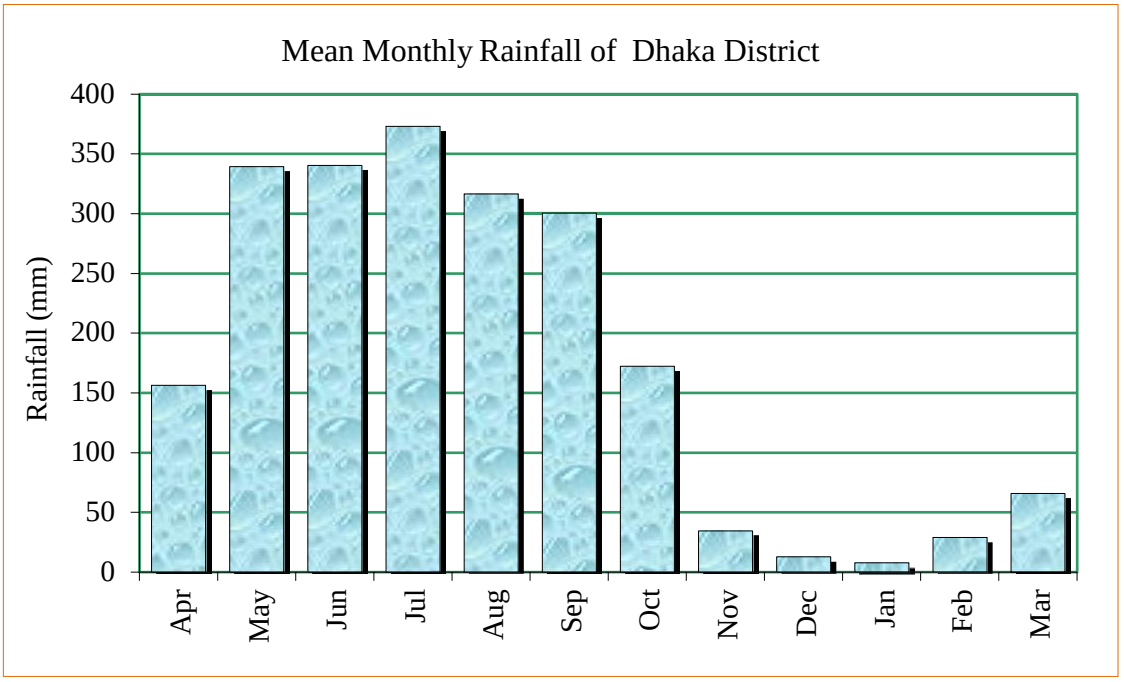


Figure 4.3: Variation of monthly rainfall in Dhaka

4.2 Biological Environment

4.2.1 Bio-ecological Zones

The site falls within the 'IUCN Bangladesh' designated 'Bio-Ecological Zone: Zone 4c-'Brahmaputra-Jamuna Floodplain'. The mighty Brahmaputra river which is interchangeably known also as the Jamuna since the latter's channel is comparatively new and its course can be clearly distinguishable from that of the older Brahmaputra. The Brahmaputra floodplain (situated in greater Mymensingh and Dhaka districts) comprises the active channel of the Brahmaputra river and the adjoining areas of the 'young' floodplain lands formed, since about 1780, when the river shifted to its present course (i.e., the Jamuna river) to the south of Dewanganj in Jamalpur district. The main river course is strongly braided. It consists of several interconnecting channels, which erode and from new lands on a large scale during each flooding season.

4.2.2 Bhahmaputra-Jamuna Floodplain

Location	:	23°37′-26°38′ N and 89°37′-91°00′ E
Physiography	:	Old Brahmaputra floodplain and Young Brahmaputra floodplain
Soil	:	Noncalcareous gray floodplain soils, Noncalcareous dark gray floodplain
Rainfall	:	2030-3300 mm
Temperature	:	Maximum 34° C, Minimum 11° C
Flooding depth	:	H-MH, MH-H, MH-L
Land use	:	Robi-Aus-T. aman (2a); Boro-Fallow-T. aman (4a); Boro-Follow-Fallow

The Brahmaputra-Jamuna floodplain possesses a unique variety of plants, medicinal herbs, fruit bearing trees, hundreds of jungle shrubs, creepers and climbers, flowering trees, etc., many of which yield valuable products. Some of the floral species, which are valued as timber producers are: The Banyan, Tamarind, Sada koroi, Simul and Ashwath. The prominent fruit-bearing trees of this zone are: The Mango, Jackfruit, and Litchi.

Like the floral diversity, this zone equally enjoys riches of faunal variety. According to Hunters (1875), leopards were frequently sited in this zone. A few species of deer, such as the Samber, Hog deer, Swamp deer, and Barking deer were also once found in abundance everywhere in the forests of this zone. Among the bird species, small game birds such as the Common peafowl, Red junglefowl, partridges, and several varieties of pheasants were commonly found. The Bengal florican and snipes are plentiful in the sandbanks and chars of this zone. On the other hand, the most common poisonous snake is the Banded krait in this zone, which could easily be identified by its broad black and yellow bands.

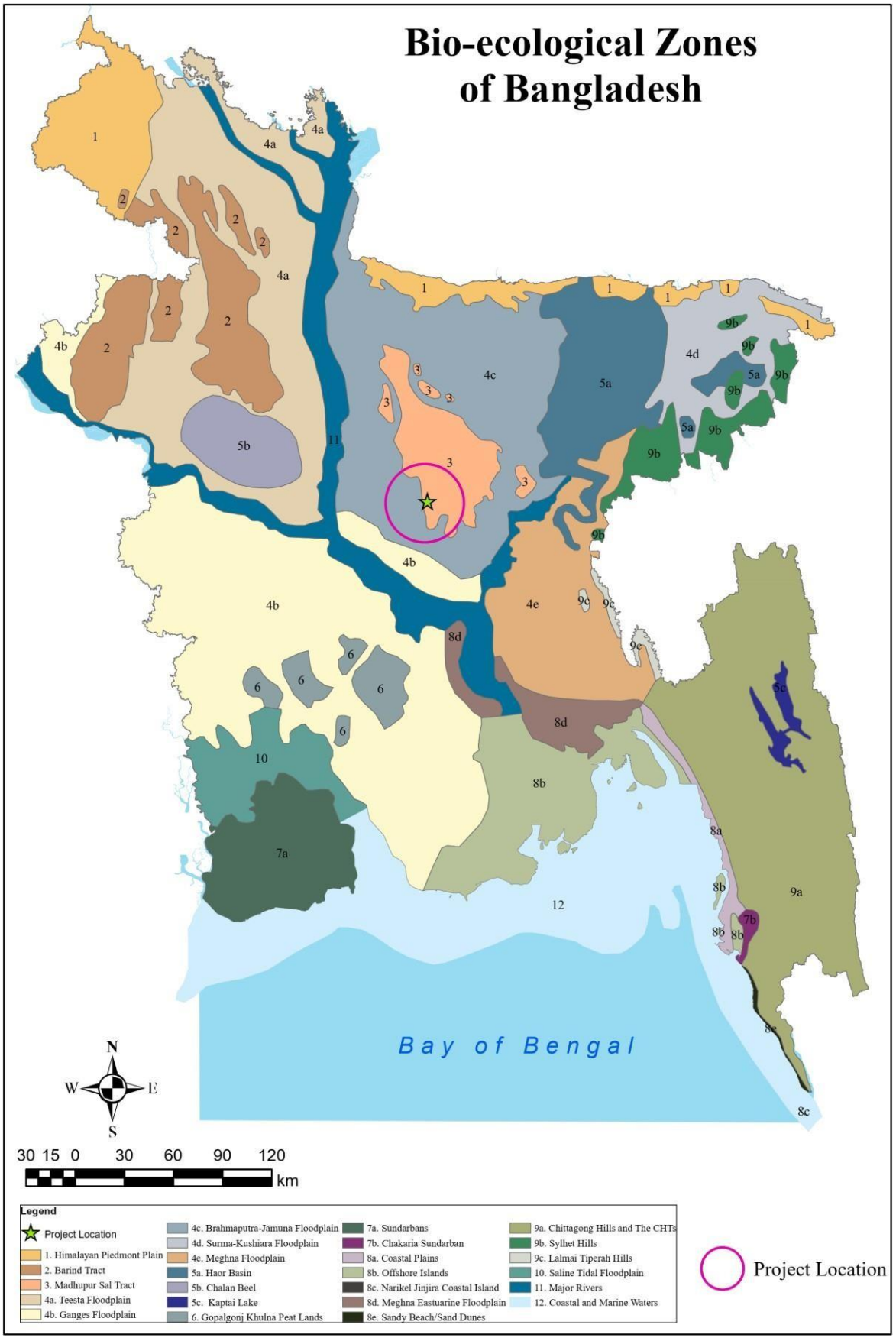


Figure 4.4: Bio-ecological Zones of Bangladesh

4.2.3 Agro-ecological Zones

The project site is located in the Agro-ecological Zone 8 i.e., Young Brahmaputra and Jamuna Floodplain. Young Brahmaputra and Jamuna Floodplain (5,924 sq km) the region comprises the area of Brahmaputra sediments. It has a complex relief of broad and narrow ridges, inter-ridge depressions, partially in filled cut-off channels and basin. This area is occupied by permeable silt loam to silty clay loam soils on the ridges and impermeable clays in the basins, neutral to slightly acid in reaction. General soil types include predominantly grey floodplain soils.

4.2.4 Flora and Fauna

Flora

The flora in Dhaka district shares much in common with neighboring areas, once rich with diverse indigenous plants. However, this unique vegetation has significantly dwindled due to extensive deforestation to accommodate growing human settlements. The primary crops cultivated in the region include rice, jute, wheat, sugarcane, various vegetables, oil seeds, tobacco, and spices.

Mammals

Of primates, the rhesus monkey is fairly common in the district, until recently, a large number of monkeys were seen frequently jumping around in the Dhaka city. They have now retreated to the city and far beyond. Other mammals that are commonly fourn in this district are: Bengal Fox, Jackal, grey mongoose etc. Bats are represented by a few species' including India fruit bats. At times, porpoises are seen in the rivers of the district.

Birds

The common birds of the district include bhat shalik, house sparrow, magpie robin, black drongo, spotted dove, lesser golden backed woodpecker, white breasted kingfisher, pond heron, little cormorant, white breasted water hen, rose ringed parakeet, common hawk cuckoo, tailor bird, koel, barn owl, house crow, brahminy kite.

Fishes

A wide variety of indigenous and exotic fishes are available in this district. In the fresh water, the popular species are ruhi, katla, mrigel, kalbaush, airh, koi, shing, magur, sar puti, pabda, pangas, chital, bacha, etc. Beside this exotic varieties of fishes namely, silver carp, nailotica, tilapia, grass carp etc. have been introduced in this area.

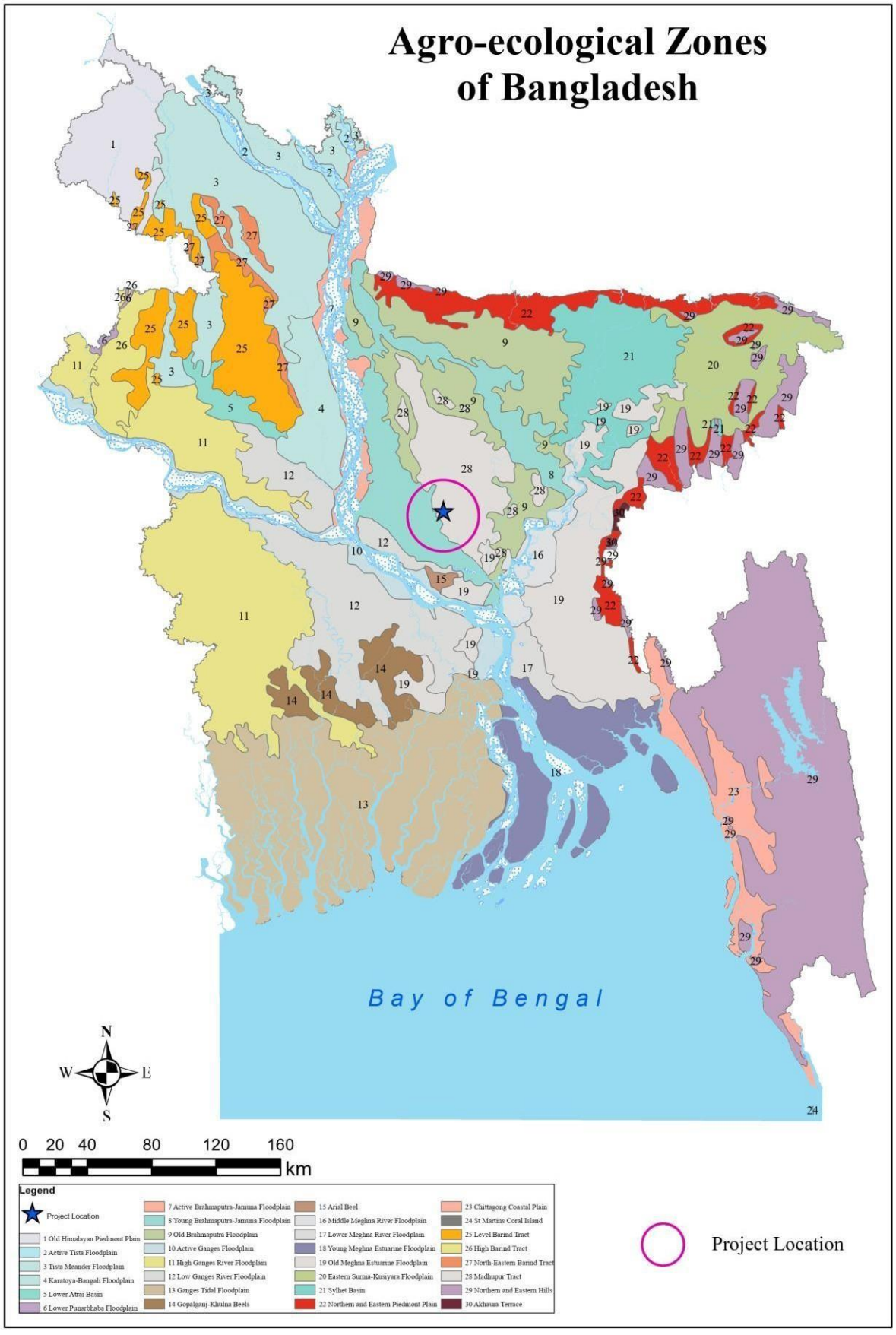


Figure 4.5: Agro-ecological Zones of Bangladesh

4.2.5 Environmental Hot Spot

Figure 4.6 shows reserve forest and protected areas which are sensitive from environmental consideration. **Figure 4.7** shows the protected areas of Bangladesh. From the map it is seen that the project area does not fall within any such environmental hot spot or Environmental Critical Areas.

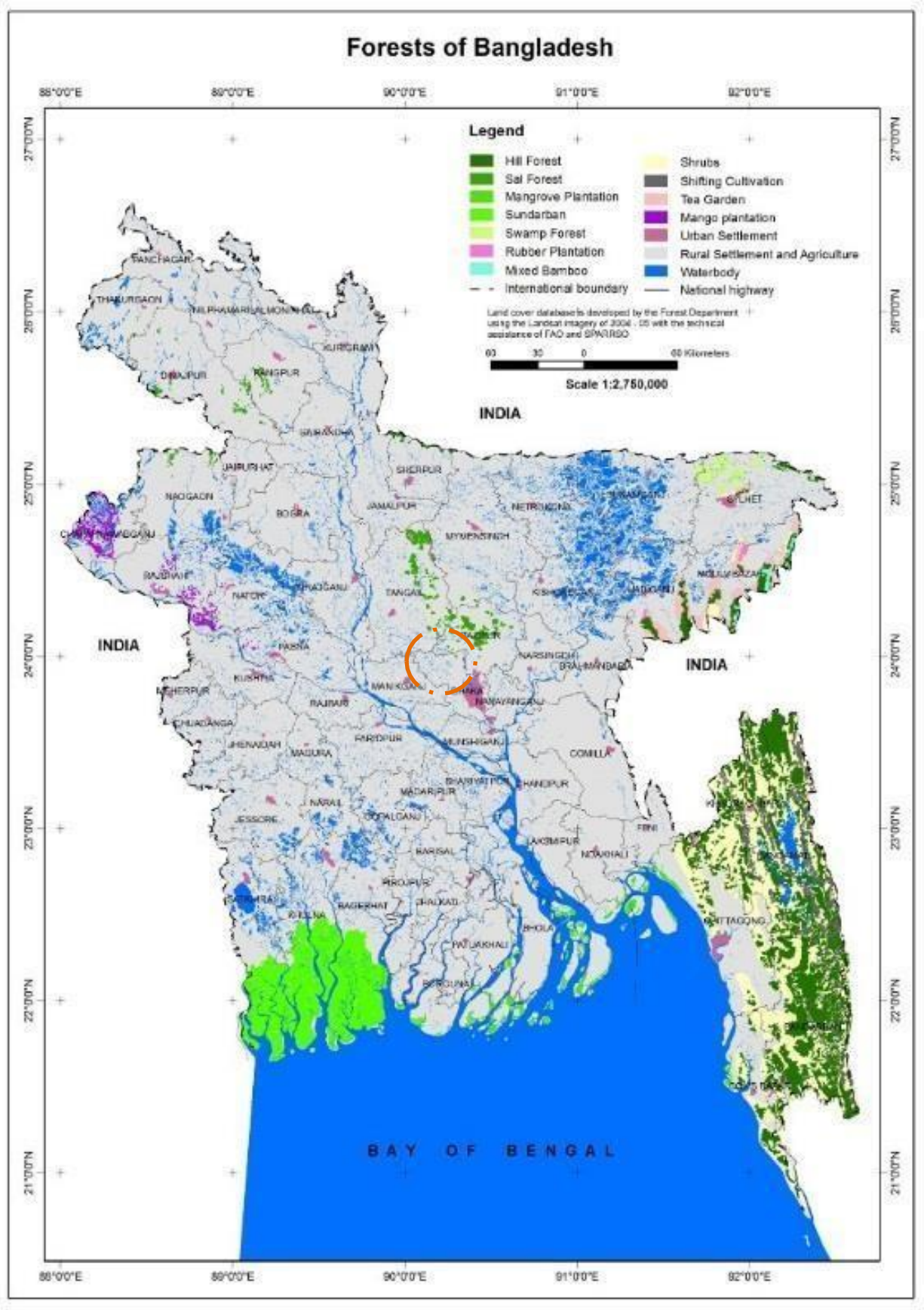


Figure 4.6: Reserve Forest and Environmental Hot Spot

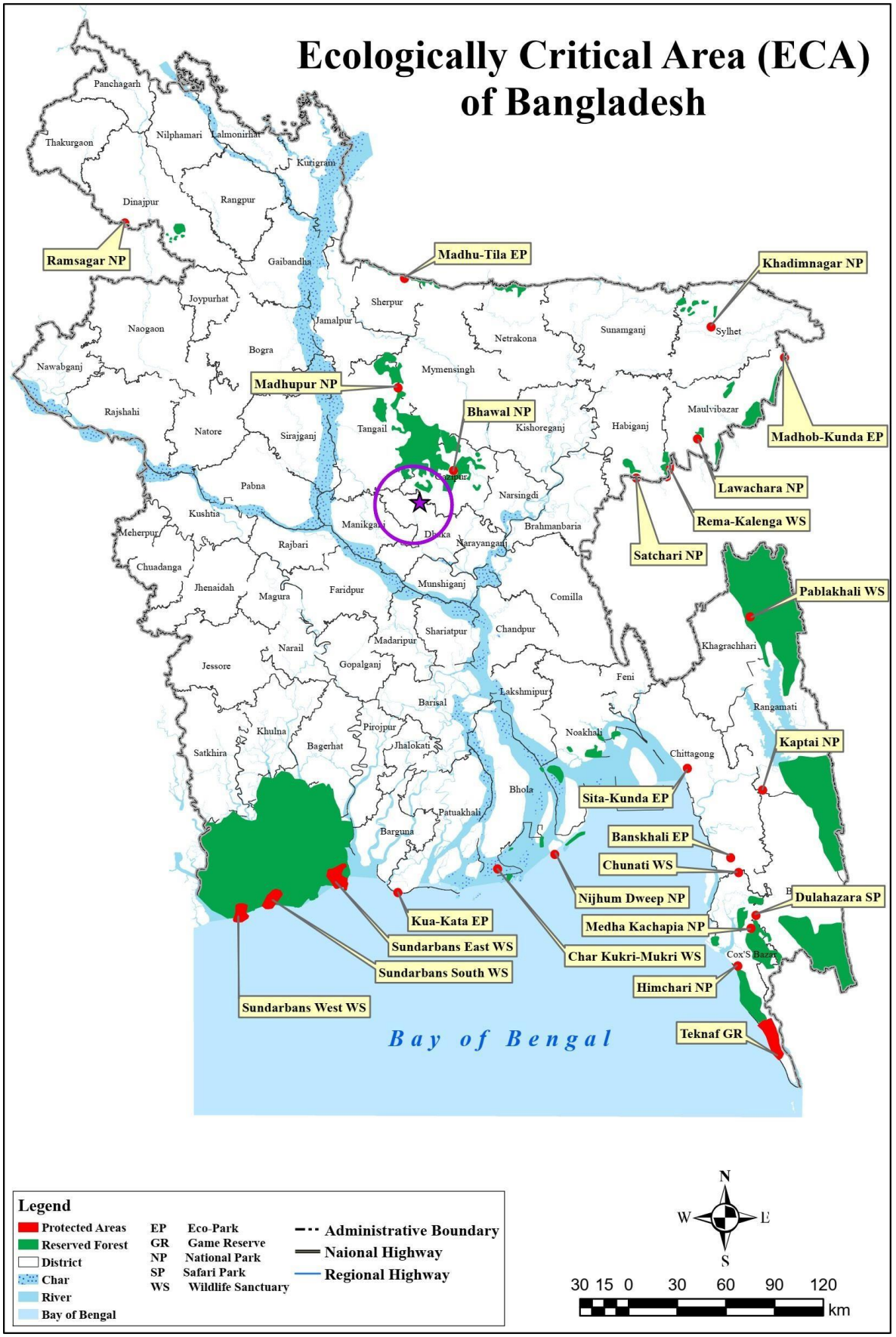


Figure 4.7: Protected Areas of Bangladesh

4.3 Environmental Quality Assessment

4.3.1 Air Quality Assessment

The primary goal of the ambient air quality monitoring program was to establish a baseline for the ambient air quality within the study area. This area is predominantly rural, characterized by a blend of scattered settlements and agricultural lands. The major sources of air pollution identified in the study area stem from agricultural activities and domestic emissions. The selection of the air quality monitoring location was strategically based on the proximity to settlements and receptors within the study area.

Methodology of Air Quality Monitoring

The monitoring of the existing ambient air quality was conducted at a single location throughout the monitoring period. The key parameters monitored included Particulate Matter (PM_{10}) and $PM_{2.5}$, with measurements taken on a 12-hourly basis for the duration of the study. This baseline status of the ambient air quality was determined through a scientifically designed ambient air quality monitoring network. The collected particulate and gaseous samples were analyzed following the procedures outlined in Tables 4.3.

Particulate Matter (PM_{10})

The 12-hourly PM_{10} concentration in the ambient air of the project study area was recorded at 156µg/m^3. The PM_{10} concentration in the project study area was notably low, attributed to the absence of industry. The PM_{10} level at the monitoring location was reported to be below the National Ambient Air Quality Standards (NAAQS).

Particulate Matter ($PM_{2.5}$)

Similarly, the 12-hourly $PM_{2.5}$ concentration in the ambient air of the project study area was recorded at 118µg/m^3. The low $PM_{2.5}$ concentration can be attributed to the lack of industrial activities in the area. The $PM_{2.5}$ level at the monitoring location was also reported to be below the NAAQS.

This comprehensive monitoring and analysis provide a clear picture of the air quality within the study area, establishing a crucial baseline for future environmental assessments and policy-making.

Table 4.3: Study Area Condition and Standard for Air Quality

Standard/ Study Area	Particulate Maters (PM_{10})	Particulate Maters ($PM_{2.5}$)	Sulphur-dioxide (SO_2)	Oxides Nitrogen (NO_X)
	µ gm/m^3	µ gm/m^3	µ gm/m^3	µ gm/m^3
Ambient Air Quality Standard	150	65	80	80
Study Area	56	28	22	54

Source for Standard: Air Pollution Control Rules, 2022, DOE.

The particulate and gaseous samples collected from AccuWeather (https://www.accuweather.com/en/bd/bogra/30530/air-quality-index/30530)

4.3.2 Water Quality Assessment

Surface Water Sampling

The approach for surface water involved a strategic selection of significant water bodies across the study area. These bodies were chosen to represent the diverse characteristics and potential influences on water quality within the region. The sampling sites were pinpointed based on the prominence and ecological relevance of each surface water body.

Ground Water Sampling

In contrast, groundwater samples were procured from pre-existing tube wells. These wells were selected to represent the varied geological and hydrological conditions present throughout the study area, ensuring a representative analysis of the groundwater quality.

Sample Collection

A total of two samples were collected during this study:

- **Surface Water Sample:** A single sample was drawn from a key surface water body, chosen for its representativeness of the area's surface water conditions.
- **Groundwater Sample:** Similarly, one groundwater sample was obtained from a strategically selected tube well to reflect the typical groundwater quality.

Quality Assessment and Standards

Surface Water Quality

The collected surface water sample was meticulously evaluated against the stringent benchmarks set forth in the Environment Conservation Rules (ECR), 2023, specifically tailored for inland surface waters. This comparison aimed to determine the sample's compliance with recognized environmental standards.

Surface Water Quality

Table 4.4 shows the analysis results of the surface water of of project site. Details Laboratory results are presented in **Appendix H**.

pH

All results for pH in surface water fell within the permissible limits is 7.07.

Dissolved Oxygen (DO)

The DO of all the samples of project area level is <MDL and thus meets the surface water classification for different usages.

Biological Oxygen Demand (BOD)

The BOD level is 17.96 mg/L for the project site and this means that river water is usable for irrigation and fishery purposes.

Table 4.4: Surface Water Quality in the Project Area

River Name	Water Quality Parameter				
	TDS (mg/L)	DO (mg/L)	pH	BOD_5	COD
Project Site	130	1.00	7.07	17.96	9.86
DOE Standard	1000	4-6	6.5-8.5	6.00	25.00

Source: Laboratory Analysis in SRDI **(Appendix-I)** & Sample Collected on 10.03.2024

Ground Water Quality

The groundwater sample underwent a comparative analysis against the drinking water specifications also outlined in ECR, 2023. This assessment was crucial to ascertain the suitability of the groundwater for consumption and its adherence to health and safety regulations.

Table 4.5: Ground Water Quality in the Project Area

River Name	Water Quality Parameter				
	TDS (mg/L)	DO (mg/L)	pH	BOD_5	COD
Project Site	110	1.70	6.79	5.99	3.29
DOE Standard	1000	4-6	6.5-8.5	6.00	25.00

Source: Laboratory Analysis in SRDI **(Appendix-G)** & Sample Collected on 10.03.2024.

The findings from the water quality monitoring, including both surface and groundwater, were systematically documented. The results were presented alongside the applicable ECR standards, facilitating a direct and transparent comparison. This juxtaposition not only highlighted the current state of water quality but also identified areas requiring attention or remediation.

4.3.3 Noise Quality Assessment

In the context of the environmental impact assessment for the project site, an extensive noise quality evaluation was conducted. This assessment was crucial to understand the ambient noise levels within the study area and to ensure compliance with regulatory standards.

Data Collection

Noise levels were meticulously measured at two strategically chosen locations within the study area over the monitoring period. The measurements were taken using a digital sound level meter, an instrument designed to accurately capture sound pressure levels.

Monitoring Locations

The locations for noise monitoring were selected with the intent to gather data that would be representative of the entire block. The details of these locations are as follows:

- **Location 1:** In proximity to a mosque
- **Location 2:** Near the EHL Office

The rationale behind these choices was to ensure that the noise levels recorded would reflect the typical ambient noise conditions experienced throughout the area.

Table 4.6: Ambient Noise Standards

Sl No	Area of Category	Standard Values (All values in dB)	
		Day	Night
1	Silent Zone	50	40
2	Residential Area	55	45
3	Mixed Activity Area	60	50
4	Commercial Area	70	60
5	Industrial Area	75	70

Source: Noise Pollution Control Rules, ECR, 1997

Measurement Technique

The sound intensity at these monitoring points was quantified in terms of A-weighted equivalent continuous sound pressure level (Leq) values. The A-weighting filter applied in the noise measuring instrument is a standard method used to mimic the human ear's response to sound, thus providing a measurement that correlates well with the perceived loudness of noise. The findings from the noise level survey are concisely presented in Table 4.6.

Table 4.7: Noise Level in the Project Site

Sl No	Location	Bangladesh Standard Values (dBA)	Average Noise Level (dBA)
1	Near to Msque	55 [at day time]	47
2	Near to EHL Office	55 [at day time]	45

Source: Field Survey March, 2024

Analysis of Noise Levels

The background noise level in the project area was found to be relatively low. This is attributed to the absence of heavy industrial activities, large-scale urban developments, or other significant sources of noise pollution. The measured ambient noise levels at each monitoring location, as summarized in Table 4.6, were within the acceptable limits as per the Noise Pollution Control Rules, 2006.

The noise quality assessment indicates that the current noise levels in the project area are well within the national standards set by Bangladesh. This suggests that, at the time of monitoring, the project site does not suffer from excessive noise pollution, and the ambient noise environment is conducive to the well-being of the local community and the natural habitat.

4.3.4 Soil Quality Evaluation

To accurately determine the soil quality with the study area, a strategic soil sampling approach was implemented. This involved the collection of soil samples from a single, carefully selected location, ensuring that the samples would be representative of the soil conditions across the entire area.

Sampling Methodology

A composite sampling method was employed to gather soil from the chosen location. This technique involved mixing soil from various points within the sampling area to form a single, homogenized sample that accurately reflects the overall soil composition. The soil was

extracted using specialized tools at a depth of 45 cm below the topsoil surface, which is considered to provide a representative sample of the soil profile. The collection was performed at one specific spot to maintain consistency. Once collected, the soil was homogenized using the quartering technique, a method that ensures a representative cross-section of the sample. The prepared soil was then securely packed in polyethylene plastic jars and sealed to prevent contamination. The sealed soil samples were promptly dispatched to the laboratory for a comprehensive analysis. The testing focused on a range of physical and chemical properties, including the presence of minerals, heavy metals, and trace elements.

Soil Quality Results

Physical Characteristics

The laboratory analysis revealed the following physical properties of the soil:

- **Particle Size Distribution:** The majority of the soil composition is sand (59.24%), followed by silt (27.28%) and clay (13.48%).
- **Texture:** The texture classification of the soil sample is Sandy Loam, indicating a balanced mix of particle sizes conducive to various forms of plant life.

Chemical Characteristics

The chemical analysis of the soil samples provided insights into the soil's fertility and potential for supporting agriculture:

- **pH Level:** The soil pH was measured at 6.40, categorizing it as slightly acidic according to standard soil classifications.
- **Organic Matter:** The soil contains 3.58% organic matter, which is beneficial for soil health and plant growth.
- **Nutrient Content:** The soil was tested for essential nutrients, revealing the presence of total nitrogen (0.18%), phosphorus (3.42 µg/g), potassium (0.38 meq/100g), and sulphur (62.66 µg/g).

Trace Elements

The presence of trace elements is crucial for plant nutrition, and the soil samples were analyzed for several key elements:

- **Micronutrients:** The soil contains zinc (5.25 µg/g), boron (0.74 µg/g), copper (3.40 µg/g), iron (197.51 µg/g), and manganese (108.07 µg/g).
- **Exchangeable Cations:** The levels of calcium (1.90 meq/100g) and magnesium (2.53 meq/100g) were also determined.

The soil quality assessment, as detailed in Table 4.7, indicates that the soil within the proposed project site possesses a Sandy Loam texture with a slightly acidic pH level. The presence of organic matter and essential nutrients, along with a range of trace elements, suggests that the soil is capable of supporting healthy plant growth. These findings, derived from laboratory analysis conducted by SRDI and documented in **Appendix G**, provide a solid foundation for any land use planning and agricultural activities within the study area.

Table 4.8: Soil Quality Results in the Proposed Project Site

Parameters	Soil Quality (SQ)
Particle size Distribution (%)	Sand-59.24% Silt-27.28% Clay-13.48%
Texture	Sandy Loam
pH	6.40
Organic Matter (%)	3.58
Total Nitrogen (%)	0.18
Phosphorus (µg/g)	3.42
Potassium (meq/100g)	0.38
Sulphur (µg/g)	62.66
Zinc (µg/g)	5.25
Boron (µg/g)	0.74
Calcium (meq/100g)	1.90
Magnesium (meq/100g)	2.53
Copper (µg/g)	3.40
Iron (µg/g)	197.51
Manganese (µg/g)	108.07

Source: Laboratory Analysis in SRDI **(Appendix-G)** & Sample Collected on 10.03.2024

Collection of Soil Sample (10.03.2024)

CHAPTER 5
SOCIO-ECONOMIC PROFILE OF THE PROJECT AREA

5.1 Savar Upazila

Savar stands as the most populous upazila within the Dhaka district, marking its inception as a thana in the year 1912 before being elevated to the status of an upazila in 1983. Historical records, particularly the district gazetteers, reveal that Savar once served as the capital of the Sambhog principality, under the reign of Raja Harish Chandra in the 17th century AD. This period is noted for its rich cultural and political significance, hinting at Savar's historical prominence and its strategic role in the region's past. There exists a widely held belief that the name 'Savar' is not merely coincidental but deeply rooted in the locale's history, possibly derived from the very site where its administrative headquarters now stand. Its name, believed to be tied to the location of its headquarters, adds a layer of historical intrigue and reflects the deep-seated heritage that the upazila carries forward into the present day.

