This ESIA is in the process of being updated

Dhaka Water Supply and Sewerage Authority (DWASA)

Bangladesh

Saidabad WTP Phase-III, Dhaka (Fasep N°990)

Environmental and Social Impact Assessment

Version 1

20 August 2014

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INSTITUTE OF WATER MODELLING IWM

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Quality Information

Quality Control

Version	Date	Written by:	Checked by:
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Version 1	20 August 2014	Prof. Dr. M. Ashraf and Dr. Tanvir Ahmed, BUET	Mr Yannick Hemon

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Acronyms and abbreviations

AFD	French Agency for Development
APHA	American Public Health Association
AQ	Aquatic
BBS	Bangladesh Bureau of Statistic
BCSIR	Bangladesh Council of Scientific and Industrial Research
BIWTA	Bangladesh Inland Water Transport Authority
BUET	Bangladesh University of Engineering and Technology
DANIDA	Danish International Development Agency
DBO	Design, Build, Operate
DCC	Dhaka City Corporation
DGPS	Differential Global Positioning System
DND	Dhaka-Narayanganj-Demra
DO	Dissolved Oxygen
DOE	Department of Environment
DWASA	Dhaka Water Supply and Sewerage Authority
ECA	Ecologically Critical Area
ECR	Environmental Conservation Rule
EMP	Environmental Management Plan
ESIA	Environmental and Social Impact Assessment
FGD	Focus Group Discussion
FR/FS	Feasibility Report/ Study
GoB	Government of Bangladesh
GR	Game reserve
HH	Households
IWM	Institute of Water Modelling
MLD	Million Litre Day
NP	National Park
PA	Protected area
PAP	Project Affected Person
PD	Project Director
PM	Particulate Matter

PS	Pumping Station
RAP	Resettlement Action Plan
RHD	Roads and Highways Department
RoW	Right of Way
RTK-GPS	Real Time Kinematic – Global Positioning System
SPM	Suspended Particulate Matter
TBM	Temporary Bench Mark
TCLP	Toxic Characteristic Leaching Procedure
TOC	Table of Content
TOR	Terms of Reference
TR	Terrestrial
(S)WTP	(Surface) Water Treatment Plant
WS	Wildlife Sanctuary

Executive Summary

Background

Dhaka Water Supply and Sewerage Authority (DWASA), entrusted with the responsibility to supply potable water to Dhaka Metropolitan City and adjacent areas, meets 78% of the water demand through extraction from ground water sources. The high rate of extraction to meet the demand of the city population is proving to be unsustainable as the ground water table is declining at an alarming rate of 2 to 3 m per year with a possibility of alarming environmental consequences in the future. To respond to this emerging scenario, DWASA has made a strategic decision to shift from ground water source to conjunctive use of surface and ground water source, as per direction of the Government of Bangladesh. Saidabad Phase-III surface water treatment plant (SWTP) will be a part of that endeavour. Therefore, the objective of the project is to increase the capacity of DWASA in supplying safe drinking water to the city population utilizing surface water sources, thereby diminishing the reliance on ground water resources and thus ensure water security.

The major activities associated with the implementation of the Saidabad phase-III project will be:

- Construction of a 450 MLD surface water treatment plant at Saidabad site. The plant will include components such as clarification, rapid sand filtration, storage and high lift pumping facilities for treated water as well as treated water primary. Works will include sludge treatment for the Phases-I, II and III;
- Construction of a primary transmission line for raw water from the proposed intake in the Meghna River to the SWTP at Saidabad;
- Construction of main feeder lines from the SWTP at Saidabad to the injection points of the water distribution system; and
- Construction of about 61.8 km distribution line.

As a part of the feasibility study, a full scale Environmental and Social Impact Assessment (ESIA) of the proposed project has been carried out. As per the Environmental Conservation Rules 1997 (GoB, 1997), the proposed project involving construction of raw water transmission line, water treatment plant, and treated water transmission line, falls under “RED category” which makes it mandatory to conduct a full-scale ESIA study.

Project Activities and Objectives of ESIA

The major activities to be carried out during the construction phase include: (i) Acquisition of required land (about 9 ha); (ii) Construction of intake channel, intake structure, raw water pumping station, and raw water transmission line; (iii) Construction of water treatment plant (WTP) including all treatment units and ancillary facilities (e.g., pre-chlorination unit, clarification units, rapid sand filter units, clear water reservoir, clear water pumping facilities, sludge treatment facilities, administrative building, workshop building, generator room, guard room); (iv) Installation of water transmission line on land; (v) Installation of water transmission lines across 2 rivers (Old Brahmaputra and Sitalakhya rivers); and (vi) Installation of about 61.8 km of distribution line.The important issues to be addressed during

the operational phase include: (i) Stability of river bank and intake channel; (ii) Availability of raw water; (iii) Raw water quality; (iv) Treated water quality; (v) Proper operation of treatment plant; (vi) Public health and DWASA service facilities; (vii) Sludge treatment and disposal; (viii) Safety of water distribution network; (ix) Disposal of additional volumes of wastewater that will be generated due to increased water supply in Dhaka city after completion of the project; and (x) Navigation in rivers and khals through which water transmission line has crossed.

The overall objectives of the ESIA of the proposed project were to identify potential significant environmental and social impacts, both positive and negative, during construction and operational phases of the project, recommend mitigation measures to avoid or reduce adverse environmental impacts and to enhance positive impacts, and to develop a comprehensive environmental management plan (EMP), including monitoring requirements, for both construction and operational phases of the project.

Baseline Environment

An environmental baseline survey has been carried out in areas surrounding the proposed locations of intake and water treatment plant, and along the route of the proposed water transmission and distribution line. The specific objectives of the baseline study were to gather information on the existing physical environment of the areas within and around the project sites, and to assess people's perception on different aspects of the proposed project.

Physicochemical environment

As a part of the baseline survey, a topographic survey was carried out along the route of the proposed transmission line from the proposed intake location at Haria to water treatment plant site at Saidabad in Dhaka.Locations of various features in the project areas, such as roads, drainage channels, water bodies, rivers, filling stations, electric poles, human settlement, and other permanent structures were identified. Relevant data on climate, geology and soils, air quality, noise level, and water quality (surface water and groundwater) were collected through field investigation as well as secondary sources.

Ecological environment

Ecological information in and around the project areas were collected through field research, consultation with local people, and literature review. The baseline ecological survey primarily focused on identifying floral and faunal diversity and their distribution and abundance as well as their biological status in Bangladesh (e.g. threatened flora and fauna). Protected areas, wildlife sanctuaries, game reserves and ecologically critical areas were also identified, if any.

Socio-economic environment

An assessment of the baseline of socio-economic conditions / attributes of the areas surrounding the proposed project sites was made. The social study covered an area of about 5 km radius surrounding the project sites. Efforts were made to identify the socio-economic attributes that may be impacted by the proposed project activities by conducting field study, questionnaire survey, formal and informal interviews.

Environmental Impacts

Environmental impacts of the specific project activities on different ecological, physicochemical and human interest related parameters, both during the construction phase and the operation phase, have been identified and assessed.

Ecological Impacts

Construction activities associated with crossing of rivers/ water bodies by water transmission line are likely to have some adverse impact on aquatic environment, especially on aquatic flora, fauna, fish and water quality.During operational phase, ecological impacts may result from improper disposal of dewatered sludge in the environment. Table 1 summarizes the impacts on terrestrial and aquatic flora and fauna resulting from different project activities in the form of a compatibility matrix. It shows that most of the evaluated impacts are of low or moderate intensity and are short-term in nature. No long-term adverse impacts to the floral species as well as to the populations of the mammals, reptiles, amphibian, birds and fishes are expected.

Table 1: Evaluation of ecological impacts resulting from different project activities

Source of Potential Impacts	Ecological Issues										
	Flora		Fish	Fauna							
				Amphibia		Reptile		Bird		Mammal	
	AQ	TR		AQ	TR	AQ	TR	AQ	TR	AQ	TR
During construction											
Camp setting	0	-1S	0	0	-1S	0	-1S	0	-1S	0	-1S
Access road construction	-1S	-1S	0	0	-1S	0	-1S	0	0	0	-1S
Land clearing	-1S	-1S	-1S	-1S	-1S	-1S	-1S	0	-1S	0	-1S
Soil excavation	-1S	-1S	-1S	-1S	-1S	-1S	-1S	0	0	0	-1S
Generation of Noise	0	0	-1S	-1S	-1S	-1S	-1S	-1S	-1S	0	-1S
Deterioration of water quality	0	0	-1S	-1S	-1S	-1S	0	-1S	0	-1S	0
Sewage discharge on soil / water	-1S	0	-1S	0	-1S	0	0	0	0	0	0
Water body crossing (during pipeline construction)	-1S	0	-1S	-1S	0	-1S	0	-1S	0	-1S	0
During Operation											
Spills (oil / Chemical) on land/ water	-1S	-1S	-2S	-1S	-1S	-1S	-1S	-1S	-1S	0	-1S
Waste/ sludge disposal	0	0	-1S	-1S	-1S	-1S	-1S	-1S	-1S	0	-1S

[Legend: AQ = Aquatic; TR = Terrestrial; 0 = No impact (negligible impact), 3 = High impact, 2 = moderate impact, 1 = Low impact, S = Short term impact, L = Long-term impact, +/- = positive/negative impact, AQ = Aquatic, TR = Terrestrial]

Physicochemical Impacts

Major physicochemical parameters considered for assessment of environmental impacts of project due to construction and operation activities include drainage congestion, air and noise pollution, sanitation and solid waste, water pollution, soil pollution and erosion. Although all the impacts were found to be low to moderate in nature, some of the activities (e.g. solid/ hazardous waste generation) have the potential to generate long-term adverse impacts on different environmental compartments if proper mitigation measures are not taken. (Table 2)

Table 2: Physicochemical impacts from activities associated with the construction and operation of Saidabad Water Treatment Plant Phase III

	Project Activities	Physicochemical Impacts						
		Drainage congestion	Noise level	Air quality	Surface Water quality	Groundwater quality	Soil Erosion	Soil quality
During Construction	Labour camp setting and its operation	0	0	0	-1S	-1S	0	0
	Access road construction	-1S	-1S	-1S	-1S	0	-1S	0
	Land clearing	-1S	0	0	0	0	-2S	0
	Soil excavation	-2S	-2S	-2S	-1S	0	-1S	-1S
	Piling work	0	-2S	-1S	-1S	-1S	0	0
	Concreting work	0	-2S	-1S	0	0	0	0
	Water body crossing work (pipeline laying)	-1S	-2S	-1S	-1S	0	0	0
	Provision for safe water and sanitation facilities for workers	0	0	0	0	0	0	0
During Operation	Solid /hazardous waste and wastewater generation	0	0	0	-1L	-2L	0	-2L
	Access to safe water supply	0	0	0	0	+2L	0	0
	Accidental chemical oil leaks, spills on land/ water	0	0	0	-1S	0	0	-1S

[+3 = High Positive Impact, +2 = Moderate positive impact, +1 = Low Positive Impact, 0 = No impact, -1 = Low Negative Impact, -2 = Moderate Negative Impact, -3 = High Negative Impact S = Short term impact, L = Long term impact]

Socio-economic Impacts

Major social parameters considered for assessment of social impacts of the proposed project include loss of land, loss of income, traffic congestion and safety, public health, effect on archeological sites, impact on topsoil, employment and commercial activities. It can be seen from Table 3 that although the project may have some negative impacts related to loss of land and income, significant beneficial impacts are associated with employment and commercial activities as well as access to safe water supply to the people under its service.

Table 3: Socio-economic impacts from activities associated with the construction and operation of Saidabad Water Treatment Plant Phase III

	Project Activities	Socio-Economic Impacts						
		Loss of Land	Loss of income and displacement	Traffic	Impact on topsoil	Public Health and safety	Effect on Archeological sites	Employment and commercial activities
During Construction	Land acquisition	-2L	-2L	0	0	0	0	0
	Labour camp setting	0	0	0	0	0	0	+2S
	Access road construction	0	-1S	-1S	-2S	-1S	0	+2S
	Land clearing	0	-1S	0	-2S	0	0	+2S
	Soil excavation	0	-1S	0	-1S	-1S	0	+2S
	Piling work	0	0	0	0	-1S	0	+2S
	Concreting work	0	0	0	0	-1S	0	+2S
	Water body crossing work	0	0	-1S	0	-1S	0	+2S
	Provision for safe water and sanitation facilities for workers	0	0	0	0	+2S	0	0
During Operation	Accidental chemical oil leaks, spills on land/ water	0	0	0	-1S	-1S	0	0
	Solid /hazardous waste and wastewater generation	0	0	0	-1S	-1S	0	0
	Access to safe water supply	0	0	0	0	+3L	0	0

[+3 = High Positive Impact, +2 = Moderate positive impact, +1 = Low Positive Impact, 0 = No impact, -1 = Low Negative Impact, -2 = Moderate Negative Impact, -3 = High Negative Impact S = Short term impact, L = Long term impact]

Public Consultation

Three Focus Group Discussions (FGDs) were carried out at 3 different locations during field visits, in order to document and record opinions of a wide range of stakeholders on different aspects of the proposed project. These three locations were selected to represent the viewpoints of the general people residing near the intake location (at Haria), the water transmission route (along Dhaka-Chittagong Highway), and the treatment plant at Saidabad. In the FGDs, an effort was made to invite a wide range of stakeholders including farmers, businessmen, land owners, house owners, laborers, teachers and students. In addition to the FGDs, a number of formal / informal meetings with stakeholders were carried out in the project areas, including along the routes of the distribution line; the study team interacted with more than 30 people during these meetings. A total of 68 people participated in the FGDs. The participants expressed their opinions regarding different issues including their knowledge about the proposed project, socio-economic condition of people in their localities, possible impact of the proposed project on the environment and in their localities, and mitigation measures to address adverse impacts.

Analysis of Alternatives

An assessment of alternative sites for the location of the intake and alternate raw water transmission routes for Saidabad Phase-III project were made. For completeness, the “no project” scenario has also been discussed. Alternative technology options for crossing of rivers by raw water transmission pipelines were also assessed.

Mitigation Measures

Table 4 and Table 5 show the mitigation measures corresponding to specific adverse impacts during construction and operation phase respectively, along with assignment of responsibilities for their implementation. The measures aim at minimizing the effects of the possible adverse impacts and enhancing the positive impacts. The tables show that most of the adverse impacts could be minimized or even removed if appropriate mitigation measures are taken.

Table 4: Environmental impact during construction phase and mitigation measures

Activity/Issues	Potential Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
Land acquisition	Loss of land / property/ trees	Raise awareness of Project Affected Persons (PAPs) through public consultation process prior to actual land acquisition. Serve land acquisition notices to actual land owners. Provide adequate (considering present market value), fair, and quick compensation to real land owners, in accordance with applicable laws of GoB and applicable resettlement policy framework of DWASA. Provide appropriate and quick compensation for loss of property on acquired land. Involve local people and people’s representatives in settling social tension	DWASA, District Lands Office

Activity/Issues	Potential Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		related to land acquisition and those that may develop during the progress of work from the very beginning of project implementation.	
	Tree cutting in acquired land or along RoW of distribution/ transmission lines	Provide adequate, quick and fair compensation to owners Plantation/ afforestation program for tree replacement (plantation of at least two trees of similar species for each cut tree) Not removing undergrowth fully where possible, so that they may re-grow naturally after the project activity.	DWASA
Construction and operation of labor shed for workers; Construction of water transmission/ distribution pipeline and water treatment plant	Loss of income during construction (e.g., road-side shops)	Include owners of affected businesses in project consultations and inform them of work in advance. Make alternative arrangements and or compensate for loss of income (e.g., shopkeepers)	DWASA
	Shifting or relocation of utility lines along alignment of distribution/ transmission lines (if needed)	Take especial care during detail design of transmission/ distribution lines to keep such shifting/ relocation to a minimum; Arrange alternative arrangement during shifting/ relocation of utilities (e.g., gas, electricity, water) in consultation with respective service providers. Take adequate safety measures to avoid accidents during shifting of utility lines.	DWASA
	Generation of sewage and solid waste	Construction of sanitary latrine and septic tank system Erection of “no litter” sign, provision of waste bins/cans, where appropriate Waste minimization, recycle and reuse principles to be followed Proper disposal of solid waste Workers awareness	Contractor (Monitoring by DWASA)
	Health of workers	Clean bill of health a condition for employment Construction of tubewells with acceptable water quality Raising awareness about hygiene practices among workers Regular medical monitoring of workers	Contractor (Monitoring by DWASA)
	Safety; Occupational health and	Take adequate measures to ensure safety/ stability of structures (buildings, walls) located close to the alignment of transmission/	Contractor (Monitoring by DWASA)

Activity/Issues	Potential Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
	safety	distribution lines. Follow standard safety protocols. Provision of protective gears and first aid facilities. Only allowing trained and certified workers in the shifting of utilities (e.g., power/ gas/ water lines).	
	Air pollution	Ensure that all project vehicles are in good operating condition Spray water on dry surfaces/ unpaved roads regularly to reduce dust generation Pave access roads Maintain adequate moisture content of soil during compaction and handling; use cover during transportation/ storage of dry materials (e.g. fine aggregates, soil). Sprinkle and cover stockpiles of loose materials (e.g., fine aggregates, excavated soil). Not using equipment such as stone crushers at site, which produce significant amount of particulate matter	Contractor (Monitoring by DWASA)
	Traffic congestion, communication problems	Schedule deliveries of material/ equipment during non-school hours and after regular working hours. Arrangement of alternative communication routes during laying of pipeline across roads. Employ flagman and provide adequate signs/ lights for traffic management and to avoid accidents; take assistance from police, where appropriate, for traffic control/ security. Take especial care to ensure safety of rails and rail tracks during crossing (by distribution line, e.g., at near Titipara near ICD Kamlapur). Provide wooden walkways to maintain pedestrian access across trenches and metal plates for vehicles (where necessary).	Contractor (Monitoring by DWASA)
	Noise pollution	Use of noise suppressors and mufflers in heavy construction equipment. Avoid using of construction equipment producing excessive noise during school hours and also at night Avoid prolonged exposure to noise (produced by equipment) by workers./ give protective	Contractor (Monitoring by DWASA)

Activity/Issues	Potential Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		gears Regulate use of horns and avoiding use of hydraulic horns in project vehicles.	
	Disruption of local drainage	Carry out crossing of water bodies and box culverts during dry season. Carry out installation of transmission/ distribution lines during the dry season as much as possible in order to avoid problems related to stability of trenches and washout excavated materials by rain. Provide adequate diversion channel, if required Provide facilities for pumping of congested water, if needed Ensure adequate monitoring of drainage effects, especially if construction works are carried out during the wet season. Find beneficial uses for excess/ waste soil, e.g., in construction, land raising and filling of excavated areas/trenches (depending on the quality of excavated materials). Use tarpaulins to cover dry soil when carried on trucks. Remove Waste quickly, cover/ spray stockpiles. Only bring sand (for backfill) to site when needed	Contractor (Monitoring by DWASA)
	Water and soil pollution	Forbid discharge of fuel, lubricants, chemicals, and wastes into surface waters or on land. Adopt proper disposal techniques for any hazardous waste (e.g. excavation materials from sludge lagoons in the SWTP Phase-III treatment plant site) Install sediment basins to trap sediments in storm water prior to discharge to surface water. Replant vegetation when soils have been exposed or disturbed.	Contractor (Monitoring by DWASA)
	Destruction of aquatic habitat and reduction of fisheries, aquatic fauna	Forbid discharge of fuel, lubricants, chemicals, and wastes into surface waters. Preservation of aquatic habitats by restricting movement of people/ equipment into them, and preventing entry of sediments into these water bodies. Restrict activities within the RoW during	Contractor (Monitoring by DWASA)

Activity/Issues	Potential Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		laying of water pipeline across a water body, keep rest of the water body undisturbed. Keep noise level (e.g., from equipment) to a minimum level, as certain fauna are very sensitive to loud noise. Special care for protection of threatened species that have been identified in the project areas (listed in Table 31)	
	Reduction/ damage to plants/ floral habitat	Provide proper compensation if there is any destruction of trees outside RoW. Control intensive movement of heavy construction vehicles.	Contractor (Monitoring by DWASA)
	Accidents	Following standard safety protocol while digging trenches and laying pipes Environmental health and safety briefing Provision of protective gear	Contractor (Monitoring by DWASA)
	Spills and leaks oil, toxic chemicals	Good house keeping Proper handling of lubricating oil and fuel Collection, proper treatment, and disposal of spills.	Contractor (Monitoring by DWASA)
	Employment of work/ labor force/ economy of the area	Employ local people in the project activities as much as possible. Promote supply from local suppliers	Contractor (Monitoring by DWASA)

Table 5: Environmental impact during operation phase and mitigation measures

Activity/Issues	Potential Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
Pumping operation at the intake	Screening waste accumulation	Screening waste needs to be removed regularly from the coarse screens. Local labor may be employed for such operations. Proper disposal of screening wastes, floating debris (to be treated as a solid waste): formulate disposal management plan and provide adequate facilities to carry it out	DWASA or the operator
	Accidental Spillage of fuel (to run generators)	Forbid discharge of fuel, lubricants, chemicals, and wastes into surface waters or on land. Adopt proper disposal techniques for any hazardous waste: hazardous waste management plan and provide adequate	DWASA or the operator

Activity/Issues	Potential Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		facilities to carry it out	
	Presence of silt, oil and grease in raw water	Design of intake structure in order not to collect water from the surface to avoid oil and grease. Design of intake structure in order to avoid collecting water very close to the river bed to prevent excess silt from entering. Facilities at intake for removing silt, oil and grease entering accidentally the system	DWASA or the operator
Treatment plant operation	Accidental Spills and leaks oil, toxic chemicals	Good house keeping Proper handling of lubricating oil and fuel Collection, proper treatment, and disposal of spills. Formulate an accident management plan	DWASA or the operator
	Generation of sludge dry cakes after sludge dewatering operation	Assessment of characteristics of sludge through Toxicity characteristic leaching procedure (TCLP) test to confirm that the material is not hazardous Exploring beneficial options for dewatered sludge disposal (e.g. land application, co-disposal with sewage sludge, selling to brick factory) If beneficial options are not available, consider landfilling in a suitable land/ location. If lands are not available, make arrangements with Dhaka City Corporation to dispose the sludge dry cakes in one of their designated landfills.	DWASA or the operator
	Generation of liquid residuals after sludge dewatering operation	Direct disposal to nearby lowlands if the residuals meet the effluent discharge criteria as per ECR 1997 (see Annex 12.4) If discharge criteria are not met, return to the head end of the plant for treatment. Must not be discharged to the head end as a pulse, rather metered in at a flow rate compatible with the hydraulic loading of the plant preferably during diurnal high flows.	DWASA or the operator
	Poor raw water quality in the Meghna river	Seeking the help of the Department of Environment (DoE) for preventing discharge of untreated industrial and domestic wastewater into Meghna River and thereby ensuring its water quality. Also it is recommended to restrict development	DWASA and DoE

Activity/Issues	Potential Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		activities both upstream and downstream of the intake point, especially those activities that could affect the water quality and hydrology at the intake location.	
Operation and maintenance of transmission/ distribution lines	Possible traffic problem during maintenance works along busy roads	Carrying out major maintenance works during night. Informing people about major maintenance works ahead of time and making provision for alternative arrangement (for movement of people/ vehicle), where possible.	DWASA or the operator

Environmental Monitoring Plan

It is recommended that the Project Director (PD) for this specific project takes the overall responsibility of environmental management and monitoring. The PD will form a team with required manpower and expertise to ensure proper environmental monitoring, and to take appropriate measures (as outlined in Table 4 and Table 5) to mitigate any adverse impact and to enhance beneficial impacts, resulting from the project activities. An environmental monitoring plan during construction and operation phase has also been developed. A Resettlement Action Plan will have to be developed and implemented also.

Environmental monitoring during Construction Phase

Specific monitoring requirements for the environmental aspects listed in Table 4 are presented in Table 6. Table 7 shows the frequency of monitoring activities during construction phase.

Table 6: Monitoring requirements during construction phase of the project

Environmental Issue	Monitoring requirements
Air pollution	Construction materials should be properly covered while hauled and stored, roads properly cleaned and water sprayed in order to minimize concentration of dust in air. Use of equipment like stone crushers, which produce excessive noise as well as generate particulate matter, must not be used close to human settlement. Concentration of particulate matter within and around the project site should be measured, at least once every three months, and air quality management plan should be revised, if needed.
Noise pollution	Equipment producing excessive noise should not be operated after dark. Use of equipment like stone crushers, which produce excessive noise as well as particulate matter, must not be used at the site. Vehicle movement to and from the site should be properly managed in order to ensure that this causes minimum disturbance to the people living in the surrounding areas.
Traffic congestion	Hauling of materials and equipment to and from project sites should preferably be done after the regular working hours, so that it causes

Environmental Issue	Monitoring requirements
	minimum disturbances to the regular traffic in and around the project site. Contractor should take responsibility of proper traffic flow and management within the immediate vicinity of the project site.
Drainage congestion	Appropriate measures should be taken to avoid temporary drainage congestion during construction activities (e.g., keeping existing drains clear, building alternative drainage line/ network, where an existing drainage canal has been filled up).
Disposal of construction waste	Waste/ wastewater (e.g., human waste from labor camps, fuel and wash-water from equipment/ material sheds) should be appropriately disposed, so that they do not find their way into adjacent water bodies. Solid waste and wastewater should be disposed of in proper fashion. Wastewater should be disposed of by constructing septic tanks. Solid waste, including construction debris, should be regularly collected and transported away from the site for disposal in a designated municipal dump site. Excavated materials from the existing sludge drying beds should be tested for toxicity before disposal.
Employment of workforce	Local people should be employed in the project activities as much as possible.
Commercial activities	Efforts should be made to ensure that local communities are benefited from the increased commercial activities during the construction phase of the project (e.g., by ensuring their participation in the activities). Care should be taken to avoid haphazard development of commercial activities (e.g., shops) in and around the project sites, which would adversely affect the local environment.

Table 7: Monitoring of water quality air quality and noise during construction phase

Parameters	Monitoring Frequency	Resource Required and Responsibility	Comment
Water quality (BOD_5, COD, EC) for construction works within or close to water bodies (river, khals, lakes)	Once every 3 months, and as directed by the PD	Appropriate water testing facilities; Contractor's responsibility	Results to be verified by a monitoring team, led by the PD
Particulate Matter (PM_{10}, $PM_{2.5}$)	Once every 3 months, and as directed by the PD	PM_{10} and $PM_{2.5}$ measuring equipment; Contractor's responsibility	
Noise Level	Once every month, and as directed by the PD	Noise level meter; Contractor's responsibility	

Note: Actual monitoring time and location will be decided by the Project Director (PD)

Environmental monitoring during Operation Phase

Specific monitoring requirements for the environmental issues listed in Table 5 are presented in Table 8.

Table 9 shows the frequency of monitoring activities during operation phase.

Table 8: Monitoring requirements during operation phase of the project

Environmental Issue	Monitoring requirements
Disposal of treatment waste	Regular (once every three months) assessment of the characteristics of sludge through TCLP test to ensure that it is not hazardous. Monitoring of discharge parameters of liquid residuals from sludge drying operations. Studies to explore the possibility beneficial sludge disposal options (e.g., land application), and in designated landfills (coordinating with the Dhaka City Corporation)
Treated water quality	Regular monitoring of treated water quality (as part of the ongoing regular plant operation) to ensure that it is safe for public consumption. Modification of treatment process (e.g., increase/decrease alum dose of chlorine dose), if needed.
Raw water quality	Regular monitoring of raw water quality, as part of ongoing regular plant operation. In association with the Department of Environment (DoE), developing of a long-term management plan for the protection of raw water quality in Meghna River (including restriction on establishment of industries producing liquid effluent within certain reaches upstream and downstream of the intake point).
Generation of additional volume of wastewater as treated water supply increases	This issue should be taken into consideration in the ongoing planning and implementation activities of DWASA aimed at expanding sewerage network and treatment facilities in Dhaka city. This would obviously necessitate additional sewage treatment plant at appropriate locations.
Safety of water distribution network	Monitoring and detection of leaks and expansion and upgradation of water distribution network of, as part of DWASA's regular monitoring and expansion works.

Table 9: Monitoring of water quality and sludge during operational phase of proposed WTP

Monitoring	Water Quality / Other Parameters	Monitoring Frequency
Raw water	pH, Color, Turbidity, Ammonia, Nitrate, Phosphate, Sulfate, TC, FC	Daily
	Lead, Chromium, Mercury, Cadmium, Total Suspended Solids, COD, BOD_5, Oil & grease	Once a month
Treated water	pH, Color, Turbidity, Ammonia, Nitrate, Residual Chlorine, TC, FC	Daily
	BOD_5, COD, Aluminum, Total Dissolved Solids	Once every two months
Dewatered sludge	TCLP test and determination of Al, Pb, Cr, Cd in TCLP extract	Once every three months
Liquid residuals from dewatering operation	pH, Ammonia-N, BOD_5, COD, Cd, Cr, Mercury, Chloride, Total Dissolved Solids, Total Suspended Solids, Nitrate, Sulfide	Once a month

Notes:
(1) The parameters listed above are based on water quality measurements of Meghna River as a part of this study. The list should be updated based on monitoring results and information on possible pollution of river water by contaminants (e.g., from an industrial source);
(2) Actual monitoring time and location will be decided by DWASA

Table 10 and Table 11 show preliminary cost estimates for monitoring activities during construction and operation phases respectively.

Table 10: Preliminary cost estimates for monitoring and other mitigation activities during construction phase

Parameter/Activity	Frequency of activity	Preliminary cost estimate	Preliminary cost for 1 year activity period
Water quality (BOD_5, COD, EC)	Once every 3 months	Tk. 25,000/- per 10 samples	Tk. 100,000/-
Particulate Matter (PM_{10}, $PM_{2.5}$)	Once every 3 months	Tk. 30,000/- per each set of PM_{10} and $PM_{2.5}$ measurement	Tk. 1,20,000/-
Noise Level	Once every month (day and night)	Tk. 25,000/- (per set of measurement)	Tk. 3,30,000/-
Water spraying for dust control	At least twice a day	Tk. 10,000/- per site per month	Tk. 1,20,000/-
Plantation of trees	At least 2 trees for each tree cut/cleared (approx. 500 trees)	Tk. 1,000/- per plant	Tk. 5,00,000/-
Total annual cost for monitoring during construction phase			**Tk. 11,62,000/-**

Notes: (1) Actual monitoring time and location will be decided by DWASA;
(2) The estimated costs for particular matter (PM) and noise level measurements are based on current rates charged by BRTC, BUET for analysis of the parameters.

Table 11: Preliminary cost estimates for monitoring and other mitigation activities during operational phase

Parameter/Activity	Frequency of activity	Preliminary cost estimate	Preliminary cost for 1 year activity period
Raw water: pH, Color, Turbidity, Ammonia, Nitrate, Phosphate, Sulfate	Daily	Tk. 6,000/- per set of measurement	Tk. 21,90,000/-
Raw water: Lead, Chromium, Mercury, Cadmium, Total Suspended Solids, COD, BOD_5, Oil & grease	Once a month	Tk. 15,000/- per set of measurement	Tk. 1,80,000/-
Treated water: pH, Color, Turbidity, Ammonia, Nitrate, Residual Chlorine, TC, FC	Daily	Tk. 5,500/- per set of measurement	Tk. 20,07,500/-
Treated water: BOD_5, COD, Aluminum, Total Dissolved Solids	Once every two months	Tk. 8,500/- per set of measurement	Tk. 51,000/-
Sludge from Clarifiers: TCLP test and determination of Al, Pb, Cr, Cd in TCLP extract	Once every three months	Tk. 14,000/- per set of measurement	Tk. 56,000/-
Total annual cost for monitoring during operation phase			**Tk. 44,84,500/-**

Notes:
(1) The parameters listed above are based on water quality measurements of Meghna River as a part of this study. The list should be updated based on monitoring results and information on possible pollution of river water by contaminants (e.g., from an industrial source);
(2) Actual monitoring time and location will be decided by DWASA and will be part of the operator's contract if any operator
(3) The estimated costs are based on current rates charged by BRTC, BUET for analysis of the parameters.

The treated water quality parameters must be checked against the Bangladesh drinking water quality standard (ECR 1997). In addition to the above, alum dose should also be checked on a regular basis. The parameters of the liquid residuals should be checked against the standards for disposal of wastewater/ effluent from industrial units or project waste as per ECR, 1997 Schedule-10.

Conclusion and Recommendations

It has been found that for the Saidabad Phase-III WTP project, most of the adverse impacts during construction phase could be minimized or even removed if appropriate mitigation measures are taken. Possible adverse impacts during operational phase are found to be insignificant. However, a monitoring program needs to be put in place to assess any unexpected adverse impacts on the environment. The EMP and the RAP should be carried out as an integral part of the project planning and execution. It has also been pointed out that for long-term sustainability of the water treatment plant, the source water quality and quantity must be ensured to meet the requirements of the treatment plant and water demand. The Department of Environment (DoE), DWASA and BIWTA should take proactive measures so that the source water quality is protected against pollution and the riverbanks remain free from illegal landgrabbing in future.

1. Introduction

1.1 Background

Dhaka Water Supply and Sewerage Authority (DWASA), entrusted with the responsibility to supply potable water to Dhaka Metropolitan City and adjacent areas, is facing significant challenges in its efforts to ensure water supply in adequate quantity and quality to the growing population of Dhaka throughout the year. The majority (about 78%) of DWASA water supply (about 1940 MLD) comes from about 660 deep tubewells (DTWs) installed in the upper Dupitila and deeper aquifers (100-350m). However, in recent years, the groundwater level has been declining rapidly. Studies conducted by the IWM have confirmed that water level in the upper aquifer is declining at a rate of 2 to 3 meters annually, causing a groundwater mining situation in Dhaka. It is noteworthy that up to 1994, the water level declination was only 0.55 meters per year, while in the last 15 years the groundwater declined by 3.52 meters per year. It has been observed that in recent years the production from the groundwater has not increased substantially in spite of the fact that the number of DTWs has increased quite significantly. This demonstrates that further abstraction from upper aquifer (100-350m) is no longer sustainable. In such a scenario, there will be scarcity of drinking water unless alternative sources are explored. To respond to this emerging scenario, DWASA has made a strategic decision to shift from groundwater source to conjunctive use of surface and ground water sources, as per the direction of the Government of Bangladesh.

The successful construction and commissioning of Phase I of Saidabad Water Treatment Plant (SWTP) in July 2002, with a capacity of 225 MLD, marked the beginning of a major surface water development program of DWASA. The Saidabad WTP accounts for the majority (over 90%) of the treated surface water supplied by the DWASA. In an effort to fully implement the strategic development plan prepared by the DWASA, a Joint Partnership Framework has been signed between the Government and the Development Partners. Based on the agreement, the Asian Development Bank (ADB) has already completed the feasibility study of “Dhaka Water Supply Improvement Plan” for a time period up to the year 2025. As per Improvement Plan, rehabilitation of water supply network and feasibility study of Khilkhet surface water treatment plant has been commenced under the ADB assistance. In addition, Phase-II of the Saidabad Water Treatment Plant with a capacity of 225 MLD has already been completed (in December 2012) under DANIDA financing. The aim is to develop the surface water capacity to meet 70% of the water demand of Dhaka city in future.

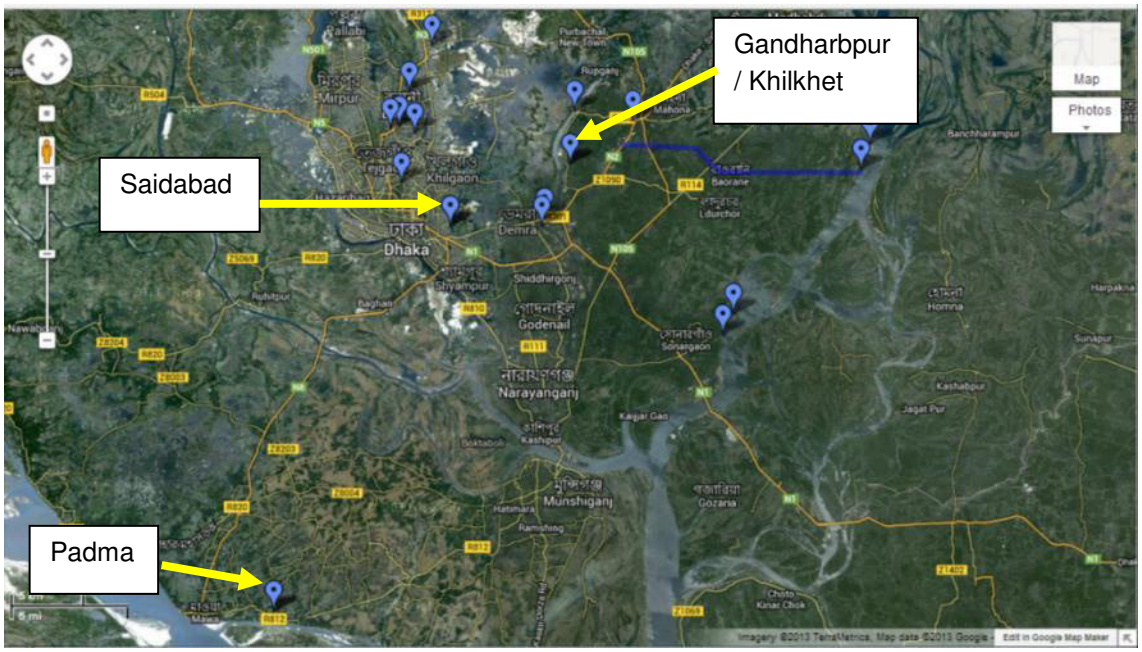


Figure 1: Google Map view showing locations of existing and proposed Water Treatment Plants for Dhaka

Widespread contamination of the peripheral rivers of the city by the indiscriminate disposal of untreated/ partially treated domestic sewage and industrial wastewater is a major impediment for the use of river water for water supply. Both Saidabad Phase-I and Phase-II water treatment plants derive raw water from Sitalakhya River through the intake at Sarulia. The water quality of Sitalakhya River is deteriorating day by day, particularly during the dry season, resulting in increased operational costs of the water treatment plants. In an effort to meet the increasing demand of safe and reliable water supply, DWASA is exploring the possibility of constructing more water treatment plants by drawing water from relatively distant surface water sources, such as from Padma and Meghna rivers, which provide better quality water throughout the year. One of the proposed treatment plants will be installed in Jashaldia village under Louhajong upazila in Munshiganj district, which will draw raw water from the Padma River at Jashaldia and have a capacity of 900 MLD to be constructed in two phases (450 MLD capacity plant under Phase-I by 2015 and another 450 MLD capacity plant by 2020). Another treatment plant (to be installed at Gandharbpur), will add 1000 MLD water to the supply system by the year 2030 (500 MLD capacity plant under Phase-I by 2020 and another 500 MLD capacity plant by 2030) by drawing the raw water from the Meghna river at Bishnondi. The third treatment plant, termed as Saidabad Phase-III, with a maximum capacity of 450 MLD, will also withdraw water from Meghna River but at Haria which is several kilometres downstream from Bishnondi.

The proposed Saidabad Phase-III project will be installed at the site of the existing Saidabad Phase-I and Phase-II plants. In the event the Sarulia intake becomes inoperable (e.g. due to poor water quality of Sitalakhya River) for certain periods of the year, the proposed project will also have provisions for drawing the entire raw water (i.e. up to 950 MLD) from the Meghna River to feed the Saidabad Phases-I, II and III treatment plants.

The major activities associated with the implementation of the Saidabad phase-III project will be:

1. Construction of a 450 MLD surface Water Treatment Plant at Saidabad site. The plant will include components such as clarification, rapid sand filtration, storage and high lift pumping facilities for treated water as well as treated water primary. Works will include sludge treatment for the Phases-I, II and III.
2. Construction of a primary transmission line for raw water from the proposed intake in the Meghna River to the WTP at Saidabad.
3. Construction of main feeder lines from the WTP at Saidabad to the injection points of the water distribution system.
4. Construction of about 61.8 km of water distribution line.

The Saidabad Phase-III project is included in DWASA strategic Development Plan for the period 2004–2015. Likely sources of foreign assistance for this project include AFD and DANIDA. This feasibility study to address Saidabad Phase-III project is being carried out by Egis Eau, funded by FASEP (Fonds d'Etudes et d'Aide au secteur Privé) of French Finance Ministry. Institute of Water Modeling (IWM), the local partner of Egis Eau, is carrying out activities related to the feasibility study. The project is expected to be implemented from mid-2015 to 2018.

A comparison of the water quality of Sitalakhya and Meghna River during the dry season showed that Sitalakhya river water does not comply with the water standard (including the raw water parameters set in the operator contract for Saidabad Ph-II) while the water quality of Meghna River has been found satisfactory (EGIS-IWM, 2013). It was also observed from preliminary studies that Meghna River had sufficient water to meet the requirement of the proposed WTP (EGIS-IWM, 2013). As a part of the feasibility study, different options were considered for the location of the intake and the raw water transmission route. Haria has been preliminarily selected as the most suitable option for intake location based on technical and implementation constraints. Also after discussion with DWASA officials and preliminary assessment, the most advantageous option for raw water transmission route has been selected (from Haria to Saidabad WTP site) taking into consideration technical and socio-economic constraints.

As a part of the feasibility study, a full scale environmental and social impact assessment of the proposed project has been carried out by Bureau of Research, Testing and Consultation (BRTC), Bangladesh University of Engineering and Technology (BUET), Dhaka. As per the Environmental Conservation Rules 1997 (GoB, 1997) of the GoB, the proposed project involving construction of raw water transmission line, water treatment plant, and treated water distribution line, falls under "RED category". Though construction of intake structure is not specifically mentioned in the ECR 1997, an intake structure is a major part of a surface water transmission and treatment plant, and preliminary assessment suggests that construction and operation of such an intake structure (including construction of raw water transmission line) may result in significant environmental impacts. Therefore, carrying out an Environmental and Social Impact Assessment (ESIA) in accordance with the Environment Conservation Act 1995 and the Environment Conservation Rules 1997 is mandatory.

The environmental and social impact assessment (ESIA) of the proposed project has been presented in this report. The ESIA has been carried out following the guidelines (GoB, 1997; GoB, 1997a) of the Department of Environment (DoE) and relevant operational guidelines, e.g., those of the GoB, the World Bank and the Asian Development Bank (World Bank, 1999a; 1999b; 2003; 2004; 2004a).

1.2 Objectives

The overall objectives of the ESIA of the proposed project were to identify potential significant environmental and social impacts, both positive and negative, during construction and operational phases of the project, recommend mitigation measures to avoid or reduce adverse environmental impacts, to enhance positive impacts, and to develop a comprehensive environmental management plan (EMP), including monitoring requirements, for both construction and operational phases of the project. The specific objectives of the ESIA are:

1. to assess the existing environmental conditions surrounding the proposed locations of intake structure, treatment plant, along the proposed routes of the raw water transmission line and treated water primary main up to the injection point, and along primarily distribution network in order to establish a baseline framework, against which potential environmental impacts due to the implementation of the project would be compared.
2. to identify and evaluate environmental impacts resulting from the project activities during both construction and operational phases of the project, and to suggest appropriate mitigation measures.
3. to carry out Focus Group Discussions (FGDs) and public consultations in order to get views and concerns of local people and people's representatives regarding different aspects of the proposed project, and to address those in the ESIA; and
4. to develop a comprehensive environmental management plan (EMP), including monitoring plans, for both construction and operational phases of the proposed project.

1.3 Outline Of Methodology

This study has used various data collection techniques to obtain primary and secondary information for conducting the environmental assessment. Relevant secondary information about the project areas and their surroundings were gathered from published literature. In addition, data and information were also collected from different governmental and non-governmental organizations. Climatic data of the project area was collected from the Bangladesh Meteorological Department (BMD).

Field visits were carried out by the study team to obtain first hand information on the surrounding environment of the intake structure, water treatment plant, and routes of the raw water transmission lines. During these field visits, informal discussions were carried out with people living in and around the project areas. A detailed reconnaissance survey was conducted to gather route specific information. In addition, a detailed route survey has been carried out along the proposed routes of raw and treated water transmission lines, covering the right of way (RoW) along the line.

An environmental baseline survey (including physical and ecological survey) and a social survey have been carried out to gather information on the existing physical, biological, and socio-economic environment of areas surrounding the proposed locations of intake structure, water treatment plant and the routes of water transmission lines. Subsequently, the possible environmental impacts of the project activities have been evaluated against these baseline environmental conditions. In addition, a number of Focus Group Discussions (FGDs) and public consultations have been carried out to get feedback from local people regarding different aspects of the proposed project.

For identification of potential environmental and social impacts, the specific project activities to be carried out have been identified. The activities have been identified separately for construction phase and operational phase. Impacts of these activities on the existing physical, ecological and social environments at the project sites and along the entire route of water transmission line have been assessed, both for construction and operational phases of the project. This exercise was followed by prediction and evaluation of the most significant impacts.

After detailed evaluation of impacts, mitigation measures have been devised for all potential adverse impacts that could result from the proposed project activities. Mitigation measures have been developed for adverse impacts during construction and operational phases separately. Finally, an environmental management plan has been developed, incorporating the mitigation measures and monitoring requirements.

1.4 The ESIA Report

The ESIA report has been prepared by Bureau of Research, Testing and Consultation (BRTC), Bangladesh University of Engineering and Technology (BUET), Dhaka and presented following the structure suggested by the Department of Environment (DoE, 1997) with some modifications to suit the needs of the present study. The TOC and TOR of the study have been approved by DOE in the letter dated 12th January 2014 appended in Annex 12.1.

The first Chapter of this ESIA report describes the background and objectives of the project. It also presents an outline of the methodology followed for carrying out the ESIA. Chapter 2 describes the specific project activities to be carried out during both construction and operation phases of the project. Chapters 3, 4 and 5 describe the existing baseline physical environment, the ecological environment, and the socio-economic environment, respectively, along the route of the transmission line and its surrounding areas. Chapter 6 presents the outcome of the public consultations carried out as a part of the social and environmental assessment. Chapter 7 presents an assessment of the potential social and environmental impacts of the proposed project, during both construction and operation phases. This Chapter also presents an evaluation of the possible impacts and suggests mitigation measures for enhancement of positive impact and for reducing or eliminating the negative impacts. Chapter 8 presents analysis of alternatives, which includes analysis of both alternative sites (intake point, treatment plant), alternative routes and alternative technologies. Chapter 9 presents the Environmental Management Plan (EMP), including the monitoring plans, for both construction and operational phases. The final Chapter (Chapter 10) of the ESIA report presents the conclusions of the environmental study and recommendations based on the study.

2. Project Description

2.1 General Features Of The Project

The proposed water treatment plant project involves construction of intake structure and associated facilities (e.g., raw water lift pump and raw water transmission line) to draw water from Meghna River, construction of a surface water treatment plant and ancillary facilities at Saidabad, and construction of treated water transmission line. This Chapter provides brief descriptions of the major infrastructure to be constructed under the proposed project and their locations and routes.

2.1.1 Water Source

Both Saidabad Phase-I (225 MLD) and Phase-II (225 MLD) WTPs derive raw water from Sitalakhya River through the Sarulia intake. However, water quality of Sitalakhya River deteriorates significantly during the dry season, resulting in operational difficulties and rise in treatment costs. Preliminary comparison of Sitalakhya and Meghna Rivers water quality shows that Meghna River has a better water quality than Sitalakhya in terms of Dissolved Oxygen, Turbidity, Ammonia and Electrical Conductivity (EGIS-IWM, 2013). The Sitalakhya River does not comply with the water standard for raw water parameters set in the operator contract for Saidabad Phase-II in the dry season. An analysis of the dry season dependable flows near the proposed intake site at Haria shows that the maximum possible withdrawal (i.e. 950 MLD) amounts to about 6.25% of the 80% dependable flow (EGIS-IWM, 2013). Since the environmental requirement is 40% of the 80% dependable flow, sufficient quantity of water would be available for extraction. The water quality of Sitalakhya River during the wet season being of acceptable quality, the feasibility study for Saidabad Phase-III project suggested a joint operation with the Sarulia intake at Sitalakhya for the 2 existing Phases of Saidababdb during that period to meet the total demand of 950 MLD. (see Table 12)

Table 12: Water source selection depending on season (EGIS-IWM, 2013)

<table>
<tr><td></td><td></td><td colspan="3">Dry season (peak)</td><td></td><td></td><td colspan="3">Wet Season (peak)</td><td></td><td></td><td></td></tr>
<tr><td>Saidabad Phase</td><td>Maximum raw water flow (MLD)</td><td>January</td><td>February</td><td>March</td><td>April</td><td>May</td><td>June</td><td>July</td><td>August</td><td>September</td><td>October</td><td>November</td><td>December</td></tr>
<tr><td>I</td><td>237</td><td colspan="5" rowspan="2">Meghna river only or Meghna river and Lakhya river at the same time, provided that water mixture quality is acceptable (especially in January and April) and justified by economic analysis in terms of operation</td><td colspan="5" rowspan="2">Lakhya River as long as raw water quality allows it (5 months)</td><td colspan="2" rowspan="2">Meghna river</td></tr>
<tr><td>II</td><td>237</td></tr>
<tr><td>III</td><td>475</td><td colspan="12">Meghna river</td></tr>
</table>

2.1.2 Intake

Three locations were considered for the intake; these included Sarulia intake at Sitalakhya, Bisnondi and Haria at Meghna River. After careful comparison of these locations (see details in Feasibility Study Report and in Chapter 8.2 of this report), the Haria site, has been found to be most suitable for Saidabad WTP. Figure 2 shows the proposed layout of transmission pipelines along with the intake locations.

