

Initial Environmental Examination

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BAN: Urban Public and Environmental Health Sector Development Program: Chittagong Controlled Landfill

Prepared by the Local Government Division, Ministry of Local Government, Rural Development and Cooperatives, Government of the People's Republic of Bangladesh for the Asian Development Bank.

ABBREVIATIONS

ADB	–	Asian Development Bank
BBS	–	Bangladesh Bureau of Statistics
BCC	–	Behavior Change Communication
BOD	–	Biochemical Oxygen Demand
CC	–	City Corporations
CCC	-	Chittagong City Corporation
CCPIU	-	City Corporations Program Implementation Units
CLF	-	Controlled Landfill
COD	–	Chemical Oxygen Demand
DES	–	Domestic Environmental Specialist
DLS	-	Department of Livestock Services
DO	–	Dissolved Oxygen
DoE	–	Department of Environment
DSC	–	Design, Supervision, and Construction Consultant
DSCC	–	Dhaka South City Corporation
DWASA	–	Dhaka Water Supply and Sewerage Authority
EA	–	executing agency
ECC	–	Environmental Clearance Certificate
EIA	–	Environmental Impact Assessment
EMP	–	Environmental Management Plan
EU	–	European Unions
HDPE	–	High Density Poly-Ethylene
IEE	–	Initial Environmental Examination
IES	–	International Environmental Specialist
IMA	–	Independent Monitoring Agency
LGD	–	Local Government Division
LGRDC	–	Ministry of Local Government, Rural Development and Cooperatives
NGO	–	nongovernmental organization
OM	–	Operations Manual
O&M	–	operation and maintenance
PPTA	–	Project Preparation Technical Assistance
RCC	–	Reinforced Cement Concrete
RF	–	Resettlement Framework
RP	–	Resettlement Plan
SCMO	–	Safeguards and Community Mobilization Officer
SIEE	–	Summary Initial Environmental Examinations
SO	–	Safety Officer
STS	-	Secondary Transfer Station
ToR	–	Terms of Reference
UPEHSDP	–	Urban Public and Environmental Health Sector Development Program
UPEHU	–	Urban Public and Environmental Health Unit
WMD	-	Waste Management Department

WEIGHTS AND MEASURES

ha	–	hectare
km	–	kilometer
m	–	Meter
Mm	–	millimeter
km/h	–	kilometer per hour

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I. INTRODUCTION

A. Purpose of the Report

1. With nearly 30% of the country's total population (around 140 million) currently living in urban areas along with a predicted to rise to 50% in the next 25 years and still a higher rate of urbanization than the previous ones, Bangladesh is beset with a situation of continued deterioration in the overall and general state of urban public and environmental health. Such a situation has its root in the existing services overwhelmed by continued influx of ever-increasing number of people in the urban areas and growth of slums and squatter settlements currently accommodating over 35% of the urban population. Disease prevention and health promotion in urban areas encompass a range of issues including water and sanitation, waste management, food safety, healthcare, awareness-raising, etc. These are all the responsibility of the city corporations and municipalities under the authority of the Local Government Division (LGD) of the Ministry of Local Government, Rural Development and Cooperatives (LGRDC). Most of these services are under-provided, particularly to the poor.

2. The Bangladesh Urban Public and Environmental Health Sector Development Program (UPEHSDP) aims to establish a sustainable approach to public and environmental health at national level to guide and support city corporations and municipalities in improving the quality of life and economic status of urban residents, especially the poor. This will be achieved by a range of measures, including: (i) creating an Urban Public and Environmental Health Unit (UPEHU) under LGD with a mandate to improve public health; (ii) improving staff and financial resources to enable city corporations and municipalities fulfill their responsibilities in public and environmental health; (iii) improving management of solid waste and hospital waste through municipality-managed public-private partnerships and other mechanisms; and (iv) improving food safety by providing food testing laboratories, food inspection services and sanitary slaughterhouses.

3. The program is being supported by ADB through: (i) a program loan to implement policy measures in institutional strengthening, financial reform, public/ environmental health strategies, governance and service delivery; and (ii) a sector loan, funding investments in municipal and hospital waste management, food safety, and pro-poor integrated services (water supply, sanitation, nutrition/ food security, and health of the urban poor). LGD of the MOLGRDC has been the Executing Agency (EA), whereas the six city corporations (Dhaka, Chittagong, Sylhet, Barisal, Chittagong and Rajshahi) have been the implementing agencies. The Program is being implemented over a period of seven years (2010-2016) in the main urban areas of the country.

4. UPEHSDP has been classified by ADB as environmental assessment category B (some negative impacts but less significant than category A). The impacts of activities under the program loan, therefore, need to be reviewed by an Environmental Assessment of the Policy Matrix. The sector loan will be implemented via a series of subprojects, providing infrastructure and other improvements in a particular sector (waste management, food safety, etc). Four sample subprojects were developed by a Project Preparation Technical Assistance (PPTA) study and the environmental impacts of these were assessed by Initial Environmental Examinations (IEE) (or Environmental Reviews for Category C subprojects). Studies were conducted according to ADB Environment Policy (2002) and Environmental Assessment Guidelines (2003). Current IEE had been in line with the Environmental Assessment and Review Framework (EARF) developed for the purpose in 2009 and assessment of environmental impacts previously conducted on the above four sample subprojects developed through the PPTA study.

5. This Initial Environmental Examination (IEE) has been undertaken to (i) assess the extent and magnitude of impacts that the proposed Chittagong Controlled Landfill subproject in Chittagong City Corporation have on the overall environment within and around the subproject site; (ii) propose mitigation measures in respect of adverse impacts, enhancement of beneficial impacts; and (iii) formulate an Environment Management Plan (EMP).

B. Extent of IEE Study

6. Bangladeshi law and ADB policy require that the environmental impacts of development projects are identified and assessed as part of the planning and design process, and that action is taken to reduce those impacts to acceptable levels. This is done through the environmental assessment process, which has become an integral part of lending operations and project development and implementation worldwide.

1. ADB Policy

7. ADB's Environment Policy requires that environmental issues are taken into account in all aspects of the Bank's operations, and the requirements for Environmental Assessment are described in Operations Manual (OM) 20: Environmental Considerations in ADB Operations (2003). This states that ADB requires environmental assessment of all project loans, program loans, sector loans, sector development program loans, financial intermediation loans and private sector investment operations.

8. The nature of the assessment required for a project depends on the significance of its environmental impacts, which are related to the type and location of the project, the sensitivity, scale, nature and magnitude of its potential impacts, and the availability of cost-effective mitigation measures. Projects are screened for their expected environmental impacts and are assigned to one of the following categories:

(i) **Category A.** Projects that could have significant environmental impacts. An Environmental Impact Assessment (EIA) is required.

(ii) **Category B.** Projects that could have some adverse environmental impacts, but of less significance than those for category A. An Initial Environmental Examination (IEE) is required to determine whether significant impacts warranting an EIA are likely. If an EIA is not needed, the IEE is regarded as the final environmental assessment report.

A Category B project may be classified as B-sensitive if it involves environmentally sensitive activities. Such projects require IEE, but have the same requirements for disclosure and Environmental Management Plans as Category A.

(iii) **Category C.** Projects those are unlikely to have adverse environmental impacts. No EIA or IEE is required, although environmental implications are reviewed.

9. For Category B projects the Draft IEE reports, Summary IEE (SIEE) and any other reports prepared to comply with ADB procedure (in this case the EA of the Policy Matrix) are reviewed by ADB's Regional Department Sector Division and Social and Environmental Safeguards Division. They are also reviewed in-country by the Executing Agency, and additional comments may be sought from project affected people and other stakeholders. All comments are incorporated in preparing final documents, which are reviewed by the Executing Agency and the national environmental protection agency (in this case the Department of Environment, DoE). The EA then officially submits the reports to ADB for consideration by the Board of Directors.

2. National Law

10. **Environmental Assessment, Protection, and Pollution Control.** The main provisions for environmental protection and pollution control in Bangladesh are contained in the Environmental Conservation Act (ECA) of 1995 and the Environmental Conservation Rules (ECR) of 1997. These legislations also provide the principal mechanism for assessing and mitigating the environmental impacts of projects, both existing and proposed. Projects are classified as green, orange or red depending on their location and environmental impacts. As per ECR 1997, it is included the Red Category in item 43 and described as 'Land-filling by industrial, household and commercial wastes'.

11. Rule 7 states that the proponent of such projects must obtain a Location Clearance Certificate and an Environmental Clearance Certificate (ECC) from the Department of Environment (DoE). For Red category projects this requires submission to the relevant DoE Divisional Officer of the following:

- (i) Completed Application for Environmental Clearance Certificate, and the appropriate fee, shown in Schedule 13 of the Rules;
- (ii) Report on the feasibility of the project;
- (iii) Report on the IEE for the project, and its Process Flow Diagram, Layout Plan;
- (iv) Report on the Environmental Management Plan;
- (v) No objection certificate from the local authority;
- (vi) Emergency plan relating to adverse environmental impact and plan for mitigation of the effect of pollution; and
- (vii) Outline of the relocation and rehabilitation plan (where applicable).

12. As part of the Environmental Clearance Certificate application, a detailed Environmental Impact Assessment and environmental management plans satisfactory to the Department of Environment must be prepared. During the process of preparing the 2009 Environmental Planning Document, DoE was consulted and it was indicated that ADB IEE, SIEE, Resettlement Framework and other reports prepared during project preparation would be acceptable to DoE as fulfilling many of their national EIA requirements. However, they will review IEEs upon further submission by LGD. All projects are to submit any further materials, if any, as per requirement of DoE toward obtaining the Environmental Clearance Certificate.

13. The Chittagong Controlled Landfill subproject is considered to have some potential for environmental impacts therefore must conduct an IEE and prepare EMPs acceptable to DoE as part of the ECC application. Under the ECR DoE has 60 days to respond from the receipt of the ECC application for a Red category project. After obtaining location clearance on the basis of Initial Environment Examination (IEE) Report, the Environmental Impact Assessment (EIA) Report in accordance with the approved terms of reference along with design of Effluent Treatment Plant (ETP) and its time schedule shall be submitted within approved time limit.

14. In short, in a simpler language the timeframe for obtaining ECC is as follows. In case of red category projects, the DOE will issue Location Clearance Certificate (LCC) within 60 days after satisfactory submission of IEE report along with other relevant documents. The DOE will mention a specific timeframe for submission of EIA report in the LCC issued by them. Then in the next step the DOE will issue Environmental Clearance Certificate (ECC) within 60 days after satisfactory submission of EIA report. In addition to fulfillment of other relevant conditions of DOE, Effluent Treatment Plant (ETP) must be designed and its implementation schedule finalized before issuance of ECC from the DOE. Five individual applications for each of the

components in Package – 4 like MWTF in Dhaka, CLRs in Chittagong, Barisal, Rajshahi and Sylhet will be lodged in five local divisional offices with a view to obtaining ECC from these authorities separately.

15. **Other Policies, Plans, and Strategies.** In addition to ECA and ECR, there are a number of other policies, plans and strategies which are applicable to the subproject. These are National 3R (Reduce, reuse, recycle) Strategy for Waste Management 2010, The Local Government (City Corporation) Act 2009, and Medical Waste Management Rules 2008.

16. The National Building Code 2006 and National Labor Act 2006 have defined certain measures to ensure proper safety and work environment as well as the compensation measures to the laborers. By national law, in order to be compensated, Contractors must follow these safety provisions and compensation arrangements. The implementing agency must ensure that the appropriate occupational health and safety provisions have been included in the bidding documents and are being implemented by Contractor. As per the Safe Drinking Water Supply and Sanitation Policy 1998, provision for arsenic free drinking water and adequate sanitation will have to be ensured. The water quality needs to be monitored to ensure that the supplied water is safe for drinking.

17. The summary of environmental regulations and mandatory requirements for the proposed subproject is shown in **Table 1**.

Table 1: Summary of Environmental Regulations and Mandatory requirements for the Chittagong CLF Subproject

Acts/ Guidelines	Purpose	Applicability to the Subproject
Environmental Conservation Act, 1995 and Environmental Conservation Rules, 1997	<ul style="list-style-type: none"> - main provisions for environmental protection and pollution control in Bangladesh - provides the principal mechanism for assessing and mitigating the environmental impacts of projects, both existing and proposed - projects are classified as green, orange or red depending on their location and environmental impacts 	<ul style="list-style-type: none"> - As per ECR 1997, it is included the Red Category in item 43 and described as 'Land-filling by industrial, household and commercial wastes'. - Rule 7 states a Location Clearance Certificate and an Environmental Clearance Certificate (ECC) must be obtained from the Department of Environment (DoE). - Recommends standards for disposal of different types of waste.
National 3R (Reduce, reuse, recycle) Strategy for Waste Management, 2010	<ul style="list-style-type: none"> - The national 3R Goal for waste management is to achieve complete elimination of waste disposal on open dumps, rivers, flood plains by 2015 through mandatory segregation of waste at source as well as to create a market for recycled products and provide incentives for recycling of waste. - The main objective of the 3R Strategy is to delineate ways and means of achieving national 3R goals through providing a uniform guideline for all stakeholders. 	<ul style="list-style-type: none"> - Source segregation is mandatory and gave directives to municipalities to pursue organic waste-recycling projects through composting, refuse derived fuel, and biogas via Public Private Partnerships (PPPs). - It makes clear that medium to large-scale organic waste-recycling projects will be implemented and managed by the private sector. Moreover, the strategy makes recommendations concerning issues such as tipping fees and access to municipal land for recycling projects.
Local Government (City Corporation) Act,	This Act was incorporated under Bangladesh Gazette on 15 October	Construction of CLF is necessary infrastructure to fulfill the

Acts/ Guidelines	Purpose	Applicability to the Subproject
2009	<p>2009. The act contains four sub-clauses regarding waste collection and management, which have been depicted as follows:</p> <ul style="list-style-type: none"> – City Corporation will take all necessary steps to collect and dispose waste from all the roads, toilets, drains, structures and areas under its jurisdiction – The occupiers of all the structures and spaces within the jurisdiction of the City Corporation will be responsible for removing waste from their possession under the control and supervision of the Corporation. – Corporation will make arrangement for waste collection containers or other type of bins at different places of the city, and wherever such containers or bins are placed, the Corporation will ask the occupiers of the neighboring houses, structures and spaces to dump their wastes into these containers or bins through issuance of a general notice. – All the wastes removed or collected by or under direction of the staff of the Corporation as well as the wastes stored in the containers or bins established by the Corporation will be treated as the property of the City Corporation. 	<p>responsibility of the City Corporations for collection, transportation and disposal of municipal solid wastes. Municipal solid waste will be collected in the Secondary Transfer Stations for onward transportation to the CLF site of the City Corporation outside the city with a view to arranging a safe and satisfactory disposal.</p>
Medical Waste Management Rules 2008	<p>The main objective is to control overall management including collection, treatment and disposal of medical waste in Bangladesh.</p>	<p>CLF will have a specific section to deal with medical wastes; these hazardous wastes will be collected, transported by special arrangement by the City Corporation and treated separately in the Medical Waste Management section of CLF.</p>

C. Scope of the Study

18. This is the IEE for the Chittagong Controlled Landfill subproject. It discusses the environmental impacts and mitigation measures relating to the location, design, construction and operation of all physical works proposed under this subproject. This IEE report will clarify the situation to the Department of Environment and fulfill the requirement for obtaining Location Clearance Certificate and an Environmental Clearance Certificate (ECC) from DOE. This report will identify the potential environmental impacts due to implementation of the subproject and will suggest appropriate mitigation measures.

II. DESCRIPTION OF THE PROJECT

A. Type, Category and Need

19. This is a subproject in the field of solid waste management, and as explained above it has been classified by ADB as Category B because it is not expected to have major negative environmental impacts. Under ADB procedures such developments require an IEE to identify and mitigate the impacts, and to determine whether further study or a more detailed EIA may be required.

20. Improvements in solid waste management facilities are needed in Chittagong and in other urban areas in Bangladesh because present services are inadequate. The main problems are that:

- (i) Although house-to-house waste collection by NGOs or CBOs is available in most urban areas, slum dwellers still mainly dispose of garbage on open spaces;
- (ii) Secondary waste collection has not expanded in line with the primary collection service because of inadequate cost recovery and insufficient public or private investment;
- (iii) The interface between private sector primary collection and municipality-run secondary collection systems is also inefficient mainly because of a lack of mechanization.
- (iv) Some improvement in the collection, storage and transportation of solid waste is anticipated after implementation of 12 Secondary Transfer Stations under UPEHSDP in different locations of the Chittagong City; but the safe disposal of these wastes in the landfill site has not been properly addressed yet.

21. UPEHSDP will address this issue by implementing modern Controlled Landfill (CLF) in Chittagong, which may then be replicated in other urban centers through further subprojects.

B. Location, Size and Implementation Schedule

22. The Chittagong CLF subproject will be implemented on the land acquired by the City Corporation and currently being used as disposal site for solid waste; photographs of the proposed site are attached as Annex 2.

23. Location of the subproject is shown in the following map (Fig 1). The site consists of a deep valley with surrounding rolling hills, permanent and intermittent streams, and views towards the Bay of Bengal and the city. It lies 6 km north of the commercial center, approximately 8 km from Chittagong University and 15 km from the city's international airport. The land surrounding the proposed landfill site represents one of the undeveloped areas of Chittagong's hilly landscape. This site is located within the city limits near a golf course and a military cantonment, the new Asia Women University to the south. The site measures about 200m on 150m, which is suitable for construction of controlled landfill. As per requirement of the EARF selection criteria #8 for waste management, it has been ensured that no habitation or sensitive receptors are within 250 meters of the proposed landfill site. Also it has been confirmed that the landfill (i) will not be constructed in areas where the groundwater table is less than 2 meters below the ground level; (ii) will not be constructed within the flood prone areas; (iii) are not within the environmentally sensitive areas; (iv) will not be constructed within or near water supply wells, and at least 500 meters of any downgraded wells; and (v) will ensure a buffer zone around the landfill with the distance agreed upon with the regulatory agencies. If during construction any of

the criteria cannot be adhered to, specific design options will be taken into consideration. NOC from the DPHE will be obtained if proposed landfill is within or near water supply wells or within 500 meters of any downgraded well.

24. Preliminary design of Chittagong CLF subproject has begun in the end of 2012 and has been completed by the end of the year 2013. As this subproject will be implemented on the basis of turnkey contract, the detailed design will be done by the contractor, and the IEE/ EMP will be updated at the time of detailed design and will be revised by the Design and Supervision Consultants (DSC) team. Construction of the civil works and procurement of equipment would take around 18 months. So the operation of the CLF should therefore begin in late 2015 or early 2016.

C. Description of the Project

25. Solid wastes in Chittagong City Corporation come from the households mostly kitchen waste and commercial area where a rough estimate considering the present rate of collection of 600 tons dumping to the site against the daily production of waste about 1350 tons by the city¹. The waste contains mostly organic portions containing enough moisture to be compacted. The wastes are primarily collected by NGO vans from houses, community bins and roadside waste bins and further sent to the disposal site. There are few legal collection points in Chittagong City Corporation which are established mainly by the side of main roads and most of them are RCC built waste collection sites which are not controlled at all. Wastes are left in scattered way which is the reason of nuisance and bad odor to the passersby and local people. The surrounding air is also being polluted. There are also some undefined illegal collection points, e.g. roadsides, drains, roadside wetlands etc. Under the present situation, there are no secondary transfer stations but in near future twelve numbers of STSs will be implemented. The CLF site is being developed on the available size of the landfill at present being used for dumping solid waste.

26. Environmental pathway study was conducted to find out the existing condition of the landfill site and take appropriate interventions to be included in the project activities. Currently, a mixture of medical waste and household waste is dumped on an uncontrolled way. The presence of the waste has a negative impact on the environment, agriculture and human health. In particular, soil and groundwater pollution are to be expected.

27. In the pathway study it is been advised that at least the environmental protection measurement mentioned in the following paragraphs should be taken.

28. Physical separation between the pollution and the environment should be guaranteed (gates and fences, covering, trees, etc.);

- Groundwater protection by draining and treatment of the polluted water and leachate:
 - o The groundwater which is affected by the current waste should be drained and should be treated in a waste water treatment plant;
 - o To prevent further contamination of the groundwater, new landfill cells should be constructed where an impermeable layer will prevent further contamination in the environment.
 - o A drainage system in the new landfill cell will drain all new leachate from the landfill cell into the waste water treatment facility.

¹ Data collection by Ecorem-DDC JV

- Leachate reducing measurements:
 - o To prevent the production of new leachate, surface waters should be separated as much as possible from the pollution source. To reduce the infiltration in the landfill mass, wastes should be covered by impermeable layers (clay layer of 0.5m; $K < 1.10^{-9}$ m/s).
- No uncontrolled landfill of untreated medical waste:
 - o Medical waste should be collected and treated separately and should be disinfected and stored safely. No unauthorised persons and animals may come into contact with medical waste. Disinfected medical waste shall be stored safely in anticipation of future technology (for incineration).
 - o Monitoring of quantity and quality of the waste for improving the environmental assessments.

29. Periodic control and measurements on the quality of the surrounding groundwater. Extra measurements can be proposed if negative impacts remain over a certain period of time. All measurements and laboratory analysis are recommended to be executed by an international credited laboratory for quality reasons.

30. The following are the modules used during the preliminary design of the landfill site:

- Module 1: Landfill for Household Waste
- Module 2: Medical Waste Treatment Facility
- Module 3: Area for Medical and Hazardous Waste (Bunkers)
- Module 4: Wheel Washing
- Module 5: Weighing Bridge
- Module 6: Zone for Wastewater Treatment
- Module 7: Pilot Composting Plant

31. **Landfill for Household Waste:** The landfill area will have protective fence of total height 3.00 meters to keep the area free from any trespassers. Surface water drainage ditch will be constructed just inside the protective fence to keep the area dry and free from accumulation of rain water or any other extra wash water within the landfill area. The surface drain will be one meter deep in the natural soil, having bottom width 1 meter, top width 3.5 meters, outside edge slope of 1:1 and inside slope of 2:3. There will be geo-textile lining for the surface drain. Next to the surface drain, one strip of 3 meters width will be kept reserve for installation or construction of utilities.

32. The entire landfill area will be divided into three cells. The cell – 2 and 3 will be developed at the present stage and the cell – 1 will be used for storage of existing waste in the landfill site. Landfill wall will be constructed surrounding the landfill area as well as to separate the two cells. The top of landfill wall will be at a level of 5.25 meters.

33. The landfill area will be backfilled by sand layer of variable thickness to attain a level surface for placing the liner system. The liner system will consist of serially from bottom to top (1) clay layer, 0.5 meter, $k < 1.10^{-9}$ m/s; (2) geo-textile; (3) drainage layer, 0.4 meter, $k > 1.10^{-4}$ m/s; (4) HDPE liner, 2.5 mm; (5) drainage geo-composite, $k = 10^{-3}$ m²/s; and (6) drainage layer, 0.4 meter, $k > 1.10^{-4}$ m/s.

34. The main leachate drainage pipe will be HDPE PN10, diameter 300 mm; and the side leachate drainage pipe will be HDPE PN10, diameter 110 mm. Both of these leachate drainage pipes will be placed above the HDPE impermeable layer. On the other hand, the groundwater drainage pipe HDPE PN10, diameter 110 mm will be placed below the impermeable layer. Geo-textile and filtering material gravel 16/32 will be placed around these pipes to prevent entrainment of sand and soil.

35. There will be inspection well in the junction point of main and side leachate drainage pipes. At the end point, there will be groundwater pumping well to pump the groundwater to surface drain. And the leachate will be pumped from the leachate well to the wastewater treatment plant. Control devices for groundwater and leachate have been incorporated; however, gas monitoring has not been incorporated due to budget constraints.

36. There will be no recycling facilities, only sorting places will be provided. This decision has been taken due to budget constraint as well as lack of adequate space in the landfill site. Wastes like plastics, glasses and tires will be taken out of the landfill site for probable recycling elsewhere.

37. **Medical Waste Treatment Facility:** This unit will contain autoclave for disinfection of disposable materials that will be taken to the bunkers. Plastic materials will be taken to the recycling plant, disinfected and grinded in the chemical disinfection and shredding unit for re-use. Sharps will be disposed in the closed bunkers for burial. Hazardous wastes will also be taken to the specific compartments in the bunkers.

38. **Area for Medical and Hazardous Waste (Bunkers):** This area is reserved for disposal of medical and hazardous wastes. There will be several compartments to deal with wastes from autoclave, ashes from the incinerator, sharps, etc.

39. **Wheel Washing:** Wheels of dump trucks and other vehicles entering the landfill site will be ensured to clean the wheels before ply in the public roads. Vehicles will pass through a depression where water will be available to wet and clean the wheels. There will also be arrangement for spraying water to the wheels and other parts of the vehicles by using water pumps and spraying nozzles.

40. **Weighing Bridge:** Weighing Bridge will be installed near the entry gate to facilitate weighing of the total solid waste carried by the dump truck and to maintain a record of total waste taken to the landfill site. Computerized system of weighing and recording will be there in the Checkpoint Cabin to ensure proper recording in an well maintained database and reporting properly in user friendly formats.

41. **Wastewater/ Effluent Treatment Plant (ETP):** Leachate will be pumped to the collection chamber from the landfill site as well as from the composting plant. Feed pump will be used to transport the leachate from this chamber to the equalization tank. Then treatment of this wastewater will be done by activated sludge method. Methane reactor will be used for separation of methane gas. Sedimentation tank will be used and chemicals like hydrochloric acid, ammonium hydroxide and ferric chloride will added for effective coagulation. Blowers will be used for aeration. Sludge will be recycled from the final clarifier and extra sludge will be returned to the landfill site for drying. The effluent from the final clarifier will be used for root zone plant system for further polishing. The final effluent from the landfill site will meet the effluent standard as per ECR 1997.

42. **Pilot Composting Plant:** The overall dimension of the composting plant is 110 meters length X 27 meters width X 5 meters height. It has the following facilities like office room, dressing cum washing room, storage, packaging corner, fixed place for containers, and a big hall room (85 meters X 27 meters) having longitudinal drain passing along one side, etc. There are 3 options for construction namely shelter steel girder (F1), shelter double slab (F2) and pre-stressed beams (F3).

43. **Management of Existing Wastes:** For preparatory step the waste from the cell – 1 will be transported to the cells 2 and 3 temporarily for placement of impermeable clay layer in the bottom of Cell – 1. Then the existing wastes of the entire landfill site will be transported to the landfill Cell – 1 located in the North West corner of the site. Wastes will be placed systematically in layers with adequate and proper compaction; suitable covering soil will be added over each of the layers; capping will be done by clay layer to prevent further pollution; and finally covering turf or grasses will be grown on properly shaped surfaces keeping adequate arrangement for drainage of rainwater.

44. No additional chemical or heavy metal testing has been planned as part of the subproject because of the fact that there was no indication of presence of these kinds of wastes in the samples used for characterization of wastes in the pathway studies.

45. Implementation of small transfer stations under the separate package in UPEHSDP is anticipated to lead to a 50% reduction in operating cost of secondary collection services per tonne. This will free up significant resources to expand the coverage and quality of secondary collection services, as well as to pay for the operating and maintenance costs of the integrated waste treatment and disposal facility.

46. Modern electrical, mechanical machineries and equipment are also included in the subproject to operate the CLF to modern sanitary standards.

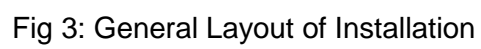
47. Figures 2 to 8 provide preliminary site layout plans including the plans for medical waste treatment facility and the compost plant.



Fig 1: CLF Site of Chittagong at Arifin Nagar (22°21'31"N, 91°49'25"E)



Fig 2: Contour Map of CLF area



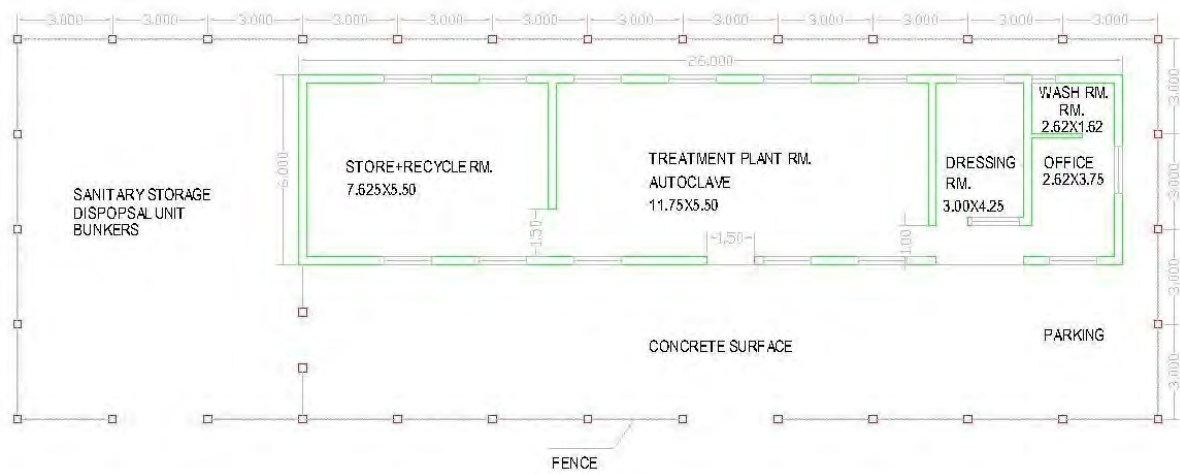


Fig 4: Medical Waste Treatment Plant

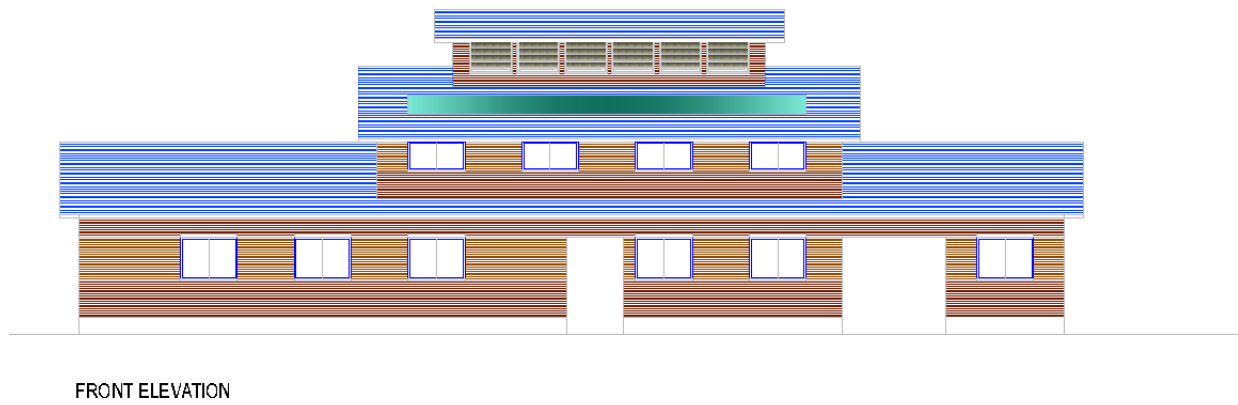


Fig 5: Front Elevation

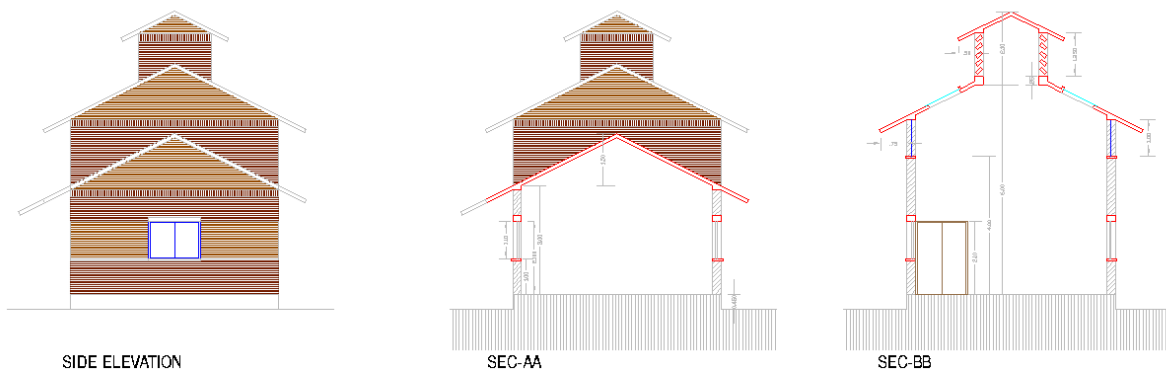


Fig 6: Side Elevation and Sections

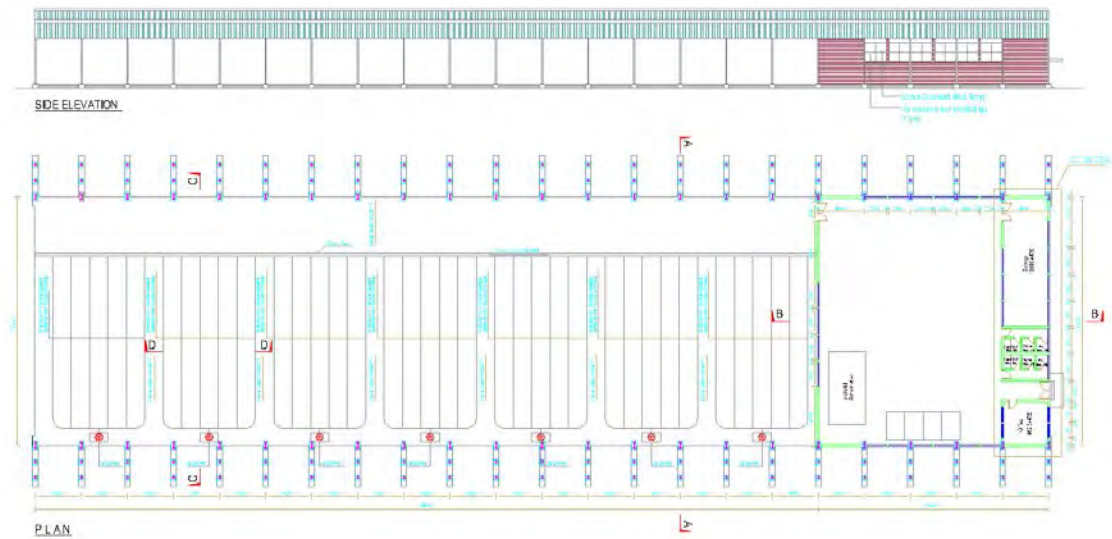


Fig 7: Plan of Composting Plant

49. Figure 9 representing the bio-ecological regions of Bangladesh shows the coastal plains (8a) where the city of Chittagong belongs. This region of Bangladesh comprises the most productive ecosystems of the world.

