

Initial Environmental Examination

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People's Republic of Bangladesh: Natural Gas Infrastructure and Efficiency Improvement Project (Component 2: Construction of Chittagong-Bakhrabad Gas Transmission Pipeline)

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CURRENCY EQUIVALENTS

(as of 3 August 2016)

Currency unit	–	Taka (Tk)
Tk 1.00	=	\$0.012755
\$1.00	=	Tk78.40

ABBREVIATIONS

ADB	-	Asian Development Bank
AIIB	-	Asian Infrastructure Investment Bank
CITES	-	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DOE	-	Department of Environment
EA	-	Executing Agency
ECA	-	Environment Conservation Act
ECC	-	Environmental Clearance Certificate
ECR	-	Environment Conservation Rules
EIA	-	Environmental Impact Assessment
EMP	-	Environmental Management Plan
EMRD	-	Energy and Mineral Resources Division
ESMS	-	Environment and Safety Management System
GoB	-	Government of Bangladesh
GRC	-	Grievance Redress Committee
GTCL	-	Gas Transmission Company Limited
IEE	-	Initial Environmental Examination
LCC	-	Locational Clearance Certificate
MOEF	-	Ministry of Environment and Forests
MPEMR	-	Ministry of Power, Energy and Mineral Resources
PIU	-	Project Implementation Unit
RoW	-	Right-of-Way
SPS	-	Safeguard Policy Statement

WEIGHTS AND MEASURES

°C	-	degree Celsius
dB(A)	-	A-weighted decibel
ha	-	hectare
lakh	-	100,000
ppb	-	parts per billion
ppm	-	parts per million
µg/m ³	-	microgram per cubic meter
m ²	-	square meter

GLOSSARY

ambient	- surrounding
Bangla	- official language of Bangladesh
bazar	- market
beel	- a 'back swamp' or depression that can be perennial or ephemeral
haor	- a bowl-shaped depression located between the natural levees of rivers
hydrostatic testing	- process of filling a pipeline with water, or a mixture of water and ethylene glycol or methanol to test the structural integrity of the pipeline under pressure
khal	- Bangla word for a small channel or canal
thana	- sub-district level of government administration, comprising several unions under the district
union	- smallest unit of local self-government comprising several villages
union parishad	- Union Council
upazila	- Bangla word for sub-district name
zila	- Bangla word for district.

NOTE

- (i) In this report, "\$" refers to US dollars

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EXECUTIVE SUMMARY

Introduction

1. The Project will be funded by Asian Development Bank (ADB) with cofinancing from the Asian Infrastructure Investment Bank (AIIB) at an estimated total project cost of \$453.90 million. Financing of the project will be ADB to provide funds of about \$167.83 million (M), AIIB of about \$60M and the Government of Bangladesh (GoB) will provide the balance of \$226.07M. Implementation of the project is expected to be from December 2016 until December 2021.

2. Component 2 of the Project will involve the construction of gas transmission pipeline from Chittagong to Bakhrabad in the Southeast region of Bangladesh. The Executing Agency (EA) for Component 2 is the Gas Transmission Corporation Limited (GTCL) which is one of the operating companies of the Bangladesh Oil, Gas and Mineral Corporation (Petrobangla) under the Energy and Mineral Resources Division (EMRD) of the Ministry of Power, Energy and Mineral Resources (MPEMR). GTCL is responsible for the centralized operations and maintenance of the national gas grid, and in expanding the national gas grid to ensure a balanced supply and usage of natural gas in all the regions of Bangladesh. A project implementation unit (PIU) will be established in GTCL to carry out the day-to-day project administration and management activities. A Project Director will lead the PIU at GTCL to be supported by about 40 designated staff.

3. The growing demand for natural gas by the industrial centres in Chittagong, Noakhali, Comilla and adjoining areas is not sustained by the GTCL. At present, the existing Chittagong-Bakhrabad gas transmission pipeline is not adequate to meet the supply of gas for distribution in this region. Due to this supply shortfall, Petrobangla will import liquefied natural gas (LNG) abroad which will come through Moheshkhali and once re-gasified will be transmitted through gas pipeline to Selimpur, Chittagong then to Bakhrabad Gas Metering Station and finally to gas distribution companies. The LNG imports will address the much needed natural gas supply for the Southeastern Chittagong region. However, this additional supply will require gas transmission infrastructure to facilitate the reliable and stable delivery to gas distribution companies. Implementing the Component 2 of the Project will address these infrastructure requirements.

Project Description

4. Component 2 will involve about 181 km of 36-inch diameter gas transmission pipeline and ancillary equipment from Uttar Selimpur, Upazila Sitakunda in the Chittagong District until Keotgaon, Muradnagar Upazila in Comilla District. The entire pipeline will traverse the districts of Chittagong, Feni and Comilla. The ancillary equipment includes: (i) nine valve stations, (ii) two town border stations in Mirersorai, Chittagong and in Bizra, Comilla, (iii) a Pipeline Inspection Gauge (PIG) launching station at Selimpur in Chittagong, (iv) a PIG receiver in Keotgaon, Muradnagar in Comilla, and a (iv) metering station also in Keotgaon. All the sites of the ancillary equipment are agricultural land.

5. Associated facilities to Component 2 include the source of natural gas which will come from the proposed floating storage regasification unit (FSRU) to be constructed at Maheshkhali, Cox's Bazar District on a build-own-operate transfer basis where the International Finance Corporation (IFC) is most likely the key financing institution, and the connecting evacuation system from the FSRU consisting of: (i) 30-inch, 90 km Maheshkhali-Anwara pipeline, and (ii) 30-inch, 30 km Anwara to Fouzdarhat pipeline. The construction of the Maheshkhali-Anwara

and the Anwara-Fouzdarhat pipelines will be completed in 2017 and the FSRU is expected to be completed by 2018.

6. The pipeline will require a permanent right-of-way (RoW) of 4 m each side along the centerline (total of 8 m) and a temporary RoW of 6 m on the right side and 9 m on the left side as workspace or construction RoW. Due to this land requirement, about 150.48 hectares (ha) will be permanently acquired as RoW and about 274.23 ha will be temporarily acquired (requisition) as construction workspace.

7. Installation of the pipeline will have four river crossings along Little Feni River, Dakatia River, Khalidas River, and Muhuri River; two railway crossings, and four road crossings. The transmission pipeline system was designed to meet the requirements of the Government of Bangladesh (GoB) gas sector industry and the international standards and specifications. Activities associated with Component 2 during construction, hydrostatic testing, commissioning, and operation will follow the relevant regulations of GoB, applicable industry and international standards, and ADB.

Environmental Requirements

8. **Government of Bangladesh** Environmental Conservation Act (ECA) 1995 and Environmental Conservation Rules (ECR) 1997 of the GoB under the Department of Environment (DOE) of the Ministry of Environment and Forests (MOEF) classify Component 2 as a “red” category project requiring an initial environmental examination (IEE) for the issuance of the locational clearance certificate (LCC) and an environmental impact assessment (EIA) for the environmental clearance certificate (ECC) after obtaining the LCC. GTCL contracted the Center for Environmental and Geographic Information Services (CEGIS), a Public Trust under the Ministry of Water Resources, to prepare the IEE required by the DOE. CEGIS completed the IEE for submission to DOE on 28 February 2016.

9. **ADB and AIIB** The Safeguard Policy Statement (SPS) 2009 of ADB sets out the requirements for environmental safeguard that applies to all ADB-financed projects. The Asian Infrastructure Investment Bank (AIIB) was established in October 2014 as a multilateral bank and the Multilateral Interim Secretariat for Establishing the AIIB has developed the Draft Environmental and Social Framework that completed public consultations on 23 October 2015. The Project will adopt SPS 2009 as the unified environmental assessment and planning process for consultation, disclosure requirements and safeguard documentation to meet the safeguard principles and requirements of both of ADB and the AIIB. Based on SPS 2009, the project is category B requiring an IEE. Thus, this IEE is prepared to meet the requirements of ADB and AIIB. Aside from complying with the provisions set forth in SPS 2009, ADB also requires GTCL to comply with the environmental requirements of the DOE. GTCL will provide to ADB the ECC to be issued by the DOE for Component 2.

Description of the Existing Environment

10. The description of the environment for Component 2 was based on the areas that will be traversed by the pipeline route, the RoW (permanent and temporary) and another 60 m each side of the RoW. This is referred to as the study area of about 2,443 ha.

11. Climatological data recorded by Bangladesh Meteorological Department from 1980 until 2013 were used to characterize the climate of the study area. Monthly average rainfall is highest in Chittagong (700 mm) and lowest in Comilla (417 mm). The highest humidity level

among the three districts is 88%. Warmest months are April and May where the temperature can reach 39°C while the coldest month is January with coldest temperature of 7.1°C. The area belongs to seismic Zone II which is considered as moderate. Highest level of surface water occurs in monsoon season where it is almost up to 11 m (Parsuram station) and during the dry season is 9.8 m. Flooding is a concern for Chittagong but not so for Feni and Comilla. During the monsoon season, water level can rise up to about 5 feet (ft) in the agricultural lands and about 2 ft along some existing roads when high tide.

12. According to the Soil Research Development Institute (1995), soil drainage characteristics within the study area are imperfectly drained (59%) and poorly drained (41%). During monsoon, as imperfectly drained, soil is often wet where water could stand at almost 1 m for some time while as poorly drained, soil remains under water from 15 days to about 7 months as water is drained very slowly. Soil types in the study are clay loam (52%) and loam (40%).

13. Available continuous ambient air quality monitoring data in January 2016 from the two sampling stations in Chittagong (i.e., TV station in Khulsi and in Agrabad) of the DOE project, Clean Air and Sustainable Environment (CASE) indicates that PM₁₀ and PM_{2.5} exceeded the National Ambient Air Quality Standards of 150 µg/m³ and 65 µg/m³, respectively. Other parameters being monitored are NO_x, SO₂, CO, lead, and ozone (O₃). CASE project is funded by the World Bank and started the continuous ambient air quality monitoring in November 2011. Results of ambient noise level measurements in December 2015 from 20 sampling stations along the pipeline route showed that it exceeded the ECR 1997 noise standards of 50 dB(A) during daytime. Existing sources of noise along the pipeline route are daily activities of the local people like in the market and vehicular movements.

14. Surface water quality measurements were conducted in December 2015. There were 11 sampling stations identified along the pipeline route and results indicated that three sampling stations exceeded the ECR 1997 limits for electrical conductivity of 1.2 mS/cm. This result suggests that wastewater from sewage treatment plant or sewage systems, and urban run-off from roads may have found their way to these water bodies.

15. The pipeline route is not located within or adjacent to any protected areas such as national park, sanctuary, or wetlands. Based on field investigations, survey, interviews of local people, and secondary data, there are several species of terrestrial and aquatic flora and fauna in the study area. Common vegetation in homesteads consist of 32 common species, from roadsides/groves vegetation include 17 species, and from crop fields, 10 species. Most of the homestead vegetation is planted by home owners for food, fruits, fuel and medicine for their daily needs. A total of 27 terrestrial fauna were identified. There are 15 species of aquatic flora and 16 species of fauna including 48 species of fish. Some species of terrestrial and aquatic fauna including fish are listed as endangered, and vulnerable according to the assessment of IUCN Bangladesh in 2000. The conservation status of species in Bangladesh is being updated by the IUCN Bangladesh according to the IUCN Red List of Threatened Species. This updating project started in December 2013 and is funded by the World Bank.

16. There are 6,954 households with a population of 35,184 consisting of 48% male and 52% female. Population density is 1,641 persons per square kilometer (km²) higher than the national level of 1,055 persons/ km². Literacy rate is 55% and about 34% of the population is gainfully employed mainly in agriculture. There are health facilities at the subdistrict level where local population can avail of primary health services from physicians. Most of the population (92%) use tube-well as source of drinking and about 79% of the households have sanitary facilities. More than half of the population (69%) has electricity.

Anticipated Impacts and Mitigation Measures

17. Land acquisition and requisition for the RoW and construction workspace will result to loss of land, crops and structures to affected people. Compensation will follow the applicable laws of GoB and the requirements of SPS 2009. Cost estimates of compensation are given in the Resettlement Plan for Component 2.

18. Before any construction works, PIU-GTCL will conduct a briefing for Engineering, Procurement, and Construction (EPC) Contractor's workers and staff on the environmental requirements of GoB and ADB for compliance, records management and reporting, and awareness about socially transmitted disease such as HIV/AIDS to prevent potential incidence in the workplace. A Construction Management Plan will be required from the EPC Contractor outlining how the potential environmental impacts during construction will be addressed by them.

19. Construction activities may pose occupational and community safety risks. A contingency fund will be made available to cover potential accidents involving local people affected by Component 2. An initial hazard assessment was prepared (**Table 5.2**). To ensure occupational and environmental health and safety, EPC Contractor will provide workers and staff with appropriate personal protective equipment, sanitary facilities, wash areas, safe drinking water, garbage bins, first aid equipment, and fire-fighting system. Good housekeeping will be enforced at all times in the construction sites and labor camps. Clear and visible warning and danger signs at and around the construction sites will be provided. Appropriate traffic signs will be installed to guide pedestrians, people with disability, motorists and other road users.

20. Site preparation for RoW and workspace will affect trees, wooded vegetation, and may disturb the adjacent agricultural lands and destruction of terrestrial habitat. About 77,319 trees will be affected by the RoW which include fruit-bearing trees, timber, medicinal trees, banana, and bamboo from homesteads, fruit and timber gardens planted by farmers and landowners. Clearing of vegetation will be done progressively to direct the escape of the wildlife away from the construction activities into the natural areas. Before clearing is done, the Environmental staff (or consultant) will assist the EPC Contractor in identifying the terrestrial habitat which may likely have significant species of flora and fauna. The Environmental staff will also conduct faunal inspections (or spot checks) before and during clearing works to supervise and ensure impacts to terrestrial fauna are minimized and proper handling of slow-moving or sedentary terrestrial fauna. In the event of an unexpected encounter or "chance find" threatened species, the procedures given in **Annex 2** will be followed.

21. Crops on agricultural lands along the pipeline RoW will be affected by the site clearing and leveling of construction RoW. The schedule of construction works will consider harvest time to give farmers the chance to benefit from their produce and to minimize loss of production. Tree planting/revegetation will be done at designated sites to be identified by GTCL in consultation with the Forest Department. Cleared vegetation will be disposed of properly and will ensure the shortest time possible in land rehabilitation after clearing. Barren (if available) or fallow land will be used for storing construction materials and for maneuvering of vehicles. Construction works will be limited to daytime to minimize disturbance to nocturnal faunal species.

22. Horizontal directional drilling (HDD) at river crossings in Little Feni River, Muhuri River, Dakatia River and Khalidas Khal may disrupt the natural drainage and navigation, and may

cause erosion. The EPC Contractor will prepare an alternative navigation plan in consultation with Bangladesh Inland Water Transport Authority (BIWTA) and approved by PIU-GTCL to minimize disruption to existing navigation use of these rivers. Construction works at the river crossings will be done only during low flow periods based on the time of the year and weather forecasts.

23. Navigation safety system and equipment will be provided and BIWTA will be consulted on the schedule of HDD works. Signboards written with radium material will be installed showing the working time, project name, safety measures, etc. Alarms will be provided. An environmental staff (or consultant) will be present during the HDD works to monitor compliance to EMP and permits from GoB. While HDD is considered the best available technology that will minimize impacts at river crossings, all relevant works will be implemented and supervised by experienced technical staff and consultants to ensure that it is done according to standards and specifications.

24. Increased dust levels and vehicular emissions at the project sites may affect ambient air quality and in some occasions, the noise level may exceed the limit for ambient noise. Workers assigned to high-level noise-generating activities will be provided with PPEs. Measures such as spraying of water to opened land areas, covering of stockyards during non-working period and trucks transporting construction materials that generate dust, and enclosing construction sites with temporary fencing of cloth or suitable material will be implemented to suppress dust dispersion.

25. During the hydrostatic testing, the spent water will be checked for quality prior to discharge to ensure compliance with Schedule 10 of ECR 1997. Discharge of wastewater will be monitored to ensure that no localized flooding and soil erosion will occur.

26. The operation and presence of the pipeline from Chittagong to Bahkrabad may pose occupational and public safety risks. GTCL has been operating gas transmission pipelines since 1987 of about 1,388 km. Given the volume of natural gas being transported over time and its corresponding national economic value, GTCL is committed in ensuring the safety of their workers and the public. The technology, safety design and specifications including operation & maintenance have improved through the years. GTCL has an environment and safety management system as well as safety and hazard mitigation plan to address the risks of explosion or fire. Among others, the operation of BGFCL is subject to the Natural Gas Safety Rules 1991 (amended 2003) and The Factories Act 1965.

27. Component 2 will be designed and constructed to comply with stringent international and gas industry safety codes aside from compliance to applicable national regulations. Operation will be monitored 24 hours a day through the SCADA. The SCADA will detect that should pressure in the pipeline drop due to leak, the valves will automatically shut off the gas flow to prevent or minimize the gas released into the environment. Clear and visible signs and danger warnings will be provided along the pipeline route.

28. GTCL staff will have regular training on safety, emergency or disaster preparedness, and efficient monitoring of the gas transmission system. GTCL will also conduct information drive and/or awareness campaign on safety to settlements in 12 upazila living close to the pipeline RoW. A contingency fund will be provided to cover accidents that will involve people living adjacent to Component 2.

29. During operation, PIGs will be placed inside the pipeline to clean or monitor its internal and external conditions. Pigging operation removes deposits inside the pipeline which could obstruct or retard the gas flow; provide information on the condition of the pipeline including the location and extent of pipeline problem (if any). This operation may pose occupational safety risks. To minimize safety risks, personnel who will be involved in pigging will have the required knowledge and essential skills. Appropriate PPE will be provided to workers and personnel who will conduct the pigging operations; barriers and warning notices will be provided to limit access to the worksite to authorized personnel only. Waste from pigging operations will be managed to ensure compliance to ECR 1997.

Analysis of Alternatives

30. GTCL's primary consideration for selecting the pipeline route is avoidance of protected areas such as national park, sanctuary or wetlands as well as dense settlements. Given this consideration, two options were evaluated and the selected pipeline route will result to lesser loss of land and cluster of settlements.

31. Under the "no project" option, the site will remain the same as the existing conditions but the current constraint of GTCL not meeting the required gas supply in the Southeastern region of Bangladesh will continue. Aside from this, the planned economic development and business opportunities within the region may not happen.

Information Disclosure, Consultation and Participation

32. A total of 17 stakeholders' engagements were undertaken on December 15-30, 2015 participated by 231 persons. Six community meetings and 11 focus group discussions were completed during the preparation of the IEE. Participants include community leaders, fisherfolks, farmers, day laborers, women, teachers, service holders, etc. Those consulted support the implementation of Component 2 as they believe the scarcity of a reliable gas supply in their area greatly hampers industrial development. They foresee employment opportunities with Component 2 but expressed concerns on the appropriate and timely compensation to affected people.

33. A strategy and program for consultation will be finalized by PIU-GTCL to ensure that stakeholders are consulted, as and when needed. A one-page flyer on the project summary including information on the grievance redress mechanism will be prepared in Bangla and made available at the field office of PIU-GTCL and in the Head Office in Dhaka. Project information will be made available also at the website of GTCL. Interested individuals will have access to the IEE at the offices of GTCL and will be posted in the ADB website as required by SPS 2009 and Public Communications Policy (PCP) 2011.

Grievance Redress Mechanism

34. GTCL has an existing grievance redress system (GRS) which is part of the mandatory strategic objectives of the Annual Performance Agreement of the GoB. GTCL signs a yearly agreement with Petrobangla to comply with GRS. The GRS requires a mandatory designation of staff as focal point. The name of the designated staff and contact details are disclose to the website of GTCL.

35. To meet the requirements of SPS 2009, a grievance redress mechanism (GRM) will be established by the Project Implementation Unit (PIU) of GTCL to deal with complaints from

affected persons (APs) that may be potentially raised during the implementation of Component 2. The APs can seek redress of their grievance at three levels: (i) the PIU-GTCL or through the representative of the EPC Contractor during construction phase, (ii) through the grievance redress committee (GRC), and (iii) the appropriate courts of law. GRC will be set up by the PIU-GTCL as soon as Component 2 commences and will consist of representative from the EPC Contractor, local government unit, designated staff of PIU-GTCL on environmental issues (or a Consultant), and witness of the AP. PIU-GTCL will ensure the representation of women in the GRC. The GTCL staff designated for the GRS required by Petrobangla will be part of the GRC.

Environmental Management Plan

36. An environmental management plan (EMP) was prepared for the impacts identified including an environmental monitoring plan. Aside from the compensation included in the Resettlement Plan of Component 2, an estimated cost of about Tk144 lakh will be allocated for the implementation of EMP and about Tk65 lakh for environmental monitoring plan.

37. GTCL will set up a PIU responsible for project management and safeguards compliance monitoring of EPC contractor during the construction stage. The EPC Contractor will recruit an environmental staff (or a Consultant) who will be primarily responsible for ensuring that the EMP is properly implemented during construction. The Environmental staff (or consultant) of the EPC Contractor will coordinate and interact with the PIU on compliance to ADB requirements, relevant government agencies and local authorities on clearances (as needed), and will prepare the required environmental reporting. During the operation phase, PIU-GTCL will designate a staff who will be responsible to deal with the environmental issues and compliance to GoB and ADB's environmental requirements.

38. PIU-GTCL will submit environmental monitoring reports to ADB starting from the date the loan will become effective. The Environmental monitoring reports will be submitted twice a year during construction phase and annually during operation. These monitoring reports will be disclosed to ADB website and will be available at the GTCL office. In the event of non-compliance to any environmental covenant in the loan agreements or any unanticipated environmental impacts, PIU-GTCL will prepare a corrective action plan (CAP) describing the process and actions that will be undertaken to ensure compliance. The CAP will be submitted to ADB for review and disclosure to their website.

Conclusion and Recommendation

39. Selection of pipeline route considered avoidance of protected areas such as national park, sanctuary or wetlands. Pipeline route chosen will result to the least amount of land requirements and moderate social impacts to affected people. Residual environmental impacts will be mitigated by using the best available technology, adherence to design standards and specifications, compliance to applicable regulations of GoB and requirements of SPS 2009, and in implementing international best practices in engineering management and operation. An EMP and environmental monitoring plan were prepared with cost estimates.

40. Given the lack of data to establish and show the distribution of fish species of IUCN conservation status, GTCL PIU-GTCL will explore opportunities to collaborate with the Department of Fisheries, Bangladesh Fisheries Research Institute, and the IUCN Bangladesh to support their initiatives to domesticate wild fish of conservation status that will be potentially affected by the pipeline route.

41. All the relevant permits that will be required by GoB (e.g., DOE, FD, BADC, BIWTA, etc.) for Component 2 will be obtained prior to construction works.

42. Stakeholders were consulted and a grievance redress mechanism will be set up during implementation. Consultations will continue during construction and operation phase. Interested individuals will have access to the IEE at the offices of GTCL including the project brief in Bangla. This IEE and the environmental monitoring reports will be posted to the ADB website as required by SPS 2009 and PCP 2011.

1.0 BACKGROUND

43. Natural gas is a significant source of commercial energy in Bangladesh and is the prime mover of its national economy. There is a growing demand for a steady and reliable supply of natural gas in the Southeast region to support its industrialization and commercial developments. The Government of Bangladesh (GoB) has recognized this need and considers it a priority to expand the gas transmission capacity in this region.

44. To address the constraints in the gas sector, the GoB, through the Energy and Mineral Resources Division (EMRD) of the Ministry of Power, Energy and Mineral Resources (MPEMR), has requested the Asian Development Bank (ADB) and the Asian Infrastructure Investment Bank (AIIB) to provide financing for the Natural Gas Infrastructure and Efficiency Improvement Project.

45. Gas Transmission Company Limited (GTCL) will be the Executing Agency (EA) of component 2. GTCL is one of the operating companies of the Bangladesh Oil, Gas & Mineral Corporation (Petrobangla) responsible for the centralized operations and maintenance of the national gas grid, and in expanding the national gas grid to ensure a balanced supply and usage of natural gas in all the regions of Bangladesh. Petrobangla coordinates the gas sector in Bangladesh and is the state agency for oil and gas exploration, production, transmission, and distribution.

1.1 Overview of the Project

46. The Project aims to increase the contribution of the energy sector to sustainable economic growth by financing the improvement of efficiency in gas production from existing gas field, and expansion of transmission pipeline capacity through construction of gas transmission pipelines. The Project details are shown in Table 1.1. The total financing is estimated at \$453.90M. ADB will arrange financing of the foreign currency cost from its resources and through cofinancing with AIIB. ADB will provide \$167.83 M while AIIB is expected to fund \$60M and the balance of \$226.07M will come from GoB.

Table 1.1 Project Details

Project Component	Description	Executing Agency
Component 1: Installation of well head compressors	Installation of wellhead gas compressor at Titas Gas Field (Location A)	Bangladesh Gas Field Company Ltd. (BGFCL)
Component 2: Construction of Chittagong-Bakhrabad gas transmission pipeline	Construction of 36-inch, 181 km Chittagong-Bakhrabad gas transmission pipeline	Gas Transmission Company Ltd. (GTCL)

47. Physical interventions of the project will involve two components: (i) installation of seven new wellhead gas compressors; and (ii) construction of 181 km, 36 inch Chittagong-Bakhrabad gas transmission pipeline.

48. As the EAs, BGFCL and GTCL will each set up a Project Implementation Unit (PIU) for implementing, monitoring, and reporting on the progress of project implementation to ADB and GoB. The PIU will consist of technical, financial, and procurement staff, while additional safeguards support will be hired, as and when required. At present, BFGCL, and GTCL have their own environment unit. PIU will be responsible for safeguards compliance and project

impacts monitoring. If necessary, consulting services will be provided to the PIU as support to supervision of technical due diligence process, safeguards due diligence, monitoring, and reporting. PIU at GTCL will be headed by a Project Director supported by about 40 designated staff during implementation of Component 2.

49. A Steering Committee will be established to guide the EAs, monitor and review the overall progress and results of implementing the Project. The Steering Committee will be chaired by the Secretary, EMRD and the members will be representatives from the Economic Relations Division (ERD), Planning Commission, Finance Division, and Petrobangla.

1.2 Environmental Requirements for the Project

50. The Project will adopt the ADB's SPS 2009 as the unified environmental assessment and planning process for consultation, disclosure requirements and safeguard documentation to meet the safeguard principles and requirements of both of ADB and the AIIB. Therefore, the project will follow the environmental policies and review procedures of ADB as embodied in SPS 2009 as well as the relevant environmental requirements of the GoB. The project is classified as Category B on environmental safeguard based on SPS 2009 which requires the preparation of an IEE.¹

51. In terms of the environmental requirements of GoB under its Department of Environment (DOE), the Project will be subject to the provisions set forth in the Environment Conservation Act (ECA) of 1995 and the Environment Conservation Rules (ECR) 1997. According to these environmental regulations, the components covered by the Project fall within the Red category requiring both an IEE to secure the LCC from the DOE and an EIA to obtain the ECC after securing the LCC.

2.0 POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

2.1 Environmental Requirements of Bangladesh

52. The following presents the regulatory agency, process, regulations and international environmental agreements relevant to the Project.

2.1.1 Environmental Agency

53. The Ministry of Environment and Forests (MOEF) is the agency that plans, promotes, coordinates and oversees the implementation of programs and plans on environment and forestry. MOEF manages all national environmental matters and is responsible for activities such as prevention and control of pollution, forestation and regeneration of degraded areas and protection of the environment, and in the framework of legislations. MOEF also conducts surveys, impact assessment, control of pollution, research, and collection and dissemination of environmental information and creation of environmental awareness among all sectors in Bangladesh.

54. MOEF performs its regulatory functions through the DOE, which was created in 1989 as the primary government agency entrusted with regulating and enforcing environmental

¹ADB, Safeguard Policy Statement, June 2009, para.50, p.19.

²AIIB. What is the Asian Infrastructure Investment Bank?. <http://www.aiib.org/html/aboutus/AIIB/>. (Accessed 17 November 2015)

management regulations to ensure sustainable development and to conserve and manage the environment. DOE ensures the consistent application of environmental rules and regulations, and provides guidance, training and promotional campaign on improving the awareness of environmental issues.

2.1.2 Applicable Environmental Regulations

55. The main environmental regulations in Bangladesh to ensure that projects are implemented sustainably include the Environment Conservation Act (ECA) of 1995 and Environment Conservation Rules (ECR) of 1997.

56. ECA together with its amendments made in 2000, 2002 and 2010 sets forth the requirements for the protection of the environment, improvement of environmental standards, and the control and abatement of environmental pollution. By this Act, the DOE is mandated to undertake any activity needed to conserve and enhance the quality of environment and to control, prevent and mitigate pollution.

57. The ECR provides for the rules relevant to the declaration of ecologically-critical areas, securing of environmental clearance certificate, environmental quality standards, acceptable limits for discharges of waste, and environmental guidelines on pollution prevention. Overall, the ECA and ECR outline the regulatory mechanism to protect the environment in Bangladesh.

58. **Requirement for Environmental Clearance Certificate** According to Section 12 of ECA 1995, no industrial unit or project can be established or undertaken without securing an ECC from the Director General, DOE. Based on ECR 1997, DOE has classified various development interventions according to the potential adverse environmental impacts for the purpose of issuing the ECC. This classification includes: (i) green, (ii) orange-A, (iii) orange-B, and (iv) red. Green category are industries or projects considered to be relatively pollution-free, thus, no environmental study will be required while the Red category are industries/projects which may cause significant adverse environmental impacts and therefore, require an EIA.

59. An ECC is issued by the DOE for all existing industrial units and projects, and to all proposed industrial units and projects under the Green category. For projects and industrial units classified as Orange-A, Orange-B, and Red, securing the ECC involves two steps: (i) issuance of LCC, and then (ii) the ECC.

60. The project components (i.e., natural gas compressor, gas transmission pipeline, and gas distribution pipelines) fall within the Red category following the classification of DOE. As such, the EAs will be required to secure LCC and ECC. **Figure 2.1** shows the process of securing ECC for a Red category project while **Table 2.1** presents the relevant national environmental regulations, and other laws and policies while **Annex 1** gives the relevant environmental quality standards of Bangladesh.

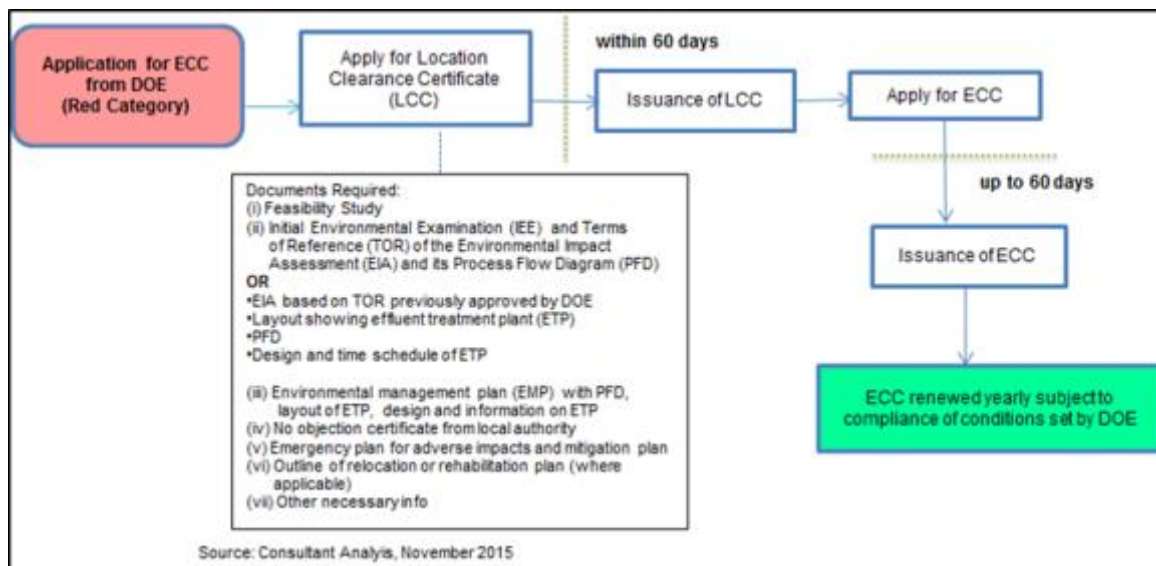


Figure 2.1 ECC Application Process for Red Category Project

Table 2.1 Relevant National Regulations, Laws and Policies

Regulation	Brief Description	Remarks
Environment Court Act 2000 (amended in 2002 and 2010)	This Act is under the Judiciary and MOEF to ensure the resolution of disputes on environmental and social damages resulting from any development activities. This Act also allows for the completion of environment-related legal proceedings effectively.	The EAs will ensure that all potential environmental issues/complaints will be dealt with effectively at the project level through the Project Management Unit (PIU). At present, the EAs have a GRS to address project-level complaints. GRS is part of the GoB Annual Performance Management System. ADB requires the establishment of a grievance redress mechanism in its funded-projects known to cause potential environmental impacts.
Vehicle Act 1927, the Motor Vehicles Ordinance 1983, and Bengal Motor Vehicle Rules 1940	These are under the Bangladesh Road Transport Authority (BRTA) which regulates vehicular emissions and noise including road safety.	BRTA regulations on vehicular emissions and noise will be complied with by vehicles that may be used during construction and operation of the project components.
Factories Act 1965 and Bangladesh Labour 2006	These regulations are the Ministry of Labour which provides for the occupational rights and safety of factory workers and the provision of comfortable work environment and reasonable working conditions.	Workers recruited under the project will be provided with what is relevant to them as set forth in these regulations.
The Forest Act 1927 (amended in 1982 and 1989)	Primary aim is to protect the forest resources and this Act is under MOEF.	No natural gas pipeline or project component will be funded if it will traverse identified protected forest areas.
National Energy	Under MPEMR and consistent with Vision	Components will be consistent with

Regulation	Brief Description	Remarks
Policy (NEP) 2008	2021, this Policy focuses on energy security and efficiency, financial transparency, cost recovery, and a bigger role for the private sector. The Policy also identifies fuel strategies for energy sustainability and security according to priority: (i) natural gas, (ii) coal, (iii) energy efficiency, (iv) renewable energy, and (v) nuclear.	NEP 2008.
Telegraph Act 1885	This Act is under the Ministry of Posts and Telecommunication which provides power to the Telegraph Authority to alter position of gas or water pipes or drain (Sect. 14, a and b).	The Project will refer to the Bangladesh Telecommunications Company Limited (BTCL) on the selection of gas pipeline route.
Electricity Act 1910	This Act relates to the supply and use of electrical energy, and which allows any person to secure a license to supply energy and to put down or place electrical supply lines for the transmission of energy. Sect 19(1) of the Act provides that the licensee, in the exercise of any of the powers conferred by or under this Act, will cause as little damage, detriment and inconvenience as may be, and will make full compensation for any damage, detriment or inconvenience caused by him or by any one employed by him.	The Project will refer to the applicable provisions in this Act.
Gas Safety Rules 1991 (amended 2003)	Provides guidelines on the materials, design and construction of gas transmission and pipeline industry. This Safety Rules were based on the American National Standard Codes for Gas Transmission and Piping System.	EAs have been complying with these safety rules and will continue to adhere for the components to be included in the Project.
The Antiquities Act 1968 (amended 1976)	Regulation on the preservation and protection of antiquities.	Selection of project sites will refer to the requirements of this Act.
Natural Water Bodies Protection Act 2000	According to this Act, the character of water bodies i.e. rivers, canals, tanks, or floodplains identified as water bodies in the master plans or in the master plans formulated under the laws establishing the municipalities in division and district towns shall not be changed without approval of concerned ministry. This Act is under the Rajdhani Unnayan Kartipakkha/Town Development Authority/Municipalities.	Gas transmission and distribution pipelines that will cross rivers, ponds, canals, and drainage channels will refer to this Act and will secure the required approval and clearances.
Wildlife (Protection and Safety) Act 2012	The Act provides for the conservation and safety of biodiversity, forest and wildlife of the country by repealing the existing law relating to conservation and management of wildlife of Bangladesh. Under this Act, hunting, trapping, killing of wildlife are strictly prohibited.	In December 2013, IUCN Bangladesh launched its flagship project of updating the national Red list. Sites of the components to be funded will ensure that no species protected by this Act and the

Regulation	Brief Description	Remarks
		updated IUCN Red List (Bangladesh) will be affected.
The Protection and Conservation of Fish Act 1950 (amended 1973, 1982, 1995, 2002)	Sets forth the requirements for the protection and conservation of fish. This Act defines fish as “all cartilaginous, bony fishes, prawn, shrimp, amphibians, tortoise, turtles, crustacean animals, molluscs, echinoderms and frogs at all stages in their life history.”	Site selection of the components will ensure that no species of fish protected under this Act will be destroyed or affected.