The water is expected to flow by gravity from the Haria intake up to pump sumps from where it will be pumped to water treatment facilities at Saidabad site. The raw water intake structure and various facilities will be designed to cater for the 100 year flood and dry season low levels in the Meghna watercourse. A pre-sedimentation chamber is proposed to settle large solid particles before pumping the collected water through the projected transmission system. Two screens will also be provided, one coarse screen at the intake inlet works and a fine screen at the inlet of pumping facilities.

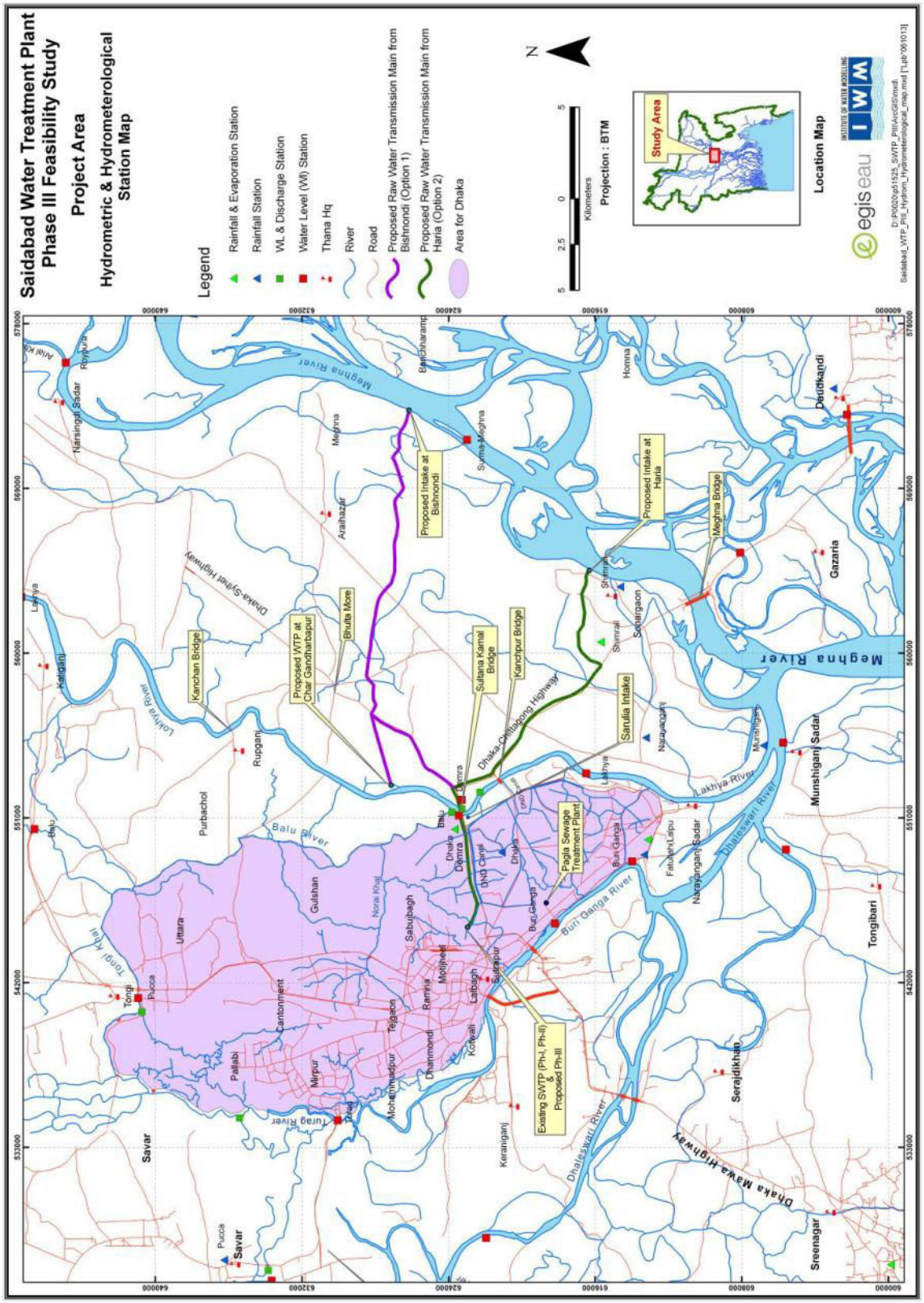


Figure 2: Project base map for Saidabad Phase-III WTP (EGIS-IWM, 2013)

2.1.3 Raw Water Transmission Pipeline

The transmission system will consist of two pipes with minimum diameter of 2,000 mm, or the nearest optimized size, to be installed in parallel in order to carry a total raw water flow in the range of 950 MLD. The gap of 50 MLD between raw and treated water flow corresponds to losses generated by the transport and treatment of raw water. The transmission system immediately after the intake and pumping facilities starts with 6 km of alignment over open areas from intake point to Dorikandi bus station, which is mainly constituted of paddy fields to the north of the Heritage Area of Sonargaon. Around 6 ha of land for transmission line and a 2 ha of land for intake PS need to be acquired. After Dorikandi bus station, the transmission pipeline follows a 13 km route along the Dhaka-Chittagong highway and the Dhaka-Sylhet highway until Tarabo Morh intersection where the transmission lines turn west to cross the Sitalakhya River. According to the latest information available regarding the upgrading of the existing Dhaka-Chittagong Highway, an additional 4-Lane Expressway is planned on the southern side of the existing Highway. For ensuring desired accessibility, the two parallel raw water transmission pipelines may be installed along the southern side of the proposed Expressway's right of way (Figure 3). In this segment no land acquisition would be required as the pipelines will be installed within lands owned by the Roads and Highways Department.

The twin pipelines will then follow a route parallel to the Dhaka-Narayanganj-Demra (DND) conveyance canal under the projected expansion of the Jatrabari-Demra road and along the existing twin culvert towards the treatment plant site at Saidabad. The existing two cell culvert (2m × 1.5m each) which conveys the raw water for Saidabad phase I and II will not be able to cater to the additional flow for Saidabad phase III. Therefore a single pipe would be constructed, and for this about 1 ha land needs to be acquired.

Wherever raw water transmission lines are running in parallel, interconnections with isolation valves will be provided to secure an uninterrupted raw water supply and an easy maintenance for the system. Clear space between pipelines will depend on land availability and costs. Such clearance will be of 1,000mm (minimum).

Along transmission line route from the intake to the treatment plant, crossing of two watercourses would be required: the old Brahmaputra River and the Sitalakhya River. Comparisons were made in the feasibility report regarding different methods of river crossing such as overhead crossing, trench laying method and Jacking or tunneling. The overhead crossing is the least advantageous option as it implies an additional pumping head at the raw water intake and some additional design restrictions for securing a minimum clearance between the maximum water level in the watercourse and the crossing structure. Moreover, the BIWTA (Bangladesh Inland Water Transport Authority) is not inclined to allow overhead crossings for navigable watercourses except in special cases such as bridges for highways. The pipe in trench crossing at river bottom will require additional protection measures against high velocity flow, scouring and erosion effects which may be difficult as scours are quite deep, unpredictable and prone to damage by shipping activities. Therefore, jacking or tunneling is being considered as a safe option, although it implies the use of special equipment which can make works more expensive in comparison with the trench laying option.

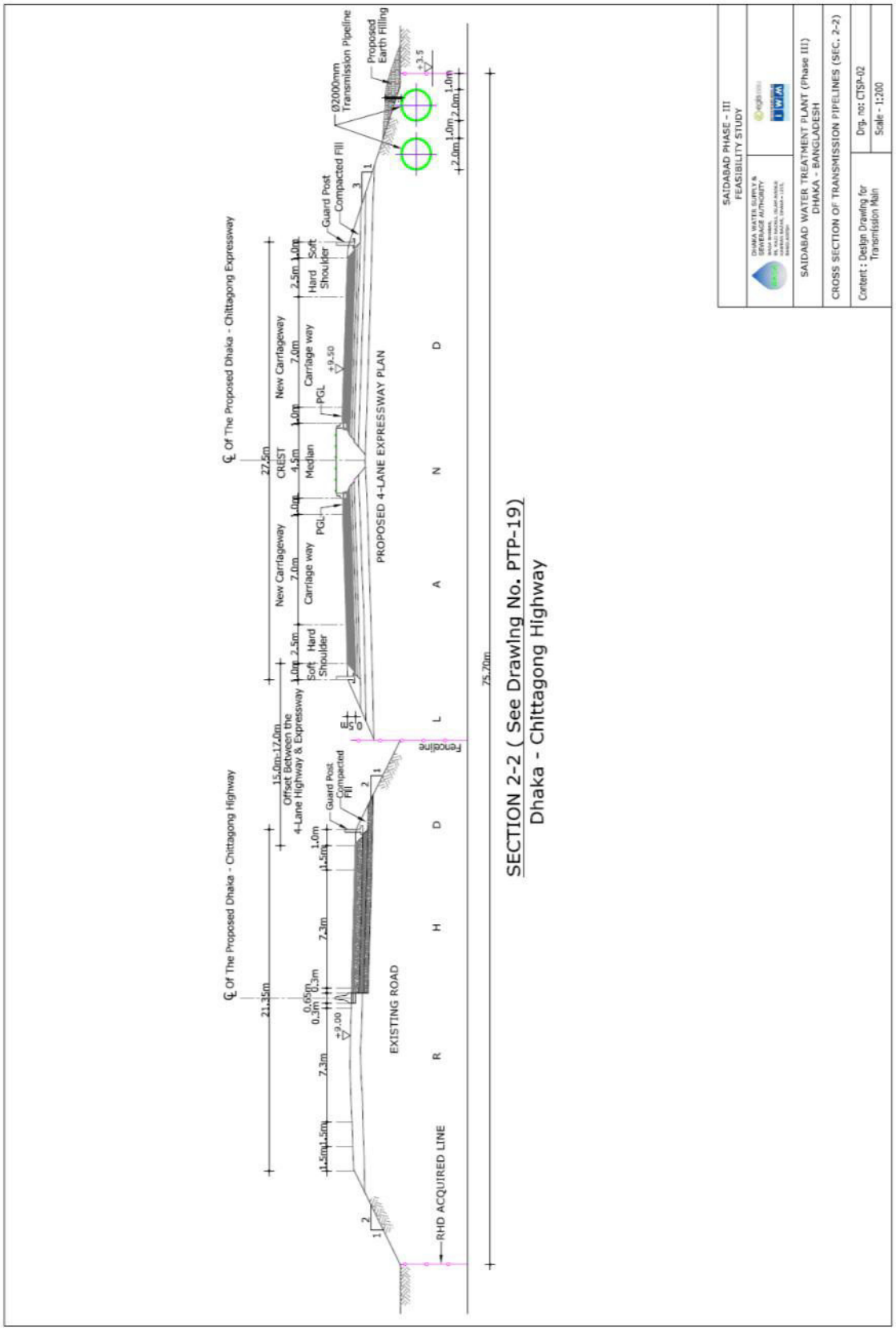


Figure 3: Cross sectional profile of the proposed raw water transmission mains along the Dhaka-Chittagong highway (EGIS-IWM, 2013)

2.1.4 Water Treatment Process

The feasibility study of water treatment process is in progress. However, by analyzing the wet season water quality of the Meghna River at the Haria intake location, it can be seen that turbidity, suspended solids, color, fecal coliform and total coliform are the parameters which needs to be removed from raw water to make it suitable for drinking. It is suggested that a coagulation-flocculation-sedimentation followed by rapid filtration and chlorination would be sufficient to bring the water quality to drinking water standards. A flowchart of the treatment process is shown in Figure 4. The water treatment plant will be located on the DWASA-owned vacant land adjacent to Saidabad Phases-I and II WTPw (Figure 5).

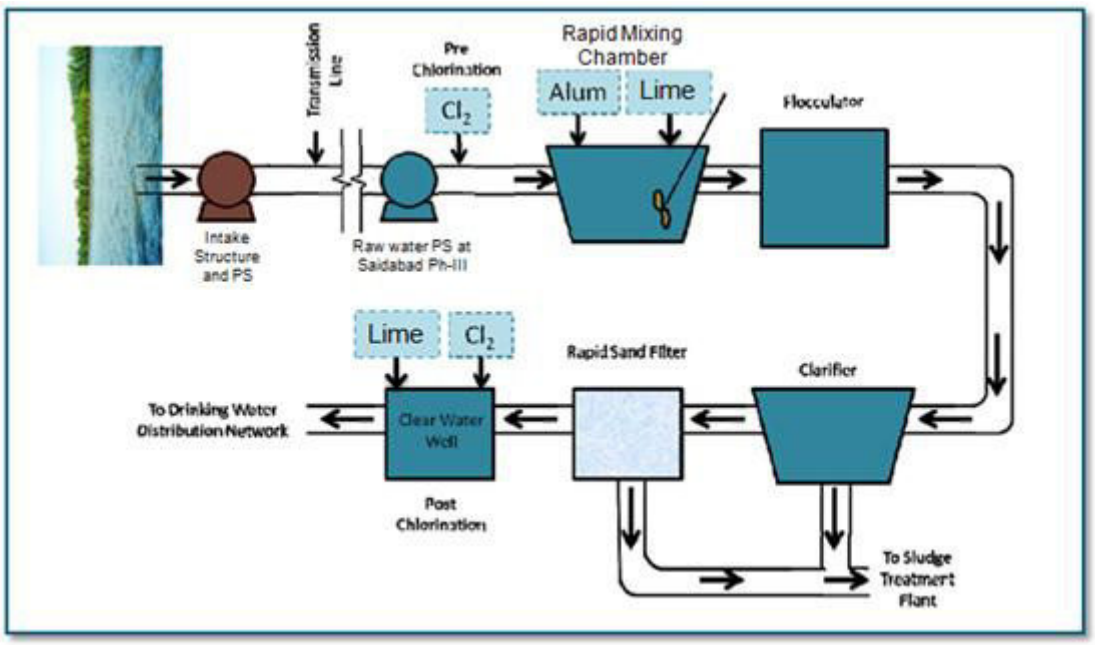


Figure 4: Treatment process flowchart for Saidabad phase-III

The results from the treatment process model study indicate that the breakpoint chlorination dose would be 1.5 – 4.5 mg/L for the wet season and 1.0 – 2.0 mg/L for the dry season. The alum dose requirement for coagulation-flocculation process was found to be 30 mg/L for both wet and dry seasons.

2.1.5 Sludge Management

The Saidabad Phase-III works include the construction of a mechanical dewatering sludge treatment unit that will replace the existing lagoons. Such a facility will free land for Saidabad Phase-III plant and reduce the sludge volume to be evacuated outside the plants. This new sludge treatment unit will be sized to cope with the sludge production of the 3 Phases of Saidabad WTP and will be designed for a total treated water flow of 900 MLD.

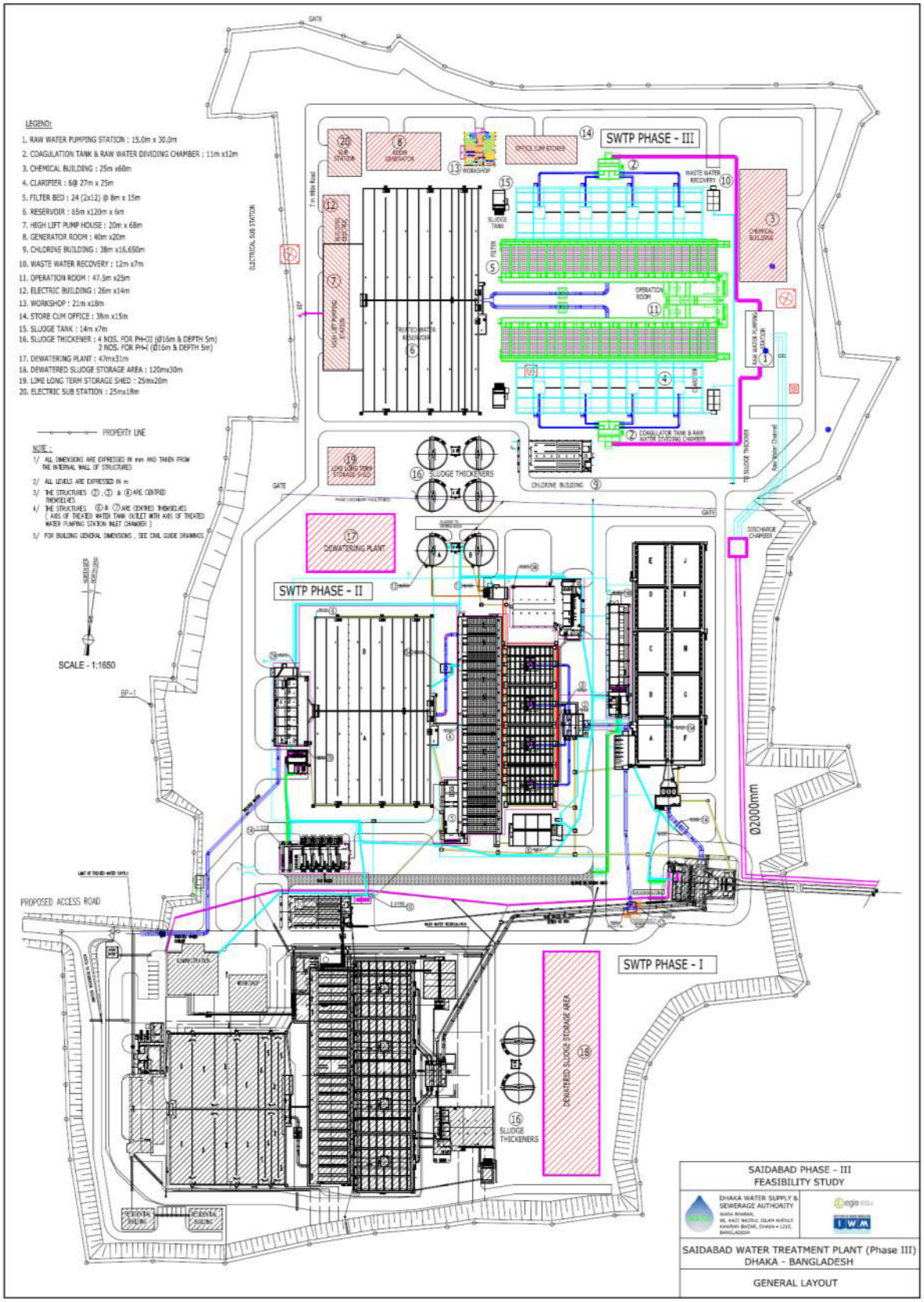


Figure 5: Proposed layout of Saidabad phase-III plant adjacent to the existing Saidabad phase I and Phase-II plants (EGIS-IWM, 2013)

Sludge treatment works will comprise:

- Sludge thickeners;
- Dewatering unit;
- Lime silos;
- Storage of dewatered sludge, if required.

Two Sludge thickeners are already used in Saidabad Phase-II. The proposed Saidabad Phase-III project will include such a layout. Moreover, Saidabad Phase-I plant will also have to be equipped with sludge thickeners for the purpose of sludge dewatering.

Therefore, 6 sludge thickeners will be necessary to treat sludge resulting from Saidabad Phase-I and Saidabad Phase-III operation. Filter press solution, which is the most effective in terms of final volume of sludge to be cleared out, would generate around 30,000 m3/ year of 30% dried sludge, which would be equivalent to around 10 trucks per day. A proposed layout of the water treatment plant for Saidabad Phase-III is shown in Figure 5.

2.1.6 Treated Water Transmission Line

The map in Figure 6 shows the injection point for Saidabad Phase-III WTP into the distribution network. The distribution network primary mains will cover new areas of Saidabad East region.

2.1.7 Existing Solid Waste Disposal Sites

Dhaka City Corporation maintains two landfills, namely Matuail landfill and Amin Bazar landfill, within their jurisdiction which can be envisaged as a potential site for final disposal of dried sludge. Matuail landfill site is around 4km and Amin Bazar landfill site is around 20 km away from Saidabad Water Treatment Plant area (Figure 7). The city of Dhaka recently expanded the capacity of the Matuail landfill and upgraded the site into a sanitary landfill with leachate collection and treatment facilities designed to clean the water that percolates out of the landfill, and a gas venting system. It also modernized operations through construction of a weigh bridge, a truck-scale to weight incoming waste; a carwash facility to avoid contamination of roads by vehicles leaving the landfill; and a waste compaction and monitoring facility. A Landfill Management Unit was created to monitor all activities at the landfills. Regular environmental monitoring is conducted to assess leachate, landfill gas, and surface water quality. Surveys also assess landfill impact on neighboring communities. Data collection at the weight bridge allows planners to adapt collection and transport plans to suit the city's needs. .

Matuail landfill could be one of the solutions for disposal of treated sludge. This solution could be studied by DWASA in collaboration with Dhaka City Corporation.
Also, it is recommended that DWASA consider the acquisition of land for temporary or permanent disposal of treated sludge.

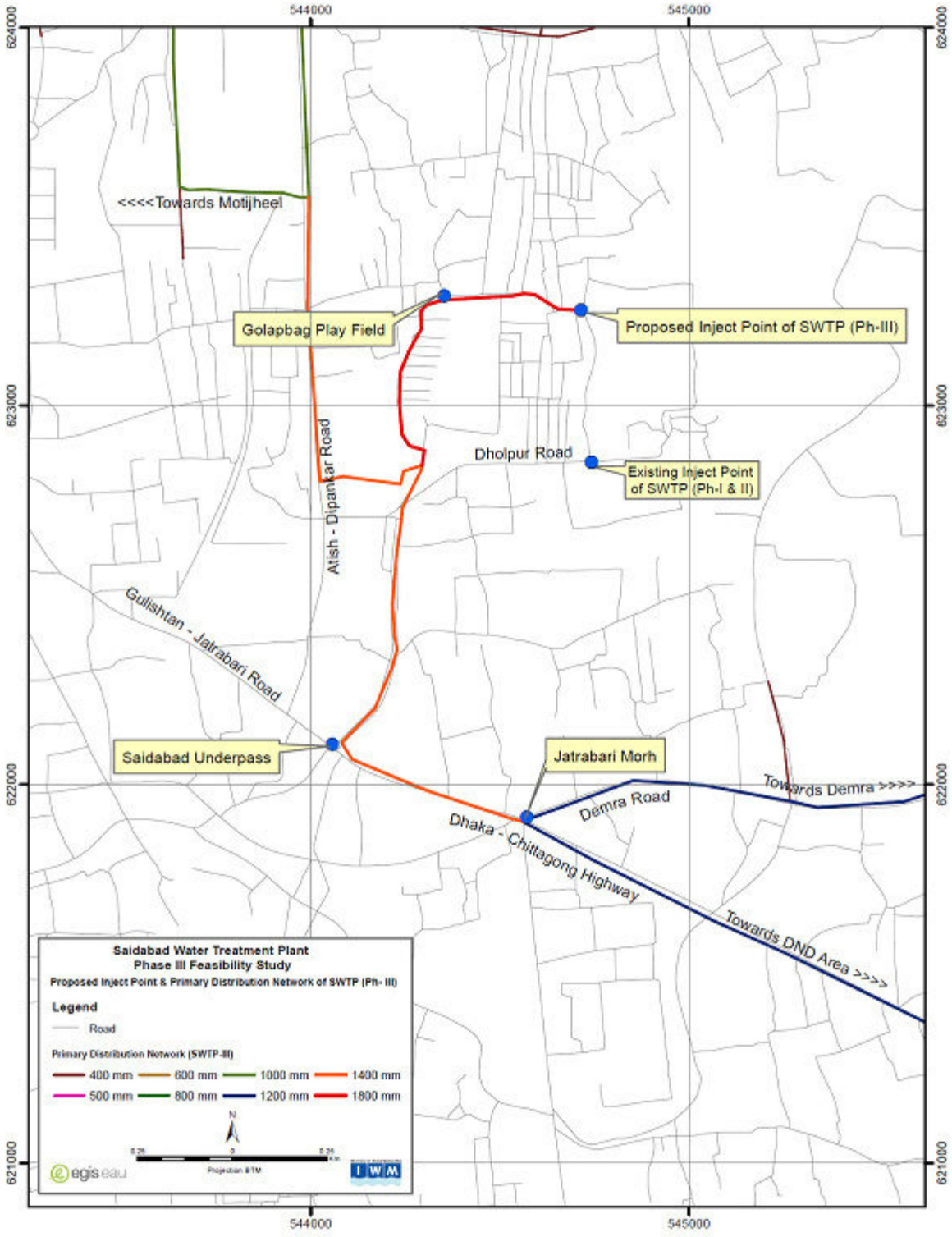


Figure 6: Injection point of Saidabad Phase-III in the distribution network (EGIS-IWM, 2013)

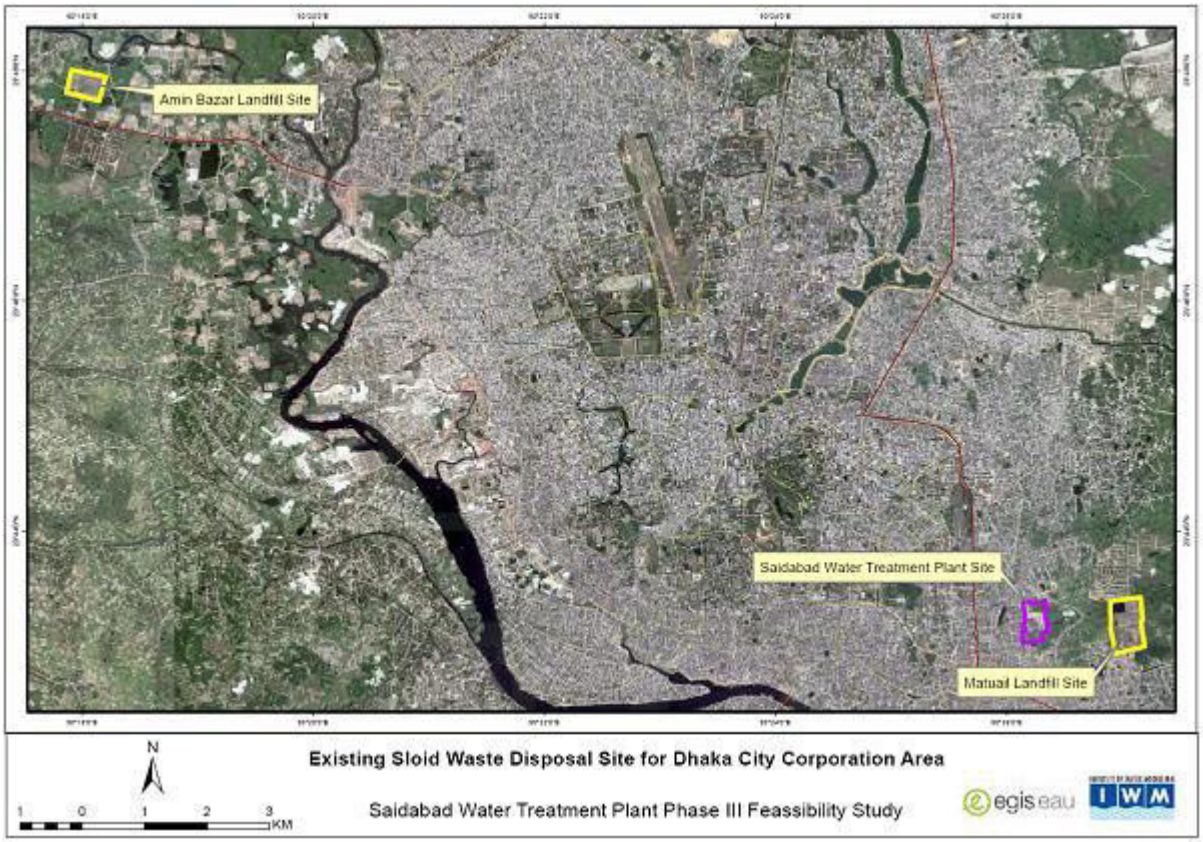


Figure 7: Location of landfill sites operated by Dhaka City Corporation

2.1.8 Primary Distribution Water Supply Network

The proposed project involves construction of water distribution network to carry the treated water of Saidabad Phase-III plant to consumers in Demra, Sabujbagh, Khilgaon, Shyampur and Narayanganj Sadar (DND) localities. Figure 8 shows the alignment of the proposed Primary Distribution Network. The details of the proposed routes are described below:

- From Saidabad Phase-III, a 1800mm diameter pipe will follow the road next to Maniknagar Government Primary School and will continue along the Maniknagar Link Road. The primary main will then be divided into two mains with 1400 mm before crossing point of Saidabad WASA road next to Golapbagh playground.
- One 1400mm diameter pipeline will follow the road next to Golapbagh play ground and will meet Atish Diponkar Raod near the CNG station. From the CNG station, this line will follow Atish Diponkar Raod and will divide into two 1000 mm pipelines at TT Para More. One 1000 mm pipe will follow the alignment of outer circular road. In front of Kamlapur Rail Station the line will be divided into two sub-mains. One will follow outer circular road and will be connected to existing 600mm diameter pipe at Shahjahanpur Circle, near Eastern boundary of Rajarbagh Police line. The second sub-main will follow the Kamlapur Road and will meet to inner circular road. This line will continue to run up to Kakrail Moshque. At Kakrail Moshque the diameter of the main will be reduced to 600mm. All these lines will distribute water to several distribution nodes.
- Another 1000mm diameter from TT Para More will follow Atish Diponkor Road and continue up to Basabo and then the line will follow Basabo-Madartek-Nandipara road. On way to Nandipara the water will be distributed to Khilgaon, Goran, Madartek, Banasree, and other adjacent areas.

- Another 1400 mm diameter pipeline will follow new Dholpur road and will continue up to Jatrabari Circle, where it will be divided into two sub-mains. One sub-main of dia 1200mm pipe will be laid along the Demra road and continue up to Demra Circle near Lakhya river. Near Demra circle the diameter of the pipe will be of 600mm. The other sub-main of dia 1200mm will follow Dhaka-Chittagong road and will continue up to Dhaka-Narayanganj Link road crossing. The diameter of the pipe at Dhaka-Narayanganj crossing will be reduced to 600mm. This line will distribute water to the adjacent areas through several distribution nodes.

Table 13: Primary Distribution Water Supply Network of Saidabad Phase-III

Diameter (mm)	Total Length (m)
400	21,123
500	9,162
600	11,425
800	4,752
1,000	6,573
1,200	5,490
1,400	2,380
1,800	884
Total	**61,789**

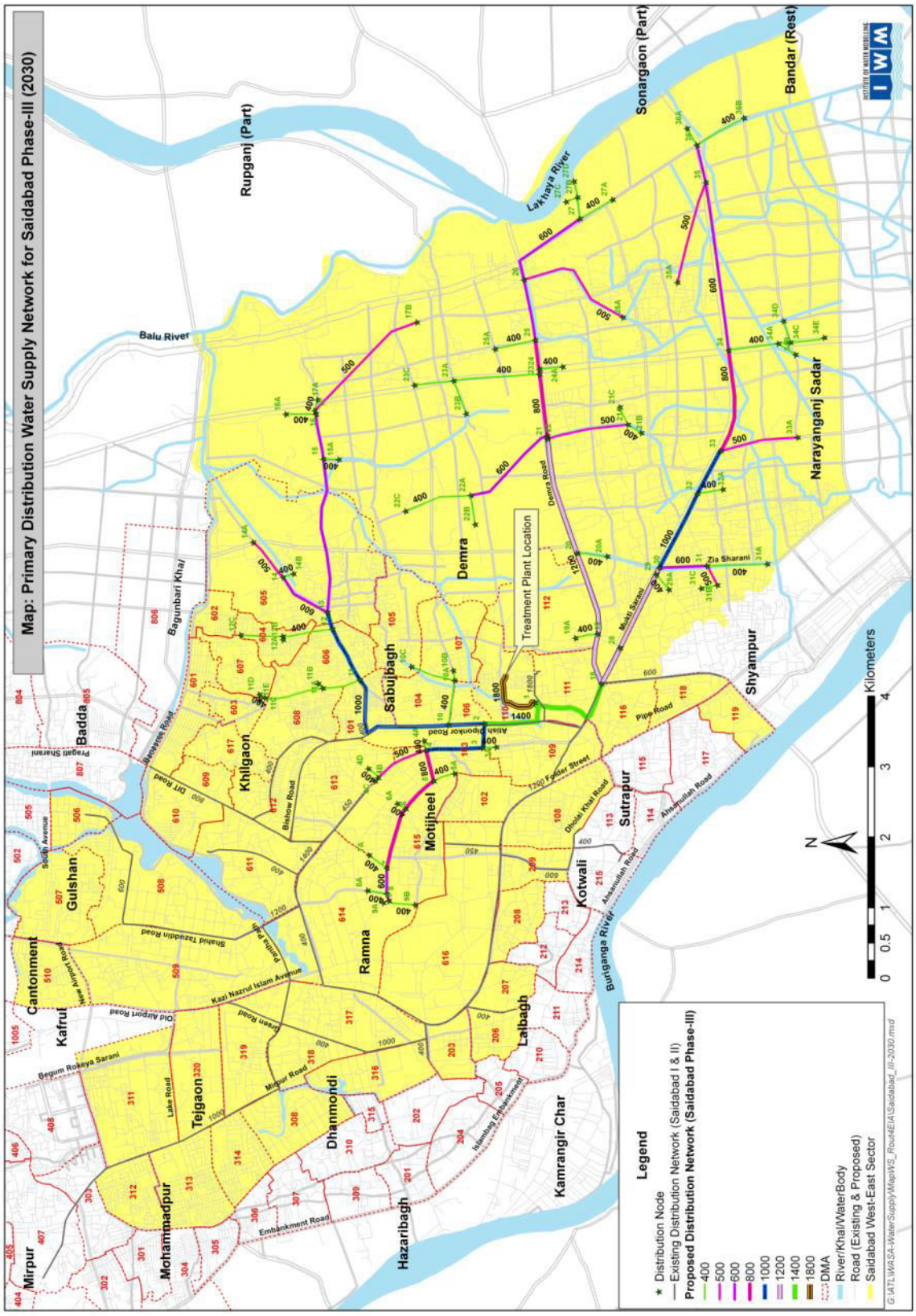


Figure 8: Primary Distribution Water Supply Network for Saidabad Phase-III (upto 2030)

2.2 Project Activities During Construction Phase

The major project activities during construction phase include the following:

- Acquisition of required land and getting permission from relevant organizations (e.g., RHD) for laying water transmission pipeline on land owned by them. The required land acquisition for the proposed project are as follows: (i) intake structure and 6 km raw water transmission line through open area up to Dorikandi bus station: ~8 ha and (ii) construction of additional box culvert/single water transmission pipeline from Demra highway extension to water treatment plant, ~ 1 ha; Thus, the total land area to be acquired for the proposed project is ~9 ha.
- Construction of intake channel, intake structure and associated facilities, and raw water pumping station.
- Construction of twin raw water transmission pipelines (minimum dia 2000 mm) from (i) Haria to Dorikandi bus stand (6 km) (ii) Dorikandi bus stand to Kanchpur bridge (~8.5 km) (iii) Kanchpur bridge circle to Sylhet circle (~2.2 km) (iv) Tarabo circle to Demra circle by crossing the Lakhya river near the upstream side of Sultana Kamal Bridge (~2.5 km) and (iv) from Demra circle along the proposed extension of Demra Highway upto the downstream end point of the DND conveyance canal near the existing twin box culvert.
- Construction of a box culvert (or a single minimum 2000 mm diameter water transmission pipe) from the end of the twin pipeline to the water treatment plant; construction of sluice gates and associated facilities.
- Construction of water treatment plant (WTP) including all treatment units and ancillary facilities (e.g., pre-chlorination unit, clarification units, rapid sand filter units, clear water reservoir, clear water pumping facilities, sludge thickening and dewatering facilities, administrative building, workshop building, generator room, guard room).
- Installation of water transmission lines (minimum 2000 mm diameter twin steel pipes) across 2 water bodies (Old Brahmaputra and Sitalakhya Rivers). Pipe jacking method has been proposed for the installation of water transmission lines across rivers. Pipe jacking is a technique for installing underground pipelines, ducts and culverts. Powerful hydraulic jacks are used to push specially designed pipes through the ground behind a shield at the same time as excavation is taking place within the shield. The method provides a flexible, structural, watertight, finished pipeline as the tunnel is excavated. Drives of several hundred meters either in a straight line or to a radius or a series of radii are readily achievable. A number of excavation systems are available including manual, mechanical and remote control. Pipes in the range 150mm to 3000mm, can be installed by employing the appropriate system.
- Installation of proposed Primary Distribution Network (about 62 km total), including finalization of pipeline alignment, excavation of trenches, preparation of pipe bedding (primarily gravel or crushed bricks), laying of pipe, placing of pipe-surrounding materials, backfilling of trenches (with excavated materials), construction of valve chambers, manholes, installation of washout thrust block arrangements, and other auxiliary facilities.

Major resources and utilities required during construction of the proposed project include:

- Fuel and Lubricants for the different equipment such as Excavator, Dump trucks, Tractors and pilling works etc.;
- Electricity for electrical equipment, which will be used for construction purposes such as base plants, vibrators, contractor site office, etc.

The proposed project is expected to be implemented from mid-2015 to 2018. The tentative schedule of implementation is presented below. The Contractors shall prepare a detailed implementation schedule. The phases stated below shall be broken down into relevant sub-tasks. At the beginning of each phase, the Contractor shall come into agreement with the Employer/Project Manager regarding all essential steps of the forthcoming phase.

Phase	Month																																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Contractor's Mobilization	X																																			
Design of the components of the works		X	X	X	X																															
Delivery of Materials						X	X	X	X	X	X	X																								
Implementation						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Completion of Work																																				X

2.3 Project Activities During Operational Phase

During the operational phase, DWASA will be responsible for the operation and maintenance of intake channel, intake structure, water treatment plant and the water transmission lines and distribution network. The important issues to be addressed during the operational phase include the following:

- Stability of river bank and intake channel;
- Availability of raw water;
- Raw water quality;
- Treated water quality;
- Proper operation of treatment plant;
- Public health and DWASA service facilities;
- Disposal of dewatered sludge;
- Safety of water distribution network;
- Disposal of additional volumes of wastewater that will be generated due to increased water supply in Dhaka city after completion of the project;
- Navigation in rivers and khals through which water transmission line has crossed; and
- Operation and maintenance of transmission and distribution pipelines.

During operational phase, power requirement for the project (intake and treatment plant) is approximately 11 MW. This will require laying additional electrical lines. Estimated yearly fuel requirement during operational phase is 1,320,000 L (440,000 L for water treatment plant, and 880,000 L for intake), and estimated yearly lubricant requirement during operational phase is 20,000 L (10,000 L for water treatment plant and 10,000 L for intake).

3. Baseline Environment: Physicochemical

3.1 Introduction

As a part of the environmental assessment of the proposed project (which has been carried out along with the feasibility study of the project), an environmental baseline survey has been carried out in areas surrounding the proposed locations of intake and water treatment plant, and along the route of the proposed water transmission and distribution lines.

The specific objectives of the baseline study were:

- To document the existing condition of physical and biological environment and prevailing socio-economic condition of the project areas;
- To identify the significant environmental and social aspects that are likely to be affected by the proposed project activities; and
- Setting of baseline parameters in order to identify possible adverse and beneficial impacts due to the proposed project activities.

This Chapter describes the baseline physical environment of project areas based on the findings of the baseline surveys. The descriptions of baseline ecological environment and baseline socio-economic environment have been presented in Chapter 4 and Chapter 5, respectively.

3.2 Physical Features Of The Study Area

3.2.1 Topographic Survey

As a part of the baseline survey, a topographic survey was carried out along the route of the proposed transmission line from the proposed intake location at Haria to water treatment plant site at Saidabad in Dhaka. For topographic survey, temporary bench marks (TBM) were established from National First Order BM Grid. Following establishment of bench mark (BM), locations of various features in the project areas, such as roads, drainage channels, water bodies, rivers, filling stations, electric poles, human settlement, and other permanent structures were recorded. The topographic survey was conducted utilizing satellite based RTK GPS instruments, high precision total stations, along with hand held GPS to locate the existing features in the project areas. The major activities performed are summarized below.

A temporary bench mark (TBM) network was established in a project area using the reference bench mark (BM) available in the proximity of the study area. TBM or Temporary control points were established at roughly 1 km interval within the project areas by conventional fly leveling. The position of each TBM was taken by DGPS.

Spot level survey was conducted along the entire route (about 24.69 km) of the proposed water transmission line from the raw water intake location at Haria up to the water treatment plant site at Saidabad. The survey was conducted using electronic total station. A major part of the route of the proposed transmission line runs along the existing roads (Dhaka-Chittagong and Dhaka-Sylhet highways), and spot levels were taken at 100 m intervals along the road covering 70 m on the eastern side of the road centerline (along which the water transmission line has been proposed to be laid).

Along the route of the proposed raw water transmission line, spot levels have been taken at 100 m interval over a 100 m wide strip. Across the pipeline alignment, spot levels have been taken at 5m interval on slope and at 10 m interval on flat land. At the proposed sites of water treatment plant and intake structure, spot levels have been taken at 20 m x 20 m grid spacing. Alignment survey of the proposed transmission line route(s) was carried out from the selected intake location to the probable locations for the construction of the SWTP. The survey was conducted using Pro-XR GPS with RECON data logger along the proposed trunk main line. During the survey, detailed information regarding features like land use, homestead and existing infrastructures were recorded in the data logger. Surveys for determining cross-sections of rivers have been carried out at 2 locations (Old Brahmaputra and Sitalakhya Rivers). Cross-sections were taken at 20 m intervals. Figure 9 shows the locations of the cross-sectional surveys along the route of the proposed transmission line from the intake at Haria to Saidabad WTP site.

Maps of the project areas have been developed from the survey data using ArcGIS software; the maps show all major features identified and recorded during the survey. Topographic maps of the proposed locations of intake structure, water treatment plant, and river crossings have been prepared. A sample alignment map from the intake at Haria to proposed WTP site at Saidabad is shown in Figure 10 and a topographic map of the proposed site for WTP at Saidabad is shown in Figure 11.

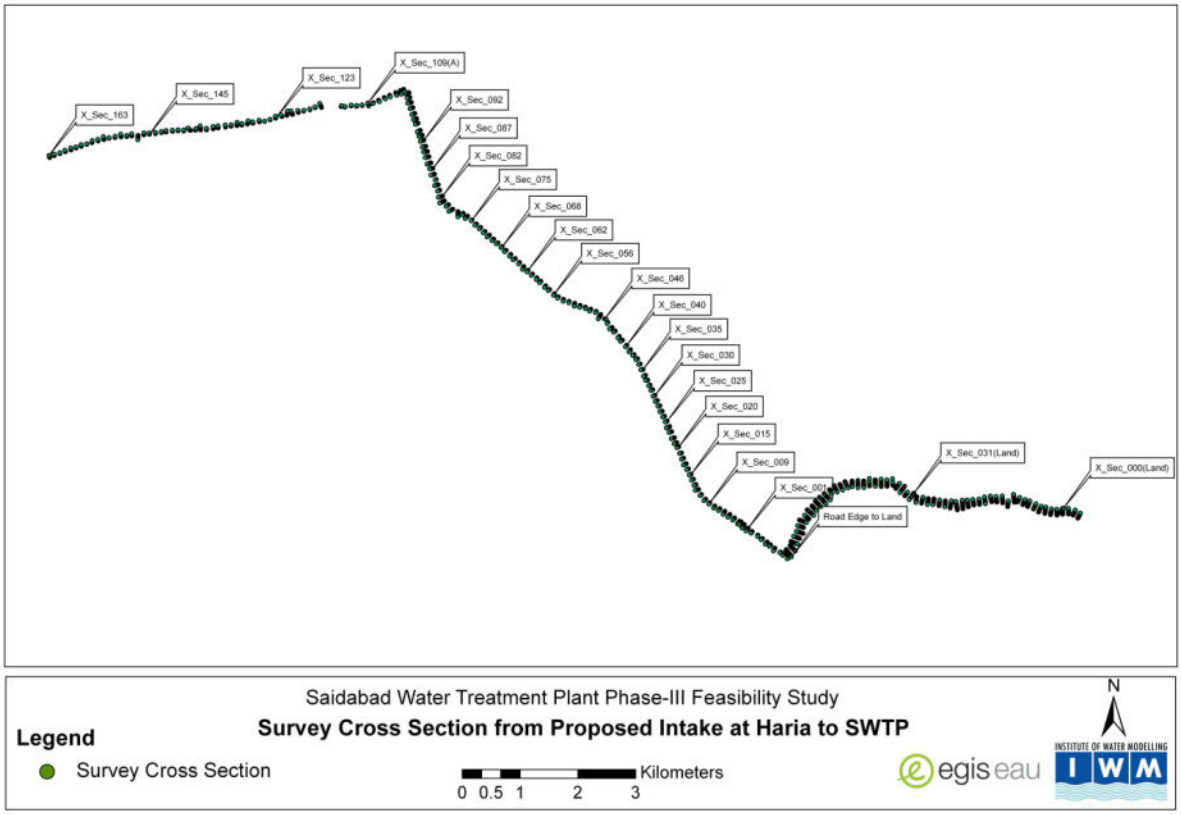


Figure 9: Cross-sectional survey locations from proposed intake at Haria to SWTP

3.2.1 Physical Features along Route of Water Transmission Line

Strip maps for the raw water transmission line from the intake point at Haria to Saidabad treatment plant site were prepared from the topographic survey as a part of the feasibility study. Physical features such as trees, electric poles, dumping stations, markets, passenger sheds, petrol pumps and CNG stations, building and homesteads, graveyard, mosques, ponds and other water bodies etc. within ~100 m wide strip along the proposed route of the raw water transmission line have been identified on the maps.

The proposed location of the pumping station at the bank of the Meghna river is a 100m x 200m land, which is currently not being used for any specific purpose. The first strip map near the intake location at the bank of the Meghna river is shown in Figure 10 which shows the proposed location of the intake and pumping station as well as different identified physical features. The full set of strip maps is available in the feasibility report.