50. The topography of the proposed CLF site is flat and at grade with the adjacent and approach road. No elevation changes occur within or around the site. The subsurface is characterized by sandy clay with silt and very fine sand particles.

51. The type of soil available around the site of CLF is sandy soil, which is suitable for earth filling during construction activities. This soil will also be very good for covering the waste during the operation phase. Huge quantity of backfilling soil may be collected from dredging of soil from river bed. But additional clay will be required to be brought from outside.

2. Climate

52. The weather of Chittagong is characterized by tropical monsoon climate. The dry and cool season is from November to March; pre-monsoon season is from April to May which is very hot. The sunny and the monsoon season is from June to October, which is warm, cloudy and wet. On average, the temperatures are always high. A lot of rain (rainy season) falls in the months of April, May, June, July, August September and October. It has dry periods in January and December. On average, the warmest month is April and the coolest month is January. On the other hand, the wettest month is July and the driest is the January. Around 70-80% of the annual rain falls during the months from April to October. The rain is often accompanied by strong winds, sometimes exceeding 100 km/h. The highest rainfall during the last ten years (2002 to 2011) recorded was 4340 mm in the year 2007 and lowest of 2331 mm in 2005. The highest maximum annual average temperature of 39.5°C in 2009 and the lowest is 35.4°C in 2011. On the other hand, the highest minimum annual average is 12.5°C in 2008 and the lowest of 9.5°C in 2011.

53. Wind data from the Bangladesh Meteorological Department Climate Division suggests that wind directions vary month-to-month in Chittagong, though predominantly in the NW, S, and NE directions.

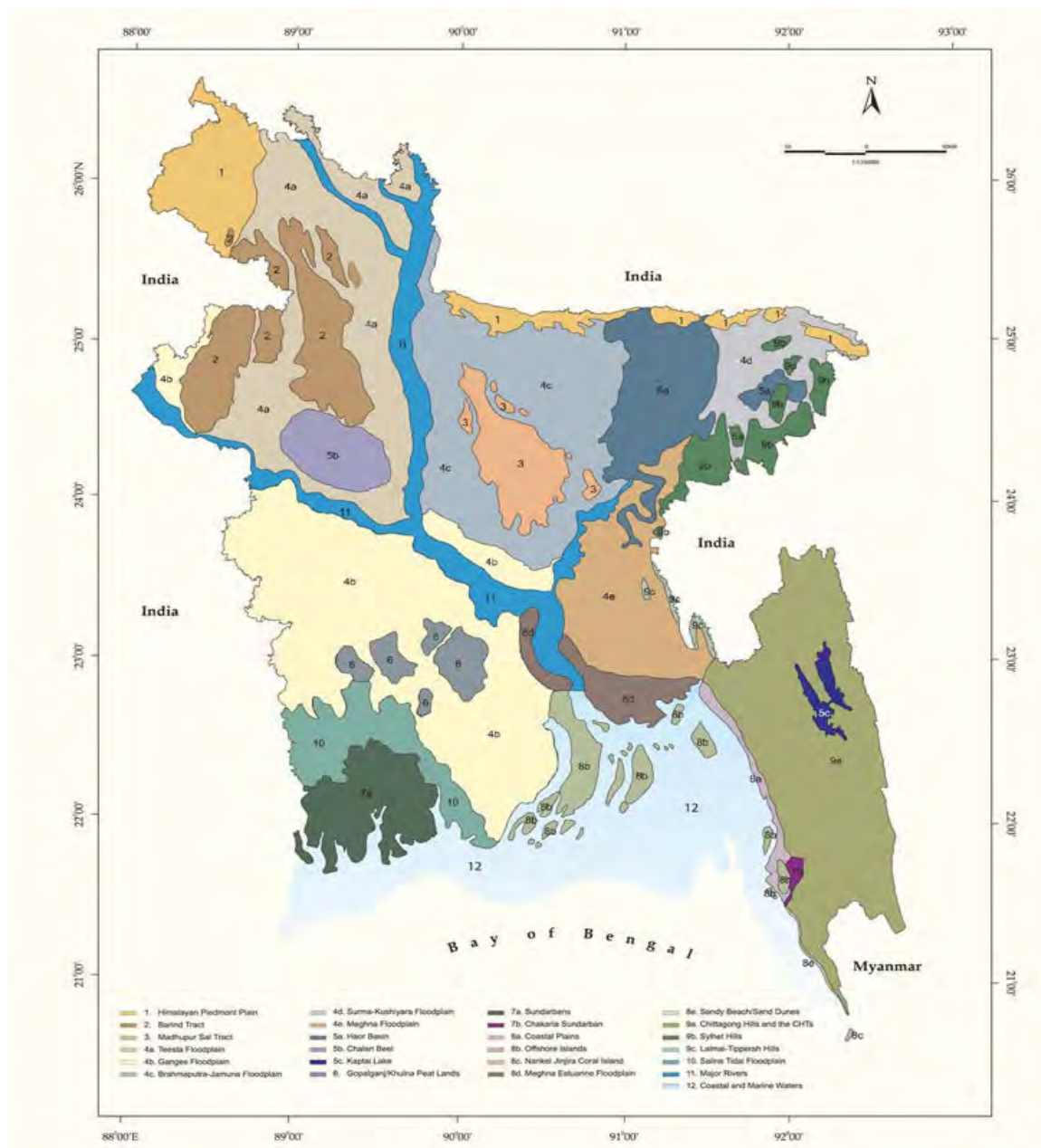


Fig 9: Bio-ecological map of Bangladesh

Source: Internet

54. Although weather patterns are broadly similar throughout the country, differences in topography, winds and other factors produce some quite marked local variations. This is particularly evident in the annual rainfall of around 3,128 mm (in 2011) in Chittagong. Relative humidity, average dry bulb temperature, maximum and minimum temperatures and rainfall patterns are represented as under based on the raw data obtained from the Bangladesh Meteorological Department (Figures 10, 11, 12, 13 and 14)².

² Source of raw data (Fig. 10,11,12, 13 and 14): Bangladesh Meteorological Department, July, 2012

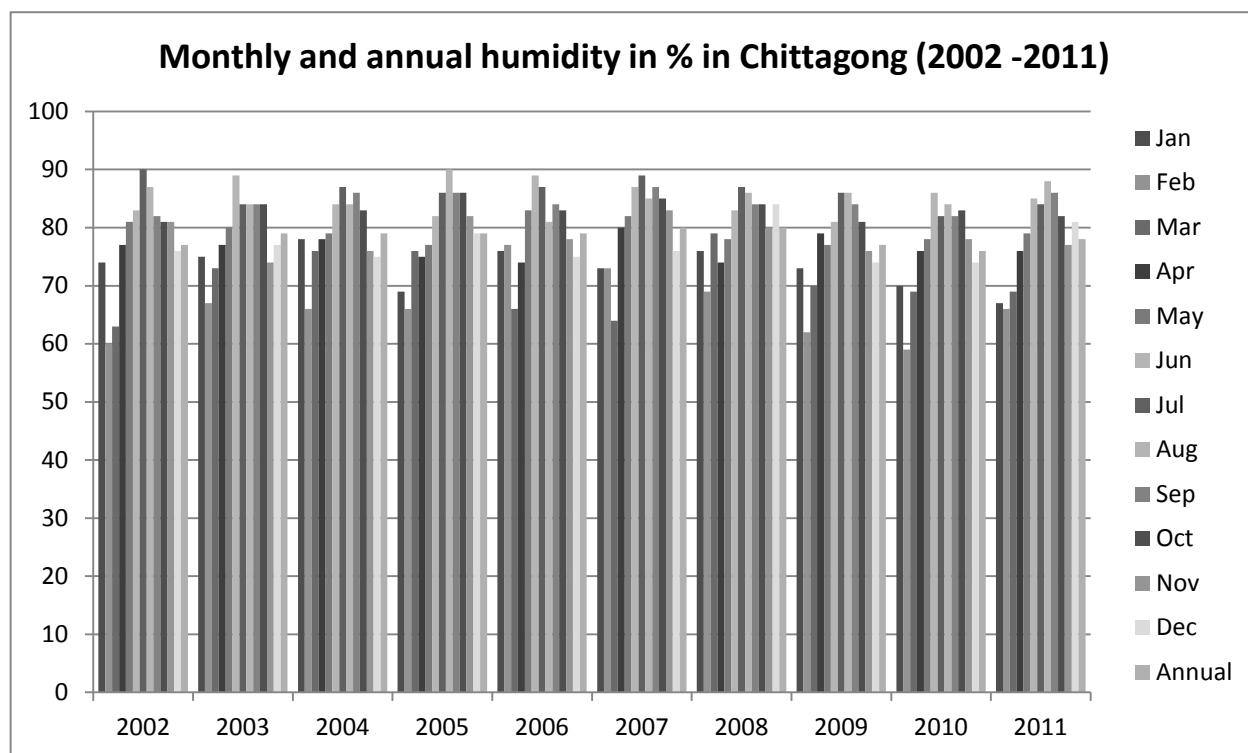


Fig 10: Monthly and annual humidity (%) in Chittagong (2002-2011)

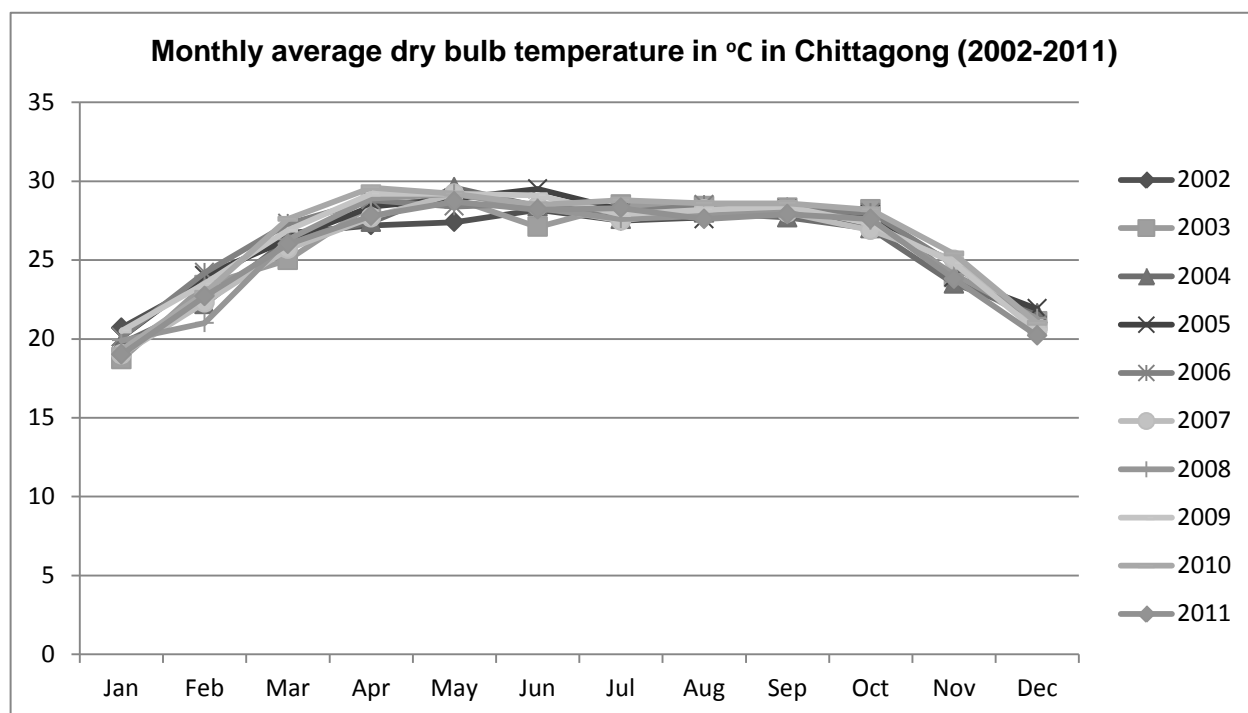


Fig 11: Monthly average dry bulb temperature (°C) in Chittagong (2002-2011)

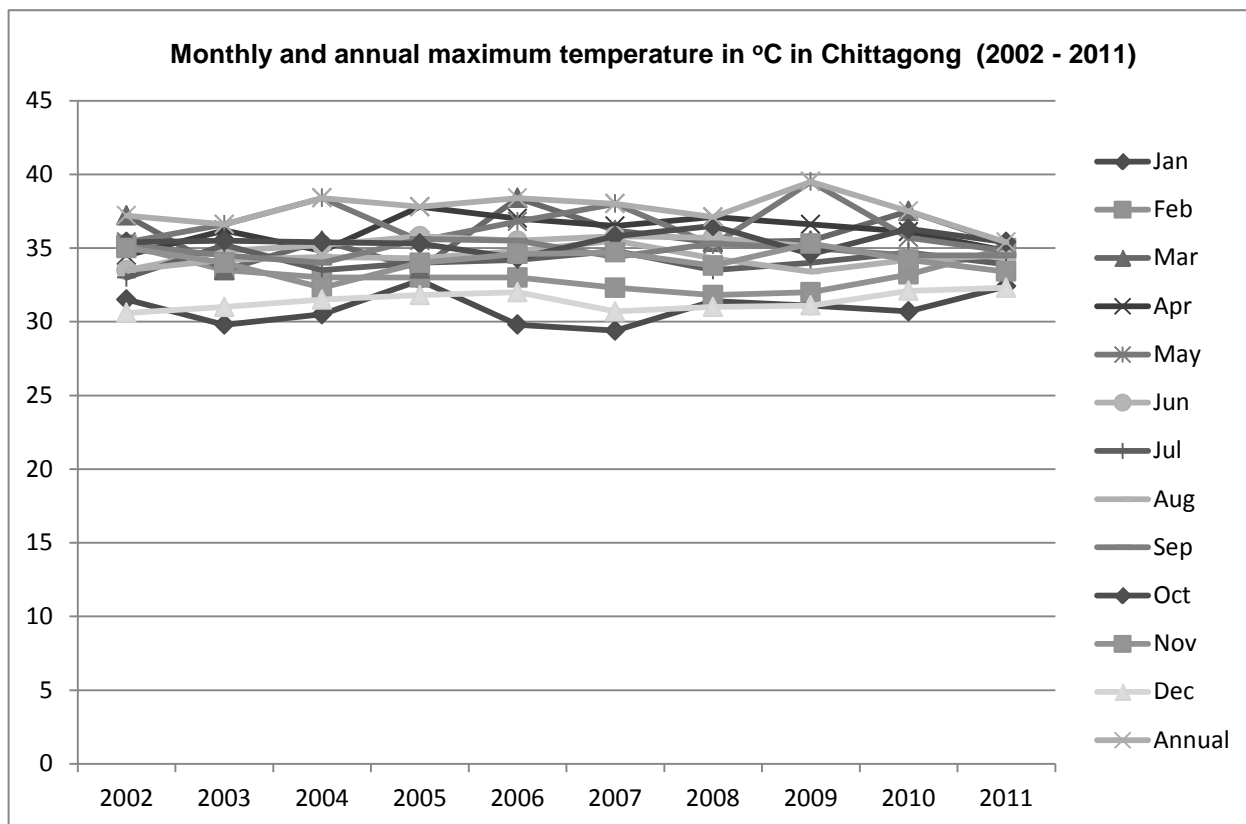


Fig 12: Monthly and annual maximum temperature (oC) in Chittagong (2002-2011)

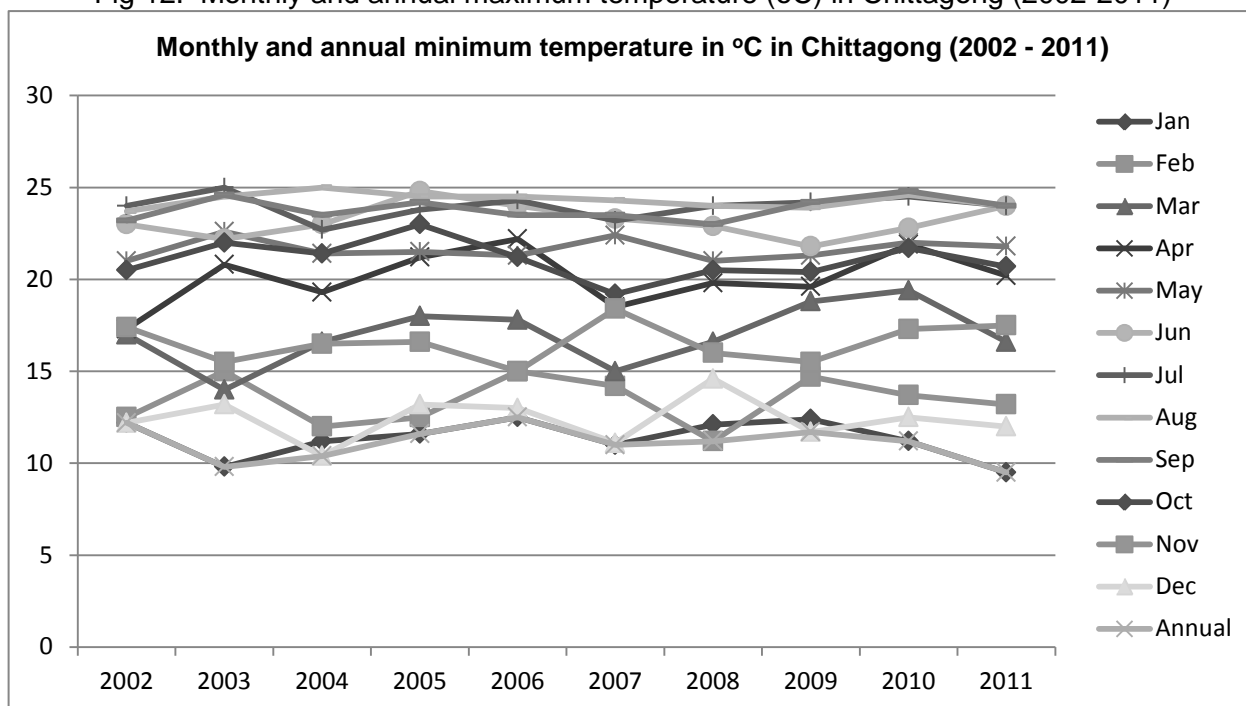


Fig 13: Monthly and annual minimum temperature (oC) in Chittagong (2002-2011)

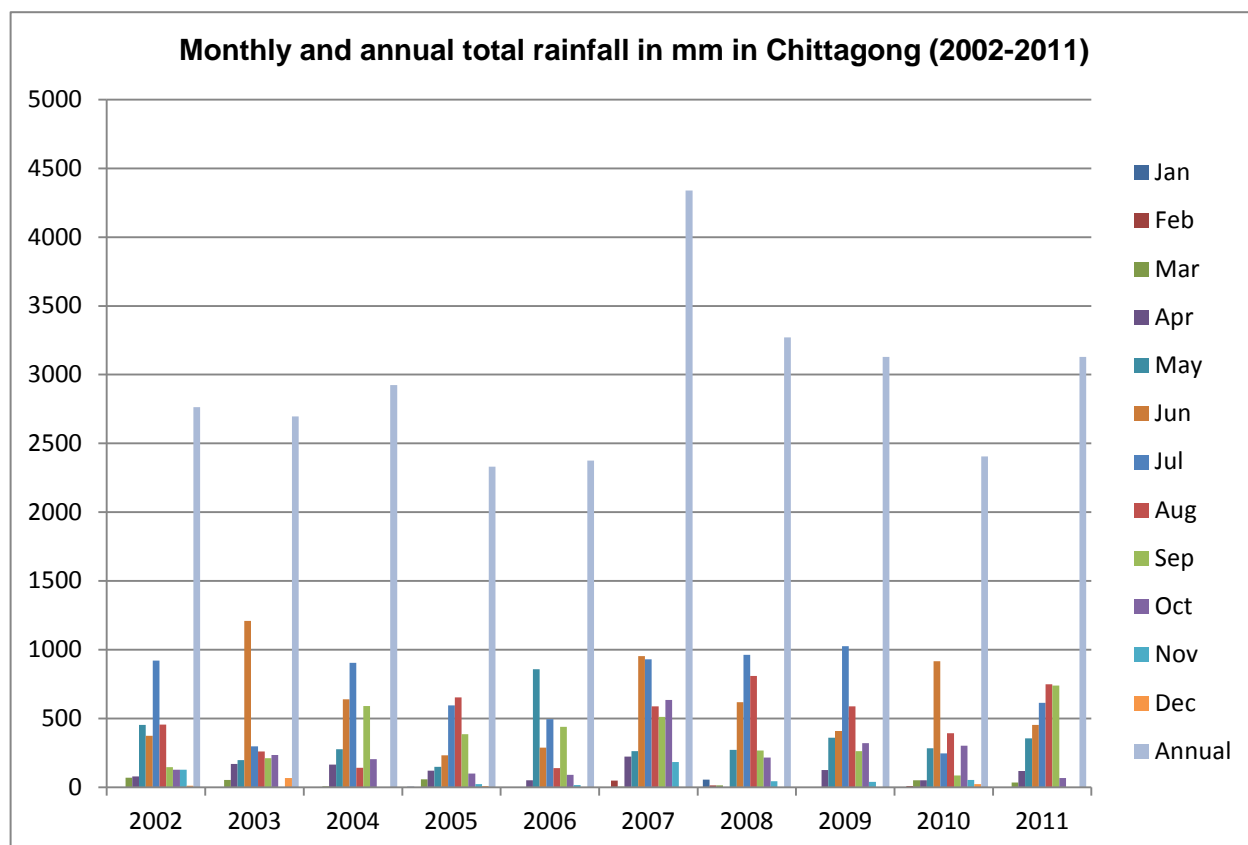


Fig 14: Monthly and annual total rainfall (mm) in Chittagong (2002-2011)

3. Air Quality

55. Air quality is generally good in rural Bangladesh, where there are few industries and low densities of people and vehicles. The situation is very different in the cities, where urbanization, industrialization and overcrowding create major air quality problems. In 1988 the World Bank estimated that 15,000 deaths per year and a million cases of major illness are caused by air pollution in Dhaka, Chittagong and Rajshahi.

56. The main atmospheric pollutants are those produced by vehicles and industries and in particular by the burning of fuels. These include particulate matter, hydrocarbons, carbon dioxide, carbon monoxide, sulphur dioxide, oxides of nitrogen, lead, ammonia and hydrogen sulphide. Many of these cause respiratory problems in humans, plus other diseases if substances accumulate in the tissues. The main causes of the poor air quality are:

- (i) Poor roads and traffic management leading to severe traffic congestion;
- (ii) Use of high sulphur diesel by buses and trucks, and inadequate control of emissions;
- (iii) Heavy industrialization, and use of cheaper high-sulphur fuels (coal, wood and tyres) by smaller industries like brick kilns; and
- (iv) Poor solid waste management, so burning is the common method of treating garbage.

57. Surveys by the DoE show levels of Suspended Particulate Matter (SPM) and sulphur dioxide (SO₂) in Chittagong and other cities that exceed Bangladesh Air Quality Standards, and

levels of atmospheric lead that are above World Health Organization (WHO) standards. These should fall over the next few years however, as laws are enforced reducing the number of two-stroke vehicles, and consumers change to vehicles using lower cost unleaded petrol and compressed natural gas.

4. Surface Water

58. Most of Bangladesh lies within the floodplains of the Ganges, Jamuna and Meghna rivers, which drain a catchment of around 1.72 million km² in India, Nepal, China, Bhutan and Bangladesh. Only 8% of the catchment is within Bangladesh, and because of its topography, flood-risk and population density, the quality and quantity of surface waters are major issues for the country. Chittagong lies in the South East Region, which is beside the river Karnafuli and the Halda is a tributary to this river in the upstream. Karnafuli is the largest and most important river in the Chittagong region, which originates in the Lushai hills in Mizoram state of India.

59. Like other towns and cities of Bangladesh, the Chittagong city dwellers, too, use both surface and groundwater as a source of domestic water. Principal difference lies in use of supply water based on treatment with some application of chlorine in Chittagong and other population centers. Pollution of rivers is a major problem, because of the discharge of industrial wastewater and inadequate sewerage system. Oil, waste materials and other toxic chemicals, discharged from ships and factories routinely pollutes the Chittagong port channel and the Karnaphuli river mouth that threatens the very existence of the prime sea port of the country. The sewerage system by using pipelines is not available in the city; the entire area is covered by open drains beside the roads. These open drains discharge to the canals and ultimately to the Karnaphuli river. The canals are very often clogged due to indiscriminate dumping of municipal solid waste and other polluting materials. Water quality of the river Karnafuli and Halda at various locations are shown as under (Table-2):

Table-2: Surface water quality of the river Karnafuli and Halda near Chittagong

Location	pH	Chloride (mg/l)	T. Alkalinity (mg/l)	TS (mg/l)	TDS (mg/l)	SS (mg/l)	DO (mg/l)	BOD5 at 200 C, 5 days	COD (mg/l)
Karnafuli River	6.36 – 9.86	2 - 13148	5.64 – 121	46 - 27700	45 - 20000	14.4 - 51000	0.00 – 7.91	0.21 – 9.17	11.39 – 179.87
Halda River	5.65 – 7.34	2.41 – 73.5	6.28 -90.78	100 - 740	30 - 200	20 - 653	3.02 – 9.90	0.70 – 5.08	14.78 – 49.28
WHO Standard	NYS	600	-	-	-	-	4 - 6	6	NYS

* Source: Pak. J. Anal. Environ. Chem. Vol. 11, No. 2 (2010) 1 – 11; NYS – Not Yet Started

60. The distance of the proposed CLF and effluent discharge point to the river Karnafuli is more than 3 kilometers. The leachate from the CLF will be treated as per effluent standard of DOE and will be allowed to flow through the properly constructed and maintained drain until it reaches the river bank discharge point.

5. Groundwater

61. There are three main aquifers in the central region of Bangladesh:

- (i) An upper (composite) aquifer, which can reach depths of 50 m and is covered with an upper silty clay layer of less than 20 m;
- (ii) A middle (main) aquifer of fine to heavy sands, which is generally 10-60 m thick and in most areas is hydraulically connected with the composite aquifer above; and

- (iii) A deep aquifer of medium, medium-to-fine or medium-to-coarse sand, which is generally found at depths below 100 m.

62. Chittagong WASA can supply only 175 MLD of water. CWASA has water supply pipeline of 570 km. Production from surface water is 91 MLD from only one treatment plant in Mohara. There are 52 DTW in the entire CWASA jurisdiction. The production from ground water is 84 MLD. Present shortfall of water supply is about 325 MLD. With available supply, demand of about 33% of the city population can be met. The ratio of surface water and ground water is 52:48. Ground water in Chittagong city contains high iron concentration (2~8 mg/l). That is why the wells strainer and the gravel pack become clogged with iron bacteria causing decline in water production within few years of installation. Again ground water of southwest area of the city contains Chloride and recently some well water found to contain Manganese and Nitrate concentration exceeding the limit of Bangladesh Standard (As per JICA feasibility study report 2000, Manganese 0.17~0.28, Nitrate 1.2~13). Also, it is found that the ground water level in the city center has been declining. As CWASA is not able to meet the demand of water in the city, many household and industries have constructed their own deep tube wells. It is obvious that due to abstraction of water by CWASA and private tube wells, the ground water development in aquifer within Chittagong city area is in near limitation. As a result, the ground water would no longer be a sustainable source of raw water for CWASA.³

63. Supply of potable water is an increasing problem for the water and sewerage authorities because of the depleting supplies and source contamination. Water for the CLF will initially be sourced from CWASA supply but provision will be kept for digging well within the site for construction of CLF. The necessary clearance for digging well will be taken from the CWASA. The ground water table in the CLF site is far more than 2 meters below the ground levels; so there is no risk of contamination of ground water resources during the operational stage of the CLF.

6. Geology and Seismology

64. The National Seismic Zoning Map (Fig 15) produced by the Geological Survey of Bangladesh (GSB), divides the country into three regions: a high risk zone between Mymensingh and Sylhet in the north and north-east; a medium risk zone stretching diagonally from Rajshahi in the north-west through Dhaka and Comilla to Chittagong and Cox's Bazar in the south-east; and a low-risk zone in the south and south-west, around Chittagong and Barisal. In the medium risk zone, shocks of moderate intensity are possible, with a probable maximum magnitude of 6-7 on the Richter scale. Seismic events in Bangladesh are relatively infrequent but historically have been severe. The Assam earthquake of 1897 was the largest in the region's history, when a force of 8.7 on the Richter scale caused extensive damage across Assam, Bengal and Bihar.

65. Chittagong city is the second largest metropolitan city of Bangladesh. It is a unique example in the country showing distinctive geomorphic divisions, ranging from undulating hill topography to tidal mud flats. Based on land satellite and SPOT imageries, 3D-aerial photographic interpretation, and ground survey eight major geomorphic units of the city have been identified, which are: tertiary hills, piedmont and valleys, alluvial plain, old tidal plain, tidal mud plain, supra tidal plain, natural levee and sandy beach. The general topography of the city

³ Status of Water and Sanitation Services in Chittagong WASA by Mohammed Osman Amin, Member Engineering, Chittagong WASA

can broadly be divided into two nearly equal halves following the Dhaka-Chittagong rail lines; the undulating north and plain south.

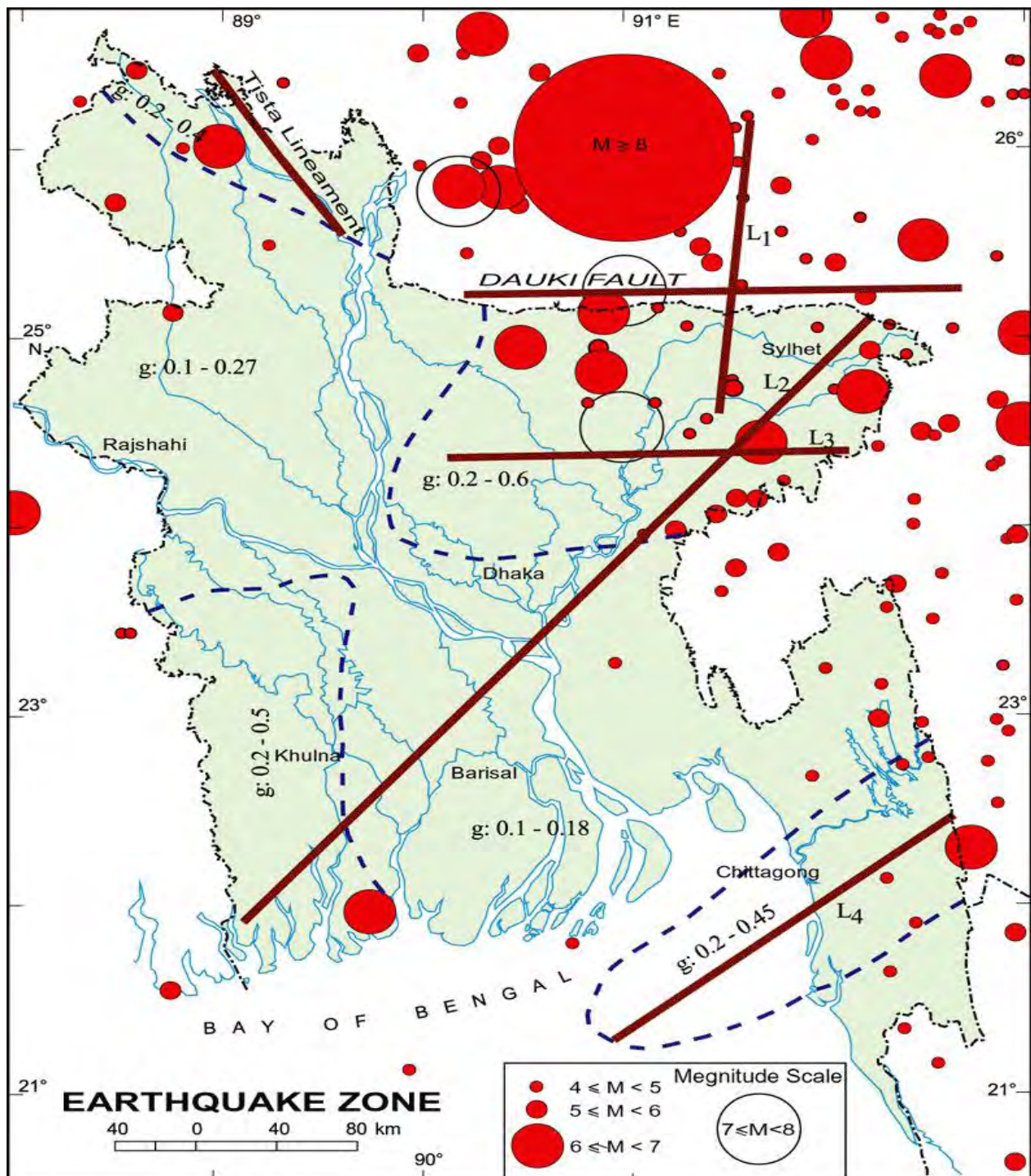


Fig 15: National Seismic Zoning Map of Bangladesh
Source: Internet

B. Ecological Resources

1. Habitats

66. The main physical features of Bangladesh are its mainly flat and low-lying topography, the dominant presence of the major rivers that drain enormous catchments in surrounding countries, a seasonal monsoon that swells river volumes for several months each year, and the resulting floods that inundate large areas of land. It is not surprising therefore that those aquatic habitats are the country's most important ecological resources.

67. There is a wide array of aquatic habitats throughout the country: natural and man-made, permanent and ephemeral, of varying sizes and characteristics. The rivers and floodplains are the most important, as they support species that are exploited by man, are the most productive of the habitats, and attract other important species, such as birds. However, as in other environmental sectors, the rapid urbanization and industrialization of the country and its expanding population (particularly the urban poor who use natural resources to supplement both food and income) have brought large scale damage and degradation to these areas.

2. Rivers

68. Most rivers in Bangladesh suffer under the influence of man, from the disposal of solid and liquid waste in urban and industrial areas around Chittagong and the other cities and towns, and from the diversion of water upstream for irrigation and/ or power generation.

69. The river Karnafuli passes on the eastern side of the main Chittagong city. The major rivers of this region are: Karnafuli and its tributaries (e.g. Rainkhiang, Kasalong, Halda, Ichamoti, etc.); Bakkhali, Sangu, Matamuhuri, Naf, and Feni. Kutubdia and Maheshkhali channels are the coastal channels of the region. Continuous dumping of highly toxic liquid and solid wastes into the Karnafuli river has created a situation that deteriorated the quality of water in the river. The riverside factories, human waste, oil spilling by boats and vessels are responsible for pollution. Once the Karnafuli used to be the heaven of fishes, but now most of the fish species have vanished. Department of Environment and Chittagong City Corporation have failed to save the river from pollution, as about 300 factories on the banks of the river are discharging wastes into the river.

