

**The People's Republic of Bangladesh**  
**Bangladesh Economic Zones Authority (BEZA)**

**SPECIAL ASSISTANCE FOR  
PROJECT IMPLEMENTATION FOR  
FOREIGN DIRECT INVESTMENT PROMOTION  
PROJECT IN THE PEOPLE'S REPUBLIC OF  
BANGLADESH  
FINAL REPORT**

**FEBRUARY 2019**

**JAPAN INTERNATIONAL COOPERATION AGENCY**

**JAPAN DEVELOPMENT INSTITUTE LTD.  
RECS INTERNATIONAL INC.**

<b>4R</b>
<b>CR(3)</b>
<b>19-003</b>





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### List of Abbreviations

ADB	Asian Development Bank
AEZ	Araihazar Economic Zone
AMEZ	Abdul Monem Economic Zone
APHA	the American Public Health Association
AZE	Alliance for Zero Extinctions Sites
BARC	Bangladesh Agricultural Research Council
BBS	Bangladesh Bureau of Statistics
BEPZA	The Bangladesh Export Processing Zones Authority
BEZA	Bangladesh Economic Zones Authority
BIFFL	Bangladesh Infrastructure Finance Fund Limited
BLT	Build-Lease-Transfer
BMD	Bangladesh Meteorological Department
BOT	Build-Operate-Transfer
CBD	Conservation on Biological Diversity
CEO	Chief Executive Officer
CETP	Central Effluent Treatment Plant
CITES	Convention on International Trade in Endangered Species of Wild Fauna and flora
DC	Deputy Commissioner
DD	Detailed Design
DEM	Digital Elevation Model
DFIs	Development Finance Institutions
DNCC	North Dhaka City Corporation
DOE	Department of Environment
DPHE	Department of Public Health Engineering
DSCC	South Dhaka City Corporation
ECA	Environmental Conservation Act
ECA	Ecologically Critical Area
ECR	Environmental Conservation Rules
EHS	Environment, Health and Safety
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan (Program)
EPZ	Export Processing Zone
EQS	Environmental Quality Standards
ESIA	Environmental and Social Impact Assessment
ESMP	Environment and Social Management Plan
EZ	Economic Zone
FDIPP	Foreign Direct Investment Promotion Project
FGD	Focus Group Discussion
F/R	Final Report
F/S	Feasibility Study
FSD	Feasibility and Sustainable Development
GDP	Gross Domestic Product
GoB	The Government of Bangladesh

GR	Game Reserve
G/S	Gas Station
GTCC	Gas Turbine Combined Cycle
G2G	Government to Government
HHs	House Holds
HSMP	Health Service Management and Policy
HW	Hazardous Waste
HWM	Hazardous Waste Management
IEC	Information, Education and Consultation Communication
IECs	Important Environmental Components
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IM	Information Memorandum
IPAs	Important Plant Areas
IRR	Internal Rate of Return
IUCN	The International Union for Conservation of Nature
JST	JICA Study Team
LAP	Livelihood Restoration Plan
LCC	Life Cycle Cost
MDRs	Minimum Development Requirements
MOEF	Ministry of Environment and Forest
NAAQS	National Ambient Air Quality Standard
NCC	Narayanganj City Corporation
NEP	National Environmental Policy
NO <sub>x</sub>	Oxides of Nitrogen
NP	National Park
NPV	Net Present Value
OSS	One Stop Services
O&M	Operation and Maintenance
PA	Project Area
PAPs	Project Affected Persons
PCM	Public Consultation Meeting
PGCB	Power Grid Company of Bangladesh
PH	Pump House
PLS	Preliminary Letter of Support
PMO	Prime Minister's Office
PPP	Public Private Partnership
PPPTAF	PPP Technical Assistance Fund
P/S	Power Station
PSC	Public Sector Comparator
QPR	Quarterly Progress Report
RAP	Resettlement Action Plan
RC	Rainwater Drainage Canal
RDF	Refuse Derived Fuel
RFP	Request for Proposal
RP	Retention Pond