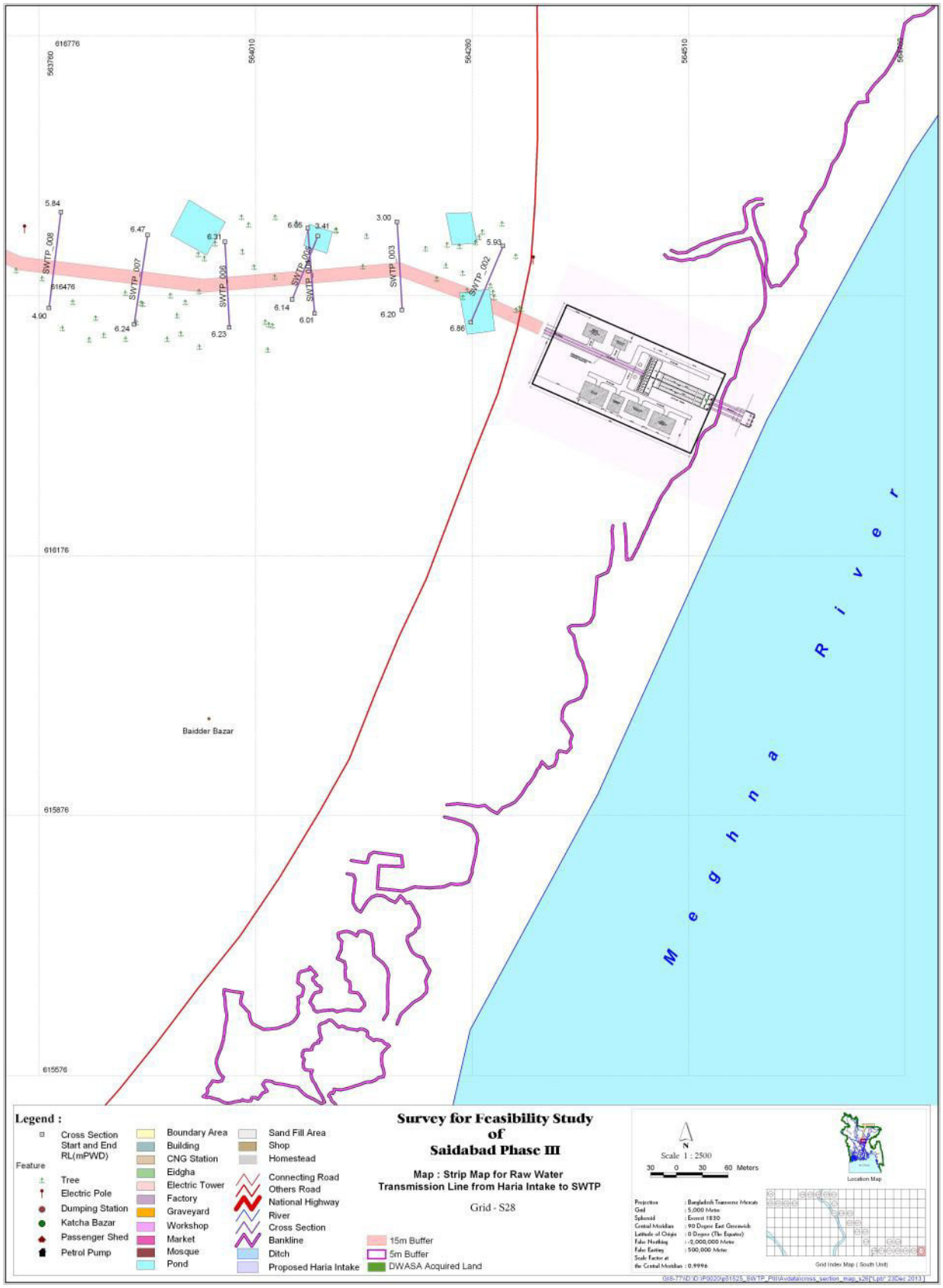


Figure 10: Strip map showing the location of the intake structure at Haria and part of the proposed route of the water transmission pipeline

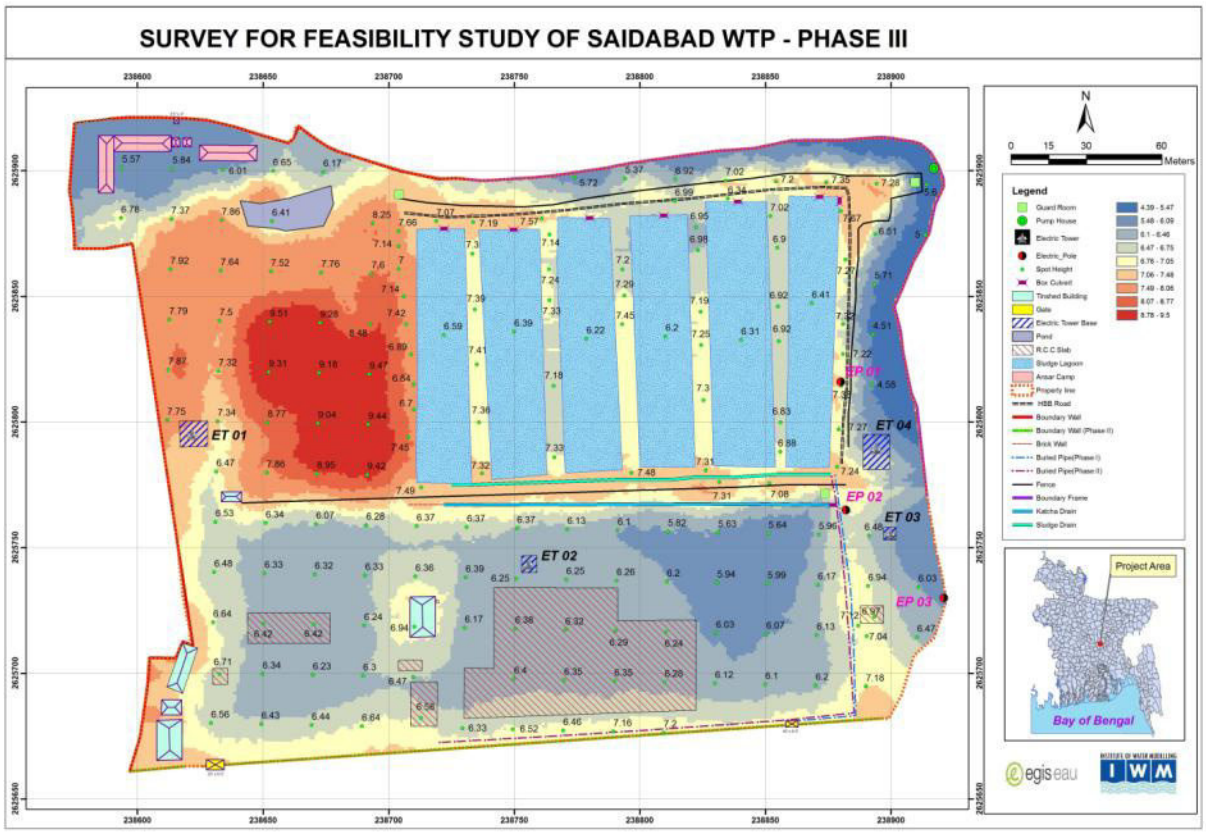


Figure 11: A topographic map of the proposed Saidabad WTP site. (EGIS-IWM, 2013)

The proposed 6 km route of the water transmission line from the intake location at Haria through the village area up to the Dorikandi bus station passes through a number of tin shed houses, homesteads, electrical poles, trees and ponds. The different physical features which could be directly or indirectly affected by construction works related to transmission lines along a ~100m wide strip of the proposed raw water transmission route are summarized in Table 14. Among these features 35 trees (17 litchi tree, 4 mango tree, 13 rain tree, 1 jackfruit tree), 1 tin-shed building, 6 homesteads, 4 electric poles and 2 ponds would have to be permanently removed as they are located directly on the proposed 6 km × 15 m strip of land to be acquired for the construction of transmission lines.

Along Dhaka-Chittagong road, Dhaka-Sylhet road, the twin water transmission pipeline has been proposed to be laid along the western side of the road. Along and around this proposed route, there are trees, electric poles, dumping stations, markets, passenger sheds, petrol pumps and CNG stations, buildings, shops, factories, markets, ponds and other water bodies (see Table 14). Within this stretch, the two raw water transmission pipelines in parallel may be installed along the southern side of the proposed 4-lane expressway's right of way in the roadside borrow pit, which is owned by the RHD (see Figure 3). Hence no land acquisition will be required; however, permission from the RHD will be required for laying the pipeline. From the Sylhet circle, the transmission pipe line will be laid along the proposed extension of the Demra-Jatrabari road up to the Mriddhabari Sluice gate, which is also the endpoint of the DND conveyance canal.

From this point one of the pipelines will be connected to the existing box culvert conveying the water to the Saidabad treatment plant while the other pipeline will continue parallel to the box culvert. Two workshops/ factories, 6 buildings, 1 electrical pole, 1 semi-pucca building and 1 semi-pucca shop needs to be permanently removed as they are located directly on the 5 m strip of land.

Table 14: Number of each physical feature within the proposed strip along the route of the proposed water transmission pipeline

	Intake area pumping station and 6km route of transmission line up to Dorikandi bus station (15 m strip)	Proposed route alongside Dhaka-Chittagong, Dhaka-Sylhet and Dhaka-Demra-Jatrabari road upto Mriddhabari sluice gate (along RHD land)	Proposed route beside existing twin culvert from Mriddhabari sluice gate to Saidabad WTP site (5 m strip)
Tree	224	40	
Electric Pole	4	414	1
Dumping Station		1	
Kacha Bazar		3	
Passenger Shed		11	
Petrol Pump		4	
Building	1	11	7
CNG Station		2	
Eidgha			
Electric Tower		1	
Factory		7	2
Graveyard			
Workshop			
Market		11	
Mosque			
Pond	2	105	
Sand Fill Area			
Shop		4	1
Homestead	6		
River		2	

3.2.2 Physical Features along Route of Water Distribution Line

The areas along the alignment of the proposed water supply distribution network have been divided into three zones as follows:

- Zone 1: 1000mm diameter pipeline will follow along the Maniknagar Road and will meet Atish Diponkar Raod. Near Mostafa Kamal Stadium the line will follow Kamlapur Road. In front of Kamlapur Rail Station the pipeline will be divided into two sub-mains. One will follow the outer circular road and will be connected to existing 600mm diameter pipe at Shahjahanpur Circle, near Eastern boundary of Rajarbagh Police Line. The second sub-main will follow the Kamlapur Road and will meet the inner circular road. This line will continue to run up to Kakrail Mosque. At Kakrail

Mosque the diameter of the main will be reduced to 600mm. This line will distribute water to several distribution nodes.

- Zone 2: 1400 mm diameter pipe will follow WASA road and meet with new Dholpur road, and will continue up to Jatrabari Circle. Here, it will be divided into two sub-mains. One sub-main of dia 1200mm pipeline will be laid along the Demra road and continue up to Demra Circle near Lakhya river. Near Demra circle the diameter of the pipe will be of 500mm. The other sub-main of dia 1200mm will follow Dhaka-Chittagong road and will continue up to Dhaka-Narayanganj crossing. The diameter of the pipe at Dhaka-Narayanganj crossing will be reduced to 600mm. This line will distribute water to the adjacent areas through several distribution nodes.
- Zone 3: 1000mm diameter pipe will follow WASA road and continue up to Basabo and then the line will follow Basabo-Madartek-Nandipara road. On way to Nandipara, the water will be distributed to Khilgaon, Goran, Madartek, Banasree other adjacent areas through several distribution nodes. The diameter of the last end of the main will be of 500mm.

Salient features of project influence areas along the route of the distribution line are summarized in Table 15.

Table 15: Summary of important features along the route of the distribution line

Sl. No.	Parameter	Description	
1	Ecologically Critical Area	No Ecologically critical areas were found	
	Reserve/Protected Forests	No reserve or protected forests area were found	
2	Predominant Geological Formations	Dhaka is situated at the southern tip of a Pleistocene terrace of the Madhupur Tract. Two characteristic geological units cover the city and surroundings, the Madhupur clay of the Pleistocence age and alluvial deposits of recent age.	
	Topography	Most of the area has an elevation of four to six meters. The highest elevation was observed in the northern part of the area. The lowest elevation was observed in the western part along the side of the Balu River.	
	Major Physiographic Units	The area falls into Physiographic unit of Madhupur Tract. It comprises central part of Dhaka the course of Brahmaputra – Jamuna Floodplain.	
	Major Soil Type	The soil in general belongs to a Pleistocene terrace consisting mainly of red colored and mottled clays. Soils in the valleys are dark grey heavy clays. They are strongly acidic in reaction with low status of organic matter, low moisture holding capacity and low fertility level.	
3	Principal crops	Like other cities of Bangladesh, agriculture is important in parts of urban fringe of the Dhaka city. Rice is the most important crop. Wheat and potatoes are also important. Others agricultural products include fruits, in particular mango, banana and pineapple.	
4	Major Water Bodies	Zone-1	Shegunbagicha Khal
		Zone-2	Dholai Khal, Zirani-Nandipara

Sl. No.	Parameter	Description	
			khal, Manda Khal, DND Khal, Balu River, Lakhya River
		Zone -3	Khilgoan-basaboo khal, Zirani khal, Balu River, Lakhya River
5	Flooding	The area is more prone to flood than the other area of Dhaka city. The area is generally flooded by the ingress from the backwater flow of the Dhaleswari, Meghna Rivers, Shitalakhya and Balu Rivers.	
6	Seismicity	The project area falls in the earthquake Zone-2 of the seismic map of Bangladesh. This zone refers medium intensity of seismic effects.	
7	Environmental Hotspots	Zone-1	School (11 nos.), Madrasha (10 nos.), College (5 nos.), University (2 nos.) Baitul Mokarram Masjid, Mosque (51 nos.) Hospital (48 nos.), Park/open space, Temple/Church (2 nos.), Bank Branch (7 nos.)fire station, Post office and police out post etc.
		Zone-2	Schools (31 nos.), Colleges (7 nos.), Madrasha (11 nos.), Grave yard, play ground, Parks, Club and post office etc.
		Zone-3	School & College (50 nos.), University (1 no.), Madrasha (12 nos.), Hospital/ clinic (98 nos.), Mosque (100 nos.), Temple/Church (5 nos.), Graveyard, Post office (1 no.) and Police out post (6 nos.) etc.
8	Major Settlement	Zone-1, Zone-2, Zone-3,	Residential area, Commercial area, Slums and Squatters, Bus terminals, Institutional etc.
9	Major Industries/ Business Entrepreneurs	Zone-1 Zone-2 Zone-3	Textile Mill, Steel Mill, Paint Industry, Food Processing Industry, Re-rolling mill, Tube mill, Agro-Engineering Industry, Metal Industry and Garments Industry, Few workshop, carpenter store, small milling etc.

3.3 Physicochemical Environment

3.3.1 Climate

Bangladesh is located at the central part within the Asiatic monsoon region where the climate is tropical. Relatively small size of the country and generally low-lying area cause moderate spatial variation of temperature, precipitation, relative humidity, wind speeds and other climatic variables. However, the climate of Bangladesh exhibits pronounced temporal variability. This is because of the moisture-laden monsoon winds flowing predominantly from the south-west during summer and the comparatively dry and colder north-western winds during winter.

Three seasons are generally recognized: a hot, muggy summer from March to June; a hot, humid and rainy monsoon season from June to November during which more than 85% of the total annual rainfall occurs; and a moderately cold, dry winter from December to February. The beginning of the rainy season vary from year to year; heavy rains may commence anywhere between mid-April and early June and may end anywhere between the end of September and mid-November. Usually winter season is dry with occasional rains. The early summer season is considered from March-April. During summer, the air becomes hot with very low humidity. Early summer is also dominated by Baishakhi cyclone and rains.

The Bangladesh Meteorological Department monitors different climatic variables from 35 stations in Bangladesh. Among them, the Agargaon station at Dhaka appears to be the closest to the project site and therefore, the meteorological parameters recorded at this station can be used to represent the general climate of the study area. Table 16 summarizes the different meteorological data monitored during the period 2001-2012.

Table 16: Monthly averages of climatic variables at the Dhaka BMD Station, 2001-2012

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	5	14	29	111	212	326	350	290	316	155	19	11
Mean Temp (°C)	18.0	21.9	26.0	28.1	28.5	28.4	28.3	28.5	28.2	27.1	23.7	19.9
Max Temp (°C)	28.3	32.3	36.0	36.7	36.5	35.7	34.8	34.8	35.0	34.8	32.3	29.2
Min Temp (°C)	10.1	12.4	16.5	19.3	20.6	22.7	23.9	24.0	23.7	20.6	15.8	11.8
Humidity (%)	69	60	59	68	72	80	81	80	80	76	70	71
Sunshine Hours	5.7	7.3	7.5	7.7	6.8	3.4	4.0	4.5	4.2	5.7	6.8	5.8
Solar Radiation ($Cal/cm^2/min$)	166	207	231	244	229	175	189	192	172	183	174	146
Evaporation (mm/d)	2.6	4.0	5.0	5.5	5.3	4.1	3.8	3.8	3.6	3.5	3.3	2.5

Source: Bangladesh Meteorological Department

Precipitation

The general pattern of precipitation (which consists entirely of rain) follows the monsoon pattern with the cooler, drier months of November to March, increasing rains in April and May, and highest rainfall in the summer months of June to September when the prevailing wind direction from the southwest brings moisture-laden air from the Bay of Bengal. The winter period (November to February) is dry with very little rainfall. Even though the temporal pattern of rainfall is pretty much similar throughout the country, there is pronounced spatial variation of rainfall over the country with the northeastern and southeastern part of the country receiving relatively higher amount of rainfall compared to the western part. The project area receives around 2500 mm rainfall annually (Figure 12), which is close to the average annual rainfall of the country.

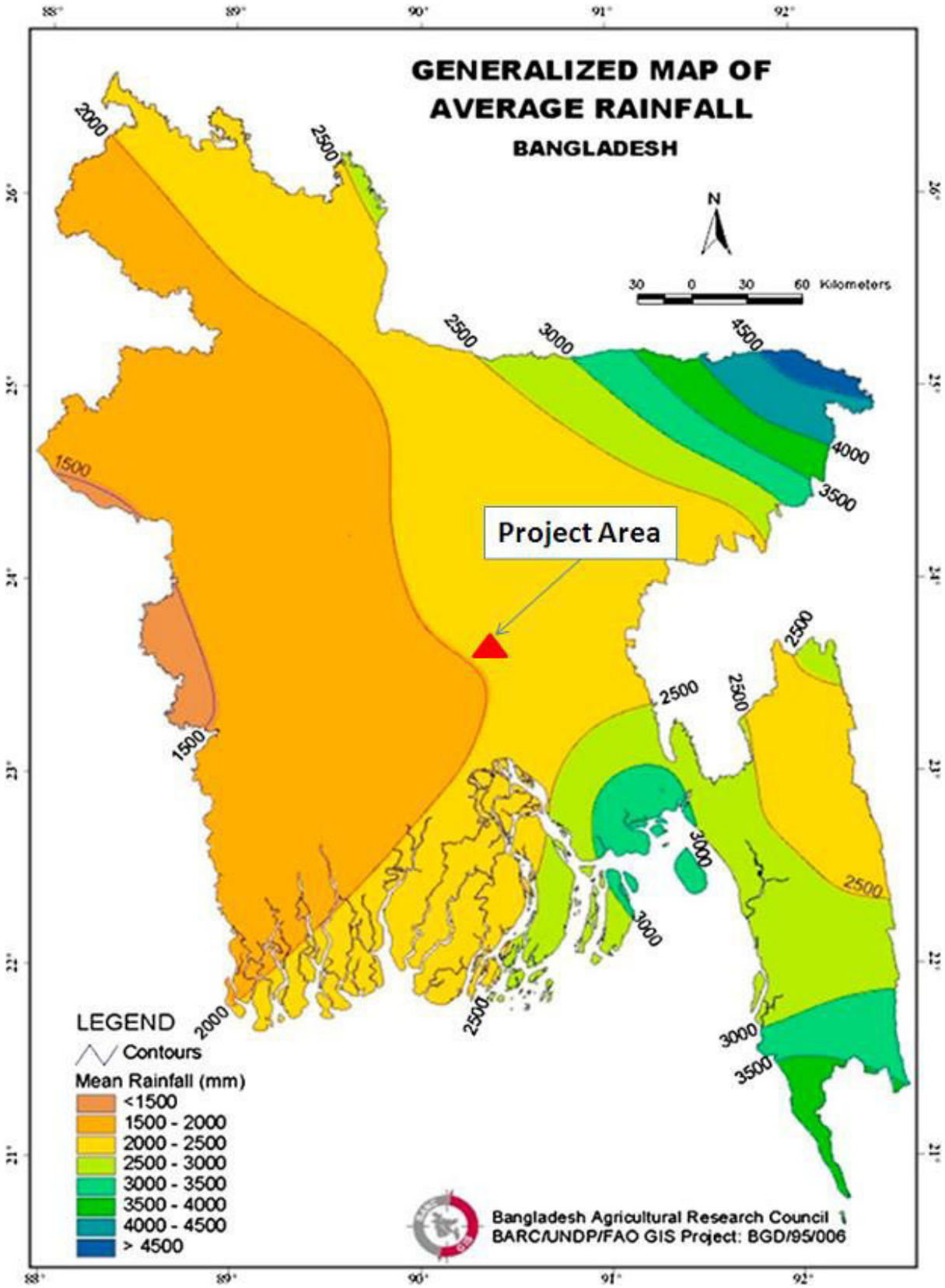


Figure 12: The location of the study area on the rainfall map of Bangladesh (map source: www.banglapedia.org

Relative Humidity

The spatial and temporal variation of Relative Humidity throughout the year is very low in Bangladesh. In the project area, the relative humidity varies from 69% to 80%.

Ambient Air Temperature

The temperature of the country is related to the period of rainfall. In general, cool seasons coincide with the period of lowest rainfall. Table 16 shows the monthly average mean, maximum and minimum temperature of the study area. Maximum average temperature over the year is usually observed in April - August and minimum average temperature in January.

Solar Radiation and Evaporation

The average incident solar radiation is comparatively higher during the period between February to May than the other months of the year. Consequently the amount of evaporation is also higher during that period.

3.3.2 Geology and Seismicity

Geology of Bangladesh is generally dominated by poorly consolidated sediments deposit over the past 10,000 to 15,000 years (Holocene age). It is mostly characterized by the rapid subsidence and filling of a basin in which a huge thickness of deltaic sediments were deposited as a mega-delta outbuilt and progressed towards the south. The delta building is still continuing in the present Bay of Bengal and a broad fluvial front of the Ganges-Brahmaputra-Meghna river system gradually follows it from behind.

Soil Characteristics

The soil formation in Bangladesh is remarkably homogeneous in appearance, both vertically and laterally. It comprises layer of unconsolidated clay, about 10m thick near Dhaka, but apparently thinner to the east and possibly much thicker in the west of the Rajshahi district. The sand mineralogy in this area is broadly similar to that of the tertiary hill sediments. Mineral contents of the soil are high in quartz, relatively low in feldspar and mica, and with zircon, tourmaline, kyanite, staurolite, sillimanite, and epidote dominating the heavy mineral fractions. The content of easily weatherable minerals ranges from 4 to 9%. The soil of Bangladesh can broadly be classified into seven tracts: (1) Madhupur Tract or Red Soil Tract, (2) Barind Tract, (3) Tista Silt, (4) Brahmaputra Alluvium, (5) Gangetic Alluvium, (6) Coastal Saline Tract, and (7) Hill Tracts. Figure 13 shows the location of the project area on the soil tract map of Bangladesh. The soil formation of the SWTP phase-III project area falls under the Brahmaputra floodplain. The dominant soil texture is sandy loam. The soils are acidic in character and the pH ranges from 5.5 to 6.8. The soils are naturally fertile and are recharged every year by fresh deposition by the floodwaters.

Seismicity

In the north and northeast of Bangladesh, there are areas of high seismic activity and some of the major earthquakes originating in these areas have affected the adjacent regions of the country. The whole of Bangladesh is divided into three seismic zones. The northern part of the country that includes the greater districts of Rangpur, Mymensingh, and Sylhet are in the Zone-I where earthquake shock of maximum intensity of IX of the Modified Mercalli Scale is possible. The Zone-II includes the

greater districts of Dinajpur, Bogra, Dhaka and Chittagong and the shocks of intensity of VIII are possible. The southern part of the country, the least active region, where the maximum intensity is not likely to exceed VII, is in the Zone-III. The SWTP project area falls under Zone II on the earthquake zone map (Figure 13), which implies that earthquakes of moderate intensities are expected here.

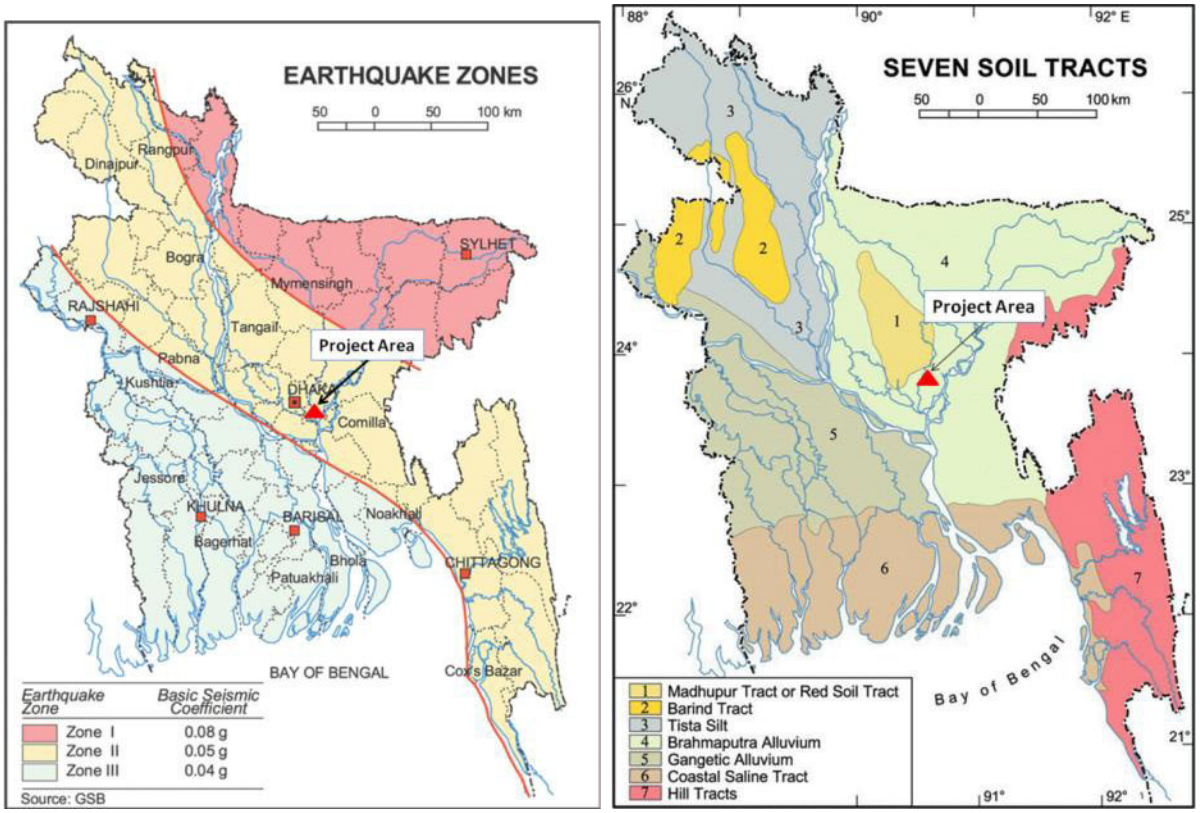


Figure 13: The location of the SWTP Phase-III project area on the seismic map (left) and soil tract map (right) of Bangladesh (map source: www.banglapedia.org)

3.3.3 Soil Quality

To assess the heavy metal contents of the natural soil in the project areas, several soil samples were collected from 3 locations (see Table 17 and Figure 14 for sampling locations) from about 0.15 m depth below the top of the original soil layer, using a split spoon. A total extraction of heavy metal from soil samples following the USEPA guidelines has been performed to determine the selected heavy metal contents and the results are presented in Table 18, along with the typical concentrations of different heavy metals usually found in natural soils. It can be seen that the heavy metal contents of soil are within usual limits of such metals found in natural soil. Lead concentrations have been found to be slightly higher than the average value especially near the Dhaka-Chittagong and Demra-Jatrabari roads. This probably indicates higher particulate matter pollution in these areas from vehicles. Also the sediment quality of the Old Brahmaputra and Sitalakhya rivers were also assessed at transects near the river-crossing locations. It can be seen from Table 18 that the heavy metal concentrations in the sediments are not significantly different from those of the soil samples.

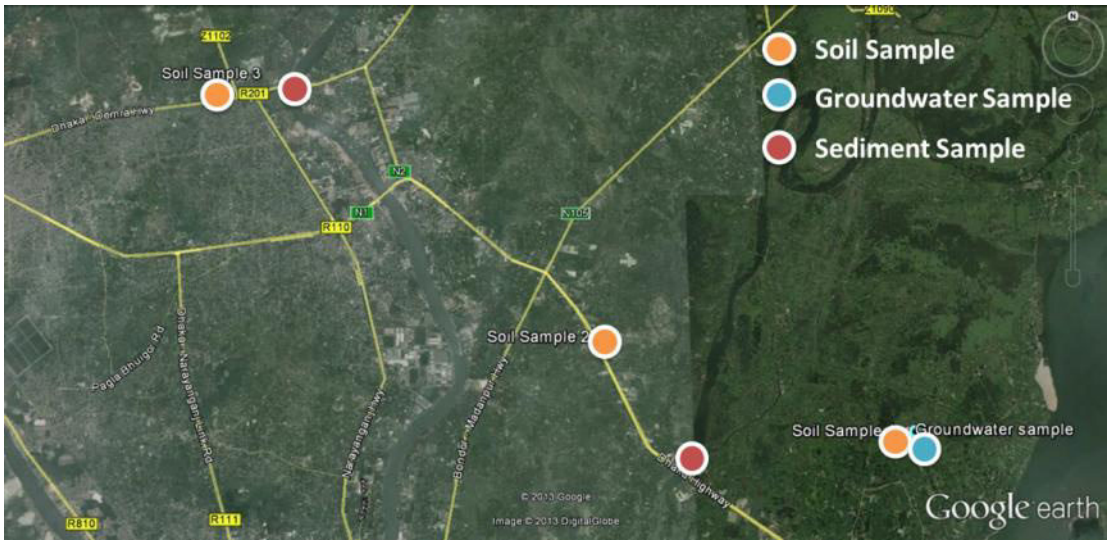


Figure 14: Map showing soil, sediment and groundwater sampling locations

Table 17: Geo-coordinates of three soil and two sediment sampling locations were collected along the proposed raw water transmission route for SWTP Phase –III Project

Sample ID	GPS Location (dd mm ss)		
	Longitude	Latitude	Location
SS1	90 36 36.0	23 39 42.2	Billia Dige (within the 6 km segment of pipeline route from the intake location, within the village area)
SS2	90 33 24.0	23 40 36.2	Jangal Bus Stand (within Dhaka-Chittagong highway)
SS3	90 29 12.7	23 43 07.9	Dallia (within Demra-Jatrabari road)
SD1	90 34 29.6	23 39 29.6	Old Brahmaputra river sediment
SD2	90 31 4.6	23 42 9.52	Sitalakhya River sediment

Table 18: Heavy metal content of the soil and sediment samples collected from three locations along the proposed raw water transmission route for SWTP Phase –III Project

Sl. No	Parameters	Unit	Concentration Present					Typical content in natural soil[a]
			SS1	SS2	SS3	SD1	SD2	
1	Lead, Pb	mg/kg	35.8	52.4	88.4	47.6	54.5	2 – 200 (avg 10)
2	Cadmium, Cd	mg/kg	0.2	0	1.2	0	0.2	0.1 – 0.7 (avg 0.6)
3	Chromium, Cr	mg/kg	39.1	43.6	33	29.9	43.4	1 – 1000 (avg 100)
4	Nickel, Ni	mg/kg	32.3	41	21.7	31.4	33.2	-
5	Iron, Fe	mg/kg	26548	28885	21941	-	-	-
6	Copper, Cu	mg/kg	17.9	41	21.7	20.7	47.1	2 – 100 (avg 30)

[a] *USEPA Office of Solid Waste & Emergency Response, Hazardous WasteLand Treatment, SW-874 (April 1983, Page 273)*

The sludge drying beds, which are used to dewater the sludge generated from Saidabad Phases-I and II and currently exist in the proposed site for WTP for Saidabad Phase-III, will be removed during construction of the proposed Phase-III treatment plant. Therefore, it would be important to monitor the quality of the excavated material. Table 19 provides an analysis of selected heavy metals (applying total extraction technique) from a sample collected from the sludge drying beds. As expected, the sample was found to be rich in Aluminum, while all other metal constituents were found to be within usual limits of such metals found in natural soil.

Table 19: Selected heavy metal contents of the settled sludge from the existing sludge drying beds inside the proposed WTP site

Sl. No	Parameters	Unit	Concentration Present
1	Lead, Pb	mg/kg	47.9
2	Cadmium, Cd	mg/kg	0
3	Chromium, Cr	mg/kg	28.8
4	Zinc, Zn	mg/kg	149.8
5	Aluminum, Al	mg/kg	75100
6	Copper, Cu	mg/kg	55.5
7	Mercury, Hg	mg/kg	2.8
8	Arsenic, As	mg/kg	43.8

3.3.4 Water Quality

As a part of the baseline survey, efforts were made to collect available information on surface water and groundwater quality in and around the project areas. A groundwater sample was collected from a handpump tubewell in the village area (GPS N 23° 39' 43.0" and E 90° 36' 39.4", see Figure 14) near the 6 km segment of the proposed transmission line from the Haria intake. Table 20 shows results of groundwater quality analysis. The groundwater quality has been found to be very good with all drinking water parameters satisfying the Bangladesh Standards.

Table 20: Summary characteristics of groundwater near the project area

Water Quality Parameters	Unit	Concentration Present	WHO Guide line values 2004	Bangladesh Standard for Drinking Water (ECR'97)
pH	-	6.97	6.5 - 8.5	6.5 - 8.5
Turbidity	NTU	0.62	5	10
Color	Pt. Co Unit	7	15	15
Total Hardness as $CaCO_3$	mg/L	206	500	200 - 500
Iron, Fe	mg/L	0.06	0.3	0.3 - 1.0
Manganese, Mn	mg/L	1.63	0.5	0.1
Arsenic, As	µg/L	5.87	10	50
Chloride, Cl^-	mg/L	71	250	150 - 600
Total Dissolved Solids, TDS	mg/L	347	1000	1000
Total Coliform, TC	# / 100 ml	0	00 TC / 100 ml	00 TC / 100 ml
Fecal Coliform, FC	# / 100 ml	0	00 FC / 100 ml	00 FC / 100 ml

Source water quality of Meghna river is periodically being assessed as part of the feasibility study and for the purpose of treatment process model studies. So far three batches of water samples were collected from the Meghna River at Haria intake, Sonargaon, Narayanganj on 13th July, 24th August and 28th September, 2013 which were used for batch experiments in the laboratory for development of treatment processes. The water quality characteristics of these samples provide the baseline water quality at the intake point of the proposed WTP. Sampling location was about 100 - 150 ft from the river bank water line. Sampling was done from about one meter below the water surface to avoid the presence of floating impurities. Separate sampling bottles and containers were used for water samples for physical and chemical water quality analysis, bacteriological water quality analysis, metal concentration analysis (acidified sample using HNO3 acid), and process model studies. During each sampling, in-situ measurements were done for the dissolved oxygen, pH, temperature and turbidity of the water sample. Detailed laboratory analysis has been conducted on the three collected water samples to determine the water quality. The results of the in-situ and laboratory analysis of the three samples are presented in Table 21 along with Bangladesh Drinking Water Standard and inland water quality standard (ECR' 97).

For the first sample, the apparent color, fecal coliform, total coliform, total suspended solids, COD and BOD concentrations exceed the Bangladesh Drinking Water Standard. For the second sample, these parameters and in addition, the true color and turbidity do not satisfy the Standard. For the third sample, color (apparent), turbidity, iron, total coliform, fecal coliform, total suspended solids, COD and BOD concentrations exceed the Bangladesh Drinking Water Standard. As expected, the surface water samples have been found to contain high concentrations of both TC and FC, common for most surface waters in Bangladesh. Considering the usability of water as a source for water supply after conventional treatment, the river water quality satisfies the criteria as per Bangladesh standards for inland water quality as per ECR 1997. It needs to be mentioned that the samples were collected in the wet season when the water quality of surface water sources are not the most critical. Additional sampling during the dry season would be required to assess the worst possible condition in terms of water quality.

Oil and grease content of the river water sample collected during the third batch of sampling was found to be 7.1 mg/L by BCSIR, which exceeds the Bangladesh Standard for Drinking Water (0.01 mg/L) (ECR'97). So, water intake structures should be constructed such that no water from the surface level can enter into the inlet pipes of the raw water pumping station.

The results of tests for pesticides, carried out by BCSIR following Standard Methods (APHA), are presented in Table 22. The water sample did not contain any of the 13 types of pesticides for which the sample was tested. It should be noted that there is no water quality standards for pesticides in drinking water in the ECR 1997.

Table 21: Water Quality Test Results from Meghna River at near Haria Intake, Sonargaon, Narayanganj

Parameter	Unit	Treated water quality standard		2013 wet season (peak)			
		Bengladesh ECR 1997	WHO guidelines (2011)	July	August	September	January
pH	-	6.5-8.5	-	7.03	7.26	7.92	7.82
Color (Apparent)	Pt-Co	15.00	15.00	62.00	159.00	85.00	27.0
Color (True)	Pt-Co	15.00	-	13.00	19.0	15.0	13.0
Turbidity	NTU	**1.00**	5.00	6.87	17.1	13.0	3.1
Total Hardness	mg/L as CaCO3	200-500	-	16.00	20.0	36.0	48.0
Chloride (Cl-)	mg/L	150-600	-	10.0	7.0	7.0	9.0
Total Dissolved Solids (TDS)	mg/L	1,000.00	-	35.00	20.0	27.0	81.0
Iron (Fe)	mg/L	0.3-1.0	-	0.38	0.44	0.32	0.2
Total Coliform (TC)	CFU/100 mL	0.00	0.00	390	20	134	328
Fecal Coliform (FC)	CFU/100 mL	0.00	-	210	20	110	72
Electrical Conductivity (EC) at 25°C	µS/cm	-	-	58	53	68	120
Dissolved Oxygen (DO)	mg/L	>6	-	7.6	6.0	5.25	7.2
Alkalinity	mg/L as CaCO3	-	-	21.0	25.0	30.0	47.0
Nitrate (NO3-N)	mg/L	10.00	50.00	0.4	0.2	0.4	0.50
Ammonium	NH4+-N	0.50		0.23	0.35	0.27	0.36
Ammonia (NH3-N)	mg/L	-	-	0.001	0.004	0.001	0.005
Phosphate (PO4)	mg/L	6.00	-	0.07	0.08	0.12	0.55
Sulfate (SO4)	mg/L	400.00	-	8.6	<7	<7	11.40
Total Suspended Solids (TSS)	mg/L	10.00	-	11.0	13.0	24.0	11.0
Temperature	oC	20-30	-	30.2	30.0	30.8	20.4
Chemical Oxygen Demand (COD)	mg/L	4	-	6.0	7.0	8.5	6.0
Biochemical Oxygen Demand (BOD5)	mg/L	0.2	-	1.0	0.4	0.6	1.20
Chorophyle a	µg/l	**1**			2.7	0.3	6.20
Lead (Pb)	mg/L	0.05	-	0.01	0.03	0.03	0.003
Cadmium (Cd)	mg/L	0.005	-	0.002	0.002	0.001	<0.001
Chromium (Cr)	mg/L	0.05	-	0.005	0.005	0.003	0.003
Zinc (Zn)	mg/L	5	-	0.05	0.03	0.02	0.04
Mercury (Hg)	mg/L	0.001	-	<0.0001	<0.0001	<0.0001	<0.0001
Oil and grease	mg/L	-	-	-	-	7.1	5,4
Pesticides							
α- BHC	µg/l	-	-	-	-	nd	nd
γ - BHC	µg/l	-	-	-	-	nd	nd
β - BHC	µg/l	-	-	-	-	nd	nd
Heptachlor	µg/l	-	-	-	-	nd	nd
Aldrin	µg/l	-	0.03	-	-	nd	nd
Heptachlor expoxyde Isomer	µg/l	-	-	-	-	nd	nd
Dieldrin	µg/l	-	0.03	-	-	nd	nd
4.4' DDE	µg/l	-	-	-	-	nd	nd
Endrin	µg/l	-	0.6	-	-	nd	nd
2.4 DDT	µg/l	-	-	-	-	nd	nd
4.4' DDT	µg/l	-	-	-	-	nd	nd
4.4' DDD	µg/l	-	-	-	-	nd	nd
2 4' DDT	µg/l	-	-	-	-	nd	nd

Legend: nd = not detectable

Table 22: Pesticides contents of raw water sample collected from Meghna River at Haria intake location on 28 September 2013

Sl. No.	Pesticide	Unit	Concentration Present	Bangladesh Drinking Water Standard (ECR1997)
1	α-BHC	µg/L	Not Detectable	-
2	Y-BHC	µg/L	Not Detectable	-
3	β-BHC	µg/L	Not Detectable	-
4	Heptachlor	µg/L	Not Detectable	-
5	Aldrin	µg/L	Not Detectable	-
6	Heptachlor Epoxide Isomer	µg/L	Not Detectable	-
7	Dieldrin	µg/L	Not Detectable	-
8	4,4'-DDE	µg/L	Not Detectable	-
9	Endrin	µg/L	Not Detectable	-
10	2-4-DDD	µg/L	Not Detectable	-
11	4,4'-DDT	µg/L	Not Detectable	-
12	4,4'-DDD	µg/L	Not Detectable	-
13	2,4'-DDT	µg/L	Not Detectable	-

Water samples were also collected on 31st October, 2013 from Old Brahmaputra river and DND canal (which conveys the water from Sitalakhya river to Saidabad Phases-I and II) and were analyzed for selected water quality parameters. Raw water transmission lines will cross Old Brahmaputra and Sitalakhya rivers and the baseline water quality scenario of these rivers need to be determined to assess the impact (if any) due to construction activities related to river-crossing.

Table 23 summarizes the water quality of these rivers. All the water samples are characterized by relatively high concentrations of dissolved oxygen and relatively low concentrations of color and suspended solids/turbidity. The COD and BOD values are also found to be within the range of typical values for acceptable river water quality for various purposes. Again, similar to the samples from the Meghna river, the sampling was carried out during the wet season during which the rivers are not in their worst possible condition with respect to water quality.

Table 23: Water Quality Test Results from water bodies within the project area

	Water Quality Parameter	Unit	Concentration present		Bangladesh Drinking Water Standard (ECR' 97)	Inland Water Quality Standard (ECR' 97)
			Old Brahmaputra River	DND Conveyance canal/ Sitalakhya River		
1	pH	-	7.09	7.22	6.5-8.5	6.5-8.5
2	Color (True)	Pt-Co	28	19	15	--
3	Turbidity	NTU	4.11	9.52	10	--
4	Total Dissolved Solids (TDS)	mg/L	119	139	1000	--
5	Electrical Conductivity (EC) at 25°C	µS/cm	210	238	--	--
6	Dissolved Oxygen (DO)	mg/L	4.79	4.55	6	≥ 5[b, d, e, f], ≥ 6[a, c]
7	Nitrate (NO_3-N)	mg/L	0.7	1.8	10	--
8	Ammonia (NH_3-N)	mg/L	0.35	0.28	--	--
9	Phosphate (PO_4)	mg/L	0.333	0.464	6	--
10	Sulfate (SO_4)	mg/L	11.4	9.4	400	--
11	Total Suspended Solids (TSS)	mg/L	10	10	10	--
12	Chemical Oxygen Demand (COD)	mg/L	9	7	4	--
13	Biochemical Oxygen Demand (BOD_5)	mg/L	1.2	3.8	0.2	≤ 2[a], ≤ 3[b], ≤ 6[c, d], ≤ 10[e, f]

Legend:
a: to be usable as a source of water supply only after disinfection; b: to be usable for recreational activity
c: to be usable as a source of water supply after conventional treatment; d: to be usable for fisheries
e: to be usable for various process and cooling industries; f: to be usable for irrigation

3.3.5 Ambient Noise Level

As a part of the baseline study, noise level measurements were carried out near the proposed intake location at Haria, at different points along the proposed raw water transmission route in proximity to the Dhaka-Chittagong, Dhaka-Sylhet and Demra-Jatrabari highways/roads and also at the proposed treatment plant site at Saidabad. Sound level measurements were taken on November 2013 during daytime. Summary of noise measurements are shown in Table 24. Noise level data show that at Dhaka-Chittagong highway crossing, Langalbandh bridge, Madan bus station, Kanchpur circle, Tarabo/Sylhet circle and DND Canal road the maximum sound levels recorded were 86.4, 89.8, 83.9, 82.7, 82 and 103.7 dBA, respectively. This is expected as these are very busy areas with high volume of traffic which generates high levels of noise. The 1 minute equivalent noise levels (Leq) in most of these locations exceeded the noise level standards in Bangladesh for Mixed to Commercial areas (see Table 25). However, in the rural areas (area near the proposed intake at Haria) and at the proposed WTP site, the measured noise levels are mostly lower and are within the noise level standards for residential areas.

Table 24: Summary of daytime noise level measurement in the project area

Sl. No.	GPS Coordinate (dd mm ss)		Time	Location	Noise Level (dBA)		
	Latitude	Longitude			L_{MAX}	L_{MIN}	1 min-L_{eq}
1	23 39 35.3	90 37 49.2	11h 23m 50s	Proposed Intake Point at Haria	67.5	54.2	58.3
2	23 39 40.3	90 37 39.5	11h 40m 30s	Lichu Garden	51.7	43.9	47.1
3	23 39 09.2	90 34 47.1	12h 15m 00s	Dhaka-Chittagang Highway Crossing	86.4	68.7	78.2
4	23 39 30.1	90 34 14.5	12h 26m 10s	Old Brahmaputra (Langalbandh Bridge)	89.8	65.5	77.4
5	23 41 24.3	90 32 48.4	12h 35m 30s	Madan Bus Station	83.9	65.2	74.7
6	23 42 20.3	90 31 23.3	12h 42m 10s	Kanchpur Circle	82.7	68.6	75.6
7	23 43 28.1	90 30 48.8	13h 01m 00s	Tarabo/ Sylhet Circle	82.0	68.7	76.4
8	23 43 09.4	90 29 26.5	13h 43m 20s	Staff Quarter (DND Canal)	103.6	69.2	86.4
9	23 42 49.30	90 27 09.7	13h 57m 20s	Middhabari Sluice Gate	62.8	53.8	57.3
10	23 43 15.3	90 26 10.8	15h 47m 30s	SWTP III site	66.2	45.5	53.5

Note: The equivalent level is the level (L_{eq}) of a hypothetical steady sound that would have the same energy (i.e., the same time-averaged mean square sound pressure) as the actual fluctuating sound observed. The equivalent level represents the time average of the fluctuating sound pressure and is close to the maximum level observed during the measurement period. For the fluctuating noise scenario the equivalent noise level (L_{eq}) is generally used for more complete noise sample and is calculated as follows:

$$L_{eq} = 10\log_{10}\left[\sum_{i=1}^{n} P_i \, 10^{L_i/10}\right]$$

where P_i is the probability of the noise level lying in the i-th measurement interval and L_i is the mid-point of that interval.

Table 25: Bangladesh standards for sound level (GoB, 2006)

Locations	Noise level (dBA) at day	Noise level (dBA) at night
Silent zone	50	40
Residential area	55	45
Mixed area	60	50
Commercial area	70	60
Industrial area	75	70

Note: Noise Levels are defined as 1 minute Leq

3.3.6 Air Quality

As a part of the environmental assessment of the proposed project, ambient air quality measurement was carried out at two locations: (a) near the intake location (inside the village area), and (b) at a location along the proposed route of the raw water transmission line beside the Dhaka-Chittagong highway. Concentration of Suspended Particulate Matter (SPM) and PM10 were measured using a high-volume sampler; while concentrations of selected gaseous pollutants (O3, NO2, NO, SO2, CO) were measured using a Gray Wolf Pack monitoring system. The concentrations were monitored on 25 December 2013 (between 12:00 noon and 4:00 p.m.), and the values are reported in Table 26.

Table 26 shows that SPM concentration near the Haria intake location inside the village is relatively lower compared to that recorded beside the Dhaka-Chittagong highway, while the PM10 concentrations were relatively similar. This may be due to high vehicular movements in the Dhaka-Chittagong highway. Both the SPM and PM10 concentrations exceed the national ambient air quality standards. High particulate matter concentrations in the ambient air are a common characteristic during dry season in Bangladesh. Measured concentrations of CO, O3 and NOX at the two locations were below the corresponding national standards of ambient air quality. Measured concentrations of SO2 were relatively high and marginally exceeded the national standards (0.14 ppm) in both the locations.

Table 26: Air quality at two locations at the project site

Air Quality Parameter	Unit	Location: Near Haria intake (N23°39′38.2″, E90°37′36.2″)	Location: Beside Dhaka-Chittagong Highway (N23°40′10.9″, E90°33′36.3′)	Ambient Air Quality Standards for Bangladesh (GoB, 2005)
SPM	$\mu g/m^3$	389	1383	200 $\mu g/m^3$ (8-hr avg.)
PM_{10}	$\mu g/m^3$	235	215	50 $\mu g/m^3$ (Annual Avg) 150 $\mu g/m^3$ (24-hr Avg)
O_3	ppm	0.01	0.02	0.12 ppm (1-hr Avg) 0.08 ppm (8-hr Avg)
NO_X	ppm	0.04	0.03	0.053 ppm (Annual Avg)
SO_2	ppm	0.2	0.2	0.03 ppm (Annual Avg.) 0.14 ppm (24-hr Avg)
CO	ppm	0	0	9 ppm (8 hr avg) 35 ppm (1 hr avg)

4. Baseline Environment: Ecological

4.1 Introduction

This Chapter describes the present status of the ecological features of areas within and surrounding the sites of the proposed project. It covers both flora and fauna including fish of the proposed project sites. The baseline ecological survey sought to determine the diversity and distribution of the flora and fauna, and the extent to which that may be impacted due to the proposed project activities. The water transmission pipeline of the proposed project may cross some water bodies, and therefore, possible impact of construction activities on aquatic environment of these water bodies is of particular interest in the environmental assessment. A team led by the ecologist of the ESIA team visited the proposed project sites in September 2013 to collect first hand data on floral and faunal diversity. The study was conducted only in day time. Herpeto-faunal and mammalian survey was done through visual search and also through discussion with local people and literature review. Aural and visual searching was the main survey method for ornithological survey. Information on fisheries was collected through interviewing fishermen as well as survey of local fish market. Rapid field survey and discussion with local people was the main method for floral survey. The collected data were cross-checked through literature review. The areas that were surveyed for this ecological assessment are: Baiddherbazar, Haria, Nakatibhangha, Ulukandi, Mamrukpur, Damdorodi under Sonargaon Union; Villages of Musapur Union at Madan Circle, Roadside areas along the Dhaka-Chittagong highway, Demra area and existing Saidabad water treatment plant site at Dhaka. This baseline information has been used in the relevant section of this report to identify and assess impact of the proposed project on the ecological resources, and finally, to suggest mitigation measures.