5.1.1 Area and Location

Spanning an area of 280.11 sq.km, the upazila is strategically positioned between the latitudes of 23°44'N and 24°02'N, and the longitudes of 90°11'E and 90°22'E. It shares its northern boundary with the Kaliakair and Gazipur Sadar upazilas of Gazipur district, while to the east, it is bordered by Gazipur Sadar of Gazipur district along with Darus Salam, Shah Ali, Mohammadpur, Adabar, Pallabi, and Turag thanas. The southern edge is adjacent to Keraniganj upazila, and to the west, it is flanked by the Dhaleshwari River, Singair upazila of Manikganj district, and Dhamrai upazila of Dhaka district. This strategic location not only defines its geographical boundaries but also highlights its connectivity and significance within the region.

5.1.2 Union Characteristics

The upazila is a vibrant administrative region, comprising a diverse and structured community layout. It includes:

1 Paurashava (Municipality): Serving as the urban core of the upazila.

9 Wards: Each ward, on average, is home to 32,983 residents, reflecting the urban density and administrative divisions within the paurashava.

56 Mahallas: These are smaller neighborhoods or sectors within the wards, with each mahalla averaging a population of 5,301, showcasing the close-knit community structure.

12 Unions: Representing the rural heartland, each union on average accommodates 90,755 inhabitants, indicating significant rural populations and agricultural communities.

216 Populated Mauzas: These are smaller administrative units or land parcels within unions, with each mauza having an average population of 5,042, highlighting the spread of rural habitation.

380 Villages: The essence of rural life, each village on average houses 2,866 people, reflecting the traditional and agricultural lifestyle of the region.

The detailed distribution of the population across each union is meticulously documented in **Table 5.1**, providing a comprehensive overview of the demographic layout and population density across the upazila's diverse administrative and residential structures. This version aims to present the information in a more organized manner, making it easier to understand the administrative and demographic structure of the upazila.

Table 5.1 : Union-wise Population Characteristics of Savar Upazila

Sl No	Name of Union/ Paurashava	Area (sq.km)	Households	Population			Literacy Rate (%)	Sex Ratio
				Male	Female	Total		
1	Savar Paurashava	14.09	75902	157018	139833	296851	74.9	112
2	Amin Bazar	10.94	8907	20397	17103	37500	54.0	119
3	Ashulia	26.10	37106	78305	65647	143952	64.7	119
4	Banagram	18.05	7813	17786	15841	33627	51.7	112
5	Bhakurta	21.06	9520	23746	21201	44947	48.2	112
6	Biralia	30.14	10070	22392	18796	41188	60.3	119
7	Dhamsana	32.77	92036	162372	145652	308024	75.0	111
8	Kaundia	11.47	6182	14952	12844	27796	54.1	116
9	Pathalia	28.74	22110	49001	44149	93150	64.6	111
10	Savar	10.20	11981	24360	21527	45887	67.5	113
11	Shimulia	34.66	19522	46987	42236	89223	60.3	111
12	Tetuljhora	15.55	26287	58214	48715	106929	63.9	119
13	Yearpur	26.35	31648	63234	53602	116836	70.9	118
Total		280.13	359084	738764	647146	1385910	68.0	114

Source: BBS Community Series, 2012

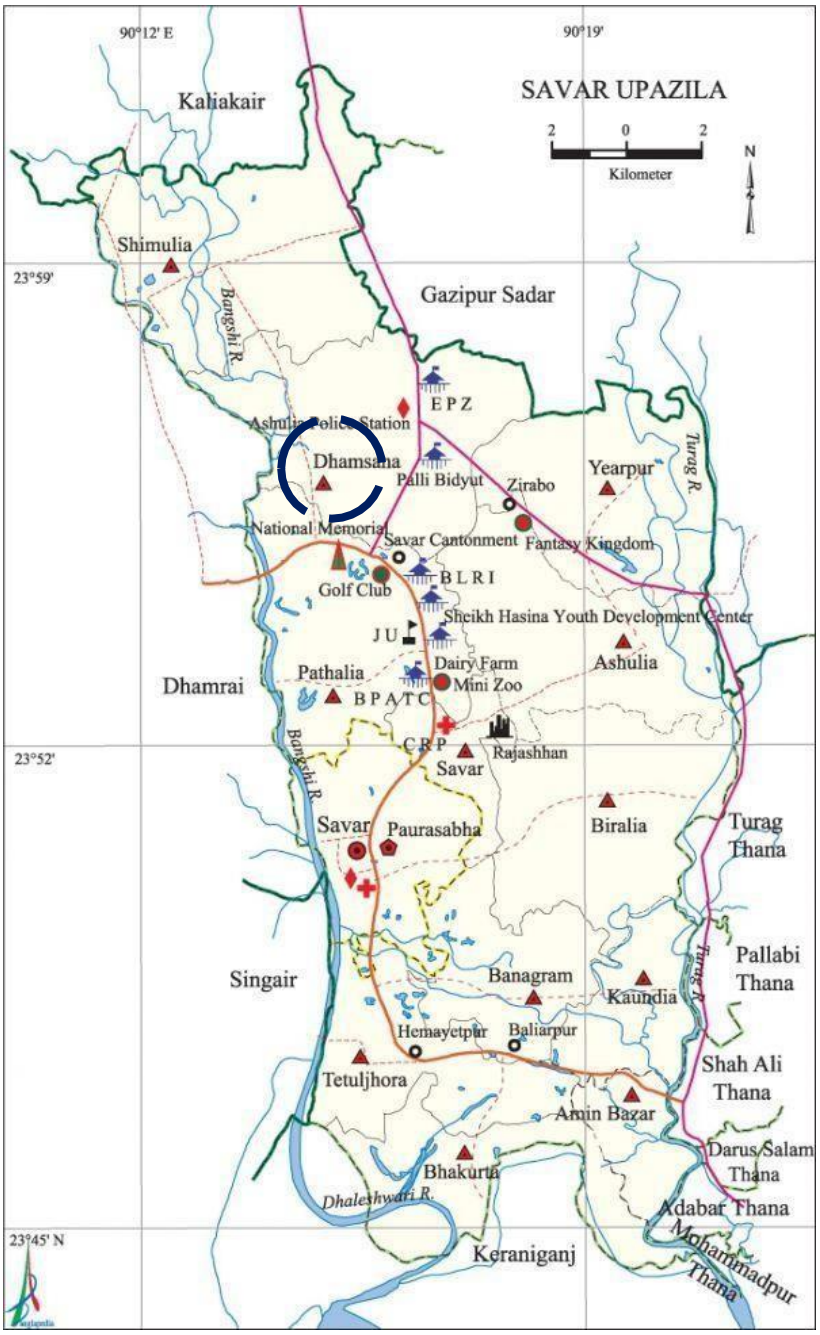


Figure 5.1: Location of Unions of Savar Upazila

5.1.3 Household and Housing Characteristics

This upazila is home to a vibrant community, as evidenced by its **359,084 households**. A closer look at the composition of these households reveals a diverse array of living arrangements:

- **General Units:** Making up the vast majority, **97.31%** of households fall into this category, reflecting the standard living arrangements for most residents.

- **Institutional Units:** A small fraction, **0.15%**, represents institutional living spaces, such as dormitories and hostels.
- **Other Units:** Comprising **2.54%** of the total, this category includes all non-standard types of living arrangements not classified as general or institutional.

Average Household Size

Across the board, the average household size remains consistent at **3.8 persons**, whether in urban or rural settings. This uniformity suggests a stable family structure throughout the upazila.

Housing Types

The diversity in housing types further illustrates the varied living conditions within the upazila:

- **Pucca Houses:** Representing more permanent and sturdy structures, **19.1%** of general households reside in pucca houses.
- **Semi-Pucca Houses:** The majority, **62.8%**, live in semi-pucca houses, which are moderately durable.
- **Kutcha Houses:** Reflecting more basic and less durable living conditions, **17.2%** of households are in kutcha houses.
- **Jhupri:** A minimal **0.8%** of households reside in jhupris, which are typically makeshift shelters.

5.1.4 Water Supply and Sanitation

Savar Upazila showcases a significant focus on ensuring access to clean water and proper sanitation for its residents, reflecting its commitment to public health and hygiene. The distribution of water supply sources and sanitation facilities among the general households in the upazila paints a picture of the current state of these essential services.

Water Supply Facilities

The majority of households in Savar Upazila rely on various sources for their drinking water needs:

- **Tubewells:** Serving as the primary source of drinking water, **66.9%** of general households draw water from tubewells. This method is widely preferred for its accessibility and reliability in providing groundwater.

- **Tap Water:** A significant **32.3%** of households have access to tap water, indicating a substantial reach of piped water supply systems within the upazila.
- **Other Sources:** A small fraction, **0.8%**, of households depend on alternative sources for their water needs. These may include rainwater harvesting, water from rivers or ponds, or water vendors, highlighting the diversity in water sourcing methods.

Sanitation Facilities

The state of sanitation facilities in Savar Upazila reveals a high level of access to hygienic latrines, underscoring the upazila's efforts towards improving public health:

- **Sanitary Latrines:** A commendable **94.5%** of general households use sanitary latrines, showcasing widespread adoption of hygienic sanitation practices.
- **Non-Sanitary Latrines:** A smaller portion, **5.1%**, still relies on non-sanitary latrines, indicating areas where improvements in sanitation infrastructure could be beneficial.
- **No Toilet Facilities:** Only a minimal **0.4%** of households are without any toilet facilities, highlighting the need for targeted interventions to ensure access for all.

5.1.5 Population Characteristics

According to Population and Housing Census 2011, the total population of the upazila is 1385910 of which 738764 are males and 647146 are females. The sex ratio of the upazila is 114 in 2011 as against 118 in 2001. The decadal population growth rate for the upazila is 136.08% and the annual compound growth rate is 8.83%. According to Banglapedia (2023), Main sources of income Agriculture 20.46%, non-agricultural labourer 3.09%, industry 2.82%, commerce 20.55%, transport and communication 5.75%, service 28.74%, construction 2.84%, religious service 0.18%, rent and remittance 2.67% and others 12.90%. Ownership of agricultural land Landowner 42.94%, landless 57.06%. Main crops Paddy, Jute, ground nut, vegetables. Extinct or nearly extinct crops Aus paddy, asha kumari paddy, sesame, linseed, kali mator, randhuni saj, mitha saj, kaun, black gram. Main fruits Jackfruit, olive, kamranga, papaya, mango, guava, blackberry, banana. Fisheries, dairies and poultries Dairy 526, poultry 754, hatchery 5.

5.1.6 Literacy and Education Attainment

In 2011, Savar Upazila reported a literacy rate of 68.0% across the population, with a breakdown of 71.6% for males and 63.9% for females. This represents a significant

improvement over the past decade, with an overall increase of 9.8 percentage points since 2001. Specifically, male literacy rose by 7.5 percentage points, while female literacy saw a more substantial rise of 12.8 percentage points, indicating progress in educational gender parity.The distribution of literacy rates within the upazila varies, reaching its peak at 84.7% in Ward No. 05 of Savar Municipality, which stands as the highest recorded rate. In contrast, the lowest literacy rate is found in Bhakurta Union, where it stands at 48.2%.

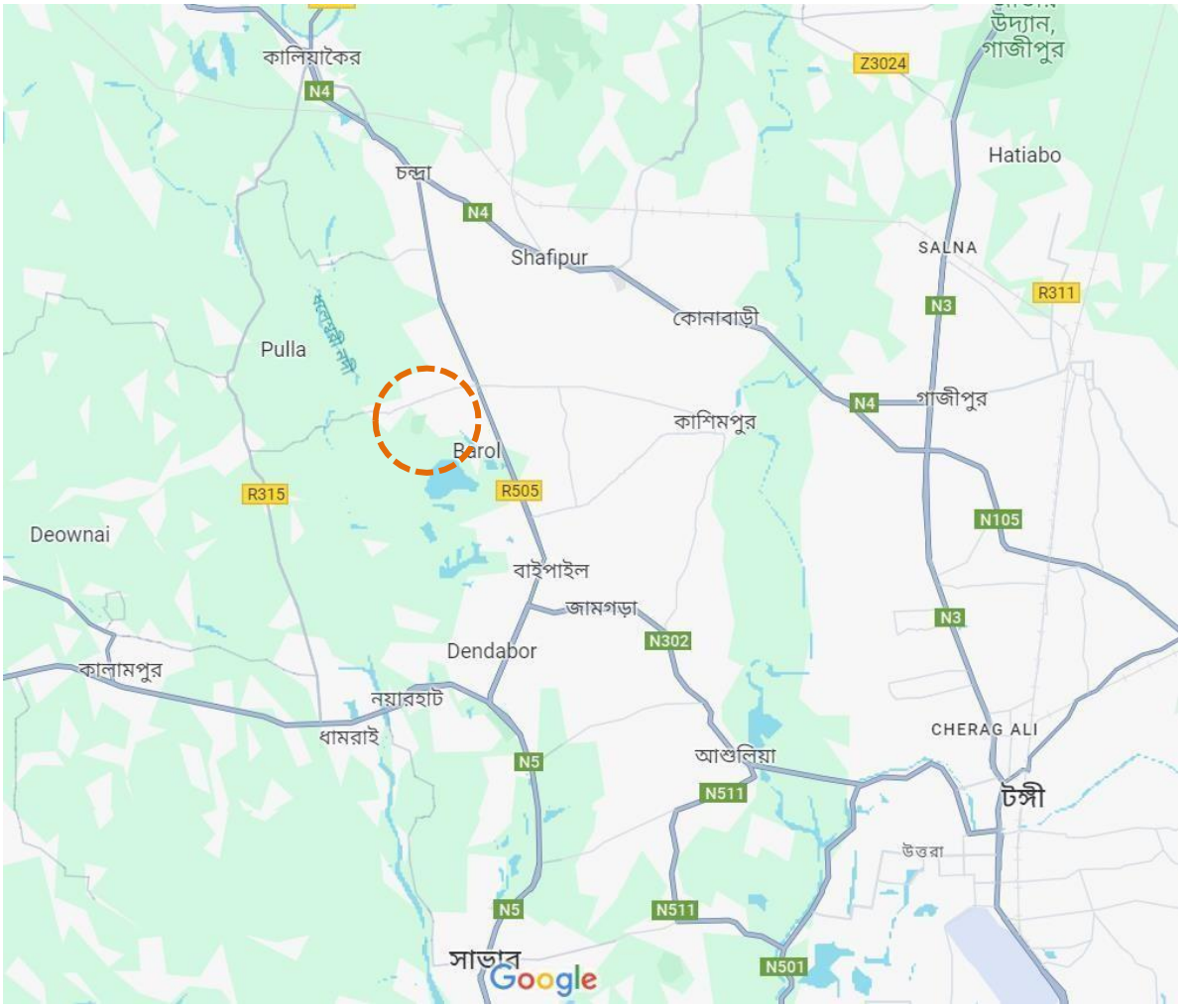
5.2 Economic Landscape of the Study Area

The economic fabric of Savar is distinctly woven from its rural and urban sectors, each with its unique foundation. The rural economy of Savar is deeply rooted in agriculture, showcasing a rich tapestry of crop production that includes both local and high-yielding varieties (HYV) of rice, wheat, jute, tobacco, potatoes, vegetables, spices, and pulses. This agricultural bounty is complemented by a diverse array of fruits that define the region's horticultural wealth, with mango, jackfruit, lichee, blackberry, palm, betel-nut, and banana standing out as the area's primary fruits. The aquatic life in Savar adds another layer to its agricultural landscape, with a variety of fish harvested from rivers, beels (wetlands), and paddy fields during the monsoon season. The most commonly found species include ruhi, katla, mrigel, magur, singi, koi, puti, shoil, gazar, and boal, all of which hold significant economic value. In addition to these, the waters of Savar are also home to well-known varieties such as pangash, airh, bacha, rita, batasi, khalisha, and chingri, enriching the local diet and economy. Transitioning from the rural to the urban, the economic heartbeat of Savar’s urban areas pulsates with industrial vigor. This shift from agrarian to industrial activities marks a significant diversification in the economic activities of the region. Beyond the realms of crops and fisheries, livestock and poultry farming emerge as vital supplementary sources of household income, integrating seamlessly into the agricultural domain and contributing to the overall economic resilience of Savar.

5.3 Project Location and Housing Demand

Spanning an expansive 125.28 acres, this housing project is strategically positioned to offer a multitude of housing plots. Its location is meticulously chosen for optimal accessibility and connectivity, situated approximately 3km from Zirani Bazar, 3km from Baipail, and 6km from the Nabinagar Bus Stand. Adding to its strategic placement, the Dhaka Export Processing Zone (DEPZ) lies within a mere 2km from the project site, enhancing its appeal to professionals and businesses alike. Furthermore, the British American Tobacco Bangladesh office is

conveniently located within walking distance, underscoring the project's proximity to significant commercial hubs. The project's vicinity to the River Dhakeswari, located about 3km away on the east side, enriches its setting with natural beauty and a pollution-free environment. This thoughtful location choice, combined with the promise of modern amenities, positions the project as a sustainable solution to the pressing housing shortage. It aims to cater to a diverse range of housing needs, from individuals seeking tranquility and natural surroundings to those prioritizing easy access to urban conveniences and workplaces. In essence, this housing project is designed with a holistic approach, considering not just the immediate needs of potential residents but also the long-term sustainability and livability of the community.



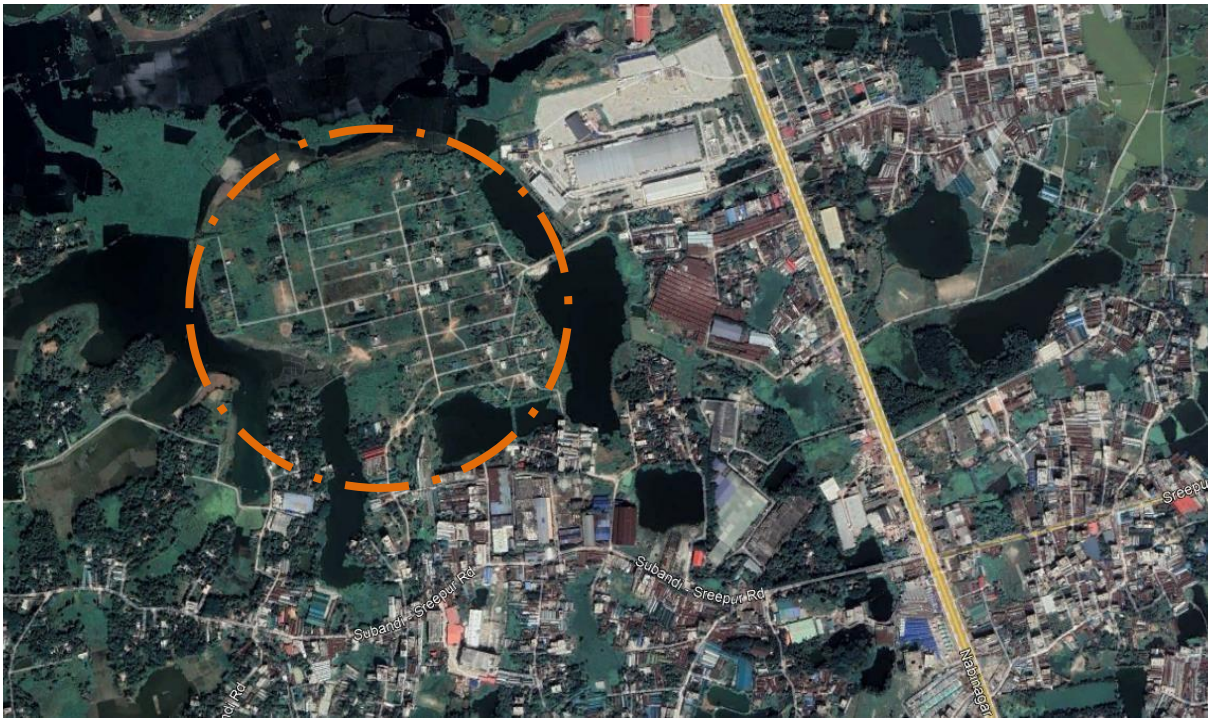


Figure 5.2: Location of Project Site on Google Map

The economic and demographic landscape of Savar Upazila, coupled with the strategic development of the housing project, paints a picture of a region on the cusp of significant transformation. From its robust agricultural base and diverse industrial activities to the strategic location of the housing project near key commercial hubs and natural settings, Savar is poised to address the pressing housing needs while fostering sustainable growth. The project, with its thoughtful integration of modern amenities, accessibility, and a pollution-free environment, not only promises to alleviate the housing scarcity but also enhances the quality of life for its future residents. As Savar continues to evolve, this housing initiative stands as a beacon of sustainable development, harmoniously blending the area's economic strengths with the aspirations for a better living environment.

CHAPTER 6
3R CONCEPT AND APPLICATION FOR SOLID WASTE MANAGEMENT

6.1 Introduction

In Bangladesh, the 3R strategy, which stands for Reduce, Reuse, and Recycle, is a critical approach to managing the escalating solid waste challenges brought on by rapid urbanization. This strategy is integral to the nation's waste management policy, as outlined in the 3R Strategy (DOE, 2010) and the National Solid Waste Management Rules 2021. By focusing on reducing waste generation at the source, reusing materials wherever possible and recycling what cannot be reused, the 3R approach not only addresses environmental concerns but also contributes to sustainable development. It helps in reducing greenhouse gas emissions, promoting energy-efficient practices and fostering resilient infrastructure. Moreover, the 3R strategy aligns with Bangladesh's commitment to achieve Sustainable Development Goals, particularly those related to sustainable cities and responsible consumption and production, thereby supporting the nation's broader environmental and economic objectives.

6.1.1 Why 3R for Bangladesh

Bangladesh is currently undergoing a significant transformation due to rapid urbanization. This shift presents numerous challenges, one of the most pressing being the management of solid waste. Traditional waste management systems are increasingly unable to cope with the volume and complexity of waste generated by growing urban populations. In response to these challenges, innovative solutions are crucial. The 3R strategy-Reduce, Reuse, Recycle-stands out as a particularly effective approach, especially for housing projects in burgeoning urban areas. This strategy is structured around three key actions:

Reduce: This first step focuses on minimizing waste generation right at the source. By adopting practices that reduce waste, the strain on waste management systems and environmental impact are significantly lowered.

Reuse: The second step encourages finding new uses for existing materials. This not only helps in cutting down waste but also reduces the demand for new raw materials, conserving resources and energy.

Recycle: Finally, recycling comes into play for materials that cannot be reused. Recycling transforms waste into valuable resources, thus closing the loop and minimizing the environmental footprint.

Implementing the 3R strategy within housing projects can lead to a more sustainable urban development in Bangladesh. It not only addresses the immediate issues of waste management but also contributes to the broader goal of sustainable living. By integrating these practices into the core of urban development strategies, Bangladesh can ensure a healthier, more sustainable future for its residents and the environment.

It is important to note, as discussed later in this chapter, that while the 3R strategy is broadly applicable, the specific practices and examples might not be universally suitable for every project site. The effectiveness of the 3R principles depends on local conditions and needs, requiring a tailored approach to ensure maximum impact.

6.1.2 Policy Context for 3R

Bangladesh has formally embraced the 3R methodology for waste management, a paradigm outlined in the 3R Strategy (DOE, 2010) and Solid Waste Management Rules 2021, established under the Environmental Conservation Act 1995. Recently, this strategic approach has been further consolidated into actionable regulations with the formulation of the National Solid Waste Management Rules 2021 (GoB 2021).

The core tenets of the 3R strategy manifest diversely across different sectors, contexts, projects, and waste types. In the realm of housing projects, especially within the Dehara Residential Project, the nuances of this strategy require context-specific considerations to derive implementable insights. For this purpose, the consultants have visited the site several times, collected opinions of the current residents and developers to glean understanding on the possible avenues for 3R adoption under a multi-stakeholder setting.

6.1.3 History and Origins of 3R

There is considerable debate on the origins of the “reduce, reuse, recycle” phrase. However, most agree that it dates back to the USA in the 1970s. During the Vietnam War, many Americans became much more environmentally conscious. There was a particular focus on air pollution, water quality, and how waste was handled and disposed of. This growing concern led to three significant events. Firstly, a US senator from Wisconsin, Gaylord Nelson, organized the first Earth Day. This event occurred on 22nd April 1970, which saw as many as

20 million Americans uniting for the environmental cause. Secondly, partly due to the success of the event and the growing clamor for improved environmental practices, the US Environmental Protection Agency (EPA) was formed later in the same year. Finally, in 1976, the Resource Conservation and Recovery Act was passed by the US Congress. It is at this time that many believe the 3Rs - reduce, reuse, recycle - were created.

6.2 Significance 3R Strategy in Bangladesh

Bangladesh faces a confluence of challenges: rapid urbanization, vulnerability to climate change, and the need for sustainable development. The 3R strategy (Reduce, Reuse, Recycle) offers a powerful approach for housing projects to address these issues simultaneously, contributing to climate risk reduction, achieving SDGs (Sustainable Development Goals), and implementing the New Urban Agenda, among other things.

- **Reduced Greenhouse Gas Emissions**

  Construction is a major contributor to global emissions (Anowar et al. 2019). The 3Rs help by:

  - **Reducing resource extraction:** Less virgin material use means less associated mining and processing emissions.
  - **Lowering energy consumption:** Recycling often requires less energy than producing virgin materials.
  - **Promoting energy-efficient designs:** Smaller unit sizes where applicable and natural ventilation/lighting in 3R housing projects can further reduce operational emissions.

- **Resilient Infrastructure**

  By incorporating salvaged or recycled materials that may be more resistant to extreme weather events, housing projects can become more resilient to climate risks like flooding and cyclones. With new entrepreneurial initiatives effective material is being manufactured and used in Bangladesh.

- **SDG Achievements (SDG11): Sustainable Cities and Communities**

  The 3Rs contribute to creating livable and resilient urban environments by:

  - Minimizing waste generation and promoting resource efficiency.
  - Improving air and water quality through reduced waste and pollution.
  - Fostering innovation and green jobs in the construction sector.

- **SDG Achievements (SDG12): Responsible Consumption and Production**

  The 3Rs promote a circular economy, minimizing environmental impact and maximizing resource recovery:

  - Less resource depletion through reduced reliance on virgin materials.
  - Lower energy and water consumption throughout the housing lifecycle.
  - Creation of a market for recycled materials in the construction sector.

- **Inclusive and Sustainable Cities**

  The 3R contribute to New Urban Agenda's vision of inclusive and sustainable cities by:

  - Promoting affordable housing options through potentially lower construction costs with reused materials and efficient designs.
  - Creating healthier living environments with improved waste management and resource efficiency.
  - Encouraging community participation in waste collection and recycling programs.
  - Promotion of recycling of different material can also provide opportunities of participation of urban poor in primary collection and sorting of waste.

Overall, the 3R strategy presents a cost-effective and environmentally friendly approach for Bangladesh's housing sector and with proper incentives private developers will also adopt it with greater interest. By embracing the 3Rs, Bangladesh can create a more sustainable future, mitigate climate risks, and achieve its national development goals.

6.3 Progress, Challenges and Learning of 3R Strategy in Bangladesh

6.3.1 Progress of 3R Adoption

The government of Bangladesh has taken the Sustainable Development Goals (SDGs), as a key reference for development goals in all sectors by taking a multi-pronged approach. Consequently, the idea of circular economy (CE) has become an integral part of policy vocabulary of Bangladesh. Most of the world currently follows a linear economy model that entails take, make and dispose. Contrarily, the CE model is composed of production, consumption and dispose of wastage to recycle it to further production and it is governed primarily by the 3R approach (Ahmed et al. 2022).

With regard to the 3R Bangladesh dwells mostly in the arena of recycling. Implementation some social changes has been observed in the matter of reuse. For instance, re-

commercialization is now more acceptable in Bangladesh and a market for used goods has recently developed (Arman and Marl-Herbert 2021). Ahmed et al (2022) has provided an elaborate description of 3R application status in various sectors in Bangladesh which shows notable progress in 3R implementation in Bangladesh. Yousuf and Reza (2013) has emphasized on a social strategy that shifts the social attitude of waste management to resource management.

6.3.2 Solid Waste and Poverty Reduction

As regards municipal solid waste an extended review was done by Alam and Qiao (2020). They have pointed out that informal sector has played a major role in municipal solid waste management in Bangladesh as in many developing countries. However, they have highlighted that the informal sector needs to be integrated with the formal sector to overcome the unhealthy practices in 3R. Currently 15% of municipal wastes are recycled in urban areas of Bangladesh, leading to a savings of 15.29 MUSD/year. For the city of Dhaka 120,000 urban poor from the informal sector are involved in value chain of the recycling value chain, for other major cities combined the number is 50,000.

6.4 Possibilities of 3R Strategy Application for Housing Projects

Housing projects have their specific characteristics and 3R can be practiced based on principles that are applicable in the context. In the following section application of solid waste management in case of housing project is discussed under 3 headings, namely land development, services and solid waste management. This should be noted here that the following applications are generic and not all of them are necessarily applicable to the current project site.

- **Land Development and Enhancement Strategies**
  - **Smart Planning for Sustainable Land Use:** To optimize land utilization and mitigate the environmental impact of development, strategic land-use planning is essential. This approach includes the design of high-density residential areas that offer shared amenities, thereby reducing the necessity for expansive, individual homes. Within the scope of the present project, a variety of plot sizes are available for purchase and subsequent development. To promote efficient land use, we propose incentivizing plot owners to consider merging their properties. Additionally, the housing company could facilitate collective purchasing agreements, fostering a community-oriented approach to land development.

- **Innovative Construction Techniques:** The construction industry is experiencing a technological revolution, presenting opportunities to adopt smarter, more resource-efficient building methods. Prefabricated components and modular housing designs stand out as promising solutions that can significantly diminish construction-related waste. The adoption of these innovative techniques will be contingent upon the preferences and practices of the plot owners. It is crucial to provide information and incentives that encourage the uptake of these advanced construction methods.
- **Brownfield Redevelopment:** In cases where the project site encompasses previously developed land, known as brownfields, prioritizing their redevelopment can be a sustainable alternative to the use of untouched land. This strategy not only conserves natural habitats but also revitalizes urban spaces, contributing to the community's economic and social fabric.
- **Utilization of Salvaged Materials:** The creative use of salvaged materials from dismantled buildings can add character and sustainability to new construction projects. These materials can be effectively incorporated into landscaping designs or serve as non-structural elements in new homes, reducing the demand for new resources and minimizing waste.
- **Effective Construction Waste Management:** A robust construction waste management plan is vital for the responsible handling of materials throughout the building process. By segregating recyclable materials such as concrete, metal, and wood, and establishing a recycling protocol, the project can significantly reduce its environmental footprint. The success of this initiative depends on a thorough understanding of the local recycling value chain and the development of practical, site-specific waste management solutions.

By embracing these strategies, land development projects can lead the way in sustainable building practices, setting a precedent for responsible growth and environmental stewardship.

Enhanced Services for Sustainable Community Living

- **Promoting Shared Community Amenities:** To foster a sense of community and reduce resource consumption, it is beneficial to encourage the use of shared amenities. Facilities such as community gardens, clubhouses, and guest rooms can serve multiple households, eliminating the need for each home to have its own separate

amenities. This approach not only saves resources but also enhances social interaction among residents.

- **Utilization of Durable Materials:** In the construction of infrastructure and communal areas, the use of durable, low-maintenance materials is crucial. These materials extend the lifespan of community facilities, decrease the frequency of repairs and replacements, and reduce long-term costs and environmental impact. Selecting materials that withstand the test of time contributes to a more sustainable community infrastructure.
- **Establishment of Community Repair Shops:** Community repair shops can play a pivotal role in promoting a culture of reuse and repair. By providing a space where residents can repair appliances, electronics, and furniture, these shops help reduce waste and extend the life of many products. This initiative not only conserves resources but also empowers residents with skills to maintain and repair their belongings, fostering a more resource-conscious community.
- **Implementation of Rainwater Harvesting Systems:** Integrating rainwater harvesting systems within the community can significantly enhance water efficiency. These systems collect rainwater to be reused for irrigation and other non-potable purposes, reducing the demand on municipal water supplies and minimizing the ecological footprint of the community. Effective rainwater management can also play a role in mitigating local flooding and erosion.
- **Development of Comprehensive Recycling Infrastructure:** To facilitate effective waste management, providing accessible recycling bins throughout the community is essential. Additionally, educating residents on proper waste segregation can greatly improve recycling rates. This education should focus on the importance of recycling, the types of materials that can be recycled, and the local recycling procedures. A well-informed community is more likely to engage in sustainable waste management practices.

By integrating these enhanced services, communities can significantly improve their sustainability and quality of life, making them more attractive to residents and environmentally responsible.