SIA	Social Impact Assessment
SPC	Special Purpose Company
SPM	Suspended Particulate Matter
S/S	Substation
ST	Stream Turbine
STD	Sexually Transmitted Diseases
STI	Sexually Transmitted Infections
STP	Sewage Treatment Plant
TGTDCL	Titas Gas Transmission and Distribution Company Limited
TOR	Terms of Reference
UNFCCC	United Nations Framework Convention on Climate Change
USEPA	United States Environmental Protection Agency
VFM	Value for Money
VGf	Viability Gap Fund
WHO	World Health Organization
WS	Wildlife Sanctuary
WTP	Water Treatment Plant

## Executive Summary

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Bangladesh has been averaging relatively high annual GDP growth rate at 5 to 6 % over the past 10 years. However, in order to achieve a transition to a middle-income nation by 2021 as the country envisions as its national goal, the country needs to accelerate its GDP growth rate to about 8%. To realize this goal, the country needs to break away from the existing economic structure that is heavily relying on garment exports and remittance from overseas workers. Moreover, it is essential that the country should seek diversification of the national industries and exports, and promote investment and strengthen industries with a focus on manufacturing industries that have competitiveness in export. Therefore, it is necessary for the country to improve the system, the administration and the implementation capacity of the pertinent government agencies responsible for the promotion of investment and industrial development.

The government of Bangladesh has announced that no new EPZ is needed, but instead, it has launched a new policy to establish “Economic Zones (EZs)” to reinforce enter-industrial relationship of export industry and domestic industry, and to optimize the domestic market.

Investment by Japanese companies in Bangladesh first began in Chittagong EPZ, which was established in 1983, and the investment from Japan continued in other new EPZs during 1990s. In recent years, the increasing number of Japanese companies started to recognize Bangladesh as “China plus 1” or their next investment destination due to its abundant labour force and the competitive labour cost as well as its huge domestic market of over 150 million people, and 240 Japanese companies, as of October 2016, have started their operation in Bangladesh. However, the existing EPZs are facing a shortage of available land for Japanese companies that are currently interested in investing in Bangladesh. In addition, a certain number of Japanese companies are hesitant to invest in Bangladesh due to the lack of stable power, gas and road infrastructure, and uncertainties towards the investment promotion policies and the implementation capability of the Bangladesh government.

Under these circumstances, the government of Bangladesh has requested the government of Japan to provide Yen loan for “the Foreign Direct Investment Promotion Project (hereinafter FDIPP)” in order to establish a new EZ mainly targeting Japanese companies and to further facilitate investments from Japan. The loan agreement for FDIPP was already signed in December 2015. The loan is expected to provide both short term and mid to long term low-interest financing for operation and capital investment of the EZ. Additionally, a part of the loan will contribute to the development of infrastructure such as roads, power and gas, as well as to assure the involvement of the government of Bangladesh to resolve and simplify the complicated system and procedures so that Japanese companies can be more confident and comfortable about their investment decision.

Previously, in connection with FDIPP, JICA implemented “Project for Development Study and Capacity Enhancement of Bangladesh Economic Zone Development Plan Authority” from February 2015 thru March 2017. Within the above project, analysis and site comparisons of the candidate EZ locations were conducted. Araihaazar and Nayanpur were selected as prominent locations for EZ development. The project also undertook pre-feasibility studies for these two locations.

Taking into consideration the site geological location, land acquisition issues, available infrastructure, existing industries, investors interest and infrastructure and logistic requirement of the proposed industries, Araihaazar Economic Zone is more like to be selected for EZ development through FDIPP.

The proposed Araihaazar Economic Zone (AEZ) site is located at Mouza: Panchrukhi, Panchgaog, Union: Satgram & Duptara, under Araihaazar Upazila, which is adjacent to the Dhaka–Sylhet highway. The project area is mainly covers agricultural low land.