Source: ADB Consultant, November 2015

2.1.3 Relevant International Environmental Agreements

61. Aside from the national environmental regulations, international environmental agreements where Bangladesh is a party will be considered, as appropriate, in the screening and final selection of project components. **Table 2.2** lists applicable international environmental agreements that can provide guidance during the site selection and implementation of the project:

Table 2.2 Bangladesh Relevant International Environmental Agreements

International Environmental Agreement	Description	Date Ratified	Comments
Convention Concerning the Protection of the World Cultural and Natural Heritage (Paris 1972)	Entered into force on 23 November 1972, this convention defines and provides for the conservation of the world's heritage by listing the natural and cultural sites whose value should be preserved.	3 November 1983	Site selection will refer to the existing list of natural and cultural sites, if available, or consult with relevant government agency to avoid impacts in areas of cultural and natural heritage value.
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar 1971)	Provides a framework for national action and international cooperation for the conservation and sustainable use of wetlands and their resources. This convention entered into force on 21 December 1975.	21 September 1992	Identified Ramsar sites <ul style="list-style-type: none"> • Tangaur Haor (Northeast of Bangladesh) – declared in 1999 • Parts of Sundarban Reserved Forest (Southwest of Bangladesh) – declared 1992 Project component site selection will avoid these two Ramsar sites.
Convention on Biological Diversity (1992)	A framework for biodiversity, entered into force on 29 December 1993, and requires signatories to develop national strategies (National Biodiversity Strategy and Action Plan) for the conservation and sustainable use of biological diversity.	3 May 1994	Project components will refer to the applicable National Biodiversity Strategy and Action Plan in selecting the sites. Any replacement of cleared vegetation resulting from the project will be consistent with the objectives and priorities of the Action Plan.
Convention on International Trade in Endangered	Entered into force on 1 July 1975, this framework	20 November 1981	Project components will ensure that it will not cause any

International Environmental Agreement	Description	Date Ratified	Comments
Species of Wild Fauna and Flora (Washington 1973) – also known as CITES	addresses the overharvesting and exploitation patterns that threaten species of flora and fauna. Under this Convention, the governments agree to restrict or regulate trade in species that are threatened by unsustainable patterns and to protect certain endangered species from overexploitation by means of a system of import/export permits.		harvesting and exploitation of wild flora and fauna during pre-construction, construction, operation, and decommissioning.
Convention on the Conservation of Migratory Species of Wild Animals (Bonn 1979)	Sets the framework for agreements between countries that are important to the migration of threatened species. This Convention came into force on 23 June 1979.	1 December 2005	Consult relevant government authorities and/or experts to avoid areas known to be habitat of migratory species of wild animals in selecting sites of project components.
Vienna Convention for the Protection of the Ozone Layer 22 March 1985	A framework for efforts to protect the globe's ozone layer by means of systematic observations, research and information exchange on the effects of human activities on the ozone layer and to adopt legislative or administrative measures against activities likely to have adverse effects on the ozone layer.	2 August 1990	Project components will not use chemicals that can affect the ozone layer such as methyl chloroform, a solvent generally used for industrial processes.
Montreal Protocol on Substances that Deplete the Ozone Layer (a protocol to the Vienna Convention for the Protection of the Ozone Layer)	This international treaty was entered into force on 1 January 1989 and is designed to protect the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion. This treaty also requires controlling emissions of substances that deplete ozone.	2 August 1990	Project components will not use chemicals that can cause harm to the ozone layer.
Kyoto Protocol (1997)	An international agreement adopted on 11 December 1997 and entered into force on 16 February 2005, which commits its Parties to set internationally-binding emission reduction targets. This agreement is linked to the United Nations Framework Convention on Climate Change (UNFCCC).	22 October 2001	Project components will ensure zero or minimal fugitive natural gas emissions. Emissions from compressors will comply with the limits set by DOE.

International Environmental Agreement	Description	Date Ratified	Comments
UNFCCC (1992)	This framework came into force on 21 March 1994 and aims to achieve stabilization of greenhouse gas (GHG) concentrations in the atmosphere at a level low enough to prevent dangerous anthropogenic interference with the climate system.	15 April 1994	Project components will ensure zero or minimal fugitive natural gas emissions.
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989)	This convention came into force on 5 May 1992 which aims to reduce the amount of waste produced by signatories and regulates the international traffic in hazardous wastes.	1 April 1993	Project components will not generate hazardous wastes. Disposal of chemicals used (if and when needed) will follow the instructions in the material data safety sheet and this convention.
UNESCO World Heritage Convention 1972	This convention describes the concepts of nature conservation and the preservation of cultural properties. Parties agree to identify and nominate properties on their national territory to be considered for inscription on the World Heritage List, gives details of how a property is protected, and provides a management plan for its upkeep.	3 August 1983 (Accession) Accession – the state accepts the offer or the opportunity to become a party to a treaty already negotiated and signed by other states	UNESCO World Heritage Sites: <ul style="list-style-type: none"> • Sundarbans Reserve Forest (1997) • Historic Mosque City of Bagerhat (1985) • Ruins of the Buddhist Vihara of Paharpur (1985) Project components will make sure that site selection will not affect these sites.

Source: ADB Consultant, November 2015

2.2 Environmental Requirements of Asian Development Bank and the Asian Infrastructure Investment Bank

62. This section discusses the key elements of the environmental requirements of ADB and the cofinancier, AIIB applicable to the Project.

2.2.1 Asian Development Bank

63. SPS 2009 provides for the environmental requirements and review procedures of ADB and applies to all projects and grants they finance. SPS 2009 comprises three key safeguard areas: environment, involuntary resettlement, and indigenous peoples; and aims to avoid adverse project impacts to both the environment and the affected people; minimize, mitigate and/or compensate for adverse project impacts; and help Borrowers to strengthen their safeguard systems and to develop their capacity in managing the environmental and social risks.

64. At the project identification phase, ADB uses a categorization system to indicate the significance of potential environmental impacts and is determined by the category of its most environmentally-sensitive component, including direct, indirect, cumulative, and induced impacts

within the project's area of influence. The project categorization system is described in **Table 2.3**.

Table 2.3 Environmental Classification According to SPS 2009

Category	Definition	Assessment Requirement
A	Likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented, and may affect an area larger than the sites or facilities subject to physical works.	Environmental impact assessment (EIA)
B	Likely to have adverse environmental impacts that are less adverse than those of Category A. Impacts are site-specific, few if any of them irreversible, and in most cases mitigation measures can be designed more readily than Category A.	Initial Environmental Examination (IEE)
C	Likely to have minimal or no adverse environmental impacts.	No environmental assessment is required but the environmental implications of the project will be reviewed.
FI	Project involves investment of ADB funds to or through a financial intermediary (FI).	FIs will be required to establish an environmental and social management commensurate with the nature and risks of the FI's likely future portfolio to be maintained as part of the FI's overall management system.

Source: ADB. Safeguard Policy Statement 2009, p. 19. <http://www.adb.org/sites/default/files/institutional-document/32056/safeguard-policy-statement-june2009.pdf>.

2.2.2 Asian Infrastructure Investment Bank

65. Established in October 2014 as a multilateral development bank, the Asian Infrastructure Investment Bank (AIIB) puts forward strong policies on governance, accountability, financial, procurement, and environmental and social frameworks.² The Multilateral Interim Secretariat for Establishing the AIIB has developed the Draft Environmental and Social Framework and has completed its public consultations on 23 October 2015. AIIB is expecting to have the Environmental and Social Framework operational by the end of 2015.³

66. The Draft Environmental and Social Framework consist of the environmental and social policy (ESP) and three mandatory environmental and social standards which set out the environmental and social requirements applicable to specific aspects of the AIIB operations.⁴ The environmental and social standards (ESS) are: Standard 1 – Environmental and Social Assessment, Standard 2 – Involuntary Resettlement, and Standard 3 – Indigenous Peoples.

²AIIB. What is the Asian Infrastructure Investment Bank? <http://www.aiib.org/html/aboutus/AIIB/>. (Accessed 17 November 2015)

³AIIB. Consultations on Draft Environmental and Social Framework. http://www.aiib.org/html/theme/Consultations_Draft/. (Accessed 12 November 2015)

⁴AIIB. Draft Environmental and Social Framework, 3 August 2015. <http://www.aiib.org/uploadfile/2015/0907/20150907061253489.pdf>. (Accessed 11 November 2015)

67. ESP is the overarching policy to facilitate the achievement of AIIB's mandate in supporting infrastructure development and in enhancing connectivity in Asia by integrating sound environmental and social management into its operations. Based on the ESP and ESS, AIIB classifies its projects according to four categories indicated in **Table 2.4**.

Table 2.4 Draft Environmental Classification of AIIB

Category	Definition	Assessment Requirements
A	Likely to have significant adverse environmental and social impacts that are irreversible, diverse or unprecedented that may affect an area larger than the sites or facilities subject to physical works.	Environmental and social impact assessment (ESIA) and an environmental and social management plan included in the ESIA
B	It has a limited number of potential adverse environmental and social impacts; the impacts are not unprecedented, and are neither irreversible nor cumulative; they are limited to the area of the operation; and have been successfully managed using good practice in an operational setting.	AIIB determines the specific environmental and social assessment requirements on a case-by-case basis.
C	It is likely to have minimal or no adverse environmental and social impacts.	No need for ESIA but a review of the environmental and social implications of the operation is required.
FI	Involves financing to or through a financial intermediary (FI)	---

Source: AIIB. Draft Environmental and Social Framework, 3 August 2015, p.8.

68. The ADB and the AIIB agreed to adopt SPS 2009 as the single environmental and social assessment and planning process for a unified documentation, consultation, and disclosure requirements to be complied by the EAs. SPS 2009 has 11 environmental safeguard principles and **Table 2.5** presents a comparison of the environmental safeguard principles of ADB, AIIB, and the GoB. Generally, the environmental requirements of ADB and the AIIB are similar. However, compared to the GoB requirements, there are several gaps (e.g., setting up of grievance redress mechanism and public disclosure of environmental reports) but can be readily addressed and complied with by the EAs.

Table 2.5 Comparison of Environmental Safeguard Principles

ADB			AIIB	GoB
SPS 2009			Draft Environment and Social Framework (3 August 2015)	
Principles	Delivery Process			
1	Use of screening process to determine the appropriate environmental assessment	Uses sector-specific rapid environmental assessment checklist for screening and assigns categories based on potential impacts: <ul style="list-style-type: none"> A - EIA required (irreversible, diverse or unprecedented adverse 	Assigns categories based on potential social and environmental impacts <ul style="list-style-type: none"> A – likely to have significant adverse environmental and social impacts that are irreversible, diverse or unprecedented; Environmental and Social Impact Assessment 	<ul style="list-style-type: none"> ECA 1995 and ECR 1997 set screening criteria to classify industries/projects based on potential environmental impacts as follows: <p>Green (pollution-free), Orange-A, Orange-B and Red (cause significant environmental impacts).</p>

ADB			AIIB	GoB
SPS 2009			Draft Environment and Social Framework (3 August 2015)	
Principles		Delivery Process		
		environmental impacts) • B - IEE required • C - no environmental assessment required but a review of environmental implications • FI - ESMS required	(ESIA) required • B - limited number of potential adverse environmental and social impacts, not unprecedented, and are neither irreversible nor cumulative, limited to the area of the operation, and have been successfully managed using good practice in an operational setting; specific environmental and social assessment requirements on a case-by-case basis • C – minimal or no adverse impact; no assessment required but implications reviewed • FI – Involves financing through FI	These screening criteria are based on project or industry type and do not consider the scale and location. The category determines the level of environmental assessment.
2	Conduct an environmental assessment	• EIA and IEE - Identify potential impacts on physical, biological, physical cultural resources, and socioeconomic aspects in the context of project's area of influence (i.e., primary project site and facilities, and associated facilities) • ESMS for FIs	• ESIA - Identify potential direct, indirect, cumulative and induced environmental and social risks and impacts to physical, biological, socioeconomic (including impacts on livelihood through environmental media, health and safety, vulnerable groups, and gender) and cultural resources in the context of the Operation's area of influence	<i>Industry/project category</i> <i>Green</i> - no environmental assessment required <i>Orange A</i> - no IEE or EIA required but must provide process flow, lay-out showing effluent treatment plant, etc. <i>Orange B</i> - IEE required <i>Red</i> - both IEE and EIA are required
3	Examine alternatives	• Analyze alternatives to the project's location, design, and technology • Document rationale for selecting the particular project location, design, and technology • Consider "no project" alternative	• Examine alternatives in terms of location, design, technology and components, and their potential environmental and social risks and impacts. • Consider "no project" alternative • Document rationale for selecting particular alternative proposed	• Regulations (i.e., ECA 1995 and ECR 1997) do not require specifically the identification and analysis of alternatives
4	Prepare an environmental management plan (EMP)	• EMP to include monitoring, budget and implementation arrangements	• Environmental and social management plan (ESMP) to be included in the ESIA	• EMP and procedures included in the IEE and EIA (i.e., Orange-A, Orange-B, and Red category projects)
5	Carry out meaningful consultation	• Starts early and continues during implementation • Undertaken in an atmosphere free of intimidation • Gender inclusive and responsive • Tailored to the needs of vulnerable groups • Allows for the	• Begins early in the project preparation stage, is to be carried out on an ongoing basis throughout the implementation • Undertaken in an atmosphere free of intimidation or coercion • Gender inclusive, responsive and tailored to the needs of vulnerable groups • Incorporation of all relevant views of people affected and	• Public consultation and participation are not mandatory based on ECA 1995 and ECR 1997 • Grievance redress mechanism is not mentioned in ECA 1995 and ECR 1997 • EIA format required by DOE includes stakeholders consultation

ADB			AIIB	GoB
SPS 2009			Draft Environment and Social Framework (3 August 2015)	
Principles		Delivery Process		
		incorporation of all relevant views of stakeholders <ul style="list-style-type: none">Establish a grievance redress mechanism	other stakeholders into decision-making. <ul style="list-style-type: none">Set up grievance redress mechanism to receive and facilitate resolution	
6	Timely disclosure of draft environmental assessment (including the EMP)	<ul style="list-style-type: none">Draft EIA report posted on ADB website at least 120 days prior to Board considerationDraft EA/EARF prior to appraisalFinal or updated EIA/IEE upon receiptEnvironmental monitoring report submitted by borrowers upon receipt	<ul style="list-style-type: none">Draft environmental and social assessment reports before appraisal stageFinal or updated environmental and social assessment reports upon receiptEnvironmental and social assessment reports during implementation under the frameworks upon receipt	<ul style="list-style-type: none">No requirement for public disclosure of environmental reports but DOE posts the Minutes of the Meeting on the application for environmental clearance certificate to its website, http://www.doe-bd.org/minutes.php
7	Implement EMP and monitor effectiveness	<ul style="list-style-type: none">Prepare monitoring reports on the progress of EMPRetain qualified and experienced external experts or NGOs to verify monitoring information for Category A projectsPrepare and implement corrective action plan if non-compliance is identifiedRequires submission of quarterly, semi-annual, and annual reports to ADB for review	<ul style="list-style-type: none">Set up procedures to monitor progress of ESMP implementationDocument, submit and disclose monitoring reportsRetain qualified experts to verify monitoring information for Operations with significant risks and impactsUse independent advisory panels or specialist individual experts to monitor implementation of complex Operation	<ul style="list-style-type: none">ECC is subject to annual renewal based on compliance of the conditions set by DOE
8	Avoid areas of critical habitats (use of precautionary approach to the use, development and management of renewable natural resources)	Provides guidance on critical habitats	Avoidance of critical areas included	<ul style="list-style-type: none">ECA 1995 and ECR 1997 identifies ecologically-critical areas and the rules to protect them
9	Use pollution prevention and control technologies and practices consistent with international good practices	<ul style="list-style-type: none">Refers to World Bank's Environmental Health and Safety (EHS) General Guidelines 2007 (or any update)If national regulations differ, more stringent will be followedIf less stringent levels are appropriate in view of specific project circumstances, provide full and detailed justification	<ul style="list-style-type: none">Refers to World Bank Group's EHS General Guidelines 2007 (or any update)	<ul style="list-style-type: none">Ambient and emission standards included in ECA 1995 and ECR 1997

ADB			AIIB	GoB
SPS 2009			Draft Environment and Social Framework (3 August 2015)	
Principles		Delivery Process		
10	Provide workers with safe and healthy working conditions	<ul style="list-style-type: none">Refers to WB EHS General Guidelines 2007 (or any update)	Covers working conditions and community health and safety	<ul style="list-style-type: none">Occupational health and safety standards included in the Factories Act 1965 and the Bangladesh Labour Law 2006.
11	Conserve physical cultural resources (PCR) and avoid destroying or damaging them	<ul style="list-style-type: none">Use of field-based surveys and experts in the assessmentConsult affected communities on PCR findingsUse chance find procedures for guidance	<ul style="list-style-type: none">Use of field-based surveys and experts in assessmentUse “chance find “procedures	<ul style="list-style-type: none">Preservation and protection of cultural resources are within the Antiquities Act 1968.

Source: ADB consultant, November 2015

2.3 Compliance of Component 2 to Environmental Requirements

2.3.1 Requirements of DOE

69. According to Sect 12 of ECA 1995 and ECR 1997, Component 2 is a Red category project requiring an IEE for the issuance of the LCC and an EIA for the ECC (after securing the LCC). GTCL contracted the Center for Environmental and Geographic Information Services (CEGIS), a Public Trust under the Ministry of Water Resources, to prepare the IEE required by the DOE. CEGIS completed the IEE for submission to DOE on 28 February 2016.

2.3.2 Requirements of ADB and AIIB

70. Based on SPS 2009, the Project is category B requiring an IEE. This draft IEE was based on the findings of CEGIS and additional research for available secondary data to meet SPS 2009. Aside from this draft IEE, GTCL will provide ADB a copy of the ECC issued by DOE for Component 2.

3.0 DESCRIPTION OF THE PROJECT

3.1 Need for the project

71. The growing demand for natural gas by the industrial centres in Chittagong, Noakhali, Comilla and adjoining areas is not sustained by the GTCL. At present, the existing Chittagong-Bakhrabad gas transmission pipeline is not adequate to meet the supply of gas for distribution in this region. Due to this supply shortfall, Petrobangla will import liquefied natural gas (LNG) which will come through Maheshkhali and once re-gasified will be transmitted through gas pipeline to Selimpur, Chittagong then to Bakhrabad Gas Metering Station and finally to gas distribution companies. The LNG imports will address the much needed natural gas supply to southeastern Chittagong region. A floating storage and re-gasification unit (FSRU) is being constructed near Maheshkhali to import about 500 million standard cubic feet per day (MMSCFD) of gas and the construction of the terminal is scheduled for completion by 2018. The initial 500 MMSCFD from the FSRU will be transported by the 30 inch, 91 km, Maheshkhali to Anwara pipeline owned and being constructed by GTCL. The regasified LNG will supply the Chittagong area and the balance will be transported through the existing 24 inch pipeline of GTCL. However, additional supply of re-gasified LNG will require gas transmission infrastructure

to facilitate the reliable and stable delivery to gas distribution companies. Implementing the Component 2 will address this infrastructure requirement as this will constitute loop transmission lines between Chittagong and Bakhrabad.

3.2 Location of the project

72. Component 2 will consist of about 181km, 36-inch gas transmission pipeline from Chittagong to Bakhrabad, southeast of Bangladesh. The gas transmission pipeline route will traverse the districts of Chittagong, Feni, and Comilla covering 11 subdistricts (*upazila*). The nearest distance of Component 2 from the border of India is about 10 km. **Figure 3.1** shows the location of the Component 2.



Figure 3.1 Location map of Component 2

3.3 Major components of the project

73. Component 2 will involve the construction of gas transmission pipeline (36-inch, 181 km), nine associated valve stations, a pig launcher, two town border station (TBS), a pig receiver and a metering station. **Figure 3.2** shows the layout of Component 2.

3.3.1 Associated Facilities

3.3.1.1 Source of Natural Gas

74. About 500 MMSCFD of natural gas will come from the re-gasified LNG out of the FSRU under the build-own-operate-transfer basis. Negotiations with Petrobangla and the private investor is ongoing and the International Finance Corporation may likely be one of the funding institutions for the FSRU. The FSRU will be located between 3 km to 8 km offshore from

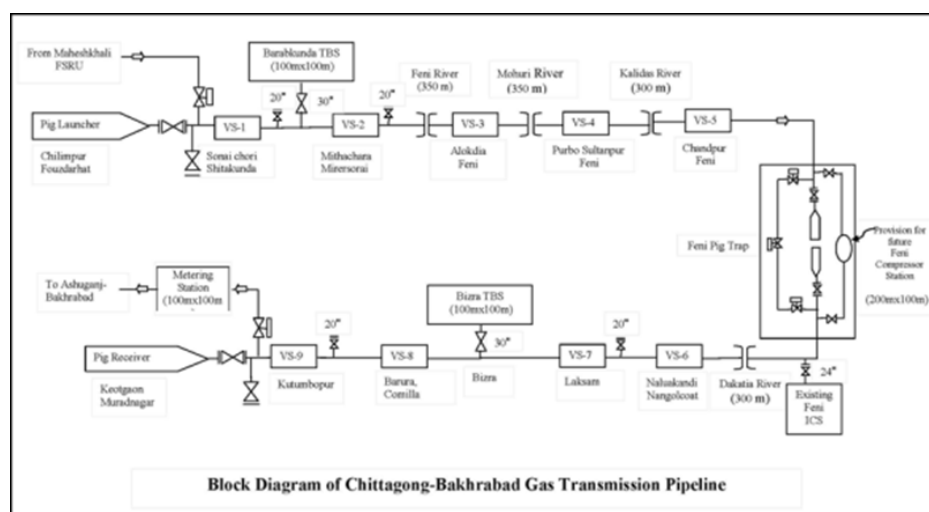
Maheshkhali Island (about 21°33'N, 91°50'E) and would be attached to a mooring system which may include a mooring tower embedded in the seafloor to withstand prevailing currents, winds and sea conditions.

3.3.1.2. Evacuation of Natural Gas from FSRU

75. Natural gas from the FSRU will be transmitted to Anwara through the 30-inch, 91 km Maheshkhali-Anwara pipeline being constructed by GTCL. Part of the gas will be fed to Chittagong ring main from Anwara for Chittagong market. GTCL will construct a 42-inch, 30 km transmission pipeline from Anwara to Faujdarhat across river Karnaphuli for supplying regasified LNG into the national network after meeting the requirements in Chittagong.

76. The construction of both the Maheshkhali-Anwara and the Anwara-Faujdarhat pipelines will be completed in 2017 and the private sector FSRU will be completed in 2018. At Faujdarhat, the remaining gas will be fed into the existing 24-inch Bakhrabad-Chittagong pipeline for onward transmission to other market areas until the proposed project is completed. Another pipeline will be constructed from Maheshkhali to Anwara (36-inch, 81 km) in the future for transmitting additional regasified LNG into the network from other projects planned for construction in the Maheshkhali area in both public and private sectors. The LNG terminal together with the Maheshkhali-Anwara and the Anwara-Faujdarhat transmission pipelines are considered as associated facilities to the Chittagong-Feni-Bakhrabad transmission pipeline proposed for financing under Component 2 as natural gas would not otherwise be available for transmission through the pipeline.

77. **Figure 3.3** graphically presents the arrangements for gas supply of Component 2. A custody transfer metering station (CTMS) is being installed at Maheshkhali for channeling LNG to the Maheshkhali-Anwara pipeline. The CTMS will also cater to future LNG supply at Maheshkhali from other sources. A city gate station (CGS) will be installed at Anwara and a regulating and metering station (RMS) will be installed at Salimpur near Faujdarhat where the gas will be fed into the Chittagong-Bakhrabad pipeline. The existing intermediate compressor station (ICS) in operation at Feni will facilitate transmission of the gas at the required pressure for distribution among consumers enroute to Bakhrabad.



Source: GTCL

Figure 3.2 Layout of Component 2

78. The features of Component 2, its location, and existing land use are given in **Table 3.1** (refer to Figure 3.1 for location). **Figure 3.1** also shows the existing incident command system (ICS) in Feni. ICS is a key component in organizing and coordinating response during emergency situation. An area of about 2 ha is planned for future compressor station at Feni. Compression station allows for the natural gas to continue flowing through the pipeline and facilitate transmission. The technical specifications of the compressor station depends on several factors such as capacity or volume of the natural gas to be transported, operating pressure of the gas pipeline system, diameter of the pipe used, and changes in the elevation along the route. At this stage, the technical specifications for the future Feni compressor station are not yet available.

Table 3.1 Summary of Project Components

Component	Location	Existing land use
Pig launcher	Pig launcher at Selimpur, Fouzdarhat, Chittagong	Agricultural land
Valve station (VS)	VS1: Sonai Chari, Sitakunda	Agricultural land
Town border station (TBS)	Miresorai TBS	Agricultural land
Valve station	VS2: Mithachhara, Miresorai	Agricultural land
Valve station	VS3: Alokedia, Feni	Agricultural land
Valve station	VS4: Purba Sultanpur, Feni.	Agricultural land
Valve station	VS5: Chandpur, Sagolnaya, Feni	Agricultural land
Compressor station	Compressor station at Feni (not funded by the project but will be part of GTCL's future plan)	Agricultural land
Valve station	VS6: Naluakandi, Nangolkot, Comilla	Agricultural land
Valve station	VS7: Laksam	Agricultural land
TBS	TBS at Bizra, Comilla	Agricultural land
Valve station	VS8: Barura, Comilla	Agricultural land
Valve station	VS9: Kutumbopur, Comilla	Agricultural land
Pig receiver and metering station	Pig receiver and metering station at Keotgaon, Muradnagar	Agricultural land

3.4 Overview of the Chittagong-Bakhrabad gas transmission pipeline

79. Natural gas pipelines are usually of three types - gathering pipelines, transmission pipelines, and distribution pipelines. The gas pipeline for the Chittagong-Bakhrabad (C-B) will be 36-inch in diameter, about 181 km in total length and will be made of carbon steel and buried underground about 2.7 m depth (but depends on the ground except in river crossing).

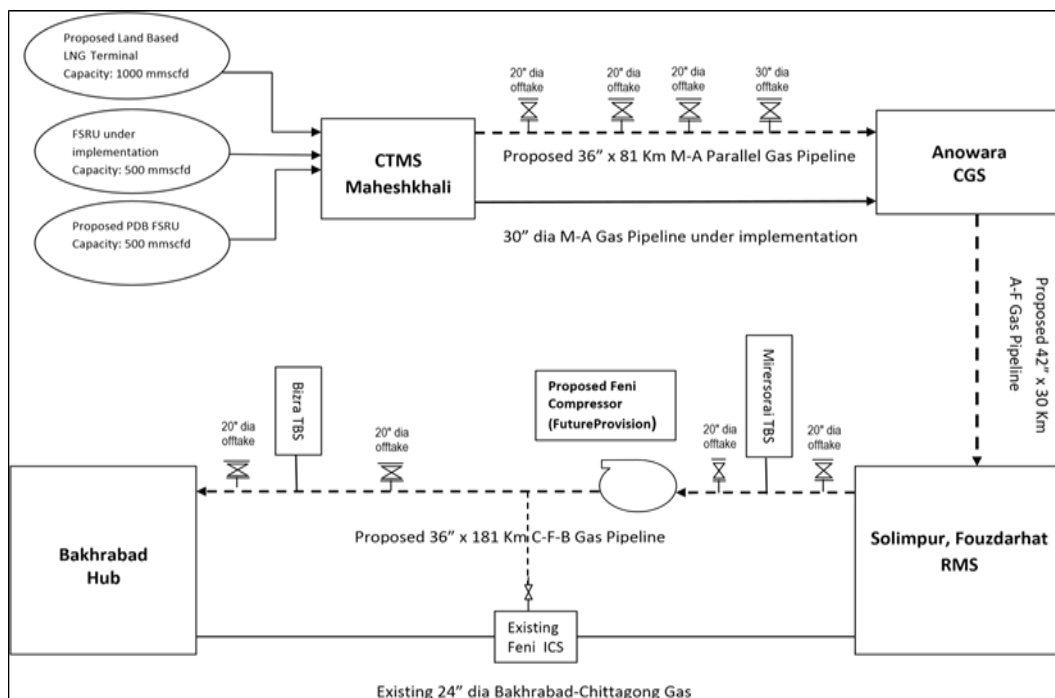
3.4.1 Pipeline Components

80. The C-B gas transmission pipeline will be a network of several components that will operate together to move natural gas from Chittagong to Bakhrabad (see Figure 3.2).

81. *Chilimpur gas injection point and pig launching station* Liquefied natural gas (LNG) will be received at the floating storage and re-gasification unit (FSRU) in Maheshkali. After receiving

the LNG, it will be re-gasified for onward transmission to Sonai Chari valve station (may be considered as injection point for this project). At Selimpur, a pig launcher (for cleaning inner side of the transmission pipe line periodically) will be installed.

82. *Compressor station (not funded by Component 2 but is part of future plans by GTCL)*
Compressors ensure that natural gas remains pressurized to facilitate transmission along the pipeline. A compressor is planned in the future between Chandpur and Feni.



Source: GTCL

Figure 3.3 Block diagram from FSRU to Component 2

83. *Town bordering station (TBS)* The TBS will allow metering of the gas being transported and reduces the pressure from that of the transmission pipeline to the corresponding pressure of the distribution system. Two TBS will be included in Component 2 and will be constructed in Barabkunda and Bizra.

84. *Block valve station* Block valves are used to isolate a segment of the main gas pipeline. These valves allow isolation of a segment of the main pipeline for maintenance work, rupture or leak. They are usually located every 30 -50 km depending on the product being transported, trajectory of the pipeline, and/or the operational conditions of the pipeline. Nine block valve stations will be installed for Component 2 (refer to Table 3.1).

85. *Regulator station* Serves to protect the pipeline system and ensures that it operates safely by reducing the gas pressure as it flows to the system (i.e., release some pressure that built into the pipeline).

86. *Metering station and pig receiver* At the terminal delivery station of Component 2 in Keotgaon, Muradnagar, there will be a metering station prior to Ashuganj-Bakhrabad gas transmission pipeline and a pig receiver. The metering station will allow GTCL to monitor,

manage, and account for the natural gas flow from the Chittagong-Bakhrabad gas transmission pipeline before it connects to the existing Ashuganj-Bakhrabad gas transmission pipeline. The pig receiver will allow the exit of the pig from the pipeline and will be equipped with safety valves and locking system to prevent accidents.

3.4.2 Pipeline Operation

87. When a gas transmission pipeline is built, the construction activities cover civil works to lay down or bury the pipeline but will also involve the installation of field devices needed to support the remote operation of the pipeline networks. These field devices include instrumentation, data gathering units, and communication systems. Field instrumentation consists of flow, pressure and temperature gauges/transmitters as well as other devices to measure the relevant data required to operate. The field instruments are installed along the pipeline at designated locations such as delivery stations, compressor stations and block valve stations.

88. The measurements from these field instruments are gathered in local remote terminal units (RTU) that transfer the field data to a central location in real time using communication systems, such as satellite channels, micro wave links, conventional telephone lines or cellular phone connections. This instrumentation network is a specialized communication system (also known as supervisory control and data acquisition or SCADA) which will allow GTCL to monitor, control and manage certain equipment in the C-B gas transmission pipeline remotely or manually from the centralized gas control facility or main control room. SCADA transmits data on operating status, flow volumes, pressure and temperature from the metering and regulator station, valves and compressor station to the main control room. **Figure 3.4** shows a typical SCADA configuration in a gas transmission pipeline.

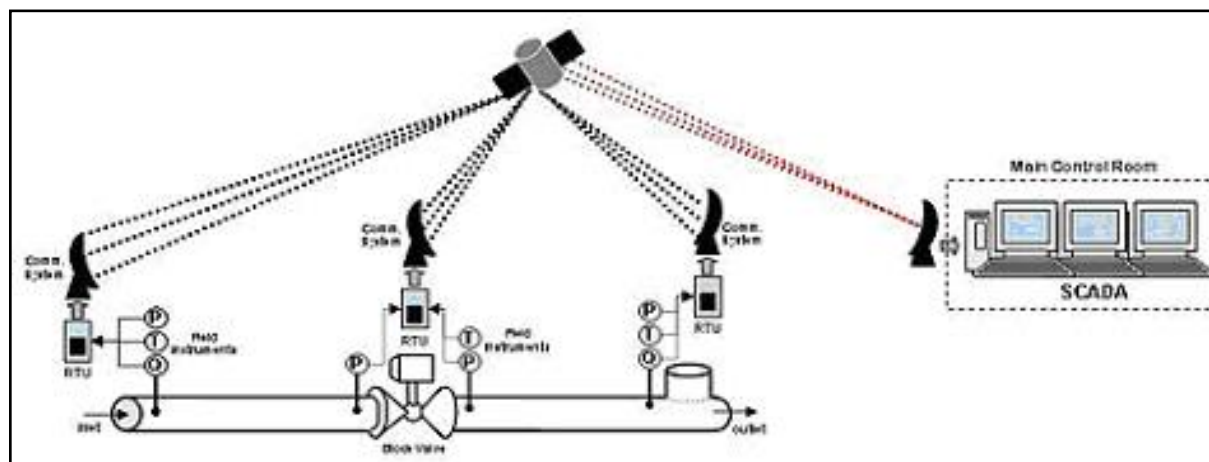


Figure 3.4 SCADA system for a gas transmission pipeline

3.5 Project activities

89. The major activities of Component 2 are as follows: (i) C-B pipeline route survey, (ii) land acquisition and requisition activities, (iii) detailed drawing and design, (iv) procurement of materials, (v) temporary storage and stockyard, (vi) equipment and vehicle mobilization, (vii) pipeline construction, and (viii) pipeline testing and commissioning

3.5.1 Pre-Construction Phase

90. At the pre-construction phase, the following activities will include:

91. *Pipeline route survey* Factors such as access to the pipeline from the main road, river crossing, railroad and major road crossings were taken into consideration in selecting the pipeline route for detailed survey. Other factors include presence of ecologically-sensitive areas and settlements. The working width of the pipeline (from the centerline) will be 23 meters (m), out of which 8 m will be permanently acquired as right-of-way (RoW) and 15 m will be temporarily acquired (requisitioned) as works pace for pipe-laying on one side of the pipeline.

92. *Preparation of land acquisition and requisition plan* The acquisition area will be 4m and 4 m on each side of the pipeline (total of 8 m). Requisition area (or construction RoW) will be 6m on the right side of the pipeline and 9m on the left side from the end point of RoW. **Figure 3.5** shows the acquisition and requisition area. Once the pipeline route is selected together with the RoW and requisition area, the acquisition and requisition plan will be submitted to the office of the District Commissioner to start the land valuation process.

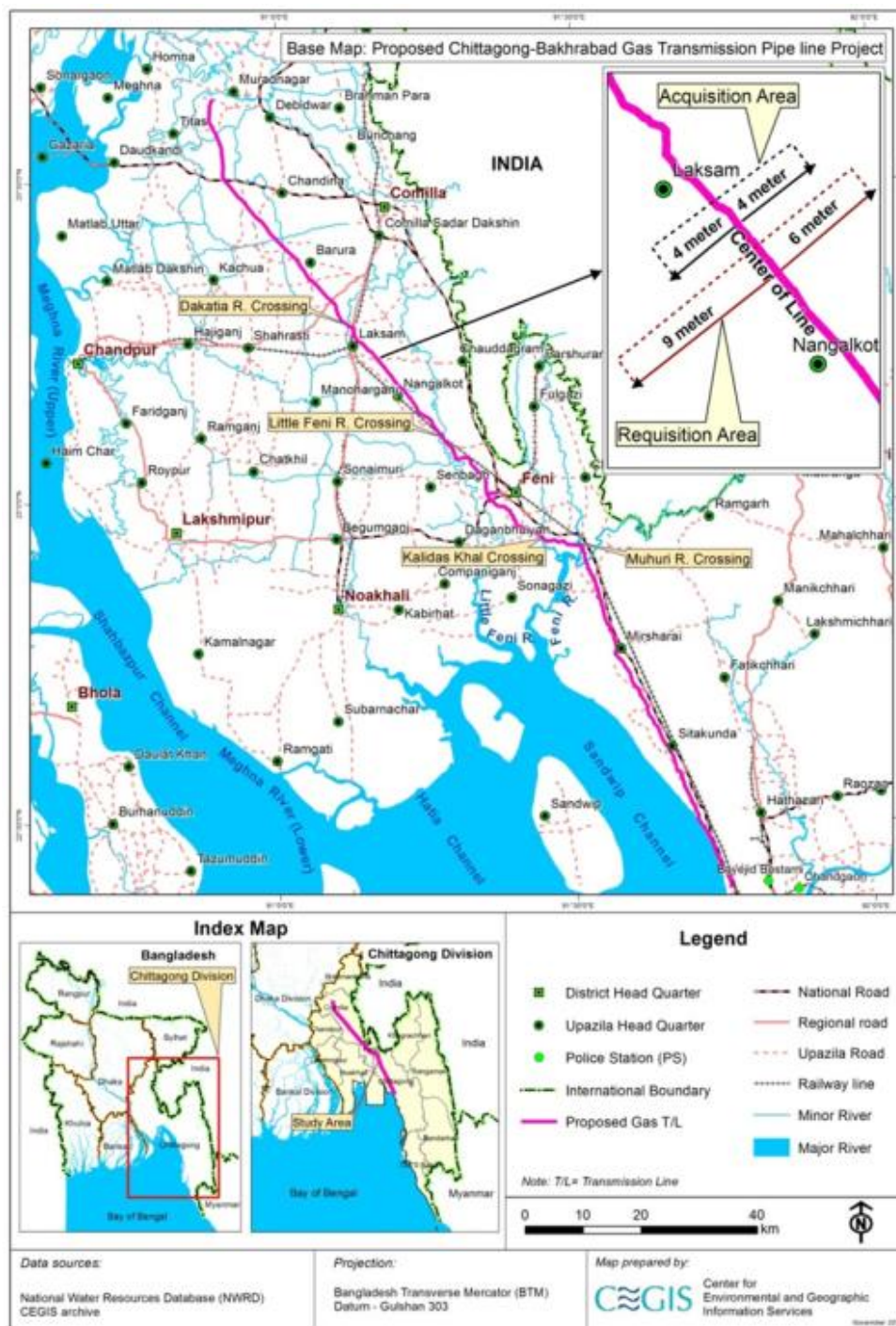


Figure 3.5 Acquisition and requisition areas

93. *Detailed drawing and design* Pipeline construction must conform to Bangladesh Mineral Gas Safety Rules of 1991 (as amended in 2003). Both social and environmental factors were considered in finalizing the pipeline route selection and design of Component 2.