Solid Waste Management Strategies

- **Promoting Waste Reduction:** Encouraging residents to minimize waste generation is crucial for sustainable community living. Implementing composting programs, educational initiatives, and providing designated areas for compostable materials can significantly reduce the volume of waste sent to landfills. These efforts not only help in managing waste more effectively but also educate the community on the importance of reducing their environmental footprint.
- **Brownfield Redevelopment:** Utilizing previously developed land, or brownfields, for new projects is a sustainable alternative that avoids the consumption of untouched, virgin land. This approach not only preserves natural resources but also revitalizes underused urban areas, contributing to the economic and environmental health of the community.
- **Utilization of Salvaged Materials:** Incorporating salvaged materials from deconstructed buildings into new construction projects can significantly reduce the demand for new raw materials. These materials can be effectively used for landscaping or as non-structural components in new buildings, promoting recycling and sustainability in construction practices.
- **Comprehensive Composting Programs:** Establishing a robust composting program is essential for reusing organic waste. By turning kitchen scraps and yard waste into compost, communities can enrich local soil, reduce the use of chemical fertilizers, and decrease methane emissions from landfills. Effective composting not only recycles organic waste but also enhances the environmental quality of the community.
- **Community Reuse Programs:** Organizing community swap meets and donation drives can foster a culture of reuse and sharing. These programs allow residents to exchange or donate items they no longer need, reducing waste and promoting a sense of community. Such initiatives are instrumental in extending the life of products and reducing the overall environmental impact of the community.
- **Efficient Solid Waste Treatment Plant (STP):** Ensuring that the community's Solid Waste Treatment Plant (STP) is designed to efficiently sort and recycle materials is fundamental. The STP should have advanced sorting technologies that maximize the recovery of recyclables and organics before the residuals are sent for final processing. This not only improves the efficiency of waste management but also supports the community's sustainability goals.

By implementing these solid waste management strategies, communities can significantly improve their sustainability practices, reduce their environmental impact, and enhance the quality of life for all residents.

6.5 Application of 3R in the Dehara Housing Project Area

To effectively implement the 3R (Reduce, Reuse, Recycle) strategy in the Dehara housing project, it is crucial to understand the overall solid waste generation and its characteristics. This section is structured into three parts: projection of population and waste generation, potential waste characteristics at the project site, and the 3R potential based on these characteristics. It is important to note that waste generation and characteristics can vary significantly by area, and precise predictions of waste generation and composition are challenging. In cases where precise data is unavailable, estimates from similar areas may be utilized.

6.5.1 Population Projection

Like any residential development, the Dehara project will generate both solid and liquid waste. The total waste generated will primarily depend on the projected population. Factors such as the socio-economic profile of the residents, the physical environment, and the local waste management system will also influence waste volumes. The project covers an area of 125.28 acres with a projected population of 44,000, resulting in a density of about 350 people per acre. However, this figure is only an approximation. According to the Private Residential Land Development Rule 2004 (PRLDR), the maximum allowable population density is 350 people per acre. Therefore, the maximum feasible population for this area would be 43,848 individuals. This figure should be used as a conservative benchmark for estimating the worst-case scenario in waste generation. The benchmarks for solid and liquid waste generation per capita are derived from empirical data found in the literature.

6.5.2 Solid Waste Generation

The initial waste generation estimate for the project, as submitted to the Department of Environment (DoE), is 225,000 kg/day, based on a population of 44,000. This equates to approximately 0.5 kg of waste per person per day. However, applying the PRLDR (elaborate) population cap of 43,848, the per capita waste generation adjusts to approximately 0.57 kg/day. According to Habib et al. (2021), a figure of 0.5 kg is a reasonable estimate for municipal waste generation in an urban setting for the year 2025, and a projection of 0.57 kg per capita per day is also considered acceptable. Following the population cap stipulated by the PRLDR

(elaborate), the revised estimate for solid waste generation in the area is approximately 25,000 kg per day.

6.5.3 Potentials of 3R for the Proposed Housing Project

The Dehara housing project, although outside the jurisdiction of major City Corporations, is expected to evolve into an urban area due to its nature. This transition necessitates the application of typical urban waste characteristics for accurate waste generation estimates. To this end, the project utilizes data on solid waste composition from various urban areas in Bangladesh, specifically focusing on wet weight percentages as detailed by Alam & Qiao (2020). This data is crucial for understanding and planning the waste management strategies tailored to the expected conditions at the site.

Waste Composition Analysis

The analysis reveals significant variations in waste composition across different municipalities in Bangladesh. A notable trend is the high proportion of organic waste, which tends to decrease as urban areas expand. This observation is critical for the Dehara project as it transitions into urban status.

Recycling and Composting Potential

The project shows a promising potential for composting, especially with 16,000 kg of organic material expected daily. The proximity to agricultural land enhances the feasibility of marketing the compost produced, providing a sustainable outlet for organic waste. Recycling initiatives can also be significantly effective, given the substantial amounts of paper, plastics, and metals generated.

This systematic approach not only facilitates efficient waste management but also aligns with the 3R principles (Reduce, Reuse, Recycle), aiming to minimize the environmental impact of the project. The data reveals significant variations in waste composition across different Bangladeshi municipalities. Notably, organic waste constitutes a large portion of urban solid waste. However, research suggests that the relative proportion of organic material generally declines as cities grow. This trend is confirmed for Bangladesh in the table below. To account for these compositional variations, we have employed the average composition data to project the amount of different waste types expected at the study area.

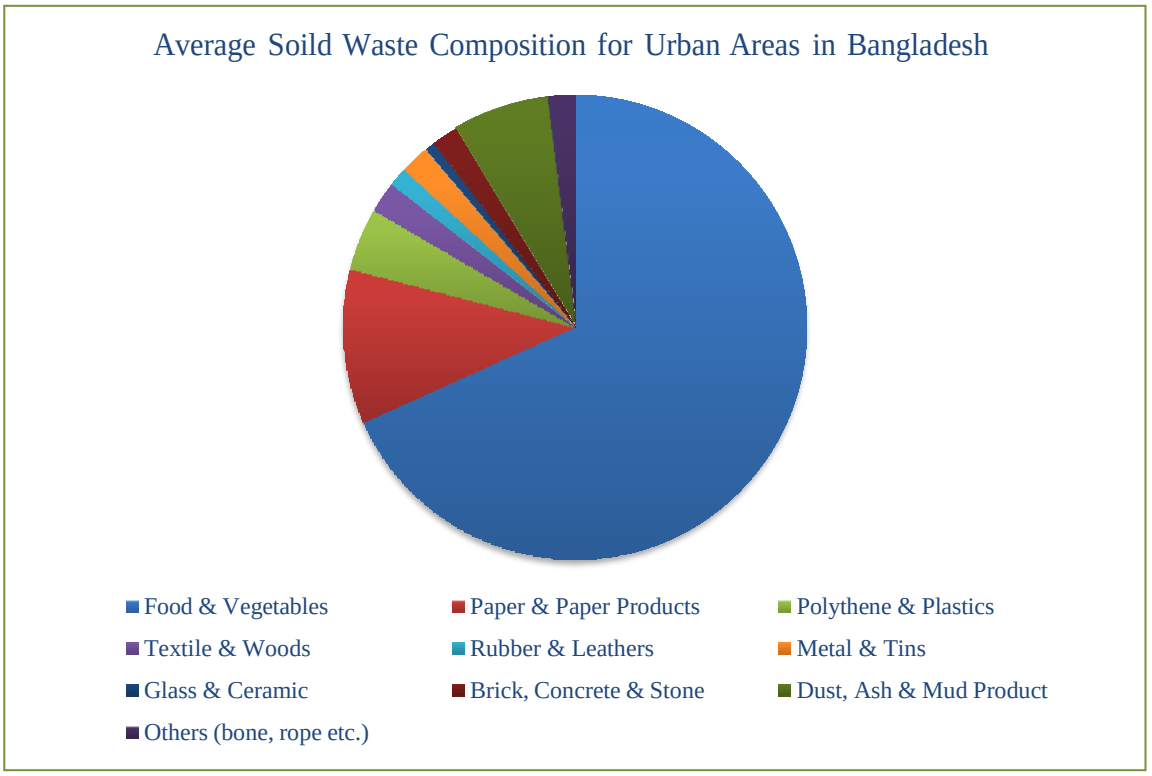


Figure 6.1: Municipal Solid Waste Composition in Bangladesh

Table 6.1: Composition of Municipal Solid Waste for Different Urban Areas in Bangladesh

Composition	Dhaka	Chottagong	Khulna	Rajshahi	Barishal	Sylhet	Average
Food & Vegetables	68.3	73.6	78.9	71.1	81.1	73.8	74.5
Paper & Paper Products	10.7	9.9	9.5	8.9	7.2	8.4	9.1
Polythene & Plastics	4.3	2.8	3.1	4.0	3.5	3.4	3.5
Textile & Woods	2.2	2.1	1.3	1.9	1.9	2.1	1.9
Rubber & Leathers	1.4	1.0	0.5	1.1	0.1	0.6	0.8
Metal & Tins	2.0	2.2	1.1	1.1	1.2	1.1	1.4
Glass & Ceramic	0.7	1.0	0.5	1.1	0.5	0.7	0.8
Brick, Concrete & Stone	1.8	1.1	0.1	2.9	0.1	1.8	1.3
Dust & Mud Product	6.7	5.1	3.7	6.5	3.1	5.3	5.1
Others (bone, rope etc.)	1.9	1.2	1.2	1.3	1.3	2.8	1.6
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**

For 22,000 kg of solid waste one can project the following for each component.

Table 6.2: Projection of Different Types of Waste Generation in the Project Area

Composition	Average (%)	Projected Component for the Proposed Project Site (kg)
Food & Vegetables	74.5	16390
Paper & Paper Products	9.1	2002
Polythene & Plastics	3.5	770
Textile & Woods	1.9	418
Rubber & Leathers	0.8	176
Metal & Tins	1.4	308
Glass & Ceramic	0.8	176
Brick, Concrete & Stone	1.3	286
Dust & Mud Product	5.1	1122
Others (bone, rope etc.)	1.6	352
Total	**100**	**22,000**

Figure 6.2: Paper Recycle Equipment in a Pulp Factory in Bangladesh

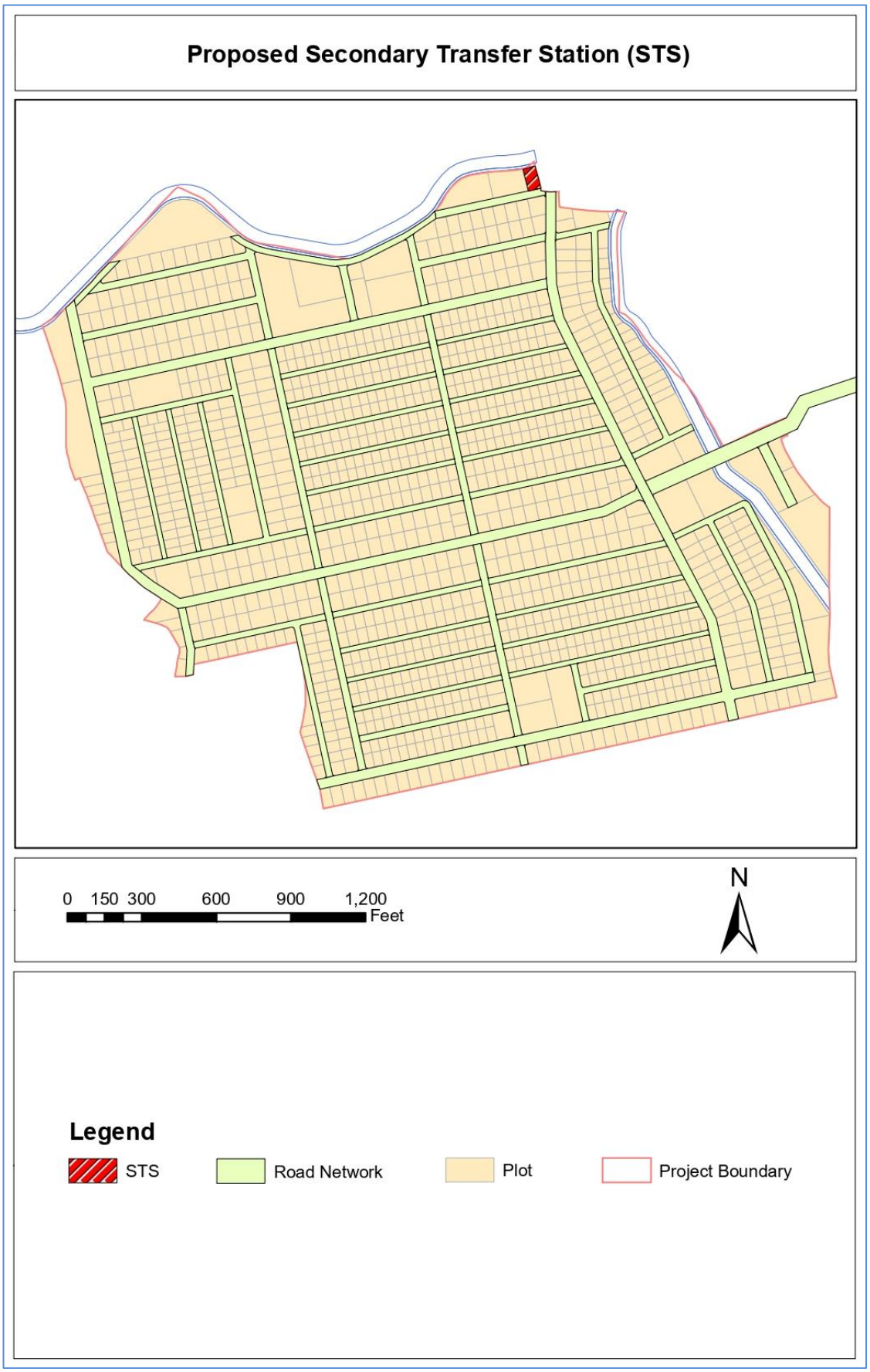
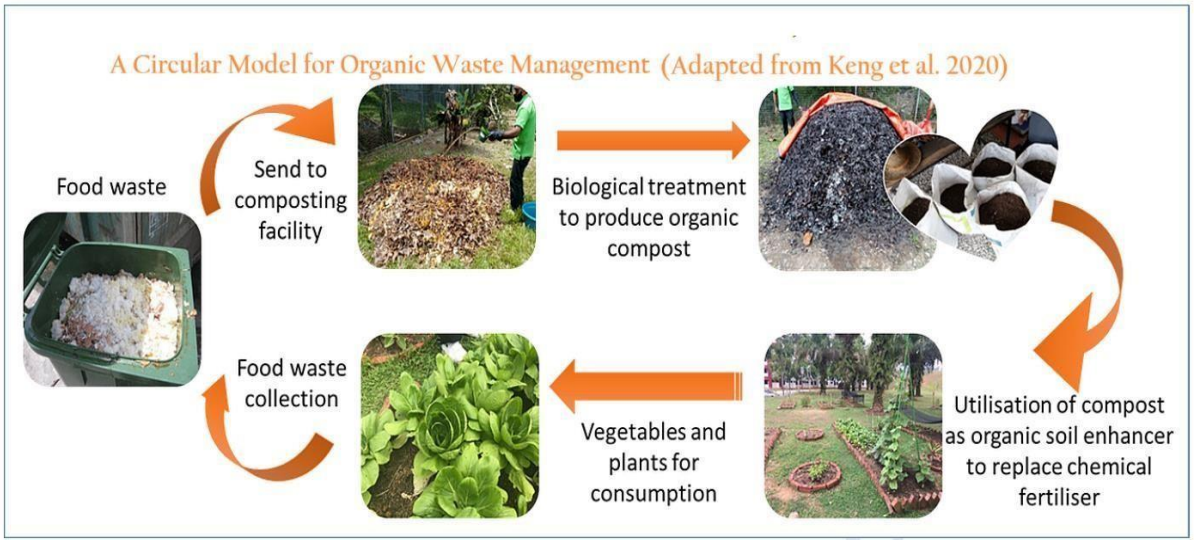


Figure 6.3: Location of Secondary Transfer Station for Dehara Project

Currently the recycling industry is expanding rapidly in the world and Bangladesh has also registred significant developmet in the recycling industry development. Specially, reclycling of plastic bottles, RMG waste, paper waste and metal waste has seen some improvement with time. With 16,000 kg of organic material this project site shows bright prospect for composting. Also due to agricultural land in the proximity of the study area this is very likely that the project area will also have good market for compost manure in the vicinity making if feasible.



In this project, solid waste will be collected from each house in separate containers. After that, they will be brought to Secondary Transfer Station. There will be 3 types of baskets:

- Organic waste will be kept in the first basket. which will later be made into compost and sold to neighboring farmers and nurseries.
- Hazard waste will be thrown in the second basket. These should be transferred separately from the second transfer station to the municipal garbage van with extra care.
- The remaining solid waste will be kept in the third basket and this waste will also be handed over to the municipality for recycling.

6.5.4 Recommended 3R Related Strategies for the Site

To effectively implement the 3R (Reduce, Reuse, Recycle) strategy at the Dehara housing project, several strategic approaches are recommended. These strategies are designed to leverage policy support, local government collaboration, integration with the waste value chain, and the promotion of composting practices.

- **Challenges and policy support:** Successful implementation of 3R strategies often relies heavily on supportive public policies. In instances where project authorities and

developers face limitations in enforcing these strategies, it becomes imperative for public policy interventions to ensure that these environmental imperatives are effectively implemented. This support can facilitate the necessary legislative and financial frameworks to foster sustainable waste management practices.

- **Collaboration with Local Government:** The role of local government is pivotal in the transition from project completion to operational phase. Effective collaboration can provide significant leverage in implementing and sustaining 3R practices. For example, the majority of waste collected at the project's secondary transfer station will require relocation to final disposal sites, such as landfills or recycling centers, with robust support from municipal services. This partnership is crucial for the seamless management of waste logistics and infrastructure.
- **Connecting with the waste value chain:** It is essential to integrate the waste generated from the housing project with the existing urban waste value chain. Materials such as paper, metal, glass, textiles, and wood already have established recycling pathways in urban areas of Bangladesh. Ensuring that these materials are collected efficiently, possibly through door-to-door collection by hawkers, will help in maintaining a sustainable cycle of reuse and recycling. This connection not only supports recycling efforts but also stimulates local economies and emerging markets related to waste management.
- **Encourage Composting:** Given the significant amount of organic waste anticipated from the project (approximately 16,000 kg per day), there is a substantial opportunity to implement on-site composting. Establishing a dedicated area for composting within the project site will allow for the centralized collection of organic materials, which can then be processed into valuable compost for agricultural use. For this initiative to be successful, it is crucial to foster cooperation between the housing society, residents, and private sector operators. This collaborative effort can transform composting into a viable and profitable business model, enhancing the project's sustainability.
- **Long-term Sustainability:** The project’s waste composition and the strategies outlined above suggest that there is a strong foundation for sustainable waste management. By adopting these 3R strategies, the housing project can significantly reduce its environmental impact and contribute to a more sustainable future for its residents. The success of these initiatives depends on continuous collaboration among all stakeholders involved, including residents, private companies, and local government bodies.

CHAPTER 7
SEWAGE TREATMENT PLANT (STP)

7.1 Sewage Treatment Process

Sewage, a complex mixture primarily consisting of human fecal material, domestic waste (including wash-water) and industrial effluents, poses a significant environmental challenge. The escalating pollution levels necessitate the decontamination of wastewater, which in turn requires a comprehensive understanding of its characteristics, particularly when it comes to human excreta-related domestic sewage. The **Table 7.1** provides an overview of the sewage generation for treatment in a specific coverage area, detailing the per capita water consumption, the breakdown of sewage types, and the total volume of sewage requiring treatment.

Table 7.1: Estimation of Sewage Capacity for Treatment

Projected Population	Per Capita Water Consumption per Day	Sewage Flow	Total Sewage Generation for Treatment
44,000	135 lpcd	80% of supplied water	4752 m^3/day

Source: Consultant's Estimate

In the past, domestic waste water treatment was mainly confined to organic carbon removal. Recently, increasing pollution in the waste water leads to developing and implementing new treatment techniques to control nitrogen and other priority pollutants. Sewage Treatment Plant is a facility designed to receive the waste from domestic, commercial and industrial sources and to remove materials that damage water quality and compromise public health and safety when discharged into water receiving systems. Various aspects of sewage treatment and and its characteristics are described bellow:

Odor: It depends on the substances which arouse human receptor cells on coming in contact with them. Thus, sewage water which contains toxic substances has pungent smell which makes it easy to distinguish.

Taste: The sense of taste result mainly from chemical stimulation of sensory nerve endings in tongue. Fundamental sensations of taste are, by research evidence, salt, sweet, bitter, and sour.

Color: Color in water results from the presence of natural metallic ions such as - Fe or Mg, humus and peat materials, planktons and weeds. It is removed to make water suitable for

general and industrial applications. After turbidity is removed the apparent color and that due to suspended matter is found out.

Total Solids: It refers to matters suspended or dissolved in water and waste water. Solids affect the water or effluent quality adversely in a number of ways. Water with highly dissolved solids are not palatable and may cause physiological reaction in transient consumer. A limit of 500 mg dissolved solids/L is desirable for drinking waters.

Floatables: One important criterion for evaluating the possible effect of waste disposal into surface water is the amount of floatable material in the waste. Two general types of floating matters are found: (i) Particulate matters like 'grease balls', (ii) Liquid component capable of spreading as thin visible film over large areas. It is important because it accumulates on the surface and may contain Pathogenic bacteria and viruses.

Turbidity: Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample. The standard method for determination of turbidity has been based on the Jackson candle turbidimeter and Nephlometer.

Chemical Characteristics of Sewage: Chemical characteristics of water state the presence of metals their treatment, the determination of inorganic non-metallic constituents and the determination of organic constituents.

Biological Characteristic of Sewage: Water quality has a key role in deciding the abundance, species composition, stability, productivity and physiological condition of indigenous populations of aquatic communities. Their existence is an expression of the quality of the water. Biological methods used for evaluating water quality include the collection, counting and identification of aquatic organisms. Most microorganisms known to microbiologists can be found in domestic wastewater like Bacteria, Protozoa, Viruses, and Algae. Planktons, Periphyton, Macro-python, Macro-invertebrates, Fish, Amphibians and Aquatic reptiles are the biotic group of interdependent Organism. Wastewater contains vast quantities of bacteria and other organisms. Aerobic bacteria break down organic matter in the presence of available oxygen.

7.2 Laboratory Analysis Techniques of Collected Sewage

7.2.1 Measurement of pH Value

The pH value is a critical parameter in assessing the quality of water and wastewater. It is defined as the negative logarithm of the hydrogen ion (H^+) concentration in a solution. The pH scale typically ranges from 0 to 14, with 7 being neutral. Values below 7 indicate acidity, while values above 7 indicate alkalinity.

Variability of pH in Water Samples

In wastewater samples, the pH can vary between 6 and 8 due to the hydrolysis of salts derived from acids and bases. The presence of dissolved gases such as carbon dioxide (CO_2), hydrogen sulfide (H_2S), and ammonia (NH_3) can also influence the pH value. Alkaline springs may exhibit pH values higher than 9, whereas acidic springs can have pH values of 4 or even lower.

Factors Affecting pH Measurement in the Laboratory

The pH of a water sample can change during laboratory analysis due to several factors, including:

- Reduced gas absorption when the sample is removed from its natural environment.
- Reactions with sediments present in the sample.
- Chemical reactions occurring within the sample container.

To minimize these effects, it is recommended to measure the pH at the time of sample collection.

Methods of pH Determination

There are two primary methods for determining pH:

- **Electrometric Method:** This is a more accurate technique that involves specialized equipment. It measures the electromotive force (EMF) generated by the reaction of hydrogen ions with an indicator electrode, such as a glass electrode.
- **Colorimetric Method:** This simpler method uses less expensive equipment and is sufficiently accurate for routine analysis. It involves the use of pH indicators that change color based on the pH of the solution.

Principle of Electrometric pH Measurement

The electrometric method is based on the measurement of the EMF of a cell composed of an indicator electrode sensitive to hydrogen ions and a reference electrode, typically a mercury or calomel electrode. The EMF is measured using a pH meter, which is essentially a high impedance voltmeter calibrated in pH units.

Electrode Systems

- Glass Electrode: This is commonly used in conjunction with a calomel electrode. The glass electrode operates on the principle that a change of one pH unit results in an electrical change of approximately 59.1 millivolts (mV) at 25°C.
- Hydrogen Gas Electrode: This is considered the primary standard for pH measurement.
- Calomel Electrode: Provides a stable reference potential.

Apparatus Required

pH Meter: Equipped with a glass and reference electrode, preferably with temperature compensation.

Thermometer: With a minimum resolution of 0.5°C.

Procedure for pH Measurement

- Standardization: Warm up the pH meter as required and standardize it using a buffer solution close to the expected pH of the sample.
- Calibration: Check the electrode against at least one additional buffer solution of a different pH value.
- Temperature Measurement: Record the temperature of the water sample. If the pH meter has temperature compensation, adjust it accordingly.
- Preparation of Electrodes: Rinse and gently wipe the electrodes with a solution to clean them.
- Sample Immersion: Immerse the electrodes in the sample beaker or directly in the sample stream. Stir the sample at a constant rate to ensure homogeneity and to keep solids in suspension.
- Observation: Minimize the stirring rate and note the air transfer rate at the air-water interface. Record the pH and temperature of the sample periodically.

By following this detailed procedure, accurate and reliable pH measurements can be obtained, which are essential for water quality analysis and treatment processes.

7.2.2 Measurement of Alkanity

The measurement of alkalinity in a liquid sample is a critical process in various scientific and industrial applications. It involves analyzing the sample's capacity to neutralize acids, which is essential in understanding water chemistry, wastewater treatment, and environmental

monitoring. The following sections detail the preparation, apparatus, reagents, procedure, and calculations involved in measuring alkalinity.

Preparation of Sample

Before proceeding with the analysis, ensure that the liquid sample is clear of any turbidity. If the sample is turbid, allow it to settle until it becomes clear. This step is crucial for obtaining accurate measurements.

Apparatus Required: For the analysis, we will need the following equipment:

- pH Meter: To measure the pH of the sample accurately.
- Burette (50-ml capacity): For titrating the sample with the acid solution.
- Magnetic Stirrer Assembly: To ensure uniform mixing of the sample during titration.

Reagents Used: The following reagents are necessary for the analysis:

- Distilled Water: Ensure the pH is above 6.0. If the pH is below 6.0, boil the water for 15 minutes and cool it to room temperature before use.
- Sulphuric Acid: Prepare by diluting 5.6 ml of concentrated sulphuric acid in one liter of distilled water.
- Standard Solution of Sulphuric Acid (0.02 N): For titration.
- Phenolphthalein Indicator: Dissolve 0.5 g of phenolphthalein in a 100 ml mixture of alcohol and water (1:1 v/v).
- Mixed Indicator Solution: Dissolve 0.02 g of methyl red and 0.01 g of bromocresol green in 100 ml of 35% ethyl or isopropyl alcohol.

Procedure

- Sample Preparation: Pipette 20 ml of the sample into a 100-ml beaker.
- Initial Titration: Add 2 to 3 drops of Phenolphthalein indicator to the sample if its pH is above 8.3. Titrate with the standard H2SO4 solution until the pink color disappears, indicating an equivalence pH of 8.3. Record the volume of H2SO4 used.
- Secondary Titration: Add 2 to 3 drops of the mixed indicator to the solution. Continue titration with the standard acid until a light pink color is achieved, corresponding to a pH range of 3-7. Record the volume of standard acid used after determining the Phenolphthalein alkalinity.

Calculation

To calculate the alkalinity of the sample, we use the following formula:

Total alkalinity (as mg/l $CaCO_3$) = (A + B) x N x 5000V

Where:

A = ml of standard H_2SO_4 used to titrate to pH 8.3,

B = ml of standard H_2SO_4 used to titrate from pH 8.3 to pH 3.7,

N = normality of the acid used, and

V = volume in ml of the sample taken for the test.

This calculation will provide the total alkalinity of the sample expressed as mg/l of $CaCO_3$, which is a standard measure for reporting water alkalinity. By following these detailed steps, we can accurately measure the alkalinity of a liquid sample, providing valuable information for various applications in water treatment, environmental science, and industrial processes.

7.2.3 Determination of Turbidity

Turbidity is a measure of the cloudiness or haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in the air. The measurement of turbidity is a key test of water quality.

Principle of Measurement

The determination of turbidity is based on the comparison of light scattering between a sample and a standard reference suspension. When light passes through a turbid sample, particles in the suspension scatter the light in different directions. The intensity of this scattered light is proportional to the turbidity of the sample. A standard reference, typically a Formalin polymer suspension, is used due to its reproducibility and stability. The turbidity of a known concentration of this suspension is defined as 40 Jackson Turbidity Units (JTU). Measurements taken with a Jackson candle turbidimeter are used as a benchmark, although results may not always be identical due to variations in the method or instrument used.

Apparatus

- Sample Tubes: These should be made of clear, colorless glass to avoid any interference with the light passing through the sample.
- Turbidimeter: An instrument designed to measure the turbidity of a sample by detecting the intensity of light scattered by particles suspended in it.

Reagents

- Turbidity-Free Water: Water that has been filtered or treated to remove any particles, ensuring it does not contribute to the turbidity reading.
- Hexamethylene Tetramine Solution: A chemical reagent used in the preparation of the turbidity standard.

- Hydrazine Sulphate Solution: Another reagent used in the preparation of the turbidity standard.
- Turbidity Standard Suspension I (Formalin): A suspension of Formalin polymer used as the primary standard for calibrating the turbidimeter.
- Turbidity Standard Suspension II: An alternative or secondary standard suspension for calibration purposes.

Procedure

- Calibration Check: Measure the standards on the turbidimeter to verify the range of interest and check the accuracy of the instrument's calibration.
- Samples with Turbidity Less Than 40 Units: Shake the sample to disperse solids and allow air bubbles to dissipate. Pour the sample into the turbidimeter tube and read the turbidity value directly from the instrument's scale.
- Samples with Turbidity Greater Than 40 Units: Dilute the sample with turbidity-free water until the turbidity falls within the measurable range of the instrument. Take readings of the diluted sample and then calculate the turbidity of the original sample using the dilution factor.

Calculation

To determine the turbidity of the original sample from the diluted sample, use the following formula:

Turbidity units = A x (B + C)/C

Where:

A = Turbidity units found in the diluted sample

B = Volume in milliliters (ml) of dilution water used

C = Volume of the sample in milliliters (ml) taken for dilution

This calculation allows for the determination of the turbidity of the original undiluted sample by accounting for the dilution factor. It is essential to ensure that all measurements are accurate and that the turbidimeter is properly calibrated to obtain reliable results.

7.2.4 Determination of Acidity in Water

The acidity of water is a critical parameter in environmental chemistry, reflecting the water's ability to neutralize alkaline substances. It is quantitatively expressed as the capacity of water to react with a strong base until a specific pH level is reached. This capacity can be measured as the equivalent concentration of hydrogen ions present in the water, typically expressed in

milligrams per liter (mg/L). The fundamental reaction underlying this process is the neutralization of hydrogen ions by sodium hydroxide, represented by the equation:

$H^+ + NaOH = H_2O + Na^+$

Apparatus - To conduct the acidity determination, the following equipment is necessary:

pH Meter: For measuring the pH of the water sample.

Burette (50-ml capacity): For the precise delivery of titrant.

Magnetic Stirring Device: To ensure uniform mixing of the sample during titration.

Reagents - The chemical reagents used in this procedure include:

Distilled Water: As the solvent for preparing solutions.

Potassium Acid Phthalate: Used for standardizing the sodium hydroxide solution.

Sodium Hydroxide Solution (0.15 N): The titrant for acidity determination.

Sodium hydroxide solution - 1 N 67 ml of 15 N NaOH solution is diluted to one liter with distilled water.

Sodium hydroxide solution - 0.02 N 20 ml of 1 N NaOH solution is diluted to one liter and is standardized using standard potassium acid phthalate.

Phenolphthalein Indicator - 0.5 g of phenolphthalein is dissolved in 100 ml 1: 1 (v/v) alcohol water mixture and 0.02 N NaOH solution is added drop by drop till slight pink color is observed.

Methyl Orange Indicator - 0.5 g of methyl orange is dissolved in distilled water and made up to 100 ml in a volumetric flask.

Procedure

Indicator Method

Sample Preparation: Pipette 20 ml of the water sample into a 100 ml beaker. Ensure the volume of the titrant required for titration does not exceed 20 ml.

pH Measurement: Determine the initial pH of the water. If the pH is below 3.7, proceed with methyl orange titration; otherwise, use phenolphthalein.

Methyl Orange Titration: For samples with pH < 3.7, add two drops of methyl orange to the beaker and titrate with 0.02 N NaOH until a faint orange color is achieved. Record the volume of NaOH used.

Phenolphthalein Titration: Add 2 to 3 drops of phenolphthalein to a second sample and titrate with 0.02 N NaOH until a faint pink color appears. Record the volume of NaOH used.

Potentiometric Method

Sample Preparation: Similar to the indicator method, start with 20 ml of the sample in a 100 ml beaker.

Titration: Titrate the sample with standard NaOH solution to pH levels of 3.7 and 8.3, respectively, measuring the volume of NaOH used for each endpoint. No indicator is required for this method.

Calculation

The acidity of the sample, expressed in mg/L as CaCO3, is calculated for both pH 3.7 and pH 8.3 using the formulas:

Acidity at pH 3.7, as mg/l $CaCO_3$ = A x N x 50000/V

Acidity at pH 8.3, as mg/l $CaCO_3$ = B x N x 50000/V

Where,

A = volume in ml of standard sodium hydroxide

N = normality of standard sodium hydroxide,

V = volume in ml of sample taken for test, and

B = volume in ml of standard sodium hydroxide used to titrate to pH 3.7 used to titrate to pH 8.3.

This comprehensive approach allows for the accurate determination of water acidity, which is essential for assessing water quality and its suitability for various uses.

7.2.5 Measurement Chloride

The measurement of chloride involves a titration process where chloride ions react with mercuric nitrate to form a slightly soluble and dissociated mercuric chloride. The endpoint of this titration is detected by the use of an indicator, Diphenyl Carbazone, which forms a purple complex with excess mercuric ions within a specific pH range.