The total land of Araihaazar Economic Zone (AEZ) is approximately 218.84 ha. Upon completion, AEZ is envisaged to create approximately 10,000 jobs when fully occupied by investors. Prospective private developers will plan onsite facilities and industrial area development on later stage.



## SUMMARY

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### 1 Technical assistance for formation of SPC and related capacity development

#### 1.1 Review of the related legal documents

For the formation of SPC in relation to BEZA and BIFFL's delivery of the PPP projects, there is the legal procedural framework for their engagement and modality to follow as an internal regulation.

#### PPP legal framework

Legal framework on the Economic Zone development in Bangladesh is built under the umbrella of the Bangladesh Economic Zone Act, 2010, whereas legal system on the PPP projects in Bangladesh is built upon the Public Private Partnership ("PPP") Act, 2015. For the Economic Zone development through PPP, the participation scheme of the government were separately defined as follow:

Table-S 1-1 PPP Legal System

Act	• Public Private Partnership ("PPP") Law, 2015
Policy	• Policy and Strategy for PPP, 2010 (Repealed and Replace by PPP Law, 2015) • Policy for Implementing PPP Projects through Government to Government (G2G) Partnership, 2017
Guidelines	• Guideline for VGF for PPP Project, 2012 • Guideline for PPPTAF, 2012 & Scheme for PPPTAF, 2012 • Procurement Guideline for PPP Projects, 2018 • Guidelines for Unsolicited Proposals, 2018

source: JICA Study Team

#### Standpoints of BEZA's legal documents on equity investment

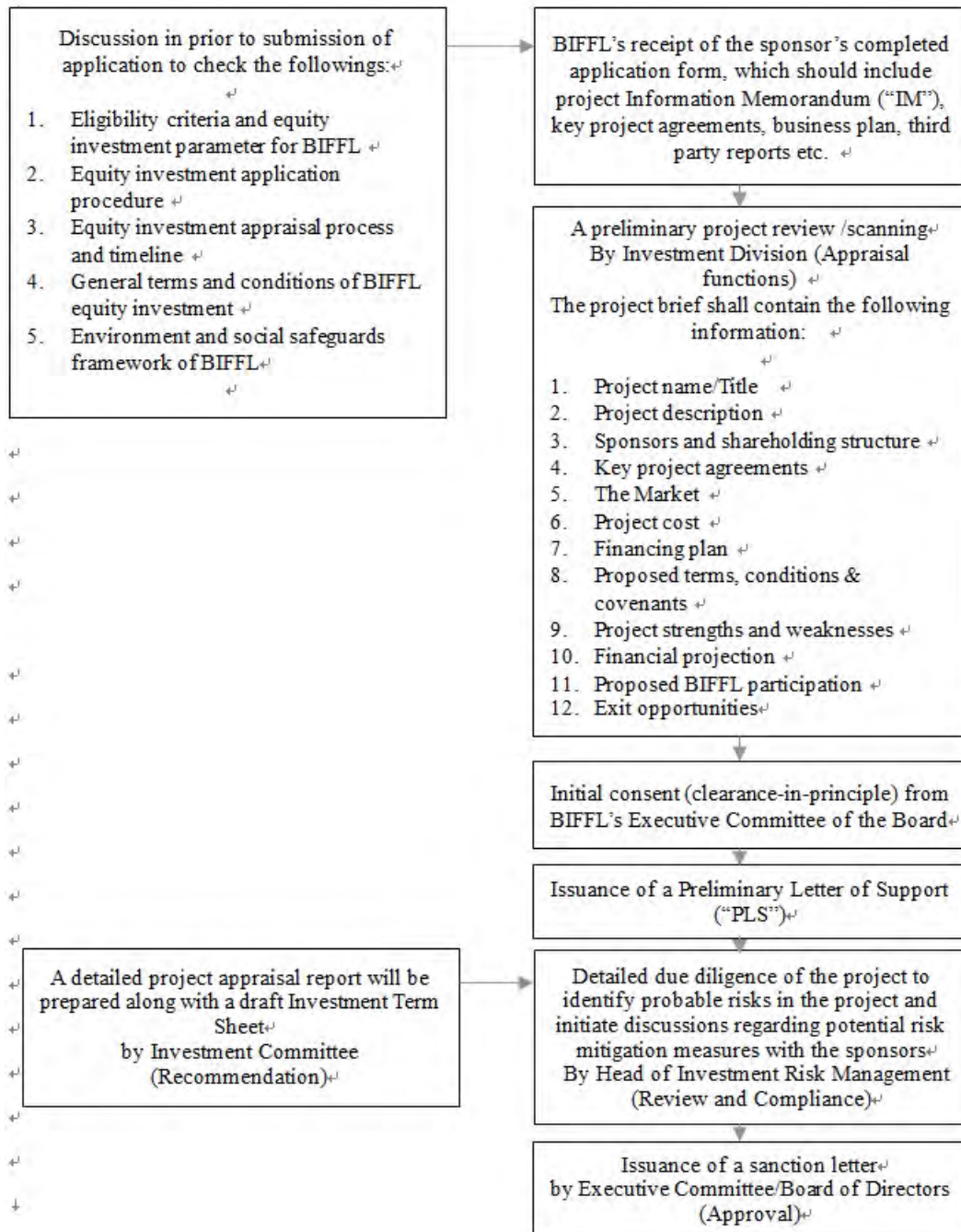
As the stand point of BEZA, the Act was amended in 2015 and provided that Government of Bangladesh (GoB) itself or through nominated agencies can enter into a partnership or joint venture with any other country or their nominated companies for the establishment and maintenance of the economic zones. The provisions of PPP Act shall apply to BEZA, and BEZA is deemed to be allowed to inject equity investment in the Economic Zone projects which engage PPP involvements.