94. *Procurement of materials* Office furniture, machinery, accessories, pipeline materials, etc. will be purchased following the procurement guidelines of GoB and ADB.

95. *Temporary storage and stockyard* A temporary storage and stockyard will be set up to keep the pipes, machinery, equipment and other support materials to facilitate construction activities.

96. *Equipment and vehicle mobilization* Vehicles will be required prior to start of construction works. The vehicles, equipment and machinery will be inspected and assessed on their current condition to ensure that they are working properly prior to start-up of the project. Regular inspection will be done to machinery and equipment such as grader, dozer, side booms, trenching machine, excavators, welding machines, water pumps, dump trucks, crane, horizontal directional drilling (HDD) machine, tools, etc.

3.5.2 Construction Phase

97. During this phase, major activities include site preparation, staking of the RoW, excavation, trenching, pipeline stringing, welding, back-filling, testing and commissioning, and clean-up. These major activities will be scheduled efficiently to ensure the completion of the total pipeline construction within the dry working season.

98. EPC Contractor will be selected following the guidelines and procedures of ADB and GoB. PIU-GTCL will monitor the performance of the EPC Contractor and supervise the overall implementation of Component 2. Labour force will consist of technical, skilled and unskilled workers and staff. GTCL will require the EPC Contractor to give priority to local labour.

99. *Main working camp* This will include the construction office of the EPC Contractor and will have camps with built-in systems for office accommodation, utilities, waste management, and sanitary facilities. Waste from construction activities will be collected regularly and disposed of at sites designated by GoB. Aside from the PIU-GTCL, selected staff from GTCL at the Dhaka office will also monitor the implementation at the construction sites.

100. *Field camp for workers* These camps will be close to the project activities in the RoW along the pipeline and will be shifted depending on the completion of the required works. The EPC Contractor (in consultation with GTCL) may rent the field camps (with sanitary facilities, water for drinking and general purpose washing, electricity, etc.) during the months that it will be needed. It is estimated that about 100 workers will stay in the field camps. With this scale, conflict with local people on jobs and basic services will be unlikely.

101. *Pipeline route and working areas* The total area that may be affected along the pipeline route will be 10 m on the right side (i.e., 4m for RoW and 6 m for workspace) and 13 m on the left side (i.e., 4 m for RoW and 9 m for workspace) with trench of about 2 m-wide and 2.7 m-deep. Generally, these areas (RoW and workspace) will be cleared during construction phase.

102. *Grading* During route site selection, the slope of the area was considered to minimize grading. However, if needed, grading will be undertaken to have a reasonably level workspace during construction. Grading will be carried out also in areas where the pipeline route cuts across steep slopes to keep a gentler slope for pipe bending limitations.

103. *Pipe diameter factor* Component 2 will have a 36-inch diameter pipeline. Larger pipeline will require a much wider RoW and very accurate bends. The number of tough bends is

kept to the minimum to avoid the use of a specialized bending machine which involves a series of clamps and hydraulic pressure to have smooth and controlled bends in the pipe.

104. *Trench depth factor* The amount of soil excavated from the ditch to meet construction specifications is the main factor in determining the width of RoW with respect to ditch depth. Ditch depth will vary depending on the diameter and operating pressure of the pipeline and applicable codes and regulations. For Component 2 with a 36-inch diameter pipeline, the depth of the trench will be approx. 2.7 m.

105. *Stringing* The pipe will be strung on the RoW that has been cleared and grading has been completed. Stringing will be done through specialized trailers and equipment that haul and lift the pipe off the trailers and then place onto the RoW carefully ensuring not to damage the pipe or its coating. GTCL will require the EPC Contractor to ensure that the pipe is strung properly at designated locations.

106. *Coating of pipeline* The outer side of the pipeline will be coated to prevent moisture from coming into direct contact with steel that may cause corrosion. Coating will be three-layer polyethylene (LPE) for pipeline on normal land and concrete coating for marshy land. Except in the HDD crossings at Dakatia River, Little Feni River, Kalidas Khal, and Muhuri River, all the pipelines will be pre-coated with 3 LPE. Suitable coating for HDD crossings could be fusion bond epoxy (FBE). Pipeline at pond and khal crossing will be pre-coated with concrete weight coating (CWC). **Figure 3.6** shows the LPE and CWC coating for pipeline.



(a) 3-layer polyethylene (LPE) coating



(b) Concrete weight coating

Figure 3.6 Coating on the gas pipeline

107. *River and road crossing* Component 2 will involve four river crossings and four road crossings (see **Figure 3.7**). HDD will be used at the crossings in Dakatia River, Little Feni River, Kalidas Khal, and Muhuri River to minimize environmental impacts. **Figure 3.8** shows the HDD process. Drilling fluid used in HDD will be discharged following Schedule-10 of ECR 1997. The river banks will be properly re-instated and protected from subsequent erosion (if any).



Figure 3.7 Location of river and road crossing

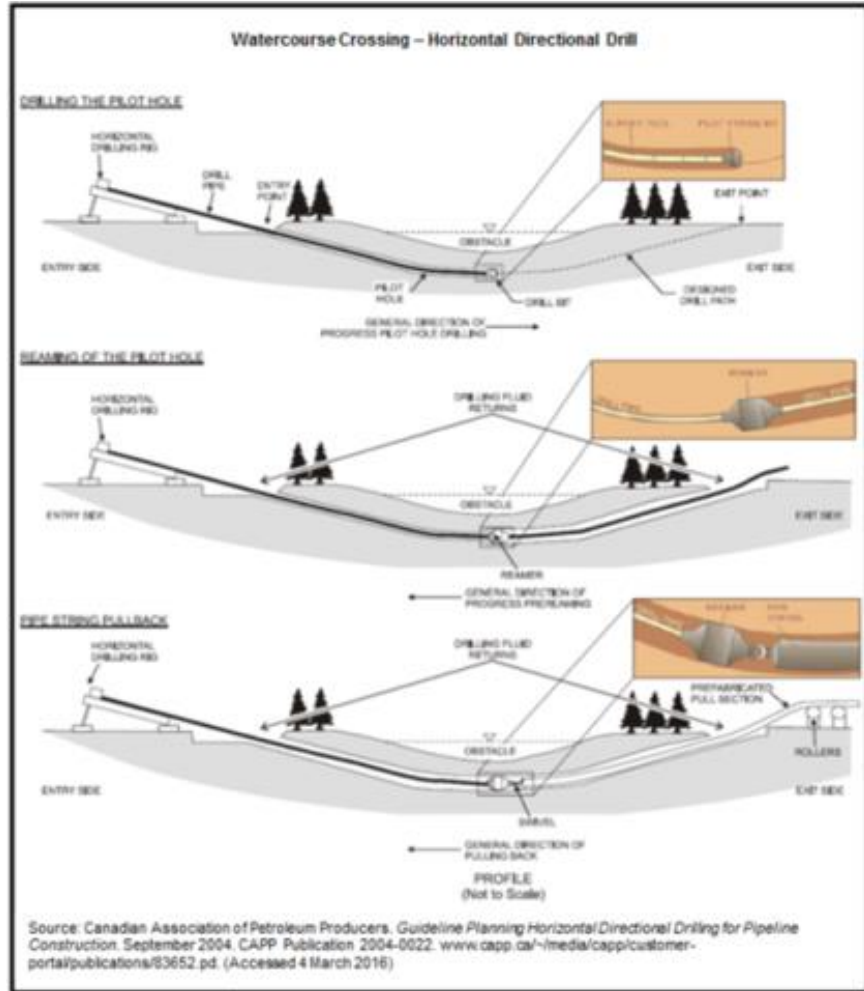
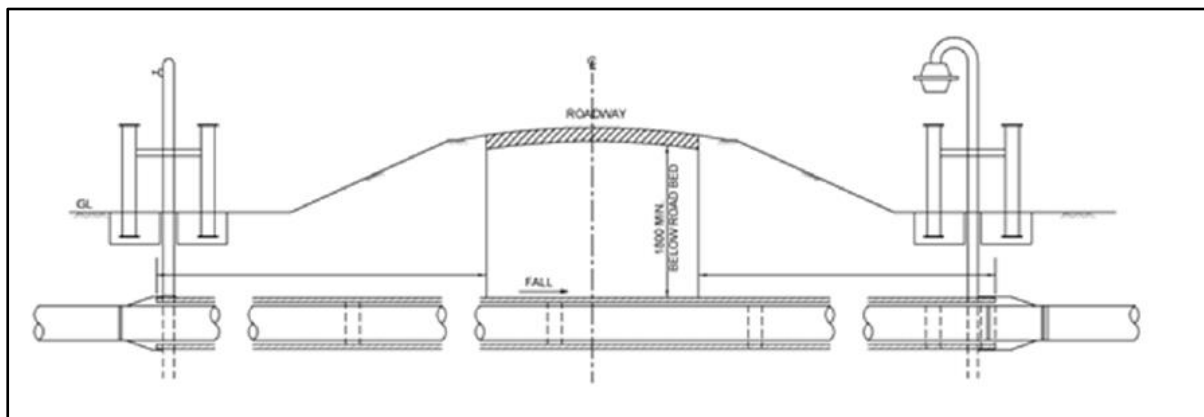


Figure 3.8 Horizontal directional drilling process

108. At road crossings, thrust boring method will be used to avoid disturbance of road grading and interference with traffic arteries (see **Figure 3.9**).



Source: Japan International Cooperation Agency. Preparatory Survey on the Natural Gas Efficiency Project in the People's Republic of Bangladesh. Final Report. March 2014. http://open_jicareport.jica.go.jp/pdf/12149522.pdf (Accessed 29 February 2016)

Figure 3.9 Thrust boring of road crossing

109. *Trenching and trench dimensions* The pipeline will have casing whenever it crosses a highway, rail track, or water body. The minimum depth of cover shall be measured from the top of the pipe to the surface of the working grade. Crown materials along the surface of the ground level will not be considered as a part of the depth of cover. The C-B pipeline will be buried to a depth of about 2.7 m but this will vary depending on the site condition and specifications by the design codes of practices. The trench shall be carefully cut so that the pipe is evenly bedded throughout its length with sufficient joint holes and trial holes made, where necessary. The minimum base width of the trench shall be specified in supplemental/standard drawings. Trenching uses heavy equipment to give enough space for the pipeline to be moved over and lowered into place, and to protect from excavation damage.

110. *Lowering-in* Prior to this, the trench is checked to make sure it is clean from any debris and other foreign material, and dewatered if needed. Lowering-in is conducted following applicable regulations of GoB, and relevant standards and specifications from American Society for Testing and Materials (ASTM), The American Society of Mechanical Engineers (ASME), American National Standards Institute (ANSI), American Petroleum Institute (API), etc. and supervised by skilled operators and engineers. Commencement of the work shall take place as soon as possible after the trench has been excavated. The trench is then backfilled using the excavated material.

111. *Tieing-in* Separate welded joint sections of the pipeline shall be tied into a continuous system in such a manner that no stress will be introduced into the pipe as a consequence of the tieing-in operation and duly certified for integrity upon Non-destructive Testing (NDT).

112. *Cathodic protection* Cathodic protection test points shall be installed and connected to temporary cathodic protection facilities in accordance with the specification at the time of final operation of lowering or tieing-in. The installation shall require inspection before backfill is placed.

113. *Backfilling* Before any backfilling is performed, the pipeline will be evenly bedded upon the bottom of the trench throughout its length and will be correctly positioned. Compaction of back filling material shall be performed by an approved method to prevent any subsequent subsidence.

114. *Re-instatement and clean-up* As soon as the pipeline has been laid and backfilled, the RoW and work areas will be cleaned up to ensure that they are returned to their original condition (before the project) as much as possible.

115. *Placing route markers* Reinforced concrete route markers will be placed on both sides of roads, rail, and river crossings with a specified maximum separation distance between markers. Specifications of other route markers along the pipe line will be also placed.

116. *Installing aerial marker* There will be aerial markers at every horizontal bend and at intervals along the pipeline route based on design specifications and standards.

117. *Hydrostatic testing and dewatering* Prior to commissioning, the entire length of the pipeline will be filled with water to carry out pressure test (also known as hydrostatic testing or hydro testing). This will identify leaks and will ensure that it has adequate safety margin beyond the operating pressure. After successful completion of the hydrotest, water used will be tested prior to discharge to ensure compliance with Schedule 10 (Rule 13) of ECR 1997.

If the water table is high or if needed, dewatering of trenches may be necessary.

118. *Commissioning* After hydrostatic testing and dewatering, the pipeline will be cleaned and dried using mechanical tools (or pigs) moved through the pipeline with the aid of pressurized dry air. The pipeline will be dried to minimize internal corrosion. Once pipeline clean-up is complete, re-instatement/clean-up of RoW is done, installation of RoW markers and aerial markers are finished in accordance to design, standards, and procedures; and acceptable to the Quality Assurance Department, then GTCL will start the operation of the system.

119. *Metering stations and other permanent above-ground facilities* Small permanent pieces of land are required for metering stations, valves/stations, scraper facilities and to provide adequate pipeline clearance at major river crossing. Construction activities for metering stations are similar to those employed for process plants, i.e., site preparation (grading, drainage construction, fencing, etc.) and plant construction/installation.

3.5.3 Operation and Maintenance Phase

120. Once the pipeline is commissioned, it is ready to transport gas at a regulated pressure. Operation and maintenance of C-B gas transmission pipeline will start from the day it is commercially commissioned.

121. Maintenance of the pipeline requires constant vigilance. Emergency maintenance engineers will be trained and be immediately available to repair line breaks, leak clamping, replacement of section of pipes and other necessary repairs along the pipeline route.

122. Patrolmen who will log down any noticeable changes on the RoW will regularly walk along the pipeline route. The pipeline will be protected by impressed current cathodic protection system. Monitoring the potential difference at the pipeline test poles will ensure ongoing cathodic protection. The operation and maintenance activities will include the following:

- Patrolman's RoW recording to ensure that there is no encroachment and no visible problems;
- Ground installations will be regularly checked and maintained, and also detect any leakage from the pipeline and its facilities;
- Pigging of the pipeline, as and when needed. The frequency is usually between 2 to 3 years for the pipelines carrying wet gas.

3.5.3.1 Operation of pipeline/metering station

123. Some of the activities associated with the operation of gas transmission pipelines and metering stations include the following:

- Removal and replacement of the length of a pipeline section, valves, meters, regulators, etc. on occasions for the purposes of inspection, repair and maintenance.
- Regular repair and maintenance.
- Pigging of pipe for cleaning purposes. This is done as part of the operation and maintenance (O & M). Significant waste is generated that requires proper disposal. GTCL transports drier and cleaner natural gas. Wastes from pigging
- Repair and vehicle maintenance in designated workshop areas.
- Proper handling and storage of condensate generated at metering stations.

3.5.4 Environmental considerations

Waste and disposal activities

124. GTCL will take all practical and cost-effective measures to minimize the generation of wastes, by adopting process of reduce, reuse, recycle and recovery through process of optimization or redesign, efficient procedures and good housekeeping.

Solid wastes

125. These types of wastes include cleared vegetation, domestic wastes, scrap materials, welding torches, drums and containers, etc. In line with the waste management procedures, identified solid wastes will be stored and disposed in designated areas. Plastic containers will be either returned to the supplies or recycled.

Chemicals

126. All chemicals used by the project will be listed, stored and ultimately disposed of according to the requirements of safe disposal procedures of GoB and ADB.

Sewage water

127. Black water will be discharged through toilets with septic tank facilities and will follow Schedule-9 of ECR, 1997.

Diesel/oil

128. Oil and water separator will be used to handle liquid waste from repairs of vehicles, equipment and other machinery. These wastes shall be contained and disposed of in designated sites.

Gaseous emissions

129. Vehicular emissions and dust from opened areas along the pipeline route will be generated during construction and installation of the pipeline system. During operation, vehicular emissions will be generated during inspection and maintenance along the pipeline route. Leaks may be expected as the pipeline system ages but there monitoring system and process to ensure that leaks, if any, during transmission will be negligible.

3.6 Proposed project schedule

130. The implementation of Component 2 will be about four years and the proposed schedule is shown in **Figure 3.10** subject to the approval of Development Project Proforma (DPP).

Construction of Chittagong-Bakhrabad Gas Transmission Pipeline Project.

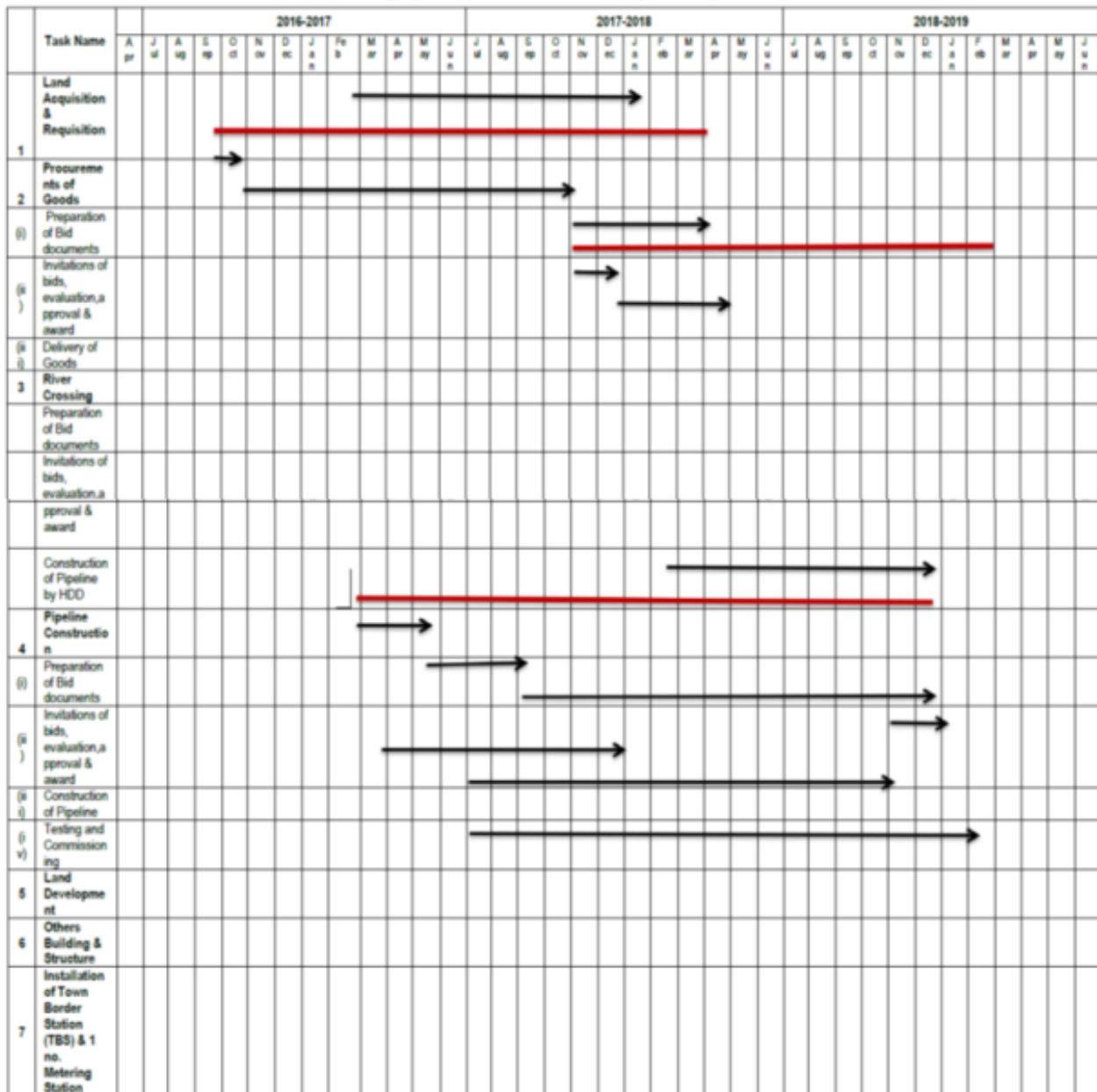


Figure 3.10 Proposed Implementation Schedule

4.0 DESCRIPTION OF THE ENVIRONMENT (BASELINE DATA)

4.1 Project's area of influence

131. For Component 2, the IEE was focused on the area where the physical impacts will be directly felt and a 120 m-strip along the pipeline RoW (i.e., 60 m each side) referred to as the general impact area (GIA).

4.2 Physical Environment

4.2.1 Meteorology

4.2.1.1 Climate

132. The project area is located in a typical monsoon climate area within Bangladesh. It has three main seasons:

- Summer/pre-monsoon - March to May
- Rainy season/monsoon - June to October
- Winter season - November to February

133. The rainy season is hot and humid having about 80% of the annual rainfall. The winter is predominantly cool and dry. The summer is hot and dry interrupted by occasional heavy rainfall. Component 2 will be within the Southeast hydrological region of Bangladesh and will run over three districts: Chittagong, Feni and Comilla where monsoon comes in July and recedes in late October. The meteorological data recorded from 1980 to 2013 at the Bangladesh Meteorological Data (BMD) stations in Chittagong, Feni and Comilla were used to describe the climatic condition within the area covered by Component 2.

4.2.1.2 Rainfall

134. The results of average monthly rainfall analyses for Chittagong, Feni and Comilla station are given in **Figure 4.1**, **Figure 4.2** and **Figure 4.3**, respectively. The pre-monsoon and monsoon periods undergo significant rainfall whereas the dry period experiences little or no rainfall.

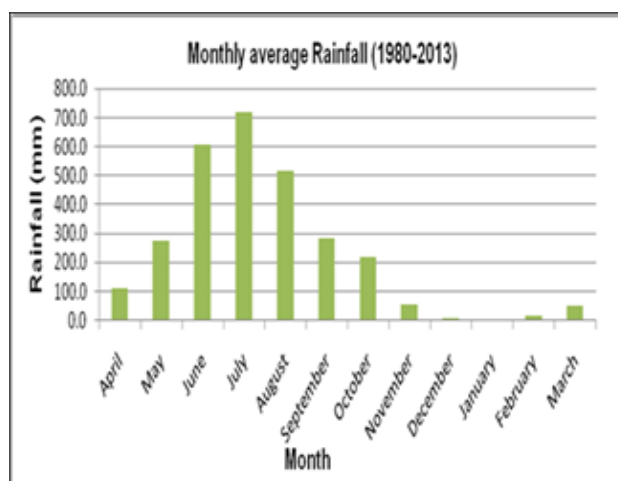


Figure 4.1 Monthly average rainfall at Chittagong BMD station

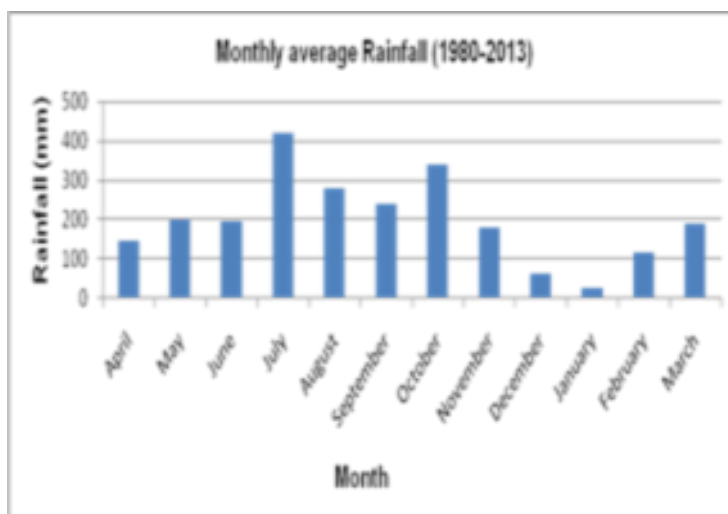


Figure 4.2 Monthly average rainfall at Feni BMD station

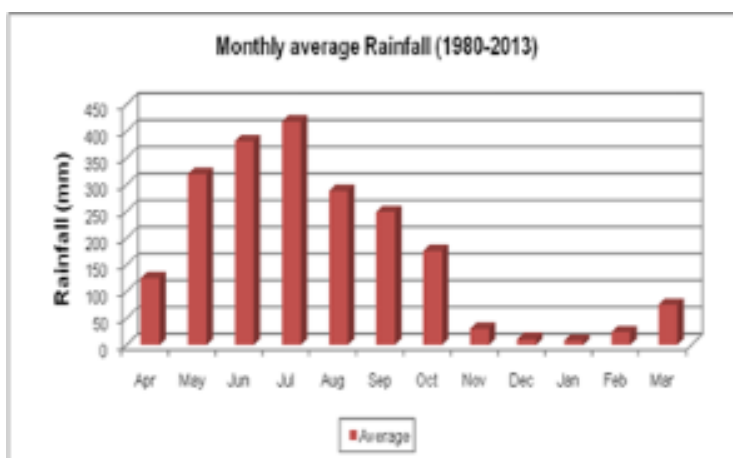


Figure 4.3 Monthly average rainfall at Comilla BMD station

4.2.1.3 Temperature

135. The average values of maximum and minimum monthly temperature have also been studied for Chittagong, Feni and Comilla station. Results show that the warmest month is April in Chittagong BMD station at 39.4°C and coolest in January at an average temperature of 9.2°C. At the Feni BMD station, maximum temperature observed in May is 38.8°C and minimum temperature at 7.1°C in January. At the Comilla BMD station, the warmest month is May (34.39°C) and the coolest month is January (10.09°C).

4.2.1.4 Humidity

136. The range of average humidity from the three BMD stations is 64% to 88%. The most humid months are June, July, August, September and October with humidity ranging from 82% to 88 %.

4.2.1.5 Evaporation

137. Mean monthly evaporation rates range from 1.9 mm/day to 4.8 mm/day where the highest values were observed in March and the lowest in January.

4.2.1.6 Wind speed

138. The monthly average wind speed varies from 48 km/day to 412 km/day which is highest in June to July and lowest in November to December.

4.2.1.7 Air quality

139. There are no available secondary data on ambient air quality in the project's area of influence. Ambient air quality may be affected temporarily and of short duration during construction phase of Component 2. Prior to any construction works particularly earthmoving, baseline ambient air quality measurements will be conducted at strategic locations considering the wind direction. Parameters will include particulate matter (PM_{2.5} and PM₁₀), carbon monoxide (CO), sulfur dioxide (SO₂) and nitrogen dioxide (NO₂).

140. The DOE conducts regular ambient air quality monitoring through their Clean Air and Sustainable Environment (CASE) Project covering eight cities in Bangladesh with 11 continuous air sampling stations.⁵ The CASE project, funded by the World Bank started in May 2009 and will be until December 2016. Monthly monitoring results were posted in their website for public information from November 2011 until January 2016.

141. The eight cities include: Dhaka, Gazipur, Narayagonj, Chittagong, Sylhet, Khulna, Rajshahi, and Barisal. Dhaka has three monitoring stations, Chittagong has two stations and the rest of the cities have one station each. Parameters being monitored in these stations include: PM₁₀, PM_{2.5}, CO, SO₂, NO₂, O₃, and hydrocarbons (HC). In Chittagong stations, only PM₁₀, PM_{2.5}, CO, SO₂, NO₂, and O₃ are measured. Monitoring results in January 2016 showed that both the stations in Chittagong did not meet the limits for PM₁₀ and PM_{2.5} (see **Table 4.1**).⁶

Table 4.1 Ambient air quality at Chittagong, January 2016

Parameter	National Ambient Air Quality Standards	Unit	Station	
			TV Station, Khulshi	Agrabad
SO ₂ - 24 hr	140	ppb	DNA	20.4
NO ₂ - 24 hr	53 (annual)	ppb	---	6.66
CO-1hr	35	ppm	1.22	1.83
CO-8hr	9	ppm	1.22	1.82
O ₃ - 1hr	120	ppb	7.31	14.8
O ₃ - 8hr	80	ppb	7.33	14.8

⁵Ministry of Environment and Forests.Clean Air and Sustainable Environment Project.http://case.doe.gov.bd/index.php?option=com_content&view=article&id=5&Itemid=9. (Accessed 24 February 2016)

⁶http://case.doe.gov.bd/index.php?option=com_content&view=article&id=5&Itemid=9. (Accessed 14 March 2016)

Parameter	National Ambient Air Quality Standards	Unit	Station	
			TV Station, Khulshi	Agrabad
PM _{2.5} - 24hr	65	µg/m ³	DNA	145
PM ₁₀ - 24hr	150	µg/m ³	367	216

Note: DNA – analyzer malfunctioned

142. The first ambient air quality standards were given in ECR 1997 based on categories (i.e., industry, residential and rural, etc.) but these limits were replaced in July 2005 by a new set according to the World Bank-funded Air Quality Management Project which reviewed the standards from ECR 1997. The new standards are Particulate Matter (PM₁₀, PM_{2.5}), NO₂, SO₂, CO, and ozone (O₃) which are the same as the ambient air quality limits set by the US Environment Protection Authority while the limit for lead (Pb) is from the guideline value set by the World Health Organization. **Table 4.2** presents a comparison of national ambient air quality standards, WHO, and US EPA.⁷

Table 4.2 Comparison of ambient air quality standards

Pollutant	Averaging Period	Bangladesh Standards ^a	WHO ^b Guideline Values (µg/m ³)	US EPA Standards (µg/m ³) ^d
CO	8-hour	10,000 µg/m ³ (9 ppm)	10,000 ^c	10,000
	1-hour	40,000 µg/m ³ (35 ppm)	30,000 ^c	40,000
Pb	Annual	0.5 µg/m ³	0.5	-
NO _x	Annual	100 µg/m ³ (0.053 ppm)	-	-
TSP	8-hour	200 µg/m ³	-	-
PM ₁₀	Annual	50 µg/m ³	20	revoked
	24-hour	150 µg/m ³	50	150
PM _{2.5}	Annual	15 µg/m ³	10	15
	24-hour	65 µg/m ³	25	35
O ₃	1-hour	235 µg/m ³ (0.12 ppm)	-	235
	8-hour	157 µg/m ³ (0.08 ppm)	100	157
SO ₂	Annual	80 µg/m ³ (0.03 ppm)	-	78
	24-hour	365 µg/m ³ (0.14 ppm)	20	365

CO = Carbon monoxide; NO_x = Nitrogen oxide; O₃ = ozone; Pb = lead; PM₁₀ = particulate matter with a diameter of not more than 10 microns; PM_{2.5} = particulate matter with a diameter of not more than 2.5 microns; SO₂ = Sulfur dioxide; S.R.O. = US EPA = United States Environmental Protection Agency; TSP = total suspended particulates; WHO = World Health Organization; µg/m³ = micrograms per cubic meter; ppm = parts per million; - = no value
Source: ^aS.R.O. No: 220-Law,2005; ^bWHO, 2005; ^cWHO, 2000; and ^dUS EPA, 2006.

4.2.1.8 Noise

143. Noise level measurements during daytime were done in December 2015 by CEGIS and are given in **Table 4.3** while **Figure 4.4** shows the sampling locations. **Table 4.4** gives the limits to ambient noise level according to Schedule 4 of ECR 1997.

⁷ADB. December 2006. Country Synthesis Report on Urban Air Quality Management. Bangladesh.Discussion Draft.http://cleanairasia.org/wp-content/uploads/portal/files/documents/bangladesh_0.pdf. (Accessed 4 August 2016)

Table 4.3 Daytime noise levels at the study area

Sl. No.	Location	Maximum noise level, dB(A)	Coordinates
1	Uttar Salimpur	49.1	22°24'08.6"N 91°45'17.6"E
2	Tawaku	44.3	22°24'48.8"N 91°44'56.1"E
3	Jahanabad	45.3	22°24'48.8"N 91°44'56.1"E
4	Sonaichari	46.2	22°28'38.6"N 91°43'03.2"E
5	Boalia	43.9	22°32'37.9"N 91°41'13.3"E
6	Ghoramara	46.5	22°29'06.2"N 91°42'50.4"E
7	Pachgachia	45.9	22°35'44.4"N 91°39'41.4"E
8	Wahedpur	48.8	22°42'59.6"N 91°35'30.9"E
9	Duaru	52.1	22°44'44.6"N 91°34'41.4"E
10	Mirsharai	54.2	22°48'16.5"N 91°33'19.6"E
11	Amirabad	47.3	22°36'47.1"N 91°39'2.2"E
12	Kedarkhil	51.8	22°38'11.5"N 91°38'14.2"E
13	Faradpur	53.5	22°40'40.2"N 91°36'56.2"E
14	Muradpur	45.2	22°49'58.2"N 91°32'35.6"E
15	Hinguli	46.7	22°53'25.9"N 91°31'13.3"E
16	Gobindapur	48.9	22°29'06.2"N 91°42'38.4"E
17	Aliara	42.6	23°08'24.6"N 91°14'16.7"E
18	Langolkot	47.2	23°10'26.4"N 91°12'44.4"E
19	Cho ori	49.4	23°20'55.4"N 91°03'25.8"E
20	Bakhrabad	52.8	23°37'45.9"N 90°52'13.4"E

Source: CEGIS field survey, December 2015

144. Based on the zone class for noise limits, the area can be considered as predominantly residential and the daytime limit of 50 dB(A) was exceeded in Duaru, Mirsharai, Kedarkhil, Faradpur and Bakhrabad. Existing sources of ambient noise within the area are the presence of bazar and vehicular movements.

Table 4.4 Standards of noise levels for different zones of Bangladesh

Zone Class	Limits in dB(A)	
	Daytime	Nighttime
	(6 am – 9 pm)	(9 pm-6 am)
Silent zone	45	35
Residential zone	50	40
Mixed	60	50
Commercial zone	70	60
Industrial zone	75	70

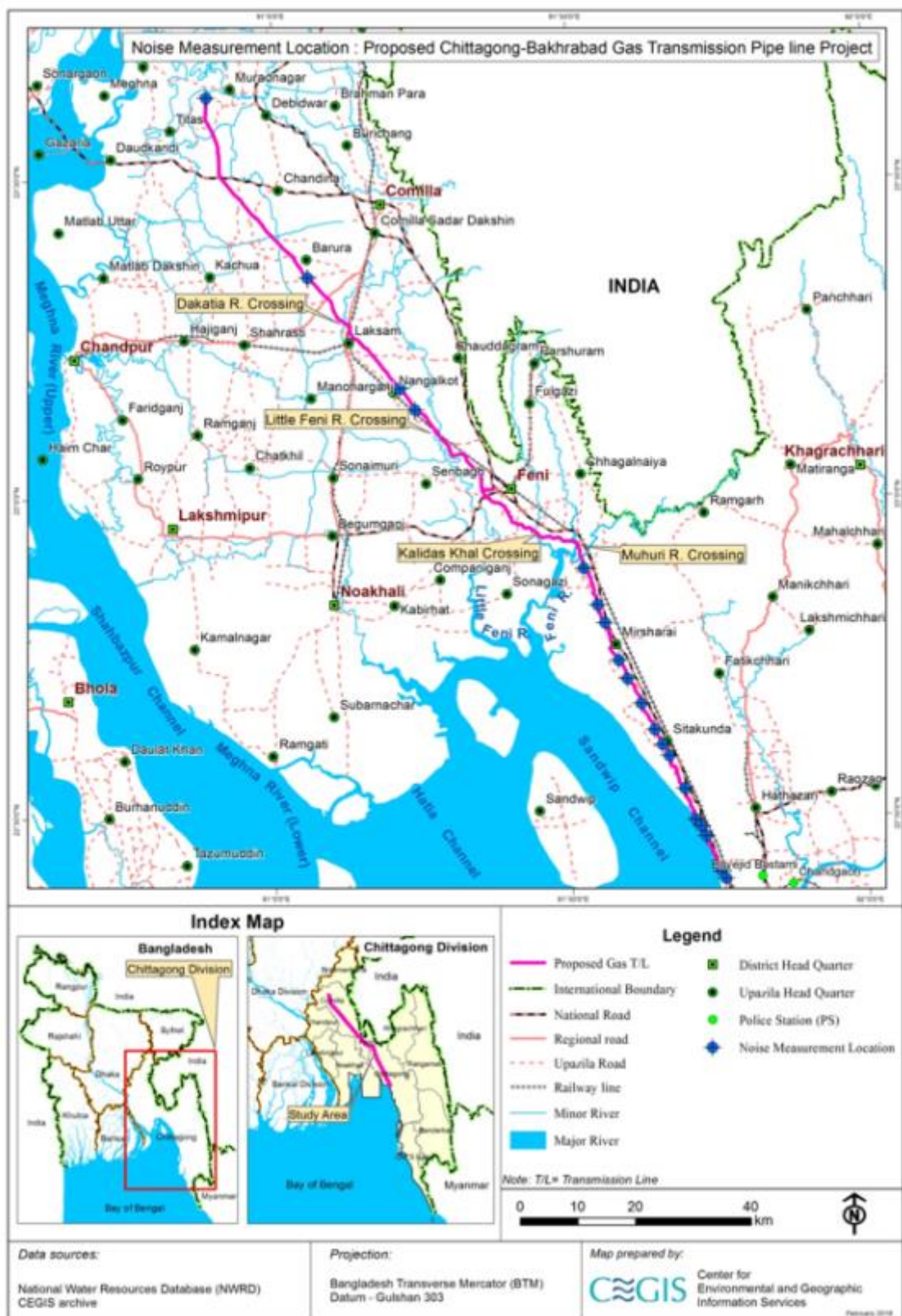


Figure 4.4 Noise sampling stations

4.2.2 Water Resources

4.2.2.1 Water level/flooding

145. Component 2 will cross Little Feni River, Dakatia River, Kalidas River and Muhuri River. In examining the water level at these rivers, the hydrograph from the measuring stations at Gunabati Railway Bridge (Little Feni River), Laksham (Dakatia River) and Parshuram (Muhuri River) were used. The hydrograph from these stations shows a typical pattern of rising surface water level in monsoon of up to almost 11m at Parsuram station and 4.5 m at the Gunabati Railway Bridge and Laksham stations. The hydrograph also shows a lowering the surface water level in dry season up to almost 9.8 m at Parsuram station and 2.5 m at Gunabati Railway Bridge and Laksham stations (see **Figure 4.4**). **Table 4.5** shows the water level at different return periods. These water levels will be considered in the design of Component 2.