4.2 Ecological Perspective Of Project Area

Bio-ecologically speaking, the entire project site falls under the Brahmaputra-Jamuna Floodplain. The ecological characteristics of water intake location, routes of transmission and distribution pipelines and treatment plant differ from each other. The water intake point is located beside the Meghna River at Haria, Sonargaon, Narayanganj. This area has some villages with planted vegetation that provides supportive habitat for certain type of fauna. Land filling activities were observed in the area. Thus, the existing ecological features of the area are changing gradually. Apart from anthropogenic influence, the ecological features generally fluctuate seasonally due to the environmental reasons. Ecological features along the route of the raw water transmission line and distribution lines have already changed by the previous development works (e.g., road construction, other infrastructure development, etc), and a new ecosystem has evolved there to support local adaptive biodiversity. The route of the proposed water transmission pipeline runs along a 6 km stretch from the Haria intake point through the village areas, fallow lands and agricultural lands that support diversified floral and faunal species. The routes of the water distribution lines primarily pass through developed areas in Demra, Sabujbagh, Khilgaon, Shyampur and Narayanganj Sadar (DND). On the other hand, the site for the proposed WTP is currently a vacant piece of land beside the existing WTP Phase-II site. This

area has been raised by land filling; the nearby areas are inundated seasonally and act as a seasonal wetland during rainy season for up to 6 months. Throughout the year, the area provides habitat for aquatic and terrestrial flora and fauna including numerous freshwater fish species. The surrounding wetland serves as the grazing ground for fish and other aquatic animals in rainy season. The changes in the physical characteristics of land (project site and its surrounding areas) have direct impacts on its dependent flora and fauna.

4.3 Ecological Features

For the purpose of this study, the macro ecological features of the study area are considered that primarily consists of floral and faunal diversity including fish species. Descriptions of these ecological features are presented in this Section.

4.3.1 Faunal Diversity

The project areas have various assemblages of animal communities. Some species use the areas as permanent habitats while others as temporary / migratory habitats. On the basis of habitats, the faunal species found in the project areas have been divided into two major categories viz. (a) terrestrial fauna, and (b) aquatic fauna.

a. Terrestrial fauna

Terrestrial environment dependent wildlife is known as terrestrial fauna. They fully or partially depend on terrestrial environment to live or to get food, shelter, nest, breed, and produce offspring. Several species of amphibia, reptile, bird and mammal are the main component of terrestrial fauna (Figure 15 to Figure 18). The project areas have different types of lands, e.g. agricultural dry land, seasonal wetland, homestead land, fallow land, roadside low land, as well as rivers, canals, ditches, which provide moderate environment for terrestrial habitat. Terrestrial wildlife is divided into 4 major group viz. mammal, bird, reptile and amphibia. A total of 62 faunal species have so far been identified in the project areas and a breakdown of the subspecies is shown in Figure 19. This indicates that the area is rich in faunal species. A complete list of terrestrial faunal species is given in Table 27.

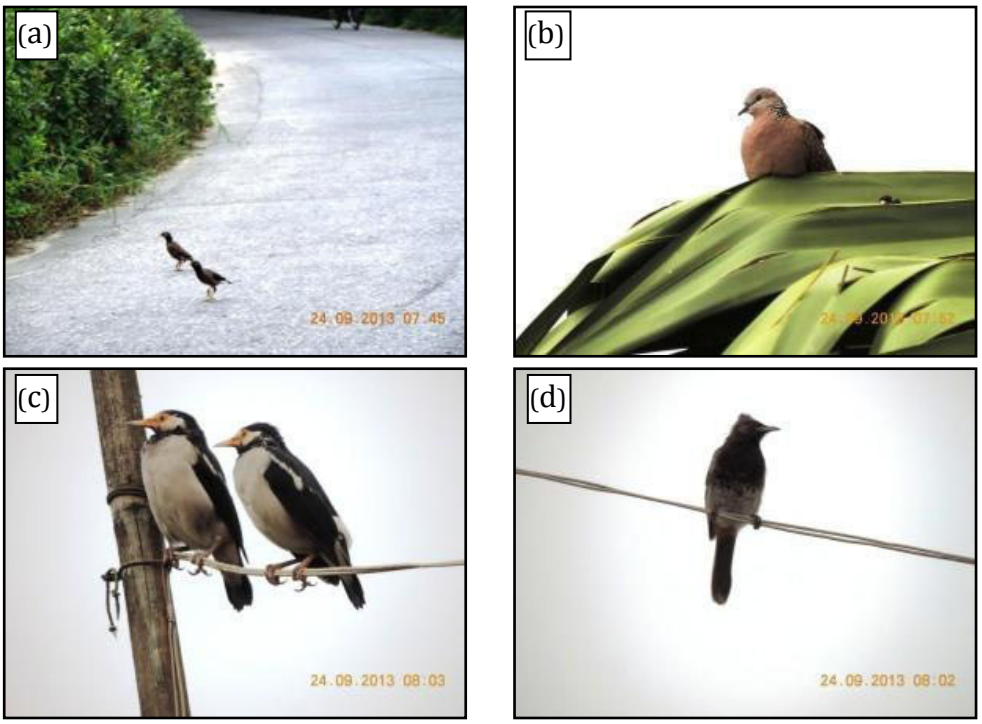


Figure 15: Terrestrial fauna at Haria, Sonargaon, Narayanganj: (a) Common Myna crossing a local road, (b) Spotted dove taking rest on a leaf of a palm tree, (c) Pied Myna resting on an electric line, and (d) Red Vented Bulbul looking for insect from an electric line

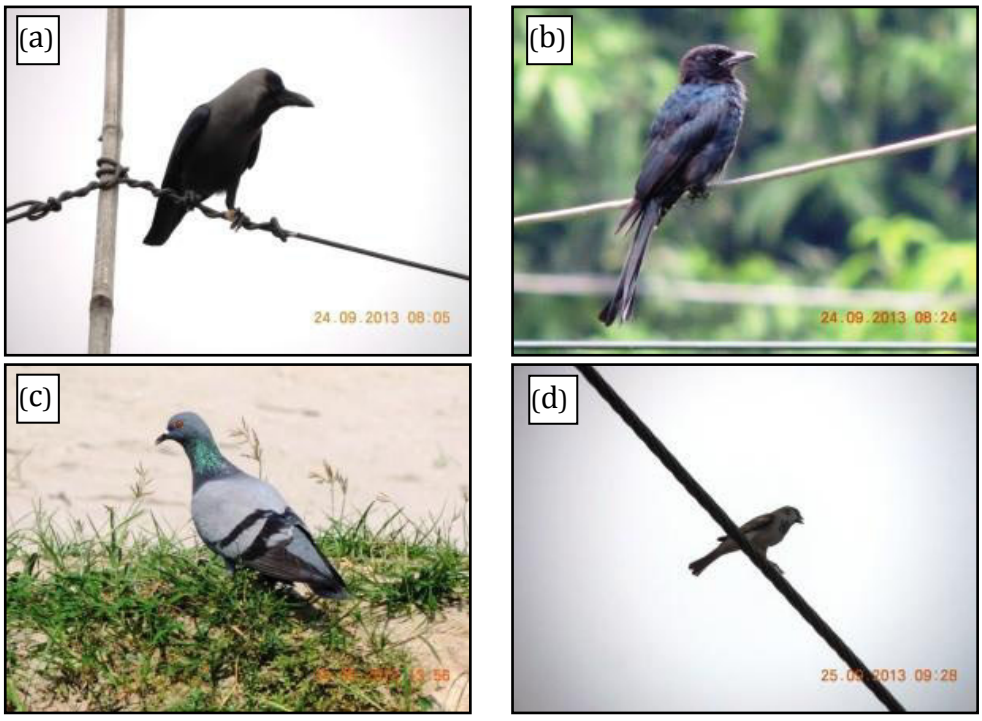


Figure 16: Terrestrial fauna at Baiddherbazar, Sonargaon, Narayanganj: (a) House Crow in a position to fly away, (b) Black Drongo looking for insect from a an electric line, (c) Rock Pigeon walking along the bank of Meghna River, and (d) House Sparrow taking rest on an electric line

Figure 17: Terrestrial fauna at Madan Circle and nearby areas: (a) House Lizard on the wall of Musapur Union office, (b) Yellow Monitor crossing a field inundated by a sudden heavy rainfall, (c) Pond Heron searching for food in a wetland, and (d) Mongoose waiting to catch fish from a water body beside the Dhaka – Chittagong Highway

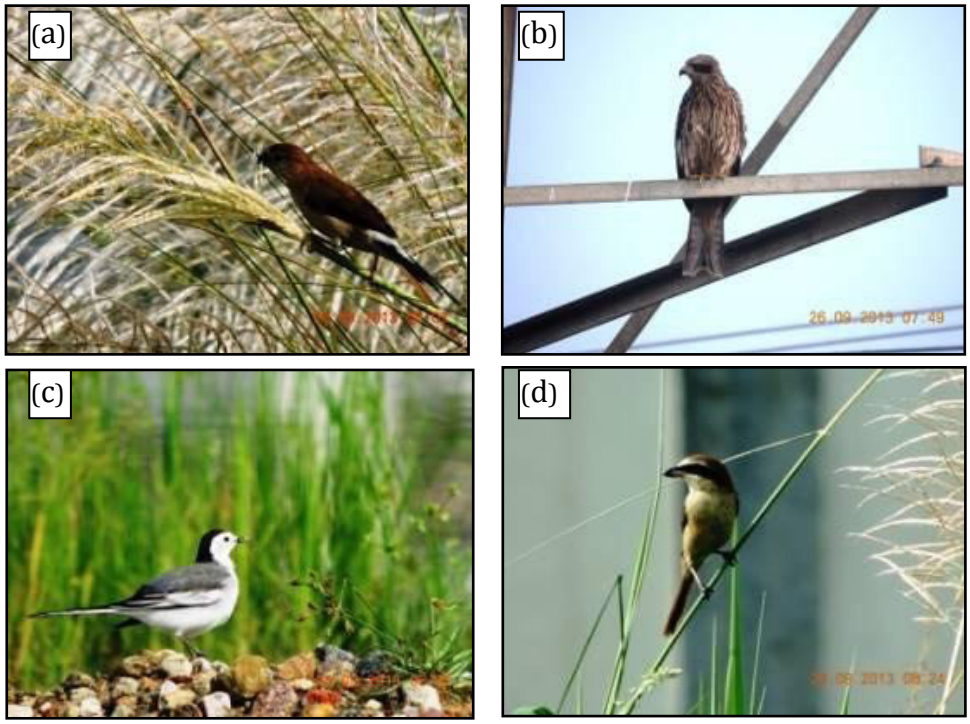


Figure 18: Terrestrial fauna adjacent to Saidabad water treatment plant area: (a) White-throated Munia searching for food, (b) Brahmony Kite resting on a power grid tower, (c) White-browed Wagtail standing on brick chips, and (d) Brown Shrike standing on a long grass

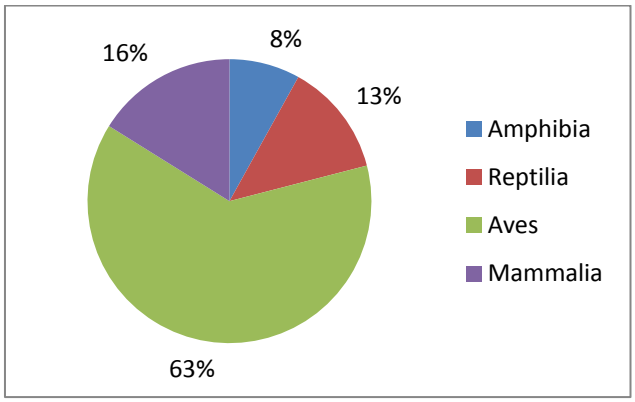


Figure 19: Distribution of terrestrial fauna in the project areas

Table 27: Identified terrestrial fauna at three major sampling areas for the SWTP Phase-III project.

CLASS	FAMILY	ENGLISH NAME	SCIENTIFIC NAME	SURVEY AREAS*		
				1	2	3
Amphibia	Bufonidae	Common Toad	*Bufo melanostictus*	✓	✓	✓
	Rhacophoridae	Maculated Tree frog	*Polypedates maculatus*	✓		
	Ranidae	Bull frog	*Hoplobatrachus tigerinus*	✓	✓	✓
		Cricket frog	*Limnonectes limnocharis*	✓	✓	✓
		Boulenger's Frog	*Rana alticola*	✓		
Reptilia	Scincidae	Common Skink	*Mabuya carinata*	✓		✓
	Gekkonidae	Common House Lizard	*Hemidactylus flaviviridis*	✓	✓	✓
		Common House Lizard	*Hemidactylus brooki*	✓		
	Agamidae	Common Garden Lizard	*Calotes versicolor*	✓	✓	✓
	Varanidae	Grey Monitor Lizard	*Varanus bengalensis*	✓		
		Yellow Monitor Lizard	*Varanus salvator*		✓	
	Dipsadidae	Common Wolf Snake	*Lycodon aulicus*	✓		
	Colubridae	Rat Snake	*Coluber mucosus*	✓		
Aves	Scolopacidae	Fantail Snipe	*Gallinago gallinago*	✓		
	Alcedinidae	Common Kingfisher	*Alcedo atthis*	✓	✓	✓
		White-throated Kingfisher	*Halcyon smyrnensis*	✓		✓
	Meropidae	Green Bee Eater	*Merops orientalis*	✓		
	Megalaimidae	Lineated Barbet	*Megalaima lineata*	✓		
	Apodidae	Asian Palm Swift	*Cypsiurus balasiensis*	✓		
	Psittacidae	Rose ringed Parakeet	*Psittacula krameri*	✓		
	Jacanidae	Bronze-winged Jacana	*Metopidius indicus*	✓		
	Laniidae	Brown Shrike	*Lanius cristatus*	✓		
	Dicruridae	Black Drongo	*Dicrurus macrocercus*	✓	✓	✓
	Pycnonotidae	Red-vented Bulbul	*Pycnonotus cafer*	✓	✓	✓
	Motacillidae	White-browed Wagtail	*Motacilla alba*	✓		
		Indian Pond heron	*Ardeola grayii*	✓	✓	✓

CLASS	FAMILY	ENGLISH NAME	SCIENTIFIC NAME	SURVEY AREAS*		
				1	2	3
	Ardeidae	Cattle Egret	*Bubulcus ibis*	✓		
		Little Egret	*Egretta garzetta*	✓		
	Centropodidae	Indian Cuckoo	*Cuculus micropterus*	✓		
	Columbidae	Spotted Dove	*Streptopelia chinensis*	✓		✓
		Rock Pigeon	*Columba livia*	✓		
	Laridae	Common Tern	*Sterna hirunda*	✓		
	Rostratulidae	Greater Painted-Snipe	*Rostratula bengalensis*	✓		
	Accipitridae	Brahminy Kite	*Haliastur Indus*			✓
	Passeridae	House Sparrow	*Passer domisticus*	✓	✓	✓
		Baya Weaver	*Ploceus philippinus*	✓	✓	
		Paddy field Pipit	*Anthus rufulus*	✓		
	Sulviidae	Striated Grassbird	*Megaurus palustris*	✓		✓
		Common Tailorbird	*Orthotomus sutorius*	✓	✓	✓
		Common Babbler	*Turdoides caudatus*	✓		
	Nectariniidae	Purple Sunbird	*Nectarinia asiatica*	✓		
	Corvidae	House crow	*Corvus splendens*	✓	✓	✓
		Rufous Tree Pie	*Dendrocitta vagabunda*	✓		✓
	Sturnidae	Asian Pied Starling	*Sturnus contra*	✓	✓	✓
		Common Myna	*Acridotheres tristis*	✓	✓	✓
	Irenidae	Common Iora	*Aegithina tiphia*	✓	✓	✓
	Laniidae	Long-tailed Shrike	*Lanius schach*	✓		
	Ploceidae	White throated Munia	Lonchura malabarica			✓
	Oriolidae	Black-headed Oriole	*Oriolus xanthornus*	✓		
	Picidae	Black-rumped Flamback	*Dinopium benghalense*	✓		
	Muscicapidae	Oriental Magpie Robin	*Copsychus saularis*	✓	✓	✓
		White-throated Fantail	*Rhipidura albicollis*	✓		
Mammalia	Muridae	House Mouse	*Mus musculus*	✓	✓	✓
		Common House Rat	*Rattus rattus*	✓	✓	✓
		Bandicoot Rat	*Bandicota indica*	✓	✓	✓
		Indian Field Mouse	*Mus booduga*	✓	✓	✓
		Indian mole Rat	*Bendicota bengalensis*	✓	✓	✓
	Soricidae	Grey Musk Shrew	*Suncus murinus*	✓	✓	✓
	Felidae	Fishing cat	*Prionailurus bengalensis*	✓		
	Pteropodidae	Flying Fox	*Pteropus gigantius*	✓		
	Herpestidae	Small Indian Mongoose	*Hervested auropunctatus*	✓	✓	✓
	Vespertilionidae	Indian Pipistrelle	*Pipistrellus coromandra*	✓	✓	✓

**Note: 1 = Sonargaon and adjacent areas, 2 = roadside and adjacent areas of Dhaka – Chittagong Highway, 3 = adjacent areas of existing Saidabad water treatment plant*

b. Aquatic fauna

Some species of amphibia, reptile, bird, mammal and freshwater fish are the main components of the aquatic fauna (Figure 20 and Figure 21). The reproduction, breeding and multiplication of aquatic fauna is finely tuned and adjusted to the rhythm and amplitude of monsoon flooding. Aquatic wildlife is divided into 4 major group viz. mammal, bird, reptile and amphibia. A total of 30 aquatic faunal species have so far been identified and a breakdown of the subspecies is provided in Figure 22. This indicates that the area is also rich in aquatic fauna. A complete list of aquatic faunal species is given in Table 28.

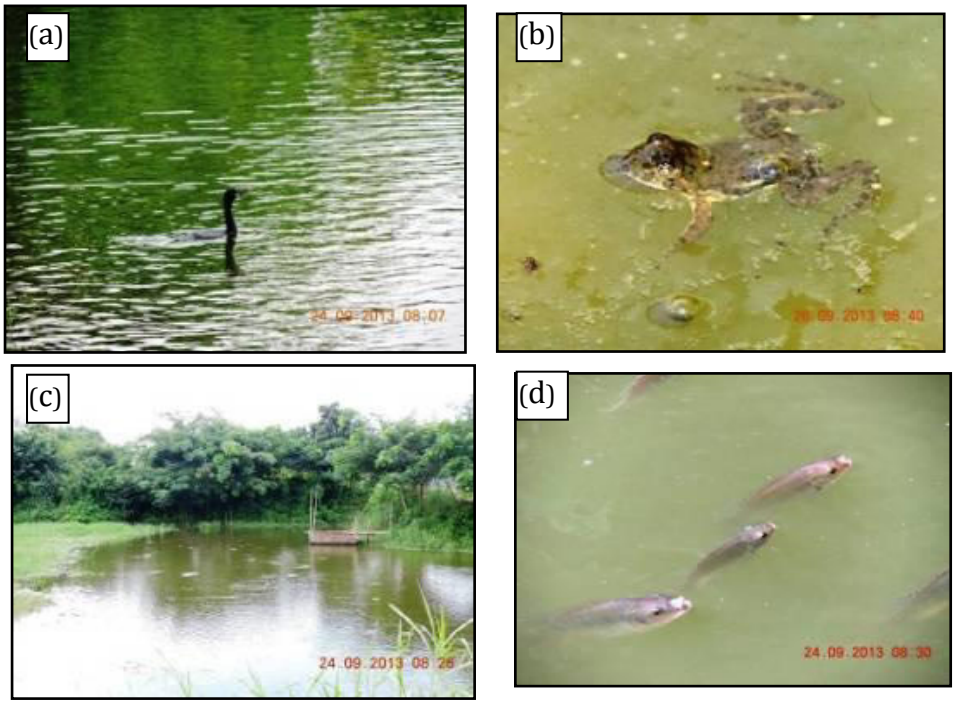


Figure 20: Aquatic fauna at Sonargaon and adjacent areas: (a) Little Cormorant searching for food in a pond, (b) Skipper Frog at shallow water, (c) A pond used for fish culture, and (d) Fish in a local pond.

Figure 21: Aquatic fauna at Baiddherbazar, Sonargaon and adjacent areas: (a) Fishing net used to catch river fish from the Meghna river, very close to the proposed water intake point, (b) local fishermen fishing in Meghna River by a non-mechanized local country boat, (c) Fish market at Baiddherbazar, Sonargaon that operate everyday afternoon, and (d) Varieties of native fish observed in a local market

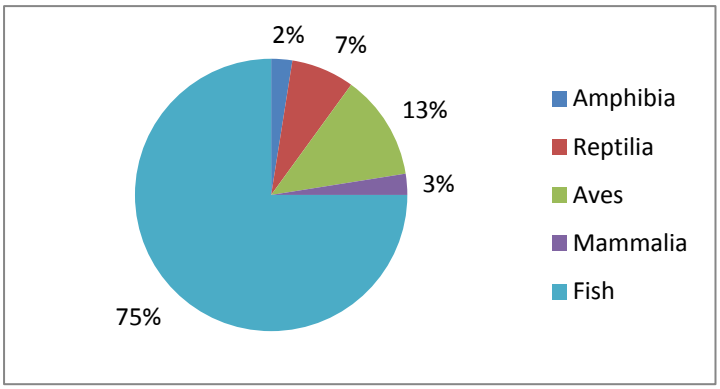


Figure 22: Distribution of aquatic fauna

Table 28: Identified aquatic fauna at three major sampling areas for the SWTP Phase-III project

CLASS	FAMILY	ENGLISH NAME (STATUS)	SCIENTIFIC NAME	SURVEY AREAS*		
				1	2	3
Amphibia	Ranidae	Skipper frog	*Euphlyctis cyanophlyctis*	✓	✓	✓
Reptilia	Bataguridae	Indian Roofed Turtle	*Kachuga tecta*	✓		
	Natricidae	Checkered Keelback	*Xenochrophis piscator*	✓		
	Homalopsidae	Common Smooth Water Snake	*Enhydris enhydris*	✓		
Aves	Anhingidae	Darter	*Anhinga melanogaster*	✓		
	Phalacrocoracidae	Little Cormorant	*Phalacrocorax niger*	✓		✓
	Dendrocygnidae	Brown Crake	*Amaurornis akool*	✓		
		White-breasted Waterhen	*Amaurornis phoenicurus*	✓	✓	
		River tern	*Sterna albiforms*	✓		
Mammalia	Platanistidae	Ganges River Dolphin	*Platanista gangetica*	✓		
Fresh water Fish / Osteichthyes	Claridae	Magur	*Clarius batrachus*	✓	✓	✓
	Gobiidae	Tank Goby	*Glossogobius giuris*	✓	✓	✓
		Bumblebee Goby	*Brachygobius nunas*	✓	✓	✓
	Clupeidae	Hilsa	*Tenualosa ilisha**	✓		
		Indian River Shad	*Gudusia chapra*	✓		
	Nanidae	Mottled Nandus	*Nandus nandus*	✓		
	Polynemidae	Indian Threadfish	*Polydactylus indicus*	✓		
	Belontiidae	Sunset Gourami	*Colisa sota*	✓		
	Heteropneustidae	Stinging Catfish	*Heteropneustes fossilis*	✓	✓	✓
	Ariidae	Gagora catfish	*Arius gagora*	✓		
		Soldier Catfish	*Osteogeneiosus militaris*	✓		
	Channidae	Asiatic Snakehead	*Channa orientalis*	✓	✓	✓
		Spotted Snakehead	*Channa punctatus*	✓	✓	✓
	Pangasidae	Pungus (cultured)	*Pangasius pangasius*	✓		
	Cyprinidae	Catla	*Catla catla*	✓		
		Rohu	*Labeo rohita*	✓	✓	
		Mrigal	*Cirrhinus mrigala*	✓	✓	
		Ticto / Firefin Barb	*Puntius ticto*	✓	✓	✓
		Swamp/ Chola Barb	*Puntius chola*	✓	✓	✓
	Mastacembelidae	Tire-trak Spinyeel	*Mastacembelus armatus*	✓	✓	✓
		One-stripe Spinyeel	*Macrognathus aculeatus*	✓	✓	✓
	Polynemidae	Indian Threadfish	*Polydactylus indicus*		✓	
	Anabantidae	Climbing Perch	*Anabas testudineus*	✓	✓	✓
	Bagridae	Tengra Mystus	*Mystus tengara*	✓	✓	✓

CLASS	FAMILY	ENGLISH NAME (STATUS)	SCIENTIFIC NAME	SURVEY AREAS*		
				1	2	3
		Long-whiskered Catfish	*Aorichthys aor*	✓	✓	
	Chacidae	Indian Chaca	*Chaca chaca*	✓		
	Notopteridae	Grey Featerback	*Notopterus notopterus*	✓		
	Synbranchidae	Gangetic mudeel	*Monopterus cuchia*	✓		
	Cyprnidae	Indian carplet	*Ambhypharyngodon microlepis*	✓		

**Note: 1 = Sonargaon and adjacent areas, 2 = roadside and adjacent areas of Dhaka – Chittagong Highway, 3 = adjacent areas of existing Saidabad water treatment plant*

4.3.2 Floral diversity

Plant species that grows in the wild in a habitat for a particular period is known as flora. It plays a vital socio-economic and ecological role in a particular habitat or ecosystem. Some flora develops adaptive features to survive in particular types of habitats. Some plants are habituated with soil, some are with water and some are with both soil and water for their normal growth and development. On the basis of habitats, the floral species found in the project areas have been divided into two major categories viz. (a) aquatic flora, and (b) terrestrial flora.

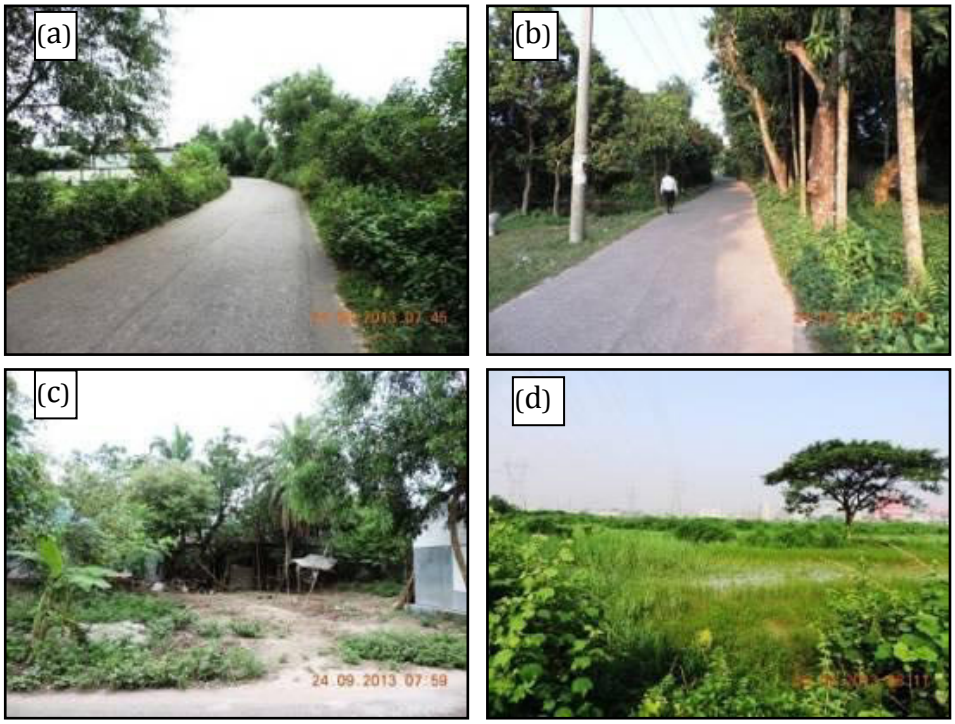


Figure 23: Terrestrial floral at project sites and adjacent areas: (a) Varieties of terrestrial flora beside a local road, (b) Matured tree along the ancient Panam city road, (c) Several types of terrestrial flora planted in a local village, and (d) few terrestrial flora adjacent to the existing Saidabad water treatment plant

a. Terrestrial flora

There are several villages along the 6 km alignment of the water transmission line from the intake point (Haria) up to Dhaka-Chittagong highway; these villages have planted terrestrial flora that have economical value to the society. The terrestrial plant species make a complex ecosystem in which wildlife has direct relationship through their ecological niche. Commercial fruit garden and vegetable plantation were observed at Sonargaon. Common terrestrial flora are Mango - Mangifera indica, Betelnut - Areca catechu, Coconut - Cocos nucifera, Rain tree - Samanea saman, etc. Scattered terrestrial flora was observed beside the Dhaka–Chittagong highway and few terrestrial flora were observed at Saidabad and adjacent areas. Three types of terrestrial plant habit e.g. trees, shrubs and herbs exist in the project areas (Figure 23). Except herbs and shrubs, few natural trees (naturally originated) exist in the project area. Most of the plants particularly the trees and shrubs are planted and cultivated. 68 floral species have so far been identified in the project areas of which 34 are tree species, 25 are herb species and the rest are shrubs. Percentage of identified terrestrial flora is given in Figure 24 and a complete list of floral species is given in Table 29.

Figure 24: Terrestrial flora in the project sites and adjacent areas: (a) Vegetable garden at Sonargaon, (b) Papaya plantation in a village, (c) Ripe fruits observed in a local village, and (d) Varieties of terrestrial flora on both sides of a small canal.

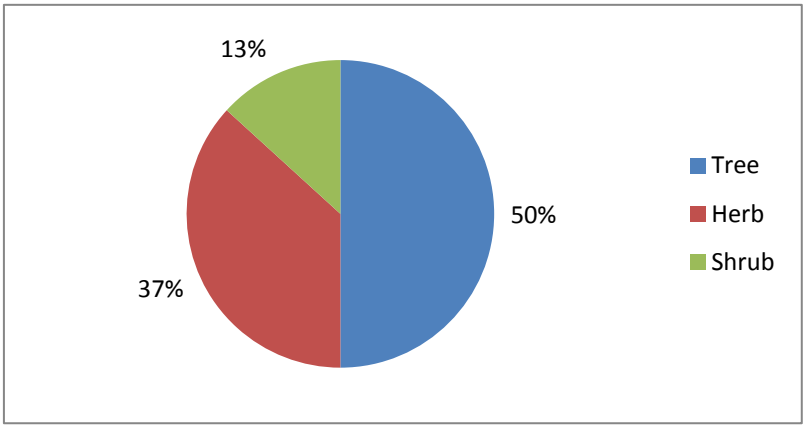


Figure 24: Distribution of terrestrial flora types in the project areas

Table 29: Identified terrestrial flora at three major sampling areas for the SWTP Phase-III project.

NAME			TYPE	STUDY AREAS		
SCIENTIFIC	FAMILY	NATIVE		1	2	3
Zizyphus mauritiana	Rhamnaceae	Boroi, Kul	Tree	✓	✓	✓
Datura metol	Solanaceae	Dhutra	Herb		✓	
Azadirachta indica	Meliaceae	Neem	Tree	✓		
Clerodendrum viscosum	Verbinaceae	Vat	Herb	✓	✓	
Litchi chinensis	Sopindaceae	Lichee	Tree	✓		
Spondias dulcis	Anacardiaceae	Golden Apple /Amra	Tree	✓		
Calotropis procera	Asclepiadaceae	Seto/Gedla Akonda	Tree	✓		
Calotropis gigantean	Asclepiadaceae	Akonda	Tree	✓		
Averrhoa carambala	Averhoaceae	Kamranga	Tree	✓		
Basella rubra	Basellaceae	Pui Shak	Shrub	✓		
Chrysopogon aciculate	Gramineae	Chore kata	Herb		✓	
Acacia auriculiformis	Leguminosae	Akashmoni	Tree	✓	✓	
Acacia mangium	Leguminosae	Mangium	Tree	✓		
Erythrina variegata	Leguminosae	Mandar	Tree	✓	✓	
Tamarindus indica	Leguminosae	Tetul	Tree	✓		
Centella asiatica	Hydrocotyleaceae	Thankuni	Herb	✓		
Solanum indicum	Solanaceae	Titbegun	Shrub	✓	✓	✓
Ficus glomoreta	Moraceae	Jagadumur	Shrub	✓	✓	
Eucalyptus citriodora	Myrtaceae	Eucalyptus	Tree	✓	✓	
Albizia procera	Leguminosae	Koroi	Tree	✓	✓	
Diospyros embryteris	Ebenaceae	Gab	Tree	✓		
Anthocephalus chinensis	Rubiaceae	Kadam	Tree	✓	✓	
Dalbergia sissoo	Leguminosae	Sisu	Tree	✓		
Musa spp	Musaceae	Kala	Herb	✓	✓	
Barringtonia acutangula	Lecythidaceae	Hijal	Tree	✓	✓	
Aegle marmelos	Rutaceae	Bel	Tree	✓		
Blumea lacera	Compositae	Sheyalmutra	Herb	✓	✓	✓

NAME			TYPE	STUDY AREAS		
SCIENTIFIC	FAMILY	NATIVE		1	2	3
Areca catechu	Plamae	Supari	Tree	✓		
Leonurus sibiricus	Libiatae	Raktadrone	Herb	✓		✓
Carica papaya	Caricaceae	Pape	Shrub	✓	✓	
Bombix cliba	Bombacaceae	Simul	Tree	✓		
Cynodon dactylon	Gramineae	Durbaghas	Herb		✓	✓
Solanum nigrum	Solanaceae	Phutibegun	Herb		✓	
Acacia nilotica	Leguminosae	Babla	Tree	✓	✓	
Mikania cordata	Compositae	Assamlata	Herb	✓	✓	✓
Samanea saman	Leguminosae	Rendi	Tree	✓	✓	
Lindernia procumbens	Scrophulariaceae	Bakpuspa	Herb	✓		
Bambusa spp	Gramineae	Bansh	Tree	✓		
Mangifera indica	Anacardiaceae	Am	Tree	✓		
Coccinia indica	Cucurbitaceae	Telakucha	Herb	✓	✓	✓
Ricinus communis	Euphorbiaceae	Reri, venna	Shrub	✓	✓	✓
Polygonum hydropiper	Polygonaceae	Bishkatali	Herb	✓		✓
Ipomoea fistulosa	Convolvulaceae	Dholkalmi	Herb	✓	✓	✓
Alstonia scholaris	Apocynaceae	Chatim	Tree	✓	✓	
Delomix regia	Leguminosae	Krishnachura	Tree	✓		
Alternanthera sesilis	Amaranthaceae	Haicha	Herb	✓	✓	✓
Clerodendrum velsosum	Verbinaceae	Bhant	Herb	✓	✓	
Heliotropium indicum	Boraginaceae	Hatisur	Herb	✓	✓	✓
Swietenia mahagoni	Meliaceae	Mehagini	Tree	✓	✓	
Ficus benghalensis	Moraceae	Bot	Tree	✓	✓	
Clematis gouriana	Ranunculaceae	Chagalbati	Herb		✓	
Coccos nucifera	Palmae	Narikel	Tree	✓	✓	
Lagerstroemia speciosa	Lythidaceae	Jarul	Tree	✓		
Phoenix sylvestris	Palmae	Khejur	Tree	✓		
Phyllanthus reticulates	Euphorbiaceae	Chitki	Shrub	✓		
Ficus hispida	Moraceae	Kakdumur	Shrub		✓	
Artocarpus heterophyllus	Moraceae	Kathal	Tree	✓	✓	
Casuarinas equisetifolie	Casuarinaceae	Jhau	Tree	✓		
Borassus fiabellifer	Palmae	Tal	Tree	✓		
Ocimum sanctum	Labiatae	Tulsi	Herb		✓	
Hyptis suaveolens	Labiatae	Tokma	Herb		✓	
Centolla asiatica	Hydrocotyleace	Than kuni	Herb	✓		
Saccharum spontaneum	Graminace	Kash	Herb	✓	✓	✓
Ocimum sanctum	Labiatae	Tulsi	Herb		✓	
Chrysopogon aciculate	Gramineae	Chore Kanta	Herb		✓	✓
Hyptis suaveolens	Labiatae	Tokma	Herb	✓		
Molocanna bambusoides		Muli bansh	Shrub	✓		
Pteris vittatai		Dhekishak	Pteridophytes	✓	✓	✓

**Note: 1 = Sonargaon and adjacent areas, 2 = roadside and adjacent areas of Dhaka – Chittagong Highway, 3 = adjacent areas of existing Saidabad water treatment plant*

b. Aquatic flora

The project area has low land / seasonal wetland with varieties of aquatic flora. The aquatic flora is divided into three major types, viz. tree, shrub and herb. These floral species grow in ponds, canals, ditches, river, seasonal wetland and low lying agricultural lands as submerged, free-floating, or rooted floating states (Figure 25). The common aquatic floral species in the project area include Sada Shapla - *Nymphaea sp,* Kachuripana - *Eichhornia crassipes,* Khudipana - *Lemna perpusilla*, Helencha- *Enhydra flactuans,* Kalmi - *Ipomoea aquatica* etc. A total of 24 aqautic foral specises have been identified of which 2 are trees, 21 are herbs and the rest are shrubs. Figure 26 shows their relative abundance and Table 30 provides a complete list of floral species.

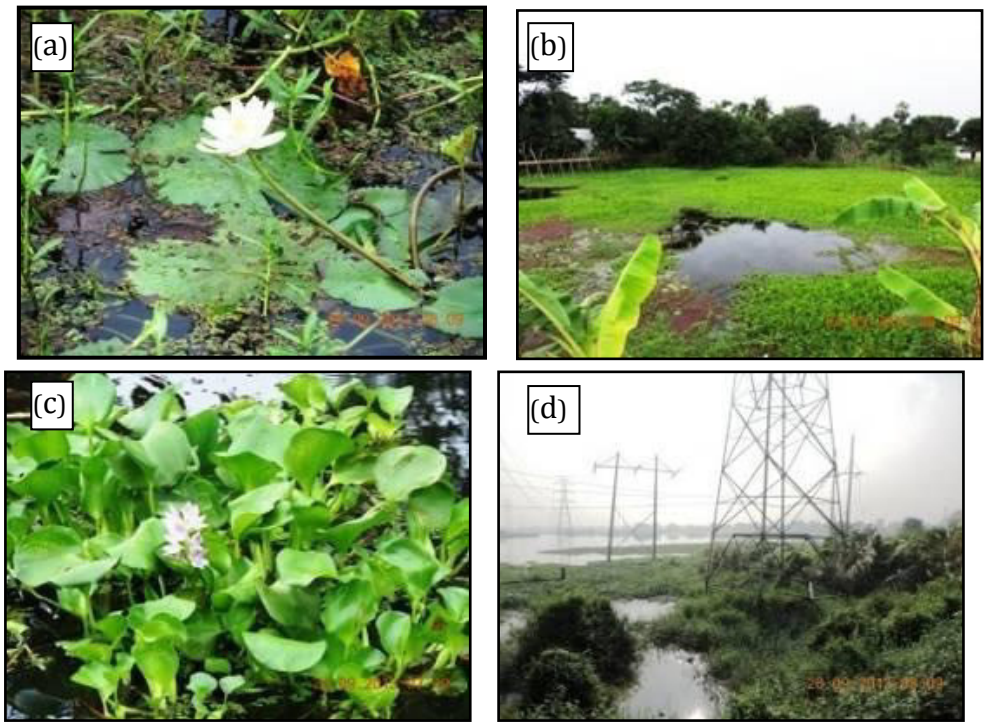


Figure 25: Aquatic flora in the project sites and adjacent areas: (a) Flower of sada shapla in a wetland at Sonargaon, (b) Large aquatic wetland provides habitat for numerous type of aquatic flora at Haria of Sonargaon, (c) Flower of water hyacinth in an aquatic habitat beside Dhaka-Chittagong highway, and (d) Mixed aquatic flora observed near the existing Saidabad water treatment plant

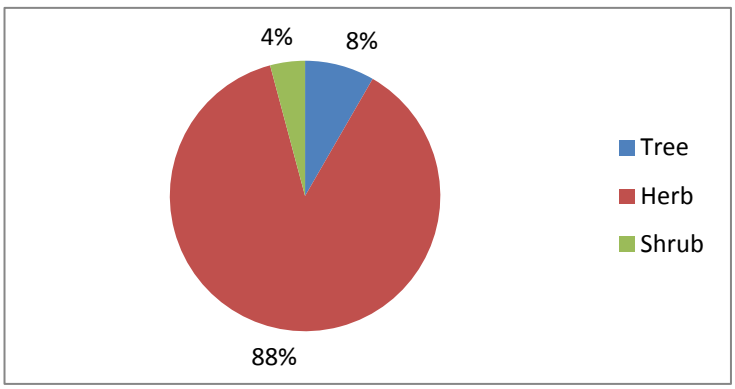


Figure 26: Distribution of aquatic flora in the project areas

Table 30: Identified terrestrial flora at three major sampling areas for the SWTP Phase-III project.

NAME			TYPE	STUDY AREAS*		
SCIENTIFIC	FAMILY	NATIVE		1	2	3
Nymphaea nouchali	Nymphaeaceae	Sada shapla	Herb	✓	✓	
Clynogyne dichotoma	Marantaceae	Sitalpati	Herb	✓		
Vallisneria spiralis	Hydrocharitaceae	Patajhangi	Herb	✓	✓	
Utricularia aurea	Utriculariaceae	Jhangi	Herb	✓	✓	
Hygroryza aristata	Gramineae	Phutki janglidhan	Herb		✓	✓
Ipomoea aquatica	Convolvulaceae	Kalmi	Herb	✓	✓	✓
Lemna perpusilla	Limnaceae	Khudipana	Herb	✓	✓	✓
Pistia strateotes	Araceae	Topapana	Herb	✓	✓	✓
Salvinia cuculata	Salviniaceae	Indurkanipana	Herb	✓	✓	
Eichhornia crassipes	Pontederiaceae	Kachuripana	Herb	✓	✓	✓
Hydrilla verticillata	Hydrocharitaceae	Janjhi, Kurcli	Herb	✓		
Dillenia pentagyna		Hargoza	Shrub	✓		
Scirpus articulatus	Cyperaceae	Chechra	Herb	✓		
Alternanthera philoxeroides	Amaranthaceae	Helencha	Herb	✓	✓	✓
Ceratophyllum dumersum	Ceratophyttaceae	Jhanjhi	Herb	✓	✓	
Barringtonia acutangula	Lecythidaceae	Hijal	Tree	✓	✓	
Crataeva nurvala	Capparidaceae	Barun, banny	Tree	✓		
Colocasia esculenta	Araceae	Katchu	Herb	✓	✓	✓
Ipomoea fistulosa	Convolvulaceae	Dholkalmi	Herb	✓	✓	✓
Enhydra fluctuans	Compositae	Helencha	Herb	✓	✓	
Aponogeton natans	Aponogetonaceae	Ghenchu	Herb	✓		
Calamus sp	Palmae	Bet	Herb	✓		
Fagopyrum hydropiper	Polygonaceae	Biskhatali	Herb	✓		
Monochoria vaginalis	Pontederiaceae	Sarkachu	Herb		✓	

*[*Note: 1 = Sonargaon and adjacent areas, 2 = roadside and adjacent areas of Dhaka – Chittagong Highway, 3 = adjacent areas of existing Saidabad water treatment plant]*

4.4 Threatened Flora and Fauna

Some specific scientific criteria are followed to declare a species as threatened (critically endangered, endangered etc). It is generally declared by the International Union for Conservation of Nature (IUCN) for each country. Floral or faunal species that exist in threatened condition are generally known as threatened species. Currently 147 wildlife and 54 freshwater fish species are threatened in Bangladesh; 40 plant species are also threatened in Bangladesh. No threatened floral species have been identified in the project area. However, some threatened wildlife and fish species have been identified in the project areas (Table 31) which are considered threatened throughout the country as well. A systematic research work in different seasons of the year will provide a complete and more accurate status of the threatened wildlife and fish fauna of the study areas.

Table 31: List of Critically Endangered, Endangered and Vulnerable wildlife and fish fauna in the study area

Biological Class	English name	Scientific name	O	CE	E	V	CT	T	DD
Reptilia	Grey Monitor Lizard	*Varanus bengalensis*				√			
	Yellow Monitor Lizard	*Varanus salvator*			√				
	Common Wolf Snake	*Lycodon aulicus*				√			
Mammalia	Ganges River Dolphin	*Platanista gangetica*			√				
Osteichthyes	Mottled Nandus	*Nandus nandus*				√	√		
	Asiatic Snakehead	*Channa orientalis*				√	√		
	Ticto / Firefin Barb	*Puntius ticto*				√	√		
	Tire-trak Spinyeel	*Mastacembelus armatus*			√		√		
	One-stripe Spinyeel	*Macrognathus aculeatus*				√	√		
	Long-whiskered Catfish	*Aorichthys aor*				√	√		
	Indian Chaca	*Chaca chaca*			√				
	Grey Featerback (V)	*Notopterus notopterus*				√	√		
	Gangetic mudeel (V)	*Monopterus cuchia*				√	√		

Legend: O = Observed, CE = Critically Endangered, E = Endangered, V = Vulnerable, CT = Commercially T = Threatened, DD = Data Deficient

4.5 Protected areas, National Park, Game reserves, Wildlife sanctuaries and ECA

Protected area (PA)

An area of land and/or ocean especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means is referred to as “Protected Area (PA)”. Such an area is predominantly a natural area established and managed in perpetuity, through legal or customary regimes, primarily to conserve their natural resources. No PA exists near any of the proposed project sites, though an ancient city namely Panam city exists near the water intake point at Sonargaon.

National Park (NP)

A National Park (NP) is a reserve land, usually declared and owned by a national government, protected from most human development activities and pollution. No NP exists at or near the proposed project sites.

Game reserve (GR)

A Game Reserve (GR) is an area of land set aside for maintenance of wildlife for tourism or hunting purposes. No GR exists at or near the proposed project sites.

Wildlife Sanctuary (WS)

A Wildlife Sanctuary (WS) is an area that assures the natural conditions necessary to protect nationally significant species, groups of species, biotic communities, or physical features of the environment where these require specific human manipulation for their perpetuation. No WS exists at or near the proposed project sites.

Ecologically Critical Area (ECA)

It is an environmental protection zone, defined by the Government of Bangladesh under the Bangladesh Environment Conservation Act, 1995, where ecosystem is considered to be threatened. The raw water transmission pipeline will cross the Sitalakhya river which has been declared as an ECA (see Annex 12.5). The declaration states restrictions on hunting, fishing, all activities that could result in the destruction of floral or faunal habitats, activities that could destroy natural characteristics of water and soil, activities detrimental to fishery, installation of polluting industrial units, and discharge of domestic/ industrial liquid waste into Sitalakhya river.

5. Baseline Environment: Socio-economic

5.1 Introduction

This Chapter describes the baseline socio-economic conditions of project areas of the proposed Saidabad Water Treatment Plant Phase-III. As a part of ESIA, a social baseline study was carried out, which included baseline socio-economic survey, FGDs and meetings. The specific objectives of the social baseline survey were to gather information on the existing social environment surrounding the proposed project sites. The social survey primarily focused on identifying the status of important economic and social factors / circumstances / attributes of the project areas. Possible impacts of the proposed project activities have to be evaluated against these baseline socio-economic attributes, and later, mitigation measures have to be suggested to reduce/ eliminate the significant adverse impacts. This Chapter describes the baseline socio-economic condition of the project areas based on the questionnaire survey as well as secondary information. Findings of the FGDs and meetings have been presented in Chapter 6 of this report.

5.2 Approach And Methodology

An assessment of the baseline of socio-economic conditions / attributes of the areas surrounding the proposed project sites was made. The social study covered an area of about 5 km radius surrounding the project sites. Efforts were made to identify the socio-economic attributes that may be impacted due to the proposed project activities. The main purposes of the baseline socio-economic study were to understand:

a. people's socio-economic condition;
b. extent of people's access to basic services; and
c. people's perception regarding the proposed project.

The proposed project will run over the Sonargaon Upazila of Narayanganj District and Demra Thana of Dhaka District. Some basic features of the social environment of both areas are available in the Population and Housing Census 2011 of Bangladesh Bureau of Statistics (BBS, 2012). Besides this, a socio-economic survey was conducted in September 2013. To collect first hand information on socio-economic attributes, the members of survey team visited the project sites (Figure 27), conducted field study, questionnaire survey, meetings (both formal and informal) and focus group discussions (FGDs). More than 200 people have been directly interacted during the study; the questionnaire survey covered 107 respondents, 68 people participated in the 3 FGDs, and others participated in the formal/informal meetings. The questionnaire used for the socio-economic survey (see Annex 12.2) covered five major themes:

a. Socio-economic background
b. Access to basic services
c. Education level and educational institutions
d. Economic situation, and
e. Attitude toward the proposed project.