#### Review on Equity Investment Policy (Draft) of BIFFL

BIFFL has separate and specific policies for credit as well as equity investment<sup>1</sup> for the project, and these are deemed to be applied for the Economic Zone projects in any cases. In the policy, internal key protocol for processing/assessing investment applications till sanctioning equity investment is stated as follow.

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<sup>1</sup> Equity investment policy for BIFFL is under preparation as of January 2018.



source: JICA Study Team

Figure-S 1.1-1: Equity investment procedures and risk analysis/ risk grading and mitigation systems

### Standpoints of BIFFL's credit and equity investment policies

Since BIFFL is a non-banking financial institution operating in Bangladesh, the Equity Investment Policy and Credit Policy must comply with the provisions given in the Financial Institution Act, 1993 and Bangladesh Bank's guideline on Credit Risk Management, Internal Control and Compliance Framework and Asset Liability Management. After careful perusal of the said two policies on legal perspective, it can be said that there is no provision which is contradictory in nature with the governing laws of Bangladesh in these policies.

## **Any legal steps for BEZA and BIFFL to undertake before signing the Shareholder's agreement**

Shareholders Agreement is an independent document, hence this is not dependent on any other agreements. However, incorporation of the project company is dependent on the provisions of the shareholders agreement.

### **1.2 Suggestions to the related legal documents**

Based on the reviews and observations shared between BEZA as well as BIFFL, JST prepared a key note suggestion for BEZA on the shareholder's agreement and offered proposition for BIFFL on the supplementary works for completion of the equity investment policy.

#### **A key note suggestion on the shareholder's agreement for BEZA**

In the discussions, it was found that BEZA staff in charge of SPC formation already have good knowledge about the procedure of SPC establishment, and also the SPC operational mechanism under a certain agreement were in the process of discussion between a prospective Japanese Developer. Consequently, as the roles of JST, requests from BEZA to enlighten the key notes of the following area in relation to the Shareholder's Agreement were responded.