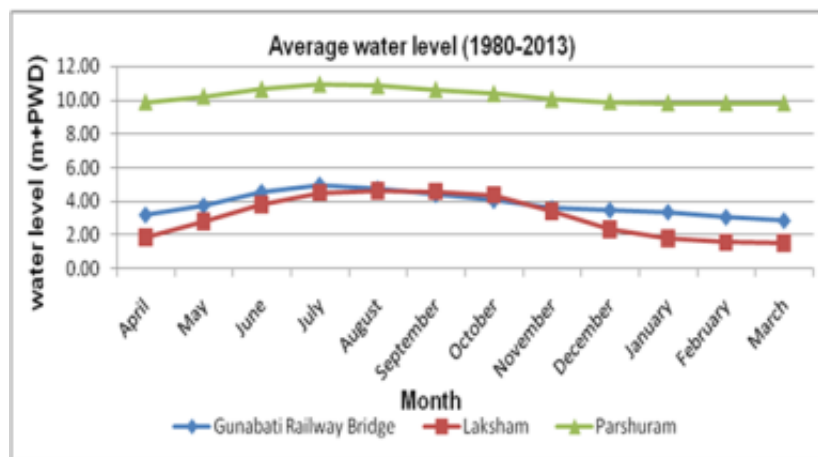


Figure 4.5 Flood hydrograph

Table 4.5 Water level at different return periods

Return Period (Years)	Water Level (m+ Public Works Datum)		
	Little Feni River (Gunabati Railway Bridge)	Dakatia River (Laksham)	Muhuri River (Parshuram)
2.33	3.82	3.10	10.24
5	4.15	3.43	10.54
10	4.42	3.70	10.80
20	4.68	3.96	11.07
50	5.01	4.29	11.30
100	5.26	4.56	11.55

Source: Bangladesh Water Development Board (BWDB), 2013

4.2.2.2 Water availability and quality

Surface water quality

146. Component 2 will cross khals and rivers. There will be four crossings at Little Feni River, Dakatia River, Muhuri River and Khalidas khal. Fresh surface water sampling was

conducted by CEGIS on 13-18 December 2015. Water quality in most of the sampling stations generally meets the limits of Schedule 10 (Rule 13) of ECR 1997. However, the electrical conductivity in Guptakhali khal, Sonaichari khal, Boalia khal exceeded the limits of 1.2 mS/cm. This suggests that wastewater from sewage treatment plant or sewage systems, and urban run-off from roads may have found their way to these water bodies. **Table 4.6** presents the results of analysis while **Figure 4.6** shows the sampling stations.

Table 4.6 Water quality at rivers and khals within the study area

Name of River/Khal	Location	Coordinates	Parameter					
			TDS (ppm)	EC (mS/cm)	Salinity (ppt)	DO (mg/L)	Temperature (°C)	pH
Muhuri river	Nijkunjara	22°55'37.7"N 91°30'30.6"E	180	0.6	0	6.7	29.5	7.1
Little Feni River	Naluakandi	23°6'03.4"N 91°16'42.3"E	210	0.8	0	5.9	29.5	7.2
Dakatia River	Gunoboti	22°44'44.6"N 91°34'41.4"E	160	0.3	0	6.3	30.0	7.6
Boriggatola khal	Solimpur	22°24'25.1"N 91°44'44.6"E	350	1.0	0	7.2	29.0	7.1
Guptakhali khal	Mandaritola	22°37'45.3"N 91°35'55.9"E	520	2.80	5	6.9	29.5	7.4
Sonaichari khal	Sonaichari	22°28'38.6"N 91°43'03.2"E	683	4.77	7	7.1	29.0	7.7
Boalia khal	Boalia	22°31'24.9"N 91°41'37.2"E	983	5.77	8	7.4	30.0	8.1
Kedarkhali khal	Kedarkhil	22°38'11.5"N 91°38'14.2"E	250	1.3	0	6.8	29.5	7.8
Rajapur khal	Amirabad	22°36'47.1"N 91°39'2.2"E	190	0.6	0	6.5	30.0	7.4
Mellar khal	Nangolkot	23°10'26.4"N 91°12'44.4"E	320	0.9	0	6.6	29.5	7.9
Barkomata khal	Surjyapur	23°30'21.7"N 90°54'30.1"E	240	1.1	0	7.0	29.0	7.2
ECR 1997, Schedule 10, Rule 13			2,100	1.2	-	4.5-8.0	40 (W), 45(S)	6.0-9.0

Source: CEGIS field survey, 13–18 December, 2015



Figure 4.6 Water quality sampling stations

Groundwater

147. Groundwater level data from three observation wells of Bangladesh Water Development Board (BWDB) located in Mirsharai, Feni Sadar and Barura were recorded from 1985 to 2010. Monthly mean groundwater table (GWT) data showed that increased dependency of local people to groundwater during the dry season lowers GWT. Higher availability of fresh surface water during the monsoon season resulted to higher groundwater recharge. Annual variations of GWT indicated a continuing trend of lowering GWT.

4.2.3 Natural Hazards

4.2.3.1 Seismicity

148. Bangladesh is divided into three seismic zones: Zone I – Severe (Seismic Factor, 0.08g), Zone II – Moderate (Seismic Factor, 0.05g), and Zone III – Minor (Seismic Factor, 0.04g). Component 2 is located under Zone II (see Figure 4.7). Design and specifications for Component 2 will incorporate the seismic factor of 0.05g. **Table 4.7** presents the historical record of seismic events in Bangladesh from 1548 until 2011.



Figure 4.7 Seismic map of Bangladesh

Table 4.7 Historical seismic events

Year	Area and Description
1548	The first recorded earthquake was a terrible one. Sylhet and Chittagong were violently shaken, the earth opened in many places and threw up water and mud of a sulphurous smell.
1642	More severe damage occurred in Sylhet district. Buildings were cracked but there was no loss of life.
1663	Severe earthquake in Assam, which continued for half an hour and Sylhet district was not free from its shock.
1762	The great earthquake of April 2, which raised the coast of Foul island by 2.74m and the northwest coast of Chedua island by 6.71m above sea level and also caused a permanent submergence of 155.40 sq km near Chittagong. The earthquake proved very violent in Dhaka and along the eastern bank of the Meghna as far as Chittagong. In Dhaka, 500 persons lost their lives, the rivers and jheels were agitated and raised high above their usual levels and when they receded, their banks were strewn with dead fish. A large river dried up, a tract of land sank and 200 people with all their cattle were lost. Two volcanoes were said to have opened in the Sitakunda hills.
1775	Severe earthquake in Dhaka around April 10, but no loss of life.
1812	Severe earthquake in many places of Bangladesh around May 11. The earthquake proved violent in Sylhet.
1865	Terrible shock was felt, during the second earthquake occurred in the winter of 1865, although no serious damage occurred.
1869	Known as Cachar Earthquake. Severely felt in Sylhet but no loss of life. The steeple of the church was shattered, the walls of the courthouse and the circuit bungalow cracked and in the eastern part of the district the banks of many rivers caved in.
1885	Known as the Bengal Earthquake. Occurred on 14 July with 7.0 magnitude and the epicenter were at Manikganj. This event was generally associated with the deep-seated Jamuna Fault.
1889	Occurred on 10 January with 7.5 magnitudes and the epicenter at Jaintia Hills. It affected Sylhet town and surrounding areas.
1897	Known as the Great India Earthquake with a magnitude of 8.7 and epicenter at Shillong Plateau. The great earthquake occurred on 12 June at 5.15 pm, caused serious damage to masonry buildings in Sylhet town where the death toll rose to 545. This was due to the collapse of the masonry buildings. The tremor was felt throughout Bengal, from the south Lushai Hills on the east to Shahbad on the west. In Mymensingh, many public buildings of the district town, including the Justice House, were wrecked and very few of the two-storied brick-built houses belonging to zamindars survived. Heavy damage was done to the bridges on the Dhaka-Mymensingh railway and traffic was suspended for about a fortnight. The river communication of the district was seriously affected (brahmaputra). Loss of life was not great, but loss of property was estimated at five million Rupees. Rajshahi suffered severe shocks, especially on the eastern side, and 15 persons died. In Dhaka damage to property was heavy. In Tippera masonry buildings and old temples suffered a lot and the total damage was estimated at Rs 9,000.
1918	Known as the Srimangal Earthquake. Occurred on 18 July with a magnitude of 7.6 and epicentre at Srimangal, Maulvi Bazar. Intense damage occurred in Srimangal, but in Dhaka only minor effects were observed.

Year	Area and Description
1930	Known as the Dhubri Earthquake. Occurred on 3 July with a magnitude of 7.1 and the epicentre at Dhubri, Assam. The earthquake caused major damage in the eastern parts of Rangpur district.
1934	Known as the Bihar-Nepal Earthquake. Occurred on 15 January with a magnitude of 8.3 and the epicentre at Darbhanga of Bihar, India. The earthquake caused great damage in Bihar, Nepal and Uttar Pradesh but did not affect any part of Bangladesh. Another earthquake occurred on 3 July with a magnitude of 7.1 and the epicentre at Dhubri of Assam, India. The earthquake caused considerable damages in greater Rangpur district of Bangladesh.
1950	Known as the Assam Earthquake. Occurred on 15 August with a magnitude of 8.4 with the epicentre in Assam, India. The tremor was felt throughout Bangladesh but no damage was reported.
1997	Occurred on 22 November in Chittagong with a magnitude of 6.0. It caused minor damage around Chittagong town.
1999	Occurred on 22 July at Maheshkhali Island with the epicentre in the same place, a magnitude of 5.2. Severely felt around Maheshkhali island and the adjoining sea. Houses cracked and in some cases collapsed.
2003	Occurred on 27 July at Kolabunia union of Barkal upazila, Rangamati district with magnitude 5.1. The time was at 05:17:26.8 hours.
2006	Known as the Narail earthquake. This tremor occurred on 5 August. The earthquake had a magnitude estimated 4.2 on the Richter scale with epicentre located 110 km southwest of Dhaka near Narail. The tremor was widely felt in Dhaka as well as other places in the country.
2008	Known as the Manikganj earthquake. A minor earthquake jolted Dhaka and surroundings on the evening of 20 March 2008 and created considerable panic among the city dwellers. The earthquake had a magnitude measured 3.8 on the Richter scale. The epicenter was situated in Manikganj 41 km west-northwest of DUEO. It was believed to be originated from the Madhupur fault.
2008	Known as Mymensingh earthquake, this temblor occurred in the middle of the night of 27 July. The epicenter was located 12 km northeast of Mymensingh city and 120 km north of Dhaka. It had a magnitude estimated 5.1 on the Richter scale. Apart from Mymensingh where the earthquake caused panic, tremors from this earthquake were felt in many parts of the Dhaka metropolitan area.
2008	Known as Chandpur Earthquake. An earthquake with couple of aftershocks jolted Dhaka on the evening of 20 September just before Iftar. It caused tremendous panic among the city dwellers. The epicenter was 50 km southeast of Dhaka near Kachua of Chandpur. The magnitude was 4.5 on the Richter scale.
2009	Known as eastern Bhutan earthquake. A strong earthquake occurred on the day of Eid-ul-Fitr, 21 September. The epicenter was situated in eastern Bhutan, 410 km north-northeast of Dhaka. It originated from the Main Central Thrust (MCT). This distant quake had a magnitude of 6.1, but shook most of Bangladesh including Dhaka.
2009	Known as Bay of Bengal Earthquake. Occurred on 11 August at Bangladesh time 01:55:35:61 hours. The epicentre was located at the North Andaman Islands of the Bay of Bengal and seacoast of Myanmar. The magnitude recorded was 7.5. Though no significant damage was reported throughout Bangladesh the tremor was felt strongly in Dhaka.

Year	Area and Description
2010	Occurred on 10 September night at 11:30 pm local time. The tremor was felt in Dhaka and its surrounding areas with magnitude 4.8. The epicenter was 45 km southwest from Dhaka.
2011	Occurred on 6:30 pm local time with magnitude 6.8. It lasted for 2 minutes. The tremor felt was strong enough in Capital city Dhaka and the districts of northern part of Bangladesh. The epicenter was 500 north from Dhaka in Indian Sikkim's capital Gangtok.

4.2.3.2 Flooding

149. In Chittagong region, flooding is a major concern but not so in Feni and Comilla. In monsoon season, water level rises up to 4-5 feet in the agricultural lands and 1.5-2 feet high from the existing road level during high tide. Flash flood from hilly areas also causes inundation by overtopping the khal banks and causes damages to households, crops, poultry, culture fishery and other properties. Component 2 will traverse some low-lying areas where rain/flood water accumulates and stays almost several months and in these locations water depth will be about 3-5 feet during monsoon. Buoyancy effect may occur due to flood water and may uplift the transmission line. Potential effects of flooding will be considered in the design and specifications of the pipeline system and site preparation.

4.2.4 Land Resources

4.2.4.1 Agro-Ecological Zone

150. Bangladesh has been divided into 30 agro-ecological zones (AEZ) and 88 sub-regions (BARC 2012). AEZ are geographical areas that show comparable climatic conditions, landform, and combination of soil which determine their ability to support agriculture. AEZ in the areas crossed by Component 2 are: (i) the Old Meghna Estuarine Floodplain (AEZ-19), (ii) Chittagong Coastal Plain (AEZ-23), (iii) Northern and Eastern Hills (AEZ-29), and (iv) Young Meghna Estuarine Floodplain (AEZ-18). Old Meghna Estuarine Floodplain covers about 60% of the areas that will be crossed by Component 2 (see **Table 4.8**). **Figure 4.8** shows the AEZs along Component 2.

Table 4.8 AEZ and sub-regions along Component 2

Region Name	Sub-region Name	Area (ha)
Chittagong Coastal Plain	Piedmont Plains and River Floodplains	630
Chittagong Coastal Plain	Young Tidal Floodplain	117
Northern and Eastern Hills	Low hills and Piedmont Plains	92
Old Meghna Estuarine Floodplain	High	736
Old Meghna Estuarine Floodplain	Low: Daudkandi - Habiganj	274
Old Meghna Estuarine Floodplain	Medium Low	289
Young Meghna Estuarine Floodplain	Saline: Noakhali, Hatiya and Meghna Es	18
Total		2,156

Source: BARC 2012

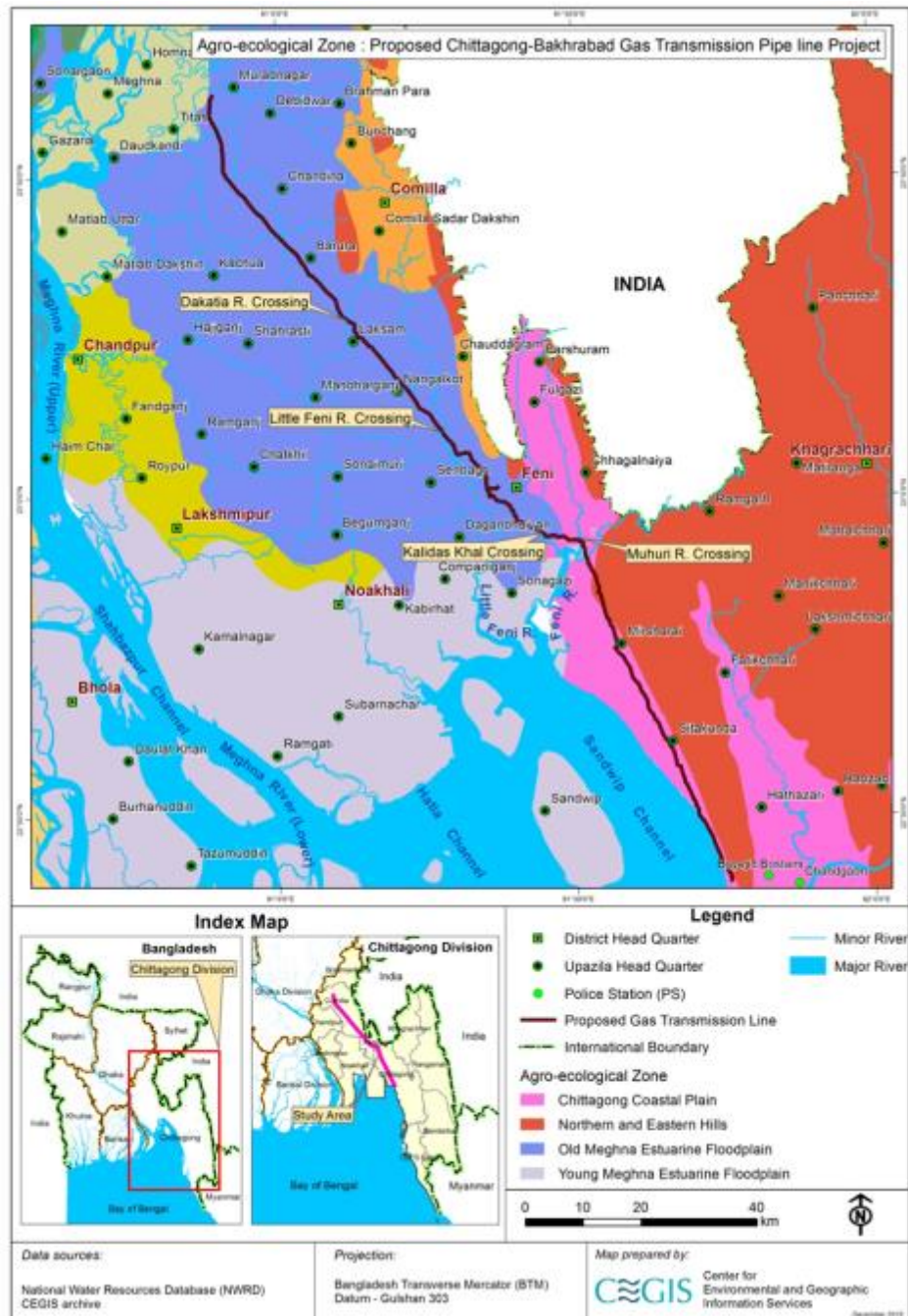


Figure 4.8 AEZ along Component 2

4.2.4.2 Soil Texture

151. Soil texture is an important soil characteristic that determines crop selection, crop production and also field management. Soil texture is the relative proportions of sand, silt, loam and clay. The main soil texture of the study area is clay loam, loam and very few amount of clay. Detailed distribution of soil texture of the study area is presented in **Table 4.9**.

Table 4.9 Soil texture in the study area

Texture	Area (ha)	% of area
Clay	126	8
Clay Loam	832	52
Loam	627	40
Total	1,585	100

Sources: SRDI1995, Google Earth December 9-10, 2015

4.2.4.3 Drainage characteristics of soil

152. For the agricultural crop production, drainage characteristics play an important role. The drainage characteristics have been divided into six classes by the Soil Resources Development Institute (SRDI) for agricultural uses. These are: (i) excessively drained, (ii) well drained, (iii) moderately well drained, (iv) imperfectly drained, (v) poorly drained and (vi) very poorly drained. The entire study area is covered by the imperfectly drained and poorly drained land (see **Table 4.10**) as shown in **Figure 4.9**.

Table 4.10 Drainage characteristics of soil in the study area

Drainage	Characteristics	Area(ha)	% of Area
Imperfectly Drained	Water is drained from soil badly or slowly. This soil often remains wet in rainy season due to rainfall. In normal situation, water does not stand on land for more than 15 days at a stretch. In rainy season, water stands within 1 meter at least for some time.	937	59
Poorly Drained	The soil remains under water from 15 days to 7/8 months. Water is drained from the soil slowly. In most cases, the land remains wet/ water logged for a considerable period of time after the rainy season.	648	41
Total		1,585	100

Source: SRDI1995, Google Earth December 9-10, 2015

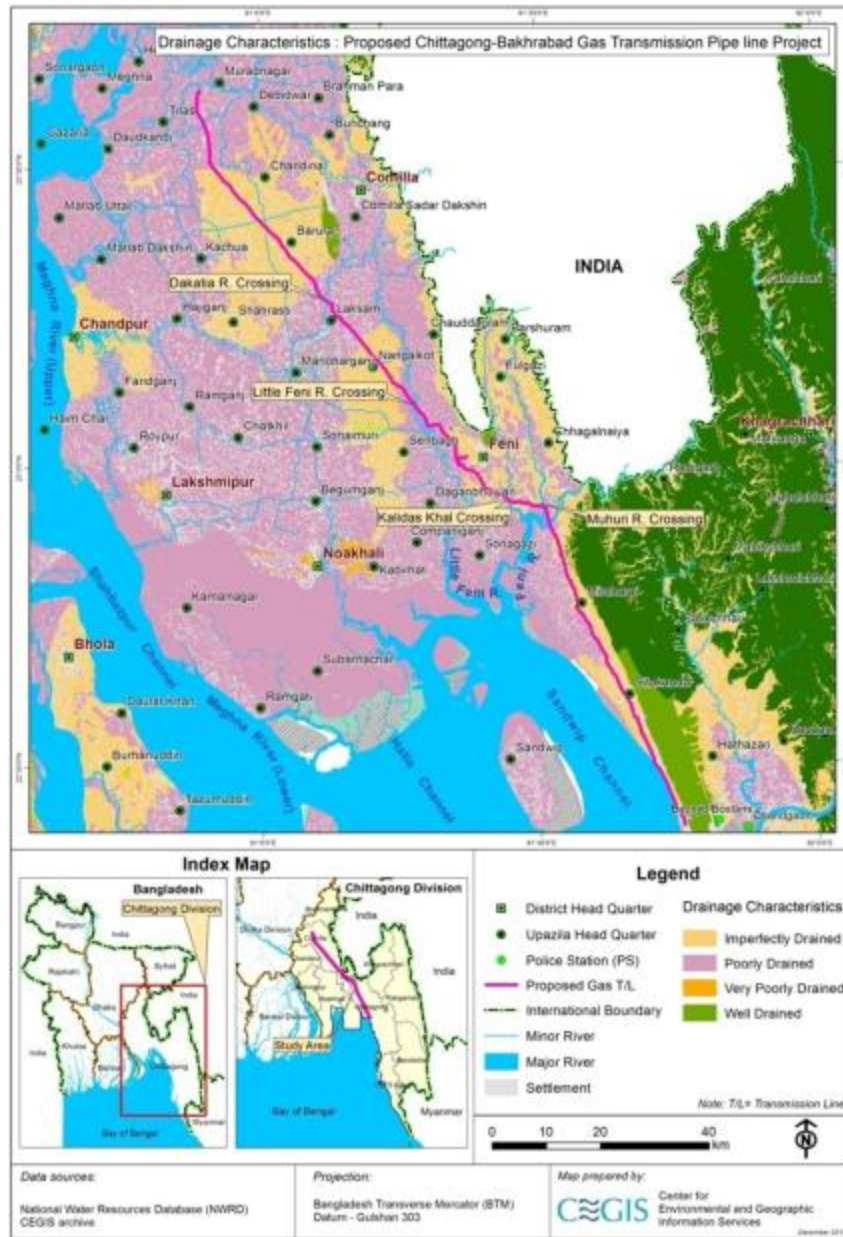


Figure 4.9 Drainage characteristics along Component 2

4.3 Terrestrial Flora

4.3.1 Homestead Vegetation

153. Homestead vegetation is one of the most important natural resources of Bangladesh based on its huge number of diversified plant species. In the study area, most of the homestead vegetation is planted by home owners for food, fruits, fuel and medicine for their daily needs. According to the vegetation survey, many tree species are present and their composition is similar all over the study area. **Table 4.11** provides a list of common tree species in homesteads in the study area.

154. Some herbs, shrubs and wild plants also grow naturally and these are found in the homesteads and village groves. Homestead vegetation provides roosting for local resident birds and nesting to waterfowls. **Figure 4.10** shows homestead vegetation in the study area.

Table 4.11 List of common plant species found in the homestead of the study area

Local/English Name	Scientific Name	Use	Abundance
Akasmoni/Vachellia aroma	<i>Acacia auriculiformis</i>	Timber and Fuel wood	H
Sirish/Monkey pod	<i>Albizia lebbek</i>	Timber and Fuel wood	H
Sada Koroil/Sil Koroil	<i>Albizia procera</i>	Timber and Fuel wood	H
Chambul/Silk tree	<i>Albizia richardiana</i>	Timber and Fuel wood	H
Supari/Indian nut palm	<i>Areca catechu</i>	Timber and Fuel wood	H
Kanthal/Jackfruit	<i>Artocarpus heterophyllus</i>	Fruit and Timber	M
Bamboo/Bash	<i>Bamboosa spp.</i>	Household use and fencing	H
Tal/Palmyra palm	<i>Boassus flabellifer</i>	Fruit	H
Shimul/Cotton tree	<i>Bombax ceiba</i>	HH use	L
Sonalu/Golder shower tree	<i>Cassia fistula</i>	Timber and Fuel wood	L
Jambura/Pomelo	<i>Ciitrus grandis</i>	Fruit and Fuel wood	L
Narikel/Coconut	<i>Cocos nucifera</i>	Fruit and Fuel wood	H
Sisoo/Indian rosewood	<i>Dalbergia sissoo</i>	Timber and Fuel wood	M
Desi Gab/Persimmon tree	<i>Diospyros peregrina</i>	Fruit and Fuel wood	L
Katbel/Wood apple	<i>Limonia acidissima</i>	Fruit and Fuel wood	M
Aam/Mango	<i>Mangifera indica</i>	Fruit and Timber and Fuel wood	M
Khejur/Date Palm	<i>Phoenix sylvestris</i>	Fruit and Fuel wood	H
Peyara/Guava	<i>Psitium guajava</i>	Fruit	M
Raintree/Labbeck tree	<i>Samanea saman</i>	Timber and Fuel wood	H
Amra/Hog plums	<i>Spondias dulcis</i>	Fruit	M
Mahogoni/American mahogani	<i>Swietenia macrophylla</i>	Timber and Fuel wood	H
Tetul/Tamarind	<i>Tamarindus indica</i>	Fruit, Timber and Fuel wood	M
Segun/Teak tree	<i>Tectona grandis</i>	Timber and Fuel wood	M
Katbadam/Almond	<i>Terminalia catappa</i>	Fruit and Fuel wood	M
Kul/Jujube	<i>Ziziphus mauritiana</i>	Fruit and Fuel wood	M
Debdaru/Cemetery tree	<i>Polialthia longifolia</i>	Timber and Fuel wood	M
Kodom/Kadamba	<i>Anthocephalas chinensis</i>	Soft Timber and Fuel wood	L
Krisnachura/Royal Poinciana	<i>Delonix regia</i>	Soft Timber and Fuel wood	L
Kola/Banana	<i>Musa paradisiaca</i>	Fruit	H
Gamari/ White teak	<i>Gmelina arborea</i>	Timber and fuel wood	M
Kalo Jam/Black Berry	<i>Rubus argutus</i>	Timber, fuel wood and fruit	M
Mandar/Flame tree	<i>Erythrina indica</i>	Fuel wood	H

Source: CEGIS field survey 2015

Note: Abundance Code, H= High, M= Medium, L= Low



Figure 4.10 Homestead vegetation in Duaru village

4.3.2 Crop field vegetation

155. The dominant cropland wild species within the study area are Dhol Kolmi (*Ipomoea carnea*), Hatisur (*Heliotropium indicum*), Durba Gash (*Cynodon dactylon*), Thankuni (*Centella asiatica*), Akand (*Calotropis procera*), Vaant/Bhat (*Clerodendron viscosum*), Bondhone (*Scoparia dulcis*), Bagha Jongla (*Borreria articularis*), Telakhucha (*Coccinia grandis*), Jhunjhuni (*Crotalaria pallida*), etc.

4.3.3 Road/riverbank side Vegetation

156. Roadside vegetation is dominated by hard wood tree species, which are mostly planted by the local community. Major species are Sirish/Monkey pod (*Albizia odoratissima*), Mahogani/American mahogani (*Swietenia mahagoni*), Akashmoni (*Acacia moniliformis*), etc. **Figure 4.11** shows the road and bank side vegetation in the study area.



Duyaru Khal bank side vegetation



Village roadside vegetation in Dakshin terail village

Figure 4.11 Road and bank side vegetation

157. Some herbs and vines also noted in roadside vegetation. The common species found in the study area include: Bonjhal (*Croton bonplandianum*), Bhand/Bleeding-heart (*Clerodendrum inerme*), Akand/Crown flower (*Calotropis gigantea*), Hatisur (*Heliotropium*

indicum) and Doab/Durba Gash (*Cynodon dactylon*). **Table 4.12** provides the list of common tree species in the roadside of the study area.

158. The type of vegetation found along the river banks of Little Feni River, Dakatia River, Muhuri River and khals include Doab/Durba Gash (*Cynodon dactylon*), Basil/Tulshi (*Ocimum tenuiflorum*), papyrus sedges/Mutha ghas (*Cyperus sp*).

Table 4.12 List of common plant species found in the roadside of the study area

Local/English Name	Scientific Name	Use	Abundance
Akasmoni/Vachellia aroma	<i>Acacia auriculiformis</i>	Timber and Fuel wood	M
Sirish/Monkey pod	<i>Albizia lebbek</i>	Timber and Fuel wood	H
Sada Koroi/Sil Koroi	<i>Albizia procera</i>	Timber and Fuel wood	H
Chambul/Silk tree	<i>Albizia richardiana</i>	Timber	H
Tal/Palmyra palm	<i>Boassus flabellifer</i>	Fruit and HH use	H
Narikel/Coconut	<i>Cocos nucifera</i>	Fruit and Fuel wood	H
Sisoo/Indian rosewood	<i>Dalbergia sissoo</i>	Timber and Fuel wood	M
Jiga/Indian ash tree	<i>Lennea coromandelica</i>	Fencing	M
Neem/Neem	<i>Azadirachta indica</i>	Timber and Fuel wood	M
Khejur/Date Palm	<i>Phoenix sylvestris</i>	Fruit and Fuel wood	M
Raintree/Labbeck tree	<i>Samanea saman</i>	Timber and Fuel wood	H
Mahogoni/American mahogani	<i>Swietenia macrophylla</i>	Timber and Fuel wood	M
Pitali/Mallotus	<i>Trewia nudiflora</i>	Fuel wood	L
Bansh/Bamboo	<i>Bamboosa sp</i>	Fuel wood and fencing	H
Mander/Flame tree	<i>Erythrina indica</i>	Fuel wood	H
Ipil ipil/White lead tree	<i>Leucaena leucocephala</i>	Timber and Fuel wood	H
Eucalyptus / Gum tree	<i>Eucalyptus sp</i>	Timber and Fuel wood	H

Source: CEGIS field survey, 2015

Note: Abundance Code, H= High, M= Medium, L= Low

4.4 Terrestrial Fauna

159. The list of common terrestrial fauna in the study area is given in **Table 4.13**.

Table 4.13 List of common terrestrial fauna in the study area

Types	Local Name	English Name	Scientific name	Habitat	Status of Conservation IUCN Bangladesh 2000
Amphibians	Kuno Bang	Common Toad	<i>Bufo melanosticus</i>	Wetland areas and the dried areas	No
	Sona Bang	Bull Frog	<i>Hoplobatrachus tigerinus</i>		No
	Gecho Bang	Tree Frog	<i>Rana temporalis</i>		No
	Jhi Jhi Bang	Cricket Frog	<i>Rana limnocharis</i>		No
Mammals	Indur	Common House Rat	<i>Rattus rattus</i>	Mostly in bamboo thickets, cropped	No
	Metho indur	Field Mouse	<i>Mus booduga</i>		No
	Chika	Grey Musk Shrew	<i>Suncus murinus</i>		No
	Badur	Flying Fox	<i>Pteropus giganteus</i>		No

Types	Local Name	English Name	Scientific name	Habitat	Status of Conservation IUCN Bangladesh 2000
	Bara Baji	Common mongoose	<i>Herpestes edwardsii</i>	fields, bushy areas.	VU
	Bon Biral	Jangle Cat	<i>Felis chaus</i>		No
	Pati shial	Golden jackal	<i>Canis aureus</i>		VU
Reptiles	Tiktiki	House Lizard	<i>Hemidactylus brooki</i>	Both wet land and dry areas	VU
	Tiktiki	Common Lizard	<i>Hemidactylus frenatus</i>		No
	Raktchusa	Garden Lizard	<i>Calotes versicolor</i>		VU
	Dora Shap	Stripes Keelback	<i>Amphiesma stolata</i>		No
	Mete Shap	Olive Keelback	<i>Atretium schistosum</i>		No
	Darash Shap	Rat Snake	<i>Ptyas mucosus</i>		VU
Birds	Bhubon Cheel	Black Kite	<i>Milvus migrans</i>	All types of vegetation	No
	Shankho Cheel	Brahminy Kite	<i>Haliastur indus</i>		EN
	Fingey	Bronzed Drongo	<i>Dicrurus aeneus</i>		No
	Pati Kak	House Crow	<i>Corvus splendens</i>		No
	Vat Salik	Common Mynah	<i>Acridotheres tristis</i>		No
	Bulbul	Red-vented	<i>Pycnonotus cafer</i>		No
	Doel	Magpie Robin	<i>Copsychus saularis</i>		No
	Laksmi Pencha	Barn Owl	<i>Tyto alba</i>		No
	Kabutor	Blue Rock Pigeon	<i>Columba livia</i>		No
	Tili Ghughu	Spotted Dove	<i>Streptopelia chinensis</i>		No

Source: Field investigation and local people interviewed, 2015
Note: NO= Not Threatened; VU= Vulnerable, EN= Endangered

160. Some species of terrestrial fauna are listed as endangered (EN) and vulnerable (VU) according to the assessment of IUCN Bangladesh in 2000. The conservation status of species in Bangladesh is being updated by the IUCN Bangladesh according to the IUCN Red List of Threatened Species. This updating project started in December 2013 and is funded by the World Bank.

161. While Brahminy Kite (*Haliastur indus*) is listed as EN by the IUCN Bangladesh (2000), the IUCN global assessment indicates that it is Least Concern (LC) in 2012.⁸ Similarly, Common mongoose or Indian grey mongoose (*Herpestes edwardsii*) is listed as VU in Bangladesh. The global assessment of IUCN Red List of Threatened Species indicates that it is LC in 2013.⁹ Common mongoose is not a native species of Bangladesh. The list of conservation status of these species will be confirmed once the updated list from IUCN Bangladesh is available.

162. An environmental staff from the PIU-GTCL and EPC Contractor will be present during the vegetation clearing stage to ensure that these species are not in the direct impact area of Component 2. A handling and rescue procedure for terrestrial fauna and a “chance find” procedure for species of conservation status will be required from the EPC Contractor.

⁸BirdLife International. 2012. *Haliastur indus*. The IUCN Red List of Threatened Species 2012: e.T22695094A40325168. <http://dx.doi.org/10.2305/IUCN.UK.2012-1.RLTS.T22695094A40325168.en>. Downloaded on 12 March 2016.

⁹Choudhury, A., Wozencraft, C., Muddapa, D., Yonzon, P., Jennings, A. & Geraldine, V. 2013. *Herpestes edwardsii*. The IUCN Red List of Threatened Species 2013: e.T41611A10508074. <http://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T41611A10508074.en>. Downloaded on 12 March 2016.

4.5 Aquatic Flora

163. Within the study area, rivers, ponds and khals provide habitat to different types of aquatic flora such as free floating, rooted floating, submerged and amphibian vegetation like sedges and meadows. Some common species of aquatic flora species is given in **Table 4.14**.

Table 4.14 Common species of aquatic flora in the wetlands of the study area

Type	Local/English Name	Scientific Name	Abundance	Goods/Services/Purpose Use
Free floating plant	Kochuripana/ Water hyacinth	<i>Eichhornia crassipes</i>	H	Compost
	Kutipan/Water velvet	<i>Azolla pinnata</i>	H	
	Khudipana/Duck weed	<i>Lemna perpusilla</i>	H	
	Topapana/water cabbage	<i>Pistia stratiotes</i>	H	
	Kuripana	<i>Salvina cucullata</i>	H	
Rooted floating plant	Shapla/Water lily	<i>Nymphaea nouchali</i>	M	Compost and Vegetable
	Poddo/Lotus	<i>Nymphaea stellata</i>	M	Compost and Vegetable
	Chandmala	<i>Nymphoides sp.</i>	M	Compost
Submerged Plant	Jhangi/waterhyme	<i>Hydrilla verticillata</i>	L	N/A
	Ghechu/Floating lace plant	<i>Aponogeton natans</i>	L	Vegetable
Amphibian plant(Sand meadows)	Jol kolmi/Pink morning glory	<i>Ipomoea aquatic</i>	M	Fuel and erosion protection
	Kochu/Taro	<i>Colocasia spp.</i>	M	Vegetable
	Alligator weed/ Helencha	<i>Alternanthera philoxiroides</i>	M	Vegetable
	Patipata/Gagenep	<i>Schumannianthusdic hotomus</i>	H	Thatching and mat making
	Nol khagra/ Common reed	<i>Phragmites australis</i>	M	Fuel and fencing

Source: Field investigation and local people interviewed, 2015 Note: Abundance Code, H= High, M= Medium, L= Low

4.6 Aquatic Fauna

164. The life cycle of aquatic fauna is dependent on seasonal variations as well as inundation depth and availability of water in all types of wetlands. Some common species of aquatic fauna is given below.