Apparatus - To perform the measurement, the following laboratory equipment is required:

- Erlenmeyer Flask: A 250 ml capacity flask is used to contain the sample during titration.
- Microburette: A 5 ml microburette with graduations at 0.01 ml intervals is used for precise measurement of the titrant.

Reagents - The following reagents are necessary for the chloride measurement procedure:

- Standard Sodium Chloride Solution: A solution of known chloride concentration for calibration purposes.
- Nitric Acid (0.1 N): Used to adjust the pH of the sample.

- Sodium Hydroxide (0.1 N): Also used for pH adjustment.

Reagents for Chloride Concentrations Below 700 mg/l: Specific reagents may be required for low-concentration chloride samples.

Indicator-Acidifier Reagent: The concentration of nitric acid in this reagent is critical for the success of the determination. It can be adjusted according to the alkalinity range of the sample. Reagent (a) is formulated to neutralize a total alkalinity equivalent to 150 mg of CaCO3 per liter to the appropriate pH in a 100 ml sample.

Procedure

- Sample Preparation: Take a 100 ml sample ensuring the chloride content is less than 10 mg.
- pH Adjustment: If dealing with highly alkaline or acidic waters, adjust the pH to about 8 before proceeding.
- Indicator Addition: Add 1.0 ml of the indicator-acidifier reagent to the sample.
- Titration: Titrate the sample with 0.411 N Mercuric Nitrate until a distinct purple endpoint is observed. The color change will transition from green-blue to blue just before reaching the endpoint.
- Blank Determination: Conduct a blank titration using 100 ml of distilled water with 10 mg of sodium bicarbonate added. This is necessary to account for any reagent impurities or apparatus contamination.

Calculation

To calculate the chloride concentration in mg/l, use the following formula:

Chloride, mg/l = (V1-V2) x N x35450 V3

Where,

V1 = volume in ml of silver nitrate used by the sample,

V2 = volume in ml of silver nitrate used in the blank titration,

V3 = volume in ml of sample taken for titration and

N = normality of silver nitrate solution.

- It is important to conduct the titration within the pH range of 2.3 to 2.8 to ensure the proper function of the Diphenyl Carbazone indicator.
- The precision of the titration is dependent on the accurate calibration of the microburette and the correct preparation of the reagents.

- Safety precautions should be taken when handling mercuric nitrate and nitric acid, as they are hazardous chemicals. Use appropriate personal protective equipment and work in a well-ventilated area.

7.2.6 Determination of Total Solids

The process of determining total solids in a sample involves evaporating the sample in a controlled environment and measuring the residue left behind. This method is crucial for assessing the solid content in various samples, particularly in water and wastewater analysis. The procedure ensures accuracy by drying the sample to a constant mass at specific temperatures. Notably, drying samples at higher temperatures (179-181°C) often yields results that align more closely with the sum of individually determined mineral salts.

Apparatus Required

- Evaporating Dish: A container used to hold the sample during the evaporation process.
- Steam-Bath: A device that provides a consistent source of steam, used to gently evaporate the sample.
- Drying Oven: An oven capable of maintaining precise temperatures, used to dry the sample to a constant mass.
- Desiccators: A sealed container used to cool and store samples in a moisture-free environment.
- Analytical Balance: A high-precision scale used to measure the mass of the sample before and after the drying process.

Procedure

- Preparation of the Evaporating Dish:
    - Heat a clean evaporating dish to 180°C for 1 hour to ensure it is completely dry and free of contaminants.
    - Allow the dish to cool in a desiccator to prevent moisture absorption, then weigh it using an analytical balance. Store the dish in the desiccator until ready for use.
- Sample Selection:
    - Choose a sample volume that will result in a residue between 25 and 250 mg, ideally aiming for 190 to 200 mg. This volume can be estimated based on specific conductance values.

- If necessary, add successive aliquots of the sample to the dish to achieve a measurable residue.

- Evaporation and Drying:
  - Transfer the selected volume of the sample into the pre-weighed evaporating dish using a pipette.
  - Place the dish on a steam-bath to gently evaporate the water. If preferred, a drying oven set to a lower temperature (around 98°C) can be used to prevent boiling and splattering.
  - After complete evaporation, transfer the dish to a drying oven set at either 103-105°C or 179-181°C. Dry the sample to a constant mass, ensuring that the difference in successive weighings is less than 0.5 mg. For efficiency, drying for a predetermined duration (typically 1 to 2 hours) can be employed, especially when handling multiple samples of a similar type. The optimal drying time may be established through trial with a given sample type.
- Weighing the Residue:
  - Once the drying process is complete and the dish has cooled in a desiccator, weigh it promptly. It is crucial to minimize the time the residue is exposed to air, as some residues are hygroscopic and may absorb moisture, potentially from the desiccant if it is not completely dry.

This method is a standard procedure for determining the total solids content in samples. It is essential for ensuring the accuracy and reliability of the results that all steps are followed meticulously, and that the apparatus used are properly calibrated and maintained.

7.2.7 Measurement of Dissolved Oxygen

Apparatus Used

To accurately measure the dissolved oxygen (DO) levels in a water sample, the following equipment is required:

- Incubation Bottles: These specialized bottles are designed to hold water samples during the incubation period, ensuring that the temperature remains consistent and no additional oxygen enters the sample.
- DO Meter: A digital or analog device that measures the concentration of oxygen dissolved in a water sample.

- Air Incubator: An apparatus that maintains a constant temperature environment for the incubation bottles, which is crucial for precise DO measurements.
- Magnetic Stirrer: A device used to create a homogenous water sample by continuously stirring the water inside the incubation bottle.

Procedure

The procedure for measuring dissolved oxygen with the aforementioned apparatus is as follows:

- Sample Preparation: Begin by placing the water sample into the incubation bottle. Ensure that the bottle is clean and free from any contaminants that could affect the DO readings.
- Incubation: Place the incubation bottle with the water sample into the air incubator. Set the incubator to the desired temperature, which should be consistent with the natural temperature of the water source to maintain ecological relevance.
- Stirring: Introduce the magnetic stirrer into the incubation bottle. This will ensure that the oxygen is evenly distributed throughout the water sample, providing more accurate readings.
- Measurement: Turn on the magnetic stirrer to begin the stirring process. Allow it to rotate continuously to maintain a homogenous mixture within the bottle.
- DO Meter Calibration: Before taking measurements, calibrate the DO meter according to the manufacturer's instructions to ensure accuracy.
- Taking Readings: With the DO meter, take three separate readings at different depths within the bottle:
    - The first reading at the bottom of the bottle to measure the oxygen concentration at the lowest point.
    - The second reading at the mid-point to gauge the average oxygen levels within the sample.
    - The third reading at the top to determine the oxygen concentration near the surface.
- Calculating the Average: After recording all three readings, calculate the average of these values. This average represents the overall dissolved oxygen concentration in the water sample.

The average dissolved oxygen reading obtained from the three different depths provides a comprehensive understanding of the oxygen levels within the water sample. This information is crucial for assessing the water quality and can be used to infer the health of aquatic

ecosystems, as well as the potential for aerobic biological activity. It is important to note that all measurements should be taken promptly and carefully to prevent any changes in the water sample that could affect the DO levels.

7.2.8 Measurement of Biochemical Oxygen Demand (BOD)

The Biochemical Oxygen Demand (BOD) test is an essential analytical procedure used to assess the level of biodegradable organic matter present in water. It is a critical parameter for evaluating water quality, particularly in the context of wastewater treatment and environmental monitoring. The BOD test measures the amount of dissolved oxygen (DO) that aerobic microorganisms consume as they decompose organic matter in a water sample under controlled conditions.

Standard Test Conditions

The standard method for BOD testing involves incubating a water sample in a sealed, dark environment at a specified temperature for a predetermined period. This process allows for the biological activity to occur without interference from external factors such as light, which could promote photosynthesis and artificially increase the DO levels.

Apparatus Used

- Incubation Bottles
  - Description: Incubation bottles typically have a 300 ml capacity and feature a narrow neck with an even mouth, complemented by ground glass stoppers to ensure an airtight seal.
  - Preparation: New bottles are thoroughly cleaned with 5 N hydrochloric acid or sulfuric acid and then rinsed with distilled water to remove any contaminants. For routine use, bottles previously employed in Winkler's method should be rinsed with tap water followed by distilled water.
  - Maintenance: During incubation, water is periodically added to the flared mouth of the bottle to maintain the seal and prevent oxygen ingress.
- Air Incubator
  - Temperature Control: The air incubator maintains a constant temperature of 27°C ± 1°C, which is thermostatically controlled.
  - Light Exclusion: The incubator is designed to exclude light to prevent photosynthetic production of oxygen, which could skew the BOD results.

Procedure

- Sample Preparation: Water samples are placed into the incubation bottles, ensuring they are filled to the appropriate level.
- Addition of Reagents: Approximately 4 grams of sodium hydroxide (NaOH) are placed at the neck of each bottle to absorb any carbon dioxide produced during the test.
- Stirring: A magnetic stirrer is placed inside the bottle to ensure continuous and uniform mixing of the sample.
- Sealing and Measurement: Special caps equipped with an electronic meter are used to seal the bottles airtight. These caps allow for direct recording of BOD readings at 24-hour intervals.
- Incubation: The sealed bottles are then placed in the incubator for the duration required by the study, which could be for a standard BOD test of 3 days (BOD3) or 5 days (BOD5), depending on the regulatory requirements or study objectives.
- Monitoring: Throughout the incubation period, BOD readings are monitored and recorded to assess the oxygen demand of the sample.
- The BOD test is a vital tool for determining the potential impact of wastewater on the aquatic environment. By measuring the oxygen consumption of microorganisms in the presence of organic matter, it provides an indirect indication of the organic pollution level in the water. Proper execution of the BOD test, with careful attention to the preparation and maintenance of equipment and adherence to the procedure, is crucial for obtaining accurate and reliable results.

7.2.9 Determination of Hardness

The determination of water hardness is a critical process in water quality analysis, primarily focusing on the concentration of calcium and magnesium ions, which are the main contributors to hardness. This method utilizes the chelating properties of ethylenediamine tetraacetic acid (EDTA) or its disodium salt to form stable complexes with these ions. The process is visually monitored using a colorimetric indicator, Eriochrome Black T (EBT), which facilitates the identification of the endpoint of the titration.

The method is based on the ability of EDTA or its disodium salt to chelate or form stable complexes with calcium and magnesium ions present in the water sample. The addition of Eriochrome Black T (EBT) dye to the solution containing these ions results in the formation of a wine-red complex at a pH of 10.0. This complex is then titrated with a standard solution of

the disodium salt of EDTA. The EDTA effectively competes with the dye for calcium and magnesium ions, gradually freeing the dye and reverting it to its original blue color. This color change indicates the endpoint of the titration, allowing for the quantification of calcium and magnesium ions, which are collectively measured as the hardness of the water.

The reagents used are:

- Buffer Solution: A mixture of ammonium chloride (NH4Cl) and ammonium hydroxide (NH_4OH).
- Standard Calcium Solution: A solution with a known concentration of calcium ions.
- Eriochrome Black T Indicator Solution: A solution of the dye used as the endpoint indicator.
- Inhibitors: Various substances used to prevent interference from other metal ions.
    - Hydroxylamine Hydrochloride Solution
    - Potassium Ferrocyanide Crystals
    - Sodium Sulphide Inhibitor
    - Sodium Cyanide Solution
- Standard EDTA Solution: A solution with a known concentration of EDTA, used for titration.

Procedure

For Drinking, Surface, and Saline Waters

- Pipette 25.0 ml of the standard calcium solution into a porcelain basin and adjust the volume to 50 ml with distilled water.
- Add 1 ml of the buffer solution and 1 to 2 drops of the Eriochrome Black T indicator solution.
- Stir continuously until the reddish tinge disappears.
- Titrate with the standard EDTA solution, adding it dropwise at 3 to 5-second intervals, while stirring.
- The endpoint is reached when the solution turns a clear sky blue.
- For Waste Waters and Highly Polluted Waters.
- Digest an aliquot of the sample with 3 ml of concentrated nitric acid (HNO_3) on a hot plate, evaporating to near dryness without boiling.
- Repeat the digestion until the digestate is light in color.
- Add 5 ml of 1:1 hydrochloric acid (HCl) and warm on a steam bath to dissolve the residue.

- Adjust the volume to approximately 50 ml, add 1 ml of hydroxylamine hydrochloride, and 2 ml of buffer solution to achieve a pH of 10.0 to 10.1.
- If necessary, add 2 ml of sodium cyanide or sodium sulphide inhibitor to sharpen the endpoint.
- Add 2 ml of Eriochrome Black T indicator solution and titrate with the standard EDTA solution until the solution turns clear sky blue.

Notes

- For Low Hardness Water: Use a micro burette for water samples with hardness less than 5 mg/l.
- Sample Size: Select a sample size that yields a result between 200 to 300 mg/l of hardness (as $CaCO_3$).

Calculation

The total hardness of the water, expressed as mg/l of CaCO3, is calculated using the formula:

Total hardness (as $CaCO_3$), mg/l = 1000V1/V2

Where:

V1 = Volume in ml of the EDTA standard solution used in the titration.

V2 = Volume in ml of the sample taken for the test.

This method provides a reliable and accurate measure of water hardness, essential for various applications, including water treatment and quality control.

7.2.10 Determination of Carbonates and Bicarbonates in Wastewater

The titrimetric method, specifically potentiometric titration, is a precise analytical procedure employed to quantify the concentrations of carbonates ($CO3^-$) and bicarbonates ($HCO3^-$) in wastewater. This method is crucial due to the significant presence of these ions in wastewater, which can affect water quality and treatment processes. The procedure involves the use of specific indicators and titration with standard acid solutions to determine the total alkalinity, which is then used to calculate the concentrations of carbonates and bicarbonates.

Apparatus Required

- Electrometric Titrator: For precise measurement of the titration endpoint.
- Titration Vessel: To contain the sample during titration.
- Magnetic Stirrer: Ensures uniform mixing of the sample with the titrant.
- Pipettes, Volumetric: For accurate measurement of liquid volumes.
- Flasks, Volumetric: Used for preparing and diluting solutions to known volumes.

- Burettes, Borosilicate Glass: For dispensing the titrant.
- Polyolefin Bottles: For storing reagents and samples.

Reagents Used

- Sodium Carbonate Solution: Approximately 0.05 N, used as a standard for titration.
- Standard Hydrochloric Acid: Available in 0.1 N and 0.02 N concentrations for titration.
- Indicators: Methyl Orange/Bromocresol Green and Metacresol Purple/Phenolphthalein solutions for endpoint determination.

Procedure

The determination of carbonate and bicarbonate concentrations in wastewater is not straightforward due to the variable sample sizes and titrant normalities required by differing alkalinity levels. The procedure is adapted based on the alkalinity of the sample, measured as mg of $CaCO_3$ per liter.

- Sample Preparation: For alkalinity less than 1000 mg as CaCO3/L, use 20 ml of the sample. For alkalinity above 1000 mg as CaCO3/L, use 5 ml.
- Titration: The sample is titrated with 0.02 N HCl for lower alkalinity levels and with 0.1 N HCl for higher levels. The endpoint can be determined colorimetrically or potentiometrically.
- Potentiometric Titration
    - Rinse the electrodes and titration vessel with distilled water.
    - Measure the initial pH of the sample.
    - Add standard hydrochloric acid in increments of 0.5 ml or less to ensure a gradual pH change.
    - Use a magnetic stirrer to mix the sample thoroughly without causing splashing.
    - Record the pH after stabilization and the cumulative volume of titrant added until the mixture reaches a pH of 8.3.

Calculation of Alkalinity

The phenolphthalein alkalinity is calculated using the volume of acid consumed to reach the phenolphthalein endpoint (pH 8.3). Total alkalinity is determined using the volume of acid required to reach the bromocresol green endpoint or potentiometrically to pH 4.5. The formula used is:

Alkalinity (as $CaCO_3$ mg/L) = A x N x 50/ml of sample

where:

A = ml of standard acid used,

N = Normality of the acid.

Determining Carbonate and Bicarbonate Concentrations

The method assumes the absence of other weak inorganic or organic acids. The concentrations of carbonate and bicarbonate are calculated based on the phenolphthalein and total alkalinity determinations:

- Carbonate (CO_3-) Alkalinity: Present when phenolphthalein alkalinity is nonzero but less than total alkalinity.
- Hydroxide (OH-) Alkalinity: Indicated if phenolphthalein alkalinity exceeds half of the total alkalinity.
- Bicarbonate (HCO_3-) Alkalinity: Assumed if phenolphthalein alkalinity is less than half of the total alkalinity.

The specific calculations for carbonate and bicarbonate concentrations involve comparing phenolphthalein alkalinity (P) with total alkalinity (T), and adjusting the values to express the results as equivalents of $CaCO_3$. This titrimetric method provides a reliable means of assessing the carbonate and bicarbonate content in wastewater, which is essential for water quality management and treatment process optimization.

7.2.11 Determination of Metals

The process of determining metal content in wastewater samples is a critical aspect of environmental monitoring and industrial waste management. The Atomic Absorption Spectrometer (AAS) is a sophisticated instrument commonly employed for this purpose. The AAS operates on the principle that atoms in a sample can absorb light at specific wavelengths, which correlates to the concentration of the element present.

Principle of Atomic Absorption Spectroscopy

When a light beam is directed through a flame, it encounters atomized elements from the sample. These elements absorb light at characteristic wavelengths. The AAS is designed to measure this absorption, which is indicative of the metal's presence and concentration. A monochromator is used to isolate the specific wavelength of interest, and a detector measures the intensity of the light absorbed. Each metal has a unique absorption wavelength,

necessitating the use of a source lamp composed of the same element to ensure specificity and to minimize spectral interference.

Importance of Metal Detection in Water

Metals in water and wastewater can have a range of effects, from being essential nutrients at trace levels to posing severe toxicity risks at higher concentrations. Accurate determination of metal concentrations is vital for assessing water quality, ensuring compliance with environmental regulations, and protecting human health and ecosystems.

Sample Collection and Preservation

- Sampling and Sample Preservation

  Proper sampling techniques and sample preservation are crucial to obtaining accurate results. The fraction of the sample to be analyzed is determined before collection. Quartz and TFE (tetrafluoroethylene) containers are preferred due to their inert properties, which minimize the risk of sample contamination.

- Acidification

  To preserve the sample and prevent changes in metal concentrations, it is acidified immediately after collection using concentrated nitric acid. This step helps to stabilize the metals and maintain the integrity of the sample until analysis.

- Avoiding Contamination

  Care is taken to avoid introducing contaminants from various sources, such as sample containers, distilled water, or membrane filters. This is essential to ensure that the results reflect the actual metal content of the sample and not artifacts from external sources.

- Airborne Contaminants

  For the analysis of trace levels of metals (microgram-per-liter concentrations), airborne contaminants in the laboratory, such as volatile compounds, dust, soot, and aerosols, must be considered. These can significantly affect the accuracy of the results.

Components of the Atomic Absorption Spectrometer

The AAS is composed of several key components:

- Light Emitting Source: Provides the initial beam of light.
- Burner (Premix type): Introduces the sample as a spray into a condensing chamber.
- Readout: The display unit that shows the measurement results.
- Lamps (Hollow Cathode type): Emit light at the specific wavelength required for the metal being analyzed.
- Pressure Reducing Valves: Control the flow of gases into the burner.

- Vent: Safely expels exhaust gases from the instrument.

Procedure for Metal Determination

The procedure for analyzing a metal begins with sample preparation, which varies depending on the specific metal of interest. The following steps are generally involved:

- Consult the manufacturer's operation manual for detailed instructions.
- Install a hollow cathode lamp corresponding to the metal to be measured.
- Set the slit width according to the manual's specifications.
- Allow the instrument to warm up for approximately 20 minutes to stabilize the energy source.
- Turn on the air supply and adjust the flow rate as per the manufacturer's guidelines.
- By following these steps and adhering to strict quality control measures, the Atomic Absorption Spectrometer can provide reliable and accurate measurements of metal concentrations in water and wastewater samples.

7.3 Design of Sewage Treatment Plant

7.3.1 Waste Water Consumption Calculation

Total Population of the Housing = 44000 People

Water Consumption = 135 L/C/D

Total water consumption = 44000 x 135 = 5940000 L/D

Waste water for STP = 80% of total water consumption

=5940000 x 0.8

=4752000 L/D

= 4752 cum/day

= 198 cum/hour

STP Capacity= 4752 cum/ day or 198 cum/hour or 3.3 cum/min

7.3.2 Components of Common STP

Screen chamber, Inlet flow meter, Septic Tank, ABR Tank, Aeration Tank, Sedimentation Tank, Post Aeration Tank, Chlorination Tank, Outlet flow meter, Sludge Thickening & Sludge drying bed, Sludge store with chlorination for disposal by Incineration/Dumping.

Sl. No.	Name of component /Tank	Hydraulic Capacity (without free board)	Retention Time
1	Screen Chamber (1)	33.2m x 1.5m x 1.0m = 49.8 cum	-
2	Septic Tank with ABR Tank (2a, 2b, 3, 4 & 5).	4770 cum	24.0 hours.
3	Aeration Tank (6a, 6b & 6c)	15.0m x 15.9m x 4.0m =954 cum 2 x 29.0m x 16.45m x4.0m = 3816.4 cum	24.0 hours.
4	Sedimentation Tank (7)	633.6 cum	3.2 hours
5	Post Aeration Tank (8)	15.0m x 4.7m x 4.0m = 282 cum	1.42 hours
6	Chlorination Tank (9)	15.0m x 4.7m x 4.0m = 282 cum	1.42 hours
7	Sludge Thickening Tank (10)	15.0m x 11.45m x 4.0m = 687cum	11.8 day

Detail dimensions of the different components of the common STP capacity 198.0 cum per hour are shown in separate drawing sheets.

Design Calculation for Screen Chamber(1):

STP Design Flow = 198 cum/hour

Selected Size of Screen Chamber:
33.2m x 1.5m x 1.0m = 49.8 cum

Design Calculation for Inlet Flow Meter:

STP Design Flow = 198 cum/hour

Selected capacity of Inlet Flow Meter = **200 - 250 cum/hour**

Design Calculation for Septic Tank (2,3,4&5):
Hydraulic volume of Septic Tank-1 = 18.25m x 16.45m x 4.0m = 1200.85 cum
Hydraulic volume of Septic Tank-2 =18.25m x 16.45m x 4.0m = 1200.85 cum
Hydraulic volume of 3 nos ABR Tank = 2368.8 cum

Total Hydraulic volume of septic tank =1200.85cum + 1200.85cum + 2368.8cum = 4770 cum
Hydraulic Retention time of Septic Tank = Volume of septic tank / Inflow Flow Rate
= 4770 cum / 198 cum
= 24.0 hour

Design Calculation for Aeration Tank (6):

STP Design Flow = 198 cum/hour = 4752 cum/day

Effluent BOD = 400 mg/l

Consider,

MLSS = 3000 mg/l

MLVSS = 80% of MLSS = 0.8X3000 = 2400 mg/l

BOD Reduced to 25% after Primary Sedimentation in Septic Tank.

So, Influent Inlet BOD for Aeration Tank = 400 mg/l X 75% = 300 mg/l

Effluent BOD after STP Treatment (Soluble BOD) = 30 mg/l

Effluent TSS = 350 mg/l

Volatile TSS =80% of TSS = 0.8X350 = 280 mg/l

Calculation of Volume of Aeration Tank & Retention Time:

True Yield Coefficient $Y_1 = 0.38$

MLSS = X = 3000 mg/l

Effluent Flow Q = 198 cum/hour = 4752 cum/day

Inlet BOD S_0= 300 mg/l

Soluble BOD S= 30 mg/l

Endogenous decay Coefficient K_d =0.05/day

Volume of Aeration Tank = V

$V = Y_1 \times Q \times (S_0\text{-}S) / X \times K_d = 0.38 \times 4752 \times (300\text{-}30) / (3000 \times 0.05) = 3250.36$ cum

Retention Time = 3250.36/198 = 16.41 Hour

Considering 24 hours Retention Time, so, Volume = 198 x 24 = 4752 cum

Selected Size of Aeration Tank = 15.0m X 15.9m x 4.0m = 954 cum

2 x 29.0m x 16.45 m x 4.0 m = 3816.4 cum

Total = 4770 cum

Selected Retention time as per size = 4770/198 = 24 hour

Design Calculation for Oxygen Requirement:

Considering, MLSS = 3000 mg/l

Effluent Flow = 198 cum/hour = 4752 cum/day

Effluent BOD = 400 mg/l

25% BOD Reduced through Primary Treatment Process.

So Influent BOD to Aeration Tank = 400 x 75% = 300 mg/l

Effluent BOD after STP Treatment = 30 mg/l

1.42 is conversion factor to find Oxygen required for ultimate BOD of biomass

Amount of BOD Removal $=1.42 \times (BOD_{in} - BOD_{out}) \times$ Effluent Flow

= 1.42 x (300-30) x 4752 cum/day

= 1821.91 cum/day (Density of BOD = 1.07 kg/cum)

=1949.44 kg/day

The Oxygen requirement is calculated as per the assumption, that is 1.8 to 2 kg O_2 is required for per kg BOD Removal. So, O_2 required in Aeration Tank = 2 x 1949.44 = 3898.88 kg O_2/day

So, Actual Oxygen Transfer Rate (AOTR) = 3898.88 /24 = 162.45 kg O_2/hour

But for fine bubble Aeration system Standard Oxygen Transfer Rate (SOTR) = AOTR/0.33

= 162.45 /0.33 = 492.27 kg O_2/hour

We know, Oxygen Transfer efficiency from air bubble produced by diffuser is only 30%

So amount of Oxygen in Inlet Air = 492.27 /0.3 = 1640.9 kg O_2/hour

= 1640.9/1.429 (Density of Oxygen = 1.429g/l)

= 1148.28 cum O_2/hour

Again we know, Oxygen Percentage is 21% in air by volume.

Required air flow to the Aeration Tank = 1148.28/0.21 = 5468 cum air/hour

Design Calculation for Sedimentation Tank (7):

STP Design Flow = 198 cum/hour

Selected Size :

Length = 15.0m, Width = 12.0m

Height = 3.5m

Total volume = 15.0m x12.0m x3.5m = 633.6 cum

Hydraulic Retention Time = 633.6 cum/198 cum = 3.2 hour.

Calculation of Surface Overflow Rate (SOR):

Surface area of Primary Clarifier = L*W

=15.0 m x 12.0 m

=180 sqm

SOR = Inflow Flow Rate(cum/hour) / Surface area of Secondary Clarifier(sqm)

=198 cum/hour/180 sqm

=1.1 cum/sqm/hour

SOR = 1.1 cum/sqm/hour

Calculation of Weir Overflow Rate (WOR):

Weir Length of Clarifier = (15m + 12m) x 2 = 54 m

WOR = Inflow Flow Rate(cum/hour) / Weir Length of Clarifier(m)

=198 (cum/hour)/54m

=3.66 sqm/hour

WOR = 3.66 sqm/hour

Design Calculation for Post Aeration Tank (8):

STP Design Flow = 198 cum/hour = 3.3 cum/min

Selected Size of Post Aeration Tank:

15.0m x 4.7m x 4.0m = 282 cum

Hydraulic Retention Time = Volume of Post Aeration Tank / Inflow Flow Rate

= 282 (cum)/198 (cum/hour)

=1.42 hour.

Design Calculation for Chlorination Tank (9):

STP Design Flow = 198 cum/hour = 3.3 cum/min

Selected Size of Treated water Tank:

15.0m x 4.7m x 4.0m = 282 cum

Hydraulic Retention Time = Volume of Post Aeration Tank / Inflow Flow Rate

= 282 (cum)/198 (cum/hour)

=1.42 hour.

Calculation for Sludge Age:

Sludge Age, Qc = MLSS (mg/l) / Influent Volatile TSS (mg/l)

= 3000 (mg/l) / 280(mg/l)

= 10.7 days

Calculation of Sludge volume Index (SVI)

SVI = Settle volume of sludge in 30 min(ml/l) / MLSS(mg/l)

Considering, Settle volume of sludge in 30 min = 375 (ml/l)

= 375(ml/l) / 3000(mg/l)

= 0.125 ml/mg

= 125 ml/g

Calculation of Return Activated Sludge (RAS) or Sludge recirculation Ratio:

Equation = Qr/Q = X/Xr-X

Where,

Q= Effluent design Flow = 4752 cum/day

Qr = Sludge Recirculation Rate (cum/day)

X = MLSS = 3000 mg/l

Xr = 10^6 /SVI = 1000000/125 = 8000 g/cum = 8000 mg/l

So, Qr = 4752 x 3000 / (8000-3000) = 2851.2 cum/day

% of return sludge per day = 2851.2(cum/day)/4752 (cum/day) = 60%

7.3.3 Sludge Production Calculation

Biological sludge from Aeration Tank Sediment in Clarifier:

Consider, MLSS = X = 3000 mg/l

Aeration Tank volume V = 4752 cum

Sludge Age Q_C = 10.7 day

Growth of Biological sludge = XV/ Q_C = 3000mg/l x 4752 cum/10.7day = **1332.33 kg/day**

Volume of Sludge = 1332.33 (kg/day)/1.03g/cum x 0.045 = **58.2 cum/day**

Selected Size of Sludge Thickening Tank = 15.0m x 11.45m x 4.0m = 687 cum

Retention time of Thickening Tank (10) = 687/58.2 = 11.8 days.

7.3.4 Design Calculation for Outlet Flow Meter

STP Design Flow = 198 cum/hour

Selected capacity of Outlet Flow Meter = **200 -250 cum/hour**

7.3.5 Diffused Aeration Process in Wastewater Treatment

Diffused aeration is a critical phase in the wastewater treatment process, particularly within the activated sludge system. This stage involves the introduction of air into the wastewater to facilitate the biological oxidation of organic pollutants. The process is designed to maximize the contact between air and the microorganisms in the activated sludge, thereby enhancing the breakdown of organic matter.

Mechanism of Diffused Aeration

During diffused aeration, compressed air is introduced into the aeration tank, where it combines with the incoming sewage and the added activated sludge—a mixture of wastewater and microorganisms. The air can be delivered through various means, such as nozzles or perforated

pipes, which release it in the form of bubbles. These bubbles rise to the surface and provide the necessary oxygen for the microorganisms to thrive and degrade the organic pollutants.

To ensure efficient oxygen transfer and maintain the movement of the sludge, the air is diffused through specialized equipment known as diffusers. These diffusers are typically 20 to 25mm in thickness and come in various sizes. They are installed atop cast iron covers or within aluminum boxes that house the air pipes. The diffusers create tiny air bubbles that rise through the wastewater, providing a large surface area for oxygen transfer. The compressed air is supplied through vertical pipes connected to the main air supply and is evenly distributed along the length of the aeration tank. This ensures that oxygen is available throughout the tank for the microorganisms to utilize.

Diffuser Construction and Placement

Diffusers are constructed from robust materials to withstand the harsh conditions within the aeration tank. They are strategically placed at the bottom of the tank to maximize the distribution of air bubbles. The positioning of the diffusers is crucial for achieving an even spread of oxygen and for preventing dead zones where insufficient aeration might occur.

Activated Sludge Return Ratios

The process efficiency is also dependent on the correct proportion of returned activated sludge. The table below outlines the recommended percentage of returned activated sludge based on the desired Biological Oxygen Demand (BOD) removal levels:

Desired BOD Removed (ppm)	Percentage of Returned Activated Sludge
150	25%
250	30%
300	35%
400	40%
500	48%
600	53%

These ratios are essential for maintaining the balance between the microorganisms and the organic load, ensuring that the system operates efficiently and effectively removes the targeted BOD levels.

Final Effluent Discharge

After the aeration process, the treated effluent is discharged into a nearby canal or water body. The quality of the final effluent is typically regulated by environmental standards to ensure that it does not adversely affect the receiving waters. Diffused aeration is a sophisticated and essential component of modern wastewater treatment facilities. By understanding and optimizing the various elements of this process, such as diffuser placement and activated sludge return ratios, treatment plants can effectively reduce BOD levels and discharge high-quality effluent into the environment.

7.3.6 Aerobic Function

Aerobic function refers to the biological process that occurs in the presence of oxygen. This process is facilitated by aerobic organisms, also known as aerobes, which require free oxygen to thrive and perform their metabolic activities. The primary role of these organisms is to decompose organic matter, which typically comprises proteins, carbohydrates, and fats.

The Aerobic Decomposition Process

When oxygen is introduced to organic matter, a series of biochemical reactions occur, leading to the breakdown of complex organic compounds. These reactions are catalyzed by aerobic bacteria, which utilize oxygen to oxidize the organic substances, resulting in the formation of simpler compounds.

Breakdown of Proteins

Proteins, when exposed to oxygen and in the presence of aerobic bacteria, undergo a decomposition process that yields carbon dioxide (CO_2), water (H_2O), and ammonia (NH_3) as end products. The reaction can be summarized as follows:

$$\text{Proteins + Oxygen} \xrightarrow[\text{Aerobes}]{\text{Bacteria}} CO_2 + H_2O + NH_3$$

Breakdown of Carbohydrates

Similarly, carbohydrates are broken down by aerobic bacteria with the aid of oxygen. The end products of this reaction are carbon dioxide and water, which can be represented by the equation:

$$\text{Carbohydrates} + \text{Oxygen} \xrightarrow[\text{Aerobes}]{\text{Bacteria}} CO_2 + H_2O$$

Breakdown of Fats

Fats are also subject to aerobic decomposition, where they react with oxygen in the presence of bacteria to form carbon dioxide and water:

$$\text{Fat} + \text{Oxygen} \xrightarrow[\text{Aerobes}]{\text{Bacteria}} CO_2 + H_2O$$

Aeration Rates

The efficiency of the aerobic process is influenced by the rate of aeration, which is the introduction of air into the waste material. Aeration rates can vary, but they typically range from 0.01 to 0.05 cubic meters of air per cubic meter of waste. Proper aeration ensures that sufficient oxygen is available for the aerobic organisms to effectively decompose the organic matter.