3. Floodplains

70. Floodplains are the natural lowlands alongside rivers, which are inundated each year in the monsoon as the increased volumes of water overflow river banks. These zones are important ecologically as they are the areas into which the adults of many species of fish migrate to breed. Floodplains are rich in nutrients from the inundated soil and decaying vegetation, and are also rich in food in the form of dead insects, soil invertebrates, and aquatic plankton that frequently bloom under such conditions. They are also protected from the strong currents in the main river, so are ideal areas for young fish to feed and grow, before entering the main river when water levels decrease. These areas also frequently attract large numbers of water birds, to feed on the juvenile fish in the shallow waters.

71. Chittagong coastal plain extends from the Feni River to the Matamuhuri delta, a distance of 121 kilometers. It comprises gently sloping piedmont plains near the hills, river floodplains alongside the Feni, Karnafuli, Halda and other rivers, tidal floodplains along the lower courses of

these rivers, a small area of young estuarine floodplain in the north, adjoining the sub-region Young Meghna estuarine Floodplain, and sandy beach reaches adjoining the coast in the south. Sediments near the hills are mainly silty, locally sandy, with clays more extensive in floodplain basins. The whole of mainland is subjected to flash floods. Flooding is mainly shallow and fluctuates in depth with the tide (except where this is prevented by river or coastal embankments). The average daily rise in the tide is about two meters. Some soils on tidal and estuarine floodplains become saline in the dry season.

4. Other Aquatic Habitats

72. There are a variety of other aquatic habitats throughout the country, and in urban areas these include man-made lakes in residential neighborhoods, permanent and ephemeral pools in natural lowlands (known as *bheels*), and flooded borrow pits excavated for building material. These are generally of little ecological value as the water is frequently polluted, and these areas are often characterized by dense growths of the water hyacinth *Echicornica crassipes*, which out-competes other plants through its rapid growth, although species such as water chestnut and lotus can be seen in places.

5. Terrestrial Ecology

73. The city of Chittagong is almost denuded of the trees and vegetation that once had beautified and made its environment congenial to terrestrial ecology specific of this area. Now trees are available on the hills only. Rapid and continuous growth in the city population has encouraged various land-grabbers and mushroom growth of land development firms with a resultant erasure of wetlands, trees, greeneries, vegetation and forest lands in and around the city and replaced by widespread concrete jungles in the name of high-rise buildings. The urban terrestrial fauna is very limited as a result, and mainly consists of animals able to live close to man, such as lizards and geckoes, scavenging birds like house sparrow and crows, mice, rats and other rodents, plus jackal, mongoose, squirrel and monkeys. There is a wider range of species in the farming areas, but even these are mainly animals that are commonly found close to man, such as cattle egrets. Fig. 16 gives an idea about the ranking of total environmental conditions of 41 wards of the Chittagong city on the basis of study based on information from 492 respondents in household level.⁴

⁴ Kathmandu University Journal of Science, Engineering and Technology, Vol 1, Number IV, August 2007

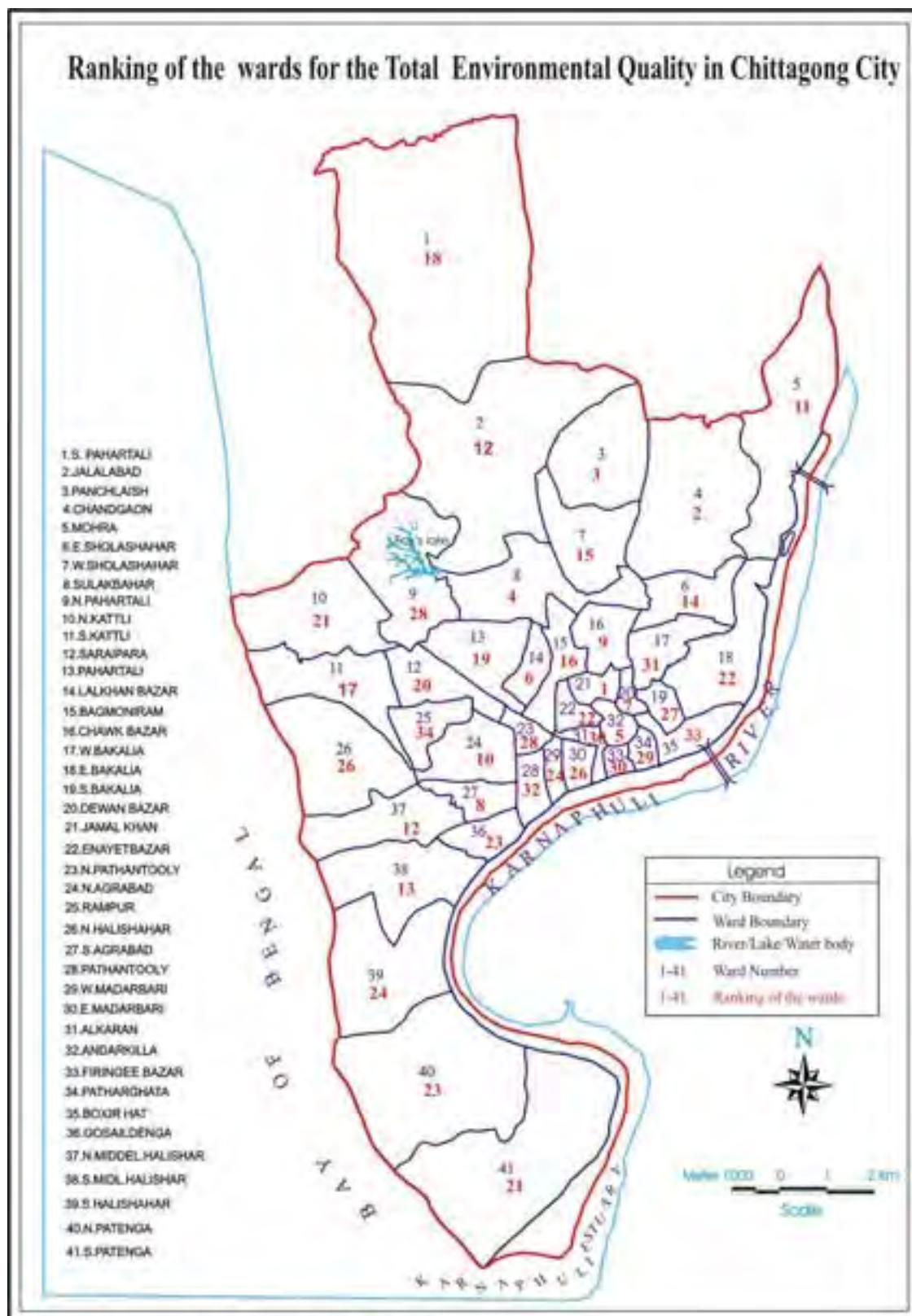


Fig 16: Ranking of the Wards of Chittagong for Total Environmental Quality

6. Protected Areas and Endangered Species

74. The beautiful buildings, mosques and shrines of Chittagong bear witness to its history from the ancient times to the present. Most of the old and new buildings of the city are built on top of low hills and hillocks and also along the valleys and plains. The massive Court Buildings which accommodate the Civil Courts, Criminal Courts and the offices of the Divisional Commissioner, Deputy Commissioner, and the District and Session Judges are on top of Fairy Hill. The top of this hill offers a panoramic view of the town below. One can see the Karnafuli River up to its mouth and the Port area along its bank, the Deang and Banskhal Ranges to the south and the Hill Tracts to the east. All along the foothills are situated the General Post Office, the Municipal High School, New Market, and the Chittagong Development Authority Building. The General Hospital stands on top of the Rangmahal hill. The Telegraph Office, Divisional Forest Office, residences of the Divisional Commissioner and the Deputy Commissioner are situated on top of a hill range known as the Tempest Hills. The nearest protected and environmentally sensitive area the famous shrine of Bayazid Bostami is about 6 km from the proposed CLF site.

75. The Chittagong region is characterized by three distinct ecological zones: inter-tidal zone, coastal plains and extensive hill areas. The northern and eastern parts of the region constitute the hilly areas and are commonly known as the Chittagong Hill Tracts. This area is covered with a deep evergreen and deciduous forest which is a habitat of many wildlife species such as the Asian Elephant (*Elephas maximus*), White Duck (*Cairina scutulata*), Banrui (*Maris crassicaudata*), Banchhagal (*Capricornis sumatraensis*), Shajaru (*Hystrix indica*) and other endangered species. The coastline consists of a 100 km long sandy sea beach on the Bay of Bengal. The remainder of the region consists of plains. The proposed CLF is located in the plain and partially in hilly area thus there are no endangered species. Flora and fauna found in the subproject site are commonly found in developed and urban areas.

C. Economic Development

1. Industry

76. Besides an oil refinery and oil-blending plants, the Chittagong city has large cotton and jute-processing mills, tea and match factories, chemical and engineering works, an iron and steel mill, and fruit-canning, leather-processing, and shipbuilding industries.

77. Chittagong is a commerce and industry hub, and a port city, in southeastern Bangladesh and the capital of an eponymous district and division. The city is home to Bangladesh's busiest seaport and has a population of over 5.5 million, making it the second largest city in the country.

78. Chittagong is one of the fastest growing cities in the world, with a GDP of \$25 Billion. A major commercial and industrial centre, the city also has a globally competitive special economic zone. With the Port of Chittagong being expanded and developed, the Dhaka Chittagong Highway being upgraded into 4 lane divided highway, and Shah Amanat International Airport being upgraded, regional neighbors of Bangladesh have eyed Chittagong as a future regional transit hub. The port city is seen as crucial to the economic development of landlocked southern Asia including Northeast India, Bhutan, Nepal and parts of Southern China and Burma.

2. Infrastructure

79. Infrastructure is a major problem in all towns and cities in Bangladesh, where many facilities are inadequate to serve the needs of such a large population, after decades of underfunding and neglect. Sewerage system is not available in Chittagong. Throughout the rest of the country people use a variety of methods including septic tanks, pit latrines, and open defecation. Septic tanks malfunction because of inadequate design, construction or maintenance, or because the high water table impedes the soak-away function. Many buildings, including high-rise developments, have no sanitation system at all, and discharge their effluent into lakes, rivers, drainage ditches or onto open ground, causing unsightly areas, health risks and water pollution.

80. Solid waste in urban areas is the responsibility of the city corporation (CCC), and in most locations NGOs or CBOs operate the primary collection service, removing waste from houses and businesses each day, mainly on cycle-rickshaws. These carry waste to Secondary Transfer Stations (STS) at various locations around the town, from where it is carried for final disposal by vehicles operated by the city corporation. There is one dumping site in Madhya Halishahar in Chittagong, where poor practices create an unsightly and insanitary facility. Also the disposal is by open dumping with little or no management or pest control, and as a result these areas are highly insanitary and hazardous to public and environmental health. But new initiatives have been taken to construct controlled landfill site including facilities for management of medical waste under the present program of UPEHSDP. After implementation of UPEHSDP, it will be possible to utilize these facilities for safe disposal of STS and slaughterhouse wastes as well as other hazardous wastes from the CCC.

81. In the landfill site, there is one compost plant with quite large capacity but with very poor and unhygienic management. It is expected that new compost plant will be installed in the Controlled landfill site to be developed under the UPEHSDP. At present, there are no transfer stations in CCC area but the collection and transportation of solid waste will be improved substantially after implementation of the 12 STSs proposed in other package of UPEHSDP.

3. Transportation

82. Transport in Chittagong is similar to that of the capital, Dhaka. Large avenues and roads are present throughout the metropolis. There are various bus systems, taxis, and as well as smaller 'baby' or 'CNG' taxis, which are basically tricycle-structured motor vehicles. There are also traditional manual rickshaws, which are very common.

83. The Dhaka-Chittagong Highway, a major arterial highway, is the only way to get in the city through land. It is a very busy and a risky highway, currently it is a 2-lane highway, with upgrading to 4 lanes being implemented. Chittagong can also be accessed by rail. It has a station on the meter gauge eastern section of the Bangladesh Railway. The headquarters of this railway are located here. There are main two railway stations in Station road Chittagong. Trains are available traveling to the Bangladeshi cities of Dhaka, Sylhet, Comilla, and Bhairab.

84. Shah Amanat International Airport serves as Chittagong's sole international airport, and the only route to get in the city by air. It is the second busiest airport in Bangladesh. It has international service to destinations such as Middle Eastern like Abu Dhabi, Dubai, Sharjah, Jeddah, Ras Al Khaimah, Muscat and Kolkata. Right know Middle Eastern low-cost carriers like Flydubai, AirArabia, RAK Airways, Oman Air fly from here to international destinations in the

Middle East. It was formerly known as MA Hannan International Airport, but was renamed on April 2, 2005 by the Government of Bangladesh.

4. Land Use

85. The proposed site for CLF is on the land owned by the CCC and at present being used as temporary dumping places for municipal solid wastes collected from the area surrounding the CLF site. There are no existing structures or sheds used by the waste pickers/ scavengers.

5. Power Sources and Transmission

86. The Bangladesh Power Development Board (BPDB) is responsible for the generation of power in the country, and distributes electricity to retail customers, as well as to two other distribution utilities: the Rural Electrification Board (REB); and the Dhaka Electric Supply Authority (DESA) in the capital. Electric power is generated in hydro, steam, gas-turbine and diesel power plants, and all the generating stations are interconnected through a national grid. As per details in February 2011, the total installed capacity of power generation is 6658 MW and the maximum power generation is 4699 MW.⁵ Karnafuli Hydro Power Station is the only hydropower plant in the country located at Kaptai, about 50 km from the port city of Chittagong. This plant was constructed in 1962 as part of the 'Karnafuli Multipurpose Project', and is one of the biggest water resources development projects of Bangladesh. After being commissioned in 1962, the plant could feed the national grid with 80 MW of electricity. In later years, the generation capacity was increased in two phases to a total of 230 MW. The plant not only plays an important role in meeting the power demand of the country but is also vital as a flood management installation for the areas downstream. The other two big power stations in the Chittagong region are Raozan (420 MW) and Sikalbaha (60 MW).

87. Power is provided to most urban areas through a network of electricity pylons and poles, mainly located beside roadways. This provides connections to individual houses, and revenue collection is by individual household meters. Generation is insufficient to offer a continuous supply, and the providers operate a system of "load-shedding" whereby they turn off the supply for 1-2 hours each day to conserve the resource. Hotels, businesses and the more wealthy residents increasingly use their own generators to augment the supply from the national grid.

6. Other Economic Development

88. The economic development of the country largely depends on the efficiency of Chittagong port. The sea-borne exports of Chittagong consist chiefly of readymade garments, knitwear, frozen food, jute and jute products, leather and leather products, tea, and chemical products. There is also a large trade by country boats, bringing chiefly cotton, rice, spices, sugar and tobacco. Sailing ships built in Chittagong include the *Betsey*, the *Argo*, and the *Mersey*. Ship breaking was introduced to the area in 1969. This industry is concentrated at Faujdarhat, a 16 kilometers long beach 20 kilometers north-west of Chittagong. Chittagong is also home to a large number of industries from small to heavy.

89. Around 40% of the heavy industrial activities of the country is located in Chittagong city and adjacent areas, which include Dry-dock, Dock yards, Oil refinery, Steel mill, Power plant, Cement clinker factory, Automobile industry, Pharmaceutical industry, Chemical plants, Cable manufacturing, Textile manufacturing, Jute mill, Urea fertilizer factory along with other private

⁵ Source: Bangladesh Economic Review 2011(Bangla Version)

sector medium size industrial developments and activities. A Korean company, Youngone Corporation, has established a special Korean Export Processing Zone (KEPZ) in the port city of Chittagong. The KEPZ is built on a land area of nearly 1,000 hectares and is expected to attract foreign direct investment worth \$1 billion. There is as well a Karnaphuli Export Processing Zone, with the same acronym (KEPZ).

D. Social and Cultural Resources

1. Population and Communities

90. Chittagong city has a population of 5.5 million, male 54.36% and female 45.64%. Population density per square km is 15,276. Islam is the most common religion among the people. 83.92% of the populations are Muslims. Other major religions are Hinduism (13.76%); Buddhism (2.01%), Christianity (0.11%) and others (0.2%). The population has increased tremendously during the last two to three decades because of various reasons.

91. One of the main reasons for the population growth has been the influx of rural migrants, attracted by the prospect of easier lives and increased incomes in urban areas. When these fail to materialize the inevitable result is an increase in the urban poor and an expansion of slums. Thirty five percent the urban population of the country now lives in slums, which is almost 15 million people, and in the six cities under UPEHSDP there are almost 10,000 slums, 55% in Dhaka and 20% in Chittagong.

2. Health Facilities

92. Health facilities are generally more widely available in towns and cities than in the rural areas, but the cost of the service means that it is not widely used by poorer people and slum dwellers in particular. This along with various other factors, including poor sanitation and nutrition (which decrease immunity and resistance), overcrowding (which facilitates disease transmission) and poor public and environmental health mean that the urban poor suffer disproportionately from ill health. As a result, child morbidity and mortality, malnutrition and growth retardation are all higher in slum areas. There are also gender inequalities, with mortality in years 1- 4 being 28 per 1,000 births in boys, compared to 38 in girls.

93. People in urban areas suffer many of the diseases associated with overcrowding and poor sanitation, including dysentery, diarrhea, whooping cough, gastro-enteritis, TB, etc. In the larger cities like Dhaka and Chittagong they also suffer respiratory problems and other illnesses caused by excessive exposure to traffic pollutants.

94. Chittagong Medical College Hospital with more than 600 beds is the largest government-run health service provider. This huge medical facility has many wards, cabins and units. At present this facility also provides medical treatment of ICU and CCU for the serious patients. Other medical service institutes in the city include General Hospital, Upazila Health Complex, Family Welfare Center, TB Hospital, Infectious Disease Hospital, Diabetic Hospital, Mother and Children Hospital and Police Hospital. Notably, the total health service of Chittagong is developing day by day. Many non government hospitals and clinics also belong to the city. Chittagong Metropolitan Hospital, Surgiscope Hospital, CSCR, Centre Point Hospital, National Hospital etc. are the noteworthy non government hospitals and clinics of Chittagong City.

95. Public health facilities provide good service, but many are under staffed and under resourced, and ratios of beds per numbers of population are inadequate. Facilities are

significantly better in the private sector, but care is expensive, and out of reach of any but the wealthier citizens.

3. Educational Facilities

96. Chittagong University, Chittagong Medical College and Chittagong University of Engineering and Technology are totally funded by the Government. Chittagong is home to two of the nation's most prominent public universities, and is the site of one of Bangladesh's largest universities, the University of Chittagong, established in 1966. The university is located in a remote place from the city (22 km north) of Chittagong. Current student enrollment is more than 20,000. The other public university is Chittagong University of Engineering and Technology established in 1968. Formerly, it was named Bangladesh Institute of Technology (BIT). The University is situated by the side of the Chittagong-Kaptai road some 25 kilometers off from the center of Chittagong City. The Asian University for Women (AUW) is another famous higher education centre located in Chittagong, is being established as a leading institution of higher learning for women.

97. At present, in Chittagong, there are some more private universities like BGC Trust University Bangladesh (2002), International Islamic University, Chittagong, University of Science and Technology-USTC (1992), Southern University, Bangladesh(1998), Premier University (PU), and University of Information Technology & Sciences. Recently Chittagong Government Veterinary College (CGVC) has been upgraded to Chittagong Veterinary and Animal Sciences University (CVASU) which is consisting of one faculty with 300 students providing theoretical, out campus work based learning and excellent scientific and technological education. It is the first university in Bangladesh of this type. Some examples of private medical colleges of Chittagong are: Chittagong Ma O Shishu Medical College, Southern Medical College, Chittagong International Dental College, BGC Trust Medical College, etc.

4. Socio-economic conditions

98. The port city of Chittagong accommodates almost 3% of the total population and is the second most urbanized area in the country. In this area people are engaged in various activities, mainly laboring, business, industry, and transport and communication. There are around 200 garment factories, in which more than two hundred thousand people work, mainly women. Other types of manufacturing are also major employers, as is the construction industry. In a study based on BBS data, Chittagong region has the highest per capita per month income of Tk. 6,430 followed by Barisal (Tk. 5,970), Chittagong (Tk. 5,960), Sylhet (Tk. 5,690), Dhaka (Tk. 5,540) and Rajshahi (Tk. 4,980).⁶

99. The trend for rural-urban migration is largely a result of a lack of secure employment and sustenance in the rural areas, so people move to the cities where they believe there are better job opportunities. As noted above these rarely materialize and the end result is an increase in the urban poor, and an expansion of the slums. More than 82% of the population of Bangladesh lives on less than \$2 per day, and such people are mainly the urban poor and the rural poor. Slum dwellers in the towns and cities include people who are in regular employment, plus large numbers who are unemployed and who obtain an income from the streets where they can. Employed slum dwellers work mainly in construction or in factories, or as domestic servants, rickshaw operators, street vendors, etc.

⁶ Rahman & Hossain: Convergence in per Capita Income across Regions

100. Waste pickers are observed at the existing dumping site and consist of male, females, and children. This is often their primary source of livelihood made from recycling waste.

5. Physical and Cultural Heritage

101. Bangladesh has many sites, buildings and artifacts that are of historical and cultural significance. Many date back to the British colonial period from the mid-19th to the mid-20th centuries, and some are from earlier periods, including the Muslim era of the 13th to 17th centuries, the Sena dynasty of the 12th and 13th centuries, and even the Gupta Buddhist era of the 4th to 7th centuries A.D. However, construction practices that pay scant regard to the possible discovery of ancient remains have meant that most of the older sites that remain are located well away from urban areas.

102. The main archaeological heritage and relics of Chittagong are Bronze statues (8th and 9th centuries, in Anwara Upazila), Fakira Mosque (Hathazari), Musa Khan Mosque (1658), Kura Katni Mosque (1806), Kala Mosque (16th century), Chhuti Khan Mosque (Mirsharai), Kadam Mobarak Mosque (1719), Andar Killah Mosque, Wali Khan Mosque (1790), Badar Awlia Dargah, Bakshi Hamid Mosque of Banshkhali (1568), Chittagong Court Building (1893), Collegiate School, Ethnological Museum (1974). The proposed CLF site is not adjacent to any of the enumerated archaeological heritage and relics of Chittagong.

6. Indigenous Peoples

103. Most inhabitants of Bangladesh are Bengali (around 98%) and Muslim (around 90%), so this ethnic group comprises the majority of inhabitants of all the towns and cities. There are also small communities of certain ethnic minorities (mainly Hindu, Buddhist and Christian), who also live in urban areas, either integrated within the majority community or living in specific locations, such as the Hindus who live in Shakhari Bazar, Tanti Bazar and Shyam Bazar in old Dhaka, and the Buddhists and Christians who live in Chandgaon and Shadarghat in Chittagong respectively.

104. Environmental degradation has made their lives even more difficult. They have become the victims of the negative impacts of modernization, as they lack the education and awareness to be able to harness and enjoy the positive benefits that Bangladesh's economic growth has created.

IV. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

105. The present report assesses the impacts of the proposed activities on various environmental attributes of the project site.

106. **Methodology.** Issues for consideration have been raised by the following means: (i) input from interested and affected parties, if any; (ii) desktop research of information relevant to the proposed project; (iii) site visit and professional assessment by environment specialist engaged by the implementing agency; and (iv) evaluation of proposed design scope and potential impacts based on the environment specialist's past experience. Categorization of the project and formulation of mitigation measures have been guided by ADB's REA Checklist for Urban Development (Annex 1) and ADB Environment Policy.

A. Location and Design Impacts

107. In the case of this subproject there are few impacts that can clearly be said to result from the design or location. This is because:

- (i) The infrastructure involves relatively straightforward construction at a single site, so it is unlikely that there will be major impacts when the facility is built;
- (ii) The proposed location of the CLF is in an area where the CCC authority has already acquired as per Government regulations and there is no running activities, and also there are no sensitive areas or receptors nearby; and
- (iii) If the CLF operates in the manner intended it should be hygienic and well managed facility that functions with few emissions and without major negative impacts.

108. Planning principles and design considerations have been reviewed and incorporated into the site planning process whenever possible. The concepts considered in design of the CLF are:

- (i) The CLF should be adequate in size to accommodate solid waste collected from the target area.
- (ii) All the ancillary facilities for CLF should be provided with safe water.
- (iii) Water points, hoses and cleaning equipment must be provided in appropriate locations in sufficient numbers. Cleaning program must be performed regularly.
- (iv) Industrial three phase electricity should be supplied and a standby generator installed.
- (v) CLF should have its own drain and all drains must be accessible for cleaning for efficient waste water system.
- (vi) The CLF area should be protected by fencing to keep out from trespassing people, animals specially dogs/ cats etc.
- (vii) Strict enforcement of relevant national rules in solid waste management.
- (viii) CLF of CCC could be managed by private organizations/ parties through competitive bidding process following government public-private partnership guideline.
- (ix) Techniques, installation, management and training should be focused on minimization of water consumption, minimization of energy use, minimization of emission to air and minimization of noise.
- (x) Future extensions or possibilities to add some other installation should be kept in mind during the design and during the period of construction.

109. Interested contractors will bid based on the concept and details included in the bid documents. The bidders will be advised to make their own diligence study prior to the bidding. Necessary documents and studies will be made available to them for their evaluation. It will be up to the bidders to maximize the use of resources made available to them.

110. No impact is anticipated due to the location as the proposed sites are owned by the Chittagong City Corporation. A Resettlement Plan by the CCC authority has been developed to compensate, restore, or relocate any building/ infrastructure that will be affected by the subproject.

B. Construction Impacts

111. **Construction method.** The work comprises the construction of Controlled Landfill. The following are the scope of work:

- (i) Site preparation works particularly in (a) areas currently used for dumping, (b) areas with medical waste, (c) existing medical waste facility, and (d) areas used by ragpickers/ scavengers.
- (ii) Preparation of the ground by forming to level and grade and excavating locally for foundations or, if necessary, by excavating unsuitable fill material and replacing with imported compacted backfill.
- (iii) Shaping of ground to suit footings and floor slab layout and falls and to allow exterior ground drainage.
- (iv) Laying and backfilling over underground and under floor drains.
- (v) Boxing foundations and placing reinforcing with column starter bars.
- (vi) Pouring of slab and footings and curing.
- (vii) Construction of unreinforced masonry infill panels.
- (viii) Placing reinforcing, boxing, and pouring columns.
- (ix) Placing reinforcing for lintel beams and pouring concrete.
- (x) Casting in bolts and anchor plates as necessary in the columns and lintels.
- (xi) Fabrication and fixing roof trusses and bracing.
- (xii) Placing and fixing purlins.
- (xiii) Fixing roof cladding, gutters and downpipes.
- (xiv) Wall framing with cladding panels and insect mesh as necessary.
- (xv) Fixing of external rails for sliding doors.
- (xvi) Placing and fixing internal beams for rails plus fitting rails and hangers.
- (xvii) Constructing weather covers for sliding door rails.
- (xviii) Hanging of hinged doors.
- (xix) Internal wall and floor plastering as required.
- (xx) Painting as required.
- (xxi) Electrical Services.
- (xxii) Supply and/ or manufacture and installation of mechanical equipment.
- (xxiii) Construction of external effluent disposal system.
- (xxiv) Construction of solid waste disposal systems.

112. As explained above the land on which the CLF is to be constructed is currently being used as dumping area for municipal solid waste. This is open space connected by road from the city center and easily accessible by the trucks. So during construction, there will be some very minor impacts like noise and dust due passage of construction materials carrying trucks on the people and there will be no issue of resettlement of affected persons.

113. Most of the site will be excavated to around 1.50 meter to create the cavities for the foundations of the buildings and paved areas. This will be done by backhoe digger and the excavated sand and soil will be loaded into trucks and transported to the municipal landfill for disposal.

114. All of the buildings and other structures will have Reinforced Cement Concrete (RCC) foundations, so metal reinforcing bars will be put into position in the cavities by hand. Concrete (mixed on site) will then be poured into the cavities to form the foundations and floors of the buildings and other structures and the paved surfaces of the roads.

115. The above-ground RCC elements will then be created by enclosing lengths of metal reinforcing in wooden shuttering and pouring in concrete, which sets to form the structure. This is then repeated in the next portion of reinforcing and so on to create the completed structure. The brick walls of the CLF ancillary buildings, toilets and boundary wall will then be created between the RCC supports by masons laying bricks and mortar by hand. Surfaces will be

finished by plastering or tiling, and corrugated iron roofing will be applied and connected up by hand. Doors, windows, electrical fittings and pipe-work for water supply and drainage will also be added by craftsmen and laborers.

116. All materials will be brought to site on small trucks and offloaded and positioned by hand, and a small crane will be used for any heavier elements such as the steel supports and reinforcing bars, doors and the metal gates for the entrance to the site. Due to limited size of the landfill, it will not be possible to accommodate the rubbish there and all debris will be cleared at the end of construction by loading into a truck and depositing at an identified disposal site.. Disposal sites for excavated soils and contaminated materials will be identified and agreed upon with the DoE before the commencement of any civil works.

117. There is sufficient space for a staging area, construction equipment, and stockpiling of materials. However, the contractor will need to remove all construction and demolition wastes on a daily basis to an identified disposal site as described in the above paragraph.

118. Workers' camp and storage area for materials to be established by the contractor will be needed for the entire 18-month construction period. Proper arrangement for health and safety including water supply and sanitation should be ensured in these places as per criteria mentioned in the EMP.

119. **Screening Out Areas of No Significant Impact.** From the descriptions given it is clear that implementation of this subproject will not have major environmental impacts because the construction work is relatively straightforward, and will all be conducted at only one site within the jurisdiction of CCC. Because of this there are several aspects of the environment that are not expected to be affected by the construction process and these can be screened out of the assessment at this stage as required by ADB procedure. These are shown in **Table 3**, with an explanation of the reasoning in each case. These environmental sectors have thus been screened out and will not be mentioned further in assessing the impacts of the construction process.

Table 3: Fields in which construction is not expected to have significant impacts

Field	Rationale
Climate	Short-term production of dust is the only effect on atmosphere
Geology and seismology	Excavation will not be large enough to affect these features
Forests, wildlife, endangered species, protected areas	There are no forests, protected nature conservation areas or important habitats or species at or near this site
Coastal resources	Chittagong CLF site is far from the sea and also such structure constructed in one site only will not affect the coastal resources
Agriculture, tourism	There is agriculture in the nearby area but will not be affected by the construction activities; there is no site for tourism at or near this site
Population and communities	Construction will not affect population numbers, location or composition
Health and education facilities	There are no schools, clinics, hospitals, etc at or near this site
Physical or cultural heritage	There are no culturally important buildings or locations at or near this site
Indigenous Peoples (IP)	The proposed site is not used by indigenous peoples or minority communities
Archaeology, paleontology	No material of archaeological or paleontological significance has been found by previous construction projects in this area
Ecological value	There are no protected areas in the vicinity of this site and no special ecological interest exists within the boundary of the site under consideration; construction should therefore have no ecological impacts.

120. **Impacts due to excavations.** Excavating the foundations for the buildings, roads, surface drains, walkways and other structures on the site will produce around 3,000 m³ of waste soil and stone. This is a relatively small quantity so it can be taken to the selected and agreed municipal disposal site without special precautions to reduce the amount of dumping. The material could be put to beneficial use if it was utilized at the landfill to cover waste, so arrangements should be made by the Contractors with the landfill operators to deposit the waste in a suitable location where it can be used for this purpose. The reserved cell of the CLF may be an option for this. In any case, disposal sites for excavated soils and contaminated materials will be identified and agreed upon with the DoE before the commencement of the excavation activities.

121. Excavation is likely to be conducted in the dry season to avoid the difficult conditions that can occur when earthworks are carried out during rain. Precautions will therefore be needed to limit dust so that it does not affect surrounding areas or workers on site. Another physical impact associated with large-scale excavation is the effect on drainage and the local water table if groundwater and/ or surface water collect in the cavities as they are dug.

122. **Impacts due to alteration of the site.** The presence of diggers, trucks and other vehicles and machinery and the developing structures as they are created will gradually alter the landscapes of this site. However most of the surrounding areas are generally not “busy” visually and there are no features of any special landscape interest at or around the site, so it should not be necessary to mask the construction site from view by erecting screens.

123. **Impacts on site-specific economy.** All of the construction related to this subproject will be conducted on land that is at present owned by the Chittagong City Corporation and currently vacant. So there will be no impact on any site-specific economy. The livelihood of waste-pickers/scavengers, if any will not be affected during construction period and they will not be displaced during operation phase; and everything will be done as per agreed and approved resettlement plan.

124. Construction work can provide short-term socio-economic gains for local communities if contractors employ local people in the workforce. To ensure that these benefits are directed to communities that are most affected by the work, contractors are often encouraged to employ people who live in the immediate vicinity of construction sites. This is possible in this case because of the presence of inhabitation in the locality, so the contractor should offer employment to any persons who are willing to work on the present site (in breaking bricks and in other activities) and who are not already employed by some other company. Such persons are economically disadvantaged and this would be improved by even a relatively short period of temporary employment.

125. **Impacts on utilities.** There are no temporary infrastructures (power lines, water supply pipes, etc.) on the land proposed for CLF construction; so there will be no economic impacts from the disruption of supply of these facilities due to damage during construction.

126. **Impacts on accessibility.** Excavation work can also have economic impacts if heavy vehicles carrying materials to site and transporting excavated waste to the disposal site cause significant disruption of traffic, particularly where work is conducted in a semi-urban environment as this. However any such impacts should not be significant in this case, because dump trucks normally have a capacity of 25-30 m³ and the disposal of 3,000 m³ of soil and stone by about 100 truck movements will be spread over a period of few months.

127. **Impacts on social and cultural resources.** Construction activities inevitably produce noise and dust, and these plus the visual appearance of the site and restrictions in access caused by excavation and the presence of vehicles and machinery, are generally the factors that disturb people who live or work in the vicinity. These should however not be major problems in this case as there are no people living on or near this site and the people who work there are already well adapted to this type of disturbance. The construction work is also small in scale, so it should not be necessary to apply measures to reduce noise, dust or other disturbance, beyond the dust suppression measures.

128. There are no major permanent public buildings at or near the site, and given the current land-use there are unlikely to be any locations that are of any special social or cultural importance to the community (shrines, meeting places, etc).