Figure 27: Surveyors filling out questionnaire sheets by interviewing local people in the study areas

5.3 Socio-Economic Perspective Of The Study Areas

As noted earlier, the proposed project will run over the Sonargaon Upazila of Narayanganj District and Demra Thana of Dhaka District. The basic socio-economic features of Sonargaon Upazila and Demra thana are summarized below (BBS, 2012):

Sonargaon Upazila: It is situated in the eastern part of Dhaka district. Total area is about 171.67 sq. km. Population density is 2332 per sq. km. It has 398 villages under 10 Unions and 1 Paurashava that have 9 Wards. A total of 400,358 people live in this area of which around 51% male and 49% female. More than 59% male and around 67% female are married. Human population growth rate is 2.7 per year. Most of the people live in the rural environment. Only about 8.19% of total population lives in the urban environment. Total number of households (HH) is 89,565 of which only about 8% exists in urban environment. Floating HH number is 476. Average HH size is 4.4. Most of the HH structure (64%) is not strong enough (i.e. Katcha / non concrete structure). About 93% HH have tube well from where they get water for their various purposes. Almost 97% HH have electricity. More than 77% HH have their own house. Average literacy rate is 54.6%. School attendance (5-24 years) rate is 48.9%. Around 24% of total population is under 30-49 age structure class. More than 96% population is Muslim.

Demra Thana: It is situated in the eastern side of Dhaka city. It has 29 villages under 3 Unions. A total of 226,679 people live in this area of which around 54% male and 46% female. More than 58.5% male and around 67.3% female are married. Human population growth rate is -6.07 per year. All people live in the peripheral urban environment. Total number of households (HH) is 52,982. Floating HH number is 21. Average HH size is 4.2. Some HH structure (around 15%) is not strong enough (i.e. Katcha / non concrete structure). Around 78.7% HH have Tap water line from where they get water for their various purposes. Almost 98.8% HH have electricity. More than 28.4% HH have their own house while 70.1% have rented houses. Average literacy rate is 73.1%. School attendance (5-24 years) rate is 52.4%. Around 26% of total population is under 30-49 age structure class. More than 97% population is Muslim.

Agro-ecologically the proposed project site falls under Young Brahmaputra–Jamuna Floodplain (BARC/UNDP/FAO, 1995). Human settlement began here more than several hundred years back. The area has non-calcareous gray / dark gray floodplain soil which provides suitable environment for growing essential foods for human consumption. The proposed water intake point and route of water transmission pipeline have rural and semi urban social settings. Areas surrounding the water

treatment plant have urban environment. Remains of an ancient city, known as Panam city, exist near to the water intake point at Haria. The Panam city is also a tourist spot and is managed by the Archeological Department of Bangladesh Government. Outside this ancient city, most areas are low lands / seasonal wetland that are utilized by the local village people for their livelihood. A significant portion of these lands are now being converted into highlands (through land filling) for various purposes like commercial fruit garden (e.g. Lychee, Papaya) and residential plots. The soil in the village area close to the intake point is very fertile, which helps the growth of agro-products (mainly rice) in plenty. Local people use the area for cultivation during the winter season. During monsoon season, most of the area becomes inundated, and people practice carp and exotic fish culture in some areas. Local fishermen have been catching natural fish from that area during monsoon over generations. Highlands are used for vegetables cultivation, cattle rearing, poultry farming, and the products are traded in the local markets as well as in Dhaka. Agricultural products, cattle and wetland fish are some of the prime economic assets to the local people. Apart from these, few small industries were also observed in the area.

On the other hand, the areas surrounding the route of the water transmission line along Dhaka-Chittagong highway has urban/ peri-urban characteristics. The areas around the proposed water treatment plant at Saidabad have urban characteristics with all types of urban facilities. Figure 28 shows some photographs of the project sites.

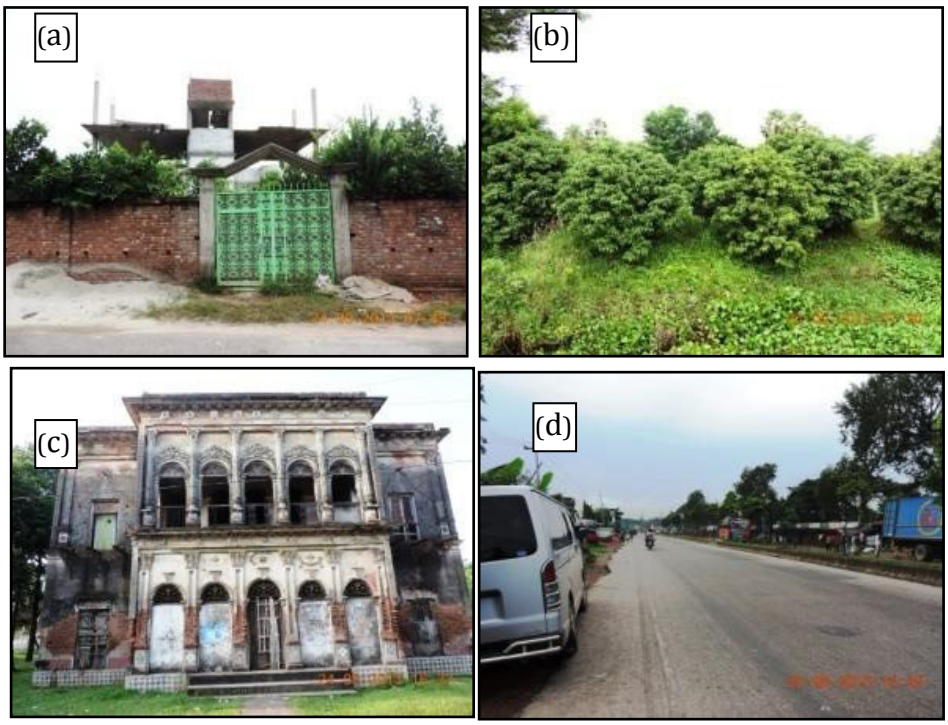


Figure 28: Some photographs of the project sites: (a) An under-construction building at Sonargaon – a symbol of growing economy, (b) Commercial fruit (lychee) garden at Sonargaon, (c) An ancient building at Panam city of Sonargaon, and (d) Small business centers (shop) on both sides of Dhaka-Chittagong Highway

5.4 Baseline Social Attributes From Questionnaire Survey

The existing socio-economic characteristics of areas surrounding the project site have been described below based on the results of the questionnaire survey under five thematic areas:

Theme # 1: Socio-economic background

The parameters considered under socio-economic conditions included respondents gender, age, marital status, family size, occupation, and duration of living in the area. These parameters provide an understanding of people's background in areas surrounding the project sites and their lives and livelihood.

Most of the respondents (92%) of the questionnaire were male; this is primarily due to their availability, willingness and social custom. All respondents were Bengali, no tribal respondent was found in the project areas. Muslims dominate the study area (96% respondents) followed by Hindus. Most of the respondents' ages are in between 35-44 years (35% or respondents). Also 96% of the respondents were married with family size varying from 4 to 6, which indicates that the family planning program is moderately accepted by the local community.

Figure 29: Some photographs from Sonargaon area: (a) A Masjid, (b) A Hindu religious structure (in ruins), (c) Land cultivation by a local farmer, and (d) A small business center – sand is sold from here for construction works

More than half of total respondents have been living in Sonargaon and adjacent Dhaka Chittagong Highway areas for a very long time, exceeding 25 years. As majority of the respondents have been staying in the area for a long period of time, it means that they have most likely developed many kinds of social and economic ties with other people living in that area. Therefore, any displacement would affect not only their income but also other social and economic relationships. However, it should be

noted that majority of lands by the side of the Dhaka-Chittagong highway are owned by Road and Highway Division (RHD) of GoB and no land acquisition would be required for laying of water transmission pipeline along the highway. Nearly half of the respondents of the Sonargaon and adjacent Dhaka-Chittagong Highway areas are migrants from various parts of the country, who came here mainly in search of a better and secured life (Figure 30 a). While the respondents are engaged in different occupations (Figure 30 b), majority of the respondents (44%) are engaged in small businesses.

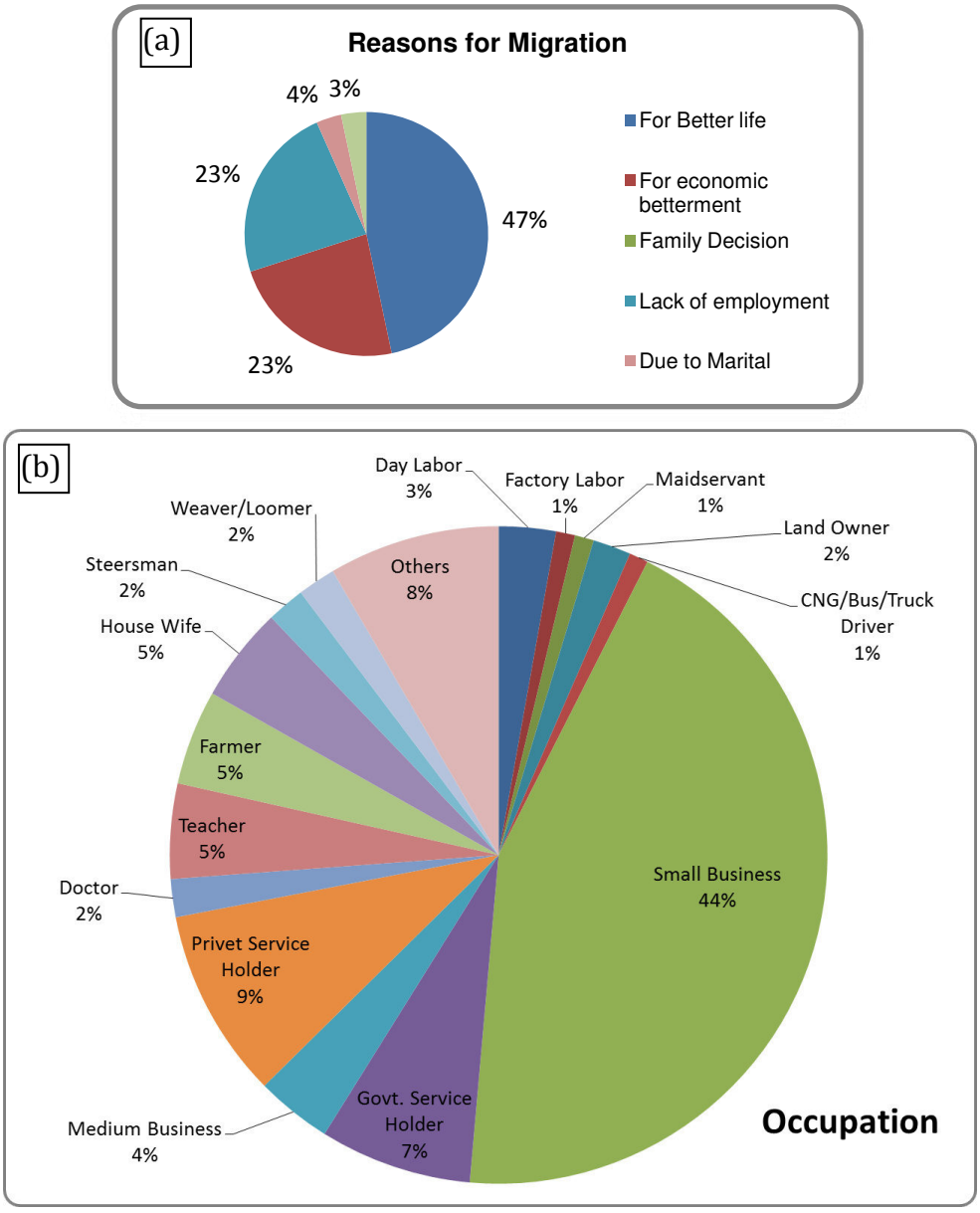


Figure 30: Questionnaire findings: (a) Respondents' reason for migration and (b) Occupation pattern of respondents.

According to the respondents, the overall environment in Sonargaon is good in terms of comfort of living. The area is not prone to natural disaster. Most respondents reported experiencing of one earth quake (last year).

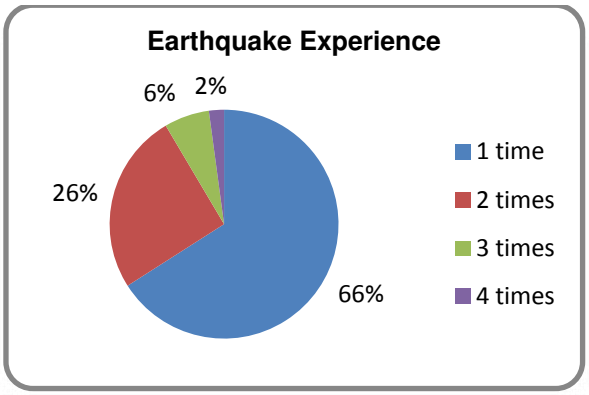


Figure 31: Respondents' experience with earthquake from questionnaire survey

Theme # 2: Access to Basic Services

The parameters considered under "basic services" included access to electricity, fuel for cooking, water, sanitation / sewerage system, and health services.

The area is covered by the national grid and most respondents have access to electric supply, though they suffer from frequent load-shedding, especially during the summer. At that time, most electricity-dependent activities are hampered seriously. Students suffer a lot during examination. Natural gas supply is available in the area, and almost half of all respondents use natural gas for cooking or other uses. Other respondents use wood / cow-dung for everyday cooking. Almost all respondents have their own tube wells. The study area does not seem to be an arsenic contaminated area.

Among the respondents, most have modern toilet or slab / RCC toilet, which indicates that respondents are habituated with the modern sanitation system. Poor people also use pit latrine. More than one third of respondents (39%) have access to the sewerage system though most of the time it does not work properly.

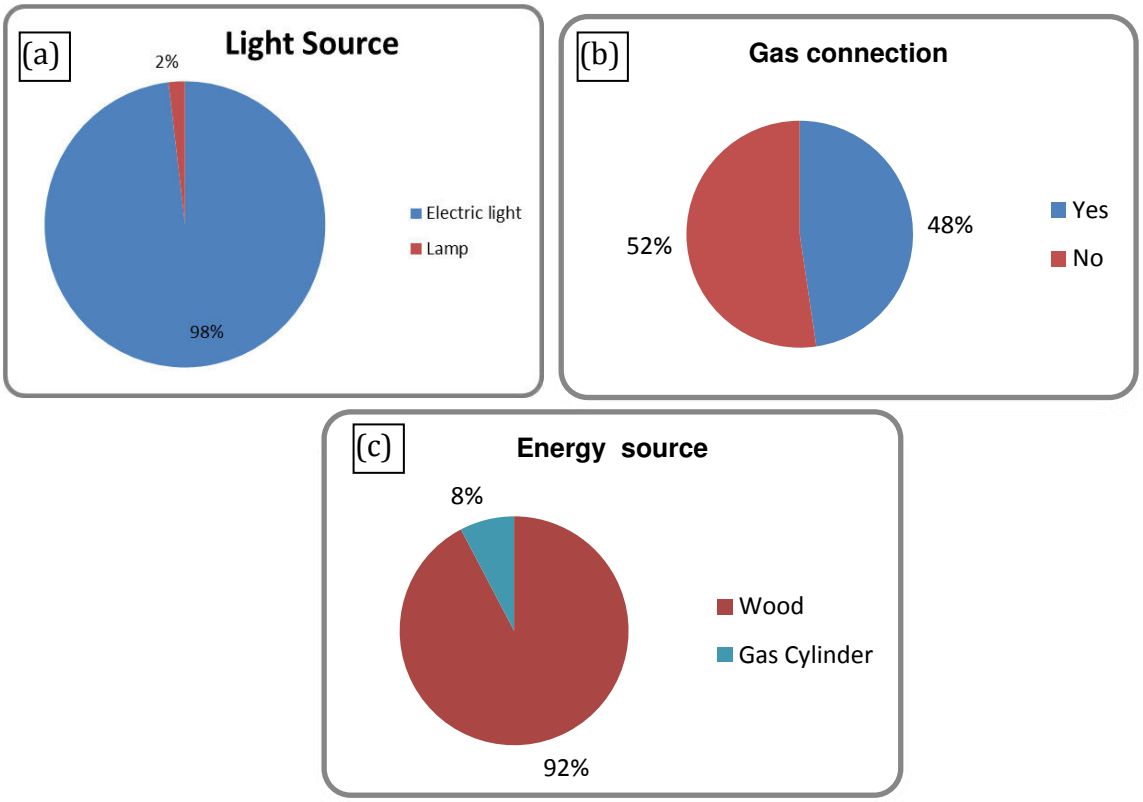
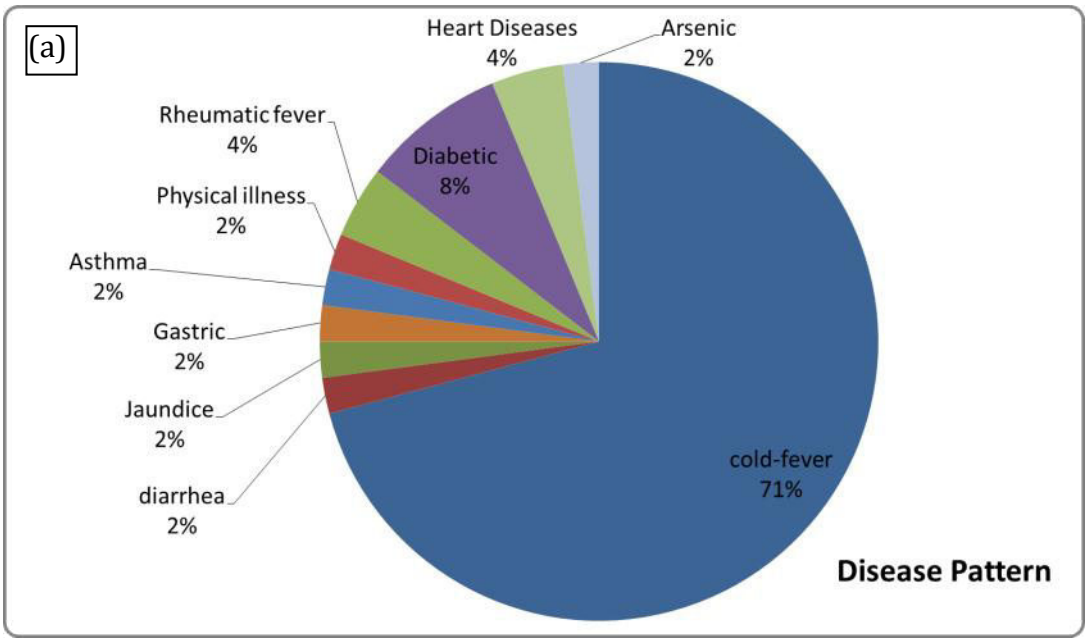


Figure 32: Questionnaire finding: Respondents' access to (a) source of light, (b) natural gas supply, and (c) source of energy used for cooking

Less than 50% respondents or their immediate family members have suffered from common diseases (e.g. fever) within the last six months. Access to pure drinking water, good health and hygiene practice, ability to avail better treatment has significant implications for the overall health. During health problems, most respondents prefer to go to the nearby pharmacy, followed by private clinic. Most respondents are aware of the health-care services at Government Hospitals, but it is not satisfactory to them. In case of emergency, most respondents prefer to go to the nearby reputed government hospital of Dhaka city. Most respondents or their immediate family members did not fall in an accident in the last six months.



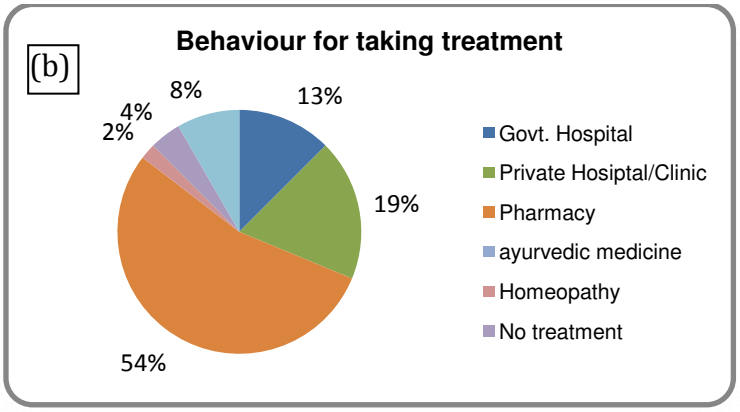


Figure 32: Questionnaire Findings: Respondents' (a) Disease pattern, and (b) Pattern of getting health-care services

Theme # 3: Education, transport system and religious and social establishments

The parameters considered under this theme included respondents' education, educational facilities/institutions, religious establishments and social organizations. Areas surrounding the project sites have schools, madrasas and colleges. Most respondents are quite happy with the overall quality of educational facilities available in their localities. Education level varies among the respondents. More than one third of all respondents reported completing secondary level education. All respondents who have children reported that their children are admitted into the local schools.

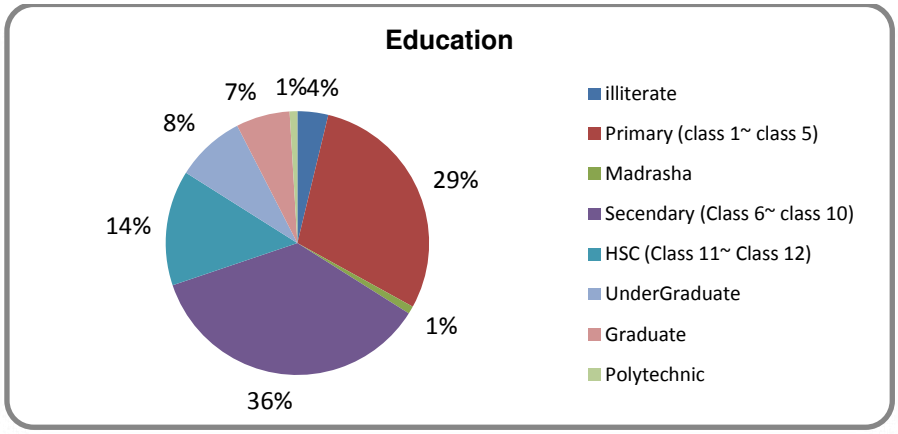


Figure 32: Questionnaire Findings: Education level of respondents in the study areas

Figure 33: Educational institutions in the study area: (a) a local high school, and (b) a local madrasha (Islamic educational institution).

Road transportation system is well-developed available in the study area. Most respondents are quite happy with road networks, while others wanted expansion of existing roads. Some village roads need carpeting. To carry human and goods from one place to another, people prefer to use road network.

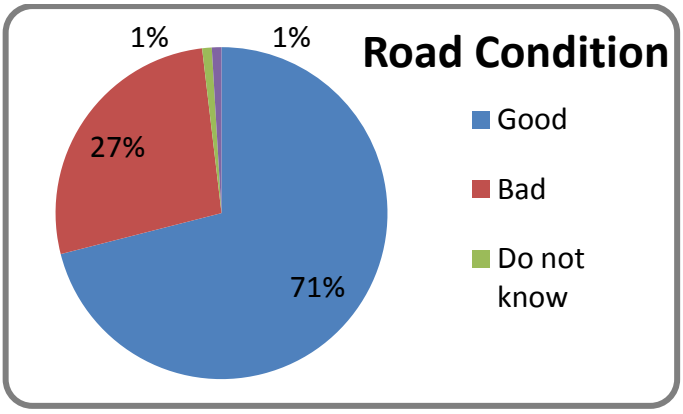


Figure 34: Questionnaire Findings: Status of road condition – respondents' opinions

There are mosques, temple and few clubs in all areas surveyed; no pagoda, church were identified within the surveyed area. The ancient Panam city is a historical establishment in the study areas. No playing field was identified in the study area and children usually use open areas in the vicinity of their homes to play games.

Figure 35: (a) a hindu religious establishment and (b) the ancient Panam city conserved by Archeological Department of GOB

Theme # 4: Economic Situation

The parameters considered under this theme included income and associated issues. In general, economic condition of the respondents appears to be relatively good. Respondents have mixed income range. Two third respondents reported income in between Taka five to fifteen thousand. They have access to bank accounts and around 60 percent of the respondents have bank accounts. Respondents also borrow money from local business institutions (e.g. NGO operated financial institutions) for expansion of business.

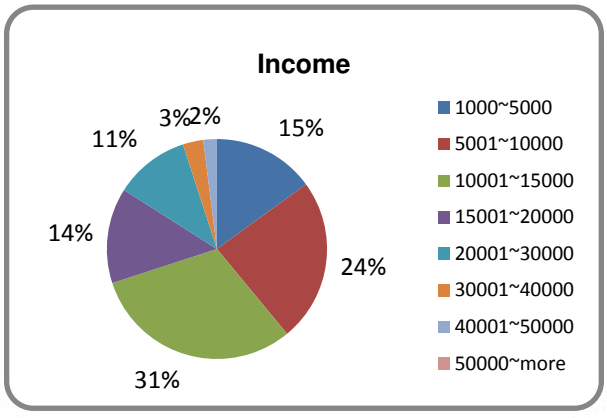


Figure 35: Questionnaire Findings: Respondents' income pattern

Most respondents are not involved with cultivation. Rather they are primarily involved with other types of income generating profession such as businesses. Respondents who are involved with cultivation prefer to cultivate paddy during winter season; during monsoon, they prefer fishing.

Figure 36: Small businesses in the study area: (a) Wood shop for furniture making, and (b) A small shop beside a local road

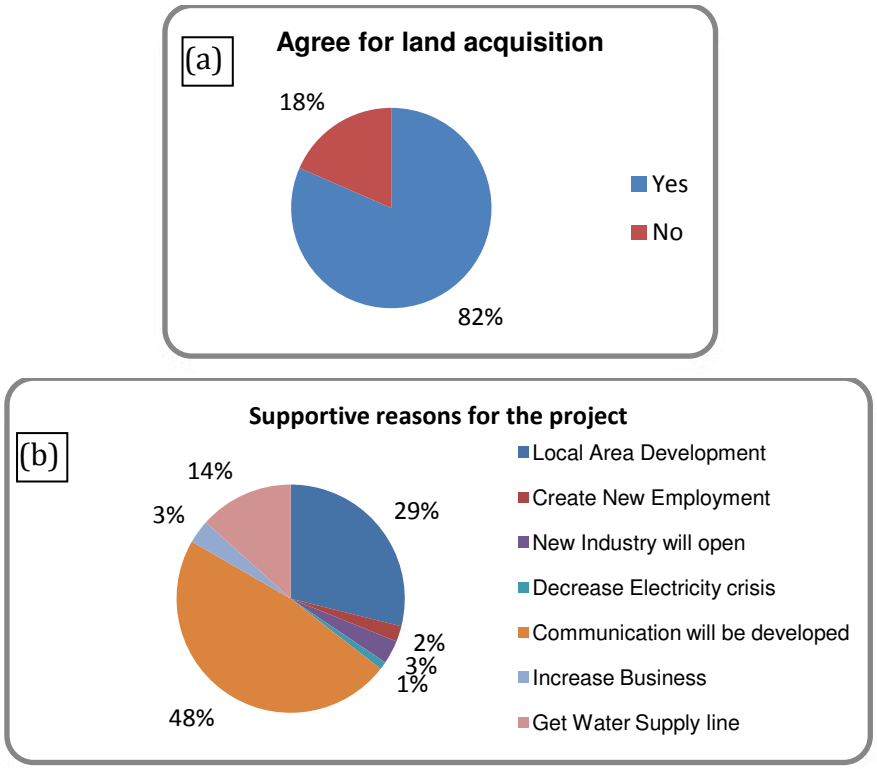


Figure 36: Questionnaire findings regarding respondents' opinion on: (a) land acquisition, and (b) reasons for supportive attitude for the proposed project

Cattle rearing and poultry farming is a good source of income for local people. In the low laying areas, fodder is available throughout the year. Cattle rearing are carried out within the house premises for both domestic and commercial purposes; the milk produced is primarily sold in Dhaka city. Rearing of domestic fowl and duck is a common practice in the study areas. The egg and meat of these animals supply nutrition to the local community. Few commercial poultry firms were also observed.

Theme # 5: Reasons for supporting the project

Overall socio-economic environment, population trend and people's perception regarding the proposed project site were considered under this theme. According to the respondents, current local population is increasing slowly due to the growth of local economy. All respondents expressed their supportive attitude for the proposed project if it does not bring any harm to them. The primarily reasons for their support is the potential overall development of the area due to project activities. About 82% of respondents expressed their support for land acquisition for the project, but emphasized that the compensation should be provided according to current market price.

5.5 Baseline Social Attributes Along Routes Of Distribution Line

5.5.1 Demography

Population

Table 32 shows the distribution of Than-wise population (according to 2011 Census) of areas through which the proposed water distribution lines would pass. The table also presents the distribution of household size of these areas.

Table 32: Thana wise population of areas through which the water distribution lines would pass

Thana	Area (Sq. Km)	Population as per Census 2011	Density(Sq. Km) In 2011	Household Size
Sabujbagh	11.7	393,167	33,604	4.26
Motijheel	5.04	280,048	55,565	4.1
Ramna	7.77	279,495	35,971	2.68
Shyampur	10.25	576,942	56,287	3.99
Demra	39.66	697,183	17,579	4.96
Khilgaon	7.47	573,203	76,734	4.20
Narayanganj Sadar	74.62	12,47,796	16,722	4.10
Total	**156.55**	**40,46, 834**		

Religion

Muslims account for majority of population (96.53 percent) in these areas, followed by Hindus (3.28 percent), Christians (0.15 percent) and Buddhists (0.03 percent).

Education

About 8.36 percent of the population in these areas are illiterate, 28.84 percent have elementary level of education, about 10.23 percent have S.S.C. (Secondary School Certificate) level education, about 21 percent have H.S.C (higher secondary school certificate) and higher level of education, 9 percent population are infants, and the rest one percent have other type of education, for instance, religious education. The most significant observation is that about 61 percent of the population in these areas has elementary to S.S.C. level of education.

5.5.2 Socioeconomic Condition

Ramna-Khilgaon-Motijheel-Sabujbagh Thana:

This area is mainly inhabited by people of middle, low to very low-income groups. The most important occupation in this area is service because a large number of mid level officers of semi government, autonomous bodies and other corporation prefer to live within this zone owing to lower rate of house-rent and relatively close proximity to Motijheel C/A, Secretariat and other Govt. Offices.

Utility services including piped water are in short supply in the area. In the eastern part of this area, which still maintains a rural character, the inhabitants generally use shallow tubewells and deep tube wells for their domestic water supply.

Narayanganj Sadar (North):

Mainly middle class and low income group reside in this area. The most common occupations include industrial labourer, craftsman, and officials working in nearby mills and factories. A number of large and small industries, including dyeing industries, are distributed throughout this area. Brick making is carried on in different areas, and stone grinding along the river banks has become a thriving business. Despite economic prosperity owing to industrialization in the area, the bulk of the people including industrial labourer, craftsmen and persons other than the owners who are associated with these enterprises, belong to low-income group.

Demra Thana:

Mainly middle class and low income group reside in this area. The most common occupations include industrial labourer, craftsman, and officials working in nearby mills and factories. A number of large and small industries are distributed throughout the Thana. Brick making is carried in this area.

Shyampur Thana:

The area, located within the OId City, has both commercial tradition and industrial heritage. Virtually, the Old City is the commercial nerve of the entire Bangladesh. It was found that many old buildings have been demolished to construct new shopping centres, and residential buildings have been converted into commercial establishments through vertical extension, since there is little scope for horizontal expansion.

6. Public Consultation and Communication

6.1 Introduction

Social survey, Focus Group Discussions (FGDs) and public consultations (formal and informal meetings) were carried out for documenting the existing socio-economic condition in the project areas and for assessment of social impact of project activities. The FGDs were conducted involving major stakeholders. The public consultations were carried out in public places within the project areas and along the routes of the proposed transmission and distribution lines for documenting views, opinions and concerns of the local people. This Chapter presents the major findings from the FGDs and public consultations.

6.2 Methodology

The FGDs were organized and conducted at 3 important places within the project areas in September, 2013. The locations were Haria Union Parishad office at Sonargaon, Musapur Union Parishad Office at Madan Circle, and Hazi Aman Super Market at Demra/ Saidabad. More than 68 people participated in the FGDs (see Table 33 for details). These three locations were selected to represent the viewpoints of the general people residing near the intake location (at Haria), the water transmission route (along Dhaka-Chittagong Highway), and the treatment plant at Saidabad, respectively. In the FGDs, an effort was made to invite a wide range of stakeholders including farmers, businessmen, land owners, house owners, laborers, teachers and students (see Figure 37 to Figure 39). In addition to the FGDs, a number of formal / informal meetings with stakeholders were carried out in the project areas; the study team interacted with more than 30 people during these meetings.

Table 33: Details of FGDs for the proposed SWTP Phase –III Project

Date	Venue	Time	Number of Participants
24-09-13	Haria Union Parishad Office, Sonargaon, Narayanganj	11.00 am – 12.00 pm	24
25-09-13	Musapur Union Parishad office, Madan Circle, Narayanganj	11.00 am – 12.00 pm	24
25-09-13	Hazi Aman Super Market, Demra / Saidabad, Dhaka	4..00 pm – 5.00 pm	20
		Total	**68**

Figure 37: FGD and public consultation and Discussion: (a) Focus group discussion at Haria Union Parishad Office, Sonargaon, Narayanganj (FGD-1), (b) Project Engineer from IWM showing the tentative route of water pipeline, and (c) Formal meeting with a local school headmaster at Haria union, Sonargaon, Narayanganj

Figure 38: (a) Focus group discussion at Musapur Union Parishad office, Madan Circle, Narayanganj (FGD-2), and (b) Project Engineer from IWM explaining the project to the participants

Figure 39: (a) Focus group discussion at Hazi Aman Super Market, Demra, Saidabad, Dhaka (FGD-3), and (b) Project Engineer from IWM showing the tentative route of water pipeline

6.3 Key Findings From FGDs And Public Consultations

During the FGDs, efforts were made to get feedback from people on the nature of impacts and their suggestions about ways to mitigate the adverse impacts and enhance beneficial impacts. People who participated in the public consultations were found enthusiastic in sharing their views. The participants expressed their opinions regarding different issues including their knowledge about the proposed project, socio-economic condition of people in their localities, possible impact of the proposed project on the environment and in their localities, and mitigation measures to address adverse impacts. The major findings of the FGDs and public consultation are summarized below.

General Opinion regarding the project:

- The participants did not have any knowledge about the proposed water treatment plant project. This indicates that news/ information about the proposed project has not been widely circulated in mass media or in the localities.
- After hearing about the project details, most participants expressed their support for the project and project activities in their locality. However, they opined that more public consultations are needed to make people aware of the project and its activities.
- Although this project will supply treated water to the people of Dhaka city, some participants wanted a part of the treated water to be supplied to the people of Sonargaon, Narayanganj. The people at the treatment plant area at Saidabad also wanted their area to be included in the treated water supply scheme of DWASA.

General opinion regarding possible impacts of the project

- Although the participants did not anticipate any adverse impact on aquatic environment from project activities, they thought that water pollution at their locality is a major concern and requested the project officials to the address the issue through this project.
- Participants hoped that the communication system (road network) in their locality (Sonargaon, Narayanganj) will be improved through implementation of this project, because access road to be constructed up to the proposed intake at Haria would facilitate connection of the locality with the Dhaka-Chittagong highway.
- The participants expressed their strong opinion against possible negative impact on social environment due to project activities.

- Some participants suggested that appropriate measures should be taken to address possible sound pollution during construction and operation phases of the project.
- Some participants suggested that local contractors should be given priority to supply construction materials.
- Some participants hoped that overall economy of the local area will be benefited due to generation of employment opportunities during construction phase of the project.
- The participants at Sonargaon demanded that compensation against any land acquisition should be provided at prevailing market rate, and that homestead areas should be avoided during land acquisition. The participants at Madanpur Circle were happy to learn that no private land needs to be acquired for the proposed water transmission line along Dhaka-Chittagong highway. The participants from Saidabad opined that the land already acquired by DWASA (for Saidabad water treatment plant) should be used for the proposed third phase of the treatment plant, and no new land should be acquired.
- The participants expressed their concern that the operation of the water treatment plant will be threatened if the river is silted up and therefore action is needed to dredge the river to get water throughout the year.
- The participants are aware about the rapid depletion of groundwater level in Dhaka city, and though that this problem will be reduced if this project is implemented. They also thought that electricity consumption in Dhaka city will be less as they would get drinking water through this project and would not have to run electric motor to pump groundwater in large quantities; this will have a positive impact on load-shedding in Dhaka city.

Expectation of people from the Project

- Proposed project will ensure enough supply of drinking water in all wards of city;
- Executing agency will give preference to engage qualified contractor to ensure quality of works as well as timely completion of work;
- Efforts will be made by government to supply drinking water round the clock;
- People whose livelihood have been affected (if any) will be given required assistance (e.g., in the form of cash compensation);
- Local people will be employed by the contractor during construction work;
- Adequate safety measures will be taken during construction work;
- Local people appreciate the initiative of the Government and will cooperate with the executing agency during project implementation.

7. Impact Evaluation

7.1 Introduction

Environmental impacts of the specific project activities on different ecological, physico-chemical and human interest related parameters, both during the construction phase and the operation phase, have been identified and assessed. The important issues to be addressed during the operational phase include: (i) Stability of river bank and intake channel; (ii) Availability of raw water; (iii) Raw water quality; (iv) Treated water quality; (v) Proper operation of treatment plant; (vi) Public health and DWASA service facilities; (vii) Sludge treatment and disposal; (viii) Safety of water distribution network; (ix) Disposal of additional volumes of wastewater that will be generated due to increased water supply in Dhaka city after completion of the project; and (x) Navigation in rivers and khals through which water transmission line has crossed.

The environmental impacts of the specific project activities listed above have been assessed separately for both construction and operational phases of the project, with special emphasis on the issues that could generate significant adverse impacts, such as: (i) Land acquisition and related social impacts, (ii) Ecological impacts affecting water bodies, and (iii) Possible disruption to road communication and navigation during the construction phase. This Chapter provides an assessment of the potential environmental impacts of the proposed project, especially focusing on these issues.

7.2 Environmental Impacts During Construction Phase

Based on the preliminary analysis of major activities during construction phase, a set of parameters/ indicators have been selected for assessment of environmental impacts of the proposed project:

- Ecological: aquatic environment (flora and fauna); fisheries; species diversity; trees and bushes.
- Physico-chemical: water pollution, air and noise pollution; drainage; sanitation and solid waste.
- Socio-economic: loss of property/ land; loss of income; communication and traffic congestion; employment and commercial activities.

7.2.1 Ecological Impacts

The proposed project activities, including construction of water treatment plant and installation of water transmission and distribution pipeline have some potential impacts (direct and indirect) on the existing ecological environment. Important project activities include land clearing and alteration, movement of people and vehicle, materials placement, excavation, accident (e.g. spills, leaks of chemicals), river/ water body crossing of water transmission line, etc. Construction activities associated with crossing of rivers/water bodies by water transmission line are likely to have some adverse impact on aquatic environment, especially on aquatic flora, fauna, fish and water quality. It should be noted that there are 2 major rivers (Old Brahmaputra and Sitalakhya rivers) along the proposed route of the transmission line which will be disturbed during the construction activities. During operational phase, ecological impacts may result from improper disposal of dewatered sludge in the environment. For the proposed project, potential ecological impacts could be divided into two broad category viz. (a) direct impact and (b) indirect impact. This Section describes both impacts on 3F (flora, fauna and fish) diversity of the project areas.

Potential Impact on Flora

Activities related to construction of WTP and installation of water transmission lines have some potential impacts (direct and indirect; positive or negative) on the existing ecological environment. Magnitude / intensity of these impacts may vary from place to place; some could easily be identified while others require long-term study/ monitoring. Potential impacts of the proposed project on flora are described below.

Potential Impact on Aquatic Flora

The area in and around the project components (intake structures, transmission lines, WTP site) consists of a number of seasonal freshwater wetlands, including permanent water bodies (e.g. canals, ponds, rivers,etc). Significant number of freshwater aquatic habitat exists there to support more than 24 aquatic floral species; however, none of them are threatened in Bangladesh. Due to proposed project activities (e.g. those associated with installation of pipeline through water bodies), some aquatic flora may have to face potential adverse impacts. If project activities run over an aquatic floral habitat, partial or entire aquatic flora may be damaged or destroyed. People, vehicle and material movement over the aquatic floral habitat may cause damage or uproot them from the ground. For example, 2 ponds exist on the land to be acquired along the 6 km segment of water transmission route from intake at Haria to Dhaka-Chittagong Highway. These two ponds with their aquatic fauna will cease to exist as these will probably be filled up. On the other hand, the water bodies surrounding the proposed route of water transmission line will be impacted indirectly due to construction activities.

Potential Impact on Terrestrial Flora

Except for the site of the proposed WTP, most project areas have significant number of terrestrial habitat to support more than 68 terrestrial floral species, though none of them are threatened in Bangladesh. Most of the floral species are planted by the local Govt. (roadside plantation) and local people (village plantation) for their livelihood, and these are common throughout the project areas. Potential impact on terrestrial flora is likely to be moderate. During construction phase, some trees may be uprooted from its original habitat. For example, 34 trees of 4 different species (Litchi tree, rain tree, jackfruit tree and mango tree) will require uprooting along the 6 km segment of transmission line from Haria to Dhaka-Chittagong Highway. Since these are used as habitat or nesting ground by birds/animals, clearing of the trees will generate adverse impacts. Terrestrial undergrowth has great contribution to the existing ecosystem, and clearing or removal of the undergrowth would also have some adverse impacts.

Potential Impact on Fauna including Fish

Construction activities related to the proposed project could have potential impacts (direct and indirect) on the existing aquatic and terrestrial fauna due to their highly sensitive and reactive behavior in response to disturbance that may occur at or near their habitat. Faunal species that are sensitive to direct (human activity and traffic) or indirect disturbance (noise) would be impacted most. Habitat disturbance would reduce habitat availability and effectiveness for a certain period for mammals, reptiles, amphibians, birds and their predators. There are also some possibilities of direct mortality and displacement of amphibians, reptiles, birds and mammals from the use of vehicle or machineries over terrestrial or aquatic faunal habitats. Quantification of these losses is difficult; however, the impact is expected to be low and short-term in nature.

Actions near fish habitats may also have some potential impact on fish e.g., mortality, disturbance of fish passage during monsoon, deposition of excavated soil on fish habitat, contamination of water, destruction of shallow fish habitat or saturated ground by movement of project vehicles, etc. Impacts on fish could be quite difficult to assess immediately, but availability of some indicative fish species could be monitored by which impacts could be evaluated.

Potential Impact on Amphibians

One amphibian (skipper frog, *Euphlyctis cyanophlyctis*) has been identified in all the project sites. Amphibians are more sensitive to the environmental changes due to their permeable skin and other biological features. Amphibians use both aquatic and terrestrial habitat for their survival and changes in characteristics of habitat have a great impacts for their survival. Some of the project activities could have some impacts on existing amphibians such as (i) undergrowth or vegetation may be cleared for construction works, affecting amphibian habitat, (ii) project vehicle and materials may enter into the shallow / deep freshwater bodies or saturated ground affecting habitat, (iii) increased sediment load or contamination of water due to various project activities, also affecting habitat. These activities may cause temporary or permanent disturbance of amphibian habitat. Impacts on amphibian population could be evaluated by monitoring the changes of species composition and richness and their relative abundance.

Potential Impact on Reptiles

Around 11 aquatic and terrestrial reptiles were identified at or near the project sites and 3 of them are nationally extinct or vulnerable. These are Grey Monitor Lizard (*Varanus bengalensis*), Yellow Monitor Lizard (*Varanus salvator*) and Common Wolf Snake (*Lycodonaulicus*). Reptiles are sensitive animal and sometimes used as indicative species for bio-environmental assessment. Burrowing reptiles are bio-sensitive and respond quickly to any man-made or natural activities/ calamities. Special care should be taken before conducting any activity in and around the habitats of these animals. If the project activities are conducted during pre or post-breeding season of the burrowing reptiles, the entire community could be affected seriously or their life cycle could be jeopardized. To evaluate impacts on reptilian species, relative abundance and changes in species composition could be used as indicators.

Potential Impact on Birds

More than 44 bird species (terrestrial and aquatic) are available at or near the project sites, of which 9 are extinct, vulnerable and threatened nationally. Potential impacts of project activities on birds include disturbance due to project related actions and excessive human presence during bird's foraging, resting and nesting time that might result in reproductive disturbance / failure. Removal of floral (tree, herb and shrub) species for the proposed project would affect some bird habitat from where they collect food (insects), take rest and also build nests. Potential impacts for those bird species include: (i) habitat destruction, (ii) temporary displacement due to increased human disturbance and vehicle movement, and (iii) nest abandonment and/or reproductive failure caused by project related disturbance.

Potential Impact on Mammals

At least 10 terrestrial and 1 aquatic mammalian species are available in the project areas, of which the one aquatic mammalian species (Ganges River Dolphin, *Platanista gangetica*) is nationally threatened. Some mammalian species may be disturbed and displaced from their habitat for some hours, days or months due to the project activities. They are likely to return to their habitat soon after

the disturbance has ceased. Some mammalian species also utilize village vegetation throughout the year or seasonally as permanent or temporary habitat. Project activities, e.g., movement of vehicle and people could displace potential prey species for some mammal within the project areas. However, disturbances associated with the proposed project works are too small to have any measurable effect on the prey for mammals. Effects are expected to be temporary, incidental and minimal.

Potential Impact on Fish

More than two dozen freshwater native fish species are available in and around the project areas, of which nine are nationally threatened. These threatened fishes are commercially important to the local community. In order to prevent habitat destruction, measures are needed for protection of water quantity, quality and fish passage/ access to habitat during flow periods. Freshwater native fish may encounter some potential impacts due to project activities, such as mortality, disturbance of fish passage, sediment deposition on fish habitat, contamination of water, destruction of shallow fish habitat due to intrusion of project vehicles, dewatering of water bodies, etc.

Table 34: Evaluation of ecological impacts resulting from different project activities

Source of Potential Impacts	Ecological Issues										
	Flora		Fish	Fauna							
				Amphibia		Reptile		Bird		Mammal	
	AQ	TR		AQ	TR	AQ	TR	AQ	TR	AQ	TR
During construction											
Camp setting	0	-1S	0	0	-1S	0	-1S	0	-1S	0	-1S
Access road construction	-1S	-1S	0	0	-1S	0	-1S	0	0	0	-1S
Land clearing	-1S	-1S	-1S	-1S	-1S	-1S	-1S	0	-1S	0	-1S
Soil excavation	-1S	-1S	-1S	-1S	-1S	-1S	-1S	0	0	0	-1S
Generation of Noise	0	0	-1S	-1S	-1S	-1S	-1S	-1S	-1S	0	-1S
Deterioration of water quality	0	0	-1S	-1S	-1S	-1S	0	-1S	0	-1S	0
Sewage discharge on soil / water	-1S	0	-1S	0	-1S	0	0	0	0	0	0
Water body crossing (during pipeline construction)	-1S	0	-1S	-1S	0	-1S	0	-1S	0	-1S	0
During Operation											
Spills (oil / Chemical) on land/water	-1S	-1S	-2S	-1S	-1S	-1S	-1S	-1S	-1S	0	-1S
Waste/sludge disposal	0	0	-1S	-1S	-1S	-1S	-1S	-1S	-1S	0	-1S

Legend: AQ = Aquatic; TR = Terrestrial; 0 = No impact (negligible impact), 3 = High impact, 2 = moderate impact, 1 = Low impact, S = Short term impact, L = Long term impact, +/- = positive/negative impact, AQ = Aquatic, TR = Terrestrial

7.2.2 Evaluation of Ecological Impact

For evaluation of ecological impact, a simple semi-quantitative descriptive checklist method has been applied. Firstly, the activities during construction and operation were identified and listed in the impact table. Then the corresponding impacts on the specific ecological components (terrestrial and aquatic flora and fauna, fish) were evaluated based on the baseline scenario and an assessment of the typical ecological interactions with project activities. Assessments were made as to whether the impacts were positive (beneficial) or negative (harmful), short-term (short recovery time) or long-term (extended recovery time); and of high or low/ moderate intensity. The results of the assessment are summarized in Table 38 which indicates that most of the evaluated ecological impacts are low or moderate (minor impact) and short-term in nature. No long-term adverse impacts to the floral species as well as to the populations of the mammals, reptiles, amphibian, birds and fishes are expected.

7.2.3 Risk Assessment

A typical environmental risk assessment matrix has been developed for flora, fauna and fish species within the project areas. A similar format is widely used in oil and gas industries. Table 35 shows the consequence severity ranking (from low to critical); Table 36 shows the likelihood ranking (from “almost certain” to “rare”), along with frequency level for each ranking. Table 37 shows the risk assessment matrix, which is based on consequence severity and likelihood/ frequency of occurrence of an event; risk has been classified from “low” to “extreme”.

Table 35: Consequence (Impact) Severity Ranking (Project Site Level)

Environmental effects				
Low	**Minor**	**Moderate**	**Major**	**Critical**
No lasting effect. Low-level impacts on biological environment. Limited damage to minimal area of low significance	Minor effects on biological environment. Minor short-medium term damage to small area of limited significance	Moderate effects on biological environment but not affecting ecosystem function. Moderate short-medium term widespread impacts (e.g. oil spill)	Serious environmental effects with some impairment of ecosystem function (e.g. displacement of species). Relative widespread medium –long term impacts.	Very serious environmental effects with impairment of ecosystem function. Long-term, widespread effects on significant environment (e.g. unique habitat, national park)

Table 36: Likelihood ranking table

Likelihood	Description	Frequency Description
Almost certain	Consequence expected to occur in most circumstances	High frequency of occurrence – occur more than once per month
Likely	Consequence will probably occur in most circumstances	Regular frequency. Event likely to occur at least once per year
Possible	Consequence should occur at some time	Occurs once every 1 – 10 years
Unlikely	Consequence could occur at some time	Unlikely to occur during life of operations – occurs once every 10 – 100 years
Rare	Consequence may occur under exceptional circumstances	Highly unlikely to occur during life of the operation. Occurs less than once every 100 years.