Composition of Organic Compounds

Organic compounds involved in aerobic decomposition contain elements such as carbon (C), hydrogen (H), oxygen (O), nitrogen (N), and sulfur (S). When these compounds combine with dissolved oxygen, the chemical reactions lead to the formation of end products including carbon dioxide, water, ammonia, and various sulfur compounds.

Importance of Aerobic Function

The aerobic function is a crucial component of waste treatment and environmental management. By converting organic waste into harmless and stable substances, aerobic decomposition helps in reducing pollution, recycling nutrients, and maintaining ecological balance.

In summary, aerobic function is a vital biological process that transforms organic waste into environmentally benign substances through the action of aerobic organisms and the presence of oxygen. This process not only helps in waste management but also contributes to the sustainability of ecosystems.

7.3.7 Microbiology of Sewage and Sewage Treatment

Sewage, or domestic wastewater, is a complex mixture that harbors a vast array of microorganisms. The microbial population in sewage plays a crucial role in both the challenges and solutions associated with sewage treatment. Understanding the microbiology of sewage is essential for designing and optimizing sewage treatment processes.

The Microbial Composition of Sewage

Domestic wastewater is teeming with microorganisms, with bacterial counts typically ranging from 500,000 to 5,000,000 per milliliter, depending on factors such as the age of the sewage and the amount of dilution water. Besides bacteria, sewage also contains viruses, protozoa, worms, and other microorganisms, although these are usually present in lower numbers and are often not a primary concern in sewage treatment. Bacteria, the predominant microorganisms in sewage, are single-celled organisms that play a key role in the degradation of organic matter. They achieve this through the production of extracellular enzymes, which break down soluble, colloidal, and solid organic matter outside their cell walls. This process is vital for the removal of organic pollutants from wastewater.

Bacterial Growth Phases in Sewage Treatment

Understanding the growth phases of bacteria is crucial for optimizing sewage treatment processes. The growth of bacteria in a given environment follows a predictable pattern, typically represented by a growth curve that includes several distinct phases:

- **Lag Phase:** A period of adaptation where bacteria prepare for growth but do not yet multiply significantly.
- **Log (Exponential) Growth Phase:** Bacteria multiply rapidly, doubling at regular intervals. This phase is characterized by the efficient breakdown of organic matter.
- **Stationary Phase:** Growth slows as the availability of nutrients decreases and waste products accumulate.
- **Death Phase:** The number of dying cells exceeds the number of new cells being produced.
- However, for simplicity, some representations of bacterial growth in the context of sewage treatment focus on three main phases: the lag phase, the log growth phase, and the endogenous (declining) phase.

Optimal Phases for Sewage Treatment

While the log growth phase is associated with the highest rate of substrate (waste) removal, it is not the most desirable phase for sewage treatment systems. This is because maintaining log growth requires a continuous supply of nutrients, which contradicts the goal of reducing nutrient concentrations in treated wastewater. Additionally, the high energy and motility of bacteria in this phase can make them difficult to remove through sedimentation. Instead, the declining growth phase is often targeted in biological treatment systems. This phase allows for more controlled treatment processes, avoiding the challenges associated with the log growth phase. Some systems, such as extended aeration and sludge digestion, operate in the endogenous phase, where bacteria consume their own stored substances for energy.

Aerobic Bacteria and Sewage Treatment

Aerobic bacteria, which require free oxygen to thrive, play a pivotal role in sewage treatment. They convert organic pollutants into carbon dioxide, water, sulfate, nitrate, ammonia, and additional bacterial biomass. This process, facilitated by various aeration techniques (e.g., bubble aeration, thin film aeration, droplet aeration), stabilizes the effluent and prevents further decomposition.

Key Parameters in Sewage Treatment

The effectiveness of sewage treatment can be assessed by measuring various parameters, including total suspended solids (TSS), volatile suspended solids (VSS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), and concentrations of ammonia and organic ions. These parameters vary depending on the strength of the sewage, categorized as weak, medium, or strong, and are crucial for monitoring and optimizing treatment processes.

In summary, the microbiology of sewage and the dynamics of bacterial growth are central to the design and operation of sewage treatment systems. By understanding and manipulating these biological processes, it is possible to achieve efficient and sustainable treatment of domestic wastewater.

7.3.8 Discharge Point and Water Network

The treatment would be split into three stages: pretreatment, primary treatment and secondary treatment. In pretreatment, large solids and grit would be removed by screening. In primary

treatment, the water would leave to face in order that solids could sink to rock bottom and oil and grease could rise to the surface. Finally, in secondary treatment, the sludge would be further treated in sludge digesters. After applying all those treatment procedures, it would be discharged into the canal which is located on the North side of the proposed project. The canal is connected to the Dhaleshwari River approximately 3.5km west-side from the proposed Sewage Treatment Plant (STP) point.

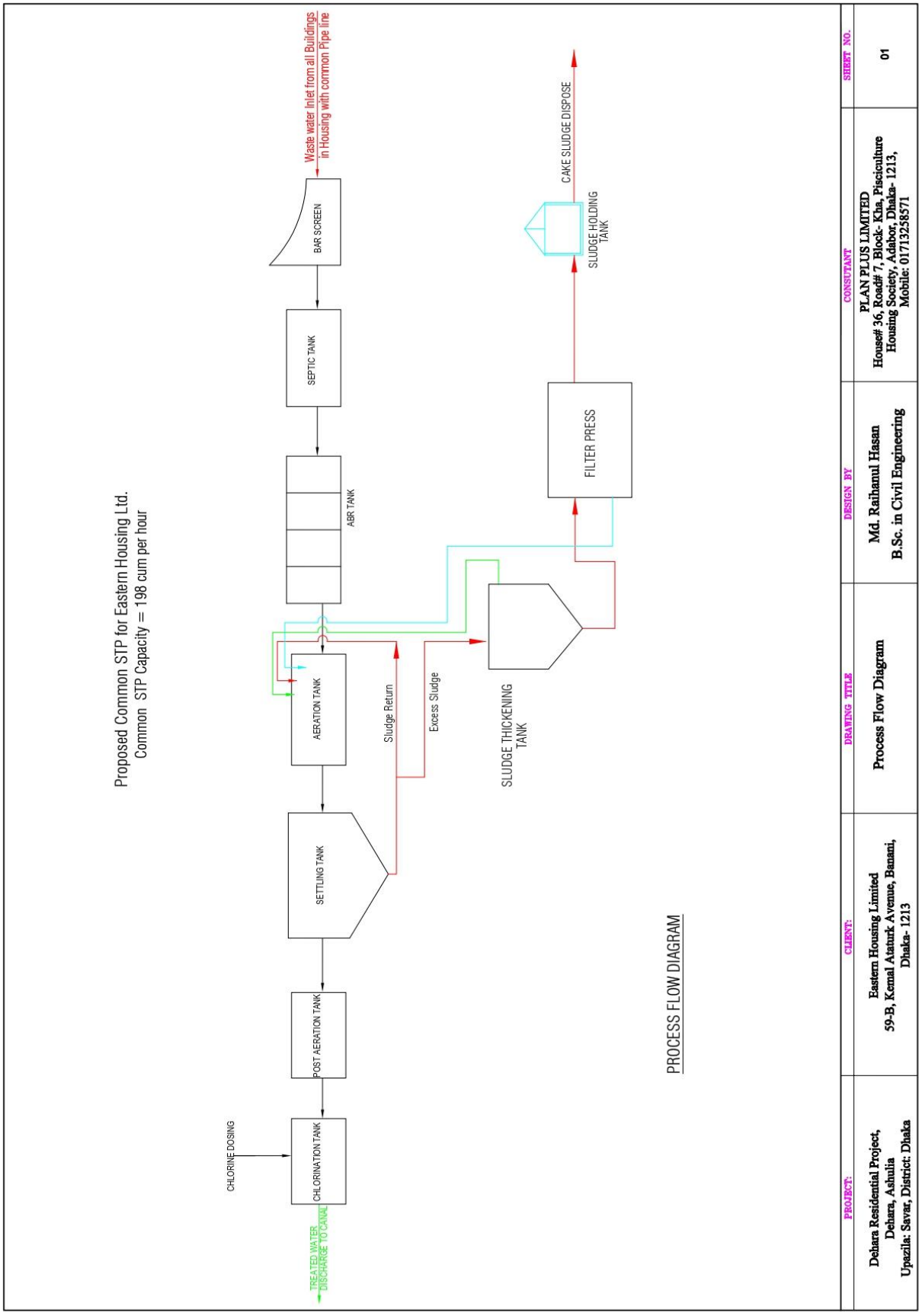


Figure 7.1: Process Flow Diagram

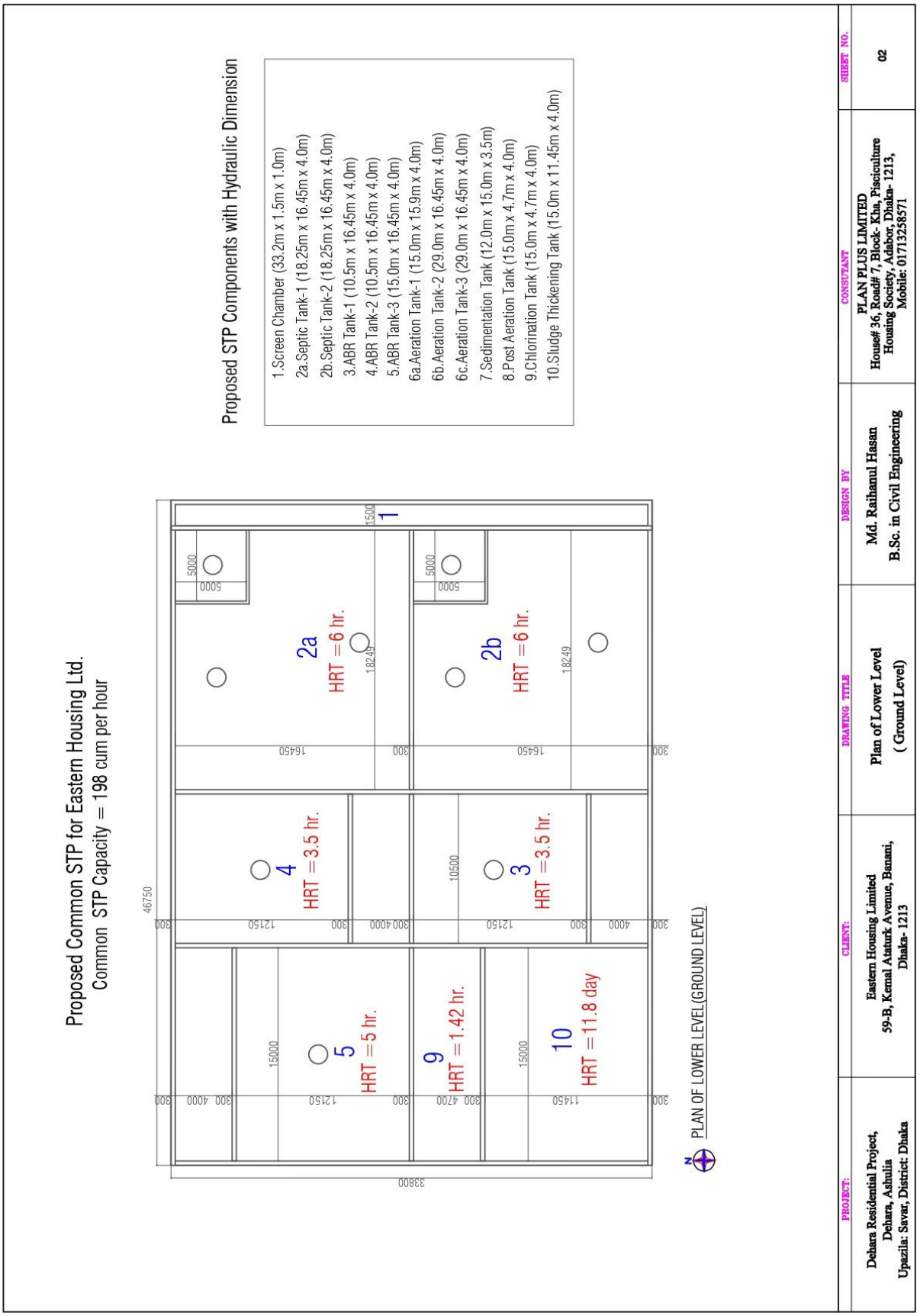


Figure 7.2: Plan of Lower Level (Ground Level)

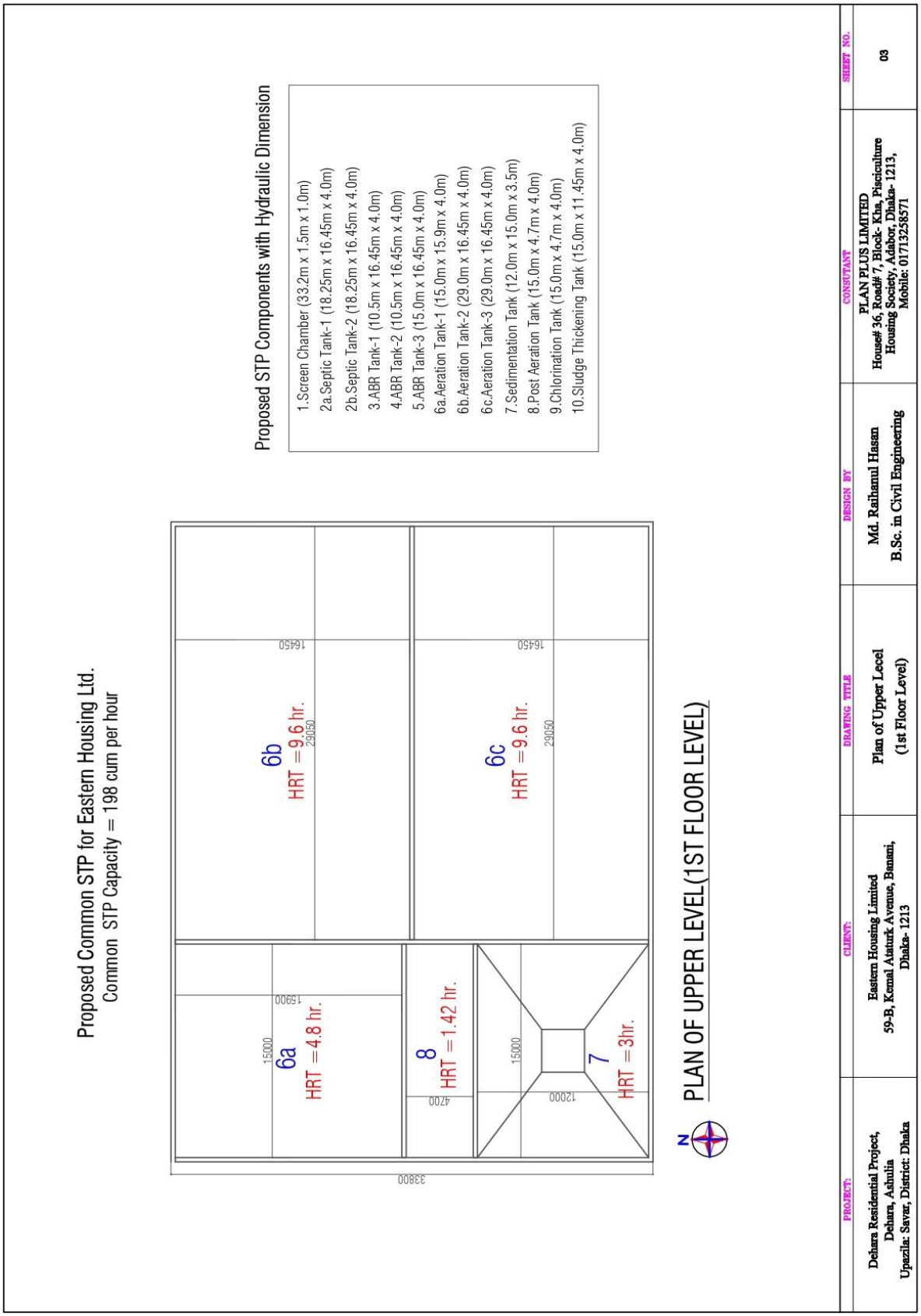


Figure 7.3: Plan of Upper Level (1st Floor Level)

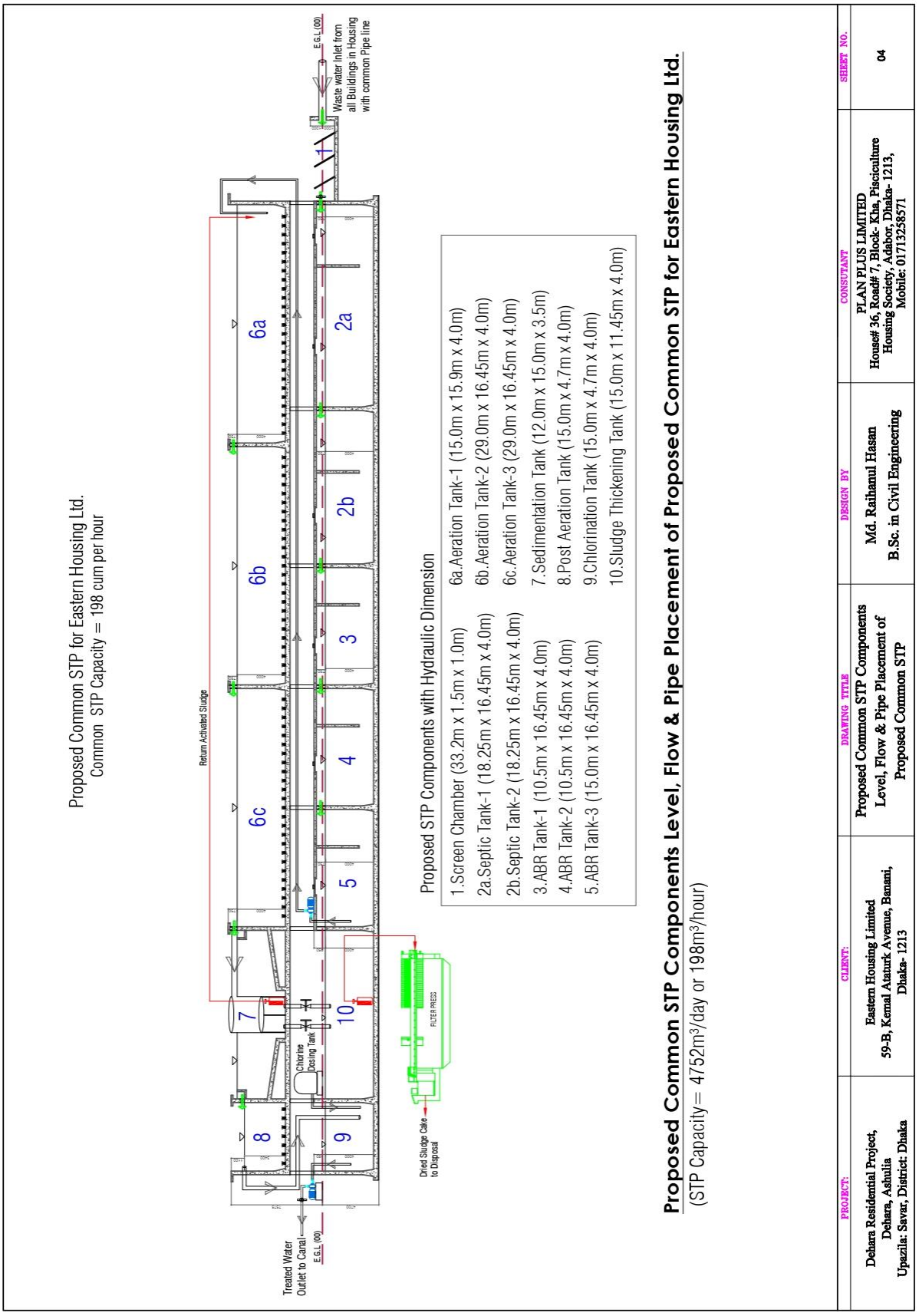


Figure 7.4: Proposed Common STP Components Level, Flow & Pipe Replacement

Figure 7.5: Location of Sewage Treatment Plant for Dehara Project

7.4 Bangladesh Standards for Sewage

The following are the sewage standards as per Environmental Conservation Rules, 2023 of Department of Environment.

Parameters	Unit	Values
Temperature	^{o}C	30
pH	-	6-9
BOD_5 at 30^0C	mg/L	30
COD	mg/L	125
Suspended Solid (SS)	mg/L	100
Oil and Grease	mg/L	10
Nitrate (No_3)	mg/L	50
Phosphate (PO_4)	mg/L	15
Total Coliforms	CFU/100mL	1000

Source: ECR, 2023

7.5 Use of Sludge in Agriculture Enhancing Soil Health through Composting

Composting represents a sustainable and efficient method for treating sludge, particularly from wastewater treatment plants. This aerobic process transforms sludge into valuable compost by mixing it with carbon-rich materials such as sawdust, straw, or wood chips. The presence of oxygen is crucial as it facilitates the activity of bacteria that digest both the wastewater solids and the added carbon sources. This bio-oxidative process not only stabilizes the organic matter but also generates significant heat, accelerating the decomposition.

The Composting Process

The essence of composting lies in its ability to convert organic waste into a nutrient-rich soil amendment. The process involves several key stages:

- **Mixing and Aeration:** The sludge is thoroughly mixed with carbonaceous materials. This mixture is then regularly turned or aerated to ensure oxygen penetration, essential for aerobic microbial activity.

- **Microbial Digestion:** Aerobic bacteria and other microorganisms break down the organic matter. This phase is characterized by a significant rise in temperature, which can reach up to 55-65°C, effectively killing pathogens and weed seeds.
- **Curing and Maturation:** After the active composting phase, the material is allowed to cure. During this period, the compost undergoes further decomposition at a slower rate, allowing the maturation of the compost and the development of beneficial humic substances.

Benefits of Composting in Agriculture

The application of compost in agriculture offers numerous benefits, not only for soil health but also for the broader ecosystem:

- **Soil Conditioner:** Compost improves soil structure, enhancing its porosity and water retention capabilities. This makes soils more resilient to erosion and drought.
- **Nutrient-Rich Fertilizer:** Compost is a source of essential nutrients for plants, including nitrogen, phosphorus, and potassium, reducing the need for chemical fertilizers.
- **Humus Addition:** The humic acids in compost play a critical role in soil fertility, helping to bind particles into aggregates and improving nutrient uptake by plants.
- **Natural Pesticide:** Compost can suppress plant diseases and pests, reducing the reliance on chemical pesticides.
- **Environmental Benefits:** By recycling organic waste into compost, this method contributes to the reduction of greenhouse gas emissions associated with landfilling and incineration of waste.

Application in Gardens, Landscaping, Horticulture, and Agriculture

- **Gardens and Landscaping:** Enhances soil structure and fertility, promoting healthier plant growth.
- **Horticulture:** Provides a nutrient-rich growing medium for fruits, vegetables, and flowers.
- **Agriculture:** Improves crop yields and soil health on a larger scale, supporting sustainable farming practices.

Composting as a method for sludge treatment and its use in farming is a testament to the principles of waste recycling and sustainability. By converting waste into a valuable resource, composting not only addresses waste management challenges but also contributes to the

enhancement of soil health, reduction of chemical inputs, and promotion of environmental sustainability. As such, it is a key ingredient in the pursuit of organic and sustainable farming practices, offering a holistic approach to managing our planet's resources wisely.

7.6 Conclusion

The design of the sewage treatment plant encompasses a comprehensive suite of components, including the receiving chamber, screening chamber, grit chamber, skimming tank, sedimentation tank, secondary clarifier, active sludge tank, and sludge drying beds. This design is meticulously crafted to accommodate future expansions over the next 50 years, ensuring the plant's longevity and adaptability to technological advancements. This measure is crucial for maintaining sustainable wastewater management practices and adhering to regulatory standards.

CHAPTER 8
ENVIRONMENTAL IMPACTS & MITIGATION MEASURES

8.1 Introduction

Before commencement of this detailed EIA study an IEE and TIA studies carried out for this site which have provided important insight regarding the potential impact of the project. This study and particularly this chapter provides greater detail on contingent aspects by identifying the possible impacts associated with the implementation of the project and suggests the mitigation and abatement measures during the entire life-cycle of the project both during construction and operation phases. The potential impacts could cover a wide range of environmental, social, and ecological aspects. The objective of this chapter is to identify and evaluate the extent of probable impacts associated with the project, which would be useful in developing mitigation measures to avoid or minimize the adverse effects. In the project area the was being transformed as human settlement for couple of decades. Therefore, at the time of the study the project area has transformed into a much-developed condition with significant human habitat in the area. Hence the baseline and possible impact are compared with existing condition. This chapter concludes by providing an Environmental Impact Valuation (EIV) table that will provide a comparative picture of the project outcome with and without Environmental Management Plan.

8.2 Methodology

An environmental impact is defined as any change to an existing condition of the environment. Identification of potential impacts has been done on the basis of baseline data collected from secondary and primary sources. The potential impacts have also been identified based on experts' opinions and inputs received from public consultation events. The impacts can be broadly classified as those taking place during construction and operational stages. The impacts are broadly classified into following three categories during construction and operation stage:

- Physio-chemical Impacts;
- Ecological Impact;
- Socio-economic Impacts.

Potential Impacts associated with the proposed development are identified from their sources that include project's activities; equipment; processes; materials against their main receptors that include the baseline environmental and social condition. Information collected from public

consultation, literature review, and professional knowledge were used to inform the baseline characteristics of the project site.

As part of the EIA process, a screening matrix was used specifically for the proposed project, focusing on the potential environmental impacts during the construction and operation phases of the proposed EHL Dehara Residential Project. The matrix examined the interaction of project activities with various important components of the environment. The potential impacts thus predicted were rated as follows based on the nature/direction and intensity of the impact:

Table 8.1: Impact Rating Score

Direction of Impact	Degree/Intensity	Corresponding Score
Positive	Severe	+5
	Higher	+4
	Moderate	+3
	Low	+2
	Very Low	+1
Neutral	Neutral	0
Negative	Very Low	-1
	Low	-2
	Moderate	-3
	Higher	-4
	Severe	-5

Again, the intensity of positive and negative impacts has been classified (qualitatively) into "Very low", "low", "moderate", "higher" and "Severe" categories. Appropriate mitigation measures have been recommended as part of this EIA, thus reducing the occurrence possibility and severity of the potentially adverse impacts.

8.3 Impact During Construction Phase

The proposed project involving development of Dehara Residential area will be implemented by Eastern Housing Limited (EHL). This section outlines the possible impact and mitigation measures corresponding to specific adverse impacts during construction phase, along with assignment of responsibilities for their implementation. The measures presented in this section

are aimed at minimizing the effects of the possible adverse impacts and enhancing the positive impacts. Most of the adverse impacts could be minimized or even removed if appropriate mitigation measures are taken. Besides this, construction of a high-rise building entails a requirement for providing uttermost safety for workers involved. Worker health can also be adversely affected at various stages of the construction due to challenging working conditions. In addition, construction of high rise buildings may require deep excavation over a large area of the project site. Shore protection using shore-piles or open cut method or any other method approved by the BNBC should be appropriately followed. It is imperative that the contractor follows the workers safety protocol during entire construction phase including deep excavation as well as superstructure construction. The impacts along with the mitigation measures in this phase of the project are narrated below:

8.3.1 Impact on Living Condition

The project site has some human habitat and also there will be construction workers and staff during the project period. At the time of execution of the project current inhabitants, workers and staff will face some adverse consequences from the construction activities. Possible impact are outlined below:

- **Noise and Dust:** Construction activities like excavation, drilling, and pounding will generate significant noise and dust pollution. This can disrupt sleep patterns, cause respiratory problems, and make daily life uncomfortable.
- **Traffic:** Construction vehicles and increased worker traffic will add congestion to existing roads, making it difficult for residents to get around.
- **Safety Concerns:** Construction sites pose safety hazards for residents, especially children, due to open trenches, heavy machinery, and increased truck movement.
- **Limited Access to Utilities:** Construction may disrupt existing utilities like water and electricity supplies, leading to temporary shortages.
- **Loss of Privacy:** The construction site will likely be close to existing homes, leading to a loss of privacy as residents grapple with constant activity and construction workers around.
- **Property Damage:** Vibrations from construction could potentially damage existing structures, particularly the tin sheds.
- **Economic Strain:** Some residents might lose their livelihoods if their homes are located within the construction zone and require demolition.

Mitigation Measures

By implementing a comprehensive mitigation plan, some of the impacts can be significantly reduced. They include communication and transparency, dust and noise control, traffic management, safety measures, socio-economic measures etc. Here are some key measures:

Communication and Transparency

- **Regular Meetings:** Hold regular meetings with residents to explain the construction process, timeline, and planned mitigation measures.
- **Grievance Redressal Mechanism:** Establish a clear mechanism for residents to voice concerns and have them promptly addressed.
- **Information Dissemination:** Provide residents with clear and consistent information through newsletters, community meetings, and signage around the construction site.

Dust and Noise Control

- **Dust Suppression Techniques:** Implement dust suppression techniques like water spraying on exposed surfaces and covered trucks for transporting materials.
- **Noise Reduction Measures:** Utilize quieter construction equipment whenever possible and restrict noisy activities to specific daytime hours.
- **Consideration of Construction Sequencing:** Plan construction sequencing to minimize noise and dust disruptions in heavily populated areas.

Traffic Management:

- **Designated Routes:** Clearly mark dedicated routes for construction vehicles to minimize disruption to existing traffic flow.
- **Staggered Work Schedules:** Consider staggering work schedules for different construction crews to distribute traffic congestion throughout the day.
- **Signage and Information:** Provide clear signage and information to residents regarding road closures, detours, and alternative routes.

Safety Measures:

- **Secure Construction Site:** Erect secure fencing around the entire construction site to restrict unauthorized access.
- **Safety Signage:** Post clear and informative safety signage throughout the site to warn residents of potential hazards.

- **Community Awareness Campaigns:** Organize community awareness campaigns, particularly targeting children, to educate residents on construction safety protocols.

Mitigation of Socio-economic Impact

- **Compensation for Property Damage:** Develop a clear process for addressing and fairly compensating residents for any property damage caused by construction activities.
- **Relocation Assistance:** If necessary, offer temporary relocation assistance or explore options for permanent relocation for residents whose homes are directly impacted by construction.
- **Local Hiring Practices:** Prioritize hiring local residents for construction jobs and related services whenever possible to create positive economic opportunities.

By proactively implementing these mitigation measures, the developer can demonstrate a commitment to minimizing disruption to existing residents and fostering a sense of collaboration with the community throughout the construction process.

Residual Impact

If the above measures are proactively implemented, the expected residual impact would be **Negligible**.

8.3.2 Impacts from Excavation and Removal of Existing Structures

The proposed EHL Dehara Residential Project involves construction of residential buildings, several community facilities such as schools, mosque, auditorium, market, hospitals and other facilities. During this process, there exists a concern of soil collapse as well as the safety of the workers. Moreover, the deep excavation will generate a huge volume of earth material, which need to be properly disposed of. There should be a good drainage system and cover so that no water logging could happen during rains within the area. The foundation work may cause collapse of the soil or may affect the surrounding structures. Extra precautions should be taken care of during this activity. Removal of utilities such as electricity line, gas connection, telephone connection, water supply and sewerage pipelines in the existing one-storied Tin-shed building.

Mitigation Measures

- All concrete structures/equipment in the proposed area to be dismantled as per BNBC guideline and sold before construction starts.
- Necessary planning and coordination with concerned authorities (DPBS-1, Titas Gas, etc.). Prior to start of construction, all utilities should be shifted with the consultation of relevant authorities. Proper health and safety measures for the workers should be taken during shifting of the utilities to avoid any accidents.
- While leveling the area the excavated earth material can be reused in filling and thus reduce amount of disposal. Where possible construction materials from demolished structure (specially bricks) can also be reused to reduce waste.
- Non brick debris can be used for dumpsite development and extension with due collaboration with local authorities.

Residual Impact

In case of proper implementation of the above measures, the expected residual impact would be **Negligible**.

8.3.3 Impacts from Wastewater and Solid Waste

Waste and wastewater that would generate during the construction phase of the project include construction debris and wastes, and some other solid wastes (e.g., from labor sheds), human wastes from people working at the project site (e.g., from labor sheds), and some liquid waste from construction processes. These waste and wastewater could lead to pollution of water and general environment, if not properly disposed of.

Wastewater

Wastewater, in the form of human wastes, will be generated mainly in the temporary labor sheds. This could be a major source of pollution (including water pollution) if not properly managed. Use of unsanitary latrines and improper disposal of human waste would create environmental pollution and adversely affect human health at the construction site by increasing the risk of disease transmission. Proper disposal of wastewater should, therefore, be ensured as suggested in Chapter 10. There is also a risk of disease transmission from workers from outside who would come to work in the EHL Dehara Residential construction site.

Mitigation Measures

- All rainwater, storm water, waste water etc. should be drained out via sewerage pipelines considering maximum harvesting of stormwater.
- Forbid discharge of fuel, lubricants, chemicals, and wastes into surface waters or on land.
- Adopt proper disposal techniques for any hazardous waste install sediment basins to trap sediments in storm water prior to discharge to surface water.

Residual Impact

On proper implementation of the above measures, the expected residual impact would be **Negligible**.