129. **Impacts on health and safety.** As is usual on construction sites, the health and safety of workers will need to be protected by measures which the contractor will be required to produce and apply. As adjacent areas are heavily used for the storage and processing of building materials, the contractor should also include measures to assure the safety of the public. The workers will also be needed to take special precautions as they will be required to work within area where unsorted solid waste, dumped medical waste, vectors like insects and rodents, wet wastes will be present with all its objectionable characteristics like excess bad smell/ odor, leachate all around, etc. so it will be needed that they should wear complete uniform usually adopted by the people working in the municipal solid waste disposal sites.

C. Operation and Maintenance Impacts

130. For the first 2 years of operations of the CLF, the Contractor will manage the operations and maintain⁷ the facility by itself or through a Contractor and if required, modify, repair or otherwise make improvements to the CLF. The Contractor, in consultation with Chittagong City Corporation, will also develop a manual for the regular and preventive maintenance of the CLF.

131. The Contractor will be required to keep the ancillary sites of the CLF clean, tidy and orderly condition free of litter, waste material (whether solid or liquid) and debris. The Contractor will also be responsible for the maintenance of the approach roads to the CLF.

132. Sufficient, safe, potable and constant supply of fresh water will be made available at adequate pressure throughout the premises of the ancillary structures. Suitable facilities for washing of hands and nail brushes should be there, soap or detergent will be provided for the workers. All sanitary facilities will be equipped with suitable flushing appliance.

133. **Land contamination.** CLF will not contaminate the land the way other industrial operations can. The main reason for this is that CLF will have special impermeable layers underneath. Most land contamination is an aesthetics issue rather than one relating to pollution.

134. **Generation of Waste Materials and By-Products.** In general, pollutants generated from CLF include: wastewater from toilet and cleaning of premises, and leachate from the solid waste.

⁷ Maintenance activities will include replacement of equipment and consumables, and also horticultural maintenance and repairs to equipment, pavements and other civil works which are part of the CLF.

135. **Water contamination.** The wastes from CLF can end up in water bodies, polluting water resources. The main pollutants are wastewater from toilets and from cleaning of the premises, and the leachate from the stored solid waste in the CLF. The quantity of leachate becomes more in the rainy season. No chemicals are used in the CLF. Although the contaminants are non-toxic in nature, they can introduce bacterial contamination and increase nitrates, phosphates and sulfates concentration in water, leading to health problems.

136. **Generation of Wastewater.** The liquid wastes of CLF are high in biological oxygen demand. The quantity of leachate may also be huge during especially in the rainy seasons. Special drains will be constructed to allow it to reach up to the leachate pond, where proper treatment will be ensured.

137. **Odor.** The tropical climate of Bangladesh enhances the process of degeneration of any organic material remaining in the solid waste collected from different parts of the city. Therefore, the CLF premises always give a particular stink. Excessive odor is a nuisance to locals and attracts vermin and scavengers.

138. **Noise.** Noise from the establishment can be a nuisance for communities living in the immediate vicinity of the CLF. Major sources of noise are the chaos created by the laborers working in the operation of the site and heavy vehicular movement to transport solid waste from the municipal areas to the CLF site.

139. **Health, hygiene, and safety.** Spread of diseases to workers and their families may occur due to inadequate provision of safety equipment and lack of practice of safety rules and precautions.

140. **Fires and release of hazardous gases.** Release of hazardous gases from the landfill sites may cause fire within the landfill area under operation.

141. **Topographical modification.** The implementation and subsequent operational activity of the landfill site may lead to unfriendly topographical alterations and modifications in the natural environment and overall landscape of the surrounding area.

142. **Gas migration.** Landfill gas migration due to pressure differentials and diffusion can occur. This can create an explosion hazard if the gas reaches sufficiently high concentrations on adjacent buildings.

143. **Vegetation covers alteration.** Nature of vegetation cover of the landfill site as well as the surrounding area will alter and will have an impact on the drainage pattern of the locality.

144. **Decline in land value.** Declination of land value may be an impact if the landfill site operation is not properly controlled and monitored.

145. **Displacement of waste-pickers/ scavengers.** Waste pickers and scavengers, if any will lose their livelihood because of change in the operational strategy of the landfill area.

146. When the CLF begins to function, it is expected to provide a modern sanitary facility for the workers and staff as well as systematic handling, transportation and disposal of solid waste without causing environmental pollution. Providing this occurs there should be few negative

environmental impacts and there are several fields that should be unaffected. These are identified in Table 4 below, with an explanation of the reasoning in each case. These factors are thus screened out of the impact assessment and will not be mentioned further.

Table 4: Fields in which operation and maintenance of the completed CLF is not expected to have significant impacts

Field	Rationale
Geology, seismology	Operating a CLF should not affect these factors
Forests, wildlife, endangered species, protected areas	There are no forests, protected nature conservation areas or important habitats or species at or near the site
Coastal resources	Chittagong CLF site is far from the sea and also such a structure situated in a single location will not affect the coastal resources
Tourism, population and communities, health and education facilities	There are no tourist attractions, inhabited areas or health/ education facilities near the CLF site
Physical or cultural heritage, archaeology, paleontology	There are also no areas of social, cultural or historical interest or importance near the site
Indigenous Peoples	There are no IP or minority communities near the sites

D. Mitigation Measures

147. There are no impacts that are significant or complex in nature, or that need an in-depth study to assess the impact. Thus, the subproject is unlikely to cause significant adverse impacts. The potential adverse impacts that are associated with design, construction, and O&M can be mitigated to acceptable levels with the following mitigation measures (Table 5).

Table 5: Recommended Mitigation Measures

Parameter	Mitigation Measures
Planning phase	
Updating of safeguard documents	- As this subproject will be implemented on the basis of turnkey contract, the detailed design will be done by the contractor, and the IEE/ EMP will be updated at the time of detailed design and will be revised by the DSC team.
Capacity Building	- Develop and submit for approval a capacity building and training program to ensure (i) all CLF workers are trained to the highest standards available in Bangladesh and given refresher training at least annually; and (ii) Chittagong City Corporation and UPEHU staffs are given a high level of training and other support sufficient to achieve the expected standards.
Work schedule	- Ensure careful planning and scheduling of the activities. - Prepare a traffic management plan and road safety plan.
Barricades and warning signs	- Use easily transportable barricades and warning signs such as those made of high reflector plastic materials. - Also use aluminized rolled warning signs to warn the public.
Workers	- Employ workers with adequate experience, training, and know-how. It is always advantageous for the contractor to employ workers with adequate experience, training, and know-how in the line of work that they are doing. These people are usually reliable and can be counted upon to exercise good judgment in the field.
Community and public awareness	- Establish extensive coordination with Chittagong City Corporation, Design and Supervision Consultants (DSC), Department of Environment, operators of landfill sites - A massive information campaign must precede any construction activity in order to make the public aware of the extent of the problem that might be present during the period of construction. - Open liaison channels should be established between Chittagong City Corporation, the contractors, and interested and affected parties such that any queries, complaints, or suggestions can be dealt with quickly and by the appropriate persons.
Legislation, permits, and agreements	- In all instances, Chittagong City Corporation, contractors and consultants must remain in compliance with relevant local and national legislation.

Parameter	Mitigation Measures
	<ul style="list-style-type: none"> - A copy of the IEE must be kept on-site and disclosed in Chittagong City Corporation, Local Government Division, Ministry of Local Government, Rural Development and Cooperatives, and ADB websites. - Ensure Environmental Clearance is obtained prior to award of turnkey contract.
Access to site	<ul style="list-style-type: none"> - Access to site will be via existing roads. The contractor will need to ascertain the existing condition of the roads and repair damage due to construction.
Setting up of construction camp ⁸	<ul style="list-style-type: none"> - Choice of site for the contractor's camp requires the DSC environment management specialist's permission and must take into account location of local residents, businesses, and existing land uses. A site plan must be submitted to the environment management specialist for approval. - If the contractor chooses to locate the camp site on private land, he must get prior permission from the environment management specialist and the landowner. - Under no circumstances may open areas or the surrounding bushes be used as a toilet facility. - Recycling and the provision of separate waste receptacles for different types of waste should be encouraged.
Establishing equipment lay-down and storage area ⁹	<ul style="list-style-type: none"> - Storage areas should be secure so as to minimize the risk of crime. They should also be safe from access by children, animals, etc. - The contractor should submit a method statement and plans for the storage of hazardous materials (fuels, oils, and chemicals) and emergency procedures.
Materials management – sourcing ¹⁰	<ul style="list-style-type: none"> - The contractor should prepare a source statement indicating the sources of all materials (including topsoil, sands, natural gravels, crushed stone, asphalt, clay liners, etc), and submit these to the environment management specialist for approval prior to commencement of any work.
Education of site staff on general and environmental conduct ¹¹	<ul style="list-style-type: none"> - Ensure that all site personnel have a basic level of environmental awareness training. - Staff operating equipment (such as excavators, loaders, etc.) should be adequately trained and sensitized to any potential hazards associated with their task. - No operator should be permitted to operate critical items of mechanical equipment without having been trained by the contractor. - All employees must undergo safety training.
Construction phase	
Excavated materials	<ul style="list-style-type: none"> - Hauling vehicles must always be present at the excavation site. - The contractor can process the excavated materials and use these as selected backfill materials. - If excavated materials are not suitable for reuse, the contractor should deposit these in an area designated by Chittagong City Corporation. - Coordinate with the landfill operators for the disposal of excavated materials. - Identify and obtain clearance from DoE for disposal sites of excavated soils and contaminated materials. - Obtain from the environment management specialist approval for disposal of excavated materials. - Remove waste rapidly by loading material onto trucks as soon as it is excavated; - Cover or damp down working areas and stockpiled soil in dry, windy weather; and - Use tarpaulins to cover loose material during transportation to and from the site. - Maintain record of excavated materials, disposal dates, and methods. - Conduct the work in the dry season will reduce these impacts, and as the excavation in this case is shallow and small in scale there should be no impact on the water table.
Hauling of Construction Materials	<ul style="list-style-type: none"> - The contractor must maintain all the materials necessary in his inventory so that these can be easily hauled to the construction site when needed. - Advance signage for affected parking areas must indicate duration and alternative parking arrangements.
Access	<ul style="list-style-type: none"> - The contractor should make available in his stock steel plates and wooden planks which will be deployed on top of excavations to provide temporary access to buildings, street

⁸ Careful planning of the construction camp can ensure that time and costs associated with environmental management and rehabilitation is reduced

⁹ Storage areas can be hazardous and unsightly and can cause environmental pollution if not designed and managed carefully.

¹⁰ Materials must be sourced in a legal and sustainable way to prevent offsite environmental degradation.

¹¹ These points need to be made clear to all staff on site before the project begins.

Parameter	Mitigation Measures
	<p>crossings, and other areas where these will be necessary.</p> <ul style="list-style-type: none"> - Advance road signage must indicate the road detour and alternative routes. Provide sign boards for pedestrians to inform them of nature and duration of construction works and contact numbers for concerns/ complaints.
Occupational health and safety	<ul style="list-style-type: none"> - Employ workers with adequate experience, training, and know-how. - These workers should be led by an experienced supervisor or engineer, who will provide the leadership in daily activities. - A general regard for the social and ecological well-being of the site and adjacent areas is expected of the site staff. Workers need to be made aware of the following general rules: (i) no alcohol/drugs on site; (ii) prevent excessive noise; (iii) construction staff are to make use of the facilities provided for them, as opposed to ad hoc alternatives (e.g. fires for cooking, the use of surrounding bushes as a toilet facility); (iv) no fires permitted on site except if needed for the construction works; (v) trespassing on private/commercial properties adjoining the site is forbidden; (vi) other than pre-approved security staff, no workers should be permitted to live on the construction site; and (vii) no worker may be forced to do work that is potentially dangerous or that he/she is not trained to do. - Because of existence of solid waste all around in the CLF site, the workers will need to wear uniform, which is usually used by the workers in the solid waste disposal site. - The contractor must monitor the performance of construction workers to ensure that the points relayed during their induction have been properly understood and are being followed. If necessary, a translator should be called to the site to further explain aspects of environmental or social behavior that are unclear. - The rules that are explained in the worker conduct section must be followed at all times.
Community health and safety	<ul style="list-style-type: none"> - Contractor's activities and movement of staff will be restricted to designated construction areas. - Should the construction staff be approached by members of the public or other stakeholders, staff should assist them in locating the environment management specialist or contractor, or provide a number through which they may contact the environment management specialist or contractor. - The conduct of the construction staff when dealing with the public or other stakeholders should be in a manner that is polite and courteous at all times. Failure to adhere to this requirement may result in the removal of staff from the site by the environment management specialist. - Disruption of access for local residents, commercial establishments, institutions, etc. must be minimized and must have the environment management specialist's permissions. - Provide walkways and metal sheets where required to maintain access for people and vehicles. - Consult businesses and institutions regarding operating hours, and factor this in work schedules. - The contractor is to inform neighbors in writing of disruptive activities at least 24 hours beforehand. This can take place by way of leaflets placed in the postboxes giving the environment management specialist's and contractor's details or other method approved by the environment management specialist. - Provide sign boards for pedestrians to inform them of nature and duration of construction works and contact numbers for concerns/complaints. - The contractor will ensure that there is provision of alternate access to business establishments during the construction, so that there is no closure of these shops or any loss of clientage. - The contractor will ensure that any damage to properties and utilities will be restored or compensated to pre-work conditions. - Lighting on the construction site should be pointed downwards and away from oncoming traffic and nearby houses. - The site must be kept clean to minimize the visual impact of the site. - If screening is being used, this must be moved and re-erected as the work front progresses. - Machinery and vehicles are to be kept in good working order for the duration of the project to minimize noise nuisance to neighbors. - Notice of particularly noisy activities must be given to residents/businesses adjacent to the construction site. Examples of these include: noise generated by jackhammers, diesel generator sets, excavators, etc. - Noisy activities must be restricted to the times given in the project specification or general

Parameter	Mitigation Measures
	<p>conditions of contract.</p> <ul style="list-style-type: none"> - The environment management specialist and contractor are responsible for ongoing communication with those people who are interested in or affected by the project. - A complaints register (refer to the grievance redressal mechanism) should be housed at the site office. This should be in carbon copy format, with numbered pages. Any missing pages must be accounted for by the contractor. This register is to be tabled during monthly site meetings. - Interested and affected parties need to be made aware of the existence of the complaints book and the methods of communication available to them. - The contractor must address queries and complaints by: (i) documenting details of such communications; (ii) submitting these for inclusion in complaints register; (iii) bringing issues to the environment management specialist's attention immediately; and (iv) taking remedial action as per environment management specialist's instruction. - The contractor should immediately take the necessary remedial action on any complaints/ grievances received by him and forward the details of the grievance along with the action taken to the environment management specialist within 48 hours of receipt of such complaint/ grievance.
Community and public awareness	<ul style="list-style-type: none"> - Storage facilities and other temporary structures on-site should be located such that they have as little visual impact on local residents as possible. - Special attention should be given to the screening of highly reflective materials on site. - In areas where the visual environment is particularly important (e.g. along commercial/ tourism routes) or privacy concerns for surrounding buildings exist, the site may require screening. This could be in the form of shade cloth, temporary walls, or other suitable materials prior to the beginning of construction.
Construction camps and storage areas	<ul style="list-style-type: none"> - The contractor is to ensure that open areas or the surrounding bushes are not being used as toilet facility. - The contractor should ensure that all litter is collected from the work and camp areas daily. - Bins and/or skips should be emptied regularly and waste should be disposed of at the pre-approved site. Waybills for all such disposals are to be kept by the contractor for review by the environment management specialist. - The contractor should ensure that his camp and working areas are kept clean and tidy at all times. - After construction work, all structures comprising the construction camp are to be removed from site or handed over to the property owner/community as per mutual agreement (if established on private/community land). - The area that previously housed the construction camp is to be checked for spills of substances such as oil, paint, etc. and these should be cleaned up. - All hardened surfaces within the construction camp area should be ripped, all imported materials removed, and the area should be top soiled and regressed. - The contractor must arrange the cancellation of all temporary services.
Dust and air pollution	<ul style="list-style-type: none"> - Vehicles travelling to and from the construction site must adhere to speed limits so as to avoid producing excessive dust. - Access and other cleared surfaces, including backfilled trenches, must be dampened whenever possible and especially in dry and windy conditions to avoid excessive dust. - Vehicles and machinery are to be kept in good working order and to meet manufacturer's specifications for safety, fuel consumption, etc. - The contractor is to have the equipment seen to as soon as possible should excessive emissions be observed.
Noise levels	<ul style="list-style-type: none"> - Noise-generating equipment must be fitted with silencers. - If a worker is exposed to noise above a noise exposure limit, the contractor must investigate options for engineered noise control such as using low-noise excavators, jackhammers, drills, and power generators. - If it is not practicable to reduce noise levels to or below noise exposure limits, the contractor must post warning signs in the noise hazard areas. Workers in a posted noise hazard area must wear hearing protection.
Utilities	<ul style="list-style-type: none"> - Prepare a list of affected utilities and operators - Prepare a contingency plan to include actions to be done in case of unintentional interruption of services.
Water quality	<ul style="list-style-type: none"> - Every effort should be made to ensure that any chemicals or hazardous substances do not contaminate the soil or water on-site.

Parameter	Mitigation Measures
	<ul style="list-style-type: none"> - Care must be taken to ensure that runoff from vehicle or plant washing does not enter the surface/ground water. - Site staff should not be permitted to use any stream, river, other open water body, or natural water source adjacent to or within the designated site for the purposes of bathing, washing of clothing, or for any construction or related activities. Municipal water (or another source approved by the environment management specialist) should instead be used for all activities such as washing of equipment or disposal of any type of waste, dust suppression, concrete mixing, compacting etc. - All concrete mixing must take place on a designated, impermeable surface. - No vehicles transporting concrete to the site may be washed on-site. - No vehicles transporting, placing, or compacting asphalt or any other bituminous product may be washed on-site. - All substances required for vehicle maintenance and repair must be stored in sealed containers until they can be disposed of or removed from the site. - Hazardous substance/ materials are to be transported in sealed containers or bags.
Waste management	<ul style="list-style-type: none"> - Wastes must be placed in the designated skips/bins which must be regularly emptied. These should remain within demarcated areas and should be designed to prevent wastes from being blown out by wind. - Littering on-site is forbidden and the site should be cleared of litter at the end of each working day/night period. - Recycling is to be encouraged by providing separate receptacles for different types of wastes and making sure that staff is aware of their uses. - All waste must be removed from the site and transported to a disposal site or as directed by the environment management specialist. Waybills proving disposal at each site should be provided for the environment management specialist's inspection. - Construction rubble should be disposed of in pre-agreed, demarcated spoil dumps that have been approved by the environment management specialist, or at disposal sites.
Conservation of natural environment	<ul style="list-style-type: none"> - As the work front progresses; the contractor is to check that vegetation clearing has the prior permission of the environment management specialist. - Only trees that have been marked beforehand are to be removed, if cutting of trees is required. - Clean the entire area and maintain immediately after completion of the construction activities to make sure that existing tranquility of the surrounding area is not disturbed in any way.
Cultural and historical environment	<ul style="list-style-type: none"> - Consult laborers who work on the site during the detailed design stage and in the unlikely event that there are social and cultural resources in the site; assistance should be given in relocating the site and any associated artifacts. - All the staff and laborers of the contractor are to be informed about the possible items of historical or archaeological value, which include old stone foundations, tools, clayware, jewelry, remains, fossils etc. - If something of this nature is uncovered, Department of Archaeology should be contacted and work should be stopped immediately.
Safeguards supervisors	<ul style="list-style-type: none"> - The contractor should appoint one environment safeguard supervisor who will be responsible for assisting the contractor in implementation of EMP, coordinating with the DSC, consultations with interested/ affected parties, reporting, and grievance redressal on a day-to-day basis. The resettlement issue will be resolved before the site will be handed over to the Contractor for construction activities.
Post-construction and post-commissioning irregularities	<ul style="list-style-type: none"> - Remove all plant/ machineries/ vehicles and any temporary structures including the workforce camps and warehouses for storage of materials after completion of construction. - Restore the original landscape of the surrounding area as much as possible.
Operation and maintenance phase	
General	<ul style="list-style-type: none"> - Develop O&M Manuals to include all aspects of the management and operation of the CLF: - nature of waste that is accepted; - sequence and location of waste placement; - operation and maintenance of the gas collection system; - introduction of moisture or recirculation of leachate, leachate collection; - maintenance and cleaning of the leachate collection system; and - environmental monitoring, and maintenance of the final cover. - Train all CLF workers to the highest standards available in Bangladesh and given refresher training at least annually

Parameter	Mitigation Measures
	<ul style="list-style-type: none"> - Control access for public/personnel; - Lock rooms or cages for waste storage; - Clean toilets daily; - Provide clean hand washing areas adequate soap and towels; - Provide clothing and laundry service for workers; and - Clean facility after the work of each day. The waste storage area and other adjacent areas should be sprinkled or sprayed regularly with disinfectants to avoid any spread of disease. - Insert plates and stops to prevent vermin from gaining access to the building. Where insect screening is required, this should consist of nylon insect mesh securely fixed to 150 x 50 reinforcing mesh with galvanized tie wire. Edges should be finished with a screw fixed beading strip where possible (all galvanized). - Audit implementation of O&M procedures at regular intervals (by an Independent Monitoring Agency)
Land contamination	- Do not store wastes outside the CLF areas to avoid issues of aesthetic nature
Wastewater	- After treatment, the discharge standards need to be followed similar to the standards mentioned in Schedule 10 of the ECR 1997 for inland water discharge
Odor	<ul style="list-style-type: none"> - Audit odor to identify and characterize sources and determine any action required. - Store wastes properly inside the premises, preferably in an aerated area to minimize biodegradation and foul odor - Vendors should be asked to pick up waste on a daily basis to minimize degradation and odor - Enclose wastes and by-products during transport, loading/unloading and storage - Carry out frequent cleaning of material storage areas to prevent odor
Vermin and pest	<ul style="list-style-type: none"> - Apply soil cover materials rigorously - Compact wastes properly - Carefully maintain general “good housekeeping” - Inspect site regularly to detect indication of prevalence of pests and vermin - Employ an experienced pest control specialist to deal with this problem in case significant numbers are identified.
Noise	<ul style="list-style-type: none"> - Activities and vehicle movements should be avoided after hours. - Vehicles should be fitted with silencers. - Vehicles and machinery are to be kept in good working order.

148. After handing over of the subproject, Chittagong City Corporation will be responsible for operating the CLF and will be given support by the project in the form of staff training and financial assistance. ADB, LGD, Urban Public and Environment Health Unit (UPEHU) will need to ensure that the budget for such support is sufficient to ensure that the management and operation of the facility is to the expected high standard and that the elements listed above are provided.

149. The successful operation of the CLF in the manner intended should bring significant benefits to the citizens by keeping the environment cleaner than before. Removal of solid waste will be more organized and efficient; the CCC will save some money because of this higher efficiency of waste removal, which can be utilized for staff training and purchase of modern equipments necessary for this kind of operation.

150. Citizens will also gain from improved health as they will lose fewer working days through illness and will spend less on healthcare. In time there will be wider improvements in quality of life at various locations in the city as the general environment and public health will greatly improve as the practices of throwing garbage here and there will decline.

V. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

A. Project Stakeholders

151. Primary stakeholders are:

- (i) Companies that operate on the proposed CLF site;
- (ii) People who work at the site, either employed by a company or self-employed;
- (iii) Companies and workers operating in areas adjacent to the CLF site;
- (iv) Workers and companies operating at landfill site elsewhere in Chittagong; and
- (v) Companies and private individuals who are benefitted from the existing landfill site.

152. Secondary stakeholders are:

- (i) LGD as the Executing Agency and UPEHU as implementer;
- (ii) Other government institutions whose remit includes areas or issues affected by the project (City Corporations, Planning Authorities, Department of Public Health Engineering, Local Government Engineering Department, Ministry of Finance, Ministry of Health, Ministry of Environment, Roads and Highways Department, etc);
- (iii) NGOs, CBOs and other representatives of persons who may be affected by the project;
- (iv) The beneficiary community in general; and
- (v) The ADB.

B. Consultation and Disclosure

153. LGD/ UPEHU will extend and expand the consultation and disclosure process significantly during implementation of UPEHSDP. The UPEHU will appoint an experienced NGO to handle this key aspect of the program, who will conduct a wide range of activities in the target urban areas to ensure that the needs and concerns of stakeholders are registered, and are addressed in project design, construction or operation where appropriate. The program of activities will be developed during the detailed design stage, and is likely to include the following:

154. Consultation during detailed design:

- (i) Focus-group discussions with affected persons and other stakeholders (including women's groups, NGOs and CBOs) to hear their views and concerns, so that these can be addressed in project design where necessary; and
- (ii) Structured consultation meetings with the institutional stakeholders (Government bodies and NGOs) to discuss and approve key aspects of the project.

155. Consultation during construction:

- (i) Public meetings with major stakeholders to discuss and plan work programs and allow issues to be raised and addressed once construction has started; and
- (ii) Smaller-scale meetings to discuss and plan construction work with primary stakeholders to reduce disturbance and other impacts, and provide a mechanism through which affected persons can participate in project monitoring and evaluation.

156. Project disclosure:

- (i) Public information campaigns (via newspaper, TV and radio) to explain the project to the urban populations and prepare them for any disruption they may experience once the construction program is underway;
- (ii) Public disclosure meetings at key stages to inform the public of progress and future plans, and to provide copies of summary documents in the Bangla language; and
- (iii) Formal disclosure of completed project reports by making copies available at convenient locations in each target town, informing the public of their availability, and providing a mechanism through which comments can be made.

C. Public Consultations Conducted

157. Different techniques of consultation with stakeholders were used by the PPTA Consultants during the planning stage of project preparation (interviews, public meetings, group discussions, etc). Details of these consultation meetings in the planning stage have been presented in the ANNEX 5. A questionnaire was designed and environmental information was collected. Apart from this, a series of public consultation meetings were conducted during the project preparation. Various forms of public consultations (consultation through ad hoc discussions on-site) have been used to discuss the project and involve the community in planning the project design and mitigation measures. Issues discussed and feedback received during preparation of IEE report along with details of date, time, location, and list of participants are given in Annex 3.

VI. ENVIRONMENTAL MANAGEMENT PLAN

A. Implementation Arrangement

158. Figure 17 is an organization chart showing how the project will be managed and implemented.

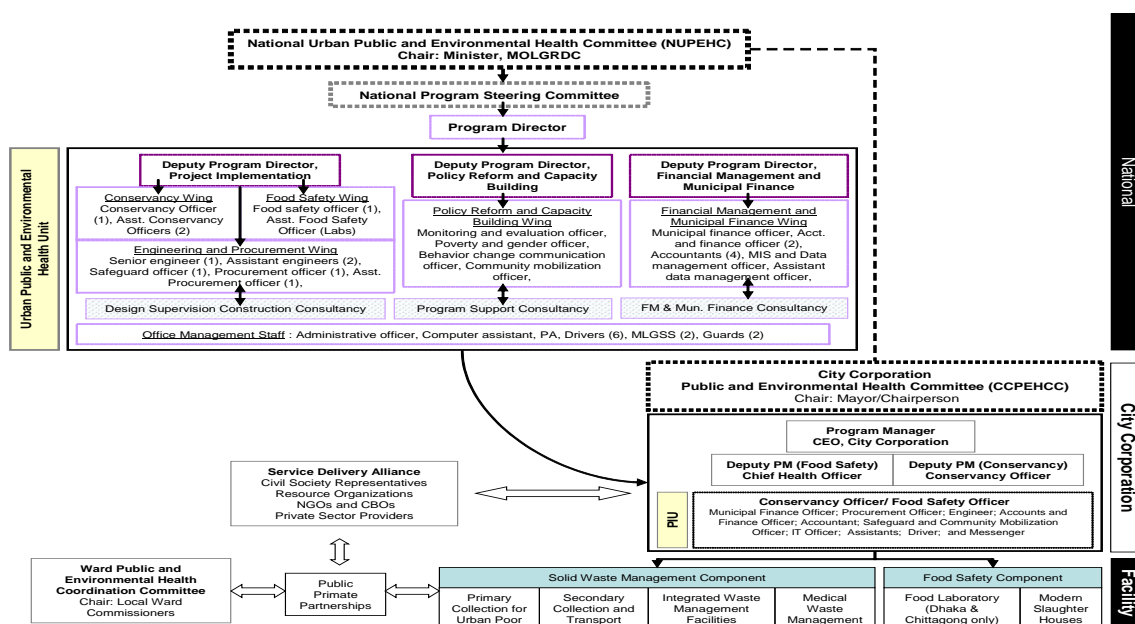


Fig 17: Organization Chart for UPEHSDP

159. **Local Government Division/ Urban Public and Environmental Health Unit.** LGD of the Ministry of Local Government, Rural Development and Cooperatives (LGRDC) will be the executing agency (EA) for UPEHSDP providing overall guidance for program implementation. LGD will have the overall responsibility to plan, organize, manage, supervise, coordinate and monitor the progress achieved. LGD will establish a support unit called the Urban Public and Environmental Health Unit (UPEHU) who will be responsible for day-to-day program implementation and will be headed by a full-time program director. UPEHU will function as the Program Management Unit (UPEHU), with responsibility for day-to-day implementation. A Safeguards Officer (SO) to coordinate resettlement and environmental safeguards for UPEHSDP will be part of the Policy and Program Wing of the UPEHU. Through the SO, the UPEHU will ensure environmental compliance with ADB policy and national law across the entire program. This includes: (i) pre-approving final IEEs prior to submission to ADB for review and approval, and (ii) assisting in resolution of complaints and grievances related to IEE implementation not resolved at the CCPIU level.

160. **City Corporations/Program Implementation Units.** City Corporation Project Implementation Units (CCPIUs) will be established in each City Corporation. The CCPIUs will include a Safeguards and Community Mobilization Officer (SCMO) who will receive training from the International Environmental Specialist (IES) and Domestic Environmental Specialist (DES) who will be assigned to work with the CCPIU staff to help monitor subprojects and to transfer implementation capability to the CCPIU team. The SCMO will work closely with the IRS and DRS in planning, implementing, and monitoring all project activities. The CCPIUs will: (i) screen and categorize sub-projects; (ii) assist in, public meetings and other consultation with stakeholders; (iii) facilitate activities of the IES/ DES in applying for Location and Environmental Clearances (LCs/ECs).

161. **Environmental Specialists.** A Design, Supervision, and Construction Consultant Team (DSC) will be contracted to assist the UPEHU and CCPIUs in implementing and managing the investment subprojects including environmental planning. Towards this, International and Domestic Environmental Specialists (IES and DES) within DSC will prepare IEEs in accordance with both ADB and Government of Bangladesh (GoB) policies during the feasibility and detailed design stage, and supervise contractors, with support from CCPIUs, during the construction process. The IES and DES will work in close coordination with UPEHU and CCPIUs. They will coordinate with the SO in the UPEHU to ensure all IEEs comply with ADB and GoB rules and guidelines. The IES and DES will also provide necessary training to CCPIUs to facilitate their monitoring of environmental impacts during construction and operation. It will provide support ensuring that all tasks of the CCPIU with regard to environmental implementation and monitoring are achieved. The IES and DES, in coordination with the contractors, will revise this IEE during detailed design stage and will ensure revised/updated IEE is approved by ADB and disclosed in LGD/ UPEHU and ADB websites.

162. **Contractors.** The Contractor shall at its own cost and expense:

- (i) Design, construct, supply, manage and maintain the CLF, in accordance with the provisions of the contract, good industry practice and applicable Laws;
- (ii) Observe and fulfill the environmental and other requirements as specified in the IEE/ EMP and under all applicable laws and applicable permits at all time during the service delivery period;
- (iii) Apply for and obtain all necessary clearances and/ or approvals for the construction of the CLF from all the concerned governmental agencies;

- (iv) Coordinate with DSC IES and DES on updating the IEE/EMP based on detailed designs;
- (v) Procure and maintain in full force and effect, as necessary, appropriate proprietary rights, licenses, contracts and permissions for materials, methods, processes and systems used in or incorporated into the subproject;
- (vi) Provide all assistance to the Project Manager as may be reasonably required for the performance of its duties and services under this subproject;
- (vii) Provide to DSC IES and DES reports on a regular basis during the service delivery period in accordance with the provisions of the contract;
- (viii) Appoint, supervise, monitor and control the activities of sub-contractors under their respective project contracts as may be necessary;
- (ix) Make efforts to maintain harmony and good industrial relations amongst the personnel employed by Chittagong City Corporation in connection with the performance of the contractor's obligations under the contract;
- (x) Develop, implement and administer a surveillance and safety program for the CLF and the users thereof and the contractors' personnel engaged in the provision of any services under any of the project contracts including correction of safety violations and deficiencies, and taking of all other actions necessary to provide a safe and hygienic environment in accordance with applicable laws and good industry practice;
- (xi) Be responsible for safety, soundness and durability of the CLF, including all structures forming part thereof;
- (xii) Ensure that the CLF site remains free from all encroachments and take all steps necessary to remove encroachments, if any;
- (xiii) Remove promptly from the CLF site all surplus construction machinery and materials, waste materials (including, without limitation, hazardous materials and waste water), rubbish and other debris and keep the area in a neat, clean and hygienic condition and in conformity with the applicable Laws and applicable Permits.

B. Capacity Building

163. A training program has been developed to build the capability of EA, city corporations, and CCPIUs. This will be conducted by the DSC and contractors. The contractor will be required to (i) conduct environmental awareness and orientation of workers prior to deployment to work site; (ii) train CLF workers to the highest standards available in Bangladesh and given a refresher training at least annually during the service delivery period; and (iii) provide EA, CCPIUs, UPEHU, etc. a high level of training and other support sufficient to achieve the expected standards.

164. The suggested outline of the training program is presented in Table 6. The capacity building and training program will be updated during the detailed design stage to incorporate the contractors output.