Table 37: Risk assessment matrix

Likelihood / Frequency	Consequence Severity				
	Low	Minor	Moderate	Major	Critical
Almost certain	High	High	Extreme	Extreme	Extreme
Likely	Moderate	High	High	Extreme	Extreme
Possible	Low	Moderate	High	Extreme	Extreme
Unlikely	Low	Low	Moderate	High	Extreme
Rare	Low	Low	Moderate	High	High

In Table 38, the potential impacts of the project activities on the flora, fauna and fish species have been ranked on the basis of consequence severity ranking, likelihood/frequency ranking, and risk rating. Both the “consequence severity” and “risk” of the possible impacts have been categorized as “low”, while “likelihood/frequency” has been categorized as “possible”. Thus, the proposed project is not likely to have any significant adverse impact on the existing ecological environment, if appropriate mitigation measures are adopted (see details in Chapter 9).

Table 38: Summary of Environmental Risk Assessment Matrix

Ecological Aspects	Potential Impact (Consequence)	Consequence severity ranking	Impact likelihood rating	Risk rating
Flora	Minor impact to flora may occur during the installation of water transmission pipeline. Construction of water treatment plant may displace or remove aquatic floral species; Removal of flora due to soil/trench excavation (for pipeline installation) may be replaced by plantation programme; hence no major effects are expected.	Low	Possible	Low
Fauna	Minor impacts (temporary displacement) to all types of fauna may occur during installation of water transmission pipeline. Soil/trench excavation and construction of WTP have negative impacts (e.g., habitat loss). Since the activities are temporary in nature, no major or long-term effects are anticipated, except loss of some habitat.	Low	Possible	Low
Fish	Fish communities could potentially be impacted from soil deposition in aquatic habitat, fish pass, noise, water pollution, etc. The majority of impacts would be temporary in nature; fish may avoid the impacted areas during construction period, but return when it ceases.	Low	Possible	Low

7.2.4 Physicochemical Impacts

Major physicochemical parameters considered for assessment of environmental impacts of project activities include drainage congestion, air and noise pollution, sanitation and solid waste, water pollution. The effects of the project activities during construction phase on these parameters have been assessed.

Water Quality

The alignments of the proposed water transmission and distribution lines pass through large number of water bodies, including two major rivers (Old Brahmaputra and Sitalakhya), ponds, and lowlands. It also passes close to a number of ponds and canals. These water bodies are susceptible to pollution from construction related activities, e.g., accidental spills of chemicals (e.g. oil/grease), materials and contamination by discharge of wastes from workforce (e.g. from labor sheds) during the construction phase. Care should be taken to avoid such contamination, especially because many of these water bodies are important for fisheries, which could be adversely affected by water pollution.

Noise and Air Pollution

Some noise and air pollution could result from excavation and other construction activities. Such activities in close proximity of densely populated areas (e.g., during installation of distribution lines within city areas) would generate some adverse impacts. However, noise generated by construction activities will typically be for a short duration with minor adverse impact. Air pollution from construction

activities is also likely to be localized close to the actual construction sites with minor impact. Increased movement of vehicles carrying construction material to and from the project sites could also increase noise and air pollution.

Sanitation and Solid Waste
Problems related to sanitation and solid waste may result from improper/ inappropriate facilities at the labor sheds. Lack of proper sanitation facilities for project people, including the labor/ construction worker and absence of proper solid waste (e.g., food waste, construction debris) disposal facilities may create an unhealthy environment within and around the project sites. The Saidabad Phase-III site consists of several sludge lagoons (where the sludge from Saidabad Phases-I and II operation is disposed), which will be excavated for the construction of treatment units (for Phase-III). The excavated material may contain harmful metals (e.g. Aluminum) and may cause environmental pollution if not disposed in a proper manner.

Drainage Congestion
Drainage congestion may result from possible obstruction to natural flow of drainage water due to the storage of materials, digging/ back-filling of water transmission/ distribution line trenches. Therefore, care should be taken to avoid any drainage congestion during the construction of the proposed intake structure, water treatment plant and water transmission/ distribution line.

The proposed water distribution lines would cross some khals, other water bodies and box culverts. Most of these khals and water bodies are shallow, and it has been proposed that pipes would be laid by open excavation method during the dry season. Special care should be taken to make sure that this does not cause any drainage congestion or interrupt movement of water/wastewater. For crossing of deeper khals and box culverts, pipe jacking method is recommended to avoid any adverse impacts.

7.2.5 Socio-economic Impacts

Major social parameters considered for assessment of social impacts of the proposed project include loss of land, loss of income, traffic congestion and safety, employment and commercial activities. The effects of the project activities on these parameters have been assessed.

Loss of Land
For the proposed project, land acquisition will be required for: (i) intake channel, intake structure and associated facilities; (ii) the segment of twin raw water transmission lines (minimum 2000 mm dia) from intake structure to Dhaka-Chittagong highway (~8 ha); (iii) construction of a single pipeline (minimum 2000 mm dia) parallel to the existing box culvert from Demra road to WTP site (~1 ha). No land acquisition is anticipated for the installation of distribution lines. Thus, the total land area to be acquired for the proposed project is ~9 ha.

The proposed 6 km segment of transmission line from the intake point at Haria on the bank of Meghna River to Dhaka-Chittagong highway passes over a number of homesteads, ponds, agricultural lands, etc. Therefore, acquisition of these lands would result in loss of land and property.

Along Dhaka-Chittagong and Dhaka-Sylhet highway, the water transmission line has been proposed to be laid along the roadside borrow pit, which is owned by the RHD. Hence no land acquisition will be required. Also transmission lines along the proposed extension of Demra highway as well as the site

for the treatment plant is also owned by DWASA/ BWDB, and no additional land acquisition will be required in this case. Therefore, land acquisition for laying of most part of the water transmission line is not significant.

Land acquisition has significant adverse social impacts, and therefore care should be taken to minimize land acquisition. Adequate compensation should be provided against land acquisition as per Government rules and regulations, and relevant resettlement policy framework of DWASA. Care should be taken to ensure that that the affected people get the compensation without delay.

Loss of Income

Loss of income may result from inability to use a particular piece of land/ establishment (e.g., agricultural land or industry; road-side shops) during the construction phase for income generation activities. Efforts should be made to keep such loss to a minimum (e.g., scheduling construction keeping in mind agricultural/ fishing practices in the area) and provide proper compensation for any loss of income.

Crossing of Roads and Water bodies

The water transmission pipeline corridor passes through two major rivers, Old Brahmaputra and Sitalakhya. Temporary disruption of river traffic is anticipated during laying of water transmission pipeline across the river. “Pipe jacking” technique has been proposed for installation of pipes across the major rivers, which is not likely to cause significant disruption to river traffic. As noted earlier, the water distribution pipeline would also cross some khals and other water bodies; but most of these are shallow and none of these are used for navigation/ transport.

The proposed water transmission lines also cross local roads as well as the Dhaka-Chittagong and Dhaka-Sylhet highways on two locations and temporary disruption of communication is expected during pipeline laying in these locations. The proposed water distribution lines would also cross some roads as well as railway line (at Titipara near ICD Kamlapur); especial care should be taken to minimize disruption of vehicular traffic during and to ensure safety of rail track construction works.

Possible traffic congestion resulting from movement of vehicles (especially on busy Dhaka-Chittagong highway) carrying material and equipment should be addressed with proper traffic management, and avoiding stockpiling of materials in a way that could hamper traffic movement.

Utility Services

Shifting or relocation of some utility lines (e.g. power, gas, water supply lines) may be required, especially during installation of transmission/ distribution lines within city areas. Such shifting often requires considerable time, and cause sufferings to people. Especial care should be taken during finalization of alignment of water lines and also during detailed design to minimize or avoid such shifting/ relocation. If shifting/relocation is unavoidable, special care should be taken, in association with respective service providers, to arrange for alternative services during the shifting/ relocation. Safety issues should be given utmost importance during shifting/ relocation, especially of power lines.

Archeological and Historical Sites

Archeological and historical sites are protected resources. Water transmission/ distribution line construction and maintenance can damage such sites by digging, crushing by heavy equipment, uprooting trees, exposing sites to erosion, or by making the sites more accessible to vandals.

However, no archeological or historical site was encountered along the route of the proposed water transmission/ distribution lines and other project areas. The historical Panam city, which is maintained by the Archeological Department, is located near the intake area site. Therefore precautions are to be taken to avoid any damage to the area.

Safety Issues
Safety (including occupational safety) is an important issue during construction phase of a water transmission and distribution lines. Construction activities in densely populated areas and along narrow roads (e.g. during installation of distribution lines within city areas) could increase risks to pedestrian and vehicular movement. Scheduling of construction works and delivery of construction materials, and proper management of traffic are very important to minimize such impacts. Safety issues (particularly occupational health and safety) are also important for general construction activities, which should be addressed as part of occupational health and safety plan.

Safety/ stability of structures (buildings, walls) located very close to the alignment of transmission/ distribution lines could be an important issue, especially during construction of water distribution lines along narrow roads. Vulnerable structures should be identified before commencement of construction works, and special care should be taken during excavation of trenches and during construction period to avoid damage to any structure.

Beneficial Impacts, Employment and Commercial Activities
The major beneficial impact of the project would certainly be on public health and indirectly on the national economy. The project will contribute to resolve the water supply problem in Dhaka city. Some beneficial impact at local level would come in the form of employment. This in turn would induce some positive impacts on some other parameters including commercial activities in the project area.

7.3 Environmental Impacts During Operational Phase

The most important benefit of the proposed water treatment plant project would be expansion of service facilities of DWASA, through addition of 450 MLD of water supply to Dhaka city. Improvement in water supply situation would alleviate sufferings of many people in different areas of the city, who go through tremendous hardships to collect potable water, especially during the dry season when many deep tubewells become inoperative. This in turn would have significant benefit on public health. Also, with the added capacity of water supply from surface water sources, the dependence on groundwater is expected to be reduced which will allow for limited abstraction from the DWASA deep tubewells and eventually reduce the pressure on groundwater resources. This will have a positive effect on groundwater quantity and quality. Other beneficial effects during the operation phase include employment of people for the operation and maintenance of the treatment plant. This in turn would induce a positive impact on some other parameters including commercial activities in the project area.

Increased water supply also means increased generation of domestic wastewater in Dhaka city. The wastewater disposal situation in Dhaka city is already poor. The DWASA needs to take up appropriate steps for expanding the sewerage network and sewage treatment system, especially in areas where water supply would be significantly increased due to the proposed project. Otherwise, it may cause long-term adverse impact on water quality. For maintaining proper quality of treated water, the raw

and treated water quality should be regularly monitored; provisions should be there for adjusting treatment process (e.g., alum dose) depending of water quality.

At the WTP, sludge will be produced from two major sources: (i) de-sludging of the Clarifiers, and (ii) wash water from filter back wash. Sludge thickeners will be provided to reduce the volume of the sludge from Saidabad Phase-III. Sludge thickeners will also be installed for the Saidabad Phase-I under this project (sludge thickeners are already installed for Saidabad Phase-II). Eventually the thickened sludge from Phases-I, II and III combined is proposed to be run through a filter press setup to generate 30% dried sludge with a volume of 30,000 m^3/year. Unsanitary dumping of aluminum-rich dried sludge may cause leaching of metals and cause soil contamination the impact of which can be long-term. Proper disposal of dried sludge has to be ensured to protect the environment. Liquid residuals from sludge dewatering operation needs to be checked against the effluent discharge criteria before disposal as it may contain excess organic matter, toxic metals, ammonia, suspended solids, etc. Besides this, Accidental chemical oil leaks, spills on land/ water from equipment/parts of the treatment plant or pumping station may cause negative impacts on surface water and soil quality and may adversely affect public health; therefore appropriate mitigation plan should be devised for such occurrences.

Stability of riverbank at the location of intake and protection of water transmission line from possible damage are important issues during the operational phase. Adequate protection measures are to be taken in this regard. Since the water transmission line would cross a number of rivers and other water bodies, maintaining proper navigation through these water bodies without any risk of damage to transmission lines is also an important issue.

Protection of Meghna River against pollution from untreated domestic and industrial wastewater is a very important consideration during operational phase of the project. Although the density of industries in areas close to the intake location is relatively low at the moment, land filling activities (for raising elevation of existing land) were observed close to the intake location, possibly for the establishment of industrial facilities. It is important to develop a long-term management plan for the protection of water quality in Meghna River, including restriction on establishment of industries producing liquid effluent within certain reaches upstream and downstream of the intake point; discharge of untreated domestic sewage into the river should also be strictly controlled.

7.4 Evaluation Of Physico-Chemical And Socio-Economic Impacts

For evaluation of physicochemical and socio-economic impacts, a simple semi-quantitative descriptive checklist method has been applied. Firstly, the activities during construction and operation phases were identified and listed in the impact table. Then the corresponding impacts on the environmental compartments (air, water, soil quality, noise level, etc.) and human-use factors (loss of land, income, traffic congestion, safety, etc.) were evaluated depending on their typical interaction with project activities. Assessments were made as to whether the impacts were positive (beneficial) or negative (harmful), short-term (short recovery time) or long-term (extended recovery time) and of high or low/moderate intensity. The results of the assessment are summarized in Table 39 and Table 40, which show that most of the evaluated impacts are of low or moderate (minor impact) intensity and are short-term in nature.

Table 39: Physicochemical from activities associated with the construction and operation of Saidabad Water Treatment Plant Phase III

	Project Activities	Physicochemical Impacts						
		Drainage congestion	Noise level	Air quality	Surface Water quality	Groundwater quality	Soil Erosion	Soil quality
During Construction	Labour camp setting and its operation	0	0	0	-1S	-1S	0	0
	Access road construction	-1S	-1S	-1S	-1S	0	-1S	0
	Land clearing	-1S	0	0	0	0	-2S	0
	Soil excavation	-2S	-2S	-2S	-1S	0	-1S	-1S
	Piling work	0	-2S	-1S	-1S	-1S	0	0
	Concreting work	0	-2S	-1S	0	0	0	0
	Water body crossing work (pipeline laying)	-1S	-2S	-1S	-1S	0	0	0
	Provision for safe water and sanitation facilities for workers	0	0	0	0	0	0	0
During Operation	Solid /hazardous waste and wastewater generation	0	0	0	-1L	-2L	0	-2L
	Access to safe water supply	0	0	0	0	+2L	0	0
	Accidental chemical oil leaks, spills on land/ water	0	0	0	-1S	0	0	-1S

Legend: +3 = High Positive Impact, +2 = Moderate positive impact, +1 = Low Positive Impact, 0 = No impact, -1 = Low Negative Impact, -2 = Moderate Negative Impact, -3 = High Negative Impact S = Short term impact, L = Long term impact

Table 40: Socio-economic impacts from activities associated with the construction and operation of Saidabad Water Treatment Plant Phase III

	Project Activities	Socio-Economic Impacts						
		Loss of Land	Loss of income and displacement	Traffic	Impact on topsoil	Public Health and safety	Effect on Archeological sites	Employment and commercial activities
During Construction	Land acquisition	-2L	-2L	0	0	0	0	0
	Labor camp setting	0	0	0	0	0	0	+2S
	Access road construction	0	-1S	-1S	-2S	-1S	0	+2S
	Land clearing	0	-1S	0	-2S	0	0	+2S
	Soil excavation	0	-1S	0	-1S	-1S	0	+2S
	Piling work	0	0	0	0	-1S	0	+2S
	Concreting work	0	0	0	0	-1S	0	+2S
	Water body crossing work	0	0	-1S	0	-1S	0	+2S
	Provision for safe water and sanitation facilities for workers	0	0	0	0	+2S	0	0
During Operation	Accidental chemical oil leaks, spills on land/ water	0	0	0	-1S	-1S	0	0
	Solid /hazardous waste and wastewater generation	0	0	0	-1S	-1S	0	0
	Access to safe water supply	0	0	0	0	+3L	0	0

Legend: +3 = High Positive Impact, +2 = Moderate positive impact, +1 = Low Positive Impact, 0 = No impact, -1 = Low Negative Impact, -2 = Moderate Negative Impact, -3 = High Negative Impact S = Short term impact, L = Long term impact

8. Analysis of Alternatives

8.1 Introduction

The Chapter provides an assessment of alternative sites for the location of the intake and alternate raw water transmission routes for Saidabad Phase-III project. For completeness, the “no project” scenario has been discussed in this Chapter. This Chapter also presents a discussion on alternative technology options for crossing of rivers by raw water transmission pipelines.

8.2 Alternate Intake Location

Three alternate locations for the raw water intake for Saidabad Phase-III were considered:

- The existing raw water intake at Sarulia along the Sitalakhya River (i.e. using the Lakhya river water for Saidabad Phase-III)
- A common intake at Bisnondi along the Meghna River to supply raw water to Saidabad Phase-III WTP as well as the proposed water treatment plant at Gandharbpur
- A separate intake for Saidabad WTP at Haria along the Meghna River.

8.2.1 Intake at Sarulia

The use of the existing raw water intake at Sarulia (after expansion with necessary facilities for additional pumping) was considered as an intake option to provide the raw water for Saidabad Phase-III. This option continues to use the Lakhya River as a water source as well as makes the best use of the investment already made for Saidabad Phases-I and II. The DND conveyance canal, which conveys the raw water from Sarulia intake upto the junction with the double cell transfer box culvert inlet to Saidabad plants, is wide enough to carry a total flow in the range of 1,000 MLD with acceptable head loss all through for the time being. In this option, the whole pumping facilities including motors, electric cabinet, power transformers should be resized and new equipment should be installed to provide the additional head needed for the increased flow. Also, the existing two cell box culvert (sizing 2m x 1.50m each) which conveys the raw water from the downstream end of the DND canal to the treatment plant site is currently not adequate to cater to the expected total flow of 1000 MLD. Therefore, an additional culvert of adequate size should be provided between DND and the treatment plant.

The capital investment associated with this option is significantly lower compared to other options, yet the intake at Sarulia is not going to be a feasible option due to the following reasons:

- The areas around the DND canal is developing day by day and the open canal is subject to the surrounding urban pressure and has become prone to pollution by discharge of wastewater and solid waste. It is generally not advisable to transfer raw water for drinking water treatment plant in open type canal in urban areas. Since the future prospect of DND canal as a reliable water conveyance canal is uncertain, it would be unwise to rely on this to convey raw water to Saidabad WTPs.
- The most important factor in favor of rejecting this option is the poor source water quality. The water quality from the Lakhya River is irremediably deteriorating over the years mainly in the dry season (ammonia content for instance is far beyond the fixed target of 15mg/l and has reached 22mg/l in 2013) and is no longer deemed as a reliable source of water supply throughout the year.

Although according to the recently prepared DWASA Sewerage Master Plan, the raw water quality of Lakhya River could be improved by implementing the program for construction of sewage treatment plant at Dasher kandi to avoid domestic and industrial pollution in the upstream of the intake & by implementing necessary steps to treat domestic and industrial waste of DND area, these measures would require more time as well as funds. Since the pollution load in the Lakhya River is increasing and has become a threat to the operation of Saidabad Phases-I and II, shifting the intake has become a matter of great necessity. Any investments relying on the water of the Sitalakhya River will not be wise under the current scenario.

8.2.2 Intake at Bisnondi

The proposed treatment plant at Gandharbpur will derive raw water from Meghna River at Bisnondi, approximately 14 km upstream of Haria, and the possibility of getting raw water for both treatment plants from a common intake (see Figure 2) was explored. The raw water transmission lines from the intake point at Bisnondi will run along a 30 m wide and 17 km wide long land (~ 53 ha, which needs to be acquired) which can be used to convey the raw water for both plants upto Dhaka-Sylhet highway. After this point pipelines may follow separate paths to reach the respective treatment plants. Although the water quality parameters of Meghna River at Bisnondi have been found to be acceptable for easy treatment and the river bank has been found to be stable and relatively erosion-free, using a common intake point at Bisnondi by sharing the intake facilities may not be an advisable option for a number of reasons, as listed below:

- In terms of capital and operation costs, the intake at Haria is preferable to that of Bisnondi for Saidabad WTP as (1) Transmission lines will be around 4 km shorter in the Haria intake option and (2) Bisnondi option will require 15% more pumping head compared to the Haria option for Saidabad WTP.
- Land acquisition in open areas will be limited to a 6 km land strip in the Haria option, which is only 30% of the land acquisition requirement for the Bisnondi option. In addition to providing a cheaper land acquisition capital cost, an intake at Haria will be safer in terms of administrative process and will minimize the probability of delay. In the Haria intake option, most part of the raw water transmission route will be located in the Right of Way of Roads & Highways Department.
  Moreover, the Water Supply Master Plan of DWASA, prepared by IWM, recommends to implement Gandharpur Phase-III at the horizon 2035. This WTP would benefit from the land acquisition and intake structure planned under Gandharpur project, initially envisaged for Saidabad.
- There is an implementation constraint if the Bisnondi intake option is adopted for Saidabad WTP. Works for the Gandarbhpur plant are expected to start in January 2014 and to be completed by December 2019. If the same intake is used for both Gandarbhpur and Saidabad WTPs, then commencement of construction of the proposed Saidabad WTP Phase-III may have to wait beyond the year 2019. With a separate intake at Haria, works from Haria to Saidabad will not depend on work progress for Bisnondi intake and Gandharbpur WTP. Thus water supply to Saidabad I, II & III can be secured more quickly from Haria than from Bisnondi. This is important because there is an urgent need to secure a reliable and alternate source of water as the existing Phases-I & II (90% of the current water supply from surface water source in Dhaka) are already facing operational problems during dry season due to poor quality of water from Lakhya River.
- It is safer for DWASA to operate multiple independent intakes instead of relying on a single intake for several treatment plants. It is estimated that adopting two intakes in Meghna River at Bisnondi for Gandharpur and at Haria for Saidabad will increase the water security by 33% (EGIS-IWM, 2013).

8.2.3 Intake at Haria

At Haria, the water quality parameters of Meghna River have been found to be acceptable for easy treatment, the river bank has been found to be stable and sufficient quantity of water has been found to be available throughout the year. As discussed above (8.2.2), an intake at Haria for the proposed Saidabad water treatment plant would be advantageous for a number of reasons. The major advantages are as follows:

- For the intake at Haria, the raw water transmission lines will be around 4 km shorter (compared to Bisnondi option); an intake at Haria will also require 15% less pumping head compared to the Bisnondi option.
- Land acquisition required for the intake at Haria is only about 30% of that required for a common intake at Bisnondi.
- With a separate intake at Haria, water supply to Saidabad I, II & III can be secured more quickly
- With two main intakes on Meghna River, DWASA ensures more security and flexibility for the future operation of the overall water supply system of Dhaka City.

8.3 Alternate Raw Water Transmission Route

Five options have been considered to transmit raw water from Demra circle to the treatment plant.

Option 1: The raw water transmission mains will follow the Dhaka-Demra road up to Mredhabari, and then one transmission main will be connected to existing connecting box culvert from DND to Saidabad treatment plant. This transmission main will supply raw water for Saidabad Phases-I & II. The second transmission main for Saidabad Phase-III will go through the acquired land available after construction of the connecting box culvert (see Figure 40).

Option 2: The first transmission main will be connected to DND canal near Demra circle, and this will provide raw water for Saidabad Phases-I & II from the river Meghna during dry season. During wet season, raw water will be supplied from Sarulia intake pump station. The second transmission main will follow the Dhaka-Demra road up to Mridhabari near the connecting culvert, and will reach Saidabad Phase-III site following the acquired land available after construction of the connecting box culvert (see Figure 41).

Option 3: The first transmission main will follow the Dhaka-Demra road up to Mridhabari, and then it will be connected to existing connecting culvert from DND to Saidabad treatment plant. The second main will go about 720 m along Demra-Amulia-Rampura road from Demra circle and then it will reach the connecting culvert following DWASA-owned land. Finally, it will reach the Saidabad treatment plant Phase-III site following the acquired land available by the side of the connecting box culvert (see Figure 42).

Option 4: Both the transmission main will follow about 720 m along Demra-Amulia-Rampura road from Demra circle, and then they will reach to the connecting culvert following DWASA-owned land. The first one will connect to the culvert at this point and the other one will reach Saidabad treatment plant Phase-III site through acquired land available after construction of the connecting box culvert (see Figure 43).

Option 5: The first transmission main will be connected to DND canal near Demra circle and this will provide raw water for Saidabad Phases-I & II from the river Meghna during dry season. During wet season raw water will be supplied from Sarulia intake pump station. The second transmission main will go to the connecting box culvert from Demra circle, following about 720 m of Demra-Amulia-Rampura road and DWASA acquired land. From this culvert it will reach the Saidabad Phase-III site through the available acquired land by the side of the culvert (see Figure 44)

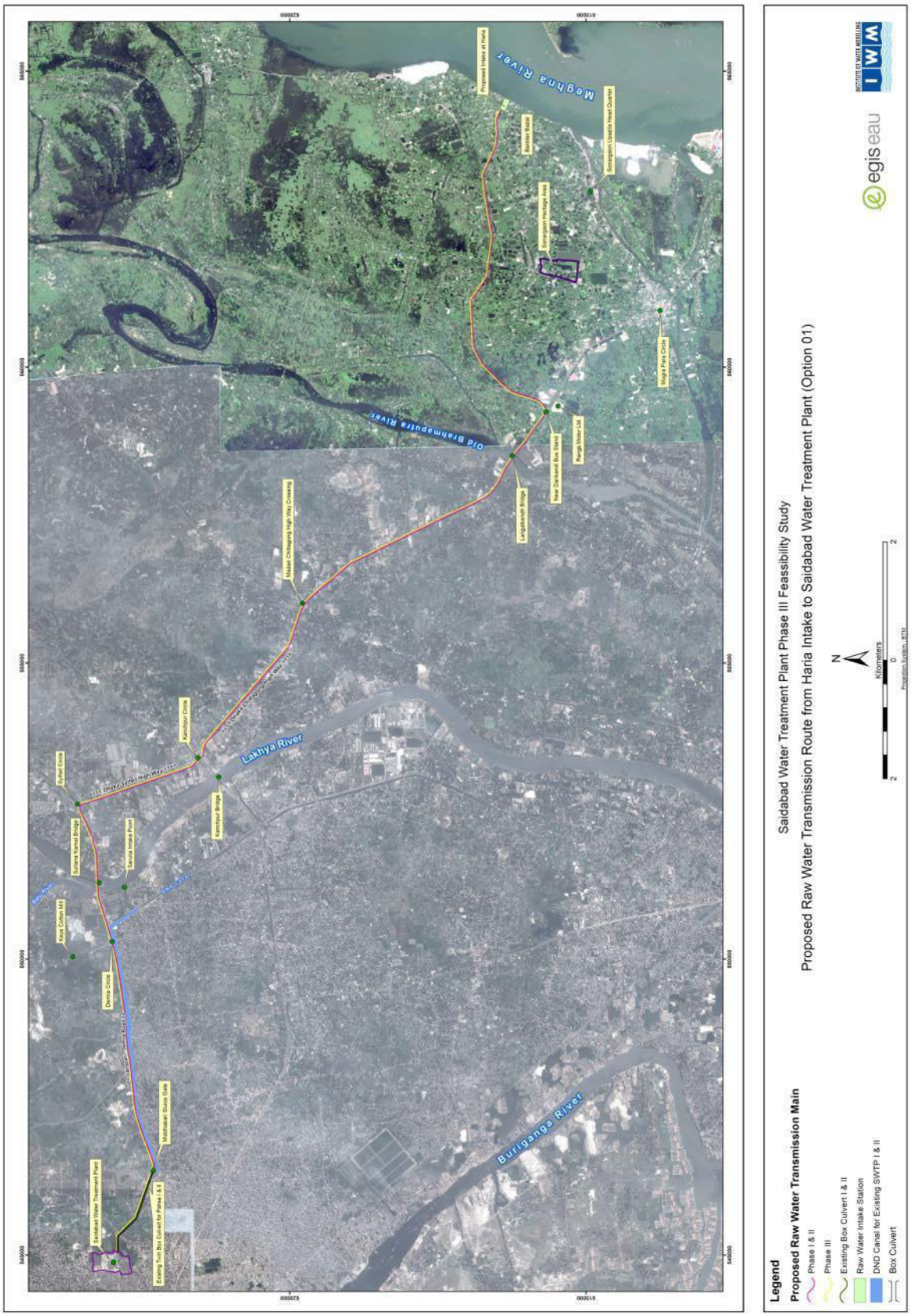


Figure 40: Proposed Raw Water Transmission Route from Haria to SWTP (Option 1)

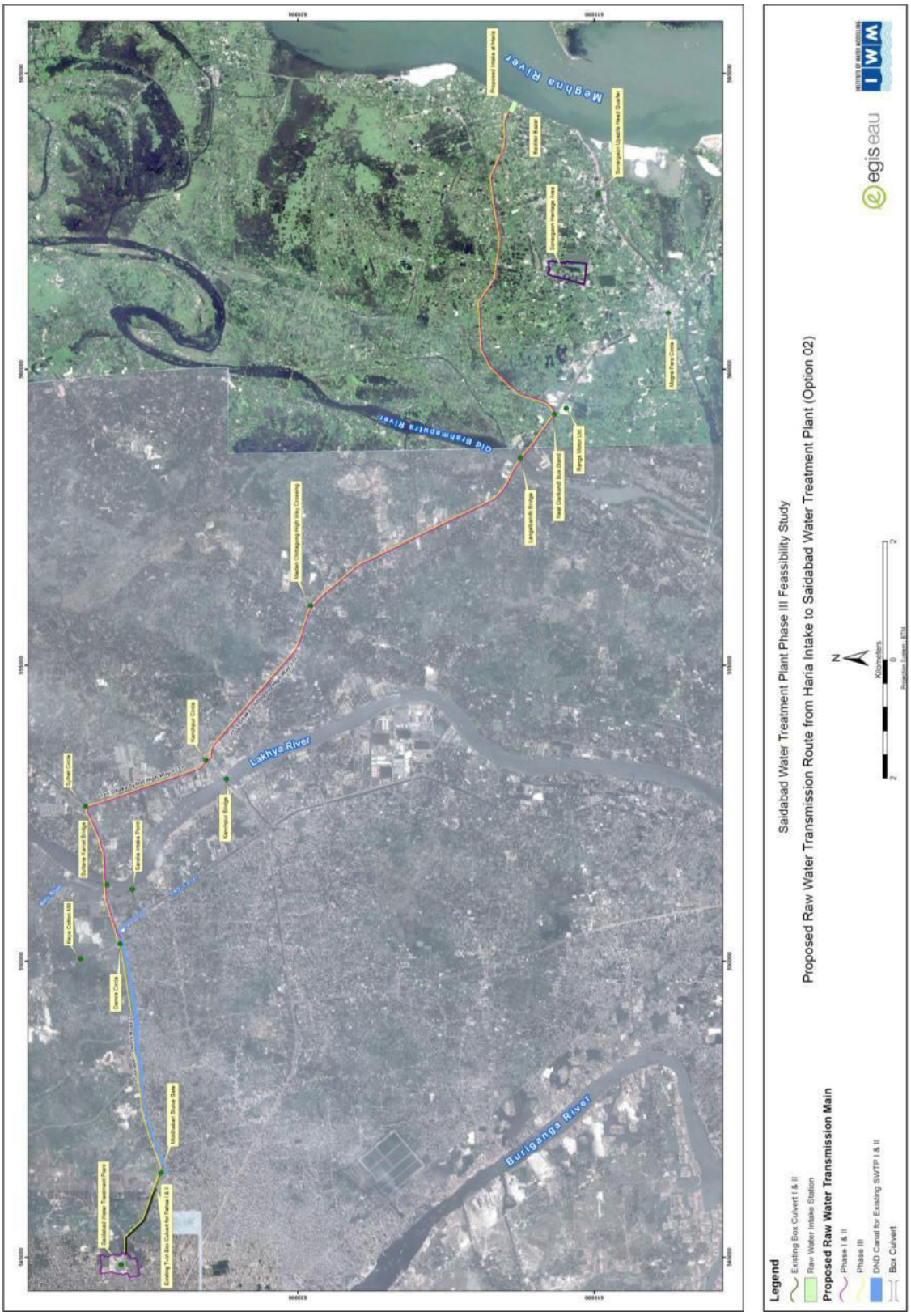


Figure 41: Proposed Raw Water Transmission Route from Haria to SWTP (Option 2)

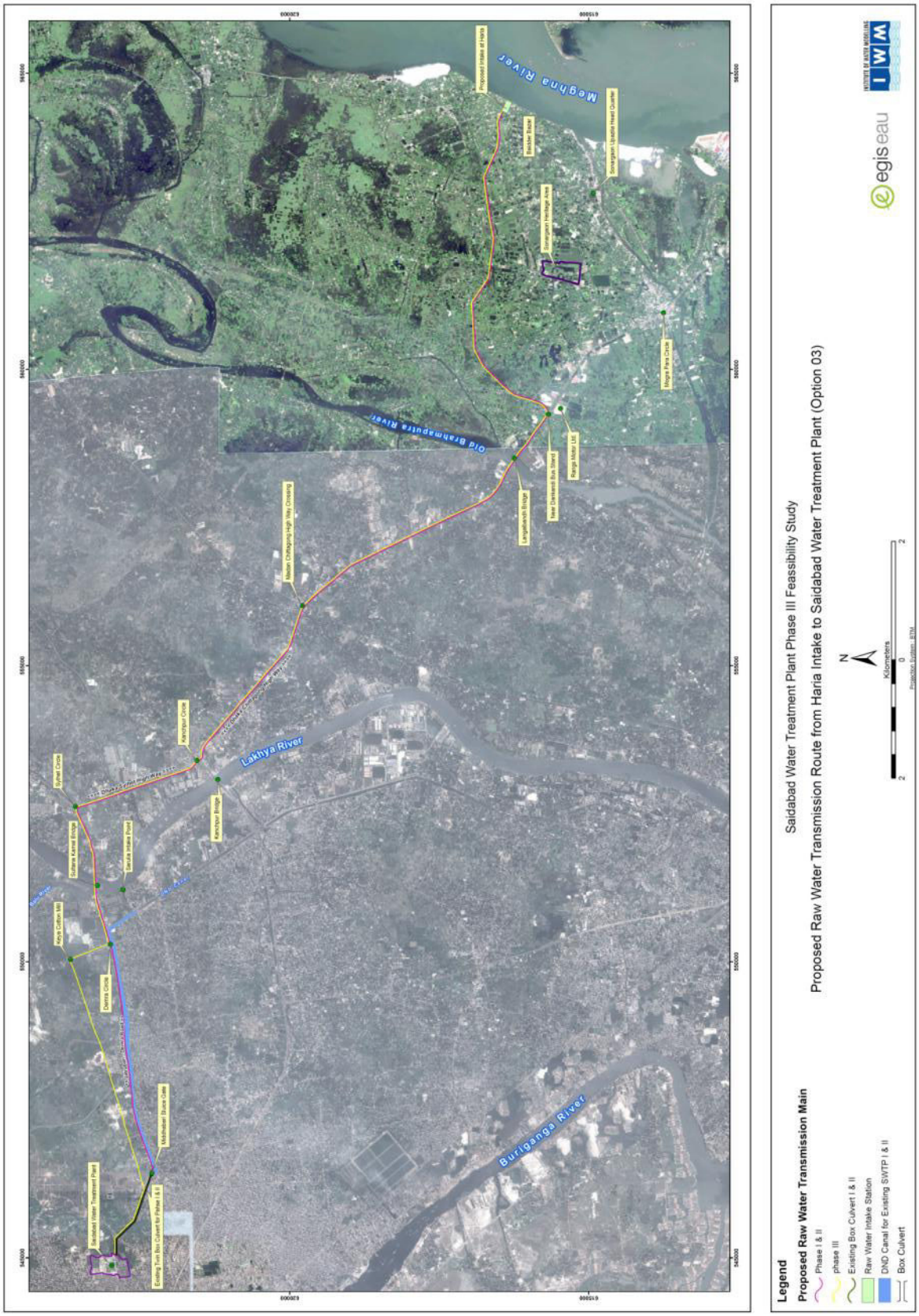


Figure 42: Proposed Raw Water Transmission Route from Haria to SWTP (Option 3)

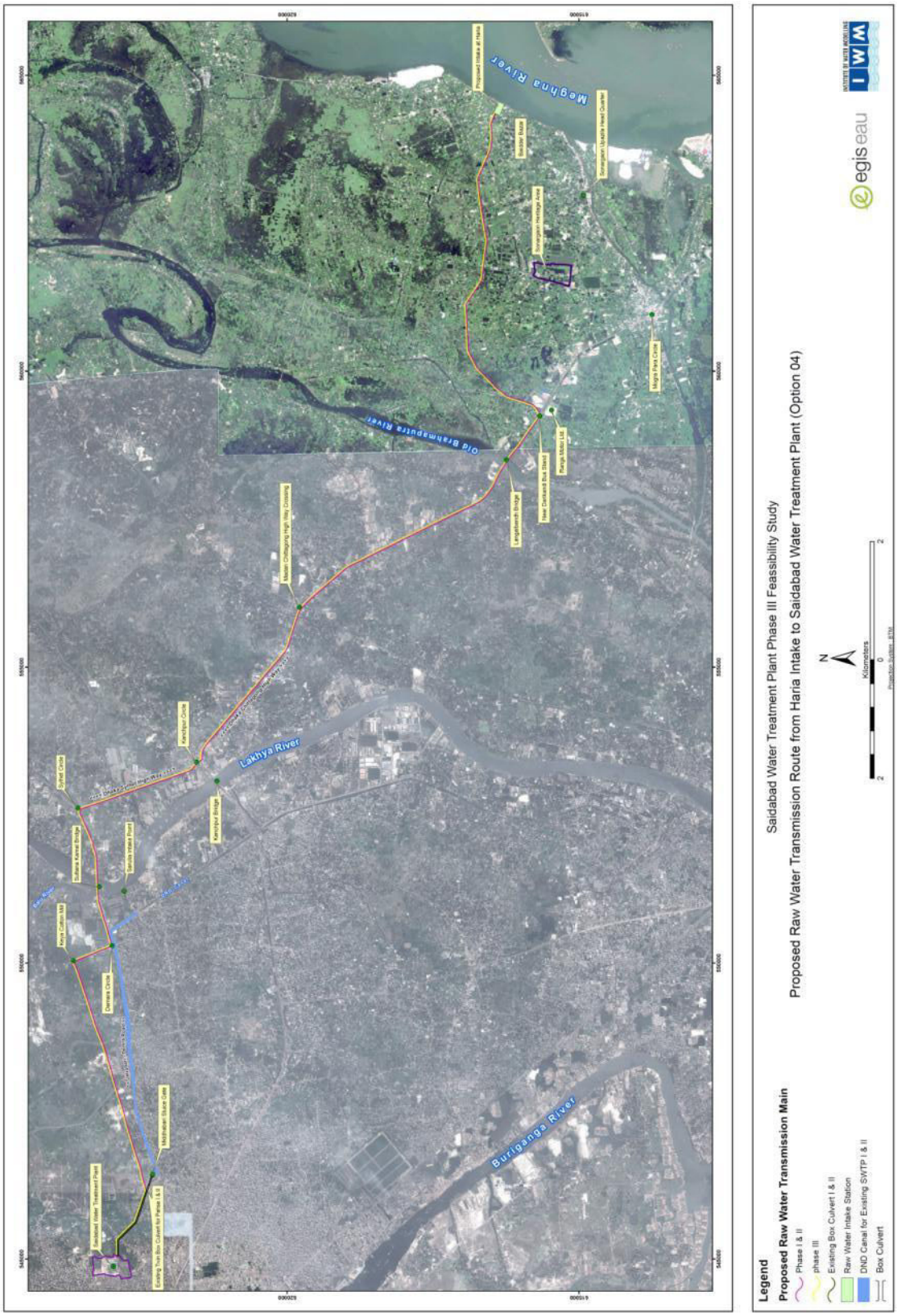


Figure 43: Proposed Raw Water Transmission Route from Haria to SWTP (Option 4)

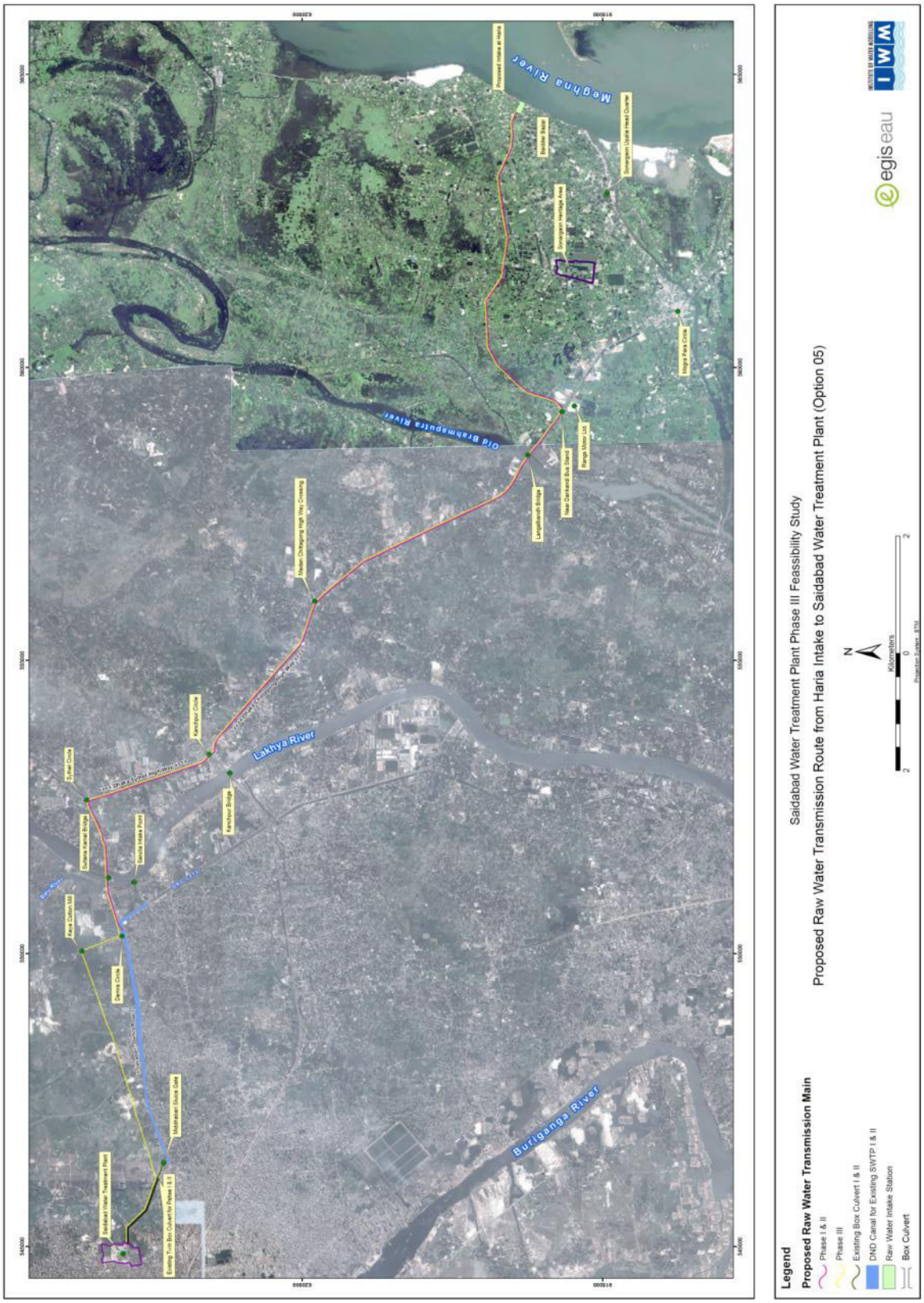


Figure 44: Proposed Raw Water Transmission Route from Haria to SWTP (Option 5)

Option-wise required raw water transmission pipeline length is provided in Table 8.1

Table 41: Different Options wise Raw Water Transmission Route Length

Options	Common length from Haria Intake to Demra circle for all phases (km)	Additional length from Demra circle to SWTP		Total length from Haria Intake to SWTP		Total length of pipelines for Phases- I, II & III (km)
		Transmission Main for Phase-I & II (km)	Transmission Main for Phase-III (km)	Transmission Main for Phase-I & II (km)	Transmission Main for Phase-III (km)	
Option 1	19.2	3.95	5.49	23.15	24.69	47.84
Option 2	19.2	0	5.49	19.2	24.69	43.89
Option 3	19.2	3.95	6.045	23.15	25.25	48.40
Option 4	19.2	4.78	6.045	23.98	25.25	49.23
Option 5	19.2	0	6.045	19.2	25.25	44.45

The total length required for raw water transmission lines for Options 2 and 5 is less because these options use the existing DND canal to partly convey the Meghna River water (by gravity flow) for Saidabad Phases-I and II. As a result, the operational cost (for pumping energy) and capital cost would be somewhat lower compared to other options. Options 3 to 5 use an alternate route to convey raw water from Demra circle to the box culvert at the downstream end of the DND canal. This strip of land from Demra-Amulia road to the connecting box culvert belongs to DWASA (no land acquisition required) and can be considered if it is desired to avoid the disruption to traffic caused by the construction of pipelines along the northern side of the heavily travelled Demra-Jatrabari road. However, considering all factors, option 1 has been selected as the most viable option due to the following reasons:

- There is possibility of increased pollution load in the DND canal in future as the area surrounding it is getting increasingly urbanized. Also the maintenance of DND canal is difficult as there are too many cross-connecting roads with insufficient opening underneath for adequate flow. Further structural rejuvenation of the DND canal (e.g. constructing a box culvert in its place) has also become very difficult due to the construction of electrical transmission towers along the canal. Therefore, the DND canal is not a viable option for transmission of raw water to the treatment plant as considered in options 2 and 5.
- Soil conditions are expected to be better along the Jatrabari-Demra Road in comparison with Dhaka WASA land strip further to the north. The latter is located in a low land within a swampy area which needs to be treated for soil quality improvement and flood protection. Pile foundations may be required to secure pipeline stability, which will increase the capital cost. Also this alternate route will have a larger number of bends; hence maintenance requirement would also be high. Also a service road needs to be constructed for maintenance purpose. All of these issues may add up to both operational and capital cost. As a result, options 3, 4 and 5 were not considered to be viable options.

8.4 Alternate Distribution Line Route

Since the proposed water distribution routes are aimed at transporting water to consumers within city areas, there were limited alternatives regarding routes of distribution pipelines. As explained in Chapter 2, the distribution pipeline network (see Figure 8) primarily passes through existing roads. The routes of primary and secondary distribution network have been selected based on following considerations:

- Avoid areas which are presently supplied by the existing surface water treatment plant (if sufficient) and the areas which will be supplied by other under-construction or proposed sources;
- Avoid land acquisition;
- Minimize disturbance of traffic movement;
- Keep pipeline alignment as straight as possible to minimize head loss;
- Ensure distribution of water with minimum number of sub-distribution nodes;
- Give priority to areas which are presently suffering from acute shortage of water;
- Follow wider roads so that the line can be laid by not disturbing existing utilities networks; and
- Carry construction works during night to avoid traffic congestion.

8.5 Alternate Options For Water Courses Crossing By Transmission and Distribution Lines

Along transmission lines routing between the intake and treatment plants site, two watercourses crossings will be needed (Old Brahmaputra River and Sitalakhya River). Three options were considered to address this issue:

1. Overhead crossing using a bridge for fixing pipes
2. Trench crossing under the watercourse bottom
3. Pipe jacking or tunnelling with a large protection cover above pipelines

The overhead crossing is the least advantageous option as it implies an additional pumping head at the raw water intake and some additional design restrictions for securing a minimum clearance between the maximum water level in the watercourse and the crossing structure. On the other hand, the BIWTA (Bangladesh Inland Water Transport Authority) is not inclined to allow overhead crossings for navigable watercourses except in special cases such as bridges for highways.

The pipe in trench crossing at river bottom will require additional protection measures against high velocity flow, scouring and erosion effects. Scours are quite deep, unpredictable and destructive in some rivers of Bangladesh. Moreover, in areas with noticeable shipping activities, pipes can be exposed to damage by sailing ships.

Jacking or tunnelling can be considered as a safe option although it implies the use of special equipment, which can make works more expensive in comparison with the trench laying option.Such method could also be considered for crossing of deeper water bodies and box culverts during construction of distribution lines.

8.6 No Project Scenario

Under the no project scenario, there will be no negative impacts associated with the project activities. However, numerous positive impacts related to socio-economic conditions and ensuring public health and safety would not be realized. The Saidabad Phase-III will not only add 450 MLD treated water to Dhaka City's water supply, but is also aimed to reduce the operational costs of Saidabad Phases-I and II on account of treating the polluted water of Sitalakhya River during the dry season. Under the no project scenario, the 450 MLD water from surface water sources will not be added to the city's water supply, the dependence on groundwater to meet the city's water demand of the future will continue, which will be a significant deviation from Dhaka City's Water Supply Master Plan.