Table 4.15 Common species of aquatic fauna in the study area

Type	Name (Scientific Name)	Status of Conservation IUCN Bangladesh 2000	Habitat
Birds	Little Egret (<i>Egretta garzetta</i>)	NO	Mudflats, canal

Type	Name (Scientific Name)	Status of Conservation IUCN Bangladesh 2000	Habitat
	Great Egret (<i>Casmerodious albus</i>)	NO	systems and seasonal wetlands
	Common Kingfisher (<i>Alcedo atthis</i>)	NO	
	Little Cormorant (<i>Phalacrocorax niger</i>)	NO	
	Pied Kingfisher (<i>Ceryle rudis</i>)	NO	
	Indian pond heron (<i>Ardeola grayii</i>)	NO	
	Asian openbill (<i>Anastomus oscitans</i>)	NO	
Reptiles	Checkered keelback (<i>Xenocrophis piscator</i>)	NO	All types of wetlands
	smooth water snake (<i>Enhydryis enhydryis</i>),	NO	
	Common Krait (<i>Bungarus caeruleus</i>)	EN	
	Rat snake (<i>Ptyas mucosus</i>),	VU	
	Common wolf snake (<i>Lycodon aulicus</i>)	NO	
	Black pond turtle (<i>Geoclemys hamiltonii</i>)	EN	
	Bengal Monitor (<i>Varanus bengalensis</i>)	VU	
Amphibians	skipper frog (<i>Euphlyctis cyanophlyctis</i>),	NO	All type of wetland areas area
	Bullfrogs (<i>Hoplobatrachus tigerinus</i>)	NO	

Source: Field investigation and local people interviewed, 2015
Note: NO= Not Threatened; VU= Vulnerable, EN= Endangered

165. According to IUCN Bangladesh (2000), some species of aquatic fauna within the study area are EN and VU. The Bengal monitor (*Varanus bengalensis*) also known as the Common Indian Monitor is listed as VU by IUCN Bangladesh (2000). Global assessment of IUCN (2010) indicates that this species has a conservation status of LC.¹⁰ Black pond turtle or black spotted turtle (*Geoclemys hamiltonii*) is listed as EN by IUCN Bangladesh (2000) while the global IUCN (2000) assessment indicates that this species is VU.¹¹ The conservation status of species in Bangladesh based on the IUCN Red List of Threatened Species is being updated since December 2013.

166. The Common Krait (*Bungarus caeruleus*) is assessed as EN by IUCN Bangladesh (2000) but was not globally assessed by the IUCN.¹² Common Krait is one of the venomous snakes of medical importance in India. Geographical distribution of this species is Afghanistan, Pakistan, India, and Nepal.¹³

4.6.1 Fish and fisheries resources

4.6.1.1 Fish diversity

¹⁰Papenfuss, T., Shafiei Bafti, S., Sharifi, M., Bennett, D. & Sweet, S.S. 2010. *Varanus bengalensis*. The IUCN Red List of Threatened Species 2010: e.T164579A5909661. <http://dx.doi.org/10.2305/IUCN.UK.2010-4.RLTS.T164579A5909661.en>. Downloaded on 12 March 2016.

¹¹Asian Turtle Trade Working Group. 2000. *Geoclemys hamiltonii*. The IUCN Red List of Threatened Species 2000: e.T9029A12951978. <http://dx.doi.org/10.2305/IUCN.UK.2000.RLTS.T9029A12951978.en>. Downloaded on 12 March 2016.

¹²The IUCN Red List of Threatened Species. Version 2015-4. <www.iucnredlist.org>. Downloaded on 12 March 2016.

¹³The Reptile Database. <http://reptile-database.reptarium.cz/species?genus=Bungarus&species=caeruleus>. Accessed on 13 March 2016.

167. There are several fish species in the freshwater and brackish water of the study area. Based on field investigation and consultations with local fishermen and elderly people, there are about 25-29 species of fish caught from regular catch in these water bodies.

168. A study by Islam and Nabi (2012) reported 29 fish species in the Feni River. However, the diversity of fish has been declining over the years. The capture habitats in the study area are dominated by small indigenous species (SIS) of fish. **Table 4.16** gives the list indicative fish species in the study area while **Figure 4.12** presents the assemblage of fish both fresh and brackish water fish.

Table 4.16 Indicative list of fish species in the study area

Scientific name	Local name	Fish habitat				Status of Conservation IUCN Bangladesh 2000
		River	Khal/Hill Creeck/ Chhara	Floodplain	Pond	
<i>Labeo rohita</i>	Rui	P	A	P	P	-
<i>Catla catla</i>	Calta	P	A	P	P	-
<i>Cirrhinus cirrhosus</i>	Mrigal, Mirka	P	A	P	P	-
<i>L. calbasu</i>	Calbaus	P	A	P	P	EN
<i>Cirrhinus reba</i>	Rayek, Bata	P	A	P	P	VU
<i>L. bata</i>	Bata	P	P	P	P	EN
<i>Wallago attu</i>	Boal	P	A	A	A	-
<i>Mystus tengra</i>	Tengra	P	A	A	A	-
<i>M. cavasius</i>	Gulsha tengra	P	A	A	A	VU
<i>Glossogobius giuris</i>	Bele	P	A	A	A	-
<i>Mastacembelus armatus</i>	Baim	P	A	A	A	EN
<i>Channa punctatus</i>	Taki	A	P	P	P	-
<i>C. striatus</i>	Shol	A	P	P		-
<i>C. marulius</i>	Gojar	A	P	A	-	EN
<i>Ailia coila</i>	Baspata	P	A	A	A	-
<i>Ompok pabda</i>	Modhu pabda	P	A	A	A	EN
<i>Clupisoma garua</i>	Gharua	P	A	A	A	CR
<i>Eutropiichthys vacha</i>	Bacha	P	A	A	A	CR
<i>Sperata aor</i>	Aor	P	A	A	A	VU
<i>Chitala chitala</i>	Chitol	P	A	A	A	EN
<i>Xenentodon cancila</i>	Kakila	P	A	A	A	-
<i>Anabas testudineus</i>	Koi	A	P	P	A	-
<i>Colisa fasciata</i>	Kholisha	A	P	P	A	-
<i>Colisa lalia</i>	Lal kholisha	A	P	P	A	-
<i>Heteropneustes fossilis</i>	Shing/ Jeol	A	P	P	A	-
<i>Charius batrachus</i>	Magur	A	P	P	A	-
<i>Amblypharyngodon mola</i>	Mola	A	P	P	A	-
<i>Chanda nama</i>	Nama chanda	A	P	P	A	VU
<i>Chanda ranga</i>	Ranga chanda	A	P	P	A	VU
<i>P. sarana</i>	sarputi	P	P	P	A	CR
<i>P. ticto</i>	Tit puti	P	P	P	A	VU
<i>Botia dario</i>	Beti/Rani	P	A	A	A	VU

Scientific name	Local name	Fish habitat				Status of Conservation IUCN Bangladesh 2000
		River	Khal/Hill Creeck/ Chhara	Floodplain	Pond	
<i>Nandas nandas</i>	Meni	P	P	A	A	VU
<i>Johnius belangerii</i>	Poa	P	A	A	A	-
<i>Polynemus paradiseus</i>	Taposhi	P	A	A	A	-
<i>Oxyurichthys microlepis</i>	Nuna Baila	P	A	A	A	-
<i>Mugil cephalus</i>	Mulet	P	A	A	A	-
<i>Macrobrachium rosenbergii</i>	Galda Chingri	P	A	A	A	-
<i>M. villisimanus</i>	Dimua icha	P	A	A	A	-
<i>M. lamarrei</i>	Gura Chingri	P	A	A	A	-
<i>Parapenaeopsis sculptelies</i>	Boro Chama	P	A	A	A	-
<i>Hypophthalmichthys molitrix</i>	Silver carp	A	A	A	P	-
<i>Ctenopharyngodon idela</i>	Grass carp	A	A	P	P	-
<i>Cyprinus carpio</i>	Carpu	A	A	P	P	-
<i>Pangasius sutchi</i>		A	A	A	P	-
<i>Barbonymus gonionotus</i>	Sarputi	A	A	A	P	-
<i>Oreochromis niloticus</i>	Nilotica	A	A	P	P	-
<i>Oreochromis mossambicus</i>	Tilapia	A	A	P	P	-

Source: CEGIS Field Survey 2015

Note: A-abundant, P-poor; Annex III, IUCN Bangladesh (2000), CR= Critical Endangered, EN= Endangered, UV =Vulnerable,

169. Some of the species of fish within the study area were assessed by IUCN Bangladesh (2000) as critically endangered (CR), VU, and EN. Calbaus, also known as Orange-fin labeo (*Labeo calbasu*) is considered as EN. IUCN globally assessed this species as LC.¹⁴ This species is native in China, India, Myanmar, Nepal, Pakistan, Thailand and Bangladesh. Rayek also known as Reba carp (*Cirrhinus reba*) was assessed as CR by IUCN Bangladesh (2000). Global assessment of IUCN (2013) indicates that this species is stable with conservation status of LC.¹⁵ Distribution of Reba carp is in Nepal, India, Pakistan, and Bangladesh. Beti/Rani (*Botia dario*) was assessed as VU by IUCN Bangladesh (2000). This species was globally assessed by IUCN (2010) as LC.¹⁶ Gharua (*Clupisoma garua*) is considered CR by IUCN Bangladesh (2000). Global assessment of IUCN indicates that the conservation status of this species is LC.¹⁷ Gharua is a native

¹⁴Dahanukar, N. 2010. *Labeo calbasu*. The IUCN Red List of Threatened Species 2010: e.T166606A6245872. <http://dx.doi.org/10.2305/IUCN.UK.2010-4.RLTS.T166606A6245872.en>. Downloaded on 12 March 2016.

¹⁵Dahanukar, N. 2013. *Cirrhinus reba*. The IUCN Red List of Threatened Species 2013: e.T172464A6897426. <http://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T172464A6897426.en>. Downloaded on 12 March 2016.

¹⁶Chaudhry, S. 2010. *Botia dario*. The IUCN Red List of Threatened Species 2010: e.T166603A6245334. <http://dx.doi.org/10.2305/IUCN.UK.2010-4.RLTS.T166603A6245334.en>. Downloaded on 13 March 2016.

¹⁷Ng, H.H. 2010. *Clupisoma garua*. The IUCN Red List of Threatened Species 2010: e.T166588A6241893. <http://dx.doi.org/10.2305/IUCN.UK.2010-4.RLTS.T166588A6241893.en>. Downloaded on 13 March 2016.

species in Bangladesh and widespread used as food fish. While IUCN global assessment of conservation status is LC, there is evidence that this species may be threatened by overfishing, and thus, there is a great need of close monitoring of harvest levels.

4.6.1.2 Fish habitat

170. Component 2 will cross Little Feni River, Muhuri River and Dakatia River. These rivers are tidal and perennial in nature and play as longitudinal migration route for migratory fishes of the area. The khals in the Chittagong district are tidal-influenced and mainly hill creeks/streams (Chhara), originating from the Sitakunda Hill and travels towards the country side and finally drains into the Bay of Bengal. Most of the khals are seasonal and function as an important route for lateral fish migration. River crossings of Component 2 will not adversely affect fish migration routes.

171. The aquaculture ponds are small to medium in size. The estimated total area of fish habitat in the study area is about 134 ha of which culture fisheries share 64% and 36%, capture fisheries (see **Table 4.17**). An estimated 8.04 ha of fish habitats will be along the pipeline RoW from Chittagong to Feni (see **Table 4.18**). **Figure 4.12** shows the fish habitats in the pipeline RoW.

Table 4.17 Distribution of fish habitats in the study area

Habitat Category	Type of Habitat	Area (ha)
Capture	River/Khal/hilly creek	15
	Floodplain	33
Sub-total		48
Culture	Pond	66
	Ditch	6
	Seasonally cultured water body	14
Sub-total		86
Grand Total		134

Source: CEGIS estimates based on Google Earth, 9-10 December, 2015

Table 4.18 Distribution of fish habitat along the pipeline RoW

District	Name of Upazila	Habitat type	Total area (ha) (within the RoW, 4 m on each side)
Chittagong	Mirsharai	Pond	1.13
		Ditch	0.06
		River/Canal	0.24
	Sub total		1.43
	Sitakunda	Pond	0.36
		River/Canal	0.06
	Sub total		0.42
Comilla	Barura	Pond	0.37
		Ditch	0.004
		Seasonally cultured water body	0.39

District	Name of Upazila	Habitat type	Total area (ha) (within the RoW, 4 m on each side)
		River/Canal	0.03
	Sub total		0.79
	Chandina	Pond	0.32
		Ditch	0.1
		Seasonally cultured water body	0.03
		River/Canal	0.03
		Sub total	
	Chauddagram	Pond	0.03
		Ditch	0.09
		River/Canal	0.19
		Sub total	
	Debidwar	Pond	0.03
		Ditch	0.02
		River/Canal	0.03
		Sub total	
	Laksam	Pond	0.32
		Ditch	0.06
		Seasonally cultured water body	0.09
		River/Canal	0.04
		Sub total	
	Muradnagar	Pond	0.05
		Ditch	0.005
		River/Canal	0.08
		Sub total	
	Nangalkot	Pond	0.6
		Ditch	0.04
		Seasonally cultured water body	0.4
		River/Canal	0.06
		Floodplains	2.31
		Sub total	
Feni	Chhagalnaiya	Pond	0.02
		River/Canal	0.05
	Sub total		0.07
	Feni Sadar	Pond	0.17
		Ditch	0.11
		River/Canal	0.12
Sub total			0.40
Grand total			8.04

Source: CEGIS estimates based on Google Earth, 9-10 December, 2015

4.6.1.3 Fisheries resources along the pipeline route

172. From Chittagong to Feni, the gas pipeline route will cross rivers, hill creeks, Khals, floodplains, seasonally culture water bodies, and fish culture ponds which act as seasonal and perennial fish habitats.

173. Fisheries resources in the study area are diversified from mainly fresh water to some brackish water fish habitats. These habitats have significant contribution to the local as well as national fisheries resources not only in terms of production but also as migratory routes, breeding and nursery grounds, etc.

174. Fish farming technologies mostly include extensive to semi-intensive culture of carps and other fast-growing fish species like Tilapia, Sharputi, Pangus, etc. The estimated yearly fish production of ponds and seasonally-cultured water bodies in the study area is about 231 and 17 MT, respectively. **Figure 4.13** shows the species of some fish catch.



Khal habitat at Chhagalnaiya, Feni



Hill Creek/Chhara at Sitakunda, Chittagong



Fish culture pond along the pipeline route at Laksam, Comilla



Laxman Dighi (Large pond) crossed by gas transmission line at Muradpur Union, Sitakunda , Chittagong



Muhuri River at Chhagalnaiya, Feni



Dakatia River at Chauddagam, Comilla

Figure 4.12 Fish habitats along the pipeline RoW



Taposi (*Polynemus paradiseus*)



Gura Chingri (*Macrobrachium lamarrei*)
dominant catch



Golda chingri
(*Macrobrachium rosenbergii*)



Mixed catches



Mixed catch (SIS) from floodplains



Mola (*Amblypharyngodon mola*) dominant catch



Cultured major carps



Cultured tilapia (*Oreochromis niloticus*)

Figure 4.13 Assemblages of fishes in the study area

4.6.1.4 Fish migration and movement

175. Different migratory fish species like Rui, Catla, Mrigal, Calbausa, Boal, Kajuli, Pabda, Shing, Magur, Koi, Kholisa, Puti, Chanda were recorded in different habitats of the study area who exhibit longitudinal and/or lateral migration to these water bodies as part of their life cycle. Generally, these fishes migrate from one habitat to another for breeding, feeding purposes and for favorable environment. The rivers and Khals have combined functions of breeding, feeding and sheltering of fishes. The migration and movement of fishes usually occurs during May-September in the study area. Current condition of khals/chhara is silted up, which reduces the length of successive migration routes. Overall, fish breeding and feeding migration is partially obstructed during early migration period (April to May) in the study area.

4.7 Socioeconomics and Land Use

4.7.1 Population

176. CEGIS estimated the 2015 population within the study area based on the 2011 data from the Bangladesh Bureau of Statistics (BBS).¹⁸ The population is about 35,184 consisting of 6,954 households (HHs). The population consists of 48% male and 52% female. The average population density is 1,641 persons per km² which is higher than the national average population density of 1,055 persons per km².

4.7.2 Age structure

177. Age groups of 0-14 years is defined as children, 15-24 years as early working age, 25-54 years as prime working age, 55-64 years as mature working age and 65 years and over as elderly people.¹⁹ Based on this classification, 21% of the population belongs to the 30-49 years old and about 3% are 60 years old and above. This classification is important as the size of young population (under age 15) would need more investment in schools, while size of older populations (ages 65 and over) would call for more investment in the health sector.

178. According to the categorization made on the basis of ILO reference for opting out potential labor force and dependent population, 15 years until 64 years old are considered as labor force whereas, populations below 14 years old and above 65 years old are considered as dependent. Following this classification, about 59% of the population belongs to labor force and 36% of the population is considered as dependent.

4.7.3 Education

179. Literacy rate in the study area is 55%. Male has a slightly higher literacy rate (57%) than female (54%). The rate of literacy reported is for population 7 years and over. Attending rate of male and female students is almost the same in pre-school and primary level. However, attending rate of female students start to decline from secondary level as the study area is one of the conservative areas in Bangladesh where females get married after completing primary education until mid-secondary level.

4.7.4 Health facilities

180. Common illnesses of people in the study area are gastric ulcer, hypertension and diabetes. Health services and facility are available and people receive treatment from registered physicians. There are Upazila health centres, family welfare centres, and community clinics where the local population can avail of primary health services but critical illnesses are referred to the district hospital.

¹⁸The estimation is based on BBS, 2011 Census data and 1.37 linear national growth rate.

¹⁹ The World Factbook, South Asia: Bangladesh.

4.7.5 Occupation and Employment

181. About 34% of the population is gainfully employed, 43% engaged in household work, and 22% are looking for work. Occupation is mainly agriculture (53%) followed by service (36), and industry (11%).

4.7.6 Housing condition

182. Housing in the study area is dominated by kutcha (76%), about 12% made of semi-pucca, 11% is pucca, and 1% is jhupri.

4.7.7 Source of drinking water

183. About 92% of the population use tube-well as source of drinking water, 3% use pipe-supplied water from the local water district, and 5% use other sources.

4.7.8 Sanitary facilities

184. About 79% of the households reported that they have sanitary toilet facilities. Type of sanitary facilities are water-sealed (19%), non-water sealed (60%), and 19% have no sanitary latrines.

4.7.9 Electricity

185. More than half of the population (69%) has electricity. The rest of the population use other sources such as cylinder gas, wood, straw, leaves, and dung as fuel. People spend a minimum of Tk2,000 monthly for fuel consumption. Women claim that cooking through mud made Chula is very difficult and time consuming. **Figure 4.14** shows the types of fuel used for cooking.



Figure 4.14 Types of fuel for cooking

4.8 Land use

186. Land use in the study area is mainly net cultivable area (73%) followed by settlement with homestead vegetation (18%). **Table 4.19** gives the types of land use.

Table 4.19 Land use in the study area

Sl. No.	Class Name	Area (ha)	% of Area
1	Net Cultivable Area(NCA)	1,585	73
2	Brickfield	1	0
3	Ditch	6	0
5	Seasonal Aquaculture (in floodplain)	14	1
6	Lowland	33	2
7	Pond	66	3
8	Railway	2	0
9	River/Canal	15	1
10	Road	20	1
11	Settlement with Homestead Vegetation	398	18
12	Ship Breaking Industry	16	1
Grand Total		2,156	100

Sources: CEGIS, Google Earth December 9-10, 2015

5.0 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

187. This section discusses the potential environmental impacts and the initial hazard assessment.

5.1 Potential environmental impacts

5.1.1 Pre-construction phase

188. Activities during this phase may involve selection of pipeline route, preparing the feasibility study, preliminary consultations, desktop and walk-over surveys, land acquisition, and drafting the Development Project Proforma/Proposal (DPP). These activities will have minimal physical disturbance on the environment.

Land acquisition

189. The RoW required for the pipeline will be 8 m (i.e., 4 m each side from the centerline) and another 15 m will be required as construction workspace (i.e., 6 m on the right and 9 m on the left side as construction RoW). With this RoW, the land needed will be about 145 hectare (ha) and another area of about 275 ha for the workspace along the entire pipeline route. This area is predominantly agricultural land and people depending on agriculture for livelihood will be affected directly. The land for the workspace will be affected also by movements of construction vehicles and heavy equipment, chemicals for cleaning and welding of pipes, and stocking of construction materials. People affected by land acquisition and requisition for construction RoW will be compensated following the regulations of GoB and the requirements of SPS 2009.

5.1.2 Construction phase

190. Construction phase will involve recruitment of workers and staff, mobilization of equipment and machineries, site preparation, installation of the pipeline and ancillary equipment, and hydrostatic testing and commissioning.

191. Prior to construction works, the PIU-GTCL will ensure that the EPC Contractor will include the responsibility of compensating for any temporary damage, loss or inconvenience as a result of implementing Component 2 as set forth in Sect. 19 of Electricity Act 1910, 1982 Acquisition and Requisition of Immovable Properties 1982 (amended 1994), and SPS 2009. Also, a Construction Management Plan (CMP) will be required from the EPC Contractor outlining how the potential environmental impacts during construction will be addressed by them.

192. Before any construction works, PIU-GTCL will conduct a briefing for EPC Contractor's workers and staff on the environmental requirements of GoB and ADB for compliance, records management, and reporting. The orientation and briefing will include awareness about socially transmitted disease such as HIV/AIDS to prevent potential incidence in the workplace.

Impacts on people

193. Construction activities may pose occupational and community safety risks. A contingency fund will be made available to cover potential accidents involving local people affected by Component 2. To prevent accidents, EPC Contractor will provide workers and staff with appropriate personal protective equipment (PPE). The EPC Contractor in coordination with

PIU-GTCL will conduct awareness program/information campaign about safety to local people living near the construction sites. Aside from this, they will inform the local people living close to construction sites on the schedule of construction activities that may pose risks to public safety.

194. Workers assigned in high-level noise generating activities will be provided with ear muffs or plugs and will be rotated every two hours. First aid kits will be made available at the construction sites. A nurse or health personnel will be assigned at the main construction site to inspect and check the condition of field camps. Fire-fighting equipment will be provided at the labor camps. Clear and visible warning and danger signs at and around the construction sites along the pipeline route will be provided. These signs will also consider persons with disabilities.

195. Component 2 will cross two regional highway roads, two national roads, 21 feeder roads, and two railways along with some village roads. Installation of the pipeline may disrupt road mobility and transport of goods and people. The EPC Contractor will be required to prepare and implement a traffic management plan that will be approved by PIU-GTCL to minimize disruption on road mobility. Appropriate, clear and visible traffic and danger signs will be installed to guide pedestrians, people with disability, motorists and other road users. Temporary walkways or crossroads will be set-up particularly in villages. A staff will be assigned to control and monitor the smooth flow of traffic within the construction sites so as not to affect the local traffic. About Tk2,237M (or \$28.9M) is included in the cost estimates as compensation for primary and secondary structures (see Resettlement Plan for Component 2). The EPC Contractor will inform the villagers or local residents on the schedule of construction works that may disrupt their daily activities.

196. HDD and/or trenching along the pipeline route adjacent to the river banks of Little Feni River, Muhuri River, Dakatia River and Khalidas Khal may disrupt the natural drainage, and if not backfilled properly may cause river bank erosion. Installation of the pipeline at these crossings may also disrupt navigation resulting to inconvenience and delay in activities of people using these water bodies. The EPC Contractor will prepare an alternative navigation plan in consultation with Bangladesh Inland Water Transport Authority (BIWTA) and approved by PIU-GTCL to minimize disruption to existing navigation use of these rivers. PIU-GTCL will ensure and monitor compliance of EPC Contractor to the navigation plan.

197. Navigation safety system and equipment will be made available at the river crossings during HDD works. BIWTA will be coordinated and/or consulted on the schedule of HDD works. To avoid potential accidents at the four river crossings, sufficient number of signboards will be provided showing the working time, project name, safety measures, etc. The signboards will be written with radium material as this can be clearly visible even at night time. Radium material is self-luminous and used for warning signs in mines, road safety and construction. Alarms will be provided. Proper fencing and enclosure will be installed to prevent unauthorized access. Security personnel will be posted to discourage pilferage and vandalism.

198. Local people will be informed of major construction works such as HDD emphasizing that these will be temporary. An environmental staff (or consultant) will be present during the HDD works at the river crossings to monitor compliance to EMP and permits from GoB.

199. **Irrigation canals** A total of 20 irrigation canals of the Bangladesh Agricultural Development Corporation (BADC) will be affected at Darora (11 canals) and in Nijmahichal, Mahichal (9 canals) at Feni District. Affected irrigation canals may cause disruption to farmers who are users of irrigation water. Irrigation canals that will be affected will be restored or replaced by another source to minimize disruption. If replacement is not possible, farmers will

be appropriately compensated for the loss of crops and damages. About Tk2,237M (or \$28.9M) is included in the cost estimates as compensation for primary and secondary structures (see Resettlement Plan for Component 2).

200. Fish habitat and culture fish production Pipe-laying may require bailing out of water in ponds crossed by the pipeline route. This process may cause disruption of one season of fish production or may be permanently affected if the pond is along the pipeline RoW.

201. Construction works that may disturb fish habitats will be undertaken from November to April and compartmentalization of ponds will be done within the smallest area possible to minimize disturbance. Loose soil from trenching will be set aside for backfilling and also for leveling the ponds during restoration/rehabilitation.

202. Pond owners affected due to economic displacement resulting from the implementation of Component 2 will be compensated based on the applicable regulations of the GoB and the requirements of SPS 2009. About Tk61.27M (or \$0.79M) is included in the cost estimates as compensation for ponds along the RoW for the pipeline and on the construction workspace, and about Tk132.62M (or \$1.71M) as compensation for crops and fish (see Resettlement Plan for Component 2).

Impacts on ambient air quality, noise and vibration

203. During site preparation, construction works such as excavation, trenching, dumping, use of heavy equipment and construction vehicles, and other earth-moving works may increase noise and dust levels. Increase dust levels and vehicular emissions at the project sites may affect ambient air quality. These activities will generate intermittent noise at the construction sites and along the pipeline corridor. In some occasions, the noise level may exceed the limit for ambient noise level. Workers assigned to high-level noise-generating activities will be provided with PPEs. The use of heavy equipment and excavation machines may also induce vibration.

204. Water will be sprayed to any opened land area (as needed) and work sites to contain dust level particularly during the summer season. Stockyards will be covered during non-working hours. Trucks that will transport construction materials will be covered with canvas or similar material to minimize dust dispersion. The construction sites will be enclosed with temporary fencing of cloth or any suitable material to contain the dust levels.

205. EPC Contractor will be required to maintain construction vehicles, heavy equipment, and generators (if needed) regularly to minimize the contribution of vehicular emissions to ambient air quality degradation. Multi-passenger vehicles will be used to transport workers to and from the construction sites. All construction vehicles and equipment will not be allowed to sit and idle for more than 30 minutes. An area will be allocated onsite as warehouse (or stockyard) for construction materials to reduce the trips for delivery of materials. No burning of solid or liquid wastes and other combustible materials will be allowed within the construction sites and labor camps.

206. Operators and drivers of construction vehicles will be required to observe driving regulations particularly on speed and use of horns. A speed limit of 20 km/hr will be enforced at the construction sites. Excessive blowing of horns at the construction sites near settlements will not be allowed. Construction activities that generate high level noise will be done only during daytime.

207. Local settlements along the pipeline route, where construction activities, will be done will be informed if construction works will generate high level noise and vibration. Also, activities generating high-level noise will be stopped during school hours, madrasa, and prayer at mosque.

Impacts on water use and water quality

208. Several labor camps or base camps will be set up in pre-selected areas along the pipeline route. These camps may generate waste and if located near water bodies may affect water quality. Excavation may cause localized flooding during the monsoon season and in other low-lying areas traversed by the pipeline from Chittagong, Feni and to Bakhrabad.

209. The labor camps will not be sited near water bodies. The EPC Contractor will provide workers with sanitary facilities, safe drinking water, wash areas, and garbage bins to minimize impacts on water quality. PIU-GTCL will require the EPC Contractor to segregate solid wastes generated at construction sites into recyclables and compostables. Solid waste management will be part of the CMP. Good housekeeping will be enforced at all times in all the labor camps. Solid wastes generated in the labor camps and in the construction sites will be collected and disposed of only in landfills or dump sites approved by GoB. Local hiring will be given priority so workers can come home after work every day. The Contractor will be required to observe priority of local hiring. This will limit the number of workers staying at the labor camps.

210. Fuel requirements at onsite fuel tanks and generators will be located in designated contained areas. No refueling of construction vehicles will be done within 30 m from the river crossings.

211. Works associated with HDD at Little Feni River, Muhuri River, Dakatia River and Khalidas Khal may affect water quality. Earthmoving works at these sites may cause soil runoff which may also affect water quality. Some local residents may use these rivers for general purpose washing and watering of plants. Alternative water source (a water tank), if needed, will be provided to people directly and adversely affected by the temporary disruption of these stretch in these rivers.

212. While HDD is considered the best available technology that will minimize impacts at river crossings, all the relevant works during the pipeline installation will be strictly supervised by experienced technical staff, workers and consultants to ensure that it is done according to standards and that water quality impacts are minimized. Areas that will be affected by HDD works will be delineated and/or provided with temporary enclosure to prevent encroaching to adjacent areas.

213. During the hydrostatic testing, the spent water will be checked for quality prior to discharge to ensure compliance with Schedule 10 of ECR 1997. Discharge of wastewater will be monitored to ensure that no localized flooding and soil erosion will occur.

214. To avoid localized flooding within the construction sites, site preparation works will be scheduled during summer in areas where there may be potential for flooding. During the monsoon season, drainage and stormwater management plan will be implemented by the EPC Contractor. Sediment control structures along the river banks will be installed such as cable concrete blocks or geobags. PIU-GTCL will monitor compliance of EPC Contractor to these measures.

Impacts to aquatic habitats

215. The types of aquatic habitat within the study area are pond, river, ditch, khal, and seasonally-cultured water body. The fish habitats are about 134 ha which accounts for culture fisheries (64%) and capture fisheries (36%). Of the 134 ha within the study area, 8.04 ha (or 6%) will be directly affected by the pipeline RoW. The 8.04 ha within the pipeline RoW covers 11 upazilas (or subdistrict) from Chittagong, Feni and Comilla. Persons or owners of these fish habitats will be compensated. About Tk76.3M (or \$0.98M) was included in the cost estimates as compensation for land occupied by ponds and ditch. For fish stocks, about Tk0.61M (or \$0.01M) was included in the cost estimates (see Resettlement Plan for Component 2).

216. The study area for Component 2 covers an area of 2,442.95 ha (i.e., RoW, workspace and GIA). The 2000 assessment of the IUCN Bangladesh indicated that several species of aquatic fauna can be found within the study area. Of the 2,442.95 ha in the study area, the amount of land that will be affected by Component 2 will be 447.95 ha (or 18%). Given the uncertainty of exactly where the habitat of these species are, the EPC Contractor will be required to mark and authorize the clearing areas and minimize disturbances as far as practicable.

217. The areas affected by the route of the 181 km gas transmission pipeline have been modified as the existing land use is mainly agricultural. Lack of baseline data is the major constraint in establishing if there is any presence of critical habitat along the route. Bangladesh has a research on fish sperm cryopreservation (i.e., preservation of fish sperm in liquid nitrogen at -196°C) which started in 2004. PIU-GTCL will explore opportunities to collaborate with the Department of Fisheries, Bangladesh Fisheries Research Institute, and the IUCN Bangladesh to support their initiatives to domesticate wild fish of conservation status that may be potentially affected by the pipeline route. There are no available data or habitat assessment in other areas in Bangladesh to indicate the distribution of the species of conservation status.

218. According to the Fifth National Report to the Convention on Biological Diversity of the DOE (October 2015), efforts in domesticating wild fishes particularly of conservation status have been beneficial to both the farmers and the environment. Of the 17 fish species of conservation status, seven fish species are included in the domestication (see below). Also, research on fish sperm cryopreservation (i.e., preservation of fish sperm in liquid nitrogen at -196°C) in Bangladesh started in 2004. All the fish species of conservation status are still present in their habitats and the fish sperm cryopreservation will be an important approach to ensure a critical mass for these species.

Local Name	Scientific Name	IUCN 2000 conservation status	Culture status	Cryopreservation of Sperm
Calbaus	<i>Labeo calbasu</i>	EN	Small-scale, sporadic	Yes
Rayek, Bata	<i>Cirrhinus reba</i>	VU	Small-scale, sporadic	No
Bata	<i>Labeo bata</i>	EN	Countrywide commercial	No
Baim	<i>Mastacembalus armatus</i>	EN	Breeding protocol developed	Yes
Modhu pabda	<i>Ompok pabda</i>	EN	Small-scale, sporadic	No
Sarputi	<i>Puntius sarana</i>	CR	Breeding protocol developed	Yes
Beti/Rani	<i>Botia dario</i>	VU	Breeding protocol developed	No

219. An environmental staff from the PIU-GTCL and EPC Contractor will be present during the site clearing of ponds and other aquatic habitat along the RoW and construction workspace,

and in the construction works at the river crossings to supervise proper handling of slow-moving or sedentary aquatic fauna and to ensure that impacts are minimized. A handling and rescue procedure for aquatic fauna and a “chance find” procedure for species of conservation status will be required from the EPC Contractor and this will be included in the CMP. **Annex 2** gives a sample fauna “chance find” handling and rescue procedures.

220. Construction works at the river crossings will be done only during low flow periods based on the time of the year and weather forecasts. Erosion control measures will be installed to minimize excessive soil coming into the rivers which will increase turbidity. High turbidity level will affect the photosynthetic activity of aquatic flora.

221. As indicated in water quality impacts, HDD is considered the best available technology that will minimize impacts at river crossings. All relevant works during the pipeline installation at river crossings will be strictly supervised by experienced technical staff, workers and consultants to ensure that it is done according to standards not only to minimize water quality impacts but also to aquatic flora and fauna. Areas that will be affected by HDD works will be delineated and marked and will be provided with temporary enclosure to prevent encroaching to adjacent areas.

Impacts on land and vegetation

222. Site preparation for RoW and workspace (i.e., construction RoW) will affect trees, wooded vegetation, and may disturb the adjacent agricultural lands. Clearing of trees and other wooded vegetation will be done progressively to direct the escape of the wildlife away from the construction activities into the natural areas. Disturbance will be minimized as far as practicable and will ensure the shortest time possible in land restoration and/or rehabilitation after clearing.

223. Before clearing is done, the Environmental staff (or consultant) will assist the EPC Contractor in identifying the terrestrial habitat which may likely have significant species of flora and fauna. The Environmental staff will also conduct faunal inspections (or spot checks) before and during clearing works to supervise and ensure impacts to terrestrial fauna are minimized and proper handling of slow-moving or sedentary terrestrial fauna. In the event of an unexpected encounter or “chance find” threatened species, similar procedures in **Annex 2** will be followed.

224. Improper disposal of waste generated from construction may cause soil contamination. Liquid wastes such as oil drains will be disposed of properly to prevent contamination of soil. An oil-water separator will be provided at the construction sites. All refueling will be monitored by designated staff and vehicles will not be left unattended while refueling is ongoing to avoid spills.

225. Earthworks for the pipeline from trenching, backfilling, excavation will displace topsoil and subsoil which may affect soil quality. Trenching and backfilling will follow design specifications from international standards and best practice including the Bangladesh Natural Gas Safety Rules 1991. The loosened topsoil will be compacted (if needed) to prevent erosion. The sequence of excavated soil for backfilling will be maintained to minimize the impacts on soil quality. Removal of about 50 cm-layer of vegetated topsoil within the trench width will be set aside for backfilling.

Riparian vegetation adjacent to the river crossings will be maintained. Vegetation within at least 30 m buffer on both sides will remain and will be removed only prior to HDD works to minimize erosion. Stockpiled soil will be stored at least 30 m away from the river banks.

226. The RoW required for the pipeline will be 8 m (i.e., 4 m each side from the centerline) and another 15 m will be required as construction workspace (i.e., 6 m on the right and 9 m on the left side as construction RoW). Clearing of vegetation along the RoW will be required and may cause destruction of terrestrial habitat. About 77,319 trees will be affected by the RoW but there are no known endangered, threatened or protected species of terrestrial flora and fauna. These include fruit-bearing trees, timber, medicinal trees, banana, and bamboo from homesteads, cultivable land, fruit and timber gardens planted by farmers and landowners. Affected owners will be compensated for the loss. About Tk317.43M (or \$4.1M) is included in the cost estimates as compensation for trees that may be affected by Component 2 (see Resettlement Plan for Component 2).