- |  |                                |
|--|--------------------------------|
| 1. Definition and Interpretation         | 8. Distributions               |
| 2. Commencement and duration             | 9. Business Plan and Budgeting |
| 3. Purpose/business of SPC               | 10. Share Transfers            |
| 4. Financial arrangement                 | 11. Warranties and undertaking |
| 5. Sponsors' Rights and Responsibilities | 12. Deadlock Resolution        |
| 6. Board of the Company/SPC              | 13. Winding Up                 |
| 7. Management of the SPC                 | 14. Miscellaneous              |

#### **Supplementary works for completion of the equity investment policy of BIFFL**

On the other hand, BIFFL has experience in financing various infrastructure projects, but has a limited experience in equity investment. Currently preparation of "Equity Investment Policy" addressing equity investment of BIFFL is being made and yet still on its way of completion. Consequently, this project is aiming to supplement to completion of the "Equity Investment Policy" related to BIFFL's investment activities.

As a method of giving provision for supplementary for completion of the Equity Investment Policy, compatibility with several other relevant Acts of Parliament of Bangladesh was scrutinized. In this line, a counter proposal in the fields of certain obligatory provisions, restriction on investments, the ways of equity investment, several safeguards for equity investors, limits the powers of a company to issue shares at a discount, protection for shareholders, settlement of dispute, arbitration agreement, environment issues, land related issues, labor regime, investment eligible criteria and risk assessment criteria are presented.

The supplemental work for completion of Equity Investment Policy was made and revision of the policy was drafted as per the Appendices. Consequently, the drafted Equity Investment Policy for BIFFL was duly discussed and approved in the Board of Directors.

### **1.3 Planning of workshops**

The capacity development of BEZA and is one of focuses for this project, then series of workshops addressing issues related to SPC formation were planned. These workshops were designed to improve implementation capacity of BEZA and BIFFL.

In planning, under the management of JST, cooperation with the local company of NewVision Solutions Limited, having many experience of establishing companies in Bangladesh, was brought in. Also,

expectations from participants on the workshops were well drawn by conducting orientation session. The workshops are deemed to stimulate the debate by further examining the potentials of the SPC formation through the PPP model for meeting the investment challenge in an efficient, cost-effective way of the Economic Zones development and operation.

#### **1.4 Contents of workshops**

Each workshop was proposed to be 2-hour session in a day, and the venue was selected at convenient and availability base, either at BEZA or BIFFL conference room. The contents describing key points of each workshop session are summarized in the following sections.

##### **First session: “The theory of Infrastructure PPP project”**

Date: 21<sup>st</sup> November, 2017

The following concepts in relation to “the theory of infrastructure PPP project” were addressed to the participants for understanding the key points as mentioned below.

- Purpose of learning Theory first for the Infrastructure PPP Project and Project Finance
- What’s to be discussed in the session
- Public and Private Partnership Project
- Merits of PPP scheme
- Merits to be measured by the Host country
- Why SPC is used for PPP Infrastructure project?
- Principles defining Infrastructure PPP project
- Source of Finance & MDRs

##### **Second session: “Parties concerned”**

Date: 21<sup>st</sup> November, 2017

The following concepts were addressed in this session of “parties concerned” in Infrastructure PPP Projects to the participant for understanding the key points of the main theme of this session.

- What are roles and relations among the parties concerned in Infrastructure PPP projects, and do they depend on the degree/level of public sector involvement?
- Why such roles and relation are defined?
- How is the project performed under such project finance scheme?
- What are typical SPC structures for PPPs under project finance scheme?
- The typical roles of SPC

##### **Third session: “Contractual relationship”**

Date: 19<sup>th</sup> February, 2018

The following concepts were augured in this session of “Contractual relationship” with regards to Infrastructure PPP Projects for participants to understand the key players and norms.

- For the PPP Infrastructure Project and Project Finance, what sorts of Agreements are going to be prepared?
- In what events are these Agreements supposed to be entered, and with whom?
- What are key norms to be included in Agreements?
- What is Security Package?
- What is Step-in Right in Project Finance?
- How should security interest be set on assets in Project Finance?
- Outline of Direct Agreement and its necessity
- How are Dispute resolution and Arbitration considered in the Agreements?