Solid Waste

Construction debris and wastes to be generated during the construction phase would include scrap iron, steel, wooden frames, piping, and other solid wastes. Most of it will be generated toward the end of the construction phase during carrying out of the finishing works, while the site will be cleared of waste materials. The volume of such construction wastes is likely to be significant. Indiscriminate storage and disposal of construction debris and wastes could create local water logging and ponding by blocking drainage lines and would be aesthetically displeasing. Solid waste of domestic nature that would be generated in the temporary labor sheds at the construction site is not likely to be significant in volume. But indiscriminate disposal of such solid waste would create environmental pollution and unhealthy situation at the project site. Proper disposal of these solid wastes, is therefore necessary.

Mitigation Measures

- Organize disposal of all wastes generated during construction in an environmentally acceptable manner. This will include consideration of the nature and location of disposal site, so as to cause less offsite environmental impacts. The disposal site should be approved by EHL prior to usage and should be rehabilitated after usage to ensure the land is not exposed to soil erosion, wind and water Contractor stagnation.
- Minimize the production of waste materials by 3R (Reduce, Recycle and Reuse) approach (more details can be found in chapter 6).
- Segregate and reuse or recycle all the wastes, wherever practical.

- Train and instruct all personnel in waste management practices and procedures as a component of the environmental induction process.
- Maintain all construction sites in a cleaner, tidy and safe condition and provide and maintain appropriate facilities as temporary storage of all wastes before transportation and final disposal.
- Ensure proper collection and disposal of all wastes within the construction camps.
- Insist on waste separation and store by source; organic wastes, inorganic wastes and recyclables in separate containers.
- Clear wastes on daily basis to waste collectors. Establish waste collection, transportation and disposal at the dumping site in adequate sizes of concrete chambers/boxes.
- Dispose organic wastes in a designated safe place and should be kept covered so that flies, mosquitoes, dogs, cats, rats, etc. are not attracted. Encourage composting of organic waste that can be used for tree planting purposes.
- Locate the garbage pit/waste disposal site away from the residence so that peoples are not disturbed with the odor likely to be produced from anaerobic decomposition of wastes at the waste dumping places.
- Do not establish site specific dumpsites. All solid waste will be collected and removed from the work camps and disposed in approved waste disposal sites.

Residual Impact

In case of proper implementation of the above measures, the expected residual impact would be **Negligible**.

8.3.4 Impacts from Drainage Congestion

Since the construction phase involves significant earthwork (e.g., excavating/ back-filling for the foundation of the building) there are chances of stagnation and ponding of stormwater if care is not taken for proper drainage of stormwater. Additional drainage congestion may result from possible obstruction to the natural flow of drainage water due to construction activities as well as storage of construction materials. Care should be taken to make sure that natural drainage paths are not obstructed, or alternate drainage paths are provided, especially during the monsoon season.

Mitigation Measures

- Temporary drainage congestion (TDC) in the foundation trench due to rainwater to be removed by pumping. Avoid monsoon period for foundation works.
- TDC in construction yard and camp of the proposed building area to be removed by temporary earth or RCC drains.
- Re-excavation might be needed for quick drainage to the existing khal inside the project area which should be executed properly.

Residual Impact

In case of proper implementation of the above measures, the expected residual impact would be **Negligible**.

8.3.5 Impacts from Generation and Disposal of Human/Solid Wastes

During construction phase, problems related to sanitation and solid waste may result from improper/ inappropriate facilities at the labor sheds. At the peak of construction period, large numbers of workers are likely to be involved in different construction activities. Lack of proper sanitation facilities for project people, including the labor/ construction worker and absence of proper solid waste (e.g., food waste, construction debris) facilities may create an unhealthy environment (including water pollution) within and around the project site.

Mitigation Measures

- Construction camp should be located at the site proposed by the contractor & approved by the Environmental Specialist of EHL.
- Construction of sanitary latrine/Pit latrine with septic tank/ Ring slab system, (separate latrines for male and female workers)
- Erection of "no litter" sign,
- Open areas/ surrounding bushes are not being used as toilet facility.

Residual Impact

In case of proper implementation of the above measures, the expected residual impact would be **Negligible**.

8.3.6 Impacts from Increase Noise Level

Noise pollution is likely to result from a wide range of construction activities at the project site, including the movement of vehicles carrying construction materials, equipment to and from the site, and different construction activities. The main sources of noise during construction period will be site preparation works, excavating, piling, barge & sand pumping, transportation and handling of materials and equipment, other engineering works like riveting, hammering, cutting, welding, etc. Operation of concrete mixers, excavator, construction vehicles, fabrication, handling of equipment and materials, etc. would generate a considerable amount of noise. The noise levels of most of the construction machineries are approximately 10 to 35dBA higher than the base noise level. The noise from these activities and machine/equipment is likely to cause an increase in noise over the "low" base noise level. This high level of noise would have a significant impact on the population residing nearby. Proper mitigation measures have to be incorporated to reduce the impact of noise upon health.

Mitigation Measures

- Maintain all vehicles in order to keep them in good working order in accordance with manufacturers maintenance procedures.
- Make sure all drivers will comply with the traffic codes concerning maximum speed limit, driving hours, etc. (20 km/hr during night time).
- Organize the loading and unloading of trucks, and handling operations for the purpose of minimizing construction noise on the work site.
- Modify equipment to reduce noise (for example, noise control kits, lining of truck trays or pipelines, silencers).
- Maintain all equipment in order to keep it in good working conditions in accordance with manufacturers" maintenance procedures. Equipment suppliers and contractors shall present proof of maintenance register of their equipment.
- Install acoustic enclosures around generators to reduce noise levels.
- Fit high efficiency mufflers to appropriate construction equipment.
- Avoid the unnecessary use of alarms, horns and sirens.
- Notify adjacent landholders prior of any typical noise events outside of daylight hours.
- Plan activities on site and deliveries to and from site to minimize impact.

- Monitor and analyze noise and vibration results and adjust construction practices as required.
- Avoid undertaking the noisiest activities, where possible, when working at night near the residential areas.

Residual Impact

The impacts associated with the noise are likely to be adequately addressed with the help of the above mitigation measures and hence the significance of residual impact will be **Negligible**.

8.3.7 Impacts from Deterioration of Ambient Air Quality

Localized and temporary air pollution may generate from earthworks (e.g., excavation, filling, leveling) during site preparation, movement of vehicles, and operation of machines and equipment. During the construction phase of the proposed project, the important sources of emissions would include those from the operations of construction equipment and machineries, vehicles carrying construction materials to the site and taking construction debris out of the site. The air pollution generated from these activities is likely to be localized (affecting immediate surroundings of the emission source/ project site). lf construction equipment, such as stone (aggregate) crusher, is used at the site, this may result in significant emission of particulate matter during its operation. Since construction of the proposed project would most likely involve significant earthworks, increase in particulate matter in the air from wind-blown dust is also a concern, especially considering the close proximity of a college and residential complex to the project site. The following mitigation measures should be adopted to minimize the possible adverse impacts of project activities on air quality.

Mitigation Measures

- Maintain construction vehicles and equipment in good working condition including regular servicing.
- Operate the construction vehicles in a fuel-efficient manner.
- Cover hauls vehicles carrying dusty materials moving outside the construction site.
- Impose speed limits (maximum 10 km/hr) on all vehicle movement at the worksite and through access roads to reduce dust emissions.
- Water spray to the construction materials or cover (especially sand and boulders/brick chips) prior to loading and transport.

- Equipment/vehicles causing excess pollution (e.g. visible smoke) should be banned from construction sites or fixed immediately prior to further usage.
- Provide filtering systems, dust collectors or humidification or other techniques (as applicable) to the concrete mixing plant to control the particle emissions at all its stages, including unloading, collection, aggregate handling, cement dumping, circulation of trucks and machinery inside the installations.
- Water spray to the material stockpiles as and when required to minimize the potential environmental nuisance due to dust.
- Increase the watering frequency during periods of high risk (e.g. high winds and dry periods). Stored materials such as boulders and sand should be covered and confined to avoid them being wind-drifted.
- Erect dust barriers along the boundary of the construction area to reduce dust movement to the surrounding areas.
- Reschedule earthwork activities when practical, if necessary to avoid during periods of high wind and if visible dust is blowing off- site.
- Immediate disposal/sale of excavated materials

Residual Impact

In case of proper implementation of the above measures, the expected residual impact would be **Negligible**.

8.3.8 Impacts from Degradation of Water Quality

The surface water and groundwater quality might get affected in the construction phase. Construction work at river side, installation of ring bundh, construction of pier, abutment, piling etc. may potentially degrade the surface water quality. In addition, the wastes from construction of labor camps, improper management of liquid wastes, dumping of untreated solid wastes as well as construction wastes in the water bodies and on the ground are the sources of surface water and groundwater quality deterioration. The significance of this potential unmitigated impact has been assessed as **Moderate** on the basis of impact magnitude and receptor sensitivity.

Mitigation Measures

- Camp waste management plan should be prepared and implemented;
- Location of labor shed, sanitary facilities should be far away from water bodies;

- Release of untreated wastes in surface water and on the ground should be prohibited;
- No tube well should be installed within 10m of the septic tank/VIP latrine;
- Construction material, debris, and other construction wastes should not be allowed to enter in the water bodies.

Residual Impact

The impacts associated with the degradation of water quality are likely to be adequately addressed with the help of the above mitigation measures and hence the significance of residual impact will be **Negligible**.

8.3.9 Impacts from Land Use Change

Due to the development of housing area in Dehara Mauza, the present land use within the project area will change with higher density residential area. However, there may also be some spill over impact of the development and this may create pressure of transformation of land use in the adjacent area. Since there are some critical water body and natural setting in the adjacent area such spill over transformation can be detrimental in the long run. The significance of this potential before mitigation impact has been assessed as **Moderate** on the basis of impact magnitude and receptor sensitivity.

Mitigation Measures

- Proper compensation should be provided to the project affected person;
- Proper care should be taken during construction phase for avoiding accident;
- Use barren area during the establishment of workers camp;
- Avoid setting up workers camp close to the vegetative area to minimize vegetation loss;
- To minimize loss of the vegetation during construction plant trees at the basement of the approach road; and
- Aware locals not to harm the planted vegetation in order to protect the green area.

Residual Impact

The impacts associated with changes of land use are likely to be adequately addressed with the help of the above mitigation measures and hence the significance of residual impact will be very **low**.

8.3.10 Potential Impacts on Fauna

The project activities of the proposed EHL Dehara Residential project have some potential impacts (direct and indirect) on the existing ecological environment. Important project activities include land clearing and alteration, movement of people and vehicle, materials placement, excavation, construction work, accident (e.g. spills, leaks of chemicals) etc. During construction phase, land excavation and construction related activities for the proposed project could have some potential impacts (direct and indirect) on the existing faunal environment due to their highly sensitive and reactive behavior in response to disturbance that may occur at or near their habitat. Faunal species that are sensitive to direct (human activity and traffic) or indirect disturbance (noise) would be impacted most. Habitat disturbance would reduce habitat availability and effectiveness for a certain period for mammals, reptiles, amphibians, birds and their predators. There are also some possibilities of direct mortality and displacement of amphibians, reptiles and mammals from the use of vehicles or machineries over the terrestrial faunal habitat or deposition of excavated soil on faunal habitat. Quantification of these losses is difficult; however, the impact is expected to be low intensity and also short term in nature.

8.3.11 Potential Impacts on Flora

The proposed residential development project site and adjacent areas have various types of terrestrial floras that are used by certain types of fauna. None of these floras are threatened in Bangladesh. The proposed project site have few floras, and almost all of these floras might be needed to uproot forever for building construction and ancillary works, hence, adverse impacts are expected. Some terrestrial undergrowth also exists within the project site and adjacent areas, and this undergrowth contributes to maintaining the balance of existing eco-environment. Clearing or removal of that undergrowth would also have some adverse impacts on the existing eco-environment. Quantification of these losses is difficult; however, the impact is expected to be low intensity and also short to long term in nature.

8.4 Impact During Operation Phase

At the operational phase, EHL will be responsible for the operation and maintenance of the Dehara Residential area and ancillary facilities. No significant air and noise pollution is expected during the operation phase. The important issues to be addressed during the operational phase include: (i) impact of additional volume of traffic, (ii) generation of solid waste and their disposal, (iii) generation of domestic wastewater from the building,

(iv) power generation using a generator and (v) fire safety, natural disaster and risk management.

Typical environmental impacts resulted during the operational phase may include:

- Groundwater depletion and water quality
- Wastewater and waste management;
- Noise pollution
- Air pollution

The impacts along with the mitigation measures in this phase of the project are narrated below:

8.4.1 Impacts on Groundwater Table

Implementation of residential area in Dehara Mauza would cause alteration of the existing land use situation and more area is likely to be covered by impervious material. Consequently, ground water recharge through subsurface infiltration would decrease to a great extent. Furthermore, extraction of ground water for regular domestic use would increase tremendously. Groundwater layer would decline at an increased rate in future. Considering the development of 50% housing area, standard rate of domestic water use, and reduced rate of ground water recharge; in future the GWT may decline at a faster rate. This infers that within next 20 years, the rate of subsurface infiltration would decrease, and groundwater abstraction would increase. Around 36~40% reduction of groundwater availability may take place in dry season. This may create concerns over groundwater security in future.

Mitigation Measures

- Rainwater Harvesting (RWH) infrastructure can be adapted at domestic level to reduce the underground water use for domestic purpose.
- For the entire residential area, one central RWH system may be introduced, by constructing artificial ponds for water retention and ground water recharge;
- Porous basement facilities may be kept in parks or amusement spaces so that significant groundwater recharge can take place despite the development.
- Use of surface water may be encouraged for domestic uses. This may be possible through construction of retention pond and surface water treatment plants within the project area.
- Grey water recycling can also be promoted in the study area residents to minimize water channeled into the STP and reduce overall water demand.

Residual Impact

In the event of proper implementation of the above measures, the expected residual impact would be **Negligible**.

8.4.2 Impacts from Wastewater and Solid Waste

During the operation phase of the Dehara Residential project, the occupants of the buildings would generate wastewater. Municipal sewage generated from the project area can cause unhygienic condition and environmental pollution, if proper sewer system is not implemented. If untreated sewage is disposed of to a surface water body (specially the surround lake/perennial water body), it could pollute the waterbody that receives the wastewater.

The occupants of the building would generate solid wastes including organic waste such as waste foods, fruits and inorganic waste such as waste papers, damaged electronic goods, containers and liquid waste such as wastewater, oil, paint etc. The point of generation of the solid wastes could be the cafeterias, office rooms, IT section, conference room, business center, and laboratory facilities. The solid waste needs to be collected and disposed of properly. Improper disposal of the solid wastes such as through open drains or sewer pipe could result in congestion in the drainage system. This could also lead to soil and groundwater contamination through the generation of leachate. If the solid waste is not removed from inside the project area regularly, it could result in unhealthy conditions in the premises and surrounding area including attracting nuisance insects such as flies and mosquitoes.

Mitigation Measures

- Ensuring proper storage, treatment, and disposal of all solid waste.
- An Sewearage Treatment Plant need to be established for treating wastewater and black water generated from in the project area. For this reason, separate drainage of black water to the STP will be useful and can be cost effective in the long run.
- Prohibit direct connection of any sanitation facilities to the stormwater drains. Septic tank needs to be installed in the establishment which will be connected to the local sewage network. Construction of septic tank will lower the pollution load to local sewage system. Septic tank should be desludged regularly.
- Designing and sizing the drains appropriately to convey the estimated quantity of stormwater and/or treated sewage
- Regular maintenance and cleaning of the drain

Residual Impact

In case of proper implementation of the above measures, the expected residual impact would be **Negligible**.

8.4.3 Impacts from Increased Noise Level and Vibration

Prolonged exposure to a high level of noise may cause significant damage to human hearing organ and may cause neurological damage. Therefore, noise assessment during the operational phase of different project components is particularly important.

During the operation phase of the EHL Dehara Residential project, the main source of noise would be the vehicles carrying the residences and visitors to the project area. The vehicle operation and honking of these vehicles could result in noise, which could have increased impacts in case of traffic jam. Another source of the noise could be generators installed as a backup power source if these are not installed in covered places properly.

Mitigation Measures

- Generator should be located in an area in the building which is isolated by noise-proof barriers,
- Greenbelts and plantations or artificial mounds may be built to reduce noise levels.
- Vehicles should strictly maintain sound level as per ECR 2006 inside the project area.
- Carry out regular maintenance of plant, equipment and vehicles.

Residual Impact

In case of proper implementation of the above measures, the expected residual impact would be **Negligible**.

8.4.4 Impacts from Deterioration of Ambient Air Quality

After commencement of the Dehara Residential project, the number of traffic occupying the local road connecting the main road and the project compound will increase. Emission from the increased number of vehicles would impact the air quality in the project area. The impact on air pollution is particularly critical in the dry season, since even at present $PM_{2}o$ and PMs concentration levels exceed the National Ambient Air Quality Standards in Bangladesh set by

the DoE. Depending on the fuel type used, the generator could be an additional source that might add up to the existing air pollution level.

Mitigation Measures

- All vehicles, equipment and machinery used should comply with the relevant ECR norms and other rules;
- All vehicles used on site for construction purposes should have currently valid fitness certificates always issued by the BRTA;
- Generators should be regularly inspected to ensure that they are operating efficiently, and emission standards are met;
- Periodical monitoring of air pollutants and if values exceed the standard limits, proper measures should be taken;
- Use less energy in individual buildings/apartments which will help to improve air quality, curb greenhouse gas emissions, encourage energy independence and save money;

Residual Impact

In case of proper implementation of the above measures, the expected residual impact would be **Negligible**.

8.4.5 Socio-economic Impacts

Housing, Social and Urban Amenities

The primary rationale for the Dehara housing project is its potential to meet increasing demand for housing and urban ameneties in the surrounding urban area which is experiencing rapid urban industrial and commercial activities. When the housing area is fully operationalized the direct housing facitlities provided by the project will provide more than direct housing facility but will also cater to better living condition to high level management staff in the emerging industrial and commercial facilities spanning in the vicinity (for more detail see chapter 9). In the absence of good quality housing and urban amenities in the area the workers and management staff in the faciltiies would find this area less attractive to work in. Also for the ever increasing urban area around Dhaka city which has well expanded to Savar and Ashulia area this housing project will be work as a planned intervention thorugh the market channel

with little government investment. This will definitely contribute to restricting urban sprawl in the adjacent are in the short, medium and long term.

Employment and Economy

There are 1324 plots of different types in the Dehara Residential project. A large number of people will be engaged in this project activities during construction, while employment of a good number of people will be generated at the post-construction period. During construction period many skilled and semi-skilled labour will be engaged, where, local people will get priority. Besides, after completing the construction period, this project area will create diverse job opportunities. Moreover, the local markets and businesses will also expand and people of the locality will also be employed in those upcoming activities. The significance of this potential positive impact is assessed as medium on the basis of impact magnitude. The Dehara Residential project would facilitate the development of resilient infrastructure in the country, which would contribute to the overall economy.

Traffic Condition

EHL-Dehara Residential project will develop 27.89 acre internal road network which will connect with mainstream roadway communication, As a result, traffic flow would be increased in the project area. Employees, students, teachers, traders will easily commute using this network. The increased traffic could be generated by considerable number of EHL vehicles, and vehicles carrying the residences and visitors to the project area.

Land Price

It is observed that any kind of development initiatives tend to ensure other infrastructural development creating new entrepreneurship opportunity that also impact on land price in the vicinity of the project location. During construction and post-construction periods, land price will increase with the passage of time due to upcoming business opportunities and other infrastructural development within the direct and indirect impact area. The land price will also be increased due to the increased productivity of land and improved communication system. To cater to the demand of the people living in the housing area local market for agricultural and consumption goods will exapand and that will have spill-over impact in the local economy.

Investment Facilities

The investment opportunities will increase significantly in two ways. Firstly, people will invest in the housing sector. Secondly, they would also like to invest in commercial and industrial purposes within or close to the study area thereby leading to more economic opportunities and transactions in local economy.

8.5 Some Sustainable Development Strategies

Apart from standard analysis of impact, some strategies are highlighted in this section based on emerging trend of environmental risk and threat.

Water Management Approach

Housing projects typically rely on pumping of groundwater for low cost water supply for the potential inhabitants. However, in the long term this can lead to lowering of groundwater table. For sustainable water management following options can be considered:

- With development of concrete surfaces, a significant portion of the current land area will become impermeable. However, with proper planning it will be worthwhile to leave some areas in permeable forms either by creating green surface or bare land. This will enable maximizing stormwater infiltration for sustainable replenishment of groundwater reserve.
- Storm water drainage channels can also be equipped with focused storm water infiltration pits or similar infrastructure where possible. Also rain gardens and bioswales to control runoff and prevent water pollution will also be useful.
- For potential community level water demand (e.g. watering green space, firefighting etc.) water reservoirs can be created by draining stormwater in the reservoirs.

Discharge and Effluent Management

- Dehara housing project will mostly create residential waste. The project area will also be close to some significant perennial waterbody that are habitat for fish and bird species. To preserve that current natural quality and baseline environmental scenario it will be a good idea to ensure that Black water (also preferably grey water) are treated in the STP before discharge.
- From the 3R approach a composting facility is recommended subject to facilitating a workable business model along with solid waste management for the project area.

Prevent Heat Island and Sustainable Micro-Climate Management

Currently urban areas are under increasing threat of micro-climate extremes with severe risk of livability and environmental degradation. Hence proactive and preventive measures to curb potential heat island effect and manage microclimates for the proposed project are outlined below.

Maximize Green Space

- Dedicate a significant portion of the project area to parks, green corridors, and strategically placed trees.
- Consider pocket parks, bioswales, and green roofs to increase greenery throughout the development.

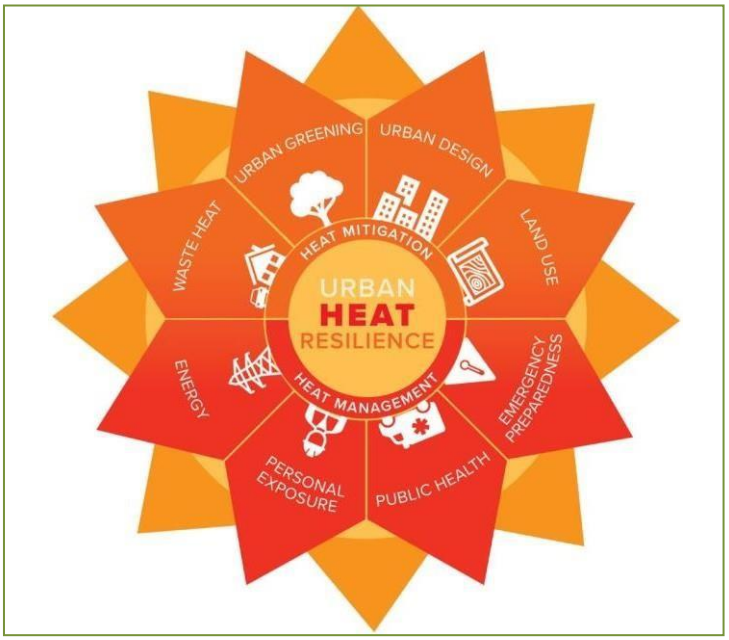


Figure 8.1: Heat Resilience Strategies in an Urban Setting (Ref: Meerow & Keith, 2022)

Urban Shading

- Design buildings to shade streets and sidewalks during peak sun hours.
- Encourage the use of awnings, overhangs, and strategically planted trees for shade.
- Permeable Surfaces.
- Minimize the use of asphalt and concrete for roads, walkways, and parking lots.
- Opt for permeable paving materials that allow rainwater to infiltrate the ground, reducing heat storage.

Building Orientation

- Orient buildings to maximize natural ventilation and minimize solar heat gain on south-facing walls.
- Consider passive cooling strategies like light shelves and wind catchers.

Reflective Surfaces

- Use light-colored, reflective materials for roofs and pavements.
- This reflects sunlight away from buildings and reduces heat absorption.

Green Roofs and Walls

- Install green roofs and vertical gardens on buildings.
- Vegetation provides natural insulation, cools buildings through evapotranspiration, and improves air quality.

Weather Features

- Integrate water features like fountains and ponds to create evaporative cooling and increase humidity.

Urban Agriculture

- Encourage residents to grow vegetables and fruits in their backyards or community gardens.
- Vegetation transpires, providing cooling and improving air quality.

Urban Forestry

Plant a diverse mix of native trees throughout the development. Trees provide shade, filter air pollutants, and reduce noise pollution.

Community Education

Educate residents on the importance of microclimate management and provide them with tips on sustainable landscaping practices.

Maintenance

Develop a long-term maintenance plan to ensure the effectiveness of green infrastructure elements.

By implementing these strategies, the housing project can create a cooler, more comfortable microclimate for residents and help mitigate the urban heat island effect and other micro-climatic instabilities.

CHAPTER 9
PUBLIC CONSULTATION AND DISCLOSURE

9.1 Introduction

Public consultation is a mandatory part of the Environmental Impact Assessment (EIA) study for any development project according to the EIA Guidelines of the DoE. It is a part of the EIA process aimed at involving the stakeholders in the project development and implementation process. Public consultation of the EIA study of **Dehara Residential Project** has been conducted by a formal meeting comprising of local people who are likely to be impacted is conducted in the close vicinity of the project location. During the consultation meeting, the proposed housing project infrastructures and their associated impacts are discussed following a comprehensive checklist. Therefore, the participants disclosed their opinions spontaneously and considered this attempt as a neutral platform to share their experiences to ensure the proposed housing project is socially acceptable and environment-friendly. This chapter is organized in the following way. After the introduction, approach and methodology has been discussed. Then a description of the consultation meeting is presented. This is followed by a compilation of feedback from the stakeholder on different aspects of the housing project. The concluding remarks based on the consultation are summarized at the end.

9.2 Approach and Methodology of Public Consultation

9.2.1 Approach

A collaborative and participatory approach is followed for identifying the participants as well as conducting public consultation meetings. Initially, the study team consulted with the project proponent to understand the project situation and to identify the potential stakeholders. For the study stakeholders were consulted in different settings. Project proponent and developers were consulted recurrently and necessary documentation were assembled to gather information pertinent to the project. Other stakeholders, specially current inhabitants, project staff, local service providers, landowners and tenants were consulted at various roadside meetings. The consultants unfold the issues and in turn, the participants gave feedback to the given issues. In some cases, two-way discussions were held in the meeting. All interviews were provided with necessary detail of the project and they have given informed consent to share their views during the consultation. The overall consultation process is shown in Figure 9.1.

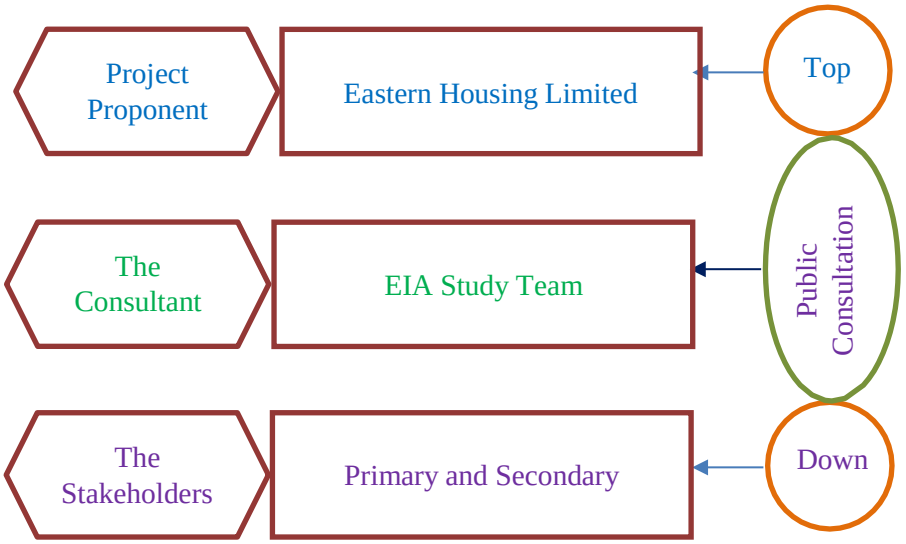


Figure 9.1: Public Consultation Approach

9.2.2 Methodology

a. Identification of Stakeholders

Stakeholders include those who affect or are being affected by policies, decisions, or actions within a particular system are identified first. Stakeholders can be groups of people, organizations, institutions, and sometimes-even individuals. Stakeholders can be divided into primary and secondary stakeholder categories.

Primary Stakeholders: Primary stakeholders are people who would be directly benefited or impacted by the proposed housing project. In this context, the people who have/had land within the project boundary, and/or are currently living in the project area are considered the primary stakeholders.

Secondary Stakeholders: This category of stakeholders pertains to those who may not be directly affected or benefitted but have interests that could contribute to the study, play a role in implementation at some stage, or affect decision-making on project aspects. The local elites, people who are living in close vicinity, occupational groups of this project are under this category.

b. Time, Date and Venue Selection

The public consultation process has been conducted by walk-in meeting at various stages and at different times and by one day formal consultation meeting. Mostly the stakeholders were approached in the project area. Since the project area has a specified boundary most people who are found roaming around or engaged in some work in that area are some how related to the project. A venue has been selected considering the closeness to the proposed project; and easy accessibility to the venue; The Date and time of formal consultation were also finalized considering the availability of the participants.

c. Tools and Techniques

The public consultation meeting has been conducted using the following tools and techniques.

Checklist: A comprehensive checklist covering all possible issues to be addressed was prepared through consultation among the multidisciplinary study team. This checklist was used in the meeting to unveil peoples' perceptions and opinions along with suggestions. Due to the adopted consultation approach not all stakeholders are consulted were approached with same discussion questions. It was mostly in the form of an open-ended discussion.

Attendance list: An inventory of the stakeholders consulted was maintained in an attendance sheet containing name, occupation and contact cell phone number. In addition, photographs were taken for these consultations at different ocassions.

d. Consultation Process

A four members study team conducted the consultation meeting in the field. During the consultation session, the following process was followed with sequences.

Greetings and introducton: While in the field, effort were taken to approach a group of people who are in the project area for some purpose so that a small FGD like situation can be created**.** At the outset, before starting the conversation, each person or group is greeted and an introduction to the project is given. This is followed by informed consent which is an ethical necessity for public consultation. Only those people who provided consent were interviewed and consultant.

Understanding the Connection: For conducting an effective and fruitful discussion, the consulting team tries to find the connection of the person(s) to the project or the project area. Some examples of diverse connection include leaser of nearby lake (*jolmohal*), farmers who came to graze their cattle in the green areas of the area, project staff, local inhabitants, land owners etc.

Thematic Discussion: After the initial introduction thematic discussion are carried out with the stakeholders and the opinions are checked and triangulated across members of the small scale FGDs or individual meetings.

Encouragement for participation: Generally, all participants cannot participate equally. In fact, a substantial number of participants tended to remain silent in any meeting. However, the study team encouraged all to participate willingly through explaining the purposed of the studya and by informing them why their opinion are important to furnish the studies.

Note taking: Discussed issues and opinions were written in notebook continuously and carefully. All issues were given equal importance. The insights were utilized in identifying and measuring the impacts and finally devising the mitigation measures.

9.3 Consultation Meeting

9.3.1 Venue, Date and Time of Consultation

The formal consultation was arranged in the project site from 4 pm to 6 pm on 20 March 2024. However, before the formal meetings some informal site visit were also conducted and people were consulted in those occasions as well. The informal consultation helped gather primary ideas on the project so that the more useful discussion can be carried out during the formal interview process.

9.3.2 Participants

A total 15 numbers of participants comprising land owners, several occupational groups, project staff, mosque imam, local transport staff, current inhabitants and local elite persons were present in the meeting. The detailed participant list is attached in **Appendix E**.

9.4 Stakeholders Knowledge about the Project

Participants indicated that they were familiar with the Dehra Residential Project from its inception. The project proponent engaged in regular consultations with them, providing updates on the project's scope and its implementation strategy. Residents of the project area expressed a keen interest in monitoring the progress of the project activities, recognizing that their future living conditions hinge on the project's successful and environmentally responsible execution. Several individuals have already invested in land within the project area and have begun residing there. Most of the people contacted have connections to the project, which has kept them well-informed about its developments.

9.5 Stakeholders Attitude towards the Project

The participants expressed a highly positive attitude towards the “Dehara Residential Project”, noting its beneficial impact. They believe that with proper implementation, the advantages of the project will further increase. Additionally, they reported that the project authorities have pledged to establish new social amenities, including schools, colleges, mosques, playgrounds, as well as enhanced services such as healthcare facilities, a road network, a post office, and a police station. The participants emphasized that these commitments should be fulfilled to ensure that community members can access and benefit from these facilities. They also observed that the project has attracted more residents to the area and significantly improved the local law-and-order situation compared to previous years.

9.6 Potential Positive Impacts and Enhancement Measures

The participants unveiled several benefits that are likely to precede for implementation of the proposed project. A few of the items discussed in the meeting are presented below.

9.6.1 Planned Residential Area

Positive Impact: The Dehara Residential Project is meticulously planned to provide comprehensive community facilities for its residents. The area surrounding the project is

rapidly developing into an industrial and commercial hub. There is an expected surge in housing demand driven by the growth of Ready Made Garments (RMG) factories, textile mills, economic zones, and potential investments from entities such as British American Tobacco, Beximco, and various public sector facilities. **Figure 9.2** illustrates the major industrial and commercial locations near the site area, confirming the strategic placement of the project. Consequently, the need for planned residential land use is increasing steadily. In response, Dehra Residential Project is committed to meeting the demand for environmentally friendly housing and playing a significant role in the area's development.