Table 6: Indicative Capacity Building and Training Program for CLF Subproject

Description	Contents	Schedule	Participants
To be conducted by DSC			
Program 1 Orientation workshop	Module 1 – Orientation ADB Safeguards Policy Statement Bangladeshi Environmental Laws and Regulations	1 day	EA, LGD, UPEHU, and city corporation officials involved in the project implementation
	Module 2 – Environmental Assessment Process		CCPIUs

Description	Contents	Schedule	Participants
	ADB environmental process, identification of impacts and mitigation measures, formulation of an environmental management plan (EMP), implementation, and monitoring requirements Review of environmental assessment report to comply with ADB requirements Incorporation of EMP into the project design and contracts		
Program 2 Orientation program/ workshop for contractors and supervisory staff	Environmental issues during construction Implementation of EMP Monitoring of EMP implementation Reporting requirements	1 day	CCPIUs contractors
To be conducted by contractors			
Program 3 Orientation and safety Issues	CLF implementation activities detailed in drawings; safeguard policy requirements as per ADB and Government of Bangladesh rules; safety instructions and use of PPEs ¹² by the staff and workers	1 day	Staff and workers of the Contractor
Program 4 Action plan for implementation of the CLF	Detailed action plan for implementation of the subproject in a timely and qualitative manner	1 day	Staff and workers of the Contractor

C. Environmental Management Action Plan

165. The EMP will guide the environmentally sound construction of the subproject and ensure efficient lines of communication between the CCPIUs, DSC, and contractors. The EMP identifies activities according to the following three phases: (i) site establishment and preliminary activities, including finalizing IEE/EMP; (ii) construction stage; and (iii) post-construction/ operational stage. Table 7 outlines the mitigation measures and persons responsible for implementation and monitoring. The EMP will be updated by DSC during the detailed design stage. Note that the final IEE/EMP should be reviewed and cleared by the EA and ADB at time of detailed design and prior to commencement of construction work.

166. **Environmental monitoring program.** Prior to commencement of any civil work, the contractors will submit a compliance report¹³ to the DSC ensuring that all identified pre-construction environmental impact mitigation measures as detailed in the EMP will be

¹² **Personal protective equipment (PPE)** refers to protective clothing, helmets, goggles, or other garment or equipment designed to protect the wearer's body from injury. The hazards addressed by protective equipment include physical, electrical, heat, chemicals, biohazards, and airborne particulate matter. Protective equipment may be worn for job-related occupational safety and health purposes, as well as for sports and other recreational activities. "Protective clothing" is applied to traditional categories of clothing, and "protective gear" applies to items such as pads, guards, shields, or masks, and others.

¹³ This compliance report will include information on (i) barricades and warning signs; (ii) area for setting up of construction camps; (iii) methodology for surveys; (iv) area for establishing lay-down and storage; (v) sources of materials; (vi) records of environmental awareness, safety training, and orientation of workers prior to deployment to work sites; (vii) contact information of the environmental and resettlement supervisors; and (viii) construction method statement.

undertaken. The DSC will review the report, and thereafter CCPIUs will allow commencement of civil works. CCPIUs and the DSC will be responsible for monitoring.

Table 7: Environmental Management Action Plan

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
Planning phase						
Appointment and duties of an ECO	An Independent Environmental Control Officer (ECO) must be appointed, who will monitor the Contractor's compliance with the environmental management plan.	Contractor	CCPIU	Appointment	Once	
	The ECO should be provided with a copy of an adjusted version of the EMP.	Contractor	CCPIU		Once	
	The Priority of the ECO is to maintain the integrity of the development conditions outlined in the EMP and must be enforced and adhered to at all time.	ECO	ECO		Continuous	
	The ECO must form part of the project management team and attend all project meetings.	Contractor	ECO	Attendance sheet meeting	Continuous	
Appointment and duties of EO	The Contractor must appoint an Environmental Officer (EO). This person will be required to monitor the situation with a direct hands-on approach, and ensure compliance and co-operation of all personnel. He should be fluent in the language of the employees.	Contractor	CCPIU	appointment	Once	
Updating of safeguard documents	- As this subproject will be implemented on the basis of turnkey contract, the detailed design will be done by the contractor, and the IEE/ EMP will be updated at the time of detailed design and will be revised by the DSC team.	DSC with input from the contractor	CCPIU	Updated IEE/EMP	---	ADB Environment Policy EARF ECR 1997
Legislation, Permits and Agreements	The Contractor shall ensure that all pertinent permits, certificates and permissions required for the project have been obtained prior to any activities commencing on site and ensure that they are strictly enforced/adhered to. This includes, for example, license for storage of flammable liquids and hazardous materials and other permits and legislative requirements applicable to the project.	Contractor	DSC CCPIU	Permits, certificates and permissions	Prior the start of the project	List of permits which have to be arranged by the Contractor
	The Contractor shall maintain a database of all pertinent permits and permissions required for the contract as a whole and for critical activities for the duration of the contract. - In all instances, the City Corporations, Contractors and consultants must remain in compliance with relevant local and national legislation. - A copy of the IEE must be kept on-site and disclosed in the City Corporations, Local	Contractor	DSC CCPIU	database	Frequent	

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	Government Division (LGD), Ministry of Local Government, Rural Development and Cooperatives, and ADB websites.					
Capacity Building	- Develop and submit for approval a capacity building and training program to ensure (i) all CLF workers are trained to the highest standards available in Bangladesh and given refresher training at least annually; and (ii) Chittagong City Corporation and UPEHU staffs are given a high level of training and other support sufficient to achieve the expected standards.	Contractors	DSC CCPIU	Capacity building and training program	---	EARF All applicable laws and regulations
Education of site staff on general and environmental conduct ¹⁴	- Ensure that all site personnel have a basic level of environmental awareness training. - Staff operating equipment (such as excavators, loaders, etc.) should be adequately trained and sensitized to any potential hazards associated with their task. - No operator should be permitted to operate critical items of mechanical equipment without having been trained by the Contractor. - All employees must undergo safety training.	Contractor	DSC CCPIU	Records of training	Prior to start of civil works and every new employee	Revised/Updated IEE/EMP (capacity building)
Workers	Employ workers with adequate experience, training, and know-how. It is always advantageous for the Contractor to employ workers with adequate experience, training, and know-how in the line of work that they are doing. These people are usually reliable and can be counted upon to exercise good judgment in the field.	Contractor	DSC CCPIU	Workers list (for internal monitoring)	Prior to approval of detailed design documents	Detailed Design documents
Work schedule	- Ensure careful planning and scheduling of the activities. - Prepare a traffic management plan and road safety plan.	Contractors	DSC CCPIU	Plan and schedules	Prior to approval of detailed design documents	Detailed Design documents
Community and public awareness	- Establish extensive coordination with the City Corporations, Design and Supervision Consultants (DSC), Department of Environment, operators of landfill sites - A massive information campaign must precede any construction activity in order to make the public aware of the extent of the problem that might be	Contractor	DSC CCPIU	Communication and participation strategy	Prior to approval of detailed design documents	Detailed Design documents

¹⁴ These points need to be made clear to all staff on site before the project begins.

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	present during the period of construction. - Open liaison channels should be established between Khulna City Corporation, the Contractors, and interested and affected parties such that any queries, complaints, or suggestions can be dealt with quickly and by the appropriate persons.					
Access to site	Access to site will be via existing roads. The Contractor will need to ascertain the existing condition of the roads and repair damage due to construction.	Contractor	DSC CCPIU	Traffic management plan	Prior to approval of detailed design documents	No complaints received Minimal traffic disturbance
Barricades and warning signs	- Use easily transportable barricades and warning signs such as those made of high reflector plastic materials. - Also use aluminized rolled warning signs to warn the public.	Contractors	DSC CCPIU	Lists and samples of warning signs and barricades	Prior to approval of detailed design documents	Detailed design documents
Method Statements	The Contractor shall submit written Method Statements to the Project Manager for the activities identified by the Project Manager or ECO. Activities that will require method statements include: -Concrete pre-cast and batching operation; -Crushing plant operation; -Storage facilities for any hazardous substances; -Emergency procedures; -Site establishment; -Removal and clearing of vegetation; -Materials, equipment and staffing requirements (camp establishment); -Transporting the materials and/ or equipment to, from and within the site; -The storage provisions for the materials and/or equipment; -The proposed construction procedure designed to implement the relevant Environmental Specifications; Other information deemed necessary by the RE and/ or ECO.	Contractor	DSC CCPIU	Method Statements	As necessary	
	The Contractor shall not commence work on that activity until such time as the Method Statement has been approved in writing by the Project Manager.	Contractor	DSC CCPIU	Approval Method Statement	As necessary	

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
Setting up of construction camp	<ul style="list-style-type: none"> - Choice of site for the contractor's camp requires the DSC environment management specialist's permission and must take into account location of local residents, businesses, and existing land uses. A site plan must be submitted to the environment management specialist for approval. - If the contractor chooses to locate the camp site on private land, he must get prior permission from the environment management specialist and the landowner. - Under no circumstances may open areas or the surrounding bushes be used as a toilet facility. - Recycling and the provision of separate waste receptacles for different types of waste should be encouraged. 	Contractor	DSC CCPIU	Location plan	Prior to approval of detailed design documents	<p>Approved location plan</p> <p>Construction method</p> <p>No complaints received</p>
Establishing equipment lay-down and storage area	<ul style="list-style-type: none"> - Storage areas should be secure so as to minimize the risk of crime. They should also be safe from access by children, animals, etc. - The contractor should submit a method statement and plans for the storage of hazardous materials (fuels, oils, and chemicals) and emergency procedures. 	Contractor	DSC CCPIU	Location plan	Prior to approval of detailed design documents	<p>Approved location plan</p> <p>Construction method</p> <p>No complaints received</p>
Materials management – sourcing	- The contractor should prepare a source statement indicating the sources of all materials (including topsoil, sands, natural gravels, crushed stone, asphalt, clay liners, etc), and submit these to the environment management specialist for approval prior to commencement of any work.	Contractor to submit sources of materials to DSC	DSC CCPIU	Lists of sources	Prior to approval of detailed design documents	<p>Section 6 of contract</p> <p>All applicable permits (e.g. from Mining Department for quarries, borrow pits, sands and gravel)</p>
Existing Services and Infrastructure	The Contractor shall ensure that existing services (e.g. roads, pipelines, power lines and telephone services) are not damaged or disrupted unless required by the contract and with the permission of the RE.	Contractor, ECO, Project Manager	DSC CCPIU	Status of existing infrastructure	As necessary	
	The Contractor shall be responsible for the repair and reinstatement of any existing infrastructure that is damaged or services which are interrupted.	Contractor	DSC CCPIU		As necessary	
	Such repair or reinstatement will be to the Contractor's cost and shall receive top priority over all other activities.	Contractor	DSC CCPIU		As necessary	

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
Management of existing waste	One cell will be selected for storage and management of existing wastes. Wastes will be placed systematically in layers with adequate and proper compaction; suitable covering soil will be added over each of the layers; capping will be done by clay layer to prevent further pollution; and finally covering turf or grasses will be grown on properly shaped surfaces keeping adequate arrangement for drainage of rainwater.	Contractor	DSC CCPIU	Existing condition	As necessary	Detailed design documents
Treatment of leachate	<p>Groundwater protection by draining and treatment of the polluted water and leachate:</p> <p>The groundwater which is affected by the current waste should be drained and should be treated in a waste water treatment plant;</p> <p>To prevent further contamination of the groundwater, new landfill cells should be constructed where an impermeable layer will prevent further contamination in the environment.</p> <p>A drainage system in the new landfill cell will drain all new leachate from the landfill cell into the waste water treatment facility.</p> <p>Leachate reducing measurements:</p> <p>To prevent the production of new leachate, surface waters should be separated as much as possible from the pollution source. To reduce the infiltration in the landfill mass, wastes should be covered by impermeable layers (clay layer of 0.5m; $K < 1.10^{-9}$ m/s).</p>	Contractor	DSC CCPIU	Existing condition	As necessary	Detailed design documents
Environmental incident	The Contractor must take corrective action to mitigate an incident appropriate to the nature and scale of the incident and must also rehabilitate any residual environmental damage caused by the incident or by the mitigation measures themselves.	EO, ECO, Contractor	DSC CCPIU		Continuous	
Construction phase						
Excavated materials	<ul style="list-style-type: none"> - Hauling vehicles must always be present at the excavation site. - The contractor can process the excavated materials and use these as selected backfill materials. 	Contractor	DSC	Construction method statement	As work progresses	<p>Construction method</p> <p>Detailed design</p>

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	<ul style="list-style-type: none"> - If excavated materials are not suitable for reuse, the contractor should deposit these in an area designated by Chittagong City Corporation. - Coordinate with the landfill operators for the disposal of excavated materials. - Obtain from the environment management specialist approval for disposal of excavated materials. - Remove waste rapidly by loading material onto trucks as soon as it is excavated; - Cover or damp down working areas and stockpiled soil in dry, windy weather; and - Use tarpaulins to cover loose material during transportation to and from the site. - Maintain record of excavated materials, disposal dates, and methods. - Conduct the work in the dry season will reduce these impacts, and as the excavation in this case is shallow and small in scale there should be no impact on the water table. 					documents Identify and obtain clearance from DoE for disposal sites of excavated soils and contaminated materials
Management of existing waste	For preparatory step the waste from the cell selected for storage of existing waste will be transported to the other cells temporarily for placement of impermeable clay layer in the bottom of selected cell. Then the existing wastes of the entire landfill site will be transported to the selected cell. Wastes will be placed systematically in layers with adequate and proper compaction; suitable covering soil will be added over each of the layers; capping will be done by clay layer to prevent further pollution; and finally covering turf or grasses will be grown on properly shaped surfaces keeping adequate arrangement for drainage of rainwater.	Contractor	DSC CCPIU	Existing condition	As necessary	Detailed design documents
Treatment of leachate	Groundwater protection by draining and treatment of the polluted water and leachate: The groundwater which is affected by the current waste should be drained and should be treated in a waste water treatment plant; To prevent further contamination of the groundwater, new landfill cells should be constructed where an impermeable layer will prevent further contamination in the environment.	Contractor	DSC CCPIU	Existing condition	As necessary	Detailed design documents

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	<p>A drainage system in the new landfill cell will drain all new leachate from the landfill cell into the waste water treatment facility.</p> <p>Leachate reducing measurements:</p> <p>To prevent the production of new leachate, surface waters should be separated as much as possible from the pollution source. To reduce the infiltration in the landfill mass, wastes should be covered by impermeable layers (clay layer of 0.5m; $K < 1.10^{-9}$ m/s).</p>					
Hauling of Construction Materials	<ul style="list-style-type: none"> - The contractor must maintain all the materials necessary in his inventory so that these can be easily hauled to the construction site when needed. - Advance signage for affected parking areas must indicate duration and alternative parking arrangements. 	Contractor	DSC	Construction method statement	As work progresses	<p>Construction method</p> <p>Detailed design documents</p>
Access	<ul style="list-style-type: none"> - The contractor should make available in his stock steel plates and wooden planks which will be deployed on top of excavations to provide temporary access to buildings, street crossings, and other areas where these will be necessary. - Advance road signage must indicate the road detour and alternative routes. Provide sign boards for pedestrians to inform them of nature and duration of construction works and contact numbers for concerns/complaints. 	Contractor	DSC	Construction method statement	As work progresses	<p>Construction method</p> <p>Detailed design documents</p> <p>Zero complaints from community/sensitive receptors</p>
Occupational health and safety	<ul style="list-style-type: none"> - Employ workers with adequate experience, training, and know-how. - These workers should be led by an experienced supervisor or engineer, who will provide the leadership in daily activities. - A general regard for the social and ecological well-being of the site and adjacent areas is expected of the site staff. Workers need to be made aware of the following general rules: (i) no alcohol/drugs on site; (ii) prevent excessive noise; (iii) construction staff are to make use of the facilities provided for them, as opposed to ad hoc alternatives (e.g. fires for cooking, the use of surrounding bushes as a toilet facility); (iv) no fires permitted on site except if 	Contractor	DSC	<p>Occupational health and safety plan</p> <p>Number of accidents and work-related injuries</p> <p>Complaints from community</p>	As work progresses	<p>Construction method</p> <p>Detailed design documents</p> <p>Zero accident and work-related injuries</p> <p>Zero complaints</p>

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	<p>needed for the construction works; (v) trespassing on private/commercial properties adjoining the site is forbidden; (vi) other than pre-approved security staff, no workers should be permitted to live on the construction site; and (vii) no worker may be forced to do work that is potentially dangerous or that he/she is not trained to do.</p> <ul style="list-style-type: none"> - Because of existence of solid waste all around in the CLF site, the workers will need to wear uniform, which is usually used by the workers in the solid waste disposal site. - The contractor must monitor the performance of construction workers to ensure that the points relayed during their induction have been properly understood and are being followed. If necessary, a translator should be called to the site to further explain aspects of environmental or social behavior that are unclear. - The rules that are explained in the worker conduct section must be followed at all times. 					from community and workers
Community health and safety	<ul style="list-style-type: none"> - Contractor's activities and movement of staff will be restricted to designated construction areas. - Should the construction staff be approached by members of the public or other stakeholders, staff should assist them in locating the environment management specialist or contractor, or provide a number through which they may contact the environment management specialist or contractor. - The conduct of the construction staff when dealing with the public or other stakeholders should be in a manner that is polite and courteous at all times. Failure to adhere to this requirement may result in the removal of staff from the site by the environment management specialist. - Disruption of access for local residents, commercial establishments, institutions, etc. must be minimized and must have the environment management specialist's permissions. - Provide walkways and metal sheets where required to maintain access for people and vehicles. - Consult businesses and institutions regarding operating hours, and factor this in work schedules. - The contractor is to inform neighbors in writing of 	Contractor	DSC	<p>Complaints from community</p> <p>Activities based on the communication and participation strategy</p>	As work progresses	Zero complaints from community and workers

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	<p>disruptive activities at least 24 hours beforehand. This can take place by way of leaflets placed in the postboxes giving the environment management specialist's and contractor's details or other method approved by the environment management specialist.</p> <ul style="list-style-type: none"> - Provide sign boards for pedestrians to inform them of nature and duration of construction works and contact numbers for concerns/complaints. - The contractor will ensure that there is provision of alternate access to business establishments during the construction, so that there is no closure of these shops or any loss of clientage. - The contractor will ensure that any damage to properties and utilities will be restored or compensated to pre-work conditions. - Lighting on the construction site should be pointed downwards and away from oncoming traffic and nearby houses. - The site must be kept clean to minimize the visual impact of the site. - If screening is being used, this must be moved and re-erected as the work front progresses. - Machinery and vehicles are to be kept in good working order for the duration of the project to minimize noise nuisance to neighbors. - Notice of particularly noisy activities must be given to residents/businesses adjacent to the construction site. Examples of these include: noise generated by jackhammers, diesel generator sets, excavators, etc. - Noisy activities must be restricted to the times given in the project specification or general conditions of contract. - The environment management specialist and contractor are responsible for ongoing communication with those people who are interested in or affected by the project. - A complaints register (refer to the grievance redressal mechanism) should be housed at the site office. This should be in carbon copy format, with numbered pages. Any missing pages must be accounted for by the contractor. This register is to 					

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	<p>be tabled during monthly site meetings.</p> <ul style="list-style-type: none"> - Interested and affected parties need to be made aware of the existence of the complaints book and the methods of communication available to them. - The contractor must address queries and complaints by: (i) documenting details of such communications; (ii) submitting these for inclusion in complaints register; (iii) bringing issues to the environment management specialist's attention immediately; and (iv) taking remedial action as per environment management specialist's instruction. - The contractor should immediately take the necessary remedial action on any complaint/grievance received by him and forward the details of the grievance along with the action taken to the environment management specialist within 48 hours of receipt of such complaint/grievance. 					
Community and public awareness	<ul style="list-style-type: none"> - Storage facilities and other temporary structures on-site should be located such that they have as little visual impact on local residents as possible. - Special attention should be given to the screening of highly reflective materials on site. - In areas where the visual environment is particularly important (e.g. along commercial/ tourism routes) or privacy concerns for surrounding buildings exist, the site may require screening. This could be in the form of shade cloth, temporary walls, or other suitable materials prior to the beginning of construction. 	Contractor	DSC	<p>Complaints from community</p> <p>Activities based on the communication and participation strategy</p>	As work progresses	Zero complaints from community and workers
Construction camps and storage areas	<ul style="list-style-type: none"> - The contractor is to ensure that open areas or the surrounding bushes are not being used as toilet facility. - The contractor should ensure that all litter is collected from the work and camp areas daily. - Bins and/or skips should be emptied regularly and waste should be disposed of at the pre-approved site. Waybills for all such disposals are to be kept by the contractor for review by the environment management specialist. - The contractor should ensure that his camp and working areas are kept clean and tidy at all times. - After construction work, all structures comprising 	Contractor	DSC	<p>Approved location plan</p> <p>Complaints from community</p>	As work progresses	<p>Approved location plan</p> <p>Zero complaints from community and workers</p>

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	<p>the construction camp are to be removed from site or handed over to the property owner/community as per mutual agreement (if established on private/community land).</p> <ul style="list-style-type: none"> - The area that previously housed the construction camp is to be checked for spills of substances such as oil, paint, etc. and these should be cleaned up. - All hardened surfaces within the construction camp area should be ripped, all imported materials removed, and the area should be top soiled and regressed. - The contractor must arrange the cancellation of all temporary services. 					
Dust and air pollution	<ul style="list-style-type: none"> - Vehicles travelling to and from the construction site must adhere to speed limits so as to avoid producing excessive dust. - Access and other cleared surfaces, including backfilled trenches, must be dampened whenever possible and especially in dry and windy conditions to avoid excessive dust. - Vehicles and machinery are to be kept in good working order and to meet manufacturer's specifications for safety, fuel consumption, etc. - The contractor is to have the equipment seen to as soon as possible should excessive emissions be observed. 	Contractor	DSC	<p>Vehicle emission testing records</p> <p>Complaints from community</p>	As work progresses	<p>No visible increase in dust and particulate matters</p> <p>Zero complaints from community</p>
Noise levels	<ul style="list-style-type: none"> - Noise-generating equipment must be fitted with silencers. - If a worker is exposed to noise above a noise exposure limit, the contractor must investigate options for engineered noise control such as using low-noise excavators, jackhammers, drills, and power generators. - If it is not practicable to reduce noise levels to or below noise exposure limits, the contractor must post warning signs in the noise hazard areas. Workers in a posted noise hazard area must wear hearing protection. 	Contractor	MASC environment management specialist	<p>Complaints from community</p> <p>Noise level monitoring record</p>	As work progresses	ECR 1997
Utilities	<ul style="list-style-type: none"> - Prepare a list of affected utilities and operators - Prepare a contingency plan to include actions to be done in case of unintentional interruption of services. 	Contractor	DSC	<p>Number of affected utilities</p> <p>Length of time</p>	As work progresses	No disrupted service

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
				to restore disrupted services		
Water quality	<ul style="list-style-type: none"> - Every effort should be made to ensure that any chemicals or hazardous substances do not contaminate the soil or water on-site. - Care must be taken to ensure that runoff from vehicle or plant washing does not enter the surface/ground water. - Site staff should not be permitted to use any stream, river, other open water body, or natural water source adjacent to or within the designated site for the purposes of bathing, washing of clothing, or for any construction or related activities. Municipal water (or another source approved by the environment management specialist) should instead be used for all activities such as washing of equipment or disposal of any type of waste, dust suppression, concrete mixing, compacting etc. - All concrete mixing must take place on a designated, impermeable surface. - No vehicles transporting concrete to the site may be washed on-site. - No vehicles transporting, placing, or compacting asphalt or any other bituminous product may be washed on-site. - All substances required for vehicle maintenance and repair must be stored in sealed containers until they can be disposed of removed from the site. - Hazardous substance/ materials are to be transported in sealed containers or bags. 	Contractor	DSC	<p>Complaints from community</p> <p>Waste disposal manifest/ record</p>	As work progresses	<p>No visible increase in water pollution due to the project</p> <p>Zero complaints from community</p>
Waste management	<ul style="list-style-type: none"> - Wastes must be placed in the designated skips/bins which must be regularly emptied. These should remain within demarcated areas and should be designed to prevent wastes from being blown out by wind. - Littering on-site is forbidden and the site should be cleared of litter at the end of each working day/night period. - Recycling is to be encouraged by providing separate receptacles for different types of wastes and making sure that staff is aware of their uses. - All waste must be removed from the site and 	Contractor	DSC	<p>Complaints from community</p> <p>Waste disposal manifest/record</p>	As work progresses	<p>No dumped wastes and litter at work sites at all times</p> <p>Zero complaints from community</p>

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	<p>transported to a disposal site or as directed by the environment management specialist. Waybills proving disposal at each site should be provided for the environment management specialist's inspection.</p> <ul style="list-style-type: none"> - Construction rubble should be disposed of in pre-agreed, demarcated spoil dumps that have been approved by the environment management specialist, or at disposal sites. 					
Conservation of natural environment	<ul style="list-style-type: none"> - As the work front progresses; the contractor is to check that vegetation clearing has the prior permission of the environment management specialist. - Only trees that have been marked beforehand are to be removed, if cutting of trees is required. - Clean the entire area and maintain immediately after completion of the construction activities to make sure that existing tranquility of the surrounding area is not disturbed in any way. 	Contractor	DSC	Vegetation clearing	As required	Only allowed trees/vegetation to be cleared
Cultural and historical environment	<ul style="list-style-type: none"> - Consult laborers who work on the site during the detailed design stage and in the unlikely event that there are social and cultural resources in the site; assistance should be given in relocating the site and any associated artifacts. - All the staff and laborers of the contractor are to be informed about the possible items of historical or archaeological value, which include old stone foundations, tools, clayware, jewelry, remains, fossils etc. - If something of this nature is uncovered, Department of Archaeology should be contacted and work should be stopped immediately. 	Contractor	DSC	Chance finds	As necessary	All chance finds shall be reported and turned over to the Department of Archaeology.
Safeguards supervisors	<ul style="list-style-type: none"> - The contractor should appoint one environment safeguard supervisor who will be responsible for assisting the contractor in implementation of EMP, coordinating with the DSC, consultations with interested/affected parties, reporting, and grievance redressal on a day-to-day basis. 	Contractor	DSC	Hiring and actual work	As work progresses	Continuous work output and reporting records
Post-construction and post-commissioning irregularities	<ul style="list-style-type: none"> - Remove all plant/ machineries/ vehicles and any temporary structures including the workforce camps and warehouses for storage of materials after completion of construction. - Restore the original landscape of the surrounding 	Contractor	DSC	Cleanliness of the site and surrounding area	End of construction phase	As specified in the O&M Manual and all applicable laws and

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	area as much as possible.					regulations
Operation and maintenance phase						
General	<ul style="list-style-type: none"> - Develop O&M Manuals to include all aspects of the management and operation of the CLF: - nature of waste that is accepted; - sequence and location of waste placement; - operation and maintenance of the gas collection system; - introduction of moisture or recirculation of leachate, leachate collection; - maintenance and cleaning of the leachate collection system; and - environmental monitoring, and maintenance of the final cover. - Train all CLF workers to the highest standards available in Bangladesh and given refresher training at least annually - Control access for public/personnel; - Clean toilets daily; - Provide clean hand washing areas adequate soap and towels; - Provide clothing and laundry service for workers; and - Clean facility after the work of each day. The waste storage area and other adjacent areas should be sprinkled or sprayed regularly with disinfectants to avoid any spread of disease. - Audit implementation of O&M procedures at regular intervals (by an Independent Monitoring Agency) 	<p>Contractor (up to service delivery period)</p> <p>Chittagong City Corporation</p>	<p>Chittagong City Corporation (up to service delivery period)</p> <p>Independent Monitoring Agency</p>	<p>Specifications in the O&M Manual</p> <p>Public health survey (5 years)¹⁵</p>	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations
Monitoring/ Waste composition, inventory and inspection	Landfill operator must ensure that a register is kept throughout the life of the facility of the quantities and characteristics of the waste deposited.	Contractor	<p>City Corporation (up to service delivery period)</p> <p>Independent Monitoring Agency</p>	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations

¹⁵ Public health survey will be conducted by the city corporation authority by its own source of fund with a view to evaluating the impact of operation and maintenance of the CLF. Outcome will be utilized to monitor the impacts and to make any changes in the modality of operation of the CLF to make it more public health friendly than before. Target population will be the residents within a distance of one kilometer around the CLF.

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	Information on waste register must include the origin of waste, type of waste, date of delivery, identify of the producer or collector.	Contractor	City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations
	Regular visual inspection of the waste at the point of deposit should be undertaken to ensure that waste is properly sorted/ separated at the site	Contractor	City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations
Monitoring of gases, wastewater and water	Indicative parameters for environmental pollution like presence of inflammable gases and quality of water and groundwater will be monitored	Contractor (up to service delivery period) Chittagong City Corporation	Chittagong City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	ECR 1997 and applicable international guidelines
Land contamination	- Do not store wastes outside the CLF premises to avoid issues of aesthetic nature	Contractor (up to service delivery period) Chittagong City Corporation	Chittagong City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations
Wastewater	- After treatment, the discharge standards need to be followed similar to the standards mentioned in Schedule 10 of the ECR 1997 for inland water discharge	Contractor (up to service delivery period) Chittagong City Corporation	Chittagong City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	ECR 1997 (Rule 13: The standard limits of the discharge of liquid wastes shall be determine in accordance with the standards specified in Schedule 10)
Other wastes	- All other wastes arising in the CLF should be properly graded and disposed of by appropriate methods.	Contractor (up to service delivery period)	Chittagong City Corporation (up to service	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and

Parameter	Mitigation Measures	Responsible for Implementation	Responsible for Monitoring	Parameters to be Monitored	Frequency of Monitoring	Guidelines/ Standards
	- Disposed into a solid waste bin (skip) and immediately transport out of the CLFs in a closed wheel-barrow or similar other device.	Chittagong City Corporation	delivery period) Independent Monitoring Agency			all applicable laws and regulations
Odor	- Audit odor to identify and characterize sources and determine any action required. - Carry out frequent cleaning of material storage areas to prevent odor	Contractor (up to service delivery period) Chittagong City Corporation	Chittagong City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations
Vermin and pest	- Apply soil cover materials rigorously - Compact wastes properly - Carefully maintain general “good housekeeping” - Inspect site regularly to detect indication of prevalence of pests and vermin - Employ an experienced pest control specialist to deal with this problem in case significant numbers are identified.	Contractor (up to service delivery period) Chittagong City Corporation	Chittagong City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations
Noise	- Activities and vehicle movements should be avoided after hours. - Vehicles should be fitted with silencers. - Vehicles and machinery are to be kept in good working order.	Contractor (up to service delivery period) Chittagong City Corporation	Chittagong City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations
Water use	- Minimize water use through dedicated metering of water consumption	Contractor (up to service delivery period) Chittagong City Corporation	Chittagong City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations
Health, hygiene, and safety	- CLF workers should undergo regular medical check-up - CLF workers should be provided with protective gear like head cover, gloves, etc - Provide training on safety to staff to avoid accidents - Regularly monitor the CLF to ensure compliance with occupational health and safety rules	Contractor (up to service delivery period) Chittagong City Corporation	Chittagong City Corporation (up to service delivery period) Independent Monitoring Agency	Specifications in the O&M Manual	As determined in the O&M Manual	As specified in the O&M Manual and all applicable laws and regulations

D. Reporting

167. The DSC will submit monthly monitoring reports to CCPIU, and the CCPIU will send semiannual monitoring reports to ADB. ADB will post the environmental monitoring reports on its website.

E. Environmental Costs

168. The contractor's cost for site establishment, preliminary activities, construction, defect liability activities, and environmental mitigation measures related to EMP implementation during planning, design, construction, and operations will be incorporated into the contractual agreements and engineers costs, which will be binding on him for implementation.

169. The mitigation measures during the operation phase (after the service delivery period) are again of good operating practices, which will be the responsibility of the implementing agency (Chittagong City Corporation). All monitoring during the operation and maintenance phase will be conducted by Chittagong City Corporation; therefore, there are no additional costs.

170. The activities identified in the EMP mainly include site inspections and informal discussions with workers and local community, and this will be the responsibility of CCPIU with the assistance of DSC, costs of which are part of project management. The budget required for capacity building and training program mentioned in Table 6 is also included in the project management cost.

171. Table 8 presents the estimated cost to implement the EMP. The EMP and the costs for the EMP implementation will be updated during detailed engineering design. The figures show that the total cost of environmental management and monitoring for all subprojects in Chittagong is Tk 22.5 million. This includes: the cost of the Independent Monitoring Agency, which will spend one week every month for five years, monitoring the operation of the CLF. It includes the cost of all surveys (long-term bi-annual wastewater monitoring will be done by DOE and test costs borne by operator according to DOE fee rates as per Schedule 14 of the ECR, 1997) and other expenses associated with implementing the EMP for this subproject during project implementation. It also includes the cost of the long-term survey of public health proposed in the EMP for this subproject.

Table 8: Environmental Management and Monitoring Costs for Chittagong CLF

Item	Quantity	Unit Cost (TK.)	Total Cost (TK.)	Sub-total
1. Monitoring during Construction (1.5 years)				
Domestic Environmental Specialist	1 x 6 month	300,000 ¹⁶	1,800,000	
Survey Expenses	Lump Sum	2,000,000	2,000,000	3,800,000
2. Monitoring during Operation (5 years)				
Independent Monitoring Expert	5 x 3 month	300,000	4,500,000	
Supporting Staff	5 x 3 month	200,000	3,000,000	
Survey Expenses	Lump Sum	5,000,000	5,000,000	12,500,000
3. IEEs/EIAs required by ADB policy & national law				
Domestic Environmental Specialist	1 x 12 month	300,000	3,600,000	

¹⁶ Unit cost of domestic consultants is based on current rates and includes fee, travel, accommodation and subsistence.

Item	Quantity	Unit Cost (TK.)	Total Cost (TK.)	Sub-total
Expenses (surveys, consultation, disclosure)	Lump Sum	1,000,000	1,000,000	4,600,000
4. Survey of Public Health (5 years)				
Domestic Consultant	5 x ½ month	300,000	750,000	
Supporting Staff	5 x ½ month	200,000	500,000	
Other Expenses	Lump Sum	350,000	350,000	1,600,000
TOTAL COST (TK.)				22,500,000

VII. FINDINGS AND RECOMMENDATIONS

A. Findings

172. The process described in this document has assessed the environmental impacts of all elements of the infrastructure proposed under the Chittagong CLF subproject. Potential negative impacts were identified in relation to the design, construction and operation of the infrastructure, and mitigation measures have been developed to reduce all negative impacts to acceptable levels. These were discussed with specialists responsible for the engineering aspects of program development, and as a result some measures have already been included in the outline designs for the infrastructure. These include:

- (i) Ensuring that the site selected for the CLF is owned by the Government and does not contain any residential property, to avoid the need to relocate households; and
- (ii) Selecting a site that is in an uninhabited area where there are no sensitive receptors.

173. This means that the number of impacts and their significance has already been reduced by amending both the design and location of elements of the subproject.

174. Regardless of these and various other actions taken during the IEE process and in developing the subproject, there will still be impacts on the environment when the infrastructure is built and when it is operating. This is mainly because a functioning CLF can have major negative impacts on public health and safety, and environmental quality, if it is not operated to the highest professional standards. Because of these factors the most significant impacts are on the physical environment and the human environment.