### **Forth session: “Project Evaluation / Risk management”**

25<sup>th</sup> April, 2018

The following risks are discussed in this session as a key concept of project evaluation and risk management in relation to the EZ projects in Bangladesh.

- Land Related risk
- Political & Policy Related Risk
- Foreign Exchange Risk
- Concession Risk
- Construction Risks
- O&M Risk
- Utility Risk
- Socio-Environmental Risk
- Financing Risk

### **Fifth session: “Project Operation”**

8<sup>th</sup> July, 2018

The following concepts were discussed in this session of “Project Operation” with regards to Economic Zone Projects for participants to understand the key activities of the Project Company.

- What makes a successful EZs under PPP?
- Ownership and Management
- Required Organization Structure
- Facilities and Services
- Economic Zone Marketing/ Investment Promotion
- Economic Zone Business Models
- Land Allocation & Leasing Procedures
- Collection System of Fees and Charge
- Technical/Administrative Office Operation

## **1.5 Assistance for conducting monitoring activities**

### **1.5.1 Preparation of Quarterly Progress Report**

For ensuring smooth and successful operations by BEZA and BIFFL as the implementing agencies for preparation of Quarterly Progress Report (QPR), JST shall aid the implementing agencies enable to submit the Report to JICA through PMO in timely and regular manner. QPRs shall be prepared separately by the Component 1, 2 and 3.

QPRs are deemed to be prepared separately by the Component 1, 2 and 3. And this SAPI project is mainly linked with the activities of Components 2 and 3. In the content of QPR, the followings are supposed to be described.

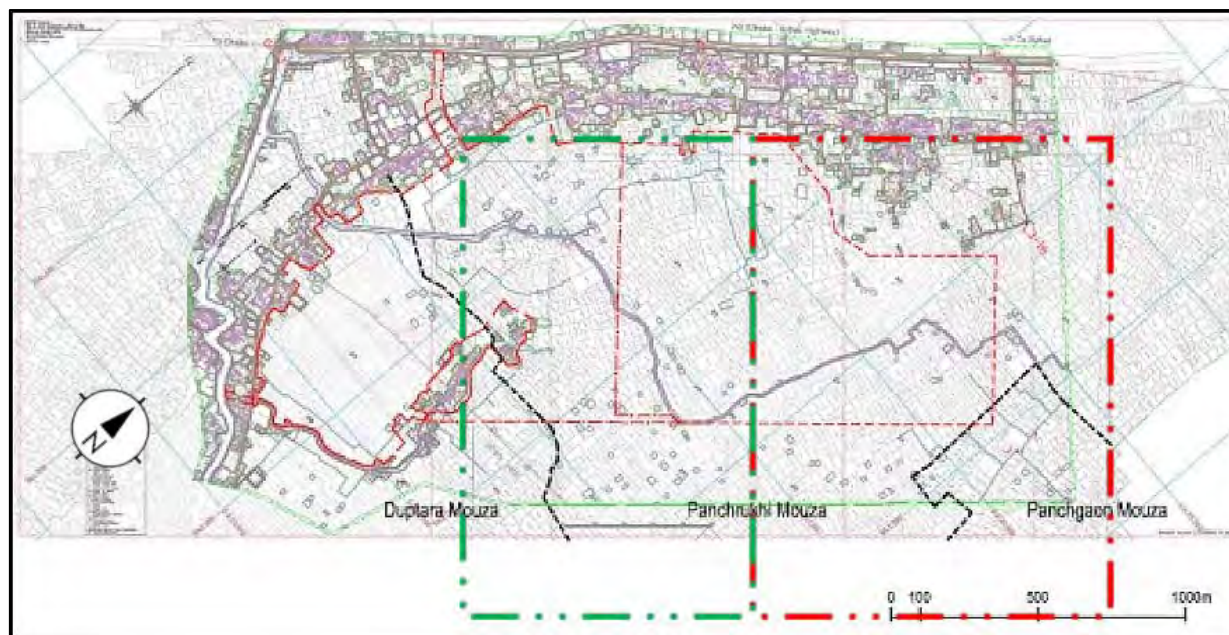
1. Current progress status
2. Substantial progress during the Quarter
3. Progress status against Implementation Plan (monitoring)
4. Issues and Necessary Measures
5. Plan for the Next Quarter
6. Annexes