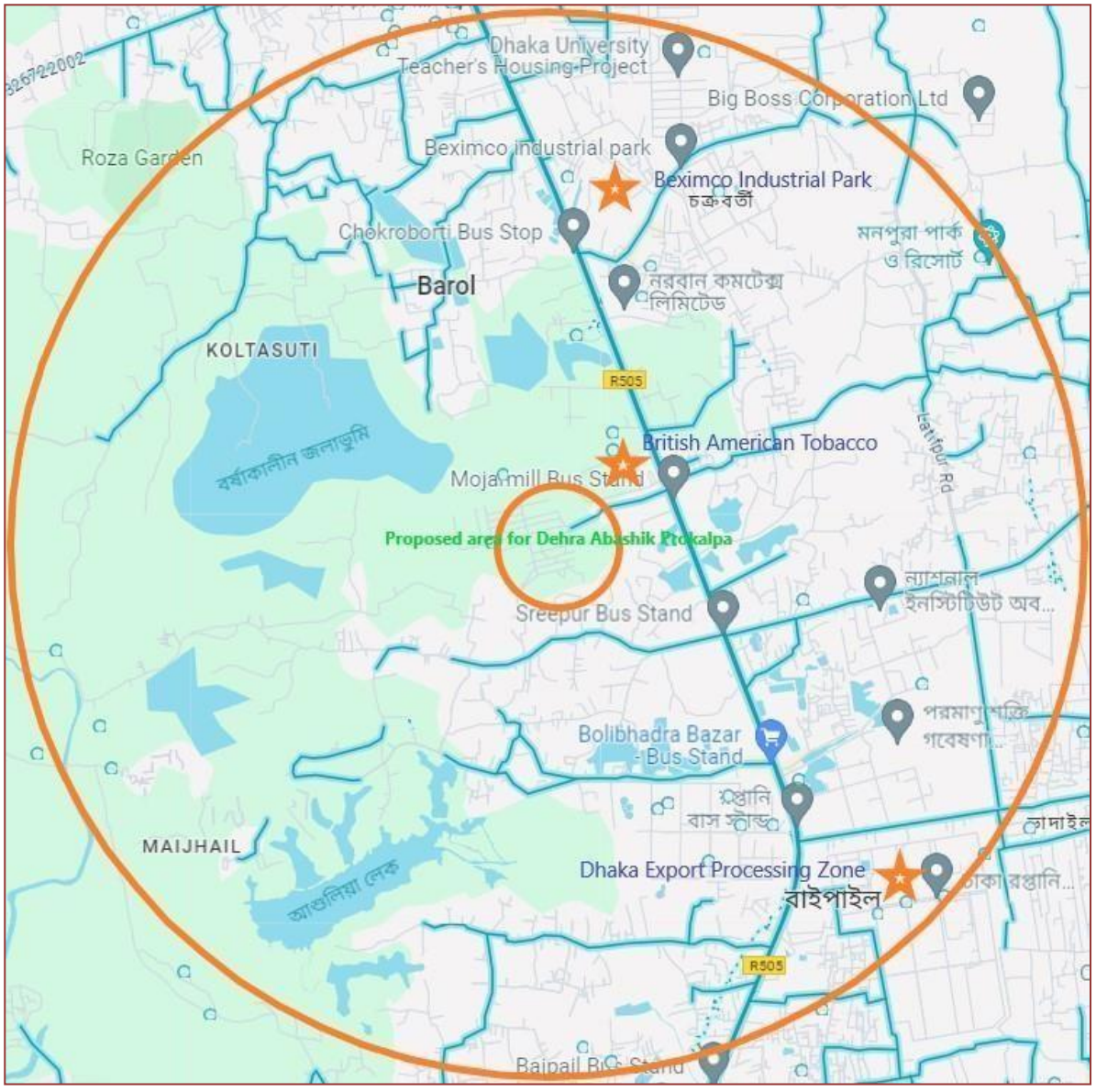


Figure 9.2: Major Industrial Activities in the Vicinity of (2km Buffer) of the Project Area

Enhancement Measure: Participants expressed concerns about the severe pollution in Dhaka city, noting the potential for similar environmental challenges to affect their area due to rapid growth. They emphasized the importance of developing housing facilities with an environmentally friendly plan to prevent the haphazard growth of residential areas. As the land use in the surrounding area shifts towards commercial and industrial purposes, the need for an environmentally friendly housing project becomes increasingly critical. Participants strongly advocated for measures to ensure a pollution-free, livable environment.

9.6.2 Communication Network

Positive Impact: According to the project plan, the Dehra Residential Project will establish new road networks specifically designed to serve the residents of the project area. These roads will notably improve connectivity, especially to the northeastern part of the project area, which currently lacks road access. All inhabitants will benefit from this new approach road, replacing the existing narrow, muddy, and fragile paths with a developed, widened roadway.

Enhancement Measure: Participants suggested that the project authority should ensure that people living beyond the project area also have access to these new road networks. However, they raised concerns that the project area, being demarcated and bounded by concrete walls, might seem like a barricade to local residents. To mitigate this, it is recommended to enhance the aesthetic and environmental quality of the area by planting trees along both sides of the roads. This measure not only promotes a greener environment but also softens the visual impact of the concrete barriers.

9.6.3 Land Utilization

Positive Impact: A considerable portion of the project area has already undergone development, with other sections being transformed and readied for future development. Some areas currently feature green cover, including trees and vegetable gardens, tended by the residents. The project will facilitate the development of these lands into housing and residential areas. The interest from government and private agencies in developing planned housing projects post-implementation is expected to increase land demand, accelerating the area's development. Consequently, landowners will likely see an increase in land value, providing them with greater financial returns. The surrounding area is experiencing rapid urbanization, with a growing demand for housing due to notable industrial facilities nearby.

Enhancement Measure: The project proponent should assist local landowners in developing their properties to capitalize on the increasing land value and demand.

9.6.4 Land Price

Positive Impact: The project proponent acquired most of the land years ago when prices were considerably lower. Presently, land values have surged by more than 120 times (is it really!), attributed to the passage of time, improved living conditions, services, and heightened demand in the locality. This increase in land price benefits both the government, through taxes, and landowners, through capital gains.

Enhancement Measure: Connecting the adjacent area with the project's road networks is likely to further elevate land prices above current market rates. Full project implementation is expected to enhance living conditions, which will, in turn, drive up land prices even more.

9.6.5 Services and Facilities

Positive Impact: Residents anticipate that the project's completion will lead to improved health and education services. The project proponent plans to establish standardized hospitals and educational institutions with the support of related stakeholders, positively impacting the local community in the future.

Enhancement Measure: Residents have expressed that service providers should offer services at more affordable rates to ensure that the less affluent can access them. They also emphasize the need for these facilities to be established promptly.

9.6.6 Employment

Positive Impact: The project is expected to create employment opportunities for various occupational groups. Laborers involved in earthworks may find work in land preparation and development, while construction workers will have opportunities in building construction. Additionally, the project is likely to stimulate local businesses, creating employment hubs for the community.

Enhancement Measure: The community has expressed a desire for local residents to be given priority when filling employment opportunities related to the project's activities.

9.7 Potential Negative Impacts and Mitigation Measures

9.7.1 Drainage Congestion

The project area is surrounded by a resourceful lake. Post-implementation, there is a risk that household wastewater and rainwater will drain into these lakes, potentially leading to contamination. Standard drainage measures will be implemented, including appropriate sloping and channeling of water. A Sewage Treatment Plant (STP) will be established to ensure that polluted water does not contaminate the lake water.

9.7.2 Population Redistribution

Negative Impact: The project aims to provide human habitation, which will concentrate a significant number of people in the area. This concentration may lead to the development of unplanned settlements around the project area. The surrounding suburb should be developed according to an effective subdivision plan, with thorough site planning considerations to prevent unplanned settlements.

9.7.3 Social Relation

The introduction of modern facilities in the area may weaken traditional social bonds. To preserve community interests and strengthen social cohesion, several community clubs and associations should be established. These groups can actively engage in community-building activities and support the maintenance of traditional social ties.

9.7.4 Traffic Congestion

The proposed development is expected to increase traffic, which could lead to significant congestion in the future. A comprehensive traffic and road plan should be developed to address potential congestion. This plan should include the development of a robust traffic management system to ensure the area remains congestion-free.

9.8 People's Concluding Remarks

Despite acknowledging the potential for some negative impacts, the local community largely views these concerns as minor compared to the anticipated benefits of the project. Most stakeholders interviewed foresee personal or communal advantages from the project's implementation, fostering a predominantly positive outlook towards it. Consequently, there is a strong community push for the immediate commencement of the project. Residents have expressed their willingness to support and assist the project authorities in its execution,

believing that the project will effectively address current issues. Particularly given the rapid industrial and commercial growth in the vicinity, stakeholders emphasize the benefits of expedited project implementation.

CHAPTER 10
ENVIRONMENTAL MANAGEMENT & MONITORING PLAN

10.1 Institutional Arrangement

The National Environmental Policy (1995) was enacted by the Ministry of Environment and Forest (MoEF) as a follow-up to the National Conservation Strategy (IUCN, 1991). The Department of Environment (DoE), serving as the implementation wing of the MoEF, is responsible for enforcing the Bangladesh Environment Conservation Act (BECA) 1995, the Bangladesh Environment Conservation Rules (BECR) 1997, and other environmental laws, ordinances, and regulations enacted by the Government of Bangladesh (GoB).

The National Environmental Council (NEC), chaired by the Prime Minister, addresses inter-sectoral conflicts related to environmental issues. The Executive Committee (EC), led by the Secretary of the MoEF, prepares working papers for the NEC and maintains all relevant records. The DoE's divisional headquarters are managed by Directors, while the Central Office in Dhaka is headed by a Director General (DG).

10.2 Objectives of the Environmental Management Plan

The primary purpose of the Environmental Management Plan (EMP) is to outline specific actions that the project authority will undertake. These actions will be integrated into the project management system and implemented at various stages of project development. The EMP includes both generic good practice measures and site-specific measures aimed at mitigating potential impacts associated with the project activities.

The main objective of the EMP is to ensure that development within the identified study area is conducted with the judicious utilization of non-renewable resources and that the stress/load on the ecosystem remains within its permissible assimilative capacity, i.e., its carrying capacity. In this context, assimilative capacity refers to the maximum amount of pollution load that can be discharged into the environment without affecting the designated use of various environmental attributes. This capacity is governed by dilution, dispersion, and removal due to physico-chemical and biological processes. An effective EMP ensures that these environmental requirements and objectives are met during all phases of the project. The long-term objectives of the EMP for all environmental attributes are as follows:

- Compliance with Regulations: To comply with all regulations and applicable laws stipulated by the Department of Environment (DoE).

- Workplace Conditions: To create good working conditions for employees.
- Performance and Response: To encourage and achieve the highest performance and response from individual employees and contractors.
- Stakeholder Engagement: To plan and implement a comprehensive strategy for stakeholder engagement.
- Budgeting and Funding: To allocate and manage funds for environmental management effectively.
- Innovation and Development: To continuously develop and search for innovative technologies for a cleaner and better future environment.
- Sustainable Development: To contribute significantly to sustainable development.

10.3 Environmental Monitoring Plan

Environmental monitoring is an essential tool for environmental management as it provides the fundamental information necessary for making rational management decisions. The purpose of the monitoring program is to ensure that the envisaged objectives of the project are achieved and result in the desired benefits for the target population. To ensure the effective implementation of the Environmental Management Plan (EMP), it is crucial to design and carry out an effective monitoring program. The Environmental Monitoring Plan within the EMP for the proposed project has been designed with the following objectives:

- Measure Impacts: To measure the extent of expected or poorly quantified impacts.
- Ensure Mitigation Measures: To ensure the incorporation of Environmental Mitigation Measures during the implementation of the proposed project.
- Observe Effectiveness: To observe the effectiveness of the implemented Environmental Mitigation Measures.
- Early Detection: To ensure early detection of unexpected impacts and facilitate the adoption of appropriate protective measures.
- Periodic Reviews: To provide periodic reviews to observe adherence to Environmental Quality Standards (EQS) and adjust Environmental Mitigation Measures if required.
- Corrective Actions: To detect unacceptable levels of impacts and adopt corrective measures promptly.

By achieving these objectives, the Environmental Monitoring Plan will play a crucial role in ensuring the successful implementation of the Environmental Management Plan and the overall environmental sustainability of the proposed EHL project.

10.3.1 Liquid Waste Management

Site development in the project areas involves no liquid discharge. Domestic wastewater from project activities and completed housing is treated in soak wells. There will be no source of air pollution in the proposed project. During land development, the process will involve raising the land with dredged sand from the river and mud from within the project area. However, there may be instances of dust emission if soil is carried from outside sources. In such cases, the proponent has assured the use of covered trucks, making air quality monitoring unnecessary. During land development, there will be no solid waste. After land development is completed, construction work will be undertaken by the occupants themselves. Noise pollution during land development will mainly be due to the operation of bulldozers and other vehicles and will be minimal in intensity.

10.3.2 Occupational Health Safety for Laborers

A comprehensive Health and Safety Plan should be developed to prevent accidents, injuries, and work-related diseases. Key measures include:

- First Aid: Provide first aid and ensure proper engagement procedures to access appropriate emergency facilities.
- Health Screening: Conduct health screening of employees before they work on-site and live in temporary accommodation facilities.
- Training: All employees must undergo induction health and safety training before commencing work.
- Youth Employment: Construction contractors should not hire individuals under the age of 18 on permanent contracts but may include short training activities for youth where possible.
- Health Insurance: Provide health insurance to employees for the duration of their contracts.

10.3.3 Safety Management

The project authority should implement a disaster management plan to protect properties from waterlogging and other potential hazards. This includes raising the land to a higher level, considering the maximum flood level. Provisions should be made for separate rescue operations in case of emergencies, such as unforeseen disasters or worker accidents, and viable measures should be taken to prevent such incidents.

10.3.4 Tree Plantation

To protect the environment and the occupants of adjacent areas from noise and dust emissions from land development activities, a buffer trip of trees and plants should be provided around the project area. Trees, plants and shrubs improve the general quality of the environment by purifying the air by absorbing toxic gases and particulate matter, reducing noise levels, providing shelter to birds, preventing soil erosion, maintaining ecological balance and improving the natural beauty. A green belt should be created around the project area and in open spaces between housing blocks. Carefully selected trees should be planted to improve environmental aesthetics, reduce dust and buffer noise. This could also be commercially viable by producing timber or fruits.

10.3.5 Environmental Aesthetics

To make the project environmentally more acceptable and pleasing, it is required to select and plant perennial species for creating the buffer zone/green belt. Additionally, plantations and grass-covered areas should be established in other possible places within the project site. This wil enhance the aesthetic appeal of the project. This measure will soften the impact of a large, permanent establishment introducing into a practically rural, calm landscape. Regulatory measures should be undertaken by the appropriate authority to prevent uncontrolled and unplanned land use in the area.

10.3.6 Transport and Traffic Facilities

The road network inside the project has a higher level of service (LOS-A) which contributes to easier accessibility and mobility. Sustainable transportation design has been considered in planning this project, ensuring that the additional traffic volume generated will be minimal. The project is located on the west of Dhaka-Kaliyakoir highway. As a residential project, it is assumed that most trips generated from Dehara Residential Project, would be short trips, thereby not significantly affecting the highway traffic flow. Key measures include:

- Maintenance: Provision of proper maintenance works on traffic signs, lane marking, pedestrian crossing and instruction to guide people.
- Parking Facilities: Provision of parking facilities should follow the Dhaka Mega City Building Construction Rules, 2008.
- Noise Reduction: Greenbelts and plantations may be used to reduce noise levels.

- School and Institution Transport: Every educational institution should have its own school and staff bus within vicinity of the study area.

10.4 EIV with EMP and without EMP

The Environmental Impact Assessment (EIA) for the housing project was conducted following a standard methodology as mentioned in Chapter 1. The Environmental Impact Valuation (EIV) revealed that the positive impacts outweighed the negative impacts during the operation phase. The EIV for the project during the operation phase is currently +21.

However, the implementation of an Environmental Management Plan (EMP) can significantly improve the overall environmental performance of the project. The EMP outlines mitigation measures to reduce negative impacts and enhancement measures to amplify positive impacts throughout the construction and operation phases. By adhering to the EMP, the project's EIV during the operation phase can potentially increase from +21 to +86. This substantial improvement in the EIV is achievable by undertaking the following measures outlined in the EMP:

- Implementing mitigation strategies to minimize or eliminate negative environmental impacts associated with the project's activities.
- Adopting enhancement measures to maximize the positive environmental impacts generated by the project's operations.

In summary, while the housing project currently has a positive EIV of +21 without the EMP, the implementation of the mitigation and enhancement measures proposed in the Environmental Management Plan can significantly boost the project's overall environmental performance, raising the EIV to +86 during the operation phase.

Table 10.1: EIV with and without EMP during Constrution Phase

Parameters	Relative importance value	Degree of Impact		EIV	
		Without EMP	With EMP	Without EMP	With EMP
1. Physical					
Hydrology and Flooding	4	-1	0	-4	0
Water Pollution	3	-1	0	-3	0
Drainage	4	-1	0	-4	0
Air Quality	2	0	0	0	0
Noise Pollution	2	-2	0	-4	0
Ground Water Table	3	-1	0	-3	0
Soil Characteristics/Soil Fertility	2	-1	0	-2	0
2. Ecological				0	15
Fish	6	-1	0	-6	0
Forest/ Green cover	4	0	0	0	0
Wildlife and Biodiversity	4	0	0	0	0
Solid Waste	2	-1	0	-2	0
Eutrophication	2	0	0	0	0
Wetland and Wetland Habitat	4	0	0	0	0
Terrestrial Habitat	2	-2	0	-4	0
Trees and Vegetation	2	-1	0	-2	0
Heat Island	3	-1	0	-3	0
Waste water	1	-1	0	-1	0
3. Impact on Human interest					
Lands use/ land value	6	0	1	0	6
Housing and Amenities	7	0	1	0	7
Commercial/ Industrial Activities	5	0	1	0	5
Employment Opportunities	5	1	2	5	10
Transportation & Communication	5	0	1	0	5
Landscape	3	-1	0	-3	0
Agricultural Growth	4	0	0	0	0
4. Quality of life					
Travel safety	3	3	-1	0	-3
Health	3	3	-1	0	-3
Education and literacy	3	3	0	0	0
Sanitation & Pure Water Supply	3	3	0	1	0
Cultural Heritage& Recreation	3	3	0	0	0
Total	**100**			**-42**	**36**

Table 10.2: EIV with and without EMP during Operation Phase

Parameters	Relative importance value	Degree of Impact		EIV	
		Without EMP	With EMP	Without EMP	With EMP
1. Physical					
Hydrology and Flooding	4	-1	1	-4	4
Water Pollution	3	-1	0	-3	0
Drainage	4	-1	1	-4	4
Air Quality	2	0	0	0	0
Noise Pollution	2	0	0	0	0
Ground Water Table	3	-1	1	-3	3
Soil Characteristics/Soil Fertility	2	0	0	0	0
2. Ecological					
Fish	6	0	0	0	0
Forest/ Green cover	4	0	0	0	0
Wildlife and Biodiversity	4	0	0	0	0
Solid Waste	2	-1	1	-2	2
Eutrophication	2	-1	0	-2	0
Wetland and Wetland Habitat	4	0	0	0	0
Terrestrial Habitat	2	-1	0	-2	0
Trees and Vegetation	2	-1	1	-2	2
Heat Island	3	-1	1	-3	3
Waste water	1	-1	0	-1	0
3. Impact on Human interest					
Lands use/ land value	6	1	2	6	12
Housing and Amenities	7	1	2	7	14
Commercial/ Industrial Activities	5	1	1	5	5
Employment Opportunities	5	1	2	5	10
Transportation & Communication	5	1	1	5	5
Landscape	3	0	1	0	3
Agricultural Growth	4	1	1	4	4
4. Quality of life					
Travel safety	3	1	1	3	3
Health	3	1	1	3	3
Education and literacy	3	1	1	3	3
Sanitation & Pure Water Supply	3	1	1	3	3
Cultural Heritage& Recreation	3	1	1	3	3
Total	**100**			**21**	**86**

10.5 Environmental Code of Practice

The environmental code of practice (ECoP) has been presented in **Table 10.3** below:

Table 10.3: Environmental Code of Practice

Parameters / Activities	Mitigation/Compensation Measure/Guideline
ECoP1: Air Quality Management	
Construction activities	Water the material stockpiles, access roads and bare soils on an as required basis to minimize the potential for environmental nuisance due to dust.
	Increase the watering frequency during periods of high risk (e.g. High winds).
	Stored materials such as excavated earth, dredged soil, gravel and sand shall be covered and confined to avoid their being wind-drifted
	Minimize the extent and period of exposure of the bare surfaces
	Reschedule earthwork activities or vegetation clearing activities, where practical, if necessary to avoid during periods of hi h wind and if visible dust is blowing off-site
	Restore disturbed areas/side of the embankment as soon as practicable plantation/vegetation/ grass-turfing
	Establish adequate locations for storage, mixing and loading of construction materials,in a way that dust dispersion is prevented because of such operations
	Crushing of rocky and aggregate materials shall be wet-crushed, or performed with particle emission control systems
Odor from Construction labor camps	Construction worker's cam shall be located at least500 m away from the nearest habitation.
	The waste disposal and sewerage system for the camp shall be properly designed, built and operated so that no odor is generated.
ECoP2: Noise Management	
Construction vehicular traffic	Maintain all vehicles in order to keep it in good working order in accordance with manufactures maintenance procedures
	Organize the loading and unloading of trucks, and handling operations for the purpose of minimizing construction noise at the work site.
Construction machinery	Appropriately site all noise generating activities to avoid noise pollution to local residents
	Maintain all equipment in order to keep it in good working order in accordance with manufactures maintenance procedures.
Construction activity	Notify adjacent landholders/schools prior an typical noise events outside of daylight hours
	Employ best available work practices on-site to minimize occupational noise levels
	Install temporary noise control barriers where appropriate
	Plan activities on site and deliveries to and from site to minimize impact
	Monitor and analyze noise and vibration results and adjust construction practices as required
	Avoid working during 09:00 m to 06:00 am within 500m from residences.
ECoP3: Water Resources	
Hazardous Waste Management	The contractor will minimize the generation of sediment, oil and grease, excess nutrients, organic matter, litter, debris and any form of waste (particularly petroleum and chemical wastes).
Drainage Congestion	Do not allow ponding of water especially near the waste storage areas and construction camps

Parameters / Activities	Mitigation/Compensation Measure/Guideline
	Discard all the storage containers that are capable of storing of water, after use or store them in inverted position.
	Reinstate relief and landscape
	Monitor drainage pattern after hi h down pouring and recession flood
	Connect water pockets to the nearest drainage structures/canals
Construction activities in water bodies	Protect water bodies from sediment loads by silt screen or bubble curtains or other barrier.
	Do not discharge cement and water curing used for cement concrete directly into water courses and drainage inlets
	Monitor the water quality in the runoff from the site or areas affected by dredge plumes, and improve work practices as necessary
ECoP4: Soil and Land Management	
Sources of Material for Earthwork	During design the segment wise soil requirement and location of the sources of soil for earthwork for each road construction/ rehabilitation will be identified.
	Selection of Borrow Areas for earthen material collection.
	No objection from land owner/Revenue authorities as applicable
	Contractor shall ensure that borrow materials used for road filling is free of pollutants
	Disposal of excess soil materials will be done at site with no objection from DoE and local authority
Borrowing of Earth	**Borrow Area Selection:** Borrowing close to the toe line on any part of the embankment is prohibited. Earth available from dredging as per design, may be used as road material (if necessary and applicable), subject to approval of the Engineer, with respect to acceptability of may be avoided on the following areas:
	Lands close to toe line and within 0.5 km from toe line.
	Irrigated agricultural lands (In case of necessity for borrowing from such lands, the topsoil shall be preserved in stockpiles.
	Grazing land.
	Lands within 1km of settlements.
	Environmentally sensitive areas such as reserve forests, protected forests, sanctuary, wetlands. Also, a distance of 500 m will be maintained from such areas.
	Unstable side-hills.
	Water-bodies (only if permitted by the local authority, and with specific pre-approved redevelopment plans by the concerned authority and engineer-in-charge)
	Streams and seepage areas.
	Areas supporting rare plant/ animal species.
	Documentation of Borrow Pit The contractor must ensure that the following data base be documented for each identified borrow areas before commencing the borrowing activity that provide the basis of the redevelopment plan.
	Chainage along with offset distance;
	Area (sqm);
	Photograph and plan of the borrow area from all sides;
	Type of access/width/kutcha/pucca etc. from the roadway;
	Soil type, Slope/drainage characteristics;
	Water table of the area or identify from the nearest well, etc;
	Existing land use, for example barren / agricultural /grazing land;
	Location/name/population of the nearest settlement from borrow area;

Parameters / Activities	Mitigation/Compensation Measure/Guideline
	Quantity excavated (likely and actual) and its use;
	Copy of agreement with owner/government; and
	Community facility in the vicinity of borrow pit.
	Rehabilitation certificate from the land owner along with at least four photograph of the rehabilitated site from different angles.
ECoP5: Protection of flora and fauna	
Construction works at a road	Limit construction works within the designated sites allocated;
	Not be permitted to destruct active nests or eggs of wildlife; and
	Provide adequate knowledge to the workers regarding protection of flora and fauna, and relevant government regulations and punishment for illegal poaching.
Plant management	Tree seedling species are selected appropriately for maintaining long-term productivity; and
	Selected tree seedlings should be suitable for site condition.
Water management	Install temporary sediment basins, where appropriate, to capture sediment-laden run-off from the nursery;
	Divert runoff from undisturbed areas around the harvesting site;
	Stockpile of fertilizer or agrochemical away from drainage lines; and
	Prevent all solid and liquid wastes entering waterways by collecting solid waste, oils, chemicals, and fertilizer wastes.
Pest management to nursery	Develop a plan during an outbreak of any deadly plant disease to manage pest in coordination with an expert by identifying existing pests and diseases and the risks of introduction of new pests and diseases in the nursery.
Plantation	Consider appropriate species, patterns and layout plan during plantation in the areas with high visual values and/or with important recreational values.
ECoP6: Socio-Economic Management	
Selection of location and construction of labor shades withallied facilities	The labour shade should be located at areas which are acceptable from environmental, cultural or social point of view.
	Consider the location of construction camps away from communities in order to void social conflict in using the natural resources such as water or to avoid the possible adverse impacts of the construction camps on the surrounding communities.
	Responsible local authorities for health, religious and security shall be duly informed on the set up of camp facilities so as to maintain effective surveillance over public health, social and security matters
	Ensure adequate housing for all workers
	Safe and reliable water supply
	Treatment facilities for sewerage of toilet and domestic wastes
	Storm water drainage facilities
	Disposal of solid wastes should be ensured
Solid Waste Management	Ensure proper collection and disposal of solid wastes within the construction camps
	Store inorganic wastes in a safe place within the household and clear organic wastes on daily basis to waste collector.
	Establish waste collection, transportation and disposal systems with the manpower and equipment/vehicles needed.
	All solid waste will be collected and removed from the work camps and disposed in a proved disposal sites
Health and Hygiene	Awareness should be built up about communicable diseases and remedies among the labour and the local people.
	Personal Protective Equipment (PPE) should be ensured during work.

Parameters / Activities	Mitigation/Compensation Measure/Guideline
	The first aid must be provided among the labour and it should be laced where any one can easily access.
	Providing training of all workers in basic sanitation and health care issues and safety matters, and on the specific hazards of their work
	Place display boards at strategic locations within the camps containing messages on best hygienic practices
	Occupational Health and Safety (OHS) should be followed strongly including safe drinking water, displaying poster proper instruction of first aid boxes, emergency phone number, safe equipment etc.
Payment of Wages	The payment of wages will be as per the Minimum Wages Act, Department of Labour, and Government of Bangladesh for both male and female workers.
	To display the minimum wages board in local languages at labor camps sites,
	Wages will be paid to the laborers only in the presence of LGED staff;
	Contractor is required to maintain register for payment of labor wages with entry of every labor working for him. Also, he has to produce it for verification if and when asked by the Engineer, EMU and/or the concerned LGED staff/Engineer's representative.
ECoP7: Agriculture Management	
Loss of Top Soil	Soil from fallow lands/ non-agricultural lands will be used in earthwork in roads
	Collect/strip top soil before earth filling and store and reuse it for final surfacing of road top and tree plantation/afforestation.
	Strip the top soil to a depth of 15 cm and store in stock piles of height not exceeding 2m
	Remove unwanted materials from top soil like grass, roots of trees and similar others
	The stockpiles with be done in slopes of 2:1 to reduce surface runoff- and enhance percolation through the mass of stored soil
	Locate topsoil stockpiles in areas outside drainage lines and protect from erosion
	Spread the topsoil to maintain the physico-chemical and biological activity of the soil.
	The stored top soil will be utilized for covering all disturbed area and along the proposed plantation sites
	Topsoil stockpiles will be monitored and should any adverse conditions be identified corrective actions with include: ▪ Anaerobic conditions-turning the stockpile or creating ventilation holes through the stockpile ▪ Erosion-temporary protective silt fencing will be erected;

CHAPTER 11
CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

The housing project is designed to be environmentally sustainable and is not expected to cause any significant long-term adverse environmental impacts. Located at Union level within Savar Upazila, the project is strategically positioned to enhance housing, social, and urban amenities. This initiative is anticipated to significantly improve local housing facilities, boost employment, and stimulate the economy of the area. The planning and design of the proposed project have comprehensively addressed environmental feasibility. This includes a well-integrated traffic and transportation plan as well as a local resource recycling management plan, ensuring that all aspects of sustainability are considered. By adhering to a robust environmental management plan during construction, the project is poised to deliver overall positive environmental impacts. This approach underscores commitment to responsible development that benefits both the community and the environment.

The project site has been strategically selected for its exceptional accessibility and connectivity. It is conveniently located approximately 3 km from Zirani Bazar, 3 km from Baipail, and 6 km from the Nabinagar Bus Stand. This prime positioning ensures easy access to key transport links, enhancing the site's appeal to both residents and businesses. Adding to its strategic value, the Dhaka Export Processing Zone (DEPZ) is just 2 km away, making the project an attractive option for professionals and businesses looking to capitalize on close proximity to a major economic zone. Additionally, the British American Tobacco Bangladesh office is within walking distance, further emphasizing the project’s closeness to significant commercial centers.

The project’s vicinity to the River Dhaleswari, located about 3 km to the east, not only adds to the aesthetic value of the location but also promotes a pollution-free environment. This proximity to natural landscapes is ideal for those seeking a tranquil living environment amidst natural beauty. The thoughtful choice of location, combined with modern amenities, positions the project as a sustainable solution to the pressing housing shortage. It aims to cater to a diverse range of preferences, accommodating individuals who seek tranquility and natural surroundings as well as those who prioritize easy access to urban conveniences and workplaces. The total Environmental Impact Value (EIV) of the proposed project currently stands at +21. With the proper implementation of the recommended Environmental Management Plan (EMP),

which includes both mitigation and enhancement measures, the EIV is projected to improve significantly to +86. This improvement indicates a substantial positive shift in the project's environmental contribution, reflecting our commitment to sustainability and responsible development.

11.2 Recommendations

The impacts of the proposed development are currently considered negligible. However, to ensure the project's long-term success and minimal disruption to the surrounding environment and community, the following recommendations are proposed:

Construction and Design Compliance

- **Parking Facilities**: Adhere to the Dhaka Mega City Building Construction Rules, 2008, for the design and construction of parking facilities.
- **Security Measures**: Implement efficient security measures at entry and exit points to minimize time consumption and ensure smooth traffic flow to and from adjacent roads.

Safety and Environmental Protection

- **Urban Safety**: The construction authorities must implement robust safety and security measures to maintain a secure and reliable urban living environment.
- **Water Body Conservation**: Given the project's proximity to water bodies, it is crucial to protect these areas in accordance with the Playground, Open Spaces, Gardens, and Water Bodies Conservation Act 2000.

Infrastructure and Urban Planning

- **Re-vegetation**: Implement re-vegetation of barren surfaces to enhance the urban landscape aesthetically and ecologically.

Construction Practices

- **Working Hours**: Restrict construction activities to daylight hours to minimize noise pollution and disturbance to the neighboring community.
- **Construction Site Amenities**: Ensure the availability of a first aid kit, proper sanitation, and water supply at the construction camp site.
- **Worker Safety**: Mandate the use of safety equipment for all workers and ensure that appropriate tools and equipment are used for construction tasks.

Environmental Restoration

- **Soil Health**: Restore disturbed soil and re-vegetate barren surfaces to maintain and improve soil health within the project area.

These recommendations aim to guide the project towards a responsible and community-friendly development, ensuring compliance with local regulations and enhancing the living conditions and safety of the area.

11.3 Concluding Remarks

The Environmental Impact Assessment (EIA) study, conducted with thoroughness and precision, has illuminated the positive environmental prospects of this housing project. At the operational phase, the project boasts an Environmental Impact Value (EIV) of +21. This promising valuation underscores the project's potential to harmonize with its surroundings while contributing positively to the environment. Crucially, the study reveals that this EIV can be elevated to an impressive +86. This enhancement is achievable through the diligent implementation of targeted mitigation strategies for any negative impacts, alongside proactive enhancement measures for positive impacts, as meticulously detailed in the project's 'Environmental Management Plan.' Given the clear evidence of the project's environmental benefits and its alignment with sustainable development goals, it is strongly recommended that the Department of Environment (DOE) proceed with granting the necessary EIA clearance. This approval will pave the way for a project that not only meets but exceeds environmental standards, setting a benchmark for future developments.

REFERENCES

ADB (2003), Environmental Assessment Guidelines, Asian Development Bank, Manila, Philippines.