175. In the construction phase there are not expected to be major negative impacts because the construction work is relatively straightforward and will be conducted at a single site. Other mitigation and enhancement measures are included in the EMP, which also shows the location of the impact, the body responsible for the mitigation, and the program for its implementation.

176. Operation and maintenance of the completed CLF will be the responsibility of the contractor up to the end of the service delivery period and afterwards, the Chittagong City Corporation. It will be vital that the facility operates to the highest professional standards because if this is not the case it could easily replicate the practices and effects that are common at existing CLF and *ad hoc* solid waste dumping places in the city. These include impacts on:

- (i) **Worker health and safety.** if equipment, procedures and hygiene are inadequate;

- (ii) **Environmental quality.** if solid waste is not properly collected, transported and disposed to proper positions on a daily basis.

177. The IEE includes a number of measures relating to the design to ensure that the facility operates to a high standard and avoids these and other impacts. The main measures are that:

- (i) All aspects of management and operation should be set out in O&M manuals prepared by an international expert in CLF management;
- (ii) Implement of the procedures is checked and audited by an Independent Monitoring Agency every month for the first five years;
- (iii) All workers are trained to the highest available standards and re-trained annually;
- (iv) Ensuring sufficient training and financial support to the Chittagong City Corporation to achieve expected standards.

178. If these and the other mitigation measures recommended by the IEE are implemented, then the CLF should operate without significant negative impacts. Public health should therefore improve and there will also be economic benefits for the people in general because there will be less possibility of getting sick and subsequent absence of the workers in offices and factories.

179. Mitigation will be assured by a program of environmental monitoring conducted during both construction and operation to ensure that all measures are provided as intended, and to determine whether the environment is protected as envisaged. This will include observations on and off site, document checks, and interviews with workers and beneficiaries during the construction stage, and weekly monitoring of all practices at the CLF for the first five years of operation, by the IMA. Any requirements for remedial action will be reported to LGD/ UPEHU and ADB. There will also be a longer-term survey to monitor the expected improvements in public health.

180. Finally, stakeholders were involved in developing the IEE through face-to-face discussions on site and a large public meeting held in the town, after which views expressed were incorporated into the IEE and the planning and development of the project. The IEE and other documents will be made available at public locations in the town and summaries will be disclosed to a wider audience via the ADB website. The consultation process will be continued and expanded during project implementation, when a nationally-recognized NGO will be appointed to handle this key element to ensure that stakeholders are fully engaged in the project and have the opportunity to participate in its development and implementation.

B. Recommendations

181. There are two straightforward but essential recommendations that need to be followed to ensure that the environmental impacts of the project are successfully mitigated. These are that LGD/ UPEHU should ensure that:

- (i) All mitigation measures proposed in this IEE report (Table 7) are implemented in full, as described in this document; and
- (ii) The EMP of this report is updated during detailed design and also implemented in full during construction and operation period.
- (iii) A copy of the EMP shall be kept on-site during the construction and operation period at all times. Also the SIEE is prepared and provided to contractors upon award of contract.
- (iv) The EMP shall be made binding on all contractors operating on the site, and will be included in the contractual clauses. Non-compliance with, or any deviation

from, the conditions set out in this document shall constitute a failure in compliance.

VIII. CONCLUSIONS

182. The environmental impacts of the proposed CLF subprojects in the Chittagong City have been assessed according to ADB guidelines and results reported in this IEE. The potential adverse environmental impacts are related to the (i) construction period, which can be minimized by the mitigating measures and environmentally sound engineering and construction practices; and (ii) operation period, which can be managed by the mitigation measures and environmentally sound O&M practices. Therefore, as per ADB Environment Policy, the project is classified as environmental category B and does not require further environmental impact assessment.

183. In relation to Bangladeshi ECR 1997, the Chittagong CLF subproject is considered to have significant environmental impacts and can be classified as Red category. The environmental impacts can be mitigated by the measures mentioned in this IEE and EMP. So this IEE document will be sufficient and acceptable to DoE as part of the ECC application although further study to prepare EIA report for impact assessment at a later stage will be necessary.

ANNEX 1: ADB Rapid Environmental Assessment Checklist

Screening Questions	Yes	No	Remarks
A. Project Siting Is the project area...			
▪ Densely populated?		X	
▪ Heavy with development activities?		X	The Landfill site is located in city corporation owned land. At present this is being used for dumping of municipal solid wastes.
▪ Adjacent to or within any environmentally sensitive areas?			
• Cultural heritage site		X	
• Protected Area		X	
• Wetland		X	
• Mangrove		X	
• Estuarine		X	
• Buffer zone of protected area		X	
• Special area for protecting biodiversity		X	
• Bay		X	
B. Potential Environmental Impacts Will the Project cause...			
▪ impacts on the sustainability of associated sanitation and solid waste disposal systems and their interactions with other urban services.		X	
▪ deterioration of surrounding environmental conditions due to rapid urban population growth, commercial and industrial activity, and increased waste generation to the point that both manmade and natural systems are overloaded and the capacities to manage these systems are overwhelmed?		X	
▪ degradation of land and ecosystems (e.g. loss of wetlands and wild lands, coastal zones, watersheds and forests)?		X	
▪ dislocation or involuntary resettlement of people?		X	There will be no dislocation or involuntary resettlement of people.
▪ disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable group?		X	
▪ degradation of cultural property, and loss of cultural heritage and tourism revenues?		X	
▪ occupation of low-lying lands, floodplains and steep hillsides by squatters and low-income groups, and their exposure to increased health hazards and risks due to pollutive industries?		X	
▪ water resource problems (e.g. depletion/degradation of available water supply, deterioration for surface and ground water quality, and pollution of receiving waters)?		X	

Screening Questions	Yes	No	Remarks
▪ air pollution due to urban emissions?	X		During construction activities for hauling of materials and operations of excavation equipment; During operations, odor from the solid wastes due to agitation and mixing
▪ risks and vulnerabilities related to occupational health and safety due to physical, chemical and biological hazards during project construction and operation?	X		During construction activities – occupational health and safety due to physical hazards; During construction activities – occupational health and safety due to physical and biological hazards
▪ road blocking and temporary flooding due to land excavation during rainy season?		X	
▪ noise and dust from construction activities?	X		During construction phase only
▪ traffic disturbances due to construction material transport and wastes?	X		During construction phase only
▪ temporary silt runoff due to construction?	X		During construction phase only
▪ hazards to public health due to ambient, household and occupational pollution, thermal inversion, and smog formation?		X	
▪ water depletion and/or degradation?		X	
▪ overpaying of ground water, leading to land subsidence, lowered ground water table, and salinization?		X	
▪ contamination of surface and ground waters due to improper waste disposal?	X		During construction phase only
▪ pollution of receiving waters resulting in amenity losses, fisheries and marine resource depletion, and health problems?		X	
▪ large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?		X	
▪ social conflicts if workers from other regions or countries are hired?		X	
▪ risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during operation and construction?		X	
▪ community safety risks due to both accidental and natural hazards, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning?		X	

ANNEX 2: Photographs of the Proposed CLF Site and the Surrounding Areas



Arifin Nagar landfill site



Heavy machineries used for placement of waste



Debris collected from approach road



Scene from the landfill site towards the road



Hills behind the landfill site



Side road towards east from the approach road

ANNEX 3: Records of Public Consultations Conducted

The stakeholders' consultation meeting was held at Landfill site located at the Arefin Nagar, Chittagong at 3-30 PM on 7 January 2013 with local people and Chittagong City Corporation (CCC) officials.

The meeting was held with local people and Conservancy Officer (Mr. Shafiqul Mannan Siddiqui Jishu) of CCC. Among the local people, most of them were laborers and engaged in waste picking activities and small businessmen who participated actively in the consultation.



Meeting at CLF site in Chittagong

The Environment and Safeguard Specialist of Package-C Consultants welcomed all participants in the meeting and explained goals and objectives of the project. He told that the Government of Bangladesh through the CCC has undertaken a project to construct one modern slaughterhouse, one Controlled land fill and 12 secondary transfer stations in CCC area to keep the city free from environmental pollution. This project will benefit the local people by improving the environmental conditions.

It was known from the discussion that the land proposed for construction of the Controlled Landfill (CLF) is owned by the Chittagong City Corporation. It is a quite big area of about 30,000 m² (7.41 acres) acquired by the CCC as per GOB rules, and it will be suitable for construction of CLF as per design adopted in UPEHSDP. It is at present temporarily being used as agricultural land. The participant from the CCC clearly stated that the area proposed for construction of CLF will be kept free from any kind of external hindrance by the own initiative of the CCC during the construction activities by the contractor in the site.

It was disclosed in the meeting that the project would be implemented soon and the local people would get benefit of getting employment as soon as the construction works would start. They also expressed their willingness to get long-term deployment after the implementation of the CLF. It was disclosed to the participants that the local people would get preference during selection of staff and workers for running the CLF in a sustainable manner.

The participants were convinced that the socio-economic and environmental condition of the local people and the locality would be definitely better after implementation of the subproject and they showed their willingness to cooperate whole heartedly during construction and operation and maintenance phase of the CLF.

There were no issues left for discussion and the meeting was closed with a vote of thanks to all participants.

Ministry of Local Government, Rural Development and Cooperatives
Urban Public and Environmental Health Sector Development Project (UPEHSDP)
Attendance Sheet

Time: 3-30 PM

Date: 7/1/2013

Place of meeting: Arifin Nagar Landfill Site, Chittagong

Union: W/2 Thana: Bayezid

Serial Number	Name of Participant	Father's/ Husband's Name	Address	Mobile Number	Signature
1	Md. Jalal Uddin	Ahmed Nabi	Arifin Nagar	01814900321	
2	Md. Mustafa	Md. A. Hakim	Arifin Nagar	01829433073	
3	Md. A. Rahman	Md. Ali Azam	Arifin Nagar	01849213938	
4	Md. Azad Hossain	Bachchu Miah	Arifin Nagar	01813268013	
5	Abu Khair	Hossain Miah	Arifin Nagar	-	
6	Sahabir	Osman Ghani	Arifin Nagar	-	
7	A. Samad	A. Ghani	Islampur	04434362655	
8	Kalu Miah	Kazi Md. Lakitullah	Halishahar	01834856996	
9	Nasir Uddin	Md. Nabab Miah	Arifin Nagar	01814314216	
10	Shah Alam	A. Jalil	Raojan	01824718979	
11	Md. Raju	Zakir Hossain	Chinnamul	01835291936	
12	Daulat Khan	Nezamat Khan	Kadam Mubarak	-	
13	Md. Bahar Uddin	Md. Abu Taher	Arifin Nagar	01829695932	
14	Ripon	Chittaranjan Roy	Arifin Nagar	01199536241	

Ministry of Local Government, Rural Development and Cooperatives
Urban Public and Environmental Health Sector Development Project (UPEHSDP)

Attendance Sheet

Time: 3-30 PM

Date: 7/1/2013

Place of meeting: Arefin Nagar Landfill site chittagong Union: W/2

Thana: Bayezid

Serial Number	Name of Participant	Father's/ Husband's Name	Address	Mobile Number	Signature
1	শ্রী: সুনীল	শ্রী: সুনীল	আমলা নগর	01814900321	শ্রী: সুনীল
2	শ্রী: সুনীল	শ্রী: সুনীল	আমলা নগর	01829433073	শ্রী: সুনীল
3	শ্রী: সুনীল	শ্রী: সুনীল	আমলা নগর	01849213938	শ্রী: সুনীল
4	শ্রী: সুনীল	শ্রী: সুনীল	আমলা নগর	01813268013	শ্রী: সুনীল
5	শ্রী: সুনীল	শ্রী: সুনীল	আমলা নগর	—	শ্রী: সুনীল
6	শ্রী: সুনীল	শ্রী: সুনীল	আমলা নগর	—	শ্রী: সুনীল
7	শ্রী: সুনীল	শ্রী: সুনীল	আমলা নগর	04434362655	শ্রী: সুনীল
8	শ্রী: সুনীল	শ্রী: সুনীল	আমলা নগর	01834856996	শ্রী: সুনীল
9	শ্রী: সুনীল	শ্রী: সুনীল	আমলা নগর	01814314216	শ্রী: সুনীল
10	শ্রী: সুনীল	শ্রী: সুনীল	আমলা নগর	01824718979	শ্রী: সুনীল
11	শ্রী: সুনীল	শ্রী: সুনীল	আমলা নগর	01835291936	শ্রী: সুনীল
12	শ্রী: সুনীল	শ্রী: সুনীল	আমলা নগর	—	শ্রী: সুনীল
13	শ্রী: সুনীল	শ্রী: সুনীল	আমলা নগর	01829695932	শ্রী: সুনীল
14	শ্রী: সুনীল	শ্রী: সুনীল	আমলা নগর	01199536241	শ্রী: সুনীল

ANNEX 4: Environmental Pathway Studies - Chittagong



Joint Venture with



FIELD REPORT

ENVIRONMENTAL PATHWAY STUDIES – CHITTAGONG

April –September 2013

URBAN PUBLIC AND ENVIRONMENTAL HEALTH SECTOR DEVELOPMENT
PROJECT (UPEHSDP)

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Annexes

Annex 1: Bore logs

Annex 2: Laboratory Test Reports

Annex 3: Location Map of Arefin Nagar Chittagong

1. PURPOSE OF THE FIELD REPORT

The purpose of the Field Report is to:

- To represent the analyses measured on the soil samples (3 nos.)
- To represent the analyses measured on the samples, groundwater samples (14nos.)
- To represent a short overview of all works done under the TOR

The present Report is the Field Report which contains all results of the Environmental Pathway Study in Chittagong, performed from April to September 2013. It has been prepared by the two partners and DDC under the JV Ecorem-DDC.

The site consists of a deep valley with surrounding rolling hills, permanent and intermittent streams, and views towards the Bay of Bengal and the city. It lies 6km north of the commercial centre, approximately 8 km from Chittagong University, 15 km from the city's international airport, and is immediately adjacent to the Foy's Lake recreational area. The land surrounding the proposed landfill site represents one of the undeveloped areas of Chittagong's hilly landscape. This site is located within the city limits, but in an undeveloped area where its closest neighbors are a golf course and a military cantonment, the new Asia Women University and the Foy's Lake natural area to south. The site has a rough dimension of about 200m on 150m.

2. GENERAL DESCRIPTION OF ACTIVITIES PERFORMED UNDER THE ENVIRONMENTAL PATHWAY STUDIES

In Chittagong ten observation wells were installed. Ground Water Samples were collected from nine of the observation wells. The tenth observation well was inoperative at the time of sample collection. Due to the lowering of water table water sample could not be collected. Water sample was collected from five adjacent private wells. Location of these five wells has been shown on the site plan. The serial numbers of these five wells are also shown on the site plan. These sites are bearing serial number 11,12,13,14 and 15, details of these wells are shown in the table. Location of the observation wells were suggested by me and Mr. Maarten Pelgrims during our joint visit to the site in May 2013.

Drilling work started at Chittagong on 16th April 2013 after installation of three observation wells the work was suspended on the ground of a controversy about the ownership of land being used as a dumping place by Chittagong City Corporation. Later on as per request of the project office the installation of the remaining seven observation wells were done taking support from the conservancy officials of Chittagong City Corporation. The remaining seven observation wells were done in a fortnight (from 22 May to 5 June 2013). The serial number of the wells follows the serial number shown in the site plan. The site plan is attached herewith. It may be mentioned here that no official confirmation about the ownership of land by City Corporation was received from the project office so far. Ground Water samples were collected from nine observation wells and five nearby private wells. Surface runoff is taking place along the direction of the observation well numbers 8,9 and 10, down the Valley, towards the east. The RL of the drain is shown at four points. RL of the borehole and its adjoining points are shown on the map.

Particulars of observation wells at Arefin Nagar in Chittagong (10 nos.)

Sl.no.	Location of observation wells	Depth (ft)	Diameter of the well	Location of the strainer (ft)	Length of strainer (ft)	Type of pump	Depth of water table	Date of installation	Sand trap (ft)	Remarks
1	Shown on the base map	55'	3"	25'to 55'	30'	Number six manually operated hand Pump with 30' pump rod in 1.5" dia pvc pipe	30.ft from the base of the pump	18.04.2013	No sand trap used	
2	Shown on the base map	52'	3"	22'-52'	30'	Number six manually operated hand Pump with 30' pump rod in 1.5" dia pvc	30.ft from the base of the pump	20.04.2013	No sand trap used	

Sl.no.	Location of observation wells	Depth (ft)	Diameter of the well	Location of the strainer (ft)	Length of strainer (ft)	Type of pump	Depth of water table	Date of installation	Sand trap (ft)	Remarks
						pipe				
3	Shown on the base map	53'	3"	23'to 53'	30'	Number six manually operated hand Pump with 30' pump rod in 1.5" dia pvc pipe	30.ft from the base of the pump	22.04.2013	No sand trap used	
4	Shown on the base map	50'	3"	20'to 50'	30'	Number six manually operated hand Pump with 30' pump rod in 1.5" dia pvc pipe	30.ft from the base of the pump	23.05.2013	No sand trap used	
5	Shown on the base map	50'	3"	20'to 50'	30'	Number six manually operated hand Pump with 30' pump rod in 1.5" dia pvc pipe	30.ft from the base of the pump	25.05.2013	No sand trap used	
6	Shown on the base map	45'	3"	15'to 45'	30'	Number six manually operated hand Pump with 30' pump rod in 1.5" dia pvc pipe	30.ft from the base of the pump	27.05.2013	No sand trap used	
7	Shown on the base map	50'	3"	20'to 50'	30'	Number six manually operated hand Pump with 30' pump rod in 1.5" dia pvc pipe	30.ft from the base of the pump	28.05.2013	No sand trap used	

Sl.no.	Location of observation wells	Depth (ft)	Diameter of the well	Location of the strainer (ft)	Length of strainer (ft)	Type of pump	Depth of water table	Date of installation	Sand trap (ft)	Remarks
8	Shown on the base map	45'	3"	15'to 45'	30'	Number six manually operated hand Pump with 30' pump rod in 1.5" dia pvc pipe	30.ft from the base of the pump	30.05.2013	No sand trap used	
9	Shown on the base map	45'	3"	15'to 45'	30'	Number six manually operated hand Pump with 30' pump rod in 1.5" dia pvc pipe	30.ft from the base of the pump	01.06.2013	No sand trap used	
10	Shown on the base map	50'	3"	20'to 50'	30'	Number six manually operated hand Pump with 30' pump rod in 1.5" dia pvc pipe	Could not be measured.	03.06.2013	No sand trap used	

Particulars of private wells

Sl. no of well	Location of the well	Depth of well (ft)	Year of installation	Type of pump used	Remarks
11	Located at a distance of about 50 ft. to the north from the observation Well number nine.	95	2006	Number six manually operated hand Pump with 30' pump rod in 1.5" dia pvc pipe	Used by six families as their courtyard water source
12	Located at a distance of about 200ft. to the north east from the observation Well number	100	2002	Number six manually operated hand Pump with 30' pump rod in 1.5" dia pvc pipe	It is used by two families as their courtyard water source

	nine.				
13	Located at a distance of about 600 ft. to the south west from the observation Well number nine	55	2010	Number six manually operated hand Pump with 30' pump rod in 1.5" dia pvc pipe	It is used by two families as their courtyard water source
14	Located at a distance of about 150 ft. to the south west from the observation Well number nine	700	2012	Submersible pump	Pumped water is stored in the roof tank of the mosque of the Ctg. City Corporation in the graveyard
15	Located at a distance of about 400 ft. to the east from the observation Well number nine	400	2011	Submersible pump	Sell water to a few households through flexible pipe connection

Table 1: Calendar of the achieved work

Bore hole number	Start of drilling work	Completion of drilling and date of installation of observation well
01	16.04.2013	18.04.2013
02	18.04.2013	20.04.2013
03	20.04.2013	22.04.2013
04	21.05.2013	23.05.2013
05	23.05.2013	25.05.2013
06	25.05.2013	27.05.2013
07	27.05.2013	28.05.2013
08	28.05.2013	30.05.2013
09	30.05.2013	01.06.2013
10	01.06.2013	03.06.2013

3. ANALYSIS AND RESULTS

1. 3.1 Groundwater samples

a. 3.1.1 Way of sampling

Before taking ground water samples, the tube wells were sufficiently pumped to bail out the standing water in the well. After that water was collected in plastic bottles. Care was taken while filling the bottle with water so that no air bubble is entrapped in the bottle.

b. 3.1.2 Analysis

Testing of the water samples were done in Bangladesh Council of Scientific and Industrial Research (BCSIR) Laboratory in Dhaka.

c. 3.1.3 Results

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10004	Water(B.H.-1, Chittagong)	pH at 25.2deg. C	6.16	4500-H ⁺ .B
		E. Conductivity	165 μ S/cm	2510.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001mg/L	3113.B
		Chromium (Cr)	0.036mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	6.24mg/L	3111.B
		Mercury (Hg)	Less than 0.001 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	3.49 mg/L	4110.B
		Bromide (Br)	Less than 1mg/L	4110.B
		Nitrite (NO ₂)	Less than 1mg/L	4110.B
		Nitrate (NO ₃)	Less than 3 mg/L	4110.B
		Sulphate (SO ₄)	Less than 4mg/L	4110.B

		Sodium (Na)	8.6 mg/L	3500-Na.B
		Potassium (K)	2.29 mg/L	3500-K.B
		Calcium (Ca)	10.5 mg/L	3111.B
		Magnesium (Mg)	13.9 mg/L	3111.B
		Temperature	27.1 ⁰ C	2550.B
		BOD	0.64 mg/L	5210.B
		COD	Less than 2mg/L.	5220.B
		Ammonium(NH ₄)	1.05 mg/L	3500.B

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10005	Water(B.H.-2, Chittagong)	pH at 25.5 ⁰ C	6.21	4500-H ⁺ .B
		E. Conductivity	454 μ S/cm	2510.B
		Lead (Pb)	0.028 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001mg/L	3113.B
		Chromium (Cr)	0.030 mg/L	3113.B
		Arsenic (As)	Less than 0.005mg/L	3114.C
		Iron (Fe)	13.6 mg/L	3111.B
		Mercury (Hg)	0.001mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	56.3 mg/L	4110.B
		Bromide (Br)	Less than 1mg/L	4110.B
		Nitrite (NO ₂)	Less than 1mg/L	4110.B
		Nitrate (NO ₃)	35.6 mg/L	4110.B
		Sulphate (SO ₄)	Less than 4mg/L	4110.B
		Sodium (Na)	13.6 mg/L	3500-Na.B
		Potassium (K)	10.4 mg/L	3500-K.B
		Calcium (Ca)	34.6 mg/L	3111.B
		Magnesium (Mg)	33.8 mg/L	3111.B
		Temperature	27.0 ⁰ C	2550.B
		BOD	1.02 mg/L	5210.B
		COD	4.95 mg/L.	5220.B
		Ammonium(NH ₄)	5.80 mg/L	3500.B

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10006	Water(B.H.-3, Chittagong)	pH at 25.6 ⁰ C	6.52	4500-H ⁺ .B
		E. Conductivity	235 μ S/cm	2510.B
		Lead (Pb)	0.067 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001mg/L	3113.B
		Chromium (Cr)	0.012 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	29.6 mg/L	3111.B
		Mercury (Hg)	0.001 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	23.7 mg/L	4110.B
		Bromide (Br)	Less than 1mg/L	4110.B
		Nitrite (NO ₂)	Less than 1mg/L	4110.B
		Nitrate (NO ₃)	Less than 3mg/L	4110.B
		Sulphate (SO ₄)	Less than 4mg/L	4110.B
		Sodium (Na)	11.5 mg/L	3500-Na.B
		Potassium (K)	2.86 mg/L	3500-K.B
		Calcium (Ca)	15.6 mg/L	3111.B
		Magnesium (Mg)	19.6 mg/L	3111.B
		Temperature	27.0 ⁰ C	2550.B
		BOD	0.39 mg/L	5210.B
		COD	Less than 2mg/L.	5220.B
		Ammonium(NH ₄)	1.94 mg/L	3500.B

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10007	Water(B.H.-4, Chittagong)	pH at 25.7 ⁰ C	6.45	4500-H ⁺ .B
		E. Conductivity	392 μ S/cm	2510.B
		Lead (Pb)	0.30 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001mg/L	3113.B
		Chromium (Cr)	0.026mg/L	3113.B
		Arsenic (As)	0.019mg/L	3114.C

		Iron (Fe)	53.2mg/L	3111.B
		Mercury (Hg)	0.001mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	32.6 mg/L	4110.B
		Bromide (Br)	Less than1mg/L	4110.B
		Nitrite (NO ₂)	Less than1mg/L	4110.B
		Nitrate (NO ₃)	Less than1mg/L	4110.B
		Sulphate (SO ₄)	Less than1mg/L	4110.B
		Sodium (Na)	16.3mg/L	3500-Na.B
		Potassium (K)	2.91mg/L	3500-K.B
		Calcium (Ca)	20.2mg/L	3111.B
		Magnesium (Mg)	82.8mg/L	3111.B
		Temperature	27.2 ⁰ C	2550.B
		BOD	0.98 mg/L	5210.B
		COD	2.97 mg/L.	5220.B
		Ammonium(NH ₄)	3.93 mg/L	3500.B
Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10008	Water(B.H.-5, Chittagong)	pH at 25.8 ⁰ C	7.01	4500-H ⁺ .B
		E. Conductivity	633 μ S/cm	2510.B
		Lead (Pb)	1.79 mg/L	3113.B
		Cadmium (Cd)	Less than 0.002 mg/L	3113.B
		Chromium (Cr)	0.014 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	97.9mg/L	3111.B
		Mercury (Hg)	0.001mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	73.9 mg/L	4110.B
		Bromide (Br)	Less than1mg/L	4110.B
		Nitrite (NO ₂)	Less than1mg/L	4110.B
		Nitrate (NO ₃)	Less than3mg/L	4110.B
		Sulphate (SO ₄)	Less than4mg/L	4110.B
		Sodium (Na)	24.3 mg/L	3500-Na.B

		Potassium (K)	5.08 mg/L	3500-K.B
		Calcium (Ca)	69.1 mg/L	3111.B
		Magnesium (Mg)	22.1 mg/L	3111.B
		Temperature	27.1 ⁰ C	2550.B
		BOD	18 mg/L	5210.B
		COD	46.6 mg/L.	5220.B
		Ammonium(NH ₄)	15.2 mg/L	3500.B
Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10009	Water(B.H.-6, Chittagong)	pH at 26.0 ⁰ C	6.46	4500-H ⁺ .B
		E. Conductivity	607 μ S/cm	2510.B
		Lead (Pb)	0.73 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001mg/L	3113.B
		Chromium (Cr)	0.022 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	85.2 mg/L	3111.B
		Mercury (Hg)	0.002 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	71.8 mg/L	4110.B
		Bromide (Br)	Less than1mg/L	4110.B
		Nitrite (NO2)	Less than1mg/L	4110.B
		Nitrate (NO3)	Less than3mg/L	4110.B
		Sulphate (SO4)	Less than4mg/L	4110.B
		Sodium (Na)	28.3 mg/L	3500-Na.B
		Potassium (K)	7.91 mg/L	3500-K.B
		Calcium (Ca)	42.5mg/L	3111.B
		Magnesium (Mg)	16.1 mg/L	3111.B
		Temperature	27.4 ⁰ C	2550.B
		BOD	24 mg/L	5210.B
		COD	54.5mg/L.	5220.B
		Ammonium(NH ₄)	45.6 mg/L	3500.B

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10010	Water(B.H.-7, Chittagong)	pH at 26.1 ⁰ C	6.56	4500-H ⁺ .B
		E. Conductivity	393 μ S/cm	2510.B
		Lead (Pb)	0.29 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001mg/L	3113.B
		Chromium (Cr)	0.015 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	60.7 mg/L	3111.B
		Mercury (Hg)	Less than 0.001mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	19.4 mg/L	4110.B
		Bromide (Br)	Less than 1mg/L	4110.B
		Nitrite (NO ₂)	Less than 1mg/L	4110.B
		Nitrate (NO ₃)	Less than 3mg/L	4110.B
		Sulphate (SO ₄)	Less than 4mg/L	4110.B
		Sodium (Na)	15.6 mg/L	3500-Na.B
		Potassium (K)	3.46 mg/L	3500-K.B
		Calcium (Ca)	38.2 mg/L	3111.B
		Magnesium (Mg)	17.4 mg/L	3111.B
		Temperature	27.3 ⁰ C	2550.B
		BOD	5.95 mg/L	5210.B
		COD	14.9 mg/L.	5220.B
		Ammonium(NH ₄)	11.5 mg/L	3500.B
Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10011	Water(B.H.-8, Chittagong)	pH at 24.9 ⁰ C	6.35	4500-H ⁺ .B
		E. Conductivity	509 μ S/cm	2510.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001mg/L	3113.B
		Chromium (Cr)	0.012 mg/L	3113.B

		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	9.14 mg/L	3111.B
		Mercury (Hg)	Less than 0.001mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	78.7 mg/L	4110.B
		Bromide (Br)	Less than 1mg/L	4110.B
		Nitrite (NO ₂)	Less than 1mg/L	4110.B
		Nitrate (NO ₃)	Less than 3mg/L	4110.B
		Sulphate (SO ₄)	Less than 4mg/L	4110.B
		Sodium (Na)	25.9 mg/L	3500-Na.B
		Potassium (K)	2.91mg/L	3500-K.B
		Calcium (Ca)	20.9 mg/L	3111.B
		Magnesium (Mg)	39.4 mg/L	3111.B
		Temperature	27.3 ⁰ C	2550.B
		BOD	0.8 mg/L	5210.B
		COD	2.97 mg/L.	5220.B
		Ammonium(NH ₄)	5.54 mg/L	3500.B
Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10012	Water(B.H.-9, Chittagong)	pH at 25.5 ⁰ C	6.66	4500-H ⁺ .B
		E. Conductivity	692 μ S/cm	2510.B
		Lead (Pb)	0.04 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001mg/L	3113.B
		Chromium (Cr)	0.017 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	18.8 mg/L	3111.B
		Mercury (Hg)	Less than 0.001mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	71.4 mg/L	4110.B
		Bromide (Br)	Less than 1mg/L	4110.B
		Nitrite (NO ₂)	Less than 1mg/L	4110.B

		Nitrate (NO ₃)	29.2 mg/L	4110.B
		Sulphate (SO ₄)	24.8 mg/L	4110.B
		Sodium (Na)	61.4mg/L	3500-Na.B
		Potassium (K)	6.87 mg/L	3500-K.B
		Calcium (Ca)	43.5 mg/L	3111.B
		Magnesium (Mg)	38.3 mg/L	3111.B
		Temperature	27.1 ⁰ C	2550.B
		BOD	8.7 mg/L	5210.B
		COD	23 mg/L.	5220.B
		Ammonium(NH ₄)	5.36 mg/L	3500.B
Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10013	Water(B.H.-11, Chittagong)	pH at 26.0 ⁰ C	7.07	4500-H ⁺ .B
		E. Conductivity	359 μ S/cm	2510.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001mg/L	3113.B
		Chromium (Cr)	0.009 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	0.86 mg/L	3111.B
		Mercury (Hg)	Less than 0.005 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	Less than 1 mg/L	4110.B
		Bromide (Br)	Less than 1mg/L	4110.B
		Nitrite (NO ₂)	Less than 1mg/L	4110.B
		Nitrate (NO ₃)	Less than 3 mg/L	4110.B
		Sulphate (SO ₄)	10.2 mg/L	4110.B
		Sodium (Na)	16.8 mg/L	3500-Na.B
		Potassium (K)	1.98 mg/L	3500-K.B
		Calcium (Ca)	28.4 mg/L	3111.B
		Magnesium (Mg)	24.9 mg/L	3111.B
		Temperature	27.3 ⁰ C	2550.B
		BOD	Less than 0.2	5210.B

			mg/L	
		COD	Less than 2mg/L.	5220.B
		Ammonium(NH ₄)	5.17 mg/L	3500.B
Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10014	Water(B.H.-12, Chittagong)	pH at 25.8 ⁰ C	7.26	4500-H ⁺ .B
		E. Conductivity	172μ S/cm	2510.B
		Lead (Pb)	Less than 0.01mg/L	3113.B
		Cadmium (Cd)	Less than 0.001mg/L	3113.B
		Chromium (Cr)	0.006 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	1.89 mg/L	3111.B
		Mercury (Hg)	0.001 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	5.48 mg/L	4110.B
		Bromide (Br)	Less than 1mg/L	4110.B
		Nitrite (NO ₂)	Less than 1mg/L	4110.B
		Nitrate (NO ₃)	Less than 3mg/L	4110.B
		Sulphate (SO ₄)	8.06 mg/L	4110.B
		Sodium (Na)	13.8 mg/L	3500-Na.B
		Potassium (K)	2.09 mg/L	3500-K.B
		Calcium (Ca)	11.0 mg/L	3111.B
		Magnesium (Mg)	10.4 mg/L	3111.B
		Temperature	27.2 ⁰ C	2550.B
		BOD	Less than 0.2 mg/L	5210.B
		COD	Less than 2mg/L.	5220.B
		Ammonium(NH ₄)	5.04 mg/L	3500.B
Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10015	Water(B.H.-13, Chittagong)	pH at 25.6 ⁰ C	6.81	4500-H ⁺ .B
		E. Conductivity	532μ S/cm	2510.B

		Lead (Pb)	Less than 0.01mg/L	3113.B
		Cadmium (Cd)	0.001mg/L	3113.B
		Chromium (Cr)	0.006 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	0.47 mg/L	3111.B
		Mercury (Hg)	Less than 0.001mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	29.4 mg/L	4110.B
		Bromide (Br)	Less than 1mg/L	4110.B
		Nitrite (NO ₂)	Less than 1mg/L	4110.B
		Nitrate (NO ₃)	Less than 3mg/L	4110.B
		Sulphate (SO ₄)	38.9 mg/L	4110.B
		Sodium (Na)	18.5 mg/L	3500-Na.B
		Potassium (K)	4.67 mg/L	3500-K.B
		Calcium (Ca)	48.9 mg/L	3111.B
		Magnesium (Mg)	38.8 mg/L	3111.B
		Temperature	27 ⁰ C	2550.B
		BOD	Less than 0.2 mg/L	5210.B
		COD	Less than 2mg/L.	5220.B
		Ammonium(NH ₄)	1.03 mg/L	3500.B

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10016	Water(B.H.-14, Chittagong)	pH at 25.7 ⁰ C	6.90	4500-H ⁺ .B
		E. Conductivity	306μ S/cm	2510.B
		Lead (Pb)	Less than 0.01mg/L	3113.B
		Cadmium (Cd)	Less than 0.001mg/L	3113.B
		Chromium (Cr)	0.006 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	0.62 mg/L	3111.B
		Mercury (Hg)	Less than	3112.B

			0.001mg/L	
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	1.64 mg/L	4110.B
		Bromide (Br)	Less than 1mg/L	4110.B
		Nitrite (NO ₂)	Less than 1mg/L	4110.B
		Nitrate (NO ₃)	Less than 3mg/L	4110.B
		Sulphate (SO ₄)	13.1 mg/L	4110.B
		Sodium (Na)	11.8 mg/L	3500-Na.B
		Potassium (K)	1.77 mg/L	3500-K.B
		Calcium (Ca)	41.1 mg/L	3111.B
		Magnesium (Mg)	17.1 mg/L	3111.B
		Temperature	27.2 ⁰ C	2550.B
		BOD	Less than 0.2 mg/L	5210.B
		COD	Less than 2mg/L.	5220.B
		Ammonium(NH ₄)	0.82 mg/L	3500.B

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10017	Water(B.H.-15 Chittagong)	pH at 25.8 ⁰ C	6.88	4500-H ⁺ .B
		E. Conductivity	361μ S/cm	2510.B
		Lead (Pb)	Less than 0.01mg/L	3113.B
		Cadmium (Cd)	Less than 0.001mg/L	3113.B
		Chromium (Cr)	0.015 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	0.36 mg/L	3111.B
		Mercury (Hg)	Less than 0.001mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	Less than 1 mg/L	4110.B
		Bromide (Br)	Less than 1mg/L	4110.B
		Nitrite (NO ₂)	Less than 1mg/L	4110.B
		Nitrate (NO ₃)	Less than 3mg/L	4110.B
		Sulphate (SO ₄)	15.2 mg/L	4110.B

		Sodium (Na)	27.2 mg/L	3500-Na.B
		Potassium (K)	2.17 mg/L	3500-K.B
		Calcium (Ca)	41.6 mg/L	3111.B
		Magnesium (Mg)	16.3 mg/L	3111.B
		Temperature	27.2 ⁰ C	2550.B
		BOD	Less than 0.2 mg/L	5210.B
		COD	Less than 2mg/L.	5220.B
		Ammonium(NH ₄)	0.81 mg/L	3500.B

2. 3.2 Surface water samples

a. 3.2.1 Way of sampling

No surface water sample was collected for testing.

b. 3.2.2 Analysis

Not Applicable

c. 3.2.3 Results

Not applicable

3. 3.3 Soils samples

a. 3.3.1 Way of sampling

Soil sampling was done by driving a 1.5" inch diameter GI pipe with attachment for collection of soil sample at the driving end of the pipe. While driving the pipe into the ground, soil enters into the attachment through the tip of the pipe. When the pipe with its attachment reaches the desired depth the pipe is withdrawn and soil entered into the attachment is collected in polythene bags and sealed for handing over to the laboratory.