9. Environmental Management Plan

9.1 Introduction

This chapter summarizes the mitigation and abatement measures both during construction and operation phases of the project. It also presents an Environment Management Plan (EMP), including a monitoring program with a preliminary cost estimate.

9.2 Mitigation Measures

9.2.1 Construction Phase

The proposed project involves construction of a Water Treatment Plant at Saidabad, which will draw raw water from the Meghna River. It also involves construction of intake channel, intake structure, treated water transmission pipeline up to injection point, and about 61.8 km of distribution line. The project will be implemented by Dhaka Water Supply and Sewerage Authority (DWASA). The significant environmental impacts of project activities during construction and operational phases have been presented in Chapter 7. Table 42 shows the mitigation measures corresponding to specific adverse impacts during construction phase, along with assignment of responsibilities for their implementation. The measures presented in Table 42 are aimed at minimizing the effects of the possible adverse impacts and enhancing the positive impacts. The table shows that most of the adverse impacts could be minimized or even removed if appropriate mitigation measures are taken. However, a post-project monitoring program needs to be put in place to ascertain that the potential impacts have been predicted adequately and that suggested mitigation measures are effective in minimizing adverse impacts on the environment.

Table 42: Environmental impact during construction phase and mitigation measures

Activity/Issues	Potential Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
Land acquisition	Loss of land / property/ trees	Raise awareness of Project Affected Persons (PAPs) through public consultation process prior to actual land acquisition. Serve land acquisition notices to actual land owners. Provide adequate (considering present market value), fair, and quick compensation to real land owners, in accordance with applicable laws of GoB; and applicable resettlement policy framework of DWASA. Provide appropriate and quick compensation for loss of property on acquired land. Involve local people and peoples' representatives in settling social tension	DWASA, District Lands Office

Activity/Issues	Potential Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		related to land acquisition and those that may develop during the progress of work from the very beginning of project implementation.	
	Tree cutting in acquired land or along RoW of distribution/ transmission lines	Provide adequate, quick and fair compensation to owners Plantation/ afforestation program for tree replacement (plantation of at least two trees of similar species for each cut tree) Not removing undergrowth fully where possible, so that they may re-grow naturally after the project activity.	DWASA
Construction and operation of labor shed for workers; Construction of water transmission/ distribution pipeline and water treatment plant	Loss of income during construction (e.g., road-side shops)	Include owners of affected businesses in project consultations and inform them of work in advance. Make alternative arrangements and or compensate for loss of income (e.g., shopkeepers)	DWASA
	Shifting or relocation of utility lines along alignment of distribution/ transmission lines (if needed)	Take especial care during detail design of transmission/ distribution lines to keep such shifting/ relocation to a minimum; Arrange alternative arrangement during shifting/ relocation of utilities (e.g., gas, electricity, water) in consultation with respective service providers. Take adequate safety measures to avoid accidents during shifting of utility lines.	DWASA
	Generation of sewage and solid waste	Construction of sanitary latrine and septic tank system Erection of “no litter” sign, provision of waste bins/cans, where appropriate Waste minimization, recycle and reuse principles to be followed Proper disposal of solid waste Workers awareness	Contractor (Monitoring by DWASA)
	Health of workers	Clean bill of health a condition for employment Construction of tubewells with acceptable water quality Raising awareness about hygiene practices among workers Regular medical monitoring of workers	Contractor (Monitoring by DWASA)
	Safety; Occupational health and	Take adequate measures to ensure safety/ stability of structures (buildings, walls) located close to the alignment of transmission/	Contractor (Monitoring by DWASA)

Activity/Issues	Potential Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
	safety	distribution lines. Follow standard safety protocols. Provision of protective gears and first aid facilities. Only allowing trained and certified workers in the shifting of utilities (e.g., power/ gas/ water lines).	
	Air pollution	Ensure that all project vehicles are in good operating condition Spray water on dry surfaces/ unpaved roads regularly to reduce dust generation Pave access roads Maintain adequate moisture content of soil during compaction and handling; use cover during transportation/ storage of dry materials (e.g. fine aggregates, soil). Sprinkle and cover stockpiles of loose materials (e.g., fine aggregates, excavated soil). Not using equipment such as stone crushers at site, which produce significant amount of particulate matter	Contractor (Monitoring by DWASA)
	Traffic congestion, communication problems	Schedule deliveries of material/ equipment during non-school hours and after regular working hours. Arrangement of alternative communication routes during laying of pipeline across roads. Employ flagman and provide adequate signs/ lights for traffic management and to avoid accidents; take assistance from police, where appropriate, for traffic control/ security. Take especial care to ensure safety of rails and rail tracks during crossing (by distribution line, e.g., at near Titipara near ICD Kamlapur). Provide wooden walkways to maintain pedestrian access across trenches and metal plates for vehicles (where necessary).	Contractor (Monitoring by DWASA)
	Noise pollution	Use of noise suppressors and mufflers in heavy construction equipment. Avoid using of construction equipment producing excessive noise during school hours and also at night Avoid prolonged exposure to noise (produced by equipment) by workers./ give protective	Contractor (Monitoring by DWASA)

Activity/Issues	Potential Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		gears Regulate use of horns and avoiding use of hydraulic horns in project vehicles.	
	Disruption of local drainage	Carry out crossing of water bodies and box culverts during dry season. Carry out installation of transmission/ distribution lines during the dry season as much as possible in order to avoid problems related to stability of trenches and washout excavated materials by rain. Provide adequate diversion channel, if required Provide facilities for pumping of congested water, if needed Ensure adequate monitoring of drainage effects, especially if construction works are carried out during the wet season. Find beneficial uses for excess/ waste soil, e.g., in construction, land raising and filling of excavated areas/trenches (depending on the quality of excavated materials). Use tarpaulins to cover dry soil when carried on trucks. Remove Waste quickly, cover/spray stockpiles. Only bring sand (for backfill) to site when needed	Contractor (Monitoring by DWASA)
	Water and soil pollution	Forbid discharge of fuel, lubricants, chemicals, and wastes into surface waters or on land. Adopt proper disposal techniques for any hazardous waste (e.g. excavation materials from sludge lagoons in the WTP Phase-III site) Install sediment basins to trap sediments in storm water prior to discharge to surface water. Replant vegetation when soils have been exposed or disturbed.	Contractor (Monitoring by DWASA)
	Destruction of aquatic habitat and reduction of fisheries, aquatic fauna	Forbid discharge of fuel, lubricants, chemicals, and wastes into surface waters. Preservation of aquatic habitats by restricting movement of people/ equipment into them, and preventing entry of sediments into these water bodies. Restrict activities within the RoW during	Contractor (Monitoring by DWASA)

Activity/Issues	Potential Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		laying of water pipeline across a water body, keep rest of the water body undisturbed. Keep noise level (e.g., from equipment) to a minimum level, as certain fauna are very sensitive to loud noise. Special care for protection of threatened species that have been identified in the project areas (listed in Table 31)	
	Reduction/ damage to plants/ floral habitat	Provide proper compensation if there is any destruction of trees outside RoW. Control intensive movement of heavy construction vehicles.	Contractor (Monitoring by DWASA)
	Accidents	Following standard safety protocol while digging trenches and laying pipes Environmental health and safety briefing Provision of protective gear	Contractor (Monitoring by DWASA)
	Spills and leaks oil, toxic chemicals	Good house keeping Proper handling of lubricating oil and fuel Collection, proper treatment, and disposal of spills.	Contractor (Monitoring by DWASA)
	Employment of work/ labor force/ economy of the area	Employ local people in the project activities as much as possible. Promote supply from local suppliers	Contractor (Monitoring by DWASA)

Also, it may be noted that leaks in the pipe may develop if pipes are not designed properly. Provisions are to be made by the Contractor in the “detail design” for detecting and taking care of leaks.

9.2.2 Operational Phase

At the operational phase, DWASA will be responsible for the operation and maintenance of the water treatment plant, intake structures, water transmission line and the ancillary facilities. No significant air and noise pollution is expected from the operation of the plant. The important issues to be addressed during operational phase include proper disposal of screening wastes at the intake and WTP, disposal of oil, grease and sand from raw water at the intakes and WTP, disposal of laboratory wastes at WTP and proper disposal of dried sludge and liquid effluent from sludge drying operations. Aluminum-rich sludge from clarifiers and wash water from filter back wash will be generated, this disposal of which is the most important issue during the operational phase. It should also be mentioned that the project needs to manage the sludge generated from Saidabad Phases-I and II. Table 43 lists the mitigation and enhancement measures for the operational phase, including measures for ensuring proper disposal of treatment waste.

Table 43: Environmental impact during operation phase and mitigation measures

Activity/Issues	Potential Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
Pumping operation at the intake	Screening waste accumulation	Screening waste needs to be removed regularly from the coarse screens. Local labor may be employed for such operations. Proper disposal of screening wastes, floating debris (to be treated as a solid waste): formulate disposal management plan and provide adequate facilities to carry it out	DWASA
	Accidental Spillage of fuel (to run generators)	Forbid discharge of fuel, lubricants, chemicals, and wastes into surface waters or on land. Adopt proper disposal techniques for any hazardous waste: hazardous waste management plan and provide adequate facilities to carry it out	DWASA
	Presence of silt, oil and grease in raw water	Design of intake structure in order not to collect water from the surface to avoid oil and grease. Design of intake structure in order to avoid collecting water very close to the river bed to prevent excess silt from entering. Facilities at intake for removing silt, oil and grease entering accidentally the system	DWASA
Treatment plant operation	Accidental Spills and leaks oil, toxic chemicals	Good house keeping Proper handling of lubricating oil and fuel Collection, proper treatment, and disposal of spills. Formulate an accident management plan	DWASA
	Generation of sludge dry cakes after sludge dewatering operation	Assessment of characteristics of sludge through Toxicity characteristic leaching procedure (TCLP) test to confirm that the material is not hazardous Exploring beneficial options for dewatered sludge disposal (e.g. land application, co-disposal with sewage sludge, selling to brick factory) If beneficial options are not available, consider landfilling in a suitable land/location. If lands are not available, make arrangements with Dhaka City Corporation to dispose the sludge dry cakes in one of	DWASA

Activity/Issues	Potential Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		their designated landfills.	
	Generation of liquid residuals after sludge dewatering operation	Direct disposal to nearby lowlands if the residuals meet the effluent discharge criteria as per ECR 1997 (see Annex 12.4) If discharge criteria are not met, return to the head end of the plant for treatment. Must not be discharged to the head end as a pulse, rather metered in at a flow rate compatible with the hydraulic loading of the plant preferably during diurnal high flows.	DWASA
	Poor raw water quality in the Meghna river	Seeking the help of the Department of Environment (DoE) for preventing discharge of untreated industrial and domestic wastewater into Meghna river and thereby ensuring its water quality. Also it is recommended to restrict development activities both upstream and downstream of the intake point, especially those activities that could affect the water quality and hydrology at the intake location.	DWASA and DoE
Operation and maintenance of transmission/ distribution lines	Possible traffic problem during maintenance works along busy roads	Carrying out major maintenance works during night. Informing people about major maintenance works ahead of time and making provision for alternative arrangement (for movement of people/ vehicle), where possible.	DWASA

It is very important that DWASA establishes its own laboratory at the proposed WTP with required manpower and chemicals/ equipment for measurement of routine water quality parameters. Establishment of the laboratory should be considered as an integral part of the proposed project.

9.3 Environmental Management Plan

9.3.1 Scope of EMP

The primary objective of environmental management and monitoring is to record environmental impacts resulting from the project activities and to ensure implementation of the "mitigation measures" identified earlier (see Table 42 and Table 43) in order to reduce adverse impacts and enhance positive impacts from specific project activities. Besides, it would also address any unexpected or unforeseen environmental impacts that may arise during construction and operation phases of the project.

The EMP should clearly lay out: (a) the measures to be taken during both construction and operation phases of the project to eliminate or offset adverse environmental impacts, or reduce them to acceptable levels; (b) the actions needed to implement these measures; and (c) a monitoring plan to assess the effectiveness of the mitigation measures employed. Environmental management and monitoring activities for the proposed transmission line project could be divided into management and monitoring: (a) during construction phase, and (b) during operation phase.

9.3.2 Work Plans and Schedules

The environmental management program should be carried out as an integrated part of the project planning and execution. It must not be seen merely as an activity limited to monitoring and regulating activities against a pre-determined checklist of required actions. Rather it must interact dynamically as project implementation proceeds, dealing flexibly with environmental impacts, both expected and unexpected.

For this purpose, it is recommended that the Project Director (PD) for this specific project takes the overall responsibility of environmental management and monitoring. The PD will form a team with required manpower and expertise to ensure proper environmental monitoring, and to take appropriate measures to mitigate any adverse impact and to enhance beneficial impacts, resulting from the project activities. The PD through its team will make sure that the Contractor undertake and implement appropriate measures as stipulated in the contract document, or as directed by the PD to ensure proper environmental management of the project activities.

It should be emphasized that local communities should be involved in the management of activities that have potential impacts on them (e.g., drainage congestion). They should be properly consulted before taking any management decision that may affect them. Environmental management is likely to be most successful if such decisions are taken in consultation with the local community.

The environmental management during the construction phase should primarily be focused on addressing the possible negative impacts arising from:

a. Land acquisition processes (loss of land/ property/ crop, loss of income)
b. Cutting/ clearing of crops/ trees/ vegetation along RoW of water transmission line, and associated impact on terrestrial fauna
c. Air pollution
d. Traffic/ communication problems
e. Noise pollution
f. Drainage congestion

g. Water and soil pollution
h. Destruction of aquatic habitat and reduction of fisheries, aquatic fauna
i. Reduction of damage to plants and floral habitat
j. Employment of labor force giving priority to local people with required skills
k. Accidents, spills and leaks

The environmental management during the operation phase should primarily be focused on addressing the possible negative impacts arising from:

a. Maintenance of screens and generation of solid waste
b. Accidental spills of oils, leaks etc.
c. Generation of sludge cakes from sludge dewatering operation
d. Generation of liquid residuals from sludge dewatering operation
e. Poor water quality of Meghna river

The mitigation measures for addressing the above issues are listed in Table 42 and Table 43. It must be ensured that these measures are implemented in the field under the supervision of the PD of the project.

9.4 Environmental Monitoring Plan

The primary objective of the Environmental Monitoring Plan is to record environmental impacts resulting from the project activities and to ensure implementation of the “mitigation measures” identified earlier in order to reduce adverse impacts and reduce negative impacts from specific project activities. In addition, monitoring plan should also include regular reviews of the impacts that cannot be adequately assessed before the start of the works, or which arise unexpectedly, along with appropriate measures to mitigate any negative impacts and/or enhancing beneficial impacts.

9.4.1 Monitoring during Construction Phase

Specific monitoring requirements for the environmental issues during construction phase listed in Table 42 are presented in Table 44.

Table 44: Monitoring requirements during construction phase of the project

Environmental Issue	Monitoring requirements/issues
Air pollution	Construction materials should be properly covered while hauled and stored, roads properly cleaned and water sprayed in order to minimize concentration of dust in air. Use of equipment like stone crushers, which produce excessive noise as well as generate particulate matter must not be used close to human settlement. Concentration of particulate matter within and around the project site should be measured, at least once every three months, and air quality management plan should be revised, if needed.
Noise pollution	Equipment producing excessive noise should not be operated after dark. Use of equipment like stone crushers, which produce excessive noise as well as particulate matter must not be used at the site. Vehicle movement to and from the site should be properly managed in order to ensure that this causes minimum disturbance to the people living in the surrounding areas.
Traffic congestion	Hauling of materials and equipment to and from project sites should preferably be done after the regular working hours, so that it causes minimum disturbances to the regular traffic in and around the project site. Contractor should take responsibility of proper traffic flow and management within the immediate vicinity of the project site.
Drainage congestion	Appropriate measures should be taken to avoid temporary drainage congestion during construction activities (e.g., keeping existing drains clear, building alternative drainage line/ network, where an existing drainage canal has been filled up).
Disposal of construction waste	Waste/ wastewater (e.g., human waste from labor camps, fuel and wash-water from equipment/ material sheds) should be appropriately disposed, so that they do not find their way into adjacent water bodies. Solid waste and wastewater should be disposed of in proper fashion. Wastewater should be disposed of by constructing septic tanks. Solid waste, including construction debris, should be regularly collected and transported away from the site for disposal in a designated municipal dump site. Excavated materials from the existing sludge drying beds should be tested for toxicity before disposal.
Employment of workforce	Local people should be employed in the project activities as much as possible.
Commercial activities	Efforts should be made to ensure that local communities are benefited from the increased commercial activities during the construction phase of the project (e.g., by ensuring their participation in the activities). Care should be taken to avoid haphazard development of commercial activities (e.g., shops) in and around the project sites, which would adversely affect the local environment.

Table 45 shows monitoring plan for air quality and noise level during construction phase of the project.

Table 45: Monitoring of water quality, air quality and noise during construction phase

Parameters	Monitoring Frequency	Resource Required and Responsibility	Comment
Water quality (BOD_5, COD, EC) for construction works within or close to water bodies (river, khals, lakes)	Once every 3 months, and as directed by the PD	Appropriate water testing facilities; Contractor's responsibility	Results to be verified by a monitoring team, led by the PD
Particulate Matter (PM_{10}, $PM_{2.5}$)	Once every 3 months, and as directed by the PD	PM_{10} and $PM_{2.5}$ measuring equipment; Contractor's responsibility	
Noise Level	Once every month, and as directed by the PD	Noise level meter; Contractor's responsibility	

Note: Actual monitoring time and location will be decided by the Project Director (PD)

9.4.2 Monitoring during Operational Phase

The environmental monitoring during the planning/ operation phase should primarily address the following issues:

a. Disposal of treatment wastes (mainly sludge and liquid residuals from sludge dewatering operations)
b. Treated water quality
c. Raw water quality
d. Generation of additional volumes of wastewater as treated water supplies in the city are improved
e. Safety of water distribution network

Specific monitoring requirements for each of the environmental issues listed above are presented inTable 45. The monitoring plan should also include regular reviews of the impacts in order to address those that may arise unexpectedly during the operation phase of the project.

Table 46: Monitoring requirements during operation phase of the project

Environmental Issue	Monitoring requirements/issues	Responsibility
Disposal of treatment waste	Regular (once every three months) assessment of the characteristics of sludge through TCLP test to ensure that it is not hazardous. Monitoring of discharge parameters of liquid residuals from sludge drying operations. Studies to explore the possibility beneficial sludge disposal options (e.g., land application), and in designated landfills (coordinating with the Dhaka City Corporation)	DWASA
Treated water quality	Regular monitoring of treated water quality (as part of the ongoing regular plant operation) to ensure that it is safe for public consumption. Modification of treatment process (e.g., increase/decrease alum dose of chlorine dose), if needed.	DWASA
Raw water quality	Regular monitoring of raw water quality, as part of ongoing regular plant operation. In association with the Department of Environment (DoE), developing of a long-term management plan for the protection of raw water quality in Meghna River (including restriction on establishment of industries producing liquid effluent within certain reaches upstream and downstream of the intake point).	DWASA
Generation of additional volume of wastewater as treated water supply increases	This issue should be taken into consideration in the ongoing planning and implementation activities of DWASA aimed at expanding sewerage network and treatment facilities in Dhaka city. This would obviously necessitate additional sewage treatment plant at appropriate locations.	DWASA
Safety of water distribution network	Monitoring and detection of leaks and expansion and up-gradation of water distribution network of, as part of DWASA's regular monitoring and expansion works.	DWASA

The raw and treated water quality of the proposed WTP should be regularly monitored. Besides, the characteristics of sludge and liquid residuals produced at the treatment plant should also be regularly monitored. Table 47 shows the monitoring plan (parameter and frequency of measurement) for the operational phase of the proposed WTP.

Table 47: Monitoring of water quality and sludge during operational phase of proposed WTP

Monitoring	Water Quality / Other Parameters	Monitoring Frequency	Responsibility
Raw water	pH, Color, Turbidity, Ammonia, Nitrate, Phosphate, Sulfate, TC, FC	Daily	DWASA
	Lead, Chromium, Mercury, Cadmium, Total Suspended Solids, COD, BOD_5, Oil & grease	Once a month	DWASA
Treated water	pH, Color, Turbidity, Ammonia, Nitrate, Residual Chlorine, TC, FC	Daily	DWASA
	BOD_5, COD, Aluminum, Total Dissolved Solids	Once every two months	DWASA
Dewatered sludge	TCLP test and determination of Al, Pb, Cr, Cd in TCLP extract	Once every three months	DWASA
Liquid residuals from dewatering operation	pH, Ammonia-N, BOD_5, COD, Cd, Cr, Mercury, Chloride, Total Dissolved Solids, Total Suspended Solids, Nitrate, Sulfide	Once a month	DWASA

Notes:
(1) The parameters listed above are based on water quality measurements of Meghna River as a part of this study. The list should be updated based on monitoring results and information on possible pollution of river water by contaminants (e.g., from an industrial source);
(2) Actual monitoring time and location will be decided by DWASA and spelt in the operator's contract if any operator

9.4.3 Cost of Environmental Monitoring

Table 48 and Table 49 show preliminary cost estimates for monitoring activities during construction and operation phases respectively.

Table 48: Preliminary cost estimates for monitoring and other mitigation activities during construction phase

Parameter/Activity	Frequency of activity	Preliminary cost estimate	Preliminary cost for 1 year activity period
Water quality (BOD_5, COD, EC)	Once every 3 months	Tk. 25,000/- per 10 samples	Tk. 100,000/-
Particulate Matter (PM_{10}, $PM_{2.5}$)	Once every 3 months	Tk. 30,000/- per each set of PM_{10} and $PM_{2.5}$ measurement	Tk. 1,20,000/-
Noise Level	Once every month (day and night)	Tk. 25,000/- (per set of measurement)	Tk. 3,30,000/-
Water spraying for dust control	At least twice a day	Tk. 10,000/- per site per month	Tk. 1,20,000/-
Plantation of trees	At least 2 trees for each tree cut/cleared (approx. 500 trees)	Tk. 1,000/- per plant	Tk. 5,00,000/-
Total annual cost for monitoring during construction phase			**Tk. 11,62,000/-**

Notes: (1) Actual monitoring time and location will be decided by DWASA (2) The estimated costs for particular matter (PM) and noise level measurements are based on current rates charged by BRTC, BUET for analysis of the parameters.

Table 49: Preliminary cost estimates for monitoring and other mitigation activities during operational phase

Parameter/Activity	Frequency of activity	Preliminary cost estimate	Preliminary cost for 1 year activity period
Raw water: pH, Color, Turbidity, Ammonia, Nitrate, Phosphate, Sulfate	Daily	Tk. 6,000/- per set of measurement	Tk. 21,90,000/-
Raw water: Lead, Chromium, Mercury, Cadmium, Total Suspended Solids, COD, BOD_5, Oil & grease	Once a month	Tk. 15,000/- per set of measurement	Tk. 1,80,000/-
Treated water: pH, Color, Turbidity, Ammonia, Nitrate, Residual Chlorine, TC, FC	Daily	Tk. 5,500/- per set of measurement	Tk. 20,07,500/-
Treated water: BOD_5, COD, Aluminum, Total Dissolved Solids	Once every two months	Tk. 8,500/- per set of measurement	Tk. 51,000/-
Sludge from Clarifiers: TCLP test and determination of Al, Pb, Cr, Cd in TCLP extract	Once every three months	Tk. 14,000/- per set of measurement	Tk. 56,000/-
Total annual cost for monitoring during operation phase			**Tk. 44,84,500/-**

Notes:
(1) The parameters listed above are based on water quality measurements of Meghna River as a part of this study. The list should be updated based on monitoring results and information on possible pollution of river water by contaminants (e.g., from an industrial source);
(2) Actual monitoring time and location will be decided by DWASA and will be part of the operator's contract if any operator
(3) The estimated costs are based on current rates charged by BRTC, BUET for analysis of the parameters.

The treated water quality parameters must be checked against the Bangladesh drinking water quality standard (ECR 1997). In addition to the above, alum dose should also be checked on a regular basis. The parameters of the liquid residuals should be checked against the standards for disposal of wastewater/effluent from industrial units or project waste as per ECR, 1997 Schedule-10 (see Annex 12.4).

10. Conclusions and Recommendations

10.1 Conclusions

In an effort to meet the increasing demand of water supply, the Dhaka Water Supply and Sewerage Authority (DWASA) is exploring the possibility of constructing a surface water treatment plant, which will draw raw water from Meghna River. The proposed Saidabad Phase-III Surface Water Treatment Plant will be installed in an area owned by DWASA, adjacent to Saidabad Phase-I and Phase-II treatment plants, and will have a water treatment capacity of 450 MLD. The intake structures and transmission lines will be designed to withdraw and transport raw water up to 950 MLD, which includes raw water to be transferred to Saidabad Phases-I and II in the dry season (instead of treating the polluted water of Sitalakhya River during the period). The proposed project involves construction of intake channel and intake structure at Haria at Sonargaon for drawing water from the Meghna River, a water treatment plant at Saidabad, around a total of 25 km of twin raw water transmission mains, and about 61.8 km of distribution lines.

Environmental and social assessments of the proposed project have been carried out following the guidelines (GoB, 1997) of the Department of Environment (DoE) and other relevant operational policies and guidelines. DOE approved the TOR and TOC of this study on 12th January 2014, as per the letter annexed in 12.1.
The overall objectives of the ESIA were to identify potential significant impacts, both positive and negative, during construction and operation phases of the proposed project, and to recommend mitigation measures to avoid or reduce adverse environmental impacts and to enhance positive impacts. Environmental impacts of the specific project activities on different ecological, physicochemical and human interest related parameters, both during the construction phase and the operation phase, have been identified and evaluated. Mitigation and abatement measures have been suggested and an environmental management plan (EMP) has been developed.

It has been found that most of the adverse impacts during construction phase could be minimized or even removed if appropriated mitigation measures are taken. However, a monitoring program needs to be put in place to assess any adverse impacts on the environment. Possible adverse impacts during operational phase are insignificant. A complete Resettlement Action Plan (RAP) will also have to be prepared for the project.

10.2 Recommendations

Possible environmental impacts of the proposed project have been evaluated and mitigation and abatement measures to reduce or eliminate potential adverse impacts and to enhance beneficial impacts have been suggested. Mitigation and abatement measures both during construction and operation phases of the project have been explained in the report. It also presents an Environment Management Plan (EMP), including a monitoring program, identifying the management

responsibilities for implementation. The EMP should be carried out as an integral part of the project planning and execution, along with the RAP.

It is recommended that the Project Director (PD) for this specific project takes the overall responsibility of environmental management and monitoring. The PD will form a team with required manpower and expertise to ensure proper environmental monitoring, and to take appropriate measures to mitigate any adverse impact and to enhance beneficial impacts, resulting from the project activities.

By the year 2030, two Water Treatment Plants (Saidabad WTP and Gandharbpur plants) will be installed with a total capacity of 2000 MLD, which will be relying on the water of Meghna River to ensure safe water supply of the inhabitants of Dhaka city. For long-term sustainability of these water treatment plants, the source water quality and quantity at Meghna should be protected for future use. The following recommendations are made to address this issue:

- Installations of polluting industries along the banks of Meghna River will degrade its water quality and jeopardize the operation of the treatment plants. Meghna is a tidal river; pollutants discharged at a certain point can travel both upstream and downstream depending on the tidal period and therefore, restriction on installation of polluting industries need to be enforced both upstream and downstream of the location of the intakes. According to Environment Conservation Act (1995), the Ministry of Environment and Forest through the Department of Environment is entrusted with the task of issuing environmental clearance for establishment of industries and enforcement of discharge standards. All industries have to obtain environmental clearance through the DoE before installation. The DoE has the jurisdiction to impose restrictions on installing industrial units which may harm or degrade the environment. The DoE must ensure water quality control of Meghna river using appropriate methods depending on the scenario and this may involve restrictions on installation of polluting industries within a certain reach (both upstream and downstream of the intake locations) of the river which may be termed as an “Environmental Protection Zone”. Water quality model simulations under the most critical scenario may be used to demarcate such a reach of the river. Until such simulations are carried out, the DoE may consider a reach extending 5 km both upstream and downstream of the intake point as critical area for protection of source water quality. Accordingly, no industry (or settlement) discharging liquid effluent should be permitted to be established within this reach (refer to the map in annex 12.6). Considering the state of rapid development (both industrial and human settlement) that is taking place surrounding and along the banks of Meghna River, and considering the sensitive nature of the water use (as raw water for WTP), the DoE should immediately look into the issue of declaring Meghna (or a certain stretch of it) as Ecologically Critical Area (ECA).
- If DoE deems that it does not possess the required manpower to carry out such activities, it may decide to delegate its functions to DWASA for conserving the Environmental Protection Zone for the Meghna River. A strong commitment by the Ministry of Environment is needed in this respect to enforce strict compliance of environmental control in the Protection Zone based on water quality monitoring by DWASA.
- Illegal landfilling/ development activities along the banks of the Meghna River can threaten the stability of river bank, adversely affect the water quality at the intake location, threaten the operation of the intake structure as well as affect the water availability of the Meghna River. BIWTA, which is mandated with the protection of river banks, should step up its effort to prohibit such activities and take legal actions if necessary and thereby, ensure the smooth operation of these two water treatment plants.

11. References

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12. Annex

12.1 Approval of TOR and TOC of ESIA by DOE

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

Memo No: DoE/Clearance/5261/2014/19 Date:12/01/2014

Subject: Approval of Terms of Reference (TOR) for Environmental Impact Assessment (EIA) in favour of Saidabad Water Treatment Plant (Phase-III) Project of Dhaka WASA.

Ref: Your application on 20 November 2013.

With reference to your letter dated 20.11.2013 for the subject mentioned above, the Department of Environment hereby gives approval of TOR for Environmental Impact Assessment (EIA) in favour of Saidabad Water Treatment Plant (Phase-III) Project of Dhaka WASA subject to fulfilling the following terms and conditions.

1. Dhaka WASA shall conduct a comprehensive Environmental Impact Assessment (EIA) study considering the overall activity of the said Project in accordance with the following indicative outlines:

1. Executive summary

2. Environmental Baseline Data
Following general aspects should be considered for baseline :
- GPS location, data sources, time period, representativeness, relevance to the identified and predicted impact, usefulness in comparing and evaluation of impact to find the significance of impacts.
- Baseline data must also relate to the monitoring plan that covers preparation, construction and operation phases of the project. Baseline data must be in consistent with monitoring plan in terms of location, timing, parameters and other conditions that imply for baseline data.

2.1. Project Data Sheet

a. Project location and area
The location of the project and area involved

b Project Concept
An outline of description of the concept and objectives of the project, the types of activities expected, and the development plans for achieving the objectives.

c Project Components
Components of the project concerning the types of activities proposed to be located in the area, the number and distribution of underground and overhead tanks, other infrastructure, utilities and service requirements.

d Project Activities
A list of the main project activities to be undertaken during: site clearing and construction, operation of activities and associated developments.

e Project schedule
The phase and timing for development of the surface water treatment plant, transmission line, underground and overhead tanks in Khulna, infrastructure and other facilities

required.

f **Resources and utilities demand**

Resources required to develop the project, such as soil and construction material and demand for utilities (water, electricity, sewerage, waste disposal and others), as well as infrastructure (road, drains, and others) to support the project.

2.2. Physical and chemical components

a Map and survey information
- Location map
- Cadastral map showing land plots (project and adjacent area)
- Topographic map for identifying catchment boundaries, general land use and terrain
- survey map showing contour information
- Aerial photograph

b Geology and soil
- Geological map showing geological units, fault zone, and other natural features
- Soil map and soil profile analysis. This may only be established from soil survey and geotechnical investigation (important for analysis for soil stability, cut and fill)
- Soil properties and composition

c Hydrology and drainage
- Catchment boundaries of rivers/lakes/canals which drain the project
- Hydrological characteristics of rivers in and around the project area, including flow, salinity and sediment load for varies return period
- Flood characteristics and historical records of flood events covering areas affected, height of flood and frequency
- Ground water potential and aspects of aquifer, such as recharge zones, ground water abstraction etc.
- Drainage system and drainage characteristics in the project area

d Water quality and use
- Water quality of the receiving water bodies likely to be affected by the project
- Beneficial uses of the water need to be established for rivers or any other water bodies likely to be impacted by the development. The locations of these water utilization should be identified in the map
- Sources of pollutants from existing and known future activities within the catchment of the rivers

e Air quality and noise
- Baseline data of the project site with respect to air quality and noise level
- Air pollutant and noise sources from existing and known sources

2.3. Ecological components

a Habitats
- Aquatic habitat likely to be impacted by the project
- Terrestrial habitat likely to be impacted by the project

b Species and Population
- Identification of population of flora and fauna to assess their conservation status of being rare, endemic and endangered
- Biodiversity of the project site

2.4. Social and Economic Factors

a Population
- Population within and around the project area
- Organizational structure of communities and the degree of public awareness and response to the proposed project

b Human settlement
- Size and distribution of human settlement
- Community infrastructure, utilities and services available
- Housing and future requirements within the impacted area
- Historical/archaeological features of significance

c Economic activities
- Economic activities of population in and around the project area. Activities should include those that are dependent on resources which may be impacted by the project
- Income dependence on economic activities impacted directly or indirectly by the project
- Employment and economic returns to the population by the project

2.5. Infrastructure and utilities

a Availability of infrastructure to support the proposed project. Attention should focus on different transportation requirements due to project, increase in traffic to and from the project area

b Availability of utilities and services, especially water, gas and electricity supply, sewerage and waste disposal facilities to cater to the projected demand for such utilities and services

3. Identification and Prediction of Potential Impacts (identification, prediction and assessment of positive and negative impacts likely to result from the proposed project). Appropriate scientific and mathematical tools and models should be used to establish cause and effect relationship for prediction of impacts.

In identification and analysis of potential impacts'-the 'Analysis' part shall include the analysis of relevant spatial and non-spatial data. The outcome of the analysis shall be presented with the scenarios, maps, graphics etc. for the cases of anticipated impacts on baseline. Description of the impacts of the project on air, water, land, hydrology, vegetation-man maid or natural, wildlife, socio-economic aspect shall be incorporated in detail.

4. EVALUATION OF IMPACTS

The judgment of significance of impacts can be based on one or more of the following :

i. comparison with laws, regulation or accepted national or international standards
ii. reference to pre-set criteria such as conservation or protected status of a site, feature or species
iii. consistency with pre-set policy objectives
iv. consultation and acceptability with the relevant decision makers, local community or the general public.

5. MITIGATION OF IMPACTS

Mitigation measures which may be considered including:

i. changing project layout, transport routes, disposal routes or locations, timing or engineering design;
ii. introducing pollution controls, waste handling, treatment and disposal, phased implementation and construction, engineering measures, monitoring, landscaping, social services or public education;
iii. compensation to restore, relocate or provision of concession for damage;
iv. most feasible, practicable, doable, cost effective, resource efficient and environment friendly alternative must be compared and selected.
v. Adequate measures to be taken, explored and documented to avoid public sufferings, nuisance and pollution of any kind during preparation, construction and operation phases.

6. Environmental Management Plan

(a)The responsibilities and actions required of the project initiator or implementing body should be identified in the EMP. Some of those responsibilities and actions include: allocation of institutional responsibilities for planning and management of environmental requirements, allocate responsibility to execute mitigation action, implement a programme of monitoring to check the effectiveness of mitigation measures, and if necessary, taking additional measures to correct or overcome the impact in question, in-house monitoring capacity building and allocation of budget.

(b) The EMP should recognize and include the following:

i. Management of soil erosion, land slides and siltation during site clearance and earth work
ii. Management of runoff
iii. Regulation of the types of activities allowed in the project activities in the project are at various phases of the project
iv. Management of liquid, solids, sludges and gaseous wastes generated from the project area
v. Environmental monitoring requirements
vi. Responsibilities and role of the project proponent for protection of environment
vii. Adequate measures to avoid and mitigate nuisance, pollution and public sufferings of any kind during preparation, construction and operational phases

(c)The program for monitoring should generally identify:

i. the type of monitoring required
ii. the location of monitoring
iii. the types of parameters to be measured (e.g. dissolve oxygen, if fisheries is important in a river)

(d) Monitoring parameters, location, timing, frequency and conditions must be in consistent with that of the baseline.

7. Management Plan/Procedures:

- For each significant major impact, proposed mitigation measures will be set out for incorporation into project design or procedures, impacts, which are not capable of mitigation, will be identified as residual impacts. Both technical and financial plans shall be incorporated for proposed mitigation measures..
- An outline of the Environmental Management Plan shall be developed for the project.
- In Environmental Monitoring Plan, a detail technical and financial proposal shall be included for developing an in-house environmental monitoring system to be operated by the proponent's own resources (equipments and expertise).

8. Consultation with Stakeholders/Public Consultation
   - Ensures that consultation with interested parties and the general public will take place and their views taken into account in the planning and execution of the project
   - Beneficial Impacts (summarize the benefits of the project to the Bangladesh nation, people and local community and the enhancement potentials)

9. Conclusion and Recommendations

2. Without approval of EIA report by the Department of Environment, Dhaka WASA shall not be able to open L/C in favor of importable machineries.

3. Without obtaining Environmental Clearance, Dhaka WASA shall not start operation of the projects.

4. Dhaka WASA shall submit the EIA report along with NOC from forest department (if it is required in case of cutting any forested plant/trees-private or public) and NOC from other relevant agencies for operational activity etc. to the Head office of DOE in Dhaka with a copy to Regional office of DOE in Dhaka.

12.01.2014

(Syed Nazmul Ahsan)
Deputy Director (Environmental Clearance)
and
Member Secretary
Environmental Clearance Committee
Phone # 8181778

Project Director
Saidabad Water Treatment Plant (Phase-III) Project
Dhaka WASA
WASA Bhaban (10th Floor), 98, Kazi Nazrul Islam Avenue
Kawran Bazar, Dhaka-1215.

Copy Forwarded to :

1) Managing Director, Dhaka WASA, 98, Kazi Nazrul Islam Avenue, Kawran Bazar, Dhaka-1215.
2) PS to Secretary, Ministry of Environment and Forests, Bangladesh Secretariat, Dhaka.
3) Director, Department of Environment, Dhaka Regional Office, Dhaka.
4) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.

12.2 Questionnaire Sample for Social Baseline Study

Questionnaire Sample for Social Baseline Study

ID No	
ID Point	

সায়েদাবাদ ওয়াটার ট্রিটমেন্ট প্লান্ট পর্ব-৩

আর্থ-সামাজিক তথ্য-উপাত্ত সংগ্রহ

পরিবার প্রধানদের জন্য প্রশ্নপত্র

ভূমিকা

আপনাকে শুভেচ্ছা। আমি ..... একজন সাক্ষাৎকার গ্রহণকারী/গবেষনা সহকারী হিসাবে সায়েদাবাদ ওয়াটার ট্রিটমেন্ট প্লান্ট পর্ব-৩ এর আর্থ-সামাজিক পরিস্থিতি বিশ্লেষণ শীর্ষক গবেষনা কাজের সাথে যুক্ত। আশা করা হচ্ছে যে, এই গবেষণাটি আপনার এলাকার খানা এবং খানা প্রধানের আর্থ-সামাজিক অবস্থার বিশ্লেষণ এবং মূল্যায়নে সহায়তা করবে, যা অবশ্যই জাতীয় নীতি নির্ধারকদের ও সুশীল সমাজকে সাহায্য করবে।

আমরা আপনাকে কিছু প্রশ্ন জিজ্ঞেস করতে চাই এবং আশা করি এজন্য প্রায় ৩০ মিনিট সময় লাগবে। উত্তরসমূহ গোপন রাখার নিশ্চয়তা দেয়া হচ্ছে এবং আপনার দেয়া তথ্যসমূহ শুধুমাত্র গবেষনার কাজে ব্যবহার করা হবে। এই সাক্ষাৎকার দেয়া না দেয়ার পূর্ণ স্বাধীনতা আপনার রয়েছে এবং যে কোন সময় আপনি এই সাক্ষাৎকার বাতিল করে দিতে পারেন। এই সাক্ষাৎকার পূর্বে আপনার সদয় সম্মতি আমাদের সম্মানিত করবে। আপনার মতামত আমাদের নিকট অত্যন্ত গুরুত্বপূর্ণ। এ বিষয়ে আপনার কোন কিছু জানার থাকলে তা স্বছন্দে জিজ্ঞেস করতে পারেন।

১) গত কয়েক দিনের/মাসের মধ্যে আমাদের প্রতিষ্ঠানের কেউ কি আপনার সাক্ষাৎকার নিয়েছেন?

ক. হ্যাঁ, যদি হ্যাঁ হয়, তবে কখন? ..... দিন/মাস আগে (সাক্ষাৎকার বন্ধ করে দিন)

খ. না (সাক্ষাৎকার চালিয়ে যান)

২) আমি কি এখন সাক্ষাৎকার শুরু করতে পারি?

ক. যদি সম্মতি প্রদান করেন, তবে সাক্ষাৎকার চালিয়ে যান।

খ. যদি অসম্মতি প্রদান করেন, তবে সাক্ষাৎকার বন্ধ করে দিন ।

সাক্ষাতকার গ্রহনের স্থান ঃ									
সাক্ষাতকার শুরুর সময়			সাক্ষাতকার শেষ সময়			সাক্ষাতকার গ্রহনের তারিখ			
	ঘন্টা	মিনিট		ঘন্টা	মিনিট		দিন	মাস	বছর

	সাক্ষাৎকার গ্রহণকারী	সম্পাদনকারী	লিপিবদ্ধকারী
নাম			
স্বাক্ষর ও তারিখ			

উত্তরদাতা/দাত্রীর নাম			মোবাইল নং	
উত্তরদাতা/দাত্রীর ঠিকানা	বাড়ী নং		ইউনিয়ন	
	গ্রাম		উপজেলা/ থানা	
	ওয়ার্ড নং		জেলা	

A: উত্তরদাতা/ দাত্রীর ব্যক্তিগত ও পরিবারিক সম্পর্কিত তথ্য ঃ

A1	লিঙ্গ	১	পুরুষ	২	মহিলা						
A2	বয়স	১	১৫-২৪ বছর	২	২৫- ৩৪ বছর	৩	৩৫-৪৪ বছর	৪	৪৫ - ৫৪বছর	৫	৫৫- উর্দ্ধে
A3	ধর্ম	১	ইসলাম	২	হিন্দু	৩	খৃষ্টান	৪	বৌদ্ধ		
A4	জাতী-গোষ্ঠী	১	বাঙ্গালী	২	অবাঙ্গালী	৩	আদিবাসী	৪	অন্যান্য		
A5	বৈবাহিক অবস্থা	১	বিবাহিত	২	অবিবাহিত	৩	বিধবা/বিপত্নীক	৪	তালাকপ্রাপ্ত		

A6	সন্তান আছে কি	১	হ্যা	২	না						
A7	যদি থাকে (সংখ্যা)		ছেলে		জন		মেয়ে		জন		
A8	কত দিন এই বাড়ীতে বসবাস করছেন	বছর			মাস						

A9	আপনার পেশা কি	১	দিনমজুর	২	কারখানাশ্রমিক	৩	গৃহ-শ্রমিক	৪	রিক্সা/ভ্যান-চালক
		৫	বাড়ীওয়ালা	৬	নাপিত/সেলুন	৭	কুলি	৮	সিএনজি/ট্রাক/বাস-চালক
		৯	ক্ষুদ্র ব্যবসা	(টং দোকান, মোবাইল রেস্টুরেন্ট ইত্যাদি)				১০	সরকারী চাকুরীজীবি
		১১	মাঝারী ব্যবসা	(ডিপার্টমেন্টাল স্টোর, চেইন সপ্ ইত্যাদি)				১২	বেসরকারী চাকুরীজীবি
		১৩	ডাক্তার	১৪	শিক্ষক	১৫	কৃষক	১৬	গৃহীনি
		১৭	মাঝি	১৮	জেলে	১৯	তাতী	২০	

A10	এই কাজ থেকে আপনি মাসে কত টাকা আয় করেন ?								
	১	১,০০০-৫,০০০	২	৫,০০১ - ১০,০০০	৩	১০,০০১ - ১৫,০০০	৪	১৫,০০১ - ২০,০০০	
	৫	২০,০০১ -৩০,০০০	৬	৩০,০০১ - ৪০,০০০	৭	৪০,০০১ - ৫০,০০০	৮	৫০,০০১ - উর্দ্ধে	

A11	এই পেশা ছাড়া দ্বিতীয় কোন পেশা আছে কি?	১	হ্যাঁ	২	না

A12	আপনার দ্বিতীয় পেশা কি	১	দিনমজুর	২	কারখানাশ্রমিক	৩	গৃহ-শ্রমিক	৪	রিক্সা/ভ্যান-চালক
		৫	বাড়ীওয়ালা	৬	নাপিত/সেলুন	৭	কুলি	৮	সিএনজি/ট্রাক/বাস-চালক
		৯	ক্ষুদ্র ব্যবসা	(টং দোকান, মোবাইল রেস্টুরেন্ট ইত্যাদি				১০	সরকারী চাকুরীজীবি
		১১	মাঝারী ব্যবসা	ডিপার্টমেন্টাল স্টোর, চেইন সপ্ ইত্যাদি				১২	বেসরকারী চাকুরীজীবি
		১৩	ডাক্তার	১৪	গৃহ-শিক্ষক	১৫	কৃষক	১৬	তাতী
		১৭	মাঝি	১৮	জেলে	১৯		২০	

A13	আপনি গবাদি পশু/পাখি পালন করেন কি ?	১	হাঁ	২	না

A14	আপনি কেন গবাদি পশু/পাখি পালন করেন ?	১	নিজ পরিবারের জন্য	২	বিক্রর জন্য

A15	যদি পালন করেন তবে কয়টি আছে ?									
	গরু	১	১-৫ টি	২	৬-১০টি	৩	১১-১৫	৪	১৫-২০টি	৫	২১- উর্দ্ধে
	মহিষ	১	১-৫ টি	২	৬-১০টি	৩	১১-১৫	৪	১৫-২০টি	৫	২১- উর্দ্ধে
	ছাগল	১	১-৫ টি	২	৬-১০টি	৩	১১-১৫	৪	১৫-২০টি	৫	২১- উর্দ্ধে
	ভেড়া	১	১-৫ টি	২	৬-১০টি	৩	১১-১৫	৪	১৫-২০টি	৫	২১- উর্দ্ধে
	হাঁস-মুরগী	১	১-৫ টি	২	৬-১০টি	৩	১১-১৫	৪	১৫-২০টি	৫	২১- উর্দ্ধে

A16	গবাদি পশু/পাখি থেকে প্রতি দিন কি পরিমান দূধ/ডিম পান ?									
	দুধ	১	১-৫ কেজি	২	৬-১০কেজি	৩	১১-১৫কেজি	৪	১৫-২০কেজি	৫	২১কেজি- উর্দ্ধে
	ডিম	১	১-৫ টি	২	৬-১০টি	৩	১১-১৫টি	৪	১৫-২০টি	৫	২১- উর্দ্ধে

A17	আপনি চাষাবাদ করেন কি ?	১	হাঁ	২	না

A18	প্রধানত কি ফসলের চাষ করেন ?												
	১	ধান	২	পাট	৩	আলু	৪	আখ	৫	সবজি	৬	সরিষা	৭	তুলা

A19	আপনার কোন ফলের/ ফুল বাগান আছে কি ? (বানিজ্যিক)	১	হাঁ	২	না

A20	কি ধরনের ফলের / ফুলের বাগান আছে? (বানিজ্যিক)										
	১	আম	২	লিচু	৩	বড়ই	৪	ফুল	৫	অন্যান্য	

A21	আপনার বাড়ীতে/ এলাকায় আর্সেনিক যুক্ত টিউবয়েল আছে কি?	১	হাঁ	২	না

A22	আপনার শিক্ষাগত যোগ্যতা কি?	১	নিরক্ষর	২	প্রাইমারী (১ম-৫ম শ্রেনী)	৩	মক্তব/মাদ্রাসা
		৪	মাধ্যমিক(৬-১০ শ্রেনী)	৫	উচ্চ মাধ্যমিক (১১তম-১২তম শ্রেনী)	৬	ভোকেশনাল
		৭	স্নাতক	৮	স্নাতকোত্তর	৯	পলিটেকনিক

A23	আপনার পরিবারের সর্বমোট সদস্য সংখ্যা কত?	প্রাপ্ত বয়স্ক	শিশু	মোট	

A24	কতজন সদস্য আয়ের সাথে সংশ্লিষ্ট ? (জন)	প্রাপ্ত বয়স্ক	শিশু	মোট	

A25	খানার বা পরিবারের সদস্যদের সর্বমোট মাসিক আয় কত? (টাকা)	প্রাপ্ত বয়স্ক	শিশু	মোট	

A26	আপনি ভোটার হয়েছেন কি?	১	হাঁ	২	না	৩	জানিনা

A27	আপনি ভোট দিয়েছেন কি?	১	হাঁ	২	না	৩	জানিনা

B: উত্তরদাতা/ দাত্রীর অভিবাসন সম্পর্কিত তথ্য ঃ

B1	আপনি কি স্থায়ী আবাস (গ্রাম/নিজ জেলা) ছেড়ে এই এলাকায় অভিবাসিত হয়ে এসেছেন?	১	হাঁ	২	না