227. Tree planting/revegetation using species common in Chittagong, Feni and Bakhrabad will be done at designated sites to be identified by GTCL in consultation with the Forest Department (DOF). Cleared vegetation will be disposed of properly at dumpsite or landfill approved by GoB. Barren (if available) or fallow land will be used for storing construction materials and for maneuvering of vehicles. Construction works will be limited to daytime only to minimize disturbance to nocturnal faunal species.

228. Lands affected by the pipeline RoW are mainly agricultural land. Crops on these agricultural lands will be affected by the site clearing and leveling of construction RoW. Schedule of construction will consider harvest time to give farmers the chance to benefit from their produce and to minimize loss of production. There is also a potential that adjacent crops to the construction areas may also be damaged. Construction works will be limited to the designated areas (pipeline RoW and construction RoW only). This will be fenced or temporarily enclosed to prevent unauthorized public or workers' access and disturbance to adjacent areas. About Tk132.62M (or \$1.71M) is included in the cost estimates as compensation for crops and fish (see Resettlement Plan for Component 2).

Impacts on physical cultural resources

229. One of the criteria for selecting the natural gas pipeline route is avoidance of sites or areas of cultural interests. The route that will be traversed by the 181 km gas pipeline is not known to be of cultural interest. However, since excavation and trenching will be involved, a chance find procedures is given in **Annex 3**. This procedure will be finalized in consultation with the Department of Archaeology (DOA) and other relevant government agency like the Ministry of Cultural Affairs. The implementation of the procedures by the Contractor will be monitored by the PIU-GTCL.

5.1.3 Operation phase

Presence of natural gas transmission line and ancillary equipment

230. The pipeline will be underground (about 2.7 m) but there are parts of the gas transmission system that will be above ground such as valve stations, metering station, pig launcher, TBS, etc. There may be potential for the real estate property values to decrease due to the presence of the gas transmission pipeline system. However, the availability of a stable

and reliable power supply will attract and promote local economic development, thus, will also enhance property values.

“Modified” terrestrial habitat along the pipeline RoW

231. Trees, large shrubs and woody-stemmed plants and vines will not be allowed in the RoW as these will interfere with safe operation and maintenance of the pipeline and their roots may damage the pipe underground. Also, the RoW will be kept clear of major vegetation and structures that may interfere with safe access during operation and maintenance. Tree planting will be done by GTCL in designated areas in consultation with the DOF. Vegetation that will be maintained by GTCL along the RoW will be predominantly grass.

Occupational and public safety risks

232. Operation of natural gas transmission pipeline system does not come without risks of explosion and fire given that natural gas is flammable. The existing gas transmission pipeline system of GTCL is shown in **Figure 5.1**. Given the technical expertise and experience in operating these gas transmission pipelines since 1987, the safety design and specifications including operation & maintenance have improved through the years.

233. Given the volume of natural gas being transported by GTCL over time through about 1,388 km and its corresponding national economic value, GTCL is committed to ensure safety of their workers and the public. GTCL has an environment and safety management system (ESMS) as well as safety and hazard mitigation plan to address the risks of explosion or fire. Among others, the operation of BGFCL is subject to the Natural Gas Safety Rules 1991 (amended 2003) and The Factories Act 1965. In August 1993, a team of safety engineering experts from British Gas experts was engaged to conduct a safety audit of the entire operations of Petrobangla and concluded that all operating companies are generally operating an adequate system and provided recommendations for safety program development which were incorporated in the ESMS.²⁰

234. The lower explosion limit of CH₄ is 5% and the upper explosion limit is 15% in the presence of an ignition source. This means that CH₄ concentration lower than 5% (“too lean”) and higher than 15% (“too rich”) will not cause fire in the presence of ignition source. The existing SCADA system of GTCL allows for emergency automatic valve shut-off along the pipeline or valves can be shut-off remotely from the main control unit. As well, GTCL staff survey and/or inspect the entire pipeline system on foot or by vehicles for signs of leaks, unauthorized activity in the RoW (or adjacent area), soil disturbances along the RoW, or any other condition that may affect the safety and integrity of the pipeline system.

235. Component 2 will be designed and constructed to comply with stringent international and gas industry safety codes aside from compliance to Natural Gas Safety Rules 1991. Natural hazards such as flooding, cyclone, and earthquake were considered in the design and configuration of the pipeline system. Operation will be monitored 24 hours a day and the SCADA will detect that should pressure in the pipeline drop due to leak, the valves will automatically shut off the gas flow to prevent or minimize the gas released into the environment. Clear and visible signs and danger warnings will be provided along the pipeline route.

²⁰World Bank. Gas Infrastructure Development Project. 1995. Environment and Safety Assessment Report: Summary. May 1994. <http://www.worldbank.org/projects/P009533/gas-infrastructure-development-project?lang=en&tab=documents&subTab=projectDocuments>. (Accessed 3 August 2016)

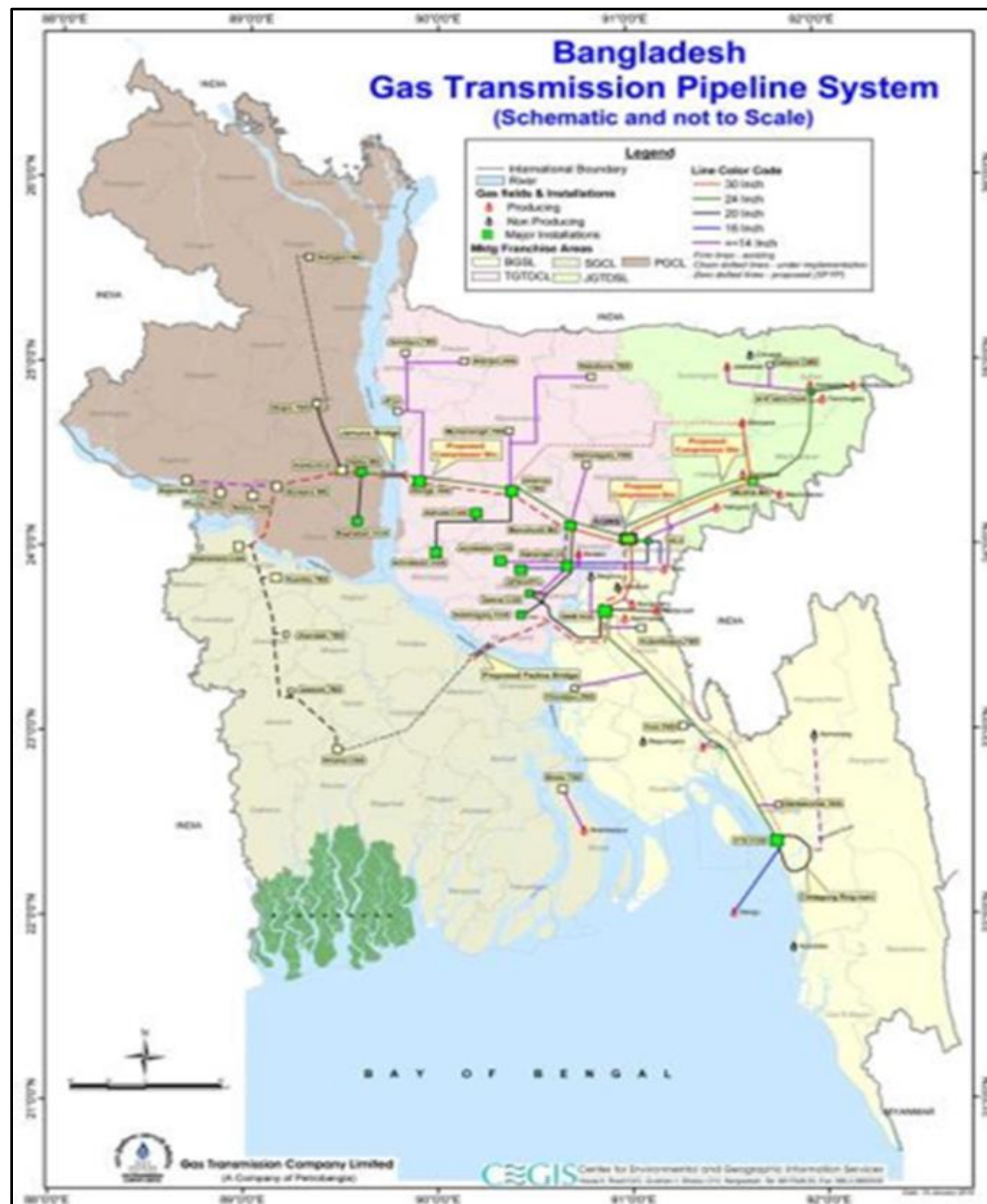
236. GTCL staff will have regular training on safety, emergency or disaster preparedness, and efficient monitoring of the gas transmission system. GTCL will also conduct information drive and/or awareness campaign on safety to settlements in 12 upazila living close to the pipeline RoW. A contingency fund will be provided to cover accidents that will involve people living adjacent to Component 2.

Occupational safety risk and waste from “pigging”

237. During operation phase, pigs (or Pipeline Inspection Gauges) will be placed inside the pipeline to clean or monitor its internal and external conditions. The pig launcher in Selimpur, Fouzdarhat in Chittagong and the pig receiver at Keotgaon, Muradnagar in Comilla will allow the pigs to be inserted into or removed from the pipeline. Pigging operation remove deposits inside the pipeline which could obstruct or retard the gas flow; provide information on the condition of the pipeline including the location and extent of pipeline problem (if any). Given the high quality of natural gas (about 97%_{mole} CH₄), waste from pigging operation will be mainly a mixture of condensate and debris (metal dust) from scale from CO₂ corrosion (i.e., FeS, FeO, FeCO₃) and hardness scale (i.e., CaCO₃, CaSO₄ and BaSO₄).²¹

238. To minimize safety risks, personnel who will be involved in pigging will have the required knowledge and essential skills. Appropriate PPE will be provided to workers and personnel who will conduct the pigging operations; barriers and warning notices will be provided to limit access to the worksite to authorized personnel only. Waste from pigging operations will be managed to ensure compliance to ECR 1997.

²¹Petroleum Technology Alliance of Canada.Cleaning of Pipelines for Abandonment.Final Report. September 2015.



5.2 Associated Facilities

5.2.1 Source of natural gas - FSRU

239. Following ECA 1995 and ECR 1997, GTCL prepared and submitted to DOE on 31 March 2013 the EIA of the offshore floating LNG and FSRU terminal to be permanently moored at Island/Finger Jetty activities project in Maheshkhali, Cox's Bazar District. A presentation of the same was held during the 362nd meeting of the Environmental Clearance Committee, DOE on 12 March 2014 which approved the EIA noting that a No Objection Certificate (NOC) on the location coordinates of the project site be obtained from the Shipping Ministry before launching the project. The NOC was unanimously decided by an inter-ministerial meeting of the Power and Energy, Forest and Environment, and the Shipping Ministry on 17 August 2015 that siting of the FSRU can be at 21° 34'25"N, 91° 49'08"E or 21° 32'01"N, E91° 48'07". Consequently, GTCL applied for the issuance of the ECC on 16 September 2015.

240. The EIA also referred to the Bangladesh Gas Safety Rules 1991 (amended in 2003), the Land Acquisition and Requisition of Immovable property Ordinance 1982, international treaties and relevant standards. While not funded by ADB, the EIA was prepared consistent with the key principles of SPS 2009. Among others, the EIA covered analysis of alternatives, public consultation and disclosure, environmental management plan and monitoring, and grievance redress mechanism.

241. The FSRU will involve the (i) construction of jetty, (ii) offshore pipeline installation, (iii) deployment and commissioning, (iv) delivery of LNG and regasification, (v) maintenance of FSRU vessel and jetty pipeline. The EIA identified the following potential impacts:

- a) Seabed disturbance due to installation of about 8 km offshore pipeline that may result to destruction of benthic habitat, increased turbidity, and sedimentation;
- b) Pile driving for the construction of mooring system will cause increased level of noise and vibration to aquatic habitat;
- c) Cooling water discharges from the cooling system of FSRU may result to localized cooling within 75 feet at discharge point;
- d) Gaseous emissions from the combustion at FSRU and greenhouse gas contribution;
- e) Presence of the FSRU may cause localized impingement and/or entrainment of ichthyoplankton;
- f) Accidents such as hydrocarbon spills, large-scale gas releases, and fire and explosion may pose occupational and public safety risks;

242. To mitigate these key impacts, an EMP was included in the EIA that covers oil spill and waste disposal plan, biodiversity management plan, soil erosion and fertility control plan, mitigation plan for air quality, noise and vibration including health, environment and safety management plan. Contractor/developer of the FSRU will ensure workers' health and safety through compliance of Labor Law 2006. A safety and security risk and hazard assessment was prepared for the FSRU. An oil spill emergency plan is also included in the EIA outlining the agencies involved and describing the roles and responsibilities. In the event of oil spill, one tugboat will be fitted with anti-pollution equipment with two x 400-m oil trapping boom designed for sea; six mooring buoys for oil trapping boom, and two pumps designed to pump very heavy and viscous oil. Tugboats will be equipped with eight fire extinguishers, two fire pumps, eight life buoys, and 12 jackets, gas detection meter, etc.

243. **Consultations** Key informants interview and focus group discussions were carried out between February and May 2012 to ensure that all stakeholders and affected people are fully informed about the project, and the views of these people on the consequences of the project are taken into account consideration. People consulted expect the following:

- (i) Local employment in different activities on a priority basis;
- (ii) Preference be given to engage local businessmen/contractors in different phases of the project for construction and development depending on their suitability;
- (iii) Prompt and proper distribution of compensation payment to affected persons; and,
- (iv) Provide supply of gas in areas traversed by the pipeline.

244. Several concerns were expressed by potentially affected people as follows:

- (i) Impacts to agricultural products and vegetation including the salt and shrimp cultivation. Compensation should be paid to affected people on the spot.
- (ii) Project activities and presence of workers may damage crops, trees, salt and shrimp cultivation at different seasons of the year until completion of project.
- (iii) Noise pollution from vehicles and equipment at the project sites may cause disturbance to human being and wild life.
- (iv) Compensation for land based on government rate would not be a fair compensation to the affected person as the rate is low compared to market rate.
- (v) Potential enhanced soil erosion particularly along shore line/banks which should be addressed properly
- (vi) Pollution of surface water may be aggravated and should be addressed as it is used for agriculture and domestic purposes.
- (vii) Inconvenience to local people particularly women, children, and disabled due to movement of vehicles.
- (viii) Air pollution due to dust and gaseous emission.
- (ix) Environmental pollution due to sanitation and waste materials including other social nuisance.
- (x) Loss of land fertility should be reduced. Proper compensation should be given to the cultivator of salt production and shrimp cultivation.

245. **Grievance redress mechanism** Handling of disputes and/or complaints will be through negotiations involving GTCL staff and the Upazila administration officers. The procedures will be set-up by GTCL in collaboration with the administration of the Moheshkhali Upazila, local community liaison, and if required, outsourced support from NGO will be considered. GTCL will ensure that they will collaborate with the operator of the FSRU on compliance to environmental requirements of GoB and ADB.

5.2.2 Evacuation of Natural Gas from FSRU

5.2.2.1 30-inch, 90 km Maheshkhali-Anwara Gas Pipeline

246. The ECC for the 30-inch, 90 km Maheshkhali-Anwara pipeline was issued by DOE on 18 December 2012. Similar to FSRU, the EIA covered impacts on ambient air quality, water quality, noise, potential economic displacement of persons involved in salt production and shrimp cultivation, temporary loss of income to farmers due to disturbance of irrigation canals and preparation of RoW for the pipeline, destruction/loss of aquatic habitat, and generation of employment. In Chittagong, 38.22 ha will be acquired for RoW and 64.1 ha will be requisitioned during construction phase while in Cox's Bazar, about 30.36 ha will be needed for the RoW and

59.23 ha to be requisitioned. Affected people will be compensated following the requirements of GoB. An EMP was prepared including monitoring. Installation of the pipeline at five river crossings will be done through horizontal directional drilling (HDD) to minimize environmental impacts. The minimum clearance that will be maintained between the bored hole and river bottom during HDD will be seven meters or as specified by design consideration. An emergency response and disaster management plan that covers the installation of the pipeline and during implementation is included in the EIA.

247. **Consultations and grievance redress process** Affected persons were consulted during August to November 2011. Prior to consultation, stakeholder mapping was done to identify the primary and secondary stakeholders. A total of 40 focus group discussions were conducted in four upazilas: Maheshkhali, Anowara, Banshkhali, and Pekua attended by about 469 persons. Some of the issues raised include proper and present market rate compensation to affected persons, employment opportunities to local labour, reduction of gas prices and availability of gas to areas traversed by the pipeline as host communities. Grievance will be set-up following the regulations of GoB.

5.2.2.2 42-inch, 30 km Anwara to Fouzdarhat Gas Pipeline

248. A draft EIA for the 42-inch, 30 km Anwara to Fouzdarhat gas pipeline was prepared in September 2016 based on the terms of reference (TOR) approved by the DOE on 25 June 2015. This pipeline will connect the 30-inch, 90 km pipeline from Maheshkhali to Anwara and from Fouzdarhat to Component 2 (refer to Figure 3.3).

249. Consistent with the FSRU and the Maheshkhali-Anwara gas pipeline, the EIA prepared for the Anwara-Fouzdarhat pipeline considered the key elements required by SPS 2009. A 200-meter radius from the centre of the pipeline route was considered for the existing environment and assessment of potential impacts. About 24.29 ha of land will be required for the RoW, the valve station and the metering station while about 50 ha will be requisitioned during the installation of the pipeline including the Kharnaphuli River crossing. Three options were considered in selecting the route considering both environmental and social impacts. The selected route of about 30 km will affect 55 trees and river crossing at the Kharnaphuli River affecting about 1.3 km stretch of the river. Installation of the pipeline along the Kharnaphuli River will employ HDD. This method will reduce potential damages to the river banks; avoid obstruction to navigational traffic movement, and any interference to fish breeding.

250. An EMP that includes environmental monitoring was included in the EIA. The EMP incorporates emergency response and disaster management plan as well as risk assessment of potential hazards.

251. **Consultations and grievance redress process** Consultations were conducted in July 2016 through public consultation meetings and focus group discussions. Local people view the project as positive development associated with generation of employment, contracting opportunities, improved drainage systems, better infrastructure and gas facilities, and supply of electricity. Concerns include potential health risks due to incoming migrant population. Another concern is the limited participation of women in employment opportunities given that Anowara and Shitakunda are highly traditional in social structure. GTCL will ensure that these concerns are addressed during implementation. Any complaints from the project will be dealt with following the regulations and procedures required by DOE and relevant regulations of GoB.

5.3 Preliminary hazard assessment

252. This section presents a preliminary hazard assessment for Component 2. A more detailed hazard assessment will be included in the EIA as required by the DOE following the requirements set forth in ECA 1995 and ECR 1997. This preliminary assessment identifies the potential hazards associated with natural gas transmission pipeline project which can be avoided by incorporating safety plans in the planning and design process.

5.3.1 Hazard assessment process

253. The assessment was based on literature review and expert opinions, and the steps followed include the:

- (i) identification of potential hazard points;
- (ii) cause identification;
- (iii) consequences of exposure; and,
- (iv) recommended actions and safety measures.

254. The potential hazard points were identified to determine the causes and consequences. **Table 5.1** presents the potential hazard points based on hazard classification.

Table 5.1 Potential hazard points identified for Component 2

Hazard classification	Hazard points
Mechanical	Clearing of standing installations in RoW, operation of laying equipment, welding equipment, etc.
	Valve and other pipeline components
	Construction sites
Fire and explosion	Gas pipeline (Stringing)
	Welding area
	Valve stations
	Pump stations
Methane gas leakage	Gas pipeline
	Valve stations
	Delivery stations
Failure mode hazard	Valve stations
	Gas pipeline
	Injection station/delivery station
	Final delivery station
Radiation Hazard	X-ray machine
Vehicular hazards	Motor vehicle and lorries, movement of vehicles

255. The potential hazards, root causes, consequences, and recommended safety measures were identified for the different phases of implementing Component 2. A summary is given in **Table 5.2**.

Table 5.2 Hazard assessment for Component 2

Hazard point	Project Activities	Potential hazard	Root causes	Consequences	Suggested Safety measures
Pre-construction phase					
Machineries, pipe and other pipeline-laying equipment	<ul style="list-style-type: none"> Bringing in machines and equipment for site clearance activities Mobilizing the pipes, valves and other construction materials along the RoW 	<ul style="list-style-type: none"> Trips and falls Cuts and bruises 	<ul style="list-style-type: none"> Fatigue or prior sickness Mechanical failure Lack of safety training Not abiding to general health and safety, and traffic rules 	<ul style="list-style-type: none"> Health injury Disability Loss of life 	<ul style="list-style-type: none"> Arrange for a Toolbox Talk* before going out for work Regular inspection and maintenance Regular health and safety training to all construction workers and lorry drivers, including the proper use of PPEs A thorough lorry driver selection process via interviews, checking whether they have the proper licenses and appropriate work experiences Training on traffic rules and regulations, including maintaining vehicle speed limit for different categories of road after the selection process is complete Limiting the movement of vehicles after sunset and before sunrise. <p>*Toolbox Talk is an informal safety meeting that focuses on safety topics related to the specific job, such as workplace hazards and safe work practices.</p>
Construction phase					
Construction site	Land excavation	<ul style="list-style-type: none"> Inhalation of dust Sickness Accident (e.g. falling of machineries, equipment and debris) Cuts and bruises Trips and falls 	<ul style="list-style-type: none"> Fatigue or prior sickness Drinking from unsafe water (e.g., ponds, arsenic-prone tube wells, etc.) Mechanical failure (e.g., equipment failure, etc.) Lack of safety training Not abiding to general health and safety rules 	<ul style="list-style-type: none"> Health injury Disability Loss of life 	<ul style="list-style-type: none"> Arrange for a toolbox talk before going out for work (during each construction activities). Regular inspection and maintenance Regular health and safety training to all construction workers, including the proper use of PPEs. Enclose the area with yellow barricade tape and restrict outside access to local people during the whole construction process Maintain hygiene at construction sites and provide appropriate training to workers on hygiene maintenance Supply workers with safe drinking water Spray water on dusty areas to minimize its dispersion Put stockpile at a designated place and cover them with GI sheets Put up GI sheet fencing around the construction site Record any unusual activities and issue fines or suspensions if any rules are broken

Hazard point	Project Activities	Potential hazard	Root causes	Consequences	Suggested Safety measures
	Backfilling of trench	<ul style="list-style-type: none"> • Accidents • Injuries from falls and slips • Inhalation of dust • Cuts and bruises 	<ul style="list-style-type: none"> • Fatigue or prior sickness • Lack of safety protocols (e.g., not putting up warning signs or enclosing the area to prevent entry of outside people) • Not maintaining a designated place for backfilling storage • Not maintaining enough lighting during the night 	<ul style="list-style-type: none"> • Health injury • Broken bones/disability 	<ul style="list-style-type: none"> • Maintain an accident registry book. • Put up appropriate florescent warning signs at construction site. • Enclose the area with yellow barricade tape and restrict outside access to local people during the whole construction process • Maintain a designated area for storing the backfilling materials • Ensure proper lighting at night time • Regular health and safety training to all construction workers including the proper use of PPEs. • Maintain an accident registry book
Gas pipelines (Stringing)	Welding of pipelines	<ul style="list-style-type: none"> • Burn damage • Spread of fire 	<ul style="list-style-type: none"> • Lack of safety training while handling the equipment • Carelessness in handling welding machines • Negligent towards the use of safety equipment (e.g., safety mask, gloves, googles, etc.) • Selection of unskilled worker for welding works • Not abiding to general health and safety rules 	<ul style="list-style-type: none"> • Injuries • Fire burns • Disability 	<ul style="list-style-type: none"> • Careful selection of workers who have prior welding experience • Inspect welding machines and PPEs before starting work; change any faulty machines or PPEs if found. • Maintain an accident registry book
	X-ray scanning of pipelines	<ul style="list-style-type: none"> • Exposure to radiation 	<ul style="list-style-type: none"> • Lack of safety training while handling 	<ul style="list-style-type: none"> • Long-term exposure that may lead to 	<ul style="list-style-type: none"> • Prevent intruders from work site to protect them against welding radiation • Protect integrity testers from

Hazard point	Project Activities	Potential hazard	Root causes	Consequences	Suggested Safety measures
			<ul style="list-style-type: none"> g the equipment Carelessness in handling the X-ray machine Negligent towards the use of proper safety equipment Not abiding to general health and safety rules 	cancer, skin diseases, and birth defects (in case of pregnant workers)	exposure to x-ray
	Cleaning of pipelines with pressurized water	<ul style="list-style-type: none"> Injuries from pressurized water Exposure to dirt and other muddy water 	<ul style="list-style-type: none"> Lack of communication Carelessness in dealing with pressurized water 	<ul style="list-style-type: none"> Health injury Broken bones/disability 	<ul style="list-style-type: none"> Maintain communication on when to release and stop water flow Make sure that effluents are released as far away from the locality as possible and at a designated site. Keep an eye on the pressure gauge when releasing water; maintain pressure as required Report any structural damage to the pipelines immediately; stop water flow as soon as any structural damage is notified to prevent accidents Maintain a record of any incidents
	Marking of the pipeline route after the pipes are put in its place	<ul style="list-style-type: none"> Falls and trips Personal security (e.g. hijack, theft, kidnapping, etc.) 	<ul style="list-style-type: none"> Traversing through a remote area alone Traversing through a remote area at night alone 	<ul style="list-style-type: none"> Possible fatal injuries Loss of belongings Mental trauma Possible death 	<ul style="list-style-type: none"> Walk in numbers when traversing through a remote area; seek the support from local security personnel to accompany workers Keep the phone numbers of the local police office and ambulance at speed dial
Motor vehicles and lorries	<ul style="list-style-type: none"> Transportation of machineries Construction activities 	<ul style="list-style-type: none"> Noise generation Accident Vehicular emissions 	<ul style="list-style-type: none"> Noise generated from running engine, hydraulic horns and construction activities Mechanical failure of machines/lorries/other equipment Poor vehicle maintenance 	<ul style="list-style-type: none"> Health injury (e.g. hearing loss, accidents etc.) Disability Fatality 	<ul style="list-style-type: none"> Regular checking, servicing and maintenance of vehicle Periodic health checkup of lorry drivers and construction workers Maintain traffic safety rules Switch off vehicles and machineries when not in use Using earmuffs to protect against loud noises (e.g., from hydraulic horns); if possible limit the use of hydraulic horns during construction.
Gas pipelines and safety valves	<ul style="list-style-type: none"> Installation of gas pipelines (laying) and 	<ul style="list-style-type: none"> Injury from falling pipes and debris 	<ul style="list-style-type: none"> Faulty safety harness of lorries, cranes and 	<ul style="list-style-type: none"> Disability Life loss 	<ul style="list-style-type: none"> Arrange for toolbox talk before going out for work Regular checking, servicing and

Hazard point	Project Activities	Potential hazard	Root causes	Consequences	Suggested Safety measures
	safety valves		pulleys <ul style="list-style-type: none"> • Mechanical failures • Lack of proper safety training • Not abiding to health and safety rules 		maintenance of lorries, cranes and pulleys and their safety harness <ul style="list-style-type: none"> • Regular health and safety training to all construction workers and lorry drivers, including the proper use of PPEs • Put up appropriate safety signs at construction site • Record any unusual activities and issue fines or suspensions if any rules are broken • Maintain an accident registry book.
Operation					
<ul style="list-style-type: none"> • Gas pipelines • Valve stations • Pump stations 	<ul style="list-style-type: none"> • Gas leakage • Thermal hazard • Environmental hazard • Mechanical hazard 	<ul style="list-style-type: none"> • Asphyxiation • Explosion • Fire ball 	<ul style="list-style-type: none"> • Faulty pipes • Faulty connections • Corrosion • Induced stress • Sabotage 	<ul style="list-style-type: none"> • Loss of life • Damage to nearby buildings, houses and properties • Damage to the environment and ecosystem 	<ul style="list-style-type: none"> • Arrange for a toolbox talk before going out for work • Inspect pipelines for leakage, corrosion, etc. before installation • Make sure that connections are made properly at each junctions • Cover the pipes with coatings/cathodic protection for corrosion protection • Proper pipeline weighting to reduce buoyancy • Periodic inspection of pipelines for corrosion and leakage • Set-up for an automated monitoring system to monitor any changes to gas pressure at junctions/metering stations • Set-up awareness programs to inform communities of the dangers and hazards associated with gas transmission pipelines and motivating them to take an active part in prevention of any sabotage activities. • Set-up an on-site emergency response team to mobilize immediately to any emergency situation to ensure minimum casualties.

6.0 ANALYSIS OF ALTERNATIVES

256. Due to limited options in selecting the pipeline routes, only two routes were considered. The analysis of the two options was based on satellite photos and Google maps. Two pipeline routes were identified on Google map from Bakhrabad to Selimpur (Option A marked dark pink and Option B marked with black dashed line, see **Figure 6.1**). A summary of the options considered is given in **Table 6.1**.

Table 6.1 Options considered for pipeline route

Description	Option A (dark pink)	Option B (black dashed line)
Length of the pipeline	181 km	approx. 182 km
Number of bends along the pipeline	592	559
Land required for RoW (acquisition)	144.58 ha	145.29 ha
Land required for construction RoW or workspace (requisition)	approx.271.11 ha	approx. 272.411ha
Ownership of land	To be determined during the EIA required by the DOE	To be determined during the EIA required by the DOE
Number of river (R)/khal (K) crossing	R= 4; K= 60	R= 4; K= 60
Number of ponds that will be potentially affected	about 12 ponds	about 12 ponds
Number of clustered settlements that may be potentially affected	647	666
Number of horticulture garden that may be potentially affected	none	none
Number of wetland crossing	about 9	about 9
Number of railway crossing	2	2
Number of national road crossing (N) and zonal highway (R)	N= 2; R= 2	N= 2; R= 2

Source: Based on Google Earth Map

257. Considering these two pipeline routes, Option A was selected for more detailed engineering study.

258. Under the “no project” option, the site will remain the same as the existing condition but the current constraint of GTCL not meeting the required gas supply will continue. At the same time, the planned economic development and business opportunities within the area may not happen. A “no project” option will be an opportunity cost for GoB. **Table 6.2** presents a comparison of “with project” and “no project” options.

Table 6.2 Comparison of “with project” and “no project” options

Description	“With Project” Option	“No Project” Option
Supply of natural gas	Provides a stable and reliable flow of natural gas for distribution to industry, transport, commercial and	Shortfall of natural gas supply to industry, residential, commercial, and transport users will continue

Description	“With Project” Option	“No Project” Option
	residential purposes	
Economic development	More opportunities for the area to develop economically due to reliable supply of natural gas	Slower economic development due to shortage of available natural gas
Impacts to ecologically-sensitive areas	No protected areas or national parks will be affected. There will be associated environmental impacts but these can be readily mitigated by adherence to applicable design standards and specifications, compliance to relevant regulations, and implementation of best practice engineering processes and procedures.	No impacts
Impacts to flora and fauna	Minimal impacts; selected route is not known to host endangered or protected species of flora and fauna, and no matured trees will be cleared.	No impacts
Greenhouse gas (GHG) emissions	Design specifications and standards will prevent leaks in the pipeline and ancillary equipment. However, if O & M is poor or not adequate, it is estimated that about 3.124 kg CH ₄ per day fugitive emissions may occur.	No GHG contribution
Disruption to local residents	Minimal impacts (i.e., temporary and short duration during construction/installation); can be mitigated by proper construction planning and scheduling of activities.	No related local disruptions
Employment	There will be jobs associated with the project during construction and operation phase.	No creation of jobs
Living conditions of related service areas of GTCL	Potential improvement in living conditions due to availability of stable and reliable flow of natural gas	Same level of living conditions or likelihood of worsening living conditions due to poor service by GTCL associated with shortfall in reliable natural gas flow



Figure 6.1 Alternative routes for Component 2

7.0 INFORMATION DISCLOSURE, CONSULTATION, AND PARTICIPATION

7.1 Identification of stakeholders

259. Stakeholders considered for Component 2 include the following:

260. *Primary stakeholders* These will be the persons who will be within the RoW of the pipeline route. They will be directly affected during construction and operation phase. The primary stakeholders the farmers, fishers, small business community as well as the households to be displaced, women groups, and wage laborers

261. *Secondary stakeholders* These will persons or organizations that may not be directly affected but may have interests that can contribute to the project, play a role during implementation at some stage, or affect decision-making on some project aspects. These will include the concerned government departments and line agencies, NGOs (if any), academia, and general public.

7.2 Approach and methodology

262. A participatory approach was followed in conducting the stakeholder consultation meetings:

- The consultants used check lists provided by ADB to maintain uniformity and relevancy in discussion, and properly recorded the opinions and views of the participants. The checklist includes information about the project, proposed implementation schedule, and potential project impacts.
- Socio-economic, agricultural, hydrological, fisheries, and ecological issues were discussed in detail, including potential project impacts the environmental and social parameters as well as institutional issues.

263. Stakeholders' engagements were conducted from 15-30 December 2015. The location of the stakeholder meetings was selected based on the consultation among GTCL, ADB, Upazila Nirbahi Officer (UNO), Union Chairmen and members, and other local knowledgeable persons.

7.3 Stakeholders' consultation and community meetings

264. CEGIS conducted the consultations in December 2015 and completed six community meetings and 11 focus group discussions (FGD). Stakeholders' consultations will continue during the implementation of Component 2.

265. During the community meetings, a total of 148 participants from public representatives, community leaders, teachers, service holders, farmers, day laborers, fishers, traders, women, etc. attended. These meetings were held at the Upazilla Parishad's auditorium, UP auditoriums, schools or community places where participants have easy access. **Table 7.1** presents the breakdown of participants while **Figure 7.1** to **Figure 7.6** shows the photographs taken during the consultations.

Table 7.1 Breakdown of stakeholders' meetings

SL. No.	Location of Meeting	Date of Meeting	Duration of Discussion	Number of Participants
1	9 No. Vatiari Union Parishad	24/12/2015	2:30	34
2	Kumira Union Parishad	26/12/2015	2:00	20
3	Purba Durgapur, Durgapur	27/12/2015	2:30	24
4	Elashpur, Pachgacia, Feni	28/12/2015	3:00	24
5	Budhura Gov. Primary School, Gunoboti, Comilla	29/12/2015	2:00	25
6	Kutumbopur, Madaia Union, Comilla	15/12/2015	2:00	21



Figure 7.1 SCM at Vatiari UP, Shitakundo



Figure 7.2 SCM at Kumira UP, Shitakundo



Figure 7.3 SCM at Purbo Durgapur, Durgapur, Shitakundo



Figure 7.4 SCM at Ilashpur, Feni



Figure 7.5 SCM at Gunoboti, Comilla



Figure 7.6 SCM at Comilla

266. Eleven FGDs were conducted with affected primary stakeholders consisting of occupational groups, landless/squatter, and women. The affected occupational groups include farmers, businessmen/traders, and fisherfolks. Vulnerable group includes squatter dwellers or informal settlers, women, and landless/day laborers in agricultural and non-agricultural sectors. Around 83 participants attended the FGDs (see **Table 7.2**). **Figure 7.7** to **Figure 7.10** shows the photographs during the FGDs.

Table 7.2 FGD schedule and participants

SL. No.	Location	Date	Duration	Type of Group	Number of Participants
1	Vatiari	24/12/2015	1:30	Women	11
2	Vatiari	24/12/2015	1:00	Businessman	7
3	Kumira	26/12/2015	1:00	Fishermen	7
4	Kumira	26/12/2015	1:00	Squatter	6
5	Purba Durgapur	27/12/2015	1:00	Women	8
6	Purba Durgapur	27/12/2015	1:00	Farmer	8
7	Ilashpur, Pachgacia, Feni	28/12/2015	1:15	Community Group	9
8	Ilashpur, Pachgacia, Feni	28/12/2015	1:20	Women	7
9	Budhara, Gunobati	29/12/2015	1:30	Wage labor	7
10	Nangalkot, Comilla	29/12/2015	1:00	Women	8
11	Kutumbopur, Chandina, Comilla	30/12/2015	1:30	Women	5



Figure 7.7 FGD at Kumira, Shitakundo



Figure 7.8 FGD with Community Group, Ilashpur, Feni



Figure 7.9 FGD with women at Purbodurgapur



Figure 7.10 FGD with Small Traders



Figure 7.11 FGD with women



Figure 7.12 Alternative site visit at Shitakundo

7.3.1 Contents of discussion and responses

267. The main topics discussed in the stakeholders' meetings and FGDs were:

- **Water resources** Surface water (tidal flooding, drainage, salinity, siltation); Water management (flood control, drainage, irrigation)
- **Land resources** Cropping practice, production and yield, water logging and drainage congestion, crop damage.
- **Socio-economic aspects** Occupation and Employment (unemployment/joblessness), migration (temporary/permanent out-migration), poverty (food and income poverty), education (poor literacy rate, non-schooling, less female education, drop out, etc.), health and nutrition (illness, diseases, poor nutrition), quality of life (poor housing and sanitation facilities, scarcity of drinking water, fuel and fodder)
- **Disasters** Cyclones, river erosion, associated damages
- **Main problems faced in the project on sustainable and integrated solutions**
Water resource management, agriculture and fisheries management, land resource management, disaster management.