Soil samples were collected from three bore holes (Bore Hole Number 1, 3 & 9). Soil samples each weighing 500gms were collected at 1.5ft intervals and one sample from each bore hole was sent to laboratory for analysis. The soil samples tested in the laboratory for bore hole number 01, 03 & 09 were from depths 10.5ft, 12ft & 15ft respectively. Please note that the soil sample tested in the laboratory for borehole number 09 sample number D-1 was from a depth of 15ft, by mistake it was shown in the test report sheet to be 1.5ft.

b. 3.3.2 Analysis

Testing of the soil samples were done in Bangladesh Council of Scientific and Industrial Research (BCSIR) Laboratory in Dhaka. Test method code has been mentioned in the original report sheet.

c. 3.3.3 Results

Analytical Result

Sample ID			Results								
Bore Hole No.	Sample No.	Depth (ft)	pH	Clay Content	Organic Matter	Lead (Pb)	Cadmium (Cd)	Chromium (Cr)	Arsenic (As)	Iron (Ir)	Mercury (Hg)
03	D-08	12.00'	8.65	21.36%	0.24%	2.29 ppm	0.051 ppm	11.71 ppm	2.25 ppm	0.150%	BDL
09	D-01	15.00'	7.24	16.12%	0.46%	BDL	0.030 ppm	7.36 ppm	1.26 ppm	0.143%	BDL
01	D-7	10.50	6.14	25.01%	0.34%	BDL	0.032 ppm	14.01 ppm	0.95 ppm	0.141%	BDL

BDL= below detection level

Methodology:

- (1) pH: pH meter, (2) Clay content: Hydrometer method, (3) Organic Matter: Wet oxidation method, (4) Pb, Cd & Cr: Atomic Absorption Spectrophotometer, (5) As: Atomic Absorption Spectrophotometer with HVG, (6) Hg: Atomic Absorption Spectrophotometer with MVU,

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Lab ID	Particulars of Supplied Sample	Name of Parameters		Concentration
A-10025	Soil Well No: 09 Sample No.D-1 Depth:1.5' Arif Nagar Chittagong	Polycyclic	Acenaphthylene	Not detectable
		Aromatic	Anthracene	Not detectable
		Hydrocarbons (PAHs)	Benzo(A) Anthracene	Not detectable
			Benzo(A)Pyrene	Not detectable
			Benzo (B)Fluoranthene	Not detectable
			Benzo (G,H,I)Perylene	Not detectable
			Benzo (K)Fluoranthene	Not detectable
			Chrysene	Not detectable
			Dibenz(A,H) Anthracene	Not detectable
			Fluorene	Not detectable
			Indeno (1,2,3-CD)Pyrene	Not detectable
			Phenanthrene	Not detectable
			Pyrene	Not detectable
A-10025	Soil Well No: 09 Sample No.D-1	Poy	2,2',3,4,4',5,5'-Heptachlorobiphenyl	Not detectable
		Chlorobiphenyl (PCB)	2,2',3,4,4',5'-Hexachlorobiphenyl	Not detectable

	Depth:1.5' Arif Nagar Chittagong		2,2',4,4',5,5'-Hexachlorobiphenyl	Not detectable
			2,2',5,5'-Tetrachlorobiphenyl	Not detectable
			2,4,4'-Trychlorobiphenyl	Not detectable
			2,6-Dichlorobiphenyl	Not detectable
A-10025	Soil Well No: 09 Sample No.D-1 Depth:1.5' Arif Nagar Chittagong	Volatile	Chlorobenzene	Not detectable
		Organic Compounds (VOC)	<i>CIS-1,2-Dichloroethylene</i>	Not detectable
			Ethylbenzene	Not detectable
			O-Xylene	Not detectable
			P-Xylene	Not detectable
			Styrene	Not detectable
			Tetrachloroethene	Not detectable
			Toluene	Not detectable
			Trans-1,2-Dichloroethylene	Not detectable
			1,2-Dichlorobenzene	Not detectable
			1,2-Dichloropropane	Not detectable

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Laboratory test report of Soil Samples (Ctg)

Lab ID	Particulars of Supplied Sample	Name of Parameters		Concentration
A-10026	Soil Well No: 01 Sample No.D-07 Depth:10.5' Arif Nagar Chittagong	Polycyclic Aromatic Hydrocarbons (PAHs)	Acenaphthylene	Not detectable
			Anthracene	Not detectable
			Benzo(A) Anthracene	Not detectable
			Benzo(A)Pyrene	Not detectable
			Benzo (B)Fluoranthene	Not detectable
			Benzo (G,H,I)Perylene	Not detectable
			Benzo (K)Fluoranthene	Not detectable
			Chrysene	Not detectable
			Dibenz(A,H) Anthracene	Not detectable
			Fluorene	Not detectable
			Indeno (1,2,3-CD)Pyrene	Not detectable
			Phenanthrene	Not detectable
			Pyrene	Not detectable
A-10026	Soil Well No: 01 Sample No.D-07 Depth:10.5' Arif Nagar Chittagong	Poy Chlorobiphenyl (PCB)	2,2',3,4,4',5,5'- Heptachlorobiphenyl	Not detectable
			2,2',3,4,4',5'- Hexachlorobiphenyl	Not detectable
			2,2',4,4',5,5'- Hexachlorobiphenyl	Not detectable
			2,2',5,5'- Tetrachlorobiphenyl	Not detectable
			2,4,4'-Trychlorobiphenyl	Not detectable
			2,6-Dichlorobiphenyl	Not detectable

A-10026	Soil Well No: 01 Sample No.D-07 Depth:10.5' Arif Nagar Chittagong	Volatile	Chlorobenzene	Not detectable
		Organic	<i>CIS-1,2-Dichloroethylene</i>	Not detectable
		Compounds	Ethylbenzene	Not detectable
		(VOC)	O-Xylene	Not detectable
			P-Xylene	Not detectable
			Styrene	Not detectable
			Tetrachloroethene	Not detectable
			Toluene	Not detectable
			Trans-1,2-Dichloroethylene	Not detectable
			1,2-Dichlorobenzene	Not detectable
			1,2-Dichloropropane	Not detectable

Contamination Pathway Study

Laboratory test report of Soil Samples (Ctg)

Lab ID	Particulars of Supplied Sample	Name of Parameters		Concentration
A-10027	Soil Well No: 03 Sample No.D-08 Depth:12.0' Arif Nagar Chittagong	Polycyclic Aromatic Hydrocarbons (PAHs)	Acenaphthylene	Not detectable
			Anthracene	Not detectable
			Benzo(A) Anthracene	Not detectable
			Benzo(A)Pyrene	Not detectable
			Benzo (B)Fluoranthene	Not detectable
			Benzo (G,H,I)Perylene	Not detectable
			Benzo (K)Fluoranthene	Not detectable
			Chrysene	Not detectable
			Dibenz(A,H) Anthracene	Not detectable
			Fluorene	Not detectable
			Indeno (1,2,3-CD)Pyrene	Not detectable
			Phenanthrene	Not detectable
			Pyrene	Not detectable
A-10027	Soil Well No: 03 Sample No.D-08 Depth:12.0' Arif Nagar Chittagong	Poy Chlorobiphenyl (PCB)	2,2',3,4,4',5,5'-Heptachlorobiphenyl	Not detectable
			2,2',3,4,4',5'-Hexachlorobiphenyl	Not detectable
			2,2',4,4',5,5'-Hexachlorobiphenyl	Not detectable
			2,2',5,5'-Tetrachlorobiphenyl	Not detectable
			2,4,4'-Trychlorobiphenyl	Not detectable
			2,6-Dichlorobiphenyl	Not detectable
A-10027	Soil	Volatile	Chlorobenzene	Not detectable

	Well No: 03 Sample No.D-08 Depth:12.0' Arif Nagar Chittagong	Organic Compounds (VOC)	<i>CIS-1,2-Dichloroethylene</i>	Not detectable
			Ethylbenzene	Not detectable
			O-Xylene	Not detectable
			P-Xylene	Not detectable
			Styrene	Not detectable
			Tetrachloroethene	Not detectable
			Toluene	Not detectable
			Trans-1,2-Dichloroethylene	Not detectable
			1,2-Dichlorobenzene	Not detectable
			1,2-Dichloropropane	Not detectable

Table 2: Soil sample No.D-07 (Borehole number 01)

Depth of sample	Description
0-1.5ft	Brown Fine Sand
1.5 – 3 ft	Brown Fine Sand
3 - 4.5ft	Brown Fine Sand
4.5 – 6 ft	Brown Fine Sand
6 - 7.5ft	Brown Fine Sand
7.5 – 9 ft	Brown Fine Sand
9 -10.5ft	Brown Fine Sand

10.5 -12 ft	Brown Fine Sand
12 – 13.5 ft	Gray Consolidated Clay
13.5 – 15 ft	Gray Consolidated Clay

Table 3: Soil sample No.D-08 (Borehole number 03)

Depth of sample	Description
0 - 1.5ft	Fine Sand
1.5 – 3 ft	Fine Sand
3 - 4.5ft	Silt & Fine Sand
4.5 – 6 ft	Silt & Fine Sand
6 - 7.5ft	Silt & Fine Sand
7.5 – 9 ft	Silt & Fine Sand
9 -10.5ft	Brown to Gray Clay
10.5 – 12 ft	Brown to Gray Clay
12 -13.5ft	Silt & Fine Sand

13.5 – 15 ft	Silt & Fine Sand
---------------------	-----------------------------

Table 4: Soil sample No.D-1 (Borehole number 09)

Depth of sample Description	
0 - 1.5ft	Brown Sand
1.5 – 3 ft	Brown Sand
3 - 4.5ft	Brown Silty Clay
4.5 – 6 ft	Brown Silty Clay
6 - 7.5ft	Sandy Clay
7.5 – 9 ft	Sandy Clay
9 -10.5ft	Sandy Clay
10.5 – 12 ft	Sandy Clay
12 -13.5ft	Gray Sandy Clay
13.5 – 15 ft	Gray Sandy Clay

4. 3.4 Waste Characterization

a. 3.4.1 Way of analysis

Selection of sampling point: For ease of identification of different types of waste the city generates day to day, preliminarily locations are identified where the waste stream is deposited. At the entrance of the site , trucks carrying the wastes are unloaded and pushed forward by mechanical means. So to have representative sample of waste this area has been selected.

Collection of sample: For the purpose of characterization of waste three spots were chosen from the entry point of the waste dumping site at a distance of about one hundred feet apart from each other. The location of the collection spot has been shown on the site plan by a mark C-1(Sample-1), C-2 (Sample-2) and C-3 (Sample-3).

Waste samples weighing about 10 to 15kg roughly was collected in polythene bags from each of the spots. It was then segregated for the items mentioned in the table and put in polythene bags and weighed for each item individually on the spot.

b. 3.4.2 Results

Waste Characterization							
Arefin Nagar							
Chittagong City Corporation							
Sample collection date: 15 June 2013							
Waste Fractions	Sample 1		Sample 2		Sample 3		Remarks
	Wt.(kg)	Percentage %	Wt.(kg)	Percentage %	Wt.(kg)	Percentage %	
Paper	0.650	6.152	1.650	10.390	0.750	5.396	
Glass	-	-	0.090	0.567	-	-	
Metal	-	-	-	-	-	-	
Plastic	0.550	5.206	1.770	11.146	1.490	10.719	
Organic Materials (food, green waste etc.)	9.000	85.187	12.050	75.882	11.010	79.209	
Textiles	0.225	2.130	0.290	1.826	0.650	4.676	
Construction waste(concrete, bricks etc)	0.100	0.947	-	-	-	-	
Hazardous household waste	-	-	0.030	0.189	-	-	
(paints, oil and fats, batteries, electronics, etc)							
Other fractions	0.040	0.379	-	-	-	-	
Total (kg)	10.565	100.000	15.880	100.000	13.900	100.000	
Samples were collected from three points as shown on the site plan. It was then segregated and weighed. Sampling was done on 15 th June 2013.							

B. 5. Conclusions and recommendations

It has been considered remarkable that the analyzed samples show no degree of pollution since they were collected for a polluted environment. Therefore the results discussed in these report only provide a very basic analysis on the contamination level of the dumpsite. The reason is likely the questionable way of transportation, preservation and the time between sample taking and analysis. As such following concerns have been raised by the second opinion analysis done in the Belgian laboratory:

- During the sample taking: no preservatives were added so following parameters could not be determined: Cyanide, phenol index, mineral oils, volatile combinations.
- During the sample taking: no metals could be determined due to fact that the sample has not been filtrated and acidified;
- During the sample taking: bottles were not filled out completely so determinations of volatile combinations were impossible;
- The preservation term for following parameters has been expired, so following parameters could not be determined: Ammonia, Phenol index, cyanides, Ortho-phosphate, volatiles preparation, COD, Chloride, Fluoride, Sulphate, Nitrite, Nitrate;
- Unknown method of transportation and preservation: Samples have not been stored in dark cooled places, which have an effect on the value of certain parameters.

It may be assumed that pollution is present or shall be present if no extra measurements are taken in the design of a controlled landfill. To minimize the negative effects of pollutants originating from the dumped household waste on the environment, the health of nearby inhabitants and on the quality and quantity of surrounding agricultural lands, at least the following measurements should be taken:

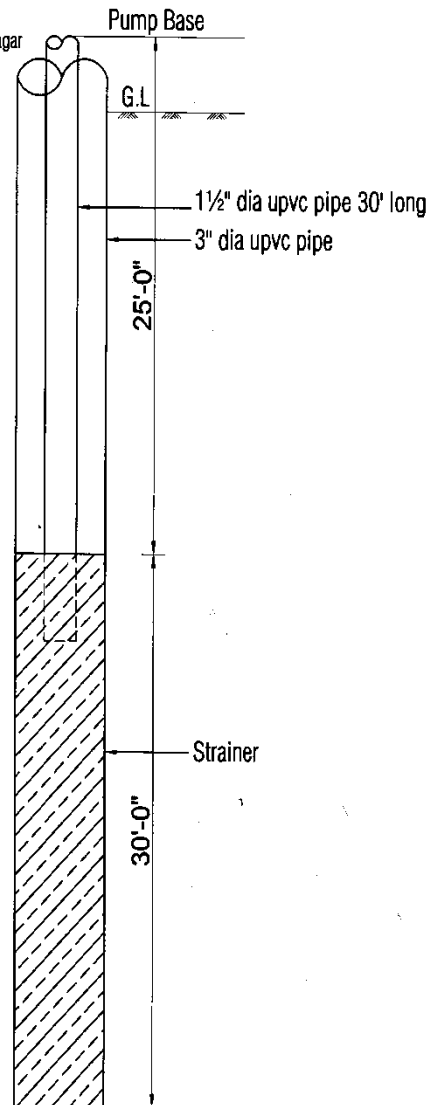
- Physical separation between the pollution and the environment;
- Draining and treatment of the polluted groundwater;
- Leachate reducing measurements (covering of waste, draining leachate, etc.);

During the design of the controlled landfill these recommendations will be taken into account.

BORE LOG OF OBSERVATION WELL

Project: Contamination Pathway Study, UPEHSDP
Location: Landfill Site of Chittagong City Corporation at Arefin Nagar
Borehole No.1

Depth in ft	Bore Log
0-3'	BFS
3'-6'	BFS
6'-9'	BFS
9'-12'	BFS
12'-15'	BFS
15'-18'	GCC
18'-21'	BFS
21'-24'	BFS
24'-27'	CCB
27'-30'	CCB
30'-33'	CCB
33'-36'	CCB
36'-39'	CCB
39'-42'	HRC
42'-45'	HRC
45'-48'	CCB
48'-51'	CCB
51'-54'	BFS
54'-57'	BFS
57'-60'	BFS



Note=Not To Scale
Pump Base 1'-0" Above G.L.

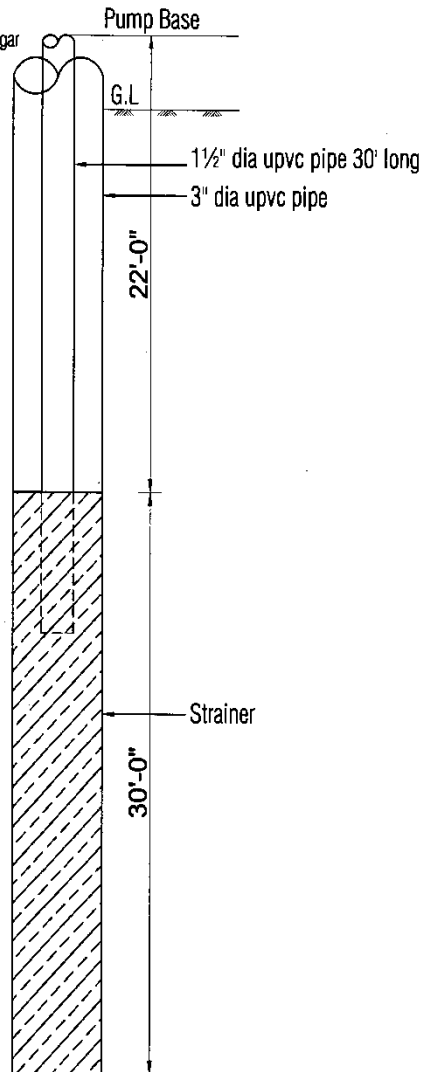
Legend:-

BFS=Brown Fine Sand
GCC=Green Consolidate Clay
CCB=Consolidate caly Brown
HRC= Hard rock Clay
CCB=Consolidate Clay Brown

BORE LOG OF OBSERVATION WELL

Project: Contamination Pathway Study , UPEHSDP
Location: Landfill Site of Chittagong City Corporation at Arefin Nagar
Borehole No.2

G.L	Depth in ft	Bore Log
	0-3'	BSC
	3'-6'	BSC
	6'-9'	BSC
	9'-12'	BC
	12'-15'	BC
	15'-18'	BC
	18'-21'	GBC
	21'-24'	GSS
	24'-27'	GSS
	27'-30'	SC
	30'-33'	SC
	33'-36'	SCG
	36'-39'	BFS
	39'-42'	BFS
	42'-45'	BFS
	45'-48'	BSC
	48'-51'	BSC
	51'-54'	SS
	54'-57'	SS
	57'-60'	BFS



Legend:-

BSC=Brown Silty Clay
BC=Brown Clay
GBC=Gray Brown Clay
BFS=Brown Fine Sand
GSS=Gray Silty Sand
SC=Silty Clay
GSS=Gray Silty Sand
SCG=Silty Clay Gray

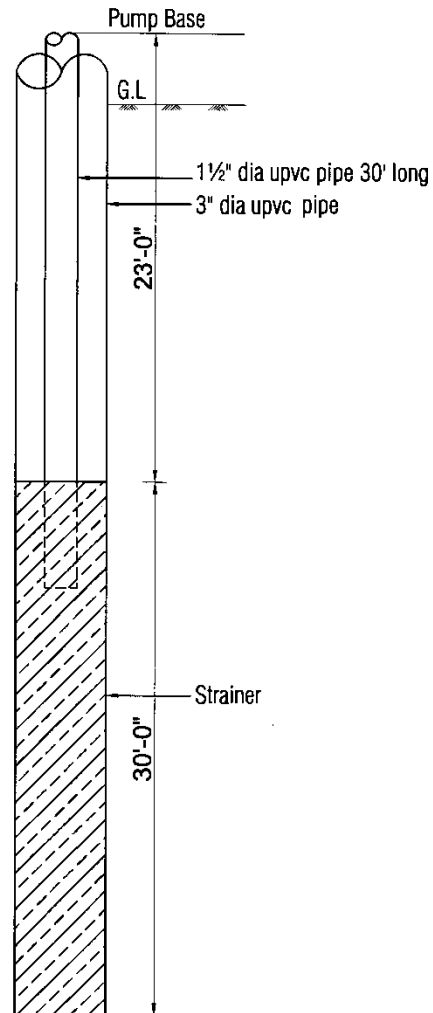
Note=Not To Scale

Pump Base 1'-0" Above G.L.

BORE LOG OF OBSERVATION WELL

Project: Contamination Pathway Study , UPEHSDP
Location: Site of Chittagong City Corporation at Arefin Nagar
Borehole No.3

Depth in ft	Bore Log	
0'-3'	FS	
3'-6'	FS	
6'-9'	SFS	
9'-12'	BFS	
12'-15'	GBC	
15'-18'	SFS	
18'-21'	GBC	
21'-24'	SC	
24'-27'	BSS	
27'-30'	BSS	
30'-33'	BFS	
33'-36'	BFS	
36'-39'	BFS	
39'-42'	BFS	
42'-45'	BSC	
45'-48'	BSC	
48'-51'	SS	
51'-54'	BFS	
54'-57'	BFS	
57'-60'	BFS	



Legend:-

FS= Fine Sand
SFS=Silty Fine Sand
SC=Silty Clay
BSS=Brown Silty Sand
BSC=Brown Silty Sand
BFS=Brown Fine Sand
SS=Silty Sand
GBC=Gray Brown Clay

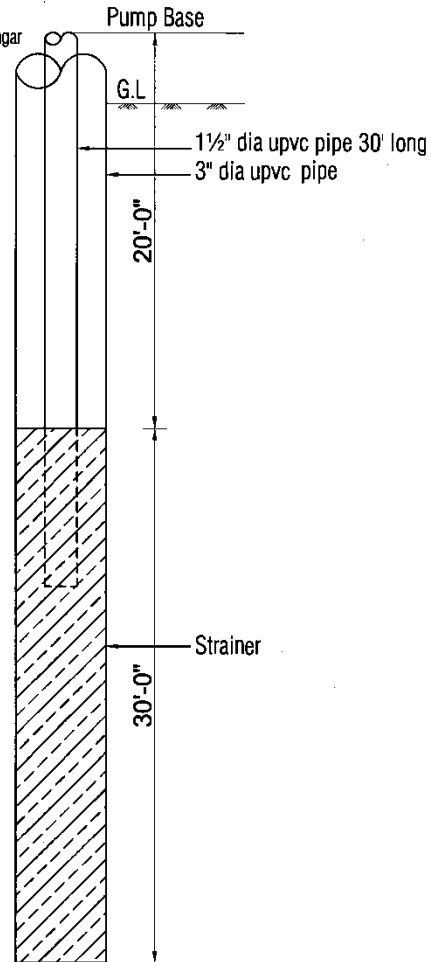
Note=Not To Scale

Pump Base 1'-0" Above G.L.

BORE LOG OF OBSERVATION WELL

Project: Contamination Pathway Study , UPEHSDP
Location: Landfill Site of Chittagong City Corporation at Arefin Nagar
Borehole No.4

G.L	Depth in ft	Bore Log
	0-3'	BC
	3'-6'	BSC
	6'-9'	GSC
	9'-12'	BSS
	12'-15'	BC
	15'-18'	BSC
	18'-21'	GBC
	21'-24'	GBC
	24'-27'	BSS
	27'-30'	SS
	30'-33'	BSS
	33'-36'	BFS
	36'-39'	BFS
	39'-42'	BFS
	42'-45'	HBC
	45'-48'	SC
	48'-51'	BFS
	51'-54'	BFS
	54'-57'	BFS
	57'-60'	BSS



Legend:-

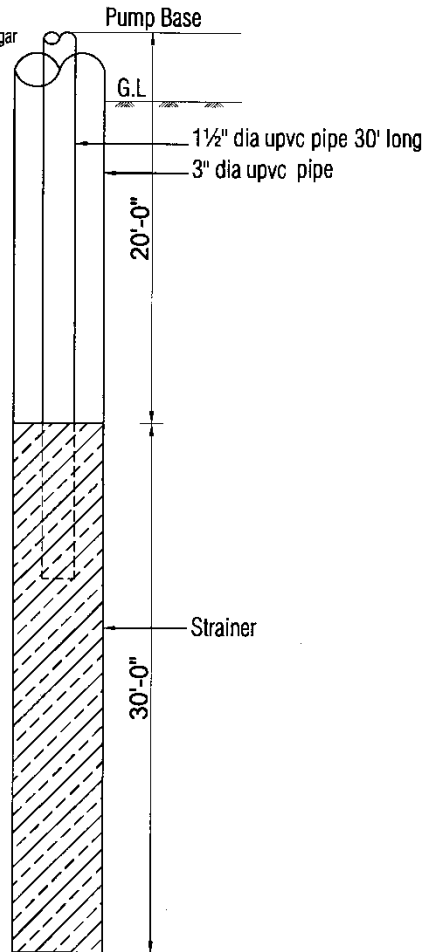
BC=Brown Clay
BSC=Brown Silty Clay
GSC=Gray Silty Clay
BSS=Brown Silty Sand
GBC=Gray Brown Clay
BFS= Brown Fine Sand
SC=Silty Clay
SS=Silty Sand
HBC=Hard Brown Clay

Note=Not To Scale
Pump Base 1'-0" Above G.L.

BORE LOG OF OBSERVATION WELL

Project: Contamination Pathway Study , UPEHSDP
Location: Landfill Site of Chittagong City Corporation at Arefin Nagar
Borehole No.5

G.L.	Depth in ft	Bore Log
	0-3'	GSC
	3'-6'	GSC
	6'-9'	GSC
	9'-12'	GSC
	12'-15'	GSC
	15'-18'	GSC
	18'-21'	GSC
	21'-24'	GSC
	24'-27'	GSC
	27'-30'	GC
	30'-33'	GBS
	33'-36'	BS
	36'-39'	GBC
	39'-42'	GBC
	42'-45'	FS
	45'-48'	BC
	48'-51'	FS
	51'-54'	FS
	54'-57'	FS
	57'-60'	FS



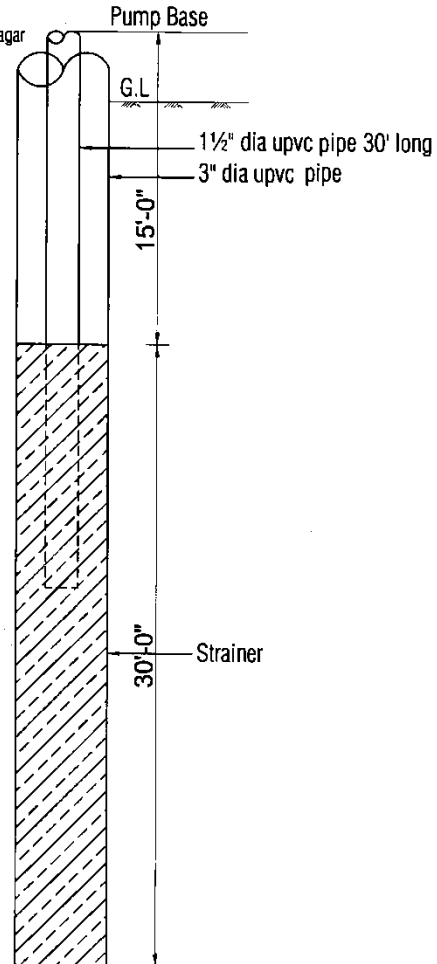
Note=Not To Scale
Pump Base 1'-0" Above G.L.

Legend:-
GSC=Gray Silty Sand
GC=Gray Clay
GBS= Gray Brown Sand
GBC=Gray Brown Clay
FS=Fine Sand
BC=Brown Clay
BS=Brown Sand

BORE LOG OF OBSERVATION WELL

Project: Contamination Pathway Study, UPEHSDP
Location: Landfill Site of Chittagong City Corporation at Arefin Nagar
Borehole No.6

G.L.	Depth in ft	Bore Log
	0-3'	BSC
	3'-6'	SGC
	6'-9'	BC
	9'-12'	BSC
	12'-15'	BSC
	15'-18'	BSC
	18'-21'	GSC
	21'-24'	BSC
	24'-27'	BC
	27'-30'	CBC
	30'-33'	BSC
	33'-36'	BC
	36'-39'	BSC
	39'-42'	BSC
	42'-45'	FS
	45'-48'	FS
	48'-51'	FS
	51'-54'	FS
	54'-57'	FS
	57'-60'	FS



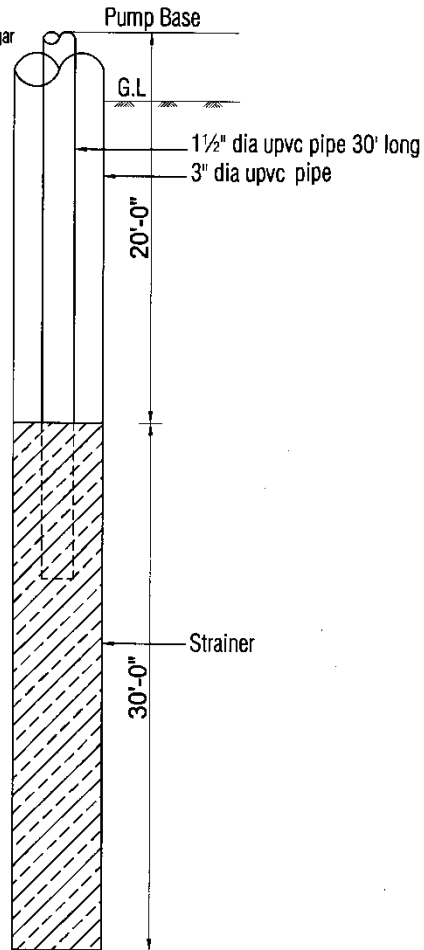
Legend:-
BSC=Brown Silty Clay
SGC=Silty Gray Clay
BC=Brown Clay
GSC=Gray Silty Clay
BC=Brown Clay
FS=Fine Sand

Note=Not To Scale
Pump Base 1'-0" Above G.L.

BORE LOG OF OBSERVATION WELL

Project: Contamination Pathway Study, UPEHSDP
Location: Landfill Site of Chittagong City Corporation at Arefin Nagar
Borehole No.7

G.L. Depth in ft	Bore Log	
0'-3'	BC	
3'-6'	BC	
6'-9'	BSC	
9'-12'	BC	
12'-15'	BC	
15'-18'	BSC	
18'-21'	GC	
21'-24'	BSC	
24'-27'	BC	
27'-30'	BC	
30'-33'	BC	
33'-36'	BGC	
36'-39'	BC	
39'-42'	BC	
42'-45'	BSC	
45'-48'	CC	
48'-51'	GCC	
51'-54'	GC	
54'-57'	GC	
57'-60'	GC	



Legend:-

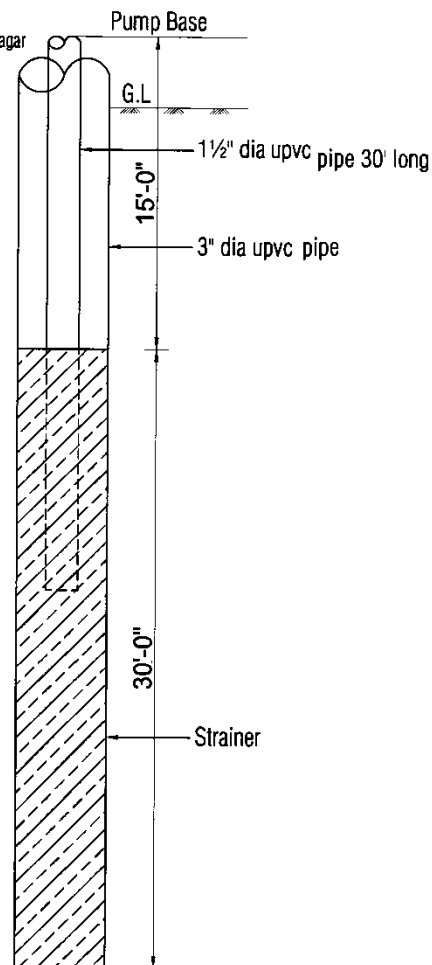
BC = Brown Clay
BSC = Brown Silty Clay
GC = Gray Clay
BGC = Brown Gray Clay
CC = Consolidated Clay
GCC = Gray Consolidated Clay

Note = Not To Scale
Pump Base 1'-0" Above G.L.