B2	আপনি কেন অভিবাসন করেছেন	১	উন্নত জীবনযাপনের আশায়	২	আর্থিক স্বচ্ছলতার জন্য	৩	পরিবারের পরামর্শে
		৪	অন্য ব্যক্তিদের চাপের কারণে (অনিচ্ছা)	৫	কাজের অভাবের কারনে		
		৬	নদীভাঙ্গনের কারনে	৭	প্রাকৃতিক দুর্যোগের কারনে		
		৮	বৈবাহিক কারনে	৯	নিজস্ব জায়গা না থাকায়		

B3	গত দশ বছরে আপনার এলাকায় জনসংখ্যার কি পরিবর্তন হয়েছে ?								
	১	দ্রুত বৃদ্ধি পাচ্ছে	২	আস্তে-আস্তে বৃদ্ধি পাচ্ছে	৩	অপরিবর্তিত আছে	৪	কমেছে	৫	জানিনা

C: উত্তরদাতা/দাত্রীর পরিবেশ সম্পর্কিত তথ্য ঃ

C1	আপনার চারিদিকের পরিবেশ কেমন?	১	কোলাহলপূর্ণ	২	কর্দমাক্ত	৩	কবরস্থান/শশ্মানের পাশে
		৪	ছিমছাম পরিবেশ	৫	স্যাঁতস্যাঁতে	৬	বন্যাকবলিত এলাকা (সাময়িক)
		৭	র্দুগন্ধময়				

C2	আপনার এলাকা কি প্রাকৃতিক দূর্য্যেগ পূর্ন এলাকা ?	১	হাঁ	২	না

C3	প্রাকৃতিক দূর্য্যেগ হলে কিভাবে মোকাবেলা করেন ?				
	১	ঘূর্নীঝড় আশ্রয় কেন্দ্রে যাই	২	বাড়ীতেই থাকি	৩	অন্য এলাকায় আশ্রয় নেই

C4	আপনার এলাকা কি গত ১০ বছরে ভুমিকম্প হয়েছে ?								১	হাঁ	২	না
	১ বছরের মধ্যে	১	১ বার	২	২ বার	৩	৩ বার	৪	৪ বার	৫	৫ - উর্দ্ধে বার	
	২ -৩ বছরের মধ্যে	১	১ বার	২	২ বার	৩	৩ বার	৪	৪ বার	৫	৫ - উর্দ্ধে বার	
	৪ - উর্দ্ধে বছরের মধ্যে	১	১ বার	২	২ বার	৩	৩ বার	৪	৪ বার	৫	৫ - উর্দ্ধে বার	

D: স্বাস্থ্য এবং স্বাস্থ্য সেবা সম্পর্কিত তথ্য ঃ

D1	আপনার এলাকায় স্বাস্থ্যসেবার জন্য কি ধরনের ব্যবস্থা আছে?	১	সরকারী হাসপাতাল	২	বিনামূল্যের/দাতব্য হাসপাতাল	৩	বেসরকারী হাসঃ / ক্লিনিক
		৪	এনজিও স্বাস্থ্যসেবা	৫	টোটকা বৈদ্য / ঝাড়ফুক	৬	ফার্মেসী
		৭	কবিরাজ/আর্য়ুবেদীক	৮	হোমিওপ্যাথিক ডাক্তার	৯	ক্যানভাসার
		১০	অন্যান্য (উল্লেখ করুন)				

D2	আপনার এলাকায় শিশু এবং গর্ভবতী মহিলাদের স্বাস্থ্যসেবার জন্য বিশেষভাবে কি কি ধরনের ব্যবস্থা আছে?	১	সরকারী হাসপাতাল	২	বিনামূল্যের/দাতব্য হাসপাতাল	৩	বেসরকারী হাসঃ / ক্লিনিক
		৪	এনজিও স্বাস্থ্যসেবা	৫	টোটকা বৈদ্য / ঝাড়ফুক	৬	ফার্মেসী
		৭	কবিরাজি/আর্য়ুবেদীক	৮	হোমিওপ্যাথিক ডাক্তার	৯	ক্যানভাসার
		১০	অন্যান্য (উল্লেখ করুন)				

D3	এলাকায় স্বাস্থ্যসেবার ব্যবস্থা কে আপনি কি পর্যাপ্ত বলে মনে করেন ?	১	হাঁ	২	না

D4	যদি না হয় তবে কি ধরনের স্বাস্থ্যসেবা প্রতিষ্ঠানের প্রয়োজন বলে মনে করেন ?	১	সরকারী হাসপাতাল	২	বিনামূল্যের/দাতব্য হাসপাতাল	৩	বেসরকারী হাসঃ / ক্লিনিক
		৪	এনজিও স্বাস্থ্যসেবা	৫	টোটকা বৈদ্য / ঝাড়ফুক	৬	ফার্মেসী
		৭	কবিরাজি/আর্য়ুবেদীক	৮	হোমিওপ্যাথিক ডাক্তার	৯	ক্যানভাসার
		১০	অন্যান্য (উল্লেখ করুন)				

D5	গত ৬ মাসের মধ্যে আপনি বা আপনার খানার কোন সদস্য কি অসুস্থ হয়েছিল ?	১	হাঁ	২	না

D6	কি আসুখ হয়েছিল	১	জ্বর - কশি	২	ডায়রিয়া	৩	জন্ডিস	৪	চোখে সমস্যা	৫	গলায় সমস্যা
		৬	গ্যাস্ট্রিক	৭	এ্যাজমা/হাপানি	৮	শরীর ব্যাথা	৯	বাঁতজ্বর	১০	ডায়াবেটিক
		১১	ম্যলেরিয়া	১২	যক্ষা	১৩	প্রেসার	১৪	হাম	১৫	হৃদরোগ
		১৬	টাইফয়েড	১৭	আমাশয়	১৮	ডেলিভারি	১৯	আরসেনিক		

D7	কোথায় চিকিৎসা গ্রহন করেছেন ?	১	সরকারী হাসপাতাল	২	বিনামূল্যের/দাতব্য হাসপাতাল	৩	বেসরকারী হাসঃ / ক্লিনিক
		৪	এনজিও স্বাস্থ্যসেবা	৫	টোটকা বৈদ্য / ঝাড়ফুক	৬	ফার্মেসী
		৭	কবিরাজি/আর্য়ুবেদীক	৮	হোমিওপ্যাথিক ডাক্তার	৯	ক্যানভাসার
		১০	চিকিৎসা নেই নাই	১১	অন্যান্য (উল্লেখ করুন)		

D8	চিকিৎসা খরচ বহনকারী কে ?	১	অভিভাবক / বাবা-মা	২	আত্মীয়-স্বজন	৩	বন্ধু-বান্ধব
		৪	নিজে	৫	বন্ধু-বান্ধব	৬	এলাকার অবস্থাপন্ন ব্যক্তি
		৭	স্থানীয় প্রতিনিধি	৮	স্থানীয় সামাজিক সংগঠন	৯	স্বামী/স্ত্রী

D9	গত ৬ মাসের মধ্যে আপনি বা আপনার খানার কোন সদস্য কি কখনো দূর্ঘটনায় পড়েছিল?	১	হাঁ	২	না

D10	কি দূর্ঘটনা ঘটেছিল	১	চোখে আঘাত	২	বৈদ্যুতিক শক	৩	মচকে যাওয়া	৪	পানিতে পরা
		৬	পুড়ে যাওয়া	৭	কেটে যাওয়া	৮	ছুরি মারা	৯	হাত-পা ভেঙ্গে যাওয়া
		১১	সড়ক দুর্ঘটনা	১২	হারিয়ে যাওয়া	১৩	অন্যান্য		

D11	কোথায় চিকিৎসা গ্রহন করেছেন ?	১	সরকারী হাসপাতাল	২	বিনামূল্যের/দাতব্য হাসপাতাল	৩	বেসরকারী হাসঃ / ক্লিনিক
		৪	এনজিও স্বাস্থ্যসেবা	৫	টোটকা বৈদ্য / ঝাড়ফুক	৬	ফার্মেসী
		৭	কবিরাজি/আর্য়ুবেদীক	৮	হোমিওপ্যাথিক ডাক্তার	৯	ক্যানভাসার
		১০	চিকিৎসা নেই নাই	১১	অন্যান্য (উল্লেখ করুন)		

D12	চিকিৎসা সেবা না	১	সরকারী হাসপাতাল নাই	২	চিকিৎসা খরচ বহনের কোন ক্ষমতা ছিল না (নিজ)

	পাওয়ার কারন	৩	ভাল চিকিৎসা কেন্দ্র নাই	৪	অভিভাবক/বাবা-মা চিকিৎসা করায়নি
		৫	রোগ সনাক্ত করা যায়নি	৬	অবহেলার কারনে

E: এলাকার মূল সেবাসমূহ সম্পর্কে উত্তরদাতা/দাত্রীর মতামত সম্পর্কিত তথ্যঃ

E1	পরিবারে আলোর উৎস কি	১	বৈদ্যুতিক বাতি	২	মোমবাতি
		৩	সোলার বাতি	৪	ব্যাটারী চালিত বাতি
		৫	কেরোসিনের হারিকেন / কুপি	৬	জেনারেটর

E2	আপনার বাসায় পাইপ গ্যাসের সংযোগ আছে কি?	১	হাঁ	২	না

E3	যদি না থাকে কোন ধরনের জ্বালানী ব্যবহার করেন?	১	বৈদ্যুতিক হিটার	২	লাকড়ী
		৩	কেরোসিনের চুলা	৪	গোবর/ ঘৈটা
		৫	গ্যাস সিলিন্ডার	৬	বায়োগ্যাস

E4	আপনার বাসায় সাপ□াই পানির সংযোগ আছে কি?	১	হাঁ	২	না

E5	যদি না থাকে, খাওয়ার ও রান্নার জন্য কি ব্যবহার করেন?	১	টিউবওয়েল	২	জলাশয় / ডোবা
		৩	পুকুর	৪	কুয়া
		৫	নদী	৬	

E6	আপনার এলাকায় পয়ঃনিস্কাসন ব্যবস্থা আছে কি? (বৃষ্টি, গৃহস্থলী ব্যবহৃত তরল পদার্থ)	১	হাঁ	২	না

E7	আপনার এলাকার পয়ঃনিস্কাসন ব্যবস্থা কি সন্তোষজনক?	১	হাঁ	২	না

E8	কেন সন্তোষজনক নয় বলে আপনি মনে করেন?	১	সুয়ারেজ লাইন নাই	২	সুয়রেজ লাইন আছে কিন্তু পরিস্কার করা হয় না
		৩	সুয়ারেজ ব্যবস্থা নষ্ট হয়ে গেছে	৪	কর্তৃপক্ষের অবহেলা
		৫	অন্যান্য		

E9	আপনি বা আপনারা কেমন পায়খানা ব্যবহার করেন?	১	আধুনিক পায়খানা	২	কংক্রিট / স্ল্যাব পায়খানা
		৩	পিট পায়খানা	৪	ড্রেইনের পাশে / খোলা জায়গায়
		৫	খোলা / ঝোলানো পায়খানা	৬	অন্যান্য

E10	আপনি কি জানেন, স্বাস্থ্যসম্মত পায়খানা প্রয়োজন কিনা?	১	হাঁ	২	না

E11	স্বাস্থ্যসম্মত পায়খানা প্রয়োজন কেন?	১	রোগজীবানু ছড়াতে পারে না	২	দূর্গন্ধ দ্বারা পরিবেশ দূষিত হতে পারে না
		৩	জানিনা	৪	পোকামাকড় (মাছি) দ্বারা রোগ ছড়ায় না
		৫	অন্যান্য		

E12	আপনার এলাকার যাতায়াত ব্যবস্থার আবস্থা কেমন ?									
সড়ক	১	খুব ভাল	২	ভাল	৩	খুব খারাপ	৪	খারাপ	৫	জানিনা
নৌ	১	খুব ভাল	২	ভাল	৩	খুব খারাপ	৪	খারাপ	৫	জানিনা
বিমান	১	খুব ভাল	২	ভাল	৩	খুব খারাপ	৪	খারাপ	৫	জানিনা

F: উত্তরদাতা/দাত্রীর ঋণ গ্রহণ, সঞ্চয় ও বিনিয়োগ সম্পর্কিত তথ্য ঃ

F1	আপনার ব্যাংক একাউন্ট আছে কি?	১	হাঁ	২	না

F2	গত ১ বৎসরের মধ্যে আপনি কোন প্রকার ঋণ গ্রহণ করেছেন কি?	১	হাঁ	২	না

F3	কোন্ উৎস্য থেকে ঋণ গ্রহন করেছেন?	১	বানিজ্যিক ব্যাংক	২	এনজিও / এনজিও সমিতি
		৩	সমবায় সমিতি	৪	বন্ধু-বান্ধব
		৫	মহাজন	৬	আত্মীয়-স্বজন

F4	কোন্ খাতে ঋনের টাকা খরচ করেছেন ?	১	খাবার	২	কৃষি	৩	ব্যবসার পুজি
		৪	চিকিৎসা	৫	শিক্ষা	৬	গৃহ নির্ম্মন
		৭	মামলা-মোকদ্দমা	৮	বিবাহ	৯	জমি ক্রয়

F5	আপনারা (খানার সদস্যরা) কি কিছুটা হলেও প্রতি মাসে সঞ্চয় করেন?	১	হাঁ	২	না

F6	কী পরিমান (টাকা) সঞ্চয় করেন? (প্রতি মাসে)						
	১	১০০- ৩০০	২	৩০১ - ৬০০	৩	৬০১ - ৯০০	৪	৯০১ - ১,২০০
	৫	১,২০১ - ১,৫০০	৬	১,৫০১ - ২০০০	৭	২,০০১ - উর্দ্ধে		

F7	সাধারণত আপনারা কোথায় টাকা সঞ্চয় করেন?	১	ব্যাংক	২	এনজিও	৩	বীমা কোম্পানী
		৪	স্থানীয় সমবায় সমিতি	৫	মাটির ব্যাংক	৬	হাতে/ ঘরে জমা রাখা হয়
		৭	অন্যান্য				

G: প্রস্তাাবিত সায়েদাবাদ ওয়াটার ট্রিটমেন্ট প্লান্ট পর্ব-৩, এর প্রভাব সম্পর্কে উত্তরদাতা/দাত্রীর মতামত সম্পর্কিত তথ্যঃ

G1	এখানে যদি সায়েদাবাদ ওয়াটার ট্রিটমেন্ট প্লান্ট পর্ব-৩, নির্মান করা হয়, তাহলে আপনি কি তা সমর্থন করেন ?	১	হাঁ	২	না

G2	যদি হ্যা হয়, তাহলে কি কারনে সমর্থন করবেন ?	১	এলাকার উন্নয়ন হবে	২	কর্মসংস্থান হবে		
		৩	লোড-সেডিং কমবে	৪	নতুন শিল্প-কারখানা তৈরি হবে।		
		৫	দেশের বিদ্যুৎ ঘাটতি কমবে	৬	নতুন রাস্তাঘাট তৈরি হবে		
		৭	ব্যবসা-বানিজ্য বৃদ্ধি পাবে	৮	অন্যান্য		

G3	যদি না হয়, তাহলে কি কারনে সমর্থন করবেন না?	১	যানযট বাড়বে	২	বায়ু দূষন হবে।	৩	রোগ বৃদ্ধি পাবে
		৪	রাস্তা নষ্ট হবে	৫	শব্দ দূষন হবে।	৬	শস্য-ফল এর উৎপাদন কমবে
		৭	পানি / নদী দূষন হবে	৮	অন্যান্য		

G4	এখানে যদি সায়েদাবাদ ওয়াটার ট্রিটমেন্ট প্লান্ট পর্ব-৩, নির্মান করতে কিছু জমি অধিগ্রহন করা হয়, তাহলে আপনি কি তা সমর্থন করেন ?	১	হাঁ	২	না

H: বিভিন্ন ধরনের ধর্মীয় এবং ঐতিহাসিক স্থাপনা সম্পর্কিত তথ্যঃ

H1	আপনার এলাকায় কি কি ধর্মীয় স্থাপনা আছে?	১	মসজিদ / মাদ্রাসা	২	মন্দির
		৩	গির্জা	৪	পেগোডা
		৫	অন্যান্য		

H2	আপনার এলাকায় কি কি ঐতিহাসিক স্থাপনা আছে?	১	পুরাতন রাজবাড়ী / স্থাপনা	২	ধর্মীয় স্থাপনা
		৩	পুকুর/দিঘী	৪	ব্রীজ
		৫	অন্যান্য		

H3	কয়টি স্থাপনা আছে ?		স্থাপনাটি কত বছরের পুরাতন (আনুমানিক)		

I: ব্যাক্তিগতভাবে বা স্থানীয়ভাবে বিভিন্ন ক্ষেত্রে সায়েদাবাদ ওয়াটার ট্রিটমেন্ট প্লান্ট পর্ব-৩, এর প্রভাব সম্পর্কে আপনার মতামত দিন ঃ

(সায়েদাবাদ ওয়াটার ট্রিটমেন্ট প্লান্ট পর্ব-৩, এর নির্মানকালীন সময়)

ক্রমিক	ক্ষেত্র সমুহ		প্রভাব							
I1	যাতায়াত যোগাযোগ ব্যবস্থা	সড়ক	১	ভাল হবে	২	ভাল হবেনা	৩	জানিনা	৪	মন্তব্য নাই
I2		নৌ	৫	ভাল হবে	৬	ভাল হবেনা	৭	জানিনা	৮	মন্তব্য নাই
I3		বিমান	৯	ভাল হবে	১০	ভাল হবেনা	১১	জানিনা	১২	মন্তব্য নাই
I4	কৃর্ষি কাজ (প্রকল্প এলাকা)		১৩	ভাল হবে	১৪	ভাল হবেনা	১৫	জানিনা	১৬	মন্তব্য নাই
I5	বাতাসের অবস্থা (গুনগত)		১৭	ভাল হবে	১৮	ভাল হবেনা	১৯	জানিনা	২০	মন্তব্য নাই
I6	শব্দ দূষণ		২১	ভাল হবে	২২	ভাল হবেনা	২৩	জানিনা	২৪	মন্তব্য নাই
I7	জনস্বাস্থ্য		২৫	ভাল হবে	২৬	ভাল হবেনা	২৭	জানিনা	২৮	মন্তব্য নাই
I8	কর্মসংস্থান		২৯	ভাল হবে	৩০	ভাল হবেনা	৩১	জানিনা	৩২	মন্তব্য নাই
I9	ব্যবসা-বানিজ্য		৩৩	ভাল হবে	৩৪	ভাল হবেনা	৩৫	জানিনা	৩৬	মন্তব্য নাই
I10	স্থানীয় অর্থনীতি		৩৭	ভাল হবে	৩৮	ভাল হবেনা	৩৯	জানিনা	৪০	মন্তব্য নাই
I11	সামাজিক সমস্যা *		৪১	ভাল হবে	৪২	ভাল হবেনা	৩৪	জানিনা	৪৪	মন্তব্য নাই
I12	জলাবদ্ধতা		৪৫	ভাল হবে	৪৬	ভাল হবেনা	৪৭	জানিনা	৪৮	মন্তব্য নাই
I13	পয়ঃনিস্কাসন		৪৯	ভাল হবে	৫০	ভাল হবেনা	৫১	জানিনা	৫২	মন্তব্য নাই
I14	পানি সর্বরাহ ব্যবস্থা		৫৩	ভাল হবে	৫৪	ভাল হবেনা	৫৫	জানিনা	৫৬	মন্তব্য নাই
I15	নদীর পানির অবস্থা		৫৭	ভাল হবে	৫৮	ভাল হবেনা	৫৯	জানিনা	৬০	মন্তব্য নাই
I16	বিদ্যুৎ ব্যবস্থা		৬১	ভাল হবে	৬২	ভাল হবেনা	৬৩	জানিনা	৬৪	মন্তব্য নাই

* (নতুন শ্রমিকের আগমন, পয়ঃনিস্কাশনে সমস্যা, অসামাজিক কার্যকলাপ, আইনশৃংঙ্খলার অবনতি ইত্যাদি।)

J: ব্যাক্তিগতভাবে বা স্থানীয়ভাবে বিভিন্ন ক্ষেত্রে সায়েদাবাদ ওয়াটার ট্রিটমেন্ট প্লান্ট পর্ব-৩, এর প্রভাব সম্পর্কে আপনার মতামত দিনঃ

(সায়েদাবাদ ওয়াটার ট্রিটমেন্ট প্লান্ট পর্ব-৩, এর সরবরাহকালীন/উৎপাদনকালীন সময়ে)

ক্রমিক	ক্ষেত্র সমুহ		প্রভাব							
J1	যাতায়াত যোগাযোগ ব্যবস্থা	সড়ক	১	ভাল হবে	২	ভাল হবেনা	৩	জানিনা	৪	মন্তব্য নাই
J2		নৌ	৫	ভাল হবে	৬	ভাল হবেনা	৭	জানিনা	৮	মন্তব্য নাই
J3		বিমান	৯	ভাল হবে	১০	ভাল হবেনা	১১	জানিনা	১২	মন্তব্য নাই
J4	বাতাসের অবস্থা		১৩	ভাল হবে	১৪	ভাল হবেনা	১৫	জানিনা	১৬	মন্তব্য নাই
J5	শব্দ দূষণ		১৭	ভাল হবে	১৮	ভাল হবেনা	১৯	জানিনা	২০	মন্তব্য নাই
J6	জনস্বাস্থ্য		২১	ভাল হবে	২২	ভাল হবেনা	২৩	জানিনা	২৪	মন্তব্য নাই
J7	ব্যবসা-বানিজ্য		২৫	ভাল হবে	২৬	ভাল হবেনা	২৭	জানিনা	২৮	মন্তব্য নাই
J8	কর্মসংস্থান		২৯	ভাল হবে	৩০	ভাল হবেনা	৩১	জানিনা	৩২	মন্তব্য নাই
J9	হাসপাতাল / স্বাস্থ্য কেন্দ্র		৩৩	ভাল হবে	৩৪	ভাল হবেনা	৩৫	জানিনা	৩৬	মন্তব্য নাই
J10	বিদ্যুৎ ব্যবস্থা		৩৭	ভাল হবে	৩৮	ভাল হবেনা	৩৯	জানিনা	৪০	মন্তব্য নাই

J11	জাতীয় অর্থনীতিতে প্রভাব		৪১	ভাল হবে	৪২	ভাল হবেনা	৩৪	জানিনা	৪৪	মন্তব্য নাই
J12	সামাজিক সমস্যা		৪৫	ভাল হবে	৪৬	ভাল হবেনা	৪৭	জানিনা	৪৮	মন্তব্য নাই
J13	পানি সর্বরাহ ব্যবস্থা		৪৯	ভাল হবে	৫০	ভাল হবেনা	৫১	জানিনা	৫২	মন্তব্য নাই
J14	জলাবদ্ধতা		৫৩	ভাল হবে	৫৪	ভাল হবেনা	৫৫	জানিনা	৫৬	মন্তব্য নাই
J15	পয়ঃনিস্কাসন		৫৭	ভাল হবে	৫৮	ভাল হবেনা	৫৯	জানিনা	৬০	মন্তব্য নাই
J16	নদীর পানির অবস্থা	পরিমান	৬১	ভাল হবে	৬২	ভাল হবেনা	৬৩	জানিনা	৬৪	মন্তব্য নাই
J17		গুনগত মান	৬৫	ভাল হবে	৬৬	ভাল হবেনা	৬৭	জানিনা	৬৮	মন্তব্য নাই

K: উত্তরদাতা/দাত্রীর মতামত এবং বাস্তব অভিজ্ঞতা সম্পর্কিত তথ্য

সার্বিকভাবে কোন্ কোন্ সমস্যাগুলোকে স্থানীয়ভাবে আপনার এলাকার প্রধানতম সমস্যা বলে মনে করেন?	
এই সমস্যা সমূহ মোকাবেলার জন্য বা সমস্যা সমাধানের জন্য কি কি উদ্যোগ নেয়া উচিত বলে আপনি মনে করেন? (একাধিক উত্তর আসতে পারে)	

ধন্যবাদ জানিয়ে সাক্ষাতকার শেষ করুন।

12.3 Participant List of Focus Group Discussions

Participant List of Focus Group Discussions

Saidabad Water Treatment Plant Phase-III
Environmental Impact Assessment
Participant List for FGD (Focus Group Discussion)

FGD # 01 Venue # বৈদ্যের বাজার ইউনিয়ন পরিষদ, নারায়ণগঞ্জ Date # ২৮/০১/২০২০ ইং Time # ১১.০০ – ১২.০০

Sl	Name	Address	Age	Sex	Profession	Mobile No	Signature
1	মোঃ মিজানুর রহমান	[illegible]	33	MALE	Business	0196732493	[illegible]
2	মো: [illegible] রশিদ	[illegible]	৫৫	M	কৃষক	01982085187	মো: [illegible] রশিদ
3	[illegible]	[illegible]	80	M	ইমাম	১৭২০২৬-৩৬ ৭১	মো: [illegible]
4	মো: মোতালেব	[illegible]	৫৮	M	ব্যবসা	০১৯১৫৫৯৪৭ ৭৬৭	মো: মোতালেব
5	মো: ইউসুফ	[illegible]	৩২	M	কৃষক	01715114730	মো: ইউসুফ
6	মো: [illegible]	[illegible]	৪২	M	কৃষক	0191848320?	মো: [illegible]
7	সুলতান	[illegible]	৫০	M	কৃষক	01913350460	সুলতান
8	[illegible]	[illegible]	৪০	"	"	0172144 9414	[illegible]
9	মো: সালাউদ্দিন	[illegible]	80	m	ব্যবসা	01947177835	মো: সালাউদ্দিন
10	[illegible]	[illegible]	82	m	ব্যবসা	0192114440?	[illegible]

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Sl	Name	Address	Age	Sex	Profession	Mobile No	Signature
11	মো: [illegible]	[illegible]	৫৫	M	ব্যবসা	[illegible]	[illegible]
12	মো: [illegible]	[illegible]	33	M	কৃষক	01920030832	[illegible]
13	মোছা: [illegible]	[illegible]	৩৫	F	[illegible]	0193165467?	[illegible]
14	মিনারা	[illegible]	৩৫	F	গৃহিনী	—	মিনারা
15	[illegible]	[illegible]	80	F	গৃহিনী	—	[illegible]
16	আবেদা	[illegible]	80	F	গৃহিনী	—	আবেদা
17	~~আবেদা~~ কমলা	[illegible]	8?	F	গৃহিনী	—	[illegible]
18	A. Mamun	[illegible]	৫৮	M	চাকরী	—	A. Mamun
19	[illegible]	[illegible]	80	F	[illegible]	0178982403	[illegible]
20	রাবেয়া	[illegible]	৩০	F	[illegible]	019678889?	রাবেয়া
21	[illegible]	[illegible]	৩৫	F	গৃহিনী	—	[illegible]
22	[illegible]	[illegible]	60	M	[illegible]	01978??	[illegible]

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Sl	Name	Address	Age	Sex	Profession	Mobile No	Signature
23	Md. MIZANUR RAHMAN	Asad ghat, DWASA	30 Years	Male	Engineer	01675387515	
24	A. HOSSAIN	[illegible]	58	M	[illegible]	[illegible]	A. Hossain
25							
26							
27							
28							
29							
30							
31							
32							
33							
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Saidabad Water Treatment Plant Phase-III
Environmental Impact Assessment
Participant List for FGD (Focus Group Discussion)

FGD # 2 Venue # MADAN CIRCLE. NARAYANGANJ Date # 25.09.2013 Time # 11.00Am 12.00Pm

Sl	Name	Address	Age	Sex	Profession	Mobile No	Signature
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]
7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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Sl	Name	Address	Age	Sex	Profession	Mobile No	Signature
11	মো: আবদুর রব	গ্রাম: বোয়ালিয়ারা মো: বাড় লেন্ড্রা থানা: কদর.	৩৮	m	ব্যবসা	০১৭৫৭০৯৪২২৪	
12	মো: মনির হোসেন	গ্রাম: বাড় লেন্ড্রা মো: বাড় লেন্ড্রা থানা: কদর	২৫	m	ড্রাইভার	—	
13	মো: ফরিদউদ্দিন	গ্রাম: বাসলেকান্দি মো: বাড়লেন্ড্রা থানা: কদর	৫০	m	কৃষি	০১৮৭০২৪৯ ৭৭৫	
14	মো: মনির হোসেন	গ্রাম: বাড়লেন্ড্রা মো: বাড় লেন্ড্রা থানা: কদর	৫০	m	আমদানি ব্যবসায়ী	০১৮১৬৭৭৫২৩১	
15	মিস: মিতু রানী	গ্রাম: ওসমপুর মো: বাড় লেন্ড্রা থানা: কদর	২৫	f	ব্যবসা	—	
16	মিস: সাবিনা	গ্রাম: ওসমপুর. মো: বাড় লেন্ড্রা থানা: কদর	২০	f	চাকরি	—	
17	মিস: আলেনা	গ্রাম: বাড় লেন্ড্রা মো: বাড় লেন্ড্রা থানা: কদর	২৫	f	চাকরি	০১৯৫৭৩২৫৫	
18	শ্রী বিমলেন্দু চক্রবর্তী	গ্রাম: ওসমপুর. মো: বাড় লেন্ড্রা থানা: কদর	৫০	m	ব্যবসা	—	
19	মিস: তমন্না খাতুন	গ্রাম: আজের হাট মো: বেতুকান্দা থানা: কদর	৩৮	f	চাকরি	—	
20	মিস: আলেনা	গ্রাম: বিশেষ বাজার মো: বাড় লেন্ড্রা থানা: কদর	৫০	f	চাকরি	—	
21	মো: আবদুল কাদের	গ্রাম: বালিয়াটুলি মো: বাড় লেন্ড্রা থানা: কদর	৬৯	m	ব্যবসা	—	
22	মিস: তাহমিনা বাবলুর	গ্রাম: বরকান্দি মো: বাড় লেন্ড্রা থানা: কদর	২২	f	ব্যবসা	—	

Sl	Name	Address	Age	Sex	Profession	Mobile No	Signature
23	মিস: মোছা: তাসলিমা বেগম	গ্রাম: ওসমপুর মো: বাড় লেন্ড্রা থানা: কদর	৩৫	f	গৃহিনী	—	
24	মো: তোফাজ্জল হোসেন	গ্রাম: দৌলতপুর মো: [illegible]	৬০	M	চাকুরী	017/5201884	
25							
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Saidabad Water Treatment Plant Phase-III
Environmental Impact Assessment
Participant List for FGD (Focus Group Discussion)

FGD # 3 Venue # হাজী আমজাদ মুন্সীর মার্কেট — সেকিন্দপুর Date # 25.09.13 Time # 4:00 – 5:00pm

Sl	Name	Address	Age	Sex	Profession	Mobile No	Signature
1	হাজী আব্দুল হামিদ	সেকিন্দপুর	৬৫	পুঃ	বেকার	01925969198	আঃ হামিদ
2	মোঃ সাখাওয়াত হোসেন	সেকিন্দপুর	৬৪	পুঃ	অবসর	01720939119	Hossain
3	আব্দুল কাদের	সেকিন্দপুর	৮০	পুঃ	বেকার	নাই	আঃ কাদের
4	মোঃ মোসলেম উদ্দিন মিয়া	সেকিন্দপুর	৬৫	পুঃ	সাবেক অবসর	01728429482	[illegible]
5	[illegible]	সেকিন্দপুর	৬৮	পুঃ	ব্যবসা	নাই	[illegible]
6	আলী আকবর	আমলাপাড়া	৭০	পুঃ	ব্যবসা	01- নাই	Ali Akbar
7	মোঃ কামাল হোসেন	সেকিন্দপুর	৬৮	পুঃ	ব্যবসা	নাই	মোঃ কামাল হোসেন
8	মোঃ রফিকুল ইসলাম	সেকিন্দপুর	৬৫	পু	ব্যবসা	0171939192	[illegible]
9	[illegible]	সেকিন্দপুর	৮০	পুঃ	কৃষি		[illegible]
10	মোঃ সালাহউদ্দিন	সেকিন্দপুর	৫৫	পুঃ	ব্যবসা	0171915061	[illegible]

Sl	Name	Address	Age	Sex	Profession	Mobile No	Signature
11	মোঃ হাসমত	সেকিন্দপুর	৬২	পু	কাঠ ব্যবসা [illegible]	নাই	হাসমত
12	এম, এ, হাসেম	সেকিন্দপুর	৫৫	পুঃ	কৃষক	01912197182	m.a. Hashem
13	ওমর ফারুক ভূঁইয়া	আমলাপাড়া	৪৫	পু	ব্যবসা	01939692068	Faruk
14	মোঃ সিরাজউদ্দিন	[illegible]	৫২	পুঃ	চাকরী	01191147699	[illegible]
15	মোঃ আলিমুদ্দিন	সেকিন্দপুর	৭০	পুঃ	বেকার	নাই	আলিমুদ্দিন
16	মোঃ আমিনুল ইসলাম	সেকিন্দপুর	৪৪	পুঃ	ব্যবসা	01722641235	[illegible]
17	মোঃ [illegible]	সেকিন্দপুর	৫৮	পুঃ	কৃষক	01720912998	[illegible]
18	মোঃ জহির উদ্দিন ভূঁইয়া	আমলাপাড়া	৪২	পুঃ	ব্যবসা	০১৯২৮২৬ ৫৫২০	Md [illegible]
19	সামসুল হক	আমলাপাড়া	৫২	পুঃ	ব্যবসা	01821842272	[illegible]
20	আব্দুল হক	সেকিন্দপুর	৫০	পুঃ	ঠিকা ব্যবসা	01833222780	মোঃ [illegible]
21							
22							

12.4 Bangladesh Standards for Waste Discharge (Schedule 10, Rule 13, Environment Conservation Rules 1997)

Bangladesh Standards for Waste Discharge

(Schedule 10, Rule 13, Environment Conservation Rules 1997)

Parameters	Unit	Places for determination of standards		
		Inland Surface Water	Public Sewerage system connected to treatment at second stage	Irrigated land
Ammonia-nitrogen (as elementary N)	mg/l	50	75	75
Ammonia (as free ammonia)	mg/l	5	5	5
Arsenic (as As)	mg/l	0.2	0.05	0.2
BOD_5 at 20°C	mg/l	50	250	100
Boron	mg/l	2	2	2
Cadmium (as Cd)	mg/l	0.5	0.05	0.05
Chloride	mg/l	600	600	600
Chromium (as total Cr)	mg/l	0.5	1.0	1.0
COD	mg/l	200	400	400
Chromium (as hexavalent Cr)	mg/l	0.1	1.0	1.0
Copper (as Cu)	mg/l	0.5	3.0	3.0
Dissolved oxygen (DO)	mg/l	4.5-8	4.5-8	4.5-8
Electro-conductivity (EC)	µSiemens/cm	1200	1200	1200
Total dissolved solids	mg/l	2100	2100	2100
Fluoride (as F)	mg/l	2	15	10
Sulfide (as S)	mg/l	1	2	2
Iron (as Fe)	mg/l	2	2	2
Total kjeldahl nitrogen (as N)	mg/l	100	100	100
Lead (as Pb)	mg/l	0.1	1.0	0.1
Manganese (as Mn)	mg/l	5	5	5
Mercury (as Hg)	mg/l	0.01	0.01	0.01
Nickel (as Ni)	mg/l	1.0	2.0	1.0
Nitrate (as elementary N)	mg/l	10.0	Not fixed	10.0
Oil and grease	mg/l	10	20	10
Phenolic compounds (as C_6H_5OH)	mg/l	1.0	5.0	1.0
Dissolved phosphorus (as P)	mg/l	8	8	15
pH		6-9	6-9	6-9

Parameters	Unit	Places for determination of standards		
		Inland Surface Water	Public Sewerage system connected to treatment at second stage	Irrigated land
Selenium (as Se)	mg/l	0.05	0.05	0.05
Zinc (as Zn)	mg/l	5	10	10
Total dissolved solids	mg/l	2100	2100	2100
Temperature (thermal effluent)	˚C (summer) ˚C (winter)	40 45	40 45	40 45
Suspended solids	mg/l	150	500	200
Cyanide	mg/l	0.1	2.0	0.2

Notes:

(1) These standards shall be applicable to all industries or projects other than those specified under the heading "Standards for sectorwise industrial effluent or emission."

(2) Compliance with these standards shall be ensured from the moment an industrial unit starts trial production, and in other cases, from the moment a project starts operation.

(3) These standards shall be inviolable even in case of any sample collected instantly at any point of time. These standards may be enforced in a more stringent manner if considered necessary in view of the environmental conditions of a particular situation.

(4) Inland Surface Water means drains/ponds/tanks/water bodies/ditches, canals, rivers, springs and estuaries.

(5) Public sewerage system means treatment facilities of the first and second stage and also the combined and complete treatment facilities.

(6) Irrigable land means such land area which is sufficiently irrigated by waste water taking into consideration the quantity and quality of such water for cultivation of selected crops on that land.

(7) Inland Surface Water Standards shall apply to any discharge to a public sewerage system or to land if the discharge does not meet the requirements of the definitions in notes 5 and 6 above.

12.5 Declaration of Sitalakhya River as Ecologically Critical Area

Declaration of Sitalakhya River as Ecologically Critical Area

রেজিস্টার্ড নং ডি এ-১

বাংলাদেশ গেজেট

অতিরিক্ত সংখ্যা

কর্তৃপক্ষ কর্তৃক প্রকাশিত

রবিবার, অক্টোবর ৪, ২০০৯

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার

পরিবেশ ও বন মন্ত্রণালয়

পরিবেশ শাখা-৩

প্রজ্ঞাপন

তারিখ, ০১ সেপ্টেম্বর, ২০০৯

নং পবম/পরিবেশ-৩/৫/মামলা-০৪/২০০৯/৩৮৫—সরকার এ মর্মে সন্তুষ্ট হয়েছে যে, মানুষের অপরিণামদর্শী এবং অপরিকল্পিত কার্যকলাপের কারণে রাজধানী ঢাকার চতুষ্পার্শে প্রবাহিত বুড়িগঙ্গা, তুরাগ, বালু ও শীতলক্ষ্যাসহ সংশ্লিষ্ট নদীসমূহের প্রতিবেশ ব্যবস্থা (Ecosystem) সংকটাপন্ন অবস্থায় উপনীত হয়েছে, যার ভবিষ্যতে আরও অবনতি হবার আশংকা রয়েছে।

এ বিষয়ে দায়েরকৃত একটি রীট পিটিশনের (নং ৩৫০৩/২০০৯) রায়ে মহামান্য সুপ্রীম কোর্টের হাইকোর্ট বিভাগ উপরোক্ত নদীসমূহকে প্রতিবেশগত সংকটাপন্ন এলাকা (Ecologically Critical Area) হিসেবে ঘোষণা করার নির্দেশ প্রদান করেছেন।

এমতাবস্থায়, প্রাকৃতিক পরিবেশ সংরক্ষণ, পরিবেশগত মান উন্নয়ন এবং পরিবেশ দূষণ নিয়ন্ত্রণ ও প্রশমন এবং টেকসই পরিবেশ ব্যবস্থাপনার লক্ষ্যে "বাংলাদেশ পরিবেশ সংরক্ষণ আইন, ১৯৯৫" (১৯৯৫ সনের ১নং আইন) এর ৫নং ধারার উপ-ধারা (১) এ প্রদত্ত ক্ষমতাবলে এবং পরিবেশ সংরক্ষণ বিধিমালা, ১৯৯৭-এর ৩ নং বিধি অনুসারে এবং সর্বোপরি মহামান্য সুপ্রীম কোর্টের হাইকোর্ট বিভাগের নির্দেশনা অনুযায়ী বুড়িগঙ্গা, তুরাগ, বালু ও শীতলক্ষ্যাসহ সংশ্লিষ্ট নদীসমূহের এবং উভয় তীরস্থ ফোরশোর এলাকাসমূহকে প্রতিবেশগত সংকটাপন্ন এলাকা (Ecologically Critical Area) হিসেবে ঘোষণা করা হলো।

মূল্য ঃ টাকা ২.০০

অতএব, বুড়িগঙ্গা, তুরাগ, বালু ও শীতলক্ষ্যাসহ সংশ্লিষ্ট নদীসমূহের এবং নদীগুলোর ফোরশোরে নিম্নলিখিত কার্যাবলী এতদ্বারা নিষিদ্ধ করা হলো, যা বাংলাদেশ সরকারের গেজেটে প্রকাশনার দিন হতে কার্যকর হবে ঃ—

* সকল প্রকার শিকার।

* নদীতে বসবাসকারী জলজ প্রাণী ধরা বা সংগ্রহ।

* প্রাণী ও উদ্ভিদের আবাসস্থল ধ্বংশ বা সৃষ্টিকারী সকল প্রকার কার্যকলাপ।

* ভূমি ও পানির প্রাকৃতিক বৈশিষ্ট্য নষ্ট/পরিবর্তন করতে পারে এমন সকল কাজ।

* মাটি, পানি, বায়ু এবং শব্দ দূষণকারী শিল্পপ্রতিষ্ঠান স্থাপন।

* মাছ এবং অন্যান্য জলজ প্রাণীর ক্ষতিকারক যে কোন প্রকার কার্যাবলী।

* নদীসমূহের চারপাশের বাসাবাড়ী, শিল্পপ্রতিষ্ঠান এবং অন্যান্য প্রতিষ্ঠানের পরঃপ্রণালী সৃষ্ট বর্জ্য ও তরল বর্জ্য নির্গমন।

উন্নততর পরিবেশগত ব্যবস্থাপনার লক্ষ্যে এ এলাকার পরিসীমা এবং বিধি-নিষেধ পরিবর্তন/পরিবর্ধন করার ক্ষমতা পরিবেশ অধিদপ্তরের মহাপরিচালক সংরক্ষণ করেন।

রাষ্ট্রপতির আদেশক্রমে

ড. মিহির কান্তি মজুমদার

সচিব।

মোঃ মাছুম খান (উপ-সচিব), উপ-নিয়ন্ত্রক, বাংলাদেশ সরকারি মুদ্রণালয়, ঢাকা কর্তৃক মুদ্রিত।
মোঃ মজিবুর রহমান (উপ-সচিব), উপ-নিয়ন্ত্রক, বাংলাদেশ ফরম ও প্রকাশনা অফিস, তেজগাঁও, ঢাকা কর্তৃক প্রকাশিত। www.bgpress.gov.bd

12.6 Responses to DoE Comments on Draft ESIA Report (V0)

DHAKA WATER SUPPLY & SEWERAGE AUTHORITY

WASA BHABAN

98, KAZI NAZRUL ISLAM AVENUE , KAWRAN BAZAR, DHAKA- 1215

PABX - 8117829 - 31, 8120223 -27, FAX : 88- 02 -8112109

Website : www.dwasa.org.bd, E-mail : mddwasa@bangla.net

Memo No : ..... Date : .....

Office of the Project Director

Saidabad Water Treatment Plant Project, Phase-III
9th Floor, Dhaka WASA, WASA Bhaban
98, Kazi Nazrul Islam Avenue, Kawran Bazar, Dhaka-1215.

Memo No: 46.113.00.00.010.2013/160 Date: 27.07.2014

পরিবেশ অধিদপ্তর, সদর দপ্তর
গৃহীত
নং.....
স্বাক্ষর.....
তারিখ.....

Director General
Department of Environment (DoE)
Dhaka.

Subject: Submission of para-wise responses on the comments raised in the meeting held on 06/07/2014 at DoE for clearance of ESIA report of Saidabad Water Treatment Plant Phase- III.

Reference: DOE/NOC/1016/2000 (4th part)/153, Dated 02-07-2014

The undersigned is pleased to inform you that a meeting was held on the draft ESIA report submitted by Dhaka WASA for the proposed Feasibility Study of Saidabad Water Treatment Plant Phase- III Project. In the meeting a Power Point presentation was given on the draft ESIA report. After presentation of the report a discussion meeting was held. The comments raised in the meeting were noted by DWASA. Hence DWASA is sending herewith para wise responses on the comments raised in the meeting.

Enclo: Para wise Responses on the comments.

27/07/14

Md. Kamrul Hasan
Superintending Engineer &
Project Director
Saidabad Water Treatment Plant
Project, Phase-III
Dhaka WASA
Mobile: 01714-005660

CC:

1. Deputy Director (Clearance), DOE, Dhaka.
2. Deputy Managing Director (RP&D), Dhaka WASA.

Response to DoE Comments on Draft ESIA Report

A meeting was held on the Draft Environmental and Social Impact Assessment (ESIA) report of "Feasibility Study of Saidabad WTP Phase III Project" at Department of Environment (DoE), Dhaka on 6th July 2014. During discussion we received some comments and queries from the DoE. Their comments and the response from the consultants are summarized below:

Sl No	Comments of DoE	Response from Consultants
1	6 months water quality data is not sufficient	Water quality data collection campaign for the feasibility study of the proposed project started from July 2013. Sampling was carried out during the critical periods, including both the dry periods (3 samples) as well as during the wet periods (3 samples). These information's were incorporated in the process model study to determine the water treatment scheme. We believe that under the given timeframe for the feasibility study, the samplings performed were adequate to design the treatment process. However as a part of the ESIA baseline study, we decided to present data for four months only (July, August, September of 2013 and January, 2014).
2	Specific area mention at U/S and D/S of Meghna River for deceleration of water quality protection zone	In order to arrive at a specific conclusion as to how much of the reach of Meghna river needs to be protected for water quality for sustainable operation of Saidabad treatment plant, it would require extensive modeling studies considering several future scenarios and was beyond the scope of work for the consultants. However, until such a study is carried out, the DoE may consider a reach extending 5 km both upstream and downstream of the intake point on the right bank of Meghna River (Map enclosed) as critical area for protection of source water quality. Accordingly, no industry (or settlement) discharging liquid effluent should be permitted to be established within this reach. This recommendation will now be added in the ESIA report.
3	Quantity and quality of sludge from 3 phases	Quantity of sludge and related issues is described in ESIA report page 27 (section 2.1.5) The quality of sludge has been determined through laboratory analysis. For information regarding

		this, page 49 (Table 19) of the ESIA report may kindly be seen.
4	Sludge disposal process	Sludge disposal process has been described in page 27 of the ESIA report (section 2.1.5)
5	Seasonal variation of Meghna river water quality for alum dosing	Sampling was carried out during the critical periods, including both the dry periods (3 samples) as well as during the wet periods (3 samples). These information were incorporated in the process model study to determine the water treatment scheme. Seasonal variation of water quality was observed and alum dosing requirement was also suggested based on these observations. The details of determining alum dosing requirements are part of the process model study report by BUET. However, as for the ESIA report we have now have included the information on alum and chlorine dosing requirement in section 2.1.4
6	Recommendation for Pipe leakage during operation phase	In table 46 (Page 126), the issue of leak detection has been addressed under the monitoring requirement in operation phase. However that Provisions are to be made by the Contractor in the "detail design" for detecting and taking care of leaks during operation, if it happens and this issue Has been incorporated in the ESIA report.
7	Harmful parameters consideration or not. If yes please describe in report	DWASA has tested (through BCSIR) the presence of 13 pesticides in raw water and found them to be non-detectable. Page 52 (Table 22) of the ESIA report may kindly be seen.
8	Safety of treated water reservoir	In the meeting, the project director of DWASA confirmed that after treatment, the water will bestored in an underground reservoir for a very short period of time before injection into the distribution mains (very similar to the method adopted for Saidabad phase I and II). This reservoir will be totally covered and protected from pollution.
9	Existing condition of air quality issue at WTP site and future protection	The design of the Saidabad water treatment plant is such that air quality in and around the plantis unlikely to adversely affect the operation of the

		plant by any means. This is because the water after treatment will not be exposed to the atmosphere before it is injected into the transmission mains.
10	How many trees cutting during construction & how compensate it	The number of trees to be cut during construction has been reflected in Table 14 (page 41) of the ESIA report. Furthermore it has been recommended that plantation of at least two trees of similar species for each cut tree. (Table 4 of ESIA report).
11	Number of FGD &participants, types of participants	3 FGDs were conducted with altogether of 68 participants from various backgrounds. It has been believed that the feedback which were received (though from a limited number of participants) were comprehensive enough to adequately address the people's concerns and comments.
12	How much land acquisition	14 ha of lands will need to be acquired. Land acquisition works will be done as per Government rule.
13	Acquired any wet land or agricultural land	2 ponds may be filled up. This information is summarized in Table 14 (page 41) of the ESIA report.
14	How many houses affected for land acquisition	6 homesteads will be affected for land acquisition. This information is summarized in Table 14 (page 41) of the ESIA report.

562500 565000 567500 570000

620000 617500 615000 612500 610000

Near Nainabad Bazar

Around 6 Kilometer

Haria Intake

M e g h n a R i v e r

Around 6 Kilometer

Meghna Bridge

562500 565000 567500 570000

Proposed Surface Water Quality Protective Zone in Meghna River for Haria Intake

Legend

Proposed Protective Zone

Haria Intake Area

N

0.5 0 0.5 1 1.5 KM

egis eau

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