268. *Perceptions of local people about the project* Most of the people have a positive attitude towards Component 2 as they feel that due to the scarcity of gas supply, the development in the industrial sector is being hampered greatly. The people who attended the stakeholders' consultation recognize that implementation of Component 2 is given high priority by GoB to solve the current and future gas supply problem. Those from Vatiari, Kumira, Gunobati, Nangalkot, Ilashpur, and other areas that may be greatly affected by the shortage of gas supply in the future are also supportive of the project.

269. *Community concerns and suggested solutions* The attendance during the stakeholders' consultation is given in **Annex 2** while **Table 7.3** gives the summary of concerns and how to address them.

Table 7.3 Summary of concerns and suggestions

Issues	Identified problems	Recommendations
Physical Resources	Noise will be generated during laying of the proposed gas transmission line	<ul style="list-style-type: none"> • Attempt at creating less noise and avoiding night for any project activity • Heavy construction equipment, pipes, vehicles should be moved with care, drivers of construction vehicles should minimize the use of horns. • Noise generation activities should be stopped during the working hour of schools, madrasa and prayer time at mosque.
	<ul style="list-style-type: none"> • Dust generation may occur from excavated soil, pipe-laying and vehicle movement, trenching works, installation, boring during road crossing, grading, lowering-in, tying-in, etc. 	<ul style="list-style-type: none"> • Sprinkling of water and ramming the materials of stockyard regularly • Stockyard should be covered properly during non-working period. • Temporary fencing should be given at construction sites

Issues	Identified problems	Recommendations
Water Resources	<ul style="list-style-type: none"> • Surface water quality may be deteriorated due to disposal of solid and liquid waste, soil runoff from the stored excavated earthen materials, storage materials, trenching works, water pump out, pigging inaccuracy etc. 	<ul style="list-style-type: none"> • Construction works should be undertaken during the dry season • The field camps, stockyards should be placed far from water bodies • Solid and liquid waste should be dumped at specified place far away from water bodies • All the project related activities should be done with proper care.
	<ul style="list-style-type: none"> • Overland drainage may hamper if the excavated earthen material is dumped beside the RoW and back filing is not done in due time and in proper manner 	<ul style="list-style-type: none"> • Backfilling of the trenches after the laying of the gas transmission pipe should be conducted immediately and properly. • Backfilling should be done with proper care and ensure excavated earthen material does not exist for longer time beside the RoW.
Agriculture Resources	<p>Crops loss: Due to different construction work for pipeline, the standing crops may be damage; crop production should be stop at the acquisition and requisition land for a year or more time. Construction work may damage the crops on the side of the stripped land.</p>	<ul style="list-style-type: none"> • Adequate compensation should be provided to the farmers/share croppers for loss of crops. • Project work might be delayed for allowing the farmers to harvest their standing crop. • Mobilization and construction work of the project should be carried out carefully. • People want compensation for damages. • People would like land rental. • Pipeline should use government land. • Make gas line facility for surrounding people.
	<p>Irrigation problem: Irrigation channels may be damaged or partially damaged where pipeline crosses over the channel. Irrigation problem may occur at crops field.</p>	<ul style="list-style-type: none"> • If any irrigation channels will be damaged or disrupted during project work, immediately the channels should be repaired or re-established. • Loss of existing source of irrigation should be replaced by another source. • Crossing of irrigation channels should be avoided. • Make the alternative channels before the damage. • Compensation for loss of crops due to irrigation problem should be given.
	<p>Soil Quality Deterioration: The trenches will be backfilled after laying the gas pipe, but the valuable topsoil and subsoils might be disturbed and is likely to be displaced. So, the covered topsoil may not be able to support agricultural crops production properly potentially affecting fertility and productivity of the land.</p>	<ul style="list-style-type: none"> • The excavated soils materials should be properly stacked for refilling the trench with soil by maintaining the sequence of the soil profile (i.e. Substratum–Subsoil– Topsoil). • The loosened topsoil's must be compacted well so that no erosion can take place. • Liquid wastes should not be spread over the surrounding of study area. • Compensation for land if quality will not be suitable for crops production over a period of time. • Make sure the contractor is careful to keep soil quality the same as before project. • After backfilling, level the land to bring it to original condition. • Liquid wastes and disposal should be dumped far from the crop fields.

Issues	Identified problems	Recommendations
Fisheries Resources	<ul style="list-style-type: none"> • Fish pond habitat will be lost in case of filling up of acquired portion of pond • Fish production from culture fish pond and seasonally- cultured water body within the acquired RoW area will be hampered/ lost for one season/ permanently • Water flow in the khals/hill creeks will be obstructed if piled up earth in the bottom during trenching is not leveled as it was before intervention • Fisheries activities like netting will face problem due to pile up earth in the pond bottom • Fish habitat quality will be deteriorated locally if hazardous materials resulting from piggings activities are discharged into the nearby water bodies. 	<ul style="list-style-type: none"> • Avoid water bodies in the installation of gas pipeline • Proper compensation should be ensured timely by following the Acquisition and Requisition of Immovable Property Act, 1984. • Ensure proper compensation for the temporal and permanent loss of fish production • The project work should be done in dry season i.e. in the month of November to March • Compartmentalization of pond have to be done with the lowest possible area for limiting disturbances to productive zone • Piled up earth in the bottom of water bodies during trenching have to be leveled as it was before the project works • Local people demand to avoid large water bodies for installation of pipeline • Pond should not be filled up fully by earth • Take necessary action so that the affected people get compensation fully, properly and timely • Take step, so that the local people get gas connection for aquaculture business purpose
Ecology Resources	<ul style="list-style-type: none"> • Tree, herbs and shrubs will be damaged/cut during site preparation for proposed route of pipeline. • Relocation of wildlife for habitats loss due to vegetation damage. • Disturbance of wildlife due to noise from construction vehicles and labour movements. • The aquatic flora and habitat will be damaged /affected when gas pipeline cross the water body. 	<ul style="list-style-type: none"> • Avoid felling of trees as much as possible. • Implement tree plantation with native species after construction works. • Create new habitat adjacent to the existing habitat before going to construction work. • Give proper compensation against homestead tree felling to the owners. • Local people request to avoid large water bodies, homestead garden for the installation of gas pipe line.
Socioeconomics	<ul style="list-style-type: none"> • A total of about 1,382 households (HHs) and units will be directly affected by the project. Among them, 892 HHs will be displaced with structures, 431 HHs are losing their agricultural lands, and a number of private and public institutions will also be affected which includes 21 large scale business and industries and 33 CPRs. Also, large trees (77,319) will also be affected by the project. Detail information of the affected assets are incorporated in the RP report. • Due to construction of new gas pipe line, communications system may be affected. • Homesteads will be affected due to proposed pipeline especially for them who have no other properties but their homesteads. • Bursting of gas pipe line and conflagration may happen any time. • Problem may happen during land acquisition and requisition period. • Due to the soil dust people, especially 	<ul style="list-style-type: none"> • Alternative road must be ensured. • Request to divert the proposed RoW of the pipeline especially from those places where the homesteads are affected. • Compensation for both acquisition and requisition of land should be satisfactory. • To avoid accidental risk, road signs must be put up at construction sites. • Local skilled and unskilled labour should be preferred during construction. • Proper monitoring of gas pipe line should be ensured by responsible agency. • People ardently requested to supply gas for their household use. • Local people want to be employed during construction. • Local people raise their voice on the question of their security as gas pipe line is risky, and can leak and burst any time.

Issues	Identified problems	Recommendations
	children and elderly may suffer from respiratory and coughing problem. • Accident may happen due to movement of heavy equipment and vehicle.	

270. Consultations with stakeholders will continue during implementation of Component 2. A strategy and program for consultation will be finalized by PIU-GTCL to ensure that stakeholders are consulted, as and when needed.

271. A one-page flyer on the project summary including details on the grievance redress mechanism will be prepared in Bangla and made available at the field office of PIU-GTCL and in the Head Office in Dhaka. Project information will be made available also at the website of GTCL. Interested individuals will have access to the IEE at the offices of GTCL and will be posted in the ADB website.

8.0 GRIEVANCE REDRESS MECHANISM

8.1 Existing Structure of Handling Grievance at GTCL

272. At present, handling of grievance at GTCL is within the Grievance Redress System (GRS) which is part of the mandatory strategic objectives of Annual Performance Agreement (APA) of the GoB (represented by the Energy and Mineral Resource Division). GTCL has signed on 1 April 2015 an agreement with Petrobangla to comply with GRS. This agreement will be signed and renewed annually.

273. GRS requires the mandatory designation of staff as Focal Point and consequently disclose the name of the designated staff and contact address in the company's website. Following the requirements of GRS, GTCL has designated a staff and publish the same at the GTCL's website. Compliance to GRS is a Performance Indicator in the APA.

8.2 Handling Grievance as Required by SPS 2009

274. To ensure that complaint(s) will be addressed properly during the implementation of Component 2, the Project Implementation Unit (PIU) which will be set up by GTCL will establish a grievance redress mechanism (GRM).

Objectives of GRM

275. GRM will ensure a process of receiving and resolving complaint(s) promptly from persons that may be affected by Component 2. Following the requirements of SPS 2009, the GRM will involve a process that is understandable, transparent, gender-responsive, culturally-appropriate, and easily accessible to affected persons without cost and retribution.

Structure of GRM

276. Affected persons (APs) can seek redress of their grievance at three levels: (i) the PIU-GTCL or through the representative of the EPC Contractor during construction phase, (ii)

through the grievance redress committee (GRC), and (iii) the appropriate courts of law.²² The PIU will set up a GRC as soon as the ADB and GoB approve the project. The GRC will continue to function from construction until the operation phase and will consist of representatives from the EPC Contractor (during construction), local government unit, designated staff of PIU-GTCL on environmental issues (or Consultant), and witness of the complainant. GTCL will ensure the representation of women in the GRC. GTCL staff designated as focal person in the GRS will be part of the GRC.

277. GRC will be responsible for resolving complaint(s) and will convene once a month to review the complaint(s) received, if any. GRC will resolve complaint(s) within 30 days from the date of receipt and will keep a record indicating the name of complainant and nature of complaint, status of resolving the complaint, decisions or actions undertaken, and the date the decision was effected. Records on grievances will be summarized and included in the environmental monitoring reports to be submitted by GTCL twice a year to ADB during construction phase and annually during operation phase.

278. PIU-GTCL will disclose the grievance redress procedure to project stakeholders such as the contact person and details on how and where to contact them, how to file a grievance, and the time for the GRC to resolve the concerns. The PIU-GTCL will review the implementation of the GRM regularly to assess the effectiveness of the process and to examine their ability to address grievances. The cost of implementing the GRM will be part of the administration cost borne by PIU-GTCL.

9.0 ENVIRONMENTAL MANAGEMENT PLAN

279. The environmental management plan (EMP) presents the activities to be undertaken in every phase of project implementation to minimize the adverse impacts and to enhance positive impacts. The EMP also includes the monitoring and institutional arrangements needed. **Table 9.1** presents a summary of the EMP while **Table 9.2** presents the monitoring plan.

9.1 Implementation Arrangements

280. GTCL will set up a PIU responsible for project management and safeguards compliance monitoring of EPC contractor during the construction stage. The EPC Contractor will recruit an environmental staff (or a Consultant) who will be primarily responsible for ensuring that the EMP is properly implemented during construction. The Environmental staff (or consultant) of the EPC will coordinate and interact with the PIU on compliance to ADB requirements, relevant government agencies and local authorities on clearances (as needed), and will prepare the environment section of the Project's Quarterly Progress Report (QPR) submitted to the PIU for review. The environment section in the Project's QPR will be summarized by the PIU and submitted as environmental monitoring reports to ADB at least twice a year during construction. The semi-annual environmental monitoring reports are posted to ADB's website.

281. Should there be any change in the route, length and diameter of the pipe, or design of the gas transmission pipeline system, this IEE will be revised and/or updated and submitted to ADB prior to any construction works. PIU-GTCL will revise or update the IEE. Revised and/or updated IEE will be re-posted to the ADB website.

²²Members of GRC will consist of: (i) GTCL staff designated for GRS, (ii) representative from the EPC Contractor (during construction phase), (iii) local government unit representative, (iv) PIU-GTCL designated staff (or consultant) on environmental issues, and (v) witness of the complainant.

282. Prior to any construction work, the EPC Contractor will be informed by the PIU-GTCL on their responsibility to comply with the EMP and the requirements of ADB. Specific responsibilities of the EPC Contractor in the EMP will be monitored by their Environment staff (or Consultant) for compliance. Overall compliance of the EPC Contractor to the EMP and ADB requirements will be supervised by the PIU-GTCL and/or environmental staff of GTCL.

283. During the operation phase, PIU-GTCL will designate a staff who will be responsible to deal with the environmental issues and compliance to GoB and ADB's environmental requirements. The requirements of ADB will include the submission of environmental monitoring reports annually. ADB will review the environmental monitoring report and will post them into their website as required by SPS 2009 and PCP 2011.

284. In the event of non-compliance to any environmental covenant in the loan agreements, GTCL will prepare a corrective action plan (CAP) describing the process and actions that will be undertaken to ensure compliance. The CAP will be submitted to ADB for review and disclosure to their website. GTCL will submit the environmental monitoring reports starting from the date the loan will become effective.

9.2 Environment and Safety Management System (ESMS) at GTCL

285. In 2000, Petrobangla established the Environment and Safety Management System (ESMS) developed for them by an international consultant in collaboration with a local consultant. The ESMS guides the operations not only in Petrobangla but also in its operating companies like GTCL.

286. The ESMS consists of guidelines and procedures organized under 10 categories to ensure that environment and safety requirements are met in the operations of Petrobangla and its operating companies. These categories are as follows:

- (i) Policy and leadership
- (ii) Continuous improvement
- (iii) Safety and health
- (iv) Risk management
- (v) Incident reporting and investigation
- (vi) Emergency preparedness and response
- (vii) Environmental protection
- (viii) Training and Orientation
- (ix) Community relations
- (x) Regulatory requirements

287. GTCL has an ESMS as required by Petrobangla and there are two sections under the Survey and Environment (S&E) Department dealing with environmental concerns related to their operations. The two sections are: (i) Survey and Soil Investigation (S&SI), and, (ii) Environment Study (ES) section. There are 11 staff in this department: S&E –four staff; S&SI – four staff; and ES – three staff.

288. Aside from the relevant environment and safety regulations of GoB, the ESMS provides GTCL guidance and tools needed to ensure safe and environmentally-sound operations. The ESMS consists of 23 elements organized in 10 environment and safety categories where GTCL can focus on. These categories include: (1) policy and leadership, (2) continuous improvement, (3) safety and health, (4) risk management, (5) incident reporting and investigation, (6) emergency preparedness and response, (7) environmental protection, (8) training and orientation, (9) community relations, and (10) regulatory requirements.

289. The ESMS Manual covers:

- (i) *Environment and Safety Guidance Manual* – there are 23 elements that provides guidance needed to meet the environment and safety requirements
- (ii) *Environment and Safety Procedures Manual* – consists of 73 requirements in the form of procedures

Table 9.1 Environmental Management Plan

Potential Impacts	Mitigation/Enhancement Measures	Estimated Cost (Lakh Tk)	Implementing Unit	Monitoring Agency
Construction phase				
Increased noise level	<ul style="list-style-type: none"> • Limit noise-generating activities during daytime and provide temporary enclosures to stationary noise sources. • Provide ear plugs/muffs to workers exposed to high-level noise and rotate schedule of these workers every two hours. 	Included in the project cost	EPC Contractor, Environmental staff of EPC Contractor (or Consultant)	PIU-GTCL, Environmental staff of PIU-GTC (or Consultant)
	<ul style="list-style-type: none"> • EPC Contractor will ensure regular maintenance and inspection of construction vehicles and heavy equipment, and other noise-generating machine • Drivers and operators will be required to strictly follow road regulations particularly speed and excessive blowing of horns will not be allowed. 			
	<ul style="list-style-type: none"> • Construction activities that generate high-level noise will be temporarily stopped during school hours (if there is a school or madrasa near the construction sites) and prayer time at mosque (if there is one near the sites). • Local settlements will be informed of the schedule if construction works that generate high level noise and vibration will be conducted. 			
	<ul style="list-style-type: none"> • Orientation of workers will be conducted by EPC Contractor and PIU-GTCL to make them aware of noise level requirements. 			
	<ul style="list-style-type: none"> • EPC Contractor will be required to prepare a Construction Management Plan (CMP) outlining measures to address noise level from construction works and traffic management. 			
Increased level of dust and vehicular emissions	<ul style="list-style-type: none"> • Temporary fencing and/or enclosures will be installed at construction sites at TBS and metering stations to contain dust levels. 	10.0	EPC Contractor, Environmental staff of EPC Contractor (or Consultant)	PIU-GTCL, Environmental staff of PIU-GTCL (or Consultant)
	<ul style="list-style-type: none"> • Water will be sprayed in opened land areas or in other areas where dust is generated. 	5.0		
	<ul style="list-style-type: none"> • Trucks that will deliver dust-generating construction materials will be covered with canvas or other suitable material to minimize dust dispersion. 	Included in the project cost		
	<ul style="list-style-type: none"> • Stockyards will be covered during non-working period. 	1.0		

Potential Impacts	Mitigation/Enhancement Measures	Estimated Cost (Lakh Tk)	Implementing Unit	Monitoring Agency
	<ul style="list-style-type: none"> Space will be provided for warehouse onsite to minimize transport or delivery of construction materials and reduce vehicular emissions. EPC Contractor will be required to maintain construction vehicles, heavy equipment, and generators (if needed) regularly to minimize the contribution of vehicular emissions to ambient air quality degradation. No burning of solid or liquid wastes and other combustible materials will be allowed within the construction sites and labor camps. Recyclables from the waste generated in labor camps and construction sites will be sold to recyclers and composting will be done for compostables such as food waste Use of multi-passenger vehicles to transport workers to and from the construction sites. Vehicles and equipment will not be allowed to sit and idle for more than 30 minutes. Contractor will be required to enforce a speed limit of 20 kph along the pipeline RoW during construction 	Included in the project cost		
Disruption to the existing beneficial uses of Little Feni River, Muhuri River, Khalidas Khal, and Dakatia River affected by installation of pipeline	<ul style="list-style-type: none"> Alternative water source (i.e., water tank) will be provided to local people/households directly and adversely affected by the disruption in the rivers. 	10.0	EPC Contractor, Environmental staff of EPC Contractor (or Consultant)	PIU-GTCL, Environmental staff of PIU-GTCL (or Consultant)
Deterioration of water quality	<ul style="list-style-type: none"> Construction works will be undertaken during the dry season. Construction camps will be provided with sanitary facilities, wash areas, safe drinking water, and garbage bins to contain waste generated by laborers. Labor camps will be located away from water bodies Local hiring will be a priority to minimize number of workers at labor camps. CMP will be required from the EPC Contractor to ensure water quality impacts are addressed during construction. PIU-GTCL will monitor the 	<p>Considered in the planning of implementation schedule</p> <p>Included in the project cost</p>	EPC Contractor, Environmental staff of EPC Contractor (or Consultant)	PIU-GTCL, Environmental staff of PIU-GTCL (or Consultant)

Potential Impacts	Mitigation/Enhancement Measures	Estimated Cost (Lakh Tk)	Implementing Unit	Monitoring Agency
	implementation of the CMP.			
	<ul style="list-style-type: none"> HDD works will be supervised by experienced technical staff and consultants to ensure that it is done according to standards to minimize water quality impacts. 			
	<ul style="list-style-type: none"> Areas that will be affected by HDD works will be marked and will be provided with temporary enclosure to prevent encroaching to adjacent areas. 			
	<ul style="list-style-type: none"> Fuel requirements in onsite fuel tanks and generators will be located in designated contained areas at the construction sites. No refueling of construction vehicles will be done within 30 m from the river crossings. 			
	<ul style="list-style-type: none"> Spent water from hydrostatic testing will be treated before discharge to ensure compliance to Schedule 10 of ECR 1997.. Discharge of water will be monitored to ensure that no localized flooding or erosion will occur. 			
Occupational and public safety risks	<ul style="list-style-type: none"> A Contingency Fund will be made available to cover potential accidents involving local people affected by Component 2 during construction. 	10.0	EPC Contractor, Environmental staff of EPC Contractor (or Consultant)	PIU-GTCL, Environmental staff of PIU-GTCL (or Consultant)
	<ul style="list-style-type: none"> Clear and visible danger and warning signs/posters will be installed at and around the construction sites to prevent accidents. Warning signs will consider people with disabilities. Will conduct awareness program/info campaign on safety to local people living near the construction sites. EPC Contractor and PIU-GTCL will inform the local people living close to the construction sites on the schedule of activities that may pose risks to public safety. EPC Contractor will be required to provide workers with personal protective equipment and safety clothes such as hard hats, steel-toe boots, etc. Staff/worker will be assigned to manage traffic within the construction sites. Temporary public crosswalks will be provided, if needed. Safety and emergency system and equipment such as fire-fighting, ambulance, first-aid kits, etc., will 	3.0		

Potential Impacts	Mitigation/Enhancement Measures	Estimated Cost (Lakh Tk)	Implementing Unit	Monitoring Agency
	<ul style="list-style-type: none"> be made available at the construction sites. A health personnel or nurse will be stationed at the main construction office to inspect labor camps and assist during minor emergency. WB EHS General Guidelines 2007 (or any update) will be followed. 			
Potential drainage disruption	<ul style="list-style-type: none"> Completion of construction works will be ensured during the dry season. Backfilling of the trenches after laying of the pipeline will be conducted following design specifications and industry standards. 	Included in the project cost	EPC Contractor, Environmental staff of EPC Contractor (or Consultant)	PIU-GTCL, Environmental staff of PIU-GTCL (or Consultant)
Potential disruption to navigation	<ul style="list-style-type: none"> Adequate number of signboards will be provided showing the working time, project name, safety measures, etc. The signboards will be written with radium material to make it clearly visible during night time. Alarms will be provided, as needed. Schedule of HDD works will be coordinated/consulted with the Bangladesh Inland Water Transport Authority. 	5.0	EPC Contractor, Environmental staff of EPC Contractor (or Consultant)	PIU-GTCL, Environmental staff of PIU-GTCL (or Consultant)
	<ul style="list-style-type: none"> Public awareness or information campaign on safety and activities about the project will be undertaken focusing on the temporary impacts due to construction and installation of the pipeline. 	Included in the project cost		
	<ul style="list-style-type: none"> Navigation safety system and equipment will be made available at the river crossings during HDD works. 	10.0		
	<ul style="list-style-type: none"> HDD works will be undertaken and supervised by skilled and experienced workers and engineers. An environmental staff will be present during HDD works at river crossings to monitor compliance to EMP and permits. 	Include in the project cost		
Erosion at riverbanks	<ul style="list-style-type: none"> Construction works will be limited during the dry season avoiding the monsoon as far as practicable. 	Considered in the planning of implementation schedule	EPC Contractor, Environmental staff of EPC Contractor (or Consultant)	PIU-GTCL, Environmental staff of PIU-GTCL (or Consultant)
	<ul style="list-style-type: none"> Trenching and backfilling works will be done following design specifications and industry standards and will be supervised by experienced technical staff. 	Included in the project cost		
	<ul style="list-style-type: none"> Riparian vegetation adjacent to the river crossings will be maintained. Vegetation within at least 30 m buffer on both sides will remain and 	Included in the project cost		

Potential Impacts	Mitigation/Enhancement Measures	Estimated Cost (Lakh Tk)	Implementing Unit	Monitoring Agency
	<ul style="list-style-type: none"> will be removed by hand just prior to HDD works to prevent erosion. • Stockpiled soil will be stored at least 30 m away from the river banks. • Sediment control structures along all the river banks will be installed such as cable concrete blocks, geobags, etc. prior to HDD works. 			
Deterioration of soil quality	<ul style="list-style-type: none"> • Pipe-laying will be done following design specifications and industry standards to prevent excessive soil disturbance. • Sequence of excavated soil for backfilling will be maintained to minimize the impacts on soil quality. • Removal of about 50 cm layer of vegetated topsoil within the trench width will be set aside for backfilling • Loose topsoil due to excavation will be compacted, if needed to minimize erosion • Liquid waste such as oil drains will be disposed of properly to prevent soil contamination. Oil-water separator will be provided at the construction sites. • All refueling will be monitored by designated staff and vehicles will not be left unattended while refueling is ongoing to avoid spills. 	0.60 (For soil quality analysis)	EPC Contractor, Environmental staff of EPC Contractor (or Consultant)	PIU-GTCL, Environmental staff of PIU-GTCL (or Consultant)
Disturbance to adjacent lands along the pipeline route	<ul style="list-style-type: none"> • Construction works will be limited to the designated area (i.e. pipeline RoW and construction Row or workspace). • Construction site will be fenced or temporarily enclosed to prevent unauthorized access and disturbance to adjacent areas. 	Included in the project cost and considered in construction planning	EPC Contractor, Environmental staff of EPC Contractor (or Consultant)	PIU-GTCL, Environmental staff of PIU-GTCL (or Consultant)
Loss of crop production	<ul style="list-style-type: none"> • Construction schedule will consider harvest time of farmers to minimize loss of crops. • Affected farmers/landowners will be compensated for the loss of their crops following GoB applicable regulations and requirements of SPS 2009. 	Compensation budget estimates included in the Resettlement Plan of Component 2	EPC Contractor, Environmental staff of EPC Contractor (or Consultant)	PIU-GTCL, District Commissioner, ADB
Disruption and/or potential damage to irrigation facilities	<ul style="list-style-type: none"> • Irrigation canals that will be affected will be restored/rehabilitated to minimize disruption to users. • Any loss of irrigation canals will be replaced with another source and corresponding damages will be compensated based on applicable GoB regulations and requirements of SPS 2009. 	20.00 (for repair of irrigation canals)	EPC Contractor, Environmental staff of EPC Contractor (or Consultant)	PIU-GTCL, Environmental staff of PIU-GTCL (or Consultant)
Destruction and/or loss of terrestrial habitat	<ul style="list-style-type: none"> • Before clearing, the Environmental staff (or consultant) will assist the EPC Contractor in identifying the 	Compensation for vegetation of value included in	EPC Contractor, Environmental staff of EPC	PIU-GTCL, Environmental staff of PIU-

Potential Impacts	Mitigation/Enhancement Measures	Estimated Cost (Lakh Tk)	Implementing Unit	Monitoring Agency
for flora and fauna	<p>terrestrial habitat likely to have significant species of flora and fauna.</p> <ul style="list-style-type: none">• Environmental staff will conduct faunal inspections (or spot checks) before and during clearing works to ensure impacts to terrestrial fauna are minimized and proper handling of slow-moving or sedentary terrestrial fauna. In the event of an unexpected encounter or “chance find” threatened species, procedures in Annex 2 will be followed.• Vegetation clearing will be done progressively to direct the escape of the wildlife away from the construction activities into the natural areas.• Will ensure the shortest time possible in land restoration and/or rehabilitation after clearing.• Agricultural land will be avoided for storing construction materials and for maneuvering of vehicles.• Tree planting/revegetation will be done to designated areas identified by PIU-GTCL in consultation with Forest Department.• Construction works will be limited during daytime to minimize disruption to nocturnal species.• Owners of homesteads, fruit and timber gardens, etc. will be appropriately compensated based on applicable GoB regulations and requirements of SPS 2009.	the budget estimates in the Resettlement Plan of Component 2	Contractor (or Consultant)	GTCL (or Consultant)
Disruption and/or destruction of aquatic habitats	<ul style="list-style-type: none">• Construction works potentially affecting fish habitat will be done from November to April.	Considered in construction planning	EPC Contractor, Environmental staff of EPC Contractor (or Consultant)	PIU-GTCL, Environmental staff of PIU-GTCL (or Consultant)
	<ul style="list-style-type: none">• Compartmentalization of pond will be done within the smallest area possible to minimize disturbance.	Included in the project cost		
	<ul style="list-style-type: none">• Environmental staff from the PIU-GTCL and EPC Contractor will be present during the site clearing of ponds and other aquatic habitats to supervise proper handling of slow-moving or sedentary aquatic fauna• Handling and rescue procedure for aquatic fauna and a “chance find” procedure for species of conservation status will be required from the EPC Contractor (see Annex 2).			
	<ul style="list-style-type: none">• Loose soil from trenching will be set aside for use in leveling the ponds during restoration/rehabilitation.			
	<ul style="list-style-type: none">• EPC Contractor will mark the			

Potential Impacts	Mitigation/Enhancement Measures	Estimated Cost (Lakh Tk)	Implementing Unit	Monitoring Agency
	clearing areas and will minimize disturbance to delineated areas.			
	<ul style="list-style-type: none"> • Disruption of aquatic habitat will be limited to 8.04 ha (or 6% of the total 134 ha within the study area) • Affected infrastructures of pond owners and loss of production will be compensated following the applicable GoB regulations and the requirements of SPS 2009. 	Cost included in the Resettlement Plan for Component 2		
Temporary damage to aquatic flora and fauna at river crossings	<ul style="list-style-type: none"> • No refueling of construction vehicles will be done within 30 m from the river crossings. • Construction works at river crossings will be done during low flow periods based on the time of the year and weather forecasts. • Appropriate erosion control measures such as geobags, nets, etc. will be used to minimize excessive soil coming to the rivers. 	Included in the project cost	EPC Contractor, Environmental staff of EPC Contractor (or Consultant)	PIU-GTCL, Environmental staff of PIU-GTCL (or Consultant)
Disruption to local traffic	<ul style="list-style-type: none"> • Local traffic management will be part of the CMP required from the EPC Contractor. • Temporary crosswalks or bridgeways will be provided, if needed to ensure safety of the workers and the public. 	50.0 to 60.0 (for temporary road establishment)		
	<ul style="list-style-type: none"> • Clear and visible road signs will be provided at all construction sites. • A staff will be assigned to control and monitor smooth flow of local traffic within the construction sites. • Traffic signs and warnings will be set up within the construction sites for children and persons with disabilities. 	3.0	EPC Contractor, Environmental staff of EPC Contractor (or Consultant)	PIU-GTCL, Environmental staff of PIU-GTCL (or Consultant)
Operation phase				
Occupational safety risks and waste from pigging operations	<ul style="list-style-type: none"> • Pigging wastes and other debris will be disposed of properly following requirements of ECR 1997 away from water bodies. • Water from pigging will be tested to ensure compliance to Schedule 10 of ECR 1997 and World Bank EHS General Guidelines 2007 (or any update) on wastewater. • Personnel who will be involved in pigging will have the required knowledge and essential skills. • Appropriate PPE will be provided to workers and personnel who will conduct the pigging operations. • Barriers and warning notices will be provided to limit access to the worksite to authorized personnel only. • Waste from pigging operations will be managed and disposed of 	Included in O&M costs	PIU-GTCL	GTCL, Petrobangla, ADB

Potential Impacts	Mitigation/Enhancement Measures	Estimated Cost (Lakh Tk)	Implementing Unit	Monitoring Agency	
	properly to ensure compliance to ECR 1997. Pigging waste will be mainly water/condensate and debris (metal dust from the pipe).				
“Modified” terrestrial habitat due to maintenance of RoW along pipeline route	<ul style="list-style-type: none">• Tree planting will be done by GTCL in designated areas in consultation with the Forest Department.• Trees, large shrubs and woody-stemmed plants and vines will not be allowed in the RoW as these will interfere with safe O&M of the pipeline and their roots may damage the pipe underground.• Vegetation that will be maintained along the RoW will be predominantly grass.• RoW will be kept clear of major vegetation and structures that may interfere with access during operation and maintenance.	4.0	PIU-GTCL	GTCL, Petrobangla, ADB	
Occupational and public safety risks	<ul style="list-style-type: none">• A contingency fund will be provided to cover accidental issues that will involve people living adjacent to the pipeline system	2.0	PIU-GTCL	GTCL, Petrobangla, ADB GTCL, Petrobangla, ADB	
	<ul style="list-style-type: none">• Clear and visible signs and danger warnings will be provided along the pipeline route				
	<ul style="list-style-type: none">• Information campaign and/or safety-awareness program will be conducted in the 12 upazila traversed by the pipeline. This could be town hall meetings or information materials such as flyers, brochure, etc.	20,000			
	<ul style="list-style-type: none">• An emergency preparedness and disaster management plan will be prepared and/or updated by GTCL describing the process, procedures, resources, and contact persons, etc.	Included in the O&M cost Included in the O&M cost			
	<ul style="list-style-type: none">• Regular inspection and maintenance of pipeline system (e.g., leaks survey)• Pipeline system is monitored 24 hours a day				
	<ul style="list-style-type: none">• Valves and control system will be designed based on international safety standards and specifications such as emergency shut-off.				
	<ul style="list-style-type: none">• Regular training and/or drills on safety, emergency and disaster preparedness will be conducted to workers and staff of GTCL managing Component 2				
Change in land use may affect real property values	<ul style="list-style-type: none">• Presence of the gas pipeline may decrease property values due to perceived safety risks• Availability of stable and reliable gas supply will promote business	---	---	GTCL, Petrobangla, ADB	

Potential Impacts	Mitigation/Enhancement Measures	Estimated Cost (Lakh Tk)	Implementing Unit	Monitoring Agency
	development in the local area which may increase value of properties.			

Table 9.2 Environmental Monitoring Plan

Parameter/Indicator		Location	Frequency	Implementin g Unit	Supervising Unit	Cost Estimate s (Lakh Tk)
Pre-construction phase						
Ambien t air quality and noise	<ul style="list-style-type: none">• NO₂• SO₂• PM₁₀ and PM_{2.5}	<ul style="list-style-type: none">• Sites identified for construction works and labor camps• One site near settlements outside of construction sites and labor camps (this will be control site)	Once before construction works	EPC Contractor *will include environmental staff (or Consultant recruited by EPC Contractor)	PIU-GTCL * will include environmental staff of GTCL or a Consultant	12.0
	<ul style="list-style-type: none">• Noise level					
Water quality	<ul style="list-style-type: none">• pH, DO, turbidity, temperature, EC, BO₅,	<ul style="list-style-type: none">• River crossings at Little Feni, Muhuri, Dakatia, and Khalidas where HDD works will be done• Upstream of four rivers (before site of HDD works)	Once before construction works	EPC Contractor	PIU-GTCL	5.0
	<ul style="list-style-type: none">• Total coliform, pH, lead, arsenic, Cr⁺⁶	<ul style="list-style-type: none">• Drinking water source at Feni, Comilla, and Chittagong)	Once before construction works	EPC Contractor	PIU-GTCL	
	<ul style="list-style-type: none">• Oil & grease, pH, Fe, EC	<ul style="list-style-type: none">• Three sites along the pipeline route (at Comilla, Feni, and Chittagong)	Once before construction works	EPC Contractor	PIU-GTCL	
Soil quality – CEC, pH, water holding capacity, nutrients (N, P, K)		<ul style="list-style-type: none">• Three sites along pipeline route (at Comilla, Feni, Chittagong)	Once before construction works	EPC Contractor	PIU-GTCL	1.0
Recruitment of local		<ul style="list-style-type: none">• EPC	Monthly	EPC	PIU-GTCL	Included

Parameter/Indicator		Location	Frequency	Implementin g Unit	Supervising Unit	Cost Estimate s (Lahk Tk)
workers • Number of local workers and staff recruited		Contractor's office		Contractor		in EPC Contract cost
Orientation of EPC Contractor and workers on issues like HIV/AIDS, compliance to ADB requirements		• Construction sites	Once before construction begins, and as needed	EPC Contractor. PIU-GTCL	---	
Construction phase						
Ambien t air quality and noise	• NO ₂ • SO ₂ • PM ₁₀ and PM _{2.5}	• Construction sites along the pipeline route • Labor camps • One site near settlements outside of construction sites and labor camps (this will be control site)	Quarterly for air quality Twice a month for noise level	EPC Contractor	PIU-GTCL	12.0
	• Noise level					
Water quality	• pH, DO, turbidity, temperature, EC, BO ₅ ,	• River crossings at Little Feni, Muhuri, Dakatia, and Khalidas where HDD works will be done • Upstream of four rivers (before site of HDD works)	Semi-annually	EPC Contractor	PIU-GTCL	5.0
	• Total coliform, pH, lead, arsenic, Cr ⁺⁶	• Drinking water source at Feni, Comilla, and Chittagong)	Semi-annually	EPC Contractor	PIU-GTCL	
	• Oil & grease, pH, Fe, EC	• Groundwater -Three sites along the pipeline route (at Comilla, Feni, and Chittagong)	Semi-annually	EPC Contractor	PIU-GTCL	
Liquid waste	• Oil & grease, pH, turbidity, TDS.	• Hydrostatic testing sites • Construction sites (machine	Semi-annually	EPC Contractor	PIU-GTCL	

Parameter/Indicator		Location	Frequency	Implementing Unit	Supervising Unit	Cost Estimates (Lakh Tk)
	BOD ₅ , EC, Pb, Cr ⁺⁶	and vehicle repair shops, refueling station, chemical storage, etc.)				
Spraying of water to exposed land and before movement of construction vehicles (or other control measures such as temporary enclosure)		<ul style="list-style-type: none"> Construction sites along the pipeline route 	Daily during dry season	EPC Contractor	PIU-GTCL	
Solid waste management (check availability of garbage bins, list of chemicals, paints, lubricants, etc. used, disposal method, etc.)		<ul style="list-style-type: none"> Construction sites along the pipeline route Labor camps 	Weekly	EPC Contractor	PIU-GTCL	
Danger and warning signs for occupational and public safety; temporary crosswalk or bridgeways		<ul style="list-style-type: none"> Construction sites along the pipeline route 	Once a month	EPC Contractor	PIU-GTCL	2.0
Housekeeping		<ul style="list-style-type: none"> Labor camps and construction sites 	Weekly	EPC Contractor	PIU-GTCL	8.0
Work schedule announcement to the public		<ul style="list-style-type: none"> Settlements adjacent to the pipeline route 	As needed	EPC Contractor	PIU-GTCL	Included in EPC Contract
Erosion control measures (e.g., geobags, nets, etc.)		<ul style="list-style-type: none"> River crossings and river banks Construction sites in low-lying areas along the pipeline route 	Once a month	EPC Contractor	PIU-GTCL	
Smoke-belching construction vehicles (inspection)		<ul style="list-style-type: none"> Construction sites along the pipeline route Labor camps 	Weekly	EPC Contractor	PIU-GTCL	
Safety and security (check presence of designated staff to ensure safety and security)		<ul style="list-style-type: none"> Construction sites along the pipeline route Labor camps 	Monthly	EPC Contractor	PIU-GTCL	
Clearing of ponds and other infrastructures (disposal of debris, procedures for		<ul style="list-style-type: none"> RoW along pipeline route 	As needed (or during clearing schedule)	EPC Contractor	PIU-GTCL	1.0

Parameter/Indicator	Location	Frequency	Implementin g Unit	Supervising Unit	Cost Estimate s (Lakh Tk)
clearing, etc.)					
Species of IUCN conservation status (inspection and/or identification)	• RoW along the pipeline route	As needed (or during clearing schedule)	EPC Contractor	PIU-GTCL	Included in EPC Contract cost
Vegetation clearing (inspect use of herbicides to avoid those listed under WHO recommended Classification of Pesticides by Hazard Classes 1a and 1b , disposal, incidence of poaching, compensation to crop damages, wildlife encounter, etc.)	• Construction sites along pipeline route	Quarterly	EPC Contractor	PIU-GTCL	6.0
Condition and restoration of RoW (visual inspection, compensation, etc.)	• Along pipeline route	Once before hydrostatic testing/commissionin g	EPC Contractor	PIU-GTCL	3.0
Use of personal protective equipment, ear muffs, etc.	• Construction sites along the pipeline route	Daily	EPC Contractor	PIU-GTCL	Included in EPC Contract cost
Incidence of accidents, sickness in labor camps, etc.	• Construction sites and labor camps	Monthly	EPC Contractor	PIU-GTCL	
Number of drills on safety and emergency preparedness (e.g., fire drill)	• Construction sites and labor camps	Quarterly	EPC Contractor	PIU-GTCL	
Site clean-up and restoration of project area	• Construction sites and labor camps • Four river crossings • Road and railway crossings	Once prior to commissioning	EPC Contractor	PIU-GTCL	
Operation phase					
Solid waste management (inspect accumulation of garbage, debris, etc.)	• Along pipeline route (RoW)	Quarterly	PIU-GTCL	GTCL/Petrobangl a	1.5
Erosion control measures	• Four river crossings	Semi-annually	PIU-GTCL	GTCL/Petrobangl a	Included in O&M cost
Leaks survey	• Along pipeline route (valve, TBS, metering station, etc.)	Annually	PIU-GTCL	GTCL/Petrobangl a	
Tree plantation	• Designated sites	Semi-annually	PIU-GTCL	GTCL/Petrobangl a	3.0

Parameter/Indicator	Location	Frequency	Implementing Unit	Supervising Unit	Cost Estimates (Lakh Tk)
	identified by GTCL and Forest Department				
Water quality – DO, pH, TDS, EC, BOD ₅ , Fe, Cr ⁺⁶ , Pb, total coliform, turbidity, temperature	<ul style="list-style-type: none"> • Pigging points (prior to disposal to water bodies) • River crossings 	Annually at river crossings; pigging schedule	PIU-GTCL	GTCL/Petrobangla	5.0

10. CONCLUSION AND RECOMMENDATION

290. Component 2 will address the much needed infrastructure for natural gas transmission in the Southeastern region of Bangladesh. The pipeline route was selected which considered several factors including environmental and social dimensions. No ecologically-sensitive areas such as national park, sanctuary or protected areas will be traversed by the pipeline route from Chittagong, Feni and Comilla.