BORE LOG OF OBSERVATION WELL

Project: Contamination Pathway Study, UPEHSDP
Location: Landfill Site of Chittagong City Corporation at Arefin Nagar
Bore Hole No.8

G.L.	Depth in ft	Bore Log
	0-3'	GSC
	3'-6'	BSC
	6'-9'	GS
	9'-12'	BSC
	12'-15'	GFS
	15'-18'	GSC
	18'-21'	GSC
	21'-24'	BFS
	24'-27'	BSC
	27'-30'	GFS
	30'-33'	GC
	33'-36'	GSC
	36'-39'	GFS
	39'-42'	GSC
	42'-45'	BSC
	45'-48'	GSC
	48'-51'	BFS
	51'-54'	GSC
	54'-57'	GC
	57'-60'	GC



Legend:-

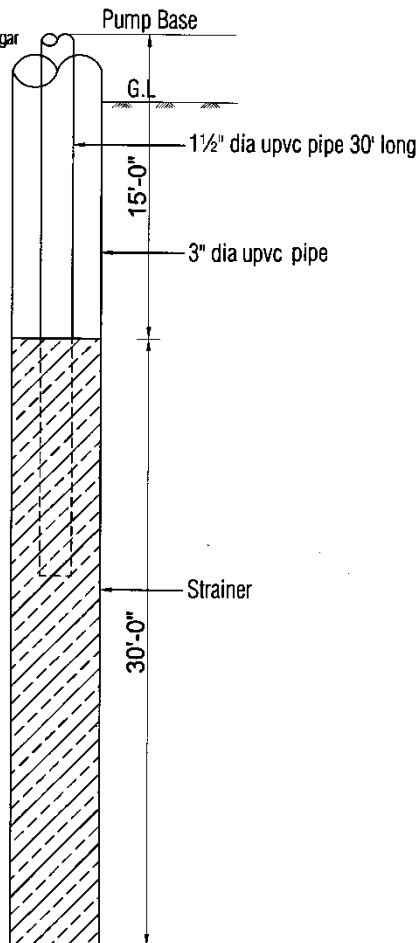
GSC=Gray Silty Clay
GBSC=Gray Brown Silty Clay
GS=Gray Sand
BSC=Brown Silty Clay
GFS=Gray Fine Sand
GSC=Gray Sandy Clay
BFS=Brown Fine Sand
GSC=Gray Sandy Clay
GC=Gray Clay

Note=Not To Scale
Pump Base 1'-0" Above G.L.

BORE LOG OF OBSERVATION WELL

Project: Contamination Pathway Study, UPEHSDP
Location: Landfill Site of Chittagong City Corporation at Arefin Nagar
Borehole No.9

Depth in ft	Bore Log	
0-3'	BS	
3'-6'	BS	
6'-9'	BSC	
9'-12'	SC	
12'-15'	GSC	
15'-18'	GSC	
18'-21'	SC	
21'-24'	GSC	
24'-27'	BSC	
27'-30'	GSC	
30'-33'	GSS	
33'-36'	GSC	
36'-39'	GFS	
39'-42'	GFS	
42'-45'	GFS	
45'-48'	GFS	
48'-51'	GFS	
51'-54'	GS	
54'-57'	GSC	
57'-60'	GFS	



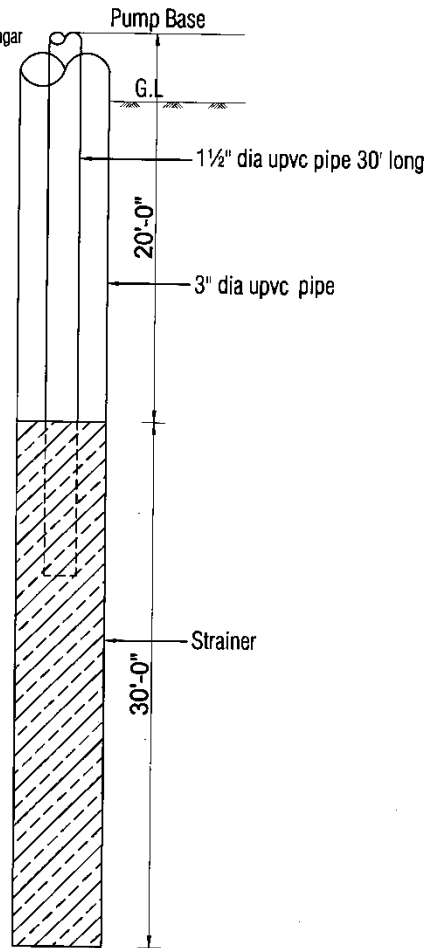
Legend:-
BS=Brown Sand
BSC=Brown Sandy Clay
SC=Sandy Clay
GSC=Gray Sandy Clay
GSS=Gray Silty Sand
GFS=Gray Fine Sand
GS=Gray Sand
GFS=Gray Fine Sand

Note=Not To Scale
Pump Base 1'-0" Above G.L.

BORE LOG OF OBSERVATION WELL

Project: Contamination Pathway Study , UPEHSDP
Location: Landfill Site of Chittagong City Corporation at Arefin Nagar
Borehole No.10

G.L. Depth in ft	Bore Log	
0-3'	BC	
3'-6'	BSC	
6'-9'	BSC	
9'-12'	BFS	
12'-15'	BFS	
15'-18'	SS	
18'-21'	BSS	
21'-24'	BSC	
24'-27'	BFS	
27'-30'	BFS	
30'-33'	BFS	
33'-36'	BFS	
36'-39'	BFS	
39'-42'	BFS	
42'-45'	BFS	
45'-48'	BFS	
48'-51'	BFS	
51'-54'	BFS	
54'-57'	BFS	
57'-60'	BFS	



Legend:-
BFS= Brown Fine Sand
SS = Silty Sand
BC=Brown Clay
BSC=Brown Silty Clay
BSS=Brown Silty Sand

Note=Not To Scale
Pump Base 1'-0" Above G.L.

i. Annex 2: Laboratory Test Reports

জীবনের জন্য বিজ্ঞান



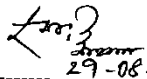
বিসিএসআইআর গবেষণাগার, ঢাকা
BCSIR LABORATORIES, DHAKA
বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ

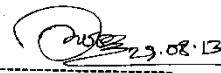
BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

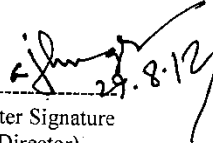
Forwarding of Analysis Report

Ref No: i) 575 of BCSIR Lab. Dhaka dt. 15/07/2013
ii) D-1386 of Analytical Service Cell, BCSIR.15/07/2013

Attachment: Please find the analysis report as an attachment (page-1 of 22).


29-08-2013
Sig, and Name of the Validator
Md. Aminul Ahsan
Principal Scientific Officer
Analytical Research Division
BCSIR Laboratories, Dhaka


29.08.13
Counter Signature
(Research Coordinator)
Dr. Parvin Noor
Research Co-ordinator
BCSIR Dhaka.


29.8.13
Counter Signature
(Director)
MD. ABU ANIS JAHANGIR
Director
BCSIR Laboratories
Dhaka-1205



বিসিএসআইআর গবেষণাগার, ঢাকা
BCSIR LABORATORIES, DHAKA
বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ

Certificate No:T-1676

BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ANALYSIS REPORT

Ref. No. : i) 575 of BCSIR Lab. Dhaka dt. 15/07/2013
ii) D-1386 of Analytical Service Cell, BCSIR. 15/07/2013

Lab ID : A-10004 to A-10029

Name and address of Customer : Md. Akhtaruzzaman
Development Design Consultants Ltd.
47 Mohakhali C/A, Dhaka-1212.

Work order details : নমুনা পরীক্ষণের জন্য আবেদন, তারিখ : ১৯/০৬/২০১৩

Type of sample* : Water

Quantity of sample : 1.5 Litre (21 bottle)

Packing and marking : Plastic bottle

Date of receipt : 16/07/2013

Period of analysis : 16/07/2013 to 27/08/2013

Visual observation/Remarks : Colourless

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10004	Water (B. H. No-1, Chittagong)	pH at 25.2°C	6.16	4500-H ⁺ .B
		E. Conductivity	165 µS/cm	2510.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Chromium (Cr)	0.036 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	6.24 mg/L	3111.B
		Mercury (Hg)	Less than 0.001 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B

Page 1 of 22

*The results relate only to the items tested.

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Certificate No:T-1676

BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10004	Water (B. H. No-1, Chittagong)	Chloride (Cl)	3.49 mg/L	4110.B
		Bromide (Br)	Less than 1 mg/L	4110.B
		Nitrite (NO ₂)	Less than 1 mg/L	4110.B
		Nitrate (NO ₃)	Less than 3 mg/L	4110.B
		Sulphate (SO ₄)	Less than 4 mg/L	4110.B
		Sodium (Na)	8.6 mg/L	3500-Na.B
		Potassium (K)	2.29 mg/L	3500-K.B
		Calcium (Ca)	10.5 mg/L	3111.B
		Magnesium (Mg)	13.9 mg/L	3111.B

[Signature]

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10005	Water (B. H. No-2, Chittagong)	pH at 25.5°C	6.21	4500-H ⁺ .B
		E. Conductivity	454 µS/cm	2510.B
		Lead (Pb)	0.028 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Chromium (Cr)	0.030 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	13.6 mg/L	3111.B
		Mercury (Hg)	0.001 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	56.3 mg/L	4110.B
		Bromide (Br)	Less than 1 mg/L	4110.B
		Nitrite (NO ₂)	Less than 1 mg/L	4110.B
		Nitrate (NO ₃)	35.6 mg/L	4110.B
		Sulphate (SO ₄)	Less than 4 mg/L	4110.B
		Sodium (Na)	13.6 mg/L	3500-Na.B
		Potassium (K)	10.4 mg/L	3500-K.B
		Calcium (Ca)	34.6 mg/L	3111.B
		Magnesium (Mg)	33.8 mg/L	3111.B

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10006	Water (B. H. No-3, Chittagong)	pH at 25.6°C	6.52	4500-H ⁺ .B
		E. Conductivity	235 µS/cm	2510.B
		Lead (Pb)	0.067 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Chromium (Cr)	0.012 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	29.6 mg/L	3111.B
		Mercury (Hg)	0.001 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	23.7 mg/L	4110.B
		Bromide (Br)	Less than 1 mg/L	4110.B
		Nitrite (NO ₂)	Less than 1 mg/L	4110.B
		Nitrate (NO ₃)	Less than 3 mg/L	4110.B
		Sulphate (SO ₄)	Less than 4 mg/L	4110.B
		Sodium (Na)	11.5 mg/L	3500-Na.B
		Potassium (K)	2.86 mg/L	3500-K.B
		Calcium (Ca)	15.6 mg/L	3111.B
		Magnesium (Mg)	19.6 mg/L	3111.B

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10007	Water (B. H. No-4, Chittagong)	pH at 25.7°C	6.45	4500-H ⁺ .B
		E. Conductivity	392 µS/cm	2510.B
		Lead (Pb)	0.30 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Chromium (Cr)	0.026 mg/L	3113.B
		Arsenic (As)	0.019 mg/L	3114.C
		Iron (Fe)	53.2 mg/L	3111.B
		Mercury (Hg)	0.001 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	32.6 mg/L	4110.B
		Bromide (Br)	Less than 1 mg/L	4110.B
		Nitrite (NO ₂)	Less than 1 mg/L	4110.B
		Nitrate (NO ₃)	Less than 3 mg/L	4110.B
		Sulphate (SO ₄)	Less than 4 mg/L	4110.B
		Sodium (Na)	16.3 mg/L	3500-Na.B
		Potassium (K)	2.91 mg/L	3500-K.B
		Calcium (Ca)	20.2 mg/L	3111.B
		Magnesium (Mg)	82.8 mg/L	3111.B

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10008	Water (B. H. No-5, Chittagong)	pH at 25.8°C	7.01	4500-H ⁺ .B
		E. Conductivity	633 µS/cm	2510.B
		Lead (Pb)	1.79 mg/L	3113.B
		Cadmium (Cd)	0.002 mg/L	3113.B
		Chromium (Cr)	0.014 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	97.9 mg/L	3111.B
		Mercury (Hg)	0.001 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	73.9 mg/L	4110.B
		Bromide (Br)	Less than 1 mg/L	4110.B
		Nitrite (NO ₂)	Less than 1 mg/L	4110.B
		Nitrate (NO ₃)	Less than 3 mg/L	4110.B
		Sulphate (SO ₄)	Less than 4 mg/L	4110.B
		Sodium (Na)	24.3 mg/L	3500-Na.B
		Potassium (K)	5.08 mg/L	3500-K.B
		Calcium (Ca)	69.1 mg/L	3111.B
		Magnesium (Mg)	22.1 mg/L	3111.B

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10009	Water (B. H. No-6, Chittagong)	pH at 26.0°C	6.46	4500-H ⁺ .B
		E. Conductivity	607 µS/cm	2510.B
		Lead (Pb)	0.73 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Chromium (Cr)	0.022 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	85.2 mg/L	3111.B
		Mercury (Hg)	0.002 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	71.8 mg/L	4110.B
		Bromide (Br)	Less than 1 mg/L	4110.B
		Nitrite (NO ₂)	Less than 1 mg/L	4110.B
		Nitrate (NO ₃)	Less than 3 mg/L	4110.B
		Sulphate (SO ₄)	Less than 4 mg/L	4110.B
		Sodium (Na)	28.3 mg/L	3500-Na.B
		Potassium (K)	7.91 mg/L	3500-K.B
		Calcium (Ca)	42.5 mg/L	3111.B
		Magnesium (Mg)	16.1 mg/L	3111.B

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10010	Water (B. H. No-7, Chittagong)	pH at 26.1°C	6.56	4500-H ⁺ .B
		E. Conductivity	393 µS/cm	2510.B
		Lead (Pb)	0.29 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Chromium (Cr)	0.015 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	60.7 mg/L	3111.B
		Mercury (Hg)	Less than 0.001 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	19.4 mg/L	4110.B
		Bromide (Br)	Less than 1 mg/L	4110.B
		Nitrite (NO ₂)	Less than 1 mg/L	4110.B
		Nitrate (NO ₃)	Less than 3 mg/L	4110.B
		Sulphate (SO ₄)	Less than 4 mg/L	4110.B
		Sodium (Na)	15.6 mg/L	3500-Na.B
		Potassium (K)	3.46 mg/L	3500-K.B
		Calcium (Ca)	38.2 mg/L	3111.B
		Magnesium (Mg)	17.4 mg/L	3111.B

[Signature]

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10011	Water (B. H. No-8, Chittagong)	pH at 24.9°C	6.35	4500-H ⁺ .B
		E. Conductivity	509 µS/cm	2510.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Chromium (Cr)	0.012 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	9.14 mg/L	3111.B
		Mercury (Hg)	Less than 0.001 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	78.7 mg/L	4110.B
		Bromide (Br)	Less than 1 mg/L	4110.B
		Nitrite (NO ₂)	Less than 1 mg/L	4110.B
		Nitrate (NO ₃)	Less than 3 mg/L	4110.B
		Sulphate (SO ₄)	Less than 4 mg/L	4110.B
		Sodium (Na)	25.9 mg/L	3500-Na.B
		Potassium (K)	2.91 mg/L	3500-K.B
		Calcium (Ca)	20.9 mg/L	3111.B
		Magnesium (Mg)	39.4 mg/L	3111.B

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10012	Water (B. H. No-9, Chittagong)	pH at 25.5°C	6.66	4500-H ⁺ .B
		E. Conductivity	692 µS/cm	2510.B
		Lead (Pb)	0.04 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Chromium (Cr)	0.017 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	18.8 mg/L	3111.B
		Mercury (Hg)	Less than 0.001 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	71.4 mg/L	4110.B
		Bromide (Br)	Less than 1 mg/L	4110.B
		Nitrite (NO ₂)	Less than 1 mg/L	4110.B
		Nitrate (NO ₃)	29.2 mg/L	4110.B
		Sulphate (SO ₄)	24.8 mg/L	4110.B
		Sodium (Na)	61.4 mg/L	3500-Na.B
		Potassium (K)	6.87 mg/L	3500-K.B
		Calcium (Ca)	43.5 mg/L	3111.B
		Magnesium (Mg)	38.3 mg/L	3111.B

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10013	Water (B. H. No-11, Chittagong)	pH at 26.0°C	7.07	4500-H ⁺ .B
		E. Conductivity	359 µS/cm	2510.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Chromium (Cr)	0.009 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	0.86 mg/L	3111.B
		Mercury (Hg)	Less than 0.005 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	Less than 1 mg/L	4110.B
		Bromide (Br)	Less than 1 mg/L	4110.B
		Nitrite (NO ₂)	Less than 1 mg/L	4110.B
		Nitrate (NO ₃)	Less than 3 mg/L	4110.B
		Sulphate (SO ₄)	10.2 mg/L	4110.B
		Sodium (Na)	16.8 mg/L	3500-Na.B
		Potassium (K)	1.98 mg/L	3500-K.B
		Calcium (Ca)	28.4 mg/L	3111.B
		Magnesium (Mg)	24.9 mg/L	3111.B

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10014	Water (B. H. No-12, Chittagong)	pH at 25.8°C	7.26	4500-H ⁺ .B
		E. Conductivity	172 µS/cm	2510.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Chromium (Cr)	0.006 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	1.89 mg/L	3111.B
		Mercury (Hg)	0.001 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	5.48 mg/L	4110.B
		Bromide (Br)	Less than 1 mg/L	4110.B
		Nitrite (NO ₂)	Less than 1 mg/L	4110.B
		Nitrate (NO ₃)	Less than 3 mg/L	4110.B
		Sulphate (SO ₄)	8.06 mg/L	4110.B
		Sodium (Na)	13.8 mg/L	3500-Na.B
		Potassium (K)	2.09 mg/L	3500-K.B
		Calcium (Ca)	11.0 mg/L	3111.B
		Magnesium (Mg)	10.4 mg/L	3111.B

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10015	Water (B. H. No-13, Chittagong)	pH at 25.6°C	6.81	4500-H ⁺ .B
		E. Conductivity	532 µS/cm	2510.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	0.001 mg/L	3113.B
		Chromium (Cr)	0.006 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	0.47 mg/L	3111.B
		Mercury (Hg)	Less than 0.001 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	29.4 mg/L	4110.B
		Bromide (Br)	Less than 1 mg/L	4110.B
		Nitrite (NO ₂)	Less than 1 mg/L	4110.B
		Nitrate (NO ₃)	Less than 3 mg/L	4110.B
		Sulphate (SO ₄)	38.9 mg/L	4110.B
		Sodium (Na)	18.5 mg/L	3500-Na.B
		Potassium (K)	4.67 mg/L	3500-K.B
		Calcium (Ca)	48.9 mg/L	3111.B
		Magnesium (Mg)	38.8 mg/L	3111.B

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*The results relate only to the items tested.

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BCSIR LABORATORIES, DHAKA
বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ

Certificate No: T-1676

BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10016	Water (B. H. No-14, Chittagong)	pH at 25.7°C	6.90	4500-H ⁺ .B
		E. Conductivity	306 µS/cm	2510.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Chromium (Cr)	0.006 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	0.62 mg/L	3111.B
		Mercury (Hg)	Less than 0.001 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	1.64 mg/L	4110.B
		Bromide (Br)	Less than 1 mg/L	4110.B
		Nitrite (NO ₂)	Less than 1 mg/L	4110.B
		Nitrate (NO ₃)	Less than 3 mg/L	4110.B
		Sulphate (SO ₄)	13.1 mg/L	4110.B
		Sodium (Na)	11.8 mg/L	3500-Na.B
		Potassium (K)	1.77 mg/L	3500-K.B
		Calcium (Ca)	41.1 mg/L	3111.B
		Magnesium (Mg)	17.1 mg/L	3111.B

*The results relate only to the items tested.

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Certificate No: T-1676

BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10017	Water (B. H. No-15, Chittagong)	pH at 25.8°C	6.88	4500-H ⁺ .B
		E. Conductivity	361 µS/cm	2510.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Chromium (Cr)	0.015 mg/L	3113.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
		Iron (Fe)	0.36 mg/L	3111.B
		Mercury (Hg)	Less than 0.001 mg/L	3112.B
		Fluoride (F)	Less than 0.5 mg/L	4110.B
		Chloride (Cl)	Less than 1 mg/L	4110.B
		Bromide (Br)	Less than 1 mg/L	4110.B
		Nitrite (NO ₂)	Less than 1 mg/L	4110.B
		Nitrate (NO ₃)	Less than 3 mg/L	4110.B
		Sulphate (SO ₄)	15.2 mg/L	4110.B
		Sodium (Na)	27.2 mg/L	3500-Na.B
		Potassium (K)	2.17 mg/L	3500-K.B
		Calcium (Ca)	41.6 mg/L	3111.B
		Magnesium (Mg)	16.3 mg/L	3111.B

*The results relate only to the items tested.

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BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ANALYSIS REPORT

Ref. No. : i) 575 of BCSIR Lab. Dhaka dt. 15/07/2013
ii) D-1386 of Analytical Service Cell, BCSIR. 15/07/2013

Lab ID : A-10004 to A-10029

Name and address of Customer : Md. Akhtaruzzaman
Development Design Consultants Ltd.
47 Mohakhali C/A, Dhaka-1212.

Work order details : নমুনা পরীক্ষণের জন্য আবেদন, তারিখ ১৯/০৬/২০১৩

Type of sample* : Water

Quantity of sample : 1.5 Litre (21 bottle)

Packing and marking : Plastic bottle

Date of receipt : 16/07/2013

Period of analysis : 16/07/2013 to 27/08/2013

Visual observation/Remarks : Colourless

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10004	Water (B. H. No-1, Chittagong)	Temperature	27.1 ⁰ C	2550.B
		BOD	0.64 mg/L	5210.B
		COD	Less than 2 mg/L	5220.B
		Ammonium (NH ₄)	1.05 mg/L	3500.B
A-10005	Water (B. H. No-2, Chittagong)	Temperature	27 ⁰ C	2550.B
		BOD	1.02 mg/L	5210.B
		COD	4.95 mg/L	5220.B
		Ammonium (NH ₄)	5.80 mg/L	3500.B

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*The results relate only to the items tested.

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10006	Water (B. H. No-3, Chittagong)	Temperature	27 ⁰ C	2550.B
		BOD	0.39 mg/L	5210.B
		COD	Less than 2 mg/L	5220.B
		Ammonium (NH ₄)	1.94 mg/L	3500.B
A-10007	Water (B. H. No-4, Chittagong)	Temperature	27.2 ⁰ C	2550.B
		BOD	0.98 mg/L	5210.B
		COD	2.97 mg/L	5220.B
		Ammonium (NH ₄)	3.93 mg/L	3500.B
A-10008	Water (B. H. No-5, Chittagong)	Temperature	27.1 ⁰ C	2550.B
		BOD	18 mg/L	5210.B
		COD	46.6 mg/L	5220.B
		Ammonium (NH ₄)	15.2 mg/L	3500.B
A-10009	Water (B. H. No-6, Chittagong)	Temperature	27.4 ⁰ C	2550.B
		BOD	24 mg/L	5210.B
		COD	54.5 mg/L	5220.B
		Ammonium (NH ₄)	45.6 mg/L	3500.B
A-10010	Water (B. H. No-7, Chittagong)	Temperature	27.3 ⁰ C	2550.B
		BOD	5.95 mg/L	5210.B
		COD	14.9 mg/L	5220.B
		Ammonium (NH ₄)	11.5 mg/L	3500.B
A-10011	Water (B. H. No-8, Chittagong)	Temperature	27.3 ⁰ C	2550.B
		BOD	0.8 mg/L	5210.B
		COD	2.97 mg/L	5220.B
		Ammonium (NH ₄)	5.54 mg/L	3500.B

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[Signature]

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-10012	Water (B. H. No-9, Chittagong)	Temperature	27.1 ⁰ C	2550.B
		BOD	8.7 mg/L	5210.B
		COD	23 mg/L	5220.B
		Ammonium (NH ₄)	5.36 mg/L	3500.B
A-10013	Water (B. H. No-11, Chittagong)	Temperature	27.3 ⁰ C	2550.B
		BOD	Less than 0.2 mg/L	5210.B
		COD	Less than 2 mg/L	5220.B
		Ammonium (NH ₄)	5.17 mg/L	3500.B
A-10014	Water (B. H. No-12, Chittagong)	Temperature	27.2 ⁰ C	2550.B
		BOD	Less than 0.2 mg/L	5210.B
		COD	Less than 2 mg/L	5220.B
		Ammonium (NH ₄)	5.04 mg/L	3500.B
A-10015	Water (B. H. No-13, Chittagong)	Temperature	27 ⁰ C	2550.B
		BOD	Less than 0.2 mg/L	5210.B
		COD	Less than 2 mg/L	5220.B
		Ammonium (NH ₄)	1.03 mg/L	3500.B
A-10016	Water (B. H. No-14, Chittagong)	Temperature	27.2 ⁰ C	2550.B
		BOD	Less than 0.2 mg/L	5210.B
		COD	Less than 2 mg/L	5220.B
		Ammonium (NH ₄)	0.82 mg/L	3500.B
A-10017	Water (B. H. No-15, Chittagong)	Temperature	27.2 ⁰ C	2550.B
		BOD	Less than 0.2 mg/L	5210.B
		COD	Less than 2 mg/L	5220.B
		Ammonium (NH ₄)	0.81 mg/L	3500.B

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জীবনের জন্য বিজ্ঞান

বিসিএসআইআর গবেষণাগার, ঢাকা
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Bangladesh Council of Scientific and Industrial Research (BCSIR)

Analytical Report

Ref No. : i) 576 of BCSIR Laboratories, Dhaka. Date: 15/07/2013
: ii) D-1387 of Analytical Service cell, BCSIR, Date: 15/07/2013
Lab ID : SE - 179
Referred by : Md. Akhtaruzzaman, Development Design Consultants Ltd. 47 Mohakhali C/A, Dhaka.
Work Order details : Analysis of the supplied samples (as supplied).
Type of Sample : Soil.
Packing and Marking : Polythene Bag
Date of Receipt : 15/07/2013
Period of analysis : 15/07/2013 to 24/07/2013
Analytical Result :

Sample ID			Results								
Bore Hole No.	Sample No.	Depth	pH	Clay content	Organic Matter	Lead (Pb)	Cadmium (Cd)	Chromium (Cr)	Arsenic (As)	Iron (Fe)	Mercury (Hg)
06	D-10	15.00'	8.49	47.31 %	0.23 %	18.93 ppm	0.050 ppm	15.26 ppm	2.21 ppm	0.152%	BDL
01	D-8	12.00'	8.64	33.86 %	0.11 %	14.40 ppm	0.041 ppm	10.29 ppm	2.28 ppm	0.151%	BDL
Well-03	D-08	12.00'	8.65	21.36 %	0.24 %	2.29 ppm	0.051 ppm	11.71 ppm	2.25 ppm	0.150%	BDL
Well-09	D-01	1.50'	7.24	16.12 %	0.46 %	BDL	0.030 ppm	7.36 ppm	1.26 ppm	0.143%	BDL
Well-01	D-7	10.50'	6.14	25.01 %	0.34 %	BDL	0.032 ppm	14.01 ppm	0.95 ppm	0.141%	BDL

BDL= Below detection limit

Methodology:

- (1) pH: pH meter, (2) Clay content: Hydrometer method, (3) Organic Matter: Wet oxidation method,
(4) Pb, Cd & Cr: Atomic Absorption Spectrophotometer, (5) As: Atomic Absorption Spectrophotometer with HVG.
(6) Hg: Atomic Absorption Spectrophotometer with MVU.

Special Notes:

- The result reported here pertained to the sample received in the laboratory only.
- The laboratory is not responsible for the data quality affected due to the above. The precision & accuracy are defined only for the laboratory process, not for the sampling, transporting & storage processes.
- The result should not be reproduced wholly or in part and cannot be used as evidence in the court of law and should not be used in any advertising media without our special permission in writing.

Signature of Scientist

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Signature of Research Coordinator

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BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ANALYSIS REPORT

Ref. No. : i) 575 of BCSIR Lab. Dhaka dt. 15/07/2013
 ii) D-1386 of Analytical Service Cell, BCSIR. 15/07/2013
 Lab ID : A-10025 to A-10029
 Name and address of Customer : Md. Akhtaruzzaman
 Development Design Consultants Ltd.
 47 Mohakhali C/A, Dhaka-1212.
 Work order details : নমুনা পরীক্ষণের জন্য আবেদন, তারিখ : ১৯/০৬/২০১৩
 Type of sample* : Soil
 Quantity of sample : 250 gm (5 Packet)
 Packing and marking : Polyethelene Pack
 Date of receipt : 16/07/2013
 Period of analysis : 16/07/2013 to 27/08/2013
 Visual observation/Remarks : Brownish

Lab ID	Particulars of supplied sample	Name of Parameters	Concentration
A-10025	Soil Well No: -09 Sample No: D-1 Depth: 1.50' ArifNagar Chittagong	Polycyclic aromatic hydrocarbons (PAHs)	Acenaphthylene
			Not detectable
			Anthracene
			Not detectable
			Benzo (A) Anthracene
			Not detectable
			Benzo (A) Pyrene
			Not detectable
			Benzo (B) Fluoranthene
			Not detectable
			Benzo (G, H, I) Perylene
			Not detectable
			Benzo (K) Fluoranthene
			Not detectable
			Chrysene
			Not detectable
			Dibenz (A, H) Anthracene
			Not detectable
			Fluorene
			Not detectable
			Indeno (1, 2, 3-CD) Pyrene
			Not detectable
			Phenanthrene
			Not detectable
			Pyrene
			Not detectable

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*The results relate only to the items tested.

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BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Lab ID	Particulars of supplied sample	Name of Parameters		Concentration
A-10025	Soil Well No -09 Sample No: D-1 Depth: 1.50' Arif Nagar Chittagong	Poly chlorobiphenyl (PCB)	2,2',3,4,4',5,5'-Heptachlorobiphenyl	Not detectable
			2,2',3,4,4',5'-Hexachlorobiphenyl	Not detectable
			2,2',4,4',5,5'- Hexachlorobiphenyl	Not detectable
			2,2',5,5'- Tetrachlorobiphenyl	Not detectable
			2,4,4'- Trichlorobiphenyl	Not detectable
			2,6- Dichlorobiphenyl	Not detectable
A-10025	Soil Well No: -09 Sample No: D-1 Depth: 1.50' Arif Nagar Chittagong	Volatile Organic Compounds (VOC)	Chlorobenzene	Not detectable
			CIS-1,2-Dichloroethylene	Not detectable
			Ethylbenzene	Not detectable
			O-Xylene	Not detectable
			P-Xylene	Not detectable
			Styrene	Not detectable
			Tetrachloroethene	Not detectable
			Toluene	Not detectable
			Trans-1,2-Dichloroethylene	Not detectable
			1,2-Dichlorobenzene	Not detectable
			1,2-Dichloropropane	Not detectable



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Lab ID	Particulars of supplied sample	Name of Parameters	Concentration
A-10026	Soil Well No: 01 Sample No:D-07 Depth: 10.50' Arif Nagar Chittagong	Polycyclic aromatic hydrocarbons (PAHs)	Acenaphthylene
			Anthracene
			Benzo (A) Anthracene
			Benzo (A) Pyrene
			Benzo (B) Fluoranthene
			Benzo (G, H, I) Perylene
			Benzo (K) Fluoranthene
			Chrysene
			Dibenz (A, H) Anthracene
			Fluorene
			Indeno (1, 2, 3-CD) Pyrene
			Phenanthrene
			Pyrene
A-10026	Soil Well No: 01 Sample No:D-07 Depth: 10.50' Arif Nagar Chittagong	Poly chlorobiphenyl (PCB)	2,2',3,4,4',5,5'-Heptachlorobiphenyl
			2,2',3,4,4',5'-Hexachlorobiphenyl
			2,2',4,4',5,5'- Hexachlorobiphenyl
			2,2',5,5'- Tetrachlorobiphenyl
			2,4,4'- Trichlorobiphenyl
			2,6- Dichlorobiphenyl
A-10026	Soil Well No: 01 Sample No:D-07 Depth: 10.50' Arif Nagar Chittagong	Volatile Organic Compounds (VOC)	Chlorobenzene
			CIS-1,2-Dichloroethylene
			Ethylbenzene
			O-Xylene
			P-Xylene
			Styrene
			Tetrachloroethene
			Toluene
			Trans-1,2-Dichloroethylene
			1,2-Dichlorobenzene
			1,2-Dichloropropane



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Lab ID	Particulars of supplied sample	Name of Parameters		Concentration
A-10027	Soil Well No: 03 Sample No: D-08 Depth: 12' Arif Nagar Chittagong	Polycyclic aromatic hydrocarbons (PAHs)	Acenaphthylene	Not detectable
			Anthracene	Not detectable
			Benzo (A) Anthracene	Not detectable
			Benzo (A) Pyrene	Not detectable
			Benzo (B) Fluoranthene	Not detectable
			Benzo (G, H, I) Perylene	Not detectable
			Benzo (K) Fluoranthene	Not detectable
			Chrysene	Not detectable
			Dibenz (A, H) Anthracene	Not detectable
			Fluorene	Not detectable
			Indeno (1, 2, 3-CD) Pyrene	Not detectable
			Phenanthrene	Not detectable
A-10027	Soil Well No: 03 Sample No: D-08 Depth: 12' Arif Nagar Chittagong	Poly chlorobiphenyl (PCB)	Pyrene	Not detectable
			2,2',3,4,4',5,5'-Heptachlorobiphenyl	Not detectable
			2,2',3,4,4',5'-Hexachlorobiphenyl	Not detectable
			2,2',4,4',5,5'-Hexachlorobiphenyl	Not detectable
			2,2',5,5'-Tetrachlorobiphenyl	Not detectable
			2,4,4'-Trichlorobiphenyl	Not detectable
A-10027	Soil Well No: 03 Sample No: D-08 Depth: 12' Arif Nagar Chittagong	Volatile Organic Compounds (VOC)	2,6-Dichlorobiphenyl	Not detectable
			Chlorobenzene	Not detectable
			CIS-1,2-Dichloroethylene	Not detectable
			Ethylbenzene	Not detectable
			O-Xylene	Not detectable
			P-Xylene	Not detectable
			Styrene	Not detectable
			Tetrachloroethene	Not detectable
			Toluene	Not detectable
			Trans-1,2-Dichloroethylene	Not detectable
			1,2-Dichlorobenzene	Not detectable
			1,2-Dichloropropane	Not detectable

ii. Annex 3: Location Map of Arefin Nagar Chittagong