Ahmed, Z., Mahmud, S., & Acet, H. (2022), Circular economy model for developing countries: evidence from Bangladesh. *Heliyon*, *8*(5).

Alam, O., & Qiao, X. (2020), An in-depth review on municipal solid waste management, treatment and disposal in Bangladesh. *Sustainable Cities and Society*, *52*, 101775.

Anik, M. A. H., Shishir, A. R., Islam, P., Naila, S. N., & Chowdhury, I. M. (2018), Sustainable solid waste management through 3R strategy in Gazipur City. *International Journal of Environment and Waste Management*, *22*(1-4), 228-238.

Arman, S. M., & Mark-Herbert, C. (2021), Re-commerce to ensure circular economy from consumer perspective. *Sustainability*, *13*(18), 10242.

Ashikuzzaman, M., & Howlader, M. H. (2020), Sustainable solid waste management in Bangladesh: issues and challenges. *Sustainable waste management challenges in developing countries*, 35-55.

Banglapedia (2006), Banglapedia-National Encyclopedia of Bangladesh. Asiatic Society of Bangladesh, 2006.

BBS (2014), Statistical Pocket Book, Bangladesh. Bangladesh Bureau of Statistics, Government of Bangladesh, Dhaka.

BBS (2012), Population and Housing Census 2011, Community Report, Dhaka District, Bangladesh Bureau of Statistics, Dhaka.

BUET (2008), Manual on Hydrologic and Hydraulic Design of Roads and Bridges, IWM-BUET, Dhaka.

DoE (1997), EIA Guidelines for Industries, Ministry of Environment and Forest (MOEF), Government of the People's Republic of Bangladesh, Dhaka.

Department of Environment (2010), National 3R Strategy for Waste Management, Ministry of Environment and Forest, Government of the People's Republic of Bangladesh.

FAO (1988), Land Resources Appraisal of Bangladesh for Agricultural Development: UNDP/FAO Project, BDG/18/035 Technical Report No. 2-13: FAO, Rome.

GoB (2021), National Solid Waste Management Rules.

Habib, M. A., Ahmed, M. M., Aziz, M., Beg, M. R. A., & Hoque, M. E. (2021), Municipal solid waste management and waste-to-energy potential from rajshahi city corporation in Bangladesh. *Applied Sciences*, *11*(9), 3744.

Islam, F. S. (2016), Solid waste management system in Dhaka City of Bangladesh. *Journal of Modern Science and Technology*, *4*(1), 192-209.

Jerin, D. T., Sara, H. H., Radia, M. A., Hema, P. S., Hasan, S., Urme, S. A., & Quayyum, Z. (2022), An overview of progress towards implementation of solid waste management policies in Dhaka, Bangladesh. *Heliyon*, *8*(2).

Keng, Z. X., Chong, S., Ng, C. G., Ridzuan, N. I., Hanson, S., Pan, G. T., & Lam, H. L. (2020), Community-scale composting for food waste: A life-cycle assessment-supported case study. Journal of Cleaner Production, 261, 121220.

Khatun, A., & Amin, M. R. (2011, December), Greywater reuse: a sustainable solution for water crisis in Dhaka, Bangladesh. In 4th Annual Paper Meet and 1st Civil Engineering Congress, Dhaka. Noor, Amin, Bhuiyan, Chowdhury and Kakoli (eds) (pp. 427-434).

LGED (2008), Environmental Assessment Guidelines for LGED Projects. Local Government Engineering Department, Government of the People's Republic of Bangladesh, October 2008.

LGED (2022), Hydrological & Morphological Study for Construction of a Bridge over Ichamati river on Nawabganj to banduna road (Banduna BS Stand) at Ch. 10+865m (Road ID: 326622006) under Nawabganj Upazila of Dhaka District.

MoEF (1992), Environmental Policy. Department of Environment (DoE), Ministry of Environment and Forest (MoEF), Government of the People's Republic of Bangladesh.

MoEF (1997), Environmental Conservation Rules, Department of Environment (DoE), Ministry of Environment and Forest (MoEF), Government of the People's Republic of Bangladesh.

Nishat, A., Huq, S.M. Imamul, Barua, Shuvashish P., Reza, Ali A.H.M., Khan, Moniruzzaman A.S. (eds.) (2002), Bio-ecological Zones of Bangladesh. IUCN Bangladesh Country Office, Dhaka, Bangladesh, xii+141 pp.

RAJUK (2004), Private Housing Land Development Act, 2004, Rajdhani Unnayan Katripakkha, Ministry of Housing and Public Works.

Rahaman, M. O., Mostafa, T., & Mamun, M. A. A. (2020), Scarcity of Road Construction Materials in Bangladesh: Exploring Pavement Recycling Option as a Solution. International Journal of Structural and Civil Engineering Research, 25-33.

Roy, H., Alam, S. R., Bin-Masud, R., Prantika, T. R., Pervez, M. N., Islam, M. S., & Naddeo, V. (2022), A review on characteristics, techniques, and waste-to-energy aspects of municipal solid waste management: Bangladesh perspective. *Sustainability*, *14*(16), 10265.

World Bank (2007), Revival of Inland Water Transport: Options and Strategies, People's Republic of Bangladesh, Bangladesh Development Series, Paper No. 20, World Bank Office, Dhaka.

WARPO (2000), National Water Management Plan Project, Development Strategy, Volume No. 11, Annex-O, Regional Environmental Profiles.

Yousuf, T. B., & Reza, A. (2013), 3R (Reduce, Reuse and Recycle) action plan for the city corporations in Bangladesh: paradigm shift of waste management to resource management. In *Proceedings of International Conference on Solid Waste Management in the Developing Countries. Paper No* (Vol. 122, pp. 1-9).

Appendix A: DOE Approved TOR for EIA

শেখ হাসিনার বাংলাদেশ
পরিচ্ছন্ন পরিবেশ

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

Memo No: 22.02.2600.137.72.62.19.85 Date: June 26 , 2023

Subject: Approval of Terms of Reference for Environmental Impact Assessment (EIA) for Dehra Abashik Prokalpa, Dehara, Ashulia, Savar, Dhaka.

Ref: Your Application on 17.05.2023

With reference to your letter received on 22.05.2023 for the subject mentioned above, the Department of Environment hereby gives approval of Terms of Reference for Environmental Impact Assessment (EIA) for **Dehra Abashik Prokalpa, Dehara, Ashulia, Savar, Dhaka** subject to fulfilling the following terms and conditions:

I. The project authority shall submit a comprehensive Environmental Impact Assessment (EIA) considering the overall activity of the said project in accordance with the ToR submitted to the Department of Environment (DoE). The EIA study shall be conducted as per the provision laid down in the Environmental Conservation Rules, 2023.

II. The EIA report shall be prepared in accordance with the guidelines provided in the schedule-11 and Rules-15 of the ECR, 2023.

III. Hence the Department of Environment issues additional ToR to include in the Environmental Mitigation, Management and Monitoring Plan as follows:

1. The STP design, calculation shall be prepared in accordance with the guideline provided in the schedule-12 of the Rule-33 of ECR, 2023.
2. EMP should include 3R concept for solid waste management.

IV. Without approval of EIA report by the Department of Environment, the project authority shall not undertake land and infrastructure development of the project and open L/C in favor of importable machineries.

V. Without obtaining Environmental Clearance, the project authority shall not start operation of the project.

Page 1 of 2

VI. The Project Authority shall submit the EIA report to the Department of Environment, Dhaka.

26.06.23

(Masud Iqbal Md. Shameem)
Director (Environment Clearance)
Phone: 02-8181673

Managing Director
Eastern Housing Limited
(Dehra Abashik Prokalpa)
59-B, Kemal Ataturk Avenue
Banani, Dhaka 1213

Copy Forwarded to:

1. Director, Department of Environment, Dhaka Regional Office, Dhaka.
2. Deputy Director, Department of Environment, Dhaka District Office, Dhaka.
3. Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.

Page 2 of 2

Appendix B: NOC from Local Authority

স্বনির্ভর ধামসোনা ইউনিয়ন পরিষদ

SANIRVAR DHAMSONA UNIO PARISHAD

থানা ঃ আশুলিয়া, উপজেলা ঃ সাভার, জেলা ঃ ঢাকা।

মোঃ আঃ কাদের দেওয়ান
মেম্বর
০৪ নং ওয়ার্ড
মোবাইল ঃ ০১৭১১৬২২৪০৭

MD ABDUL KADER DEWAN
MEMBOR
04 NO WORD
MOBILE : 01711622407

স্মারক নং- ২৪০১৪/২০ তারিখ ঃ .....

অবস্থানগত/পরিবেশগত ছাড়পত্রের জন্য স্থানীয় কর্তৃপক্ষ কর্তৃক প্রদেয় অনাপত্তিপত্রের ছক

১। আবেদনকারীর নাম ঃ মনজুরুল ইসলাম

২। পিতার নাম ঃ মরহুম আলহাজ্ব জহুরুল ইসলাম

৩। আবেদনকারীর ঠিকানা ঃ ৫৯/বি, কামাল আতাতুর্ক এভিনিউ, বনানী, ঢাকা-১২১৩

৪। প্রকল্পের অবস্থানগত ঠিকানা ঃ মৌজাঃ দেহরা, ইউনিয়নঃ স্বনির্ভর ধামসোনা, আশুলিয়া, সাভার, ঢাকা।

৫। প্রকল্পের তফসিল ঃ

জেলার নাম	থানার নাম	মৌজার নাম	খতিয়ান নং	দাগ নং	জমির ধরণ	মোট জমির পরিমান
ঢাকা	আশুলিয়া	দেহরা	জমির সিডিউল খতিয়ান নং সংযুক্ত	জমির সিডিউল দাগ নং সংযুক্ত	নাল, চালা, ভিটা ইত্যাদি	১২৫.২৮ একর

৬। প্রকল্পের উৎপাদিত পন্যের নাম ঃ ''দেহরা আবাসিক প্রকল্পের'' আবাসন প্লট।

উপরোক্ত তথ্যাদির আলোকে দেহরা আবাসিক প্রকল্পটিকে নিম্নবর্ণিত শর্তসাপেক্ষে অনাপত্তিপত্র প্রদান করা হলো।

শর্তাবলী ঃ

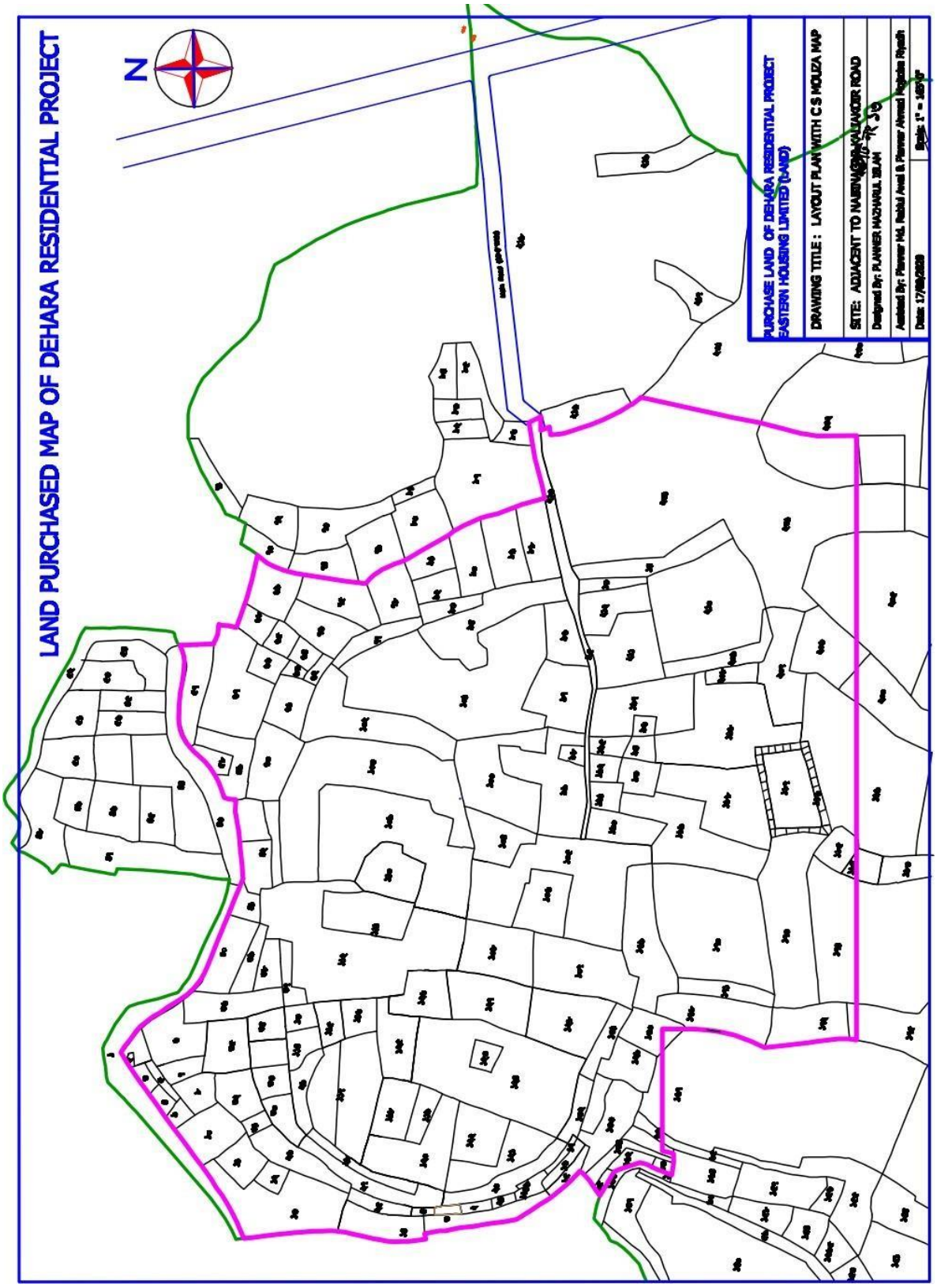
১. প্রকল্প/কারখানা স্থাপন ও পরিচালনার ক্ষেত্রে পরিবেশ সংরক্ষণ আইন ও বিধি যথাযথভাবে অনুসরণ করতে হবে।
২. পরিবেশ অধিদপ্তর হতে বিধি দ্বারা নির্ধারিত পদ্ধতিতে ছাড়পত্র গ্রহণ করতে হবে।
৩. কর্মরত শ্রমিকদের পেশাগত স্বাস্থ্য ও নিরাপত্তা নিশ্চিত করতে হবে।
৪. উপযুক্ত অগ্নি নির্বাপক ব্যবস্থা রাখতে হবে এবং অগ্নিকান্ড কিংবা অন্য কোন দূর্ঘটনার সময় জরুরী নির্গমন ব্যবস্থা থাকতে হবে।
৫. বায়ু ও শব্দদূষণ করা যাবে না।
৬. কারখানা প্রকল্প সৃষ্ট তরল বর্জ্য অপরিশোধিত অবস্থায় বাইরে নির্গমন করা যাবে না।

উল্লেখিত যে কোন শর্ত লঙ্ঘন করলে যথোপযুক্ত কর্তৃক কারখানা/প্রকল্পের বিরুদ্ধে আইনানুগ ব্যবস্থা নেওয়া হবে।

তারিখ ঃ ২২/০৯/২০২০ ইং

স্থানীয় কর্তৃপক্ষের স্বাক্ষর ও সীল
মোঃ আঃ কাদের দেওয়ান
সদস্য, ৪নং ওয়ার্ড
স্বনির্ভর ধামসোনা ইউনিয়ন পরিষদ
থানা: আশুলিয়া, উপজেলা: সাভার, জেলা: ঢাকা

Appendix C: Mouza Map showing Project Location



Appendix D: Photograph Taken during Field Visit

	
Public Consultation	Public Consultation
	
Existing Vegetation	Existing Site Condition
	
Air Quality Test	Transect Walk

	
Existing Electricity Facilities	Sample Collection
	
Public Consultation	Water Bodies around the Project Area
	
Existing Site Condition	Existing Road Network

Appendix E: Meeting Attendance for Public Consultation

পরিবেশগত প্রভাব নিরূপণ (EIA) -এর জন্য মতবিনিময় সভা

দেহারা আবাসিক প্রকল্প, সাভার, ঢাকা।

স্থানঃ দেহারা আবাসিক প্রকল্প তারিখঃ ২০.০৩.২০২৪ সময়ঃ বিকাল ৪টা

উপস্থিতি তালিকা

ক্রমিক নং	নাম	পেশা	মোবাইল নং	স্বাক্ষর
০১	মোঃ নিজামউদ্দিন	কৃষক	01711244925	
02	মোঃ সহেল	চাকুরি	01916004292	
০৩	মোঃ আবুল কাশেম	চাকুরি	01922183564	
০৪		চাকরি	01935684538	
০৫	মোঃ সালাম	চাকুরী	01710580338	
০৬	মোঃ কায়েস মিয়া	চাকুরী	01916975519	
০৭	Md, Idris Ahamed	চাকুরী	01938447458	
০৮	[illegible]	[illegible]	01691359876	
০৯	[illegible]	চাকুরি/ব্যবসায়ী	01724666475	
১০	[illegible]	[illegible]	01756863450	
১১	[illegible]	[illegible]	01738148430	
১২	[illegible]	[illegible]	01798838264	
১৩	[illegible]	[illegible]	01792000763	
১৪	[illegible]	[illegible]	01324280044	
১৫	[illegible]	[illegible]	01728874959	

Appendix F: Environmental Glossary

Baseline Conditions

The "baseline" essentially comprises the factual understanding and interpretation of existing environmental, social and health conditions of where the business activity is proposed. Understanding the baseline shall also include those trends present within it, and especially how changes could occur regardless of the presence of the project, i.e. the "No-development Option".

Biological Diversity

The variety of life forms, the different plants, animals and microorganisms, genes they contain and the ecosystems they form. It is usuallyconsidered at three levels: genetic diversity, species diversity and ecological diversity.

Ecosystem

A dynamic complex of plant, animal, fungal and microorganism communities and associated non-living environment interacting as an ecological unit.

Emission

The total amount of solid, liquid or gaseous pollutant emitted into the atmosphere from a given source within a given time, as indicated, for e.g., in grams per cubic meter of gas or by a relative measure, upon discharge from the source.

Endangered Species

Species in danger of extinction and whose survival is unlikely if the existing conditions continue to operate. Included among those are species whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to suffer from immediate danger of extinction.

Environmental Impact

An estimate or judgment of the significance and value of environmental effects for natural, socio-economic and human receptors. Environment Management Plan (EMP): A Plan to undertake an array of follow-up activities which provide for the sound environmental

management of a project/ intervention so that adverse environmental impacts are minimized and mitigated; beneficial environmental effects are maximized; and sustainable development is ensured.

Important Environmental Component (IEC)

These are environmental components of biophysical or socio-economic importance to one or more interested parties. The use of important environmental components helps to focus the environmental assessment.

Stakeholders

Those who may be potentially affected by a proposal, e.g. Local people, the proponent, government agencies, NGOs, donors and others, all parties who may be affected by the project or to take an interest in it.

Biological Oxygen Demand (BOD_5)

Biochemical oxygen demand (BOD) is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period. The term also refers to a chemical procedure for determining this amount. This is not a precise quantitative test, although it is widely used as an indication of the organic quality of water. The BOD value is most commonly expressed in milligrams of oxygen consumed per litre of sample during 5 days of incubation at 20°C and is often used as a robust surrogate of the degree of organic pollution of water.

Chemical Oxygen Demand (COD)

In environmental chemistry, the chemical oxygen demand (COD) test is commonly used to indirectly measure the amount of organic in water. Most applications of COD determine the amount of organic pollutants found in surface water (e.g. lakes and rivers) or wastewater, making COD a useful measure of water quality. It is expressed in milligrams per liter (mg/l) also referred to as ppm (parts per million), which indicates the mass of oxygen consumed per liter of solution.

Dissolved Oxygen (DO)

Dissolved Oxygen is the amount of gaseous oxygen (O_2) dissolved in the water. Oxygen enters the water by direct absorption from the atmosphere, by rapid movement, or as a waste product of plant photosynthesis. Water temperature and the volume of moving water can affect dissolved oxygen levels. Oxygen dissolves easier in cooler water than warmer water.

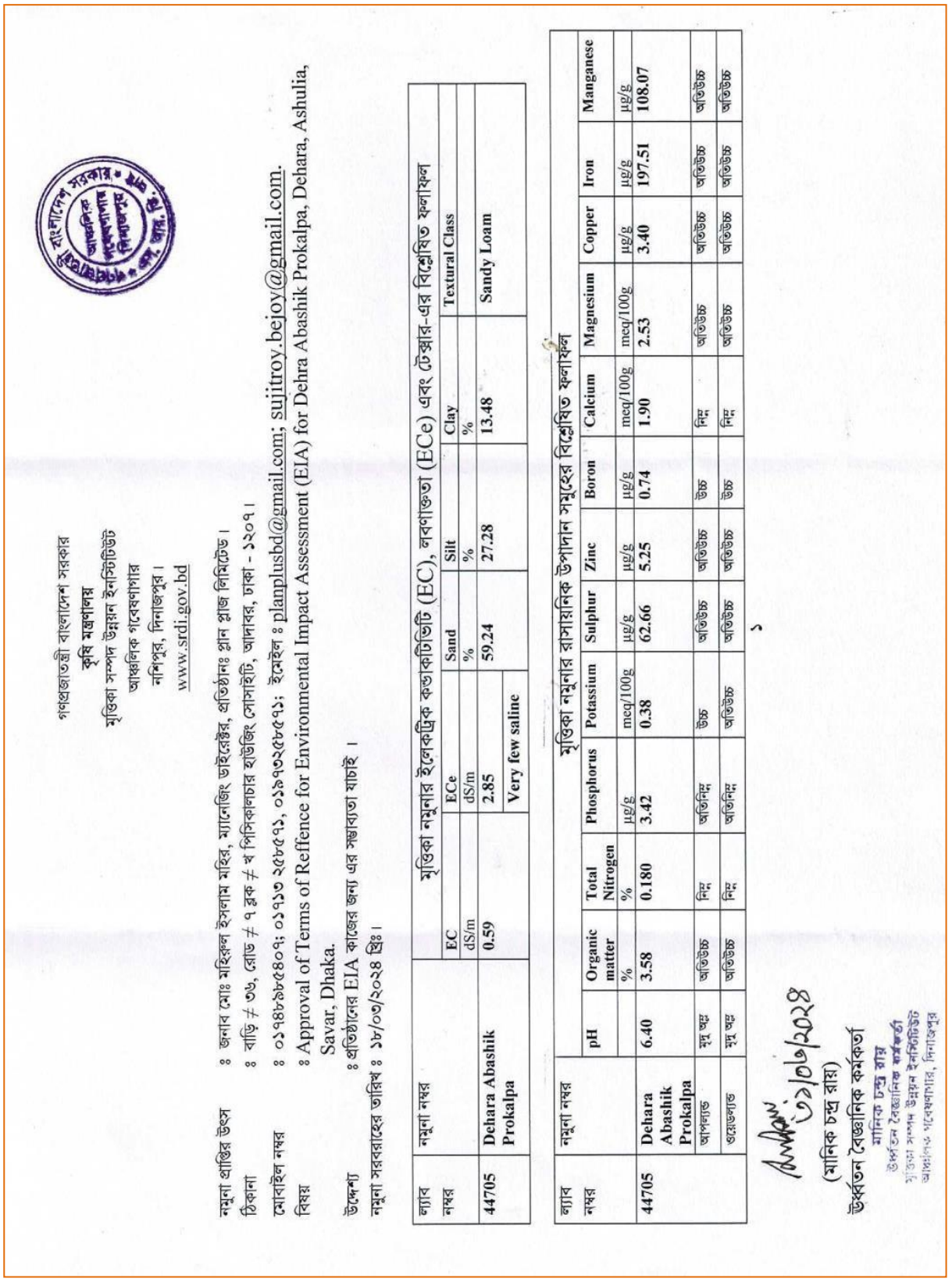
Electrical Conductivity (EG)

Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). Organic compounds like oil, phenol, alcohol, and sugar do not conduct electrical current very well and therefore have a low conductivity when in water. Conductivity is also affected by temperature: the warmer the water, the higher the conductivity. For this reason, conductivity is reported as conductivity at 25 degrees Celsius (25^0C). The basic unit of measurement of conductivity is the mho or siemens. Conductivity is measured in micromhos per centimeter (umhos/cm) or microsiemens per centimeter (µs/cm).

Total Dissolved Solids (TDS)

Total dissolved solids (TDS) are the term used to describe the inorganic salts and amounts of organic matter present in water. The principal constituents are usually calcium, magnesium, sodium, and potassium cations and carbonate, hydrogen carbonate, chloride, sulfate, and nitrate anions.

Appendix G: Soil Quality Test Report



গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
কৃষি মন্ত্রণালয়
মৃত্তিকা সম্পদ উন্নয়ন ইনস্টিটিউট
আঞ্চলিক গবেষণাগার
নশিপুর, দিনাজপুর।
www.srdi.gov.bd

নমুনা প্রাপ্তির উৎস ঃ জনাব মোঃ মহিবুল ইসলাম মহির, ম্যানেজিং ডাইরেক্টর, প্রতিষ্ঠানঃ প্লান প্লাজ লিমিটেড।
ঠিকানা ঃ বাড়ি ≠ ৩৬, রোড ≠ ৭ ব্লক ≠ খ পিসিকালচার হাউজিং সোসাইটি, আদাবর, ঢাকা - ১২০৭।
মোবাইল নম্বর ঃ ০১৭৪৮৬৮৫৪০৭; ০১৭১৩ ২৫৮৫৭১, ০১৯৭৩২৫৮৫৭১; ইমেইল ঃ planplusbd@gmail.com; sujitroy.bejoy@gmail.com.
বিষয় ঃ Approval of Terms of Reffence for Environmental Impact Assessment (EIA) for Dehra Abashik Prokalpa, Dehara, Ashulia, Savar, Dhaka.
উদ্দেশ্য ঃ প্রতিষ্ঠানের EIA কাজের জন্য এর সম্ভাব্যতা যাচাই।
নমুনা সরবরাহের তারিখ ঃ ১৮/০৩/২০২৪ খ্রিঃ।

মৃত্তিকা নমুনার ইলেকট্রিক কন্ডাকটিভিটি (EC), লবণাক্ততা (ECe) এবং টেক্সার-এর বিশ্লেষিত ফলাফল

ল্যাব নম্বর	নমুনা নম্বর	EC	ECe	Sand	Silt	Clay	Textural Class
		dS/m	dS/m	%	%	%	
44705	Dehara Abashik Prokalpa	0.59	2.85	59.24	27.28	13.48	Sandy Loam
			Very few saline				

মৃত্তিকা নমুনার রাসায়নিক উপাদান সমূহের বিশ্লেষিত ফলাফল

ল্যাব নম্বর	নমুনা নম্বর	pH	Organic matter	Total Nitrogen	Phosphorus	Potassium	Sulphur	Zinc	Boron	Calcium	Magnesium	Copper	Iron	Manganese
			%	%	µg/g	meq/100g	µg/g	µg/g	µg/g	meq/100g	meq/100g	µg/g	µg/g	µg/g
44705	Dehara Abashik Prokalpa	6.40	3.58	0.180	3.42	0.38	62.66	5.25	0.74	1.90	2.53	3.40	197.51	108.07
	আপল্যান্ড	মৃদু অম্ল	অতিউচ্চ	নিম্ন	অতিনিম্ন	উচ্চ	অতিউচ্চ	অতিউচ্চ	উচ্চ	নিম্ন	অতিউচ্চ	অতিউচ্চ	অতিউচ্চ	অতিউচ্চ
	ওয়েলল্যান্ড	মৃদু অম্ল	অতিউচ্চ	নিম্ন	অতিনিম্ন	অতিউচ্চ	অতিউচ্চ	অতিউচ্চ	উচ্চ	নিম্ন	অতিউচ্চ	অতিউচ্চ	অতিউচ্চ	অতিউচ্চ

১৯/০৩/২০২৪
(মানিক চন্দ্র রায়)
উর্ধ্বতন বৈজ্ঞানিক কর্মকর্তা
মানিক চন্দ্র রায়
উর্ধ্বতন বৈজ্ঞানিক কর্মকর্তা
মৃত্তিকা সম্পদ উন্নয়ন ইনস্টিটিউট
আঞ্চলিক গবেষণাগার, দিনাজপুর

Appendix H: Ground Water Quality Test Report

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
কৃষি মন্ত্রণালয়
মৃত্তিকা সম্পদ উন্নয়ন ইনস্টিটিউট
আঞ্চলিক গবেষণাগার
নশিপুর, দিনাজপুর।
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নমুনা প্রাপ্তির উৎস ঃ জনাব মোঃ মহিরুল ইসলাম মহির, ম্যানেজিং ডাইরেক্টর, প্রতিষ্ঠানঃ প্লান প্লাজ লিমিটেড।
ঠিকানা ঃ বাড়ি ≠ ৩৬, রোড ≠ ৭ ব্লক ≠ খ পিসিকালচার হাউজিং সোসাইটি, আদাবর, ঢাকা - ১২০৭।
মোবাইল নম্বর ঃ ০১৭৪৮৯৮৫৪০৭; ০১৭১৩ ২৫৮৫৭১, ০১৯৭৩২৫৮৫৭১; ইমেইল ঃ planplusbd@gmail.com; sujitroy.bejoy@gmail.com.
বিষয় ঃ Approval of Terms of Reffence for Environmental Impact Assessment (EIA) for Dehra Abashik Prokalpa, Dehara, Ashulia, Savar, Dhaka.
উদ্দেশ্য ঃ প্রতিষ্ঠানের EIA কাজের জন্য এর সম্ভাব্যতা যাচাই ।
নমুনা সরবরাহের তারিখ ঃ ১৮/০৩/২০২৪ খ্রিঃ।

নমুনা নম্বর	Source of water	গ্রাউন্ড ওয়াটার নমুনার বিশ্লেষিত ফলাফল					
		pH	EC	TDS	Dissolved Oxygen (DO)	Biological Oxygen Demand (BOD)	Chemical Oxygen Demand (COD)
			dS	mg/L	mg/L	mg/L	mg/L
02	Dehara Abashik Prokalpa Ground water	6.79	0.50	110.00	1.7	5.99	3.29
	Status	Nutral	Safe	Low	Low	Optimum	Very low
	Acceptable levels	6.5-8.5	1.6	150-300	4-6	6.00	6-10
Comment for quality		Good	Safe	Less nutrified	Polluted	Normal	Purification makes perfact.

[pH : The optimum value for good water quality is ranges 6.6-7.3; EC : The optimum value for safe water quality is below 0.75 dS.
TDS: Need purification for drinking;
DO : The optimum value for good water quality is ranges 4-6 mg/L which ensures healthy aquatic life. Lower DO values indicate water pollution.
BOD : The optimum value for good water quality is 6 mg/L. Higher BOD values indicate water pollution;
COD : The optimum value for good water quality is ranges 6-10. Higher COD values indicate water pollution]

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০১/০৩/২০২৪

(মানিক চন্দ্র রায়)
ঊর্ধ্বতন বৈজ্ঞানিক কর্মকর্তা

Appendix I: Surface Water Quality Test Report

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
কৃষি মন্ত্রণালয়
মৃত্তিকা সম্পদ উন্নয়ন ইনস্টিটিউট
আঞ্চলিক গবেষণাগার
নশিপুর, দিনাজপুর।
www.srdi.gov.bd

নমুনা প্রাপ্তির উৎস ঃ জনাব মোঃ মহিরুল ইসলাম মহির, ম্যানেজিং ডাইরেক্টর, প্রতিষ্ঠানঃ প্লান প্লাজ লিমিটেড।
ঠিকানা ঃ বাড়ি ≠ ৩৬, রোড ≠ ৭ ব্লক ≠ খ পিসিকালচার হাউজিং সোসাইটি, আদাবর, ঢাকা - ১২০৭।
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নমুনা সরবরাহের তারিখ ঃ ১৮/০৩/২০২৪ খ্রিঃ।

নমুনা নম্বর	Source of water	সারফেজ ওয়াটার নমুনার বিশ্লেষিত ফলাফল					
		pH	**EC**	**TDS**	**Dissolved Oxygen (DO)**	**Biological Oxygen Demand (BOD)**	**Chemical Oxygen Demand (COD)**
			dS	mg/L	mg/L	mg/L	mg/L
01	**Dehara Abashik Prokalpa Surface water**	**7.07**	**0.50**	**130.00**	**1.00**	**17.96**	**9.86**
	Status	**Nutral**	**Safe**	**Low**	**Very low**	**Extreamely high**	**Optimum**
	Acceptable levels	**6.5-8.5**	**1.6**	**150-300**	**4-6**	**6.00**	**6-10**
Comment for quality		**Good**	**Safe**	-	**Polluted**	**polluted**	**Purification makes perfact.**

[pH : The optimum value for good water quality is ranges 6.6-7.3; EC : The optimum value for safe water quality is below 0.75 dS.
TDS: Need purification for drinking;
DO : The optimum value for good water quality is ranges 4-6 mg/L which ensures healthy aquatic life. Lower DO values indicate water pollution.
BOD : The optimum value for good water quality is 6 mg/L. Higher BOD values indicate water pollution;
COD : The optimum value for good water quality is ranges 6-10. Higher COD values indicate water pollution]

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(মানিক চন্দ্র রায়)
ঊর্ধ্বতন বৈজ্ঞানিক কর্মকর্তা
মৃত্তিকা সম্পদ উন্নয়ন ইনস্টিটিউট
আঞ্চলিক গবেষণাগার, দিনাজপুর

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