291. Potential environmental impacts during construction phase may include increased level of noise and dusts, generation of waste from construction works, clearing of vegetation, disruption to navigation at the Little Feni River, Muhuri River, Dakatia River and Khalidas River, disturbance to local traffic at road and railway crossings, land acquisition, and fragmentation or loss of some aquatic and terrestrial habitats due to river crossings and RoW. These potential impacts can be mitigated by compliance to design specifications and standards on safety and operation, best construction engineering practices, and adherence to relevant regulations of GoB and requirements of ADB. Mitigation measures for identified environmental impacts are included in the EMP and the parameters for monitoring have been identified in the environmental monitoring plan. Component 2 will be designed, constructed, and operated by experienced engineers, technical staff, and consultants.

292. Local people were consulted in December 2015 and are supportive to the implementation of Component 2 particularly in Vatiari, Kumira, Gunobati, Nangalkot, Ilashpur, etc. Local people look forward to employment opportunities but expressed concerns on the timely and appropriate compensation of potentially affected persons. All concerns raised during consultations will be addressed by GTCL and a grievance redress mechanism will be set up by the PIU-GTCL to deal with issues that may be raised during implementation. Consultations with local people during the preparation of IEE will continue in varying degrees during construction and operation of Component 2.

293. Given the lack of data to establish and show the distribution of fish species of IUCN conservation status, GTCL/PIU-GTCL will explore opportunities to collaborate with the Department of Fisheries, Bangladesh Fisheries Research Institute, and the IUCN Bangladesh to support their initiatives to domesticate wild fish of conservation status that will be potentially affected by the pipeline route.

294. This draft IEE will be publicly disclosed at the ADB website as required by SPS 2009 and PCP 2011. A project brief and/or factsheet including the grievance redress mechanism details will be prepared in Bangla and will be made available to the public at the PIU-GTCL field office and in Dhaka. Project information will be also available at the GTCL website. All the relevant permits that will be required by GoB (e.g., DOE, FD, BADC, BIWTA, etc.) for Component 2 will be obtained prior to construction works. Environmental monitoring reports will be submitted by GTCL to ADB twice a year during construction phase and annually during operation. These monitoring reports will be disclosed to ADB website and will be available at the GTCL office.

295. The implementation of Component 2 will have potential environmental impacts but these can be readily mitigated. Safety, emergency and disaster preparedness plans will be prepared for Component 2. Awareness and information drive on the safety of living near gas pipeline systems will be undertaken to the public through townhall meetings, flyers, school activities, etc.

Annex1

Relevant Environmental Quality Standards of Bangladesh

SCHEDULE – 2 Standards for Air [See Rule 12]

Density in microgram per cusec meter

Sl. No.	Categories of Area	Suspended Particulate Matter (SPM)	Sulphur Dioxide	Carbon Monoxide	Oxides of Nitrogen
a	Industrial and mixed	500	120	5,000	100
b	Commercial and mixed	400	100	5,000	100
c	Residential and rural	200	80	2,000	80
d	Sensitive	100	30	1,000	30

Notes:

- (1) At national level, sensitive area includes monuments, health center, hospital, archeological site, educational institution, and government designated areas (if any).
- (2) Industrial units located in areas not designated as industrial areas shall not discharge pollutants which may contribute to exceeding the standard for air surrounding the areas specified at Sl. nos. c and d above.
- (3) Suspended particulate matter means airborne particles of a diameter of 10 micron or less.

SCHEDULE – 3 Standards for Water [See Rule 12]

(A) Standards for inland surface water

	Best Practice-based classification	Parameter			
		pH	BOD (mg/l)	DO (mg/l)	Total Coliform (number/100)
a.	Source of drinking water for supply only after disinfecting:	6.5-8.5	2 or less	6 or above	50 or less
b.	Water usable for recreational activity :	6.5 – 8.5	3 or less	5 or more	200 or less
c.	Source of drinking water for supply after conventional treatment :	6.5 – 8.5	6 or less	6 or more	5,000 or less
d.	Water usable by fisheries:	6.5 – 8.5	6 or less	5 or more	---
e.	Water usable by various process and cooling industries :	6.5 – 8.5	10 or less	5 or more	5,000 or less
f.	Water usable for irrigation:	6.5 – 8.5	10 or less	5 or more	1,000 or less

Notes:

1. In water used for pisciculture, maximum limit of presence of ammonia as Nitrogen is 1.2 mg/l.
2. Electrical conductivity for irrigation water – 2250 μ mhos/cm (at a temperature of 25°C); Sodium less than 26%; boron less than 0.2%.

(B) Standards for drinking water

Sl	Parameter	Unit	Standard
1.	Aluminum	mg/l	0.2
2.	Ammonia (NH ₃)	mg/l	0.5
3.	Arsenic	mg/l	0.5
4.	Barium	mg/l	0.01
5.	Benzene	mg/l	0.01
6.	BOD ₅ at 20°C	mg/l	0.2
7.	Boron	mg/l	1.0

Sl	Parameter	Unit	Standard
8.	Cadmium	mg/l	0.005
9.	Calcium	mg/l	75
10.	Chloride	mg/l	150 – 600
11.	Chlorinated alkanes		
	Carbon tetrachloride	mg/l	0.01
	1,1 dichloroethylene	mg/l	0.001
	1,2 dichloroethylene	mg/l	0.03
	Tetrachloroethylene	mg/l	0.03
	Trichloroethylene	mg/l	0.09
12.	Chlorinated phenols		
	Pentachlorophenol	mg/l	0.03
	2,4,6 trichlorophenol	mg/l	0.03
13.	Chlorine (residual)	mg/l	0.2
14.	Chloroform	mg/l	0.09
15.	Chromium (hexavalent)	mg/l	0.05
16.	Chromium (total)	mg/l	0.05
17.	COD	mg/l	4.0
18.	Coliform (fecal)	n/100 ml	0
19.	Coliform (total)	n/100 ml	0
20.	Color	Hazen unit	15
21.	Copper	mg/l	1.0
22.	Cyanide	mg/l	0.1
23.	Detergents	mg/l	0.2
24.	DO	mg/l	6.0
25.	Fluoride	mg/l	1
26.	Hardness (as CaCO ₃)	mg/l	200 – 250
27.	Iron	mg/l	0.3 – 1.0
28.	Kjeldahl Nitrogen (total)	mg/l	1.0
29.	Lead	mg/l	0.05
30.	Magnesium	mg/l	30 – 35
31.	Manganese	mg/l	0.1
32.	Mercury	mg/l	0.001
33.	Nickel	mg/l	0.1
34.	Nitrate	mg/l	10
35.	Nitrite	mg/l	Less than 1
36.	Odor	mg/l	Odorless
37.	Oil and grease	mg/l	0.01
38.	pH	mg/l	6.5 – 8.5
39.	Phenolic compounds	mg/l	0.002
40.	Phosphate	mg/l	6.0
41.	Phosphorous	mg/l	0
42.	Potassium	mg/l	12
43.	Radioactive materials (gross alpha activity)	Bq/l	0.01
44.	Radioactive materials (gross beta activity)	Bq/l	0.1
45.	Selenium	mg/l	0.01
46.	Silver	mg/	0.02
47.	Sodium	mg/	200
48.	Suspended particulate matter	mg/	10
49.	Sulfide	mg/	0
50.	Sulfate	mg/	400
51.	Total dissolved solids	mg/	1,000
52.	Temperature	°C	20 – 30
53.	Tin	mg/	2.0
54.	Turbidity	JTU	10.0
55.	Zinc	mg/	5.0

SCHEDULE – 4
Standards for Sound
[See Rule 12]

SI No.	Category of areas	Standards determined at dBa unit	
		Day	Night
a	Silent zone	45	35
b	Residential area	50	40
c	Mixed area (mainly residential area, and also simultaneously used for commercial and industrial purposes)	60	50
d	Commercial area	70	60
e	Industrial area	75	70

Notes:

1. The time from 6 a.m. to 9 p.m. is counted as daytime.
2. The time from 9 p.m. to 6 a.m. is counted as night time.
3. Area up to a radius of 100 meters around hospitals or educational institutions or special institutions/ establishments identified/to be identified by the Government is designated as Silent Zones where use of horns of vehicles or other audio signals, and loudspeakers are prohibited.

SCHEDULE – 5
[See Rule 12]
Standards for Sound originating from Motor Vehicles or Mechanized Vessels

Category of Vehicles	Unit	Standards	Remarks
*Motor Vehicles (all types)	dBa	85	As measured at a distance of 7.5 meters from exhaust pipe.
		100	As measured at a distance of 0.5 meter from exhaust pipe.
Mechanized Vessels	dBa	85	As measured at a distance of 7.5 meters from the vessel which is not in motion, not loaded and is at two thirds of its maximum rotating speed.
		100	As measured at a distance of 0.5 meter from the vessel which is in the same condition as above.

* At the time of taking measurement, the motor vehicle shall not be in motion and its engine conditions shall be as follows:-

- (a) Diesel engine – maximum rotating speed.
- (b) Gasoline engine –at two thirds of its maximum rotating speed and without any load.
- (c) Motorcycle – If maximum rotating speed is above 5000 rpm; two thirds of the speed, and if maximum rotating speed is less than 5000 rpm, three-fourth of the speed.

SCHEDULE – 6
Standards for Emission from Motor Vehicles
[See Rule 12]

Parameter	Unit	Standard Limit
Black Smoke	Hartridge Smoke Unit (HSU)	65
Carbon Monoxide	gm/k.m. area	24
	Percent area	04
Hydrocarbon	gm/k.m. area	02
	ppm	180
Oxides of Nitrogen	gm/k.m. area	02
	ppm	600

* As measured at two thirds of maximum rotating speed.

SCHEDULE – 7
Standards for Emission from Mechanized Vessels
[See Rule 12]

Parameter	Unit	Standard Limit
Black Smoke	Hartridge Smoke Unit (HSU)	65

* As measured at two thirds of maximum rotating speed.

SCHEDULE – 8
Standards for Odor
[See Rule 12]

Parameter	Unit	Standard Limit
Acetaldehyde	ppm	0.5 - 5
Ammonia	ppm	1 - 5
Hydrogen sulfide	ppm	0.02 – 0.2
Methyl disulfide	ppm	0.009 – 0.1
Methyl sulfide	ppm	0.01 – 0.2
Styrene	ppm	0.4 – 2.0
Trimethylamine	ppm	0.005 – 0.07

Notes :

(1) Following regulatory limit shall be generally applicable to emission/exhaust outlet pipe of above 5 meter height:

$Q = 0.108 \times He^2 Cm$ (Where Q = Gas Emission rate Nm³/hour)

He = Height of exhaust outlet pipe (m)

Cm = Above mentioned limit (ppm)

(2) In cases where a special parameter has been mentioned, the lower limit shall be applicable for warning purposes, and the higher limit shall be applicable for prosecution purpose or punitive measure.

SCHEDULE – 9
Standards for Sewage Discharge
[See Rule 12]

Parameter	Unit	Standard Limit
BOD ₅	mg/l	40
Nitrate		250
Phosphate		35
Suspended solids		100
Temperature	°C	30
Coliform	Number per 100 ml	1,000

Notes :

(1) This limit shall be applicable to discharges into surface and inland waters bodies.

(2) Sewage shall be chlorinated before final discharge.

National Ambient Air Quality Standards (NAAQS)
(Source: S.R.O. No: 220-Law 2005:Air Quality Management Project, DOE)

Pollutant	Unit	Standard	Averaging Time
Carbon monoxide, CO ^(a)	mg/m ³	10 (9 ppm)	8 hour
		40 (35 ppm)	1-hour
Lead, Pb	µg/m ³	0.5	Annual
Nitrogen oxides, NO _x	µg/m ³	100 (0.053 ppm)	Annual
PM ₁₀ ^(b)	µg/m ³	50	Annual
PM ₁₀ ^(c)	µg/m ³	150	24- hour
PM _{2.5}	µg/m ³	15	Annual
	µg/m ³	65	24-hour
Total suspended	µg/m ³	200	8-hr

Pollutant	Unit	Standard	Averaging Time
particulates, TSP			
Ozone, O ₃ ^(d)	µg/m ³	235	1-hour
	µg/m ³	157	8-hour
Sulfur dioxide, SO ₂ ^(a)	µg/m ³	80	Annual
	µg/m ³	365	24-hour

Notes:

- (a) Not to be exceeded more than once per year
- (b) The objective is attained when the annual arithmetic mean is less than or equal to 50 µg/m³
- (c) The objective is attained when the expected number of days per calendar year with a 24-hour average of 150 µg/m³ is equal to or less than 1
- (d) The objective is attained when the expected number of days per calendar year with the maximum hourly average of 235 µg/m³ is equal to or less than 1

Annex 2

Fauna “Chance Find” Rescue and Handling Procedures

1.0 Introduction

The following outlines the actions and measures that will be undertaken in the event of an accidental encounter with a threatened fauna during the construction phase of Component 2. This chance find procedures will be finalized in consultation with the IUCN Bangladesh, Forest Department, MOEF, Fisheries Department, and the Bangladesh Fisheries Research Institute under the Ministry of Fisheries and Livestock to ensure compliance with applicable regulations.

These procedures will be included in the Construction Management Plan that will be required from the EPC Contractor and will be an integral part of the bid documents. These procedures aim to identify and promote the protection and recording of threatened fauna that may be encountered during the site preparation and construction activities.

2.0 Scope

This will be applicable to construction activities by workers or personnel who may have the potential to encounter or contact with threatened species.

3.0 Orientation of Workers

The EPC Contractor, with the assistance from relevant authorities of GoB, will conduct an orientation of all workers, particularly those who will be involved in site clearing along the RoW and construction works in river crossings on how to recognize and identify the potential threatened species that may be encountered including the actions to be done. The orientation will be done prior to construction works and during the regular toolbox talks.

Pictures of the threatened species will be provided as well as description of their habitats. Potential “hot spots” along the pipeline route will be identified by relevant agencies of GoB. The pictures and the “hot spots” will be part of the references on-site to guide the construction supervision staff.

4.0 Procedures

The environmental staff (or consultant) of EPC Contractor together with the environmental staff of PIU-GTCL will be responsible for implementing these procedures.

IUCN Bangladesh identified the conservation status of five species of terrestrial fauna as vulnerable (VU), one species as endangered (EN); two species of aquatic fauna as VU and two species as EN; and eight species of fish as VU, six species as EN, and three species critically endangered (CR) and are listed below:

A. Terrestrial fauna

Type	Local Name	English Name	Scientific name	Habitat	Status of Conservation IUCN Bangladesh 2000
Mammal	Bara Baji	Common mongoose	<i>Herpestes edwardsii</i>	Mostly in bamboo thickets, cropped fields, bushy areas.	VU
	Pati shial	Golden jackal	<i>Canis aureus</i>		VU
Reptile	Tiktiki	House Lizard	<i>Hemidactylus brooki</i>	Both wet land and dry areas	VU
	Raktochusa	Garden Lizard	<i>Calotes versicolor</i>		VU
	Darash Shap	Rat Snake	<i>Ptyas mucosus</i>		VU
	Shankho Cheel	Brahminy Kite	<i>Haliastur indus</i>		EN

B. Aquatic fauna

Type	Name (Scientific Name)	Status of Conservation IUCN Bangladesh 2000	Habitat
Reptile	Common Krait (<i>Bungarus caeruleus</i>)	EN	All type of wetland areas area
	Rat snake (<i>Ptyas mucosus</i>),	VU	
	Black pond turtle (<i>Geoclemys hamiltonii</i>)	EN	
	Bengal Monitor (<i>Varanus bengalensis</i>)	VU	
	Bullfrogs (<i>Hoplobatrachus tigerinus</i>)	NO	

C. Fish

Scientific name	Local name	Fish habitat				Status of Conservation IUCN Bangladesh 2000
		River	Khal/Hill Creeck/ Chhara	Floodplain	Pond	
<i>L. calbasu</i>	Calbaus	P	A	P	P	EN
<i>Cirrhinus reba</i>	Rayek, Bata	P	A	P	P	VU
<i>L. bata</i>	Bata	P	P	P	P	EN
<i>M. cavasius</i>	Gulsha tengra	P	A	A	A	VU
<i>Mastacembelus armatus</i>	Baim	P	A	A	A	EN
<i>C. marulius</i>	Gojar	A	P	A	-	EN
<i>Ompok pabda</i>	Modhu pabda	P	A	A	A	EN
<i>Clupisoma garua</i>	Gharua	P	A	A	A	CR
<i>Eutropiichthys vacha</i>	Bacha	P	A	A	A	CR
<i>Sperata aor</i>	Aor	P	A	A	A	VU
<i>Chitala chitala</i>	Chitol	P	A	A	A	EN
<i>Chanda nama</i>	Nama chanda	A	P	P	A	VU
<i>Chanda ranga</i>	Ranga chanda	A	P	P	A	VU
<i>P. sarana</i>	sarputi	P	P	P	A	CR
<i>P. ticto</i>	Tit puti	P	P	P	A	VU
<i>Botia dario</i>	Beti/Rani	P	A	A	A	VU
<i>Nandas nandas</i>	Meni	P	P	A	A	VU

In the event a threatened species is encountered or discovered during construction activities, the following steps will be done:

- 1) Stop the work within the vicinity of the species and immediately notify the environmental staff (or consultant) of the EPC Contractor and construction supervision staff.
- 2) The environmental staff will assess the impacts; identify the species, and the appropriate management measures such as relocation. The location where the species was encountered will be identified using a global positioning system (GPS) unit to determine the exact coordinates and photographs will be taken.
- 3) The construction supervision staff will secure the approval of the environmental staff of PIU-GTCL (in consultation with relevant agencies of GoB) to resume construction works.
- 4) The construction works will resume as soon as the environmental staff (from EPC Contractor and PIU-GTCL) has done the following actions:
 - Secured the approval/permit (if required)
 - Corrective actions and/or management measures identified
 - Complete the rescue event record/report to include: date and time the species was found, location, type of fauna (e.g., snake, fish, turtle, etc.) and species name, actions taken (e.g., treated by fauna specialist, fauna relocated and where, etc.)

The EPC Contractor will not be entitled for compensation due to work stoppage as a result of the encounter and the associated subsequent actions.

Annex 3

Chance Find Procedures for Physical Cultural Resources

1.0 Introduction

These procedures describe the measures to be undertaken if an accidental discovery or chance find, or an encounter with a physical cultural resource (PCR) occurred during the construction phase. The chance find procedures will be finalized as Physical Cultural Resources Plan (PCRP) by GTCL and the Contractor(s), in consultation with the Department of Archaeology (DOA) or the Ministry of Cultural Affairs to ensure compliance to The Antiquities Act 1968 (amended 1976), National Cultural Policy 2006, and applicable regulations. The PCRP will be included in the Construction Management Plan that will be required from the Contractor(s). These procedures aim to identify and promote the preservation, protection, and recording of any PCR that may be discovered or exposed during excavation other earthmoving works and ground alteration along the 181 km pipeline route traversing Chittagong through Feni to Bakhrabad.

2.0 Orientation and/or Briefing of Workers

The Contractor(s), with the assistance from the DOA or Ministry of Cultural Affairs and PIU-GTCL, will conduct an orientation or training for all workers, particularly those who will be involved in earth movements and excavation on how to recognize artifacts that they may encounter or discover. The Contractor will be responsible for creating awareness to construction personnel on the ADB requirements for any unanticipated impacts such as discovery of a physical cultural resource.

An archeological map of Bangladesh (if available) will be obtained from the DOA or other relevant sources to examine if there are potential "hot spots" within Titas Gas Field. This map will be part of the references on-site to guide the construction supervision staff in determining the potential "hot spots."

3.0 Procedures

3.1 General

In case a PCR was encountered during excavation, construction activities including traffic within a 30.5 meter radius in the area will be stopped immediately by the Contractor. The discovery will be reported by the Contractor to the PIU-GTCL environment staff (or Consultant). The site or area discovered will be marked or demarcated using a global positioning system (GPS) unit to determine the exact coordinates and photographs will be taken. The construction supervision staff of the Contractor and PIU-GTCL site engineer/staff will secure the site to prevent damage, loss or pilferage of removable objects. The PIU-GTCL site engineer or designated staff will be responsible for coordinating with the DOA.

If the encounter involves removable items, a security person will be posted until the representative of DOA or Ministry of Cultural Affairs arrives to assess and determine its value. The DOA staff will be responsible in determining the appropriate course of action. Further excavation or earth moving works may be conducted at the distance and demarcation area recommended by the DOA staff.

If the chance find will have significant cultural value, this may entail consequent changes in the lay-out particularly if the discovery is considered or assessed as remains of cultural or archeological importance that is not removable.

The Contractor will not be entitled for compensation due to work stoppage as a result of the discovery and its associated subsequent actions.

3.2 Assessment and Recovery

Appropriate heavy equipment such as wheel loader will be made available to recover the excavated material from the excavation site to allow the geologist onsite or the DOA staff to inspect, recover or conduct sampling. A safe storage area will be provided to protect the discovered object. If the chance find is part of a large artifact, deposit or structure, the inspection or recording will include photography and video on an "as-is, where is" manner. The exact location will be recorded using a GPS unit.

3.3 Resumption of Work

The Contractor can continue with excavation and construction works within the affected area after the DOA staff has given clearance. All the discovered objects of value will be given to the Government.

4.0 Reporting

The Contractor will prepare a Chance Find Report within a week showing the date and time of discovery, specific location, description of the PCR, and interim protection measures implemented. This Report will be submitted to PIU-GTCL who will provide it to the DOA or Ministry of Cultural Affairs. The chance find including measures on how it was dealt with will be included in the environmental monitoring report submitted to ADB.

Annex 4
Attendance during Public Consultation



Ministry of Power, Energy and Mineral Resources
Gas Transmission Company Ltd (GTCL)
(A Company of Petrobangla)

List of Participants: ১৫ জনের উপস্থিতিতে পাবনা জেলায়।

Sl. No	Name	Age	Sex	Education	Occupation	Signature
01	Md. Nurul Annah	50	M	H.S.C	Chairman	[Signature]
02	Kasmin Akter	43			Member	[Signature]
03	Delwara Begum	48		S.S.C	member	[Signature]
	মোঃ জামাল				মহাসচিব	
05	Md. Jamaluddin	66				[Signature]
06	Md Nurul Amin					
07	মোঃ জামাল	৬৫	৩০/৫			[Signature]
08	মোঃ জামাল	৩৫	৩০/৫			[Signature]
09	মোঃ জামাল	৩৫	৩০/৫			[Signature]
10	NARUL	৬৫	৩০/৫			[Signature]
11	মোঃ জামাল	৩৫	৩০/৫			[Signature]
12	মোঃ জামাল	৬৫	৩০/৫			[Signature]
13	মোঃ জামাল	৩৫	৩০/৫			[Signature]
14	মোঃ জামাল	৩৫	৩০/৫			[Signature]
15	Mohd Nabi (M)	37	07	S.S.C.	Member	[Signature]
16	M.D. H. HAD					[Signature]
17	Bappy	22	M	Diploma	Eng	[Signature]
18	MUJ	58	M	Primary	UP member	[Signature]
19	মোঃ জামাল					

Sl.	NAME	age	Sex	Education	Occupation	Signature
21	Anwar ul Haq Bhatti	40	F	H.S.C.	F.N.V	Anwar
22	Sufiyya Day	30	F	S.S.C	Area	Sufiyya
23	Elias Rana	23	F	B.B.S	Student	Elias
23	Diptaraj Alam Sahin	28	M	BSc Hons	Job	Diptaraj
24	Mona -					
25	Alia					
26	Ms. Mansoor					Mansoor
27	Mr. Qasim					
28	Mr. Javed					Javed
29	Mr. Mansoor					Mansoor
30	Mr. Mansoor					Mansoor
31	Mr. Mansoor					
32	Mr. Mansoor					
33	Mr. Mansoor					Mansoor
34	Mr. Mansoor					



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Sl. No	Name	Age	Sex	Education	Occupation	Signature
১	জন. মুন্সিংগ					
২	মমতাজ কাম					
৩	জন. হোসেন					
৪	সমিষ্ঠা					
৫	মহমুদুল হক					
৬	জন. মুন্সিংগ					
৭	মহমুদুল হক					
৮	মহমুদুল হক					
৯	মহমুদুল হক					
১০	মহমুদুল হক					
১১	মহমুদুল হক					
১২	মহমুদুল হক					
১৩	মহমুদুল হক					
১৪	মহমুদুল হক					
১৫	মহমুদুল হক					
১৬	মহমুদুল হক					
১৭	মহমুদুল হক					
১৮	মহমুদুল হক					
১৯	মহমুদুল হক					
২০	মহমুদুল হক					
২১	মহমুদুল হক					
২২	মহমুদুল হক					

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Ministry of Power, Energy and Mineral Resources
Gas Transmission Company Ltd (GTCL)
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১	উপস্থাপন পরিচালনা					উপস্থাপন
২	উপস্থাপন পরিচালনা	৬২	মহা	ডাঃ এম. এ. এম. এ.	উপস্থাপন	উপস্থাপন
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৯	উপস্থাপন পরিচালনা	৬০	মহা		উপস্থাপন	উপস্থাপন
১০	উপস্থাপন পরিচালনা	৬০	মহা		উপস্থাপন	উপস্থাপন
১১	উপস্থাপন পরিচালনা	৬৬	মহা		উপস্থাপন	উপস্থাপন
১২	উপস্থাপন পরিচালনা	২৬	মহা	স. স. এ.	উপস্থাপন	উপস্থাপন
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১৪	উপস্থাপন পরিচালনা	৬৬	মহা		উপস্থাপন	উপস্থাপন
১৫	উপস্থাপন পরিচালনা	৬৬	মহা		উপস্থাপন	উপস্থাপন
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১৭	উপস্থাপন পরিচালনা	৬০	মহা		উপস্থাপন	উপস্থাপন
১৮	উপস্থাপন পরিচালনা	২৬	মহা		উপস্থাপন	উপস্থাপন
১৯	উপস্থাপন পরিচালনা	২৬	মহা		উপস্থাপন	উপস্থাপন



Ministry of Power, Energy and Mineral Resources
Gas Transmission Company Ltd (GTCL)
(A Company of Petrobangla)

List of Participants:

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Asian Development Bank



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Ministry of Power, Energy and Mineral Resources
Gas Transmission Company Ltd (GTCL)
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Date: ২২.১২.১৫

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০৫	শ্রী: মঈনুজ্জামান	৬০	পুরুষ	খারদারগী	কম্পা	
০৬	শ্রী: আব্দুল হান্নান	৫৫	পুরুষ	খারদারগী	কম্পা	
০৭	শ্রী: মোস্তাফিজুর রহমান	২০	পুরুষ	খারদারগী	কম্পা	
০৮	শ্রী: মোস্তাফিজুর রহমান	২০	পুরুষ	খারদারগী	কম্পা	
০৯	শ্রী: মোস্তাফিজুর রহমান	২০	পুরুষ	খারদারগী	কম্পা	
১০	শ্রী: মোস্তাফিজুর রহমান	২০	পুরুষ	খারদারগী	কম্পা	
১১	শ্রী: মোস্তাফিজুর রহমান	২০	পুরুষ	খারদারগী	কম্পা	
১২	শ্রী: মোস্তাফিজুর রহমান	২০	পুরুষ	খারদারগী	কম্পা	
১৩	শ্রী: মোস্তাফিজুর রহমান	২০	পুরুষ	খারদারগী	কম্পা	
১৪	শ্রী: মোস্তাফিজুর রহমান	২০	পুরুষ	খারদারগী	কম্পা	
১৫	শ্রী: মোস্তাফিজুর রহমান	২০	পুরুষ	খারদারগী	কম্পা	
১৬	শ্রী: মোস্তাফিজুর রহমান	২০	পুরুষ	খারদারগী	কম্পা	
১৭	শ্রী: মোস্তাফিজুর রহমান	২০	পুরুষ	খারদারগী	কম্পা	
১৮	শ্রী: মোস্তাফিজুর রহমান	২০	পুরুষ	খারদারগী	কম্পা	
১৯	শ্রী: মোস্তাফিজুর রহমান	২০	পুরুষ	খারদারগী	কম্পা	
২০	শ্রী: মোস্তাফিজুর রহমান	২০	পুরুষ	খারদারগী	কম্পা	

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Ministry of Power, Energy and Mineral Resources
Gas Transmission Company Ltd (GTCL)
(A Company of Petrobangla)

Place: উপকূলীয়, জামায়েয়া মেডিকেল, হামিনা ডেল্টা, জামিনা

Date: ০৬.০২.১৯২১

List of Participants:

Sl. No	Name	Age	Sex	Education	Occupation	Signature
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02	শ্রী. সায়দা হাছানা		M		সহকারী	
03	শ্রী. সায়দা		M		সহকারী	
04	শ্রী. সায়দা দেবনাথ		M		সহকারী	
05	শ্রী. সায়দা		M		সহকারী	
06	শ্রী. সায়দা সায়দা		M		সহকারী	
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09	শ্রী. সায়দা সায়দা		M		সহকারী	
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12	শ্রী. সায়দা সায়দা		M		সহকারী	
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19	শ্রী. সায়দা সায়দা		M		সহকারী	

20	শ্রী. সায়দা সায়দা					
21	শ্রী. সায়দা সায়দা					

Annex 5

Emergency Response and Disaster Management Plan

The initial response to an incident, in a critical step, is the main focus in the overall emergency response. GoB does not have any legal binding yet to put emergency preparedness in place for oil and gas processing and supply industry. However, like all other industries and installations, gas production and process facilities must have adequate measures against accidents or incidents to meet the emergency situation. The purpose of having an emergency response plan (ERP) is to:

- Provide appropriate procedures and guidelines to guide all staff in determining the appropriate response to emergency situations.
- Notify the appropriate Company Emergency Response Team including regulatory/government. agencies as required and also take all necessary steps to reduce impact of incidents
- Notify the next-to-kin of accident victim.
- Promote inter-departmental communications to ensure a “Company-wide” coordinated emergency response, if required.
- Respond immediately to safeguard the surrounding environment and community.

As a general rule, the initial response is guided by three priorities which are as follows:

1. People
2. Property
3. Environment

Emergency response procedures will identify who does what and when, in the event of an emergency situation. Responsibilities for the Officials who are in charge and their coordination for emergency actions shall be identified under the specific “Roles and Responsibilities”. The anticipated nature of emergency and hazardous situations may be categorized as follows:

I. Emergency

- Fire
- Explosion
- Medical Emergency
- Leaks and other releases of hazardous substances
- Spillage of toxic chemical, and electrocution

II. Natural Disasters

- Flood
- Earthquake/ Cyclone
- Storm/ Typhoon/
- Tornados and
- Cloud bust lightening

III. External Factors

- Food poisoning/ water poisoning
- Sabotage and
- War

Six steps in emergency response:

Steps	Emergency Responses
Steps-1)	a. Determine the potential hazards associated with the incident, substance or circumstances and take appropriate action to identify the type and qualities of dangerous goods involved and any known associated hazards. b. Determine controlling of potential hazards considering local conditions such as inclement weather/water bodies, etc. and ensure that the initial response team is aware of these conditions.
Steps-2)	Determine the sources/cause of the event resulting to the emergency and prevent further losses.
Steps-3)	Conduct an assessment of the incident site for any further information on hazards or remedies.
Steps-4)	Initiate redress procedures.
Steps-5)	Report the incidence, its nature, cause, impacts, applied redresses procedures and any further assistance required, etc., to the appropriate company, government and/or land owner.
Steps-6)	Take appropriate steps to protect impacts of hazards on wildlife, other resources and addressing public and media concerns and issues that are applicable. Response priorities are to protect human lives, property and the environment.

Emergency response planning

1. The ERP describes the procedures to ensure the health and safety of staff and the public in the event of any incident. Although the ERPs for gas pipelines have a different scope than those of other facilities, the purpose and key elements of the plans are similar.
2. Three levels of planning (reduce, normal and special) may be used depending on the particular circumstances, potential incidence rate, and the location and number of residents living in the community/locality in close proximity along the project sites. The scope of the ERP is also dependent on the potential impact of the project activities, complexity of evacuation logistics and proximity to public facilities, etc. A key feature of all plans of Emergency Planning Zone is to define the area to be evacuated or protected in the event of an emergency. Another fundamental requirement of ERP is stakeholder engagement/discussions with the appropriate local residents and public within the Emergency Planning Zone and must include any pertinent or health factors which must be considered.

The essential components of the ERP are as follows:

1. The plan must include a definition of “An Emergency” and an action plan to address that emergency. This includes defining the “Stages of Alert” that may be applicable for various aspects of the work. This is important since it requires good coordination between aspects such as welding, testing, commissioning and tie-in, etc. Each action plan defines what level of evacuations should be occurring, who should be notified, what monitoring should be done and when emergency response teams are to be notified.
2. ERP shall have description of responsibilities of the emergency response personnel including: off-side personnel, team coordinators safety and evacuation personnel, monitoring crews, public relations and systems equipment lists and post emergency procedures must also be defined.

3. The roles and responsibilities for the various governments are to be defined and coordinated within the plan which should include the provision for the company/government to establish on-site command post and a main control headquarters to provide advice to affected persons, union parishads, local administrations, fire brigade and the media.
4. To ensure preparedness, there should be provision for testing the response and usefulness of the planned emergency response exercises. These exercises usually involved the company and contractor personnel as well as various governments' organizations and the community leaderships that would be involved in actual emergency incidents.