## 2 DPP preparation support for basic infrastructure sub-projects for the EZ

### 2.1 Review of the existing development plan of Araihaazar EZ

#### 2.1.1 Confirmation of location of Araihaazar EZ

In prior to the SAPI survey, JICA conducted initial studies “Project for Development Study and Capacity Enhancement of BEZA” through 2015 to 2017 to compare 13 EZ candidate sites. The planned location for development of Araihaazar EZ is determined by BEZA from the view point of land acquisition situation in order to minimize the number of resettlement and affected households. The area is shown in Figure-S 2.1-1 by the thick red two-dot chain lines. The green two-dot chain lines for the future expansion area.



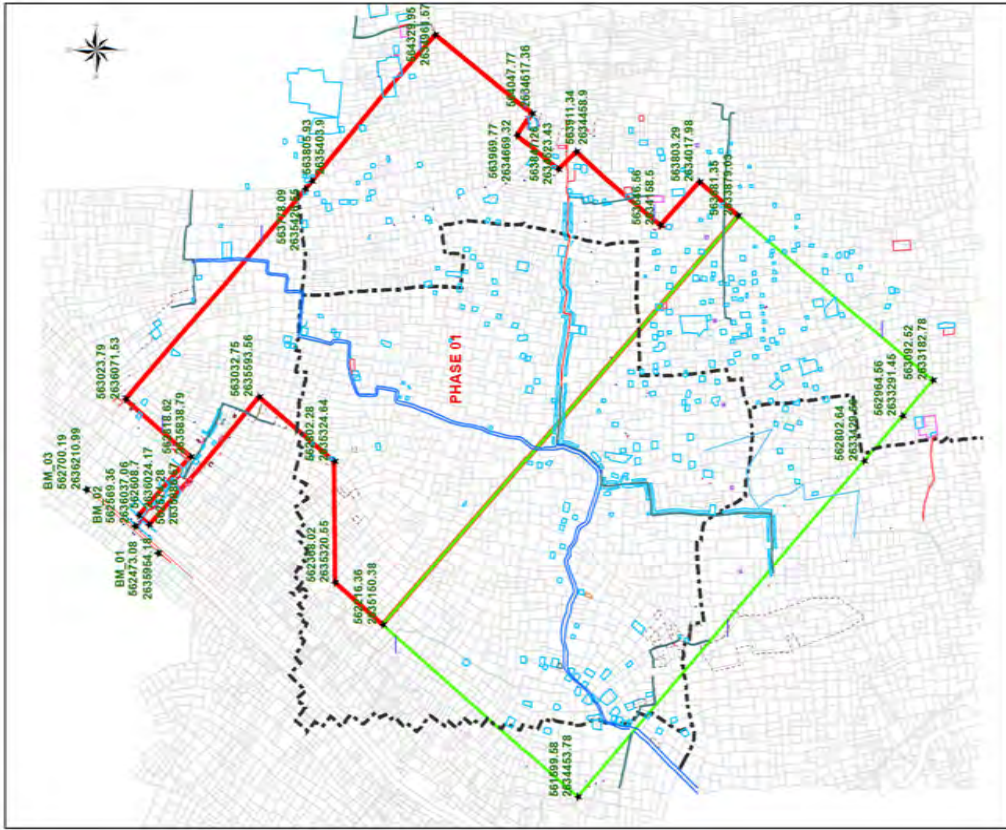
Source: JICA Study team and the previous JICA study

Figure-S 2.1-1: Planned location of development of Araihaazar EZ

#### 2.1.2 Topographic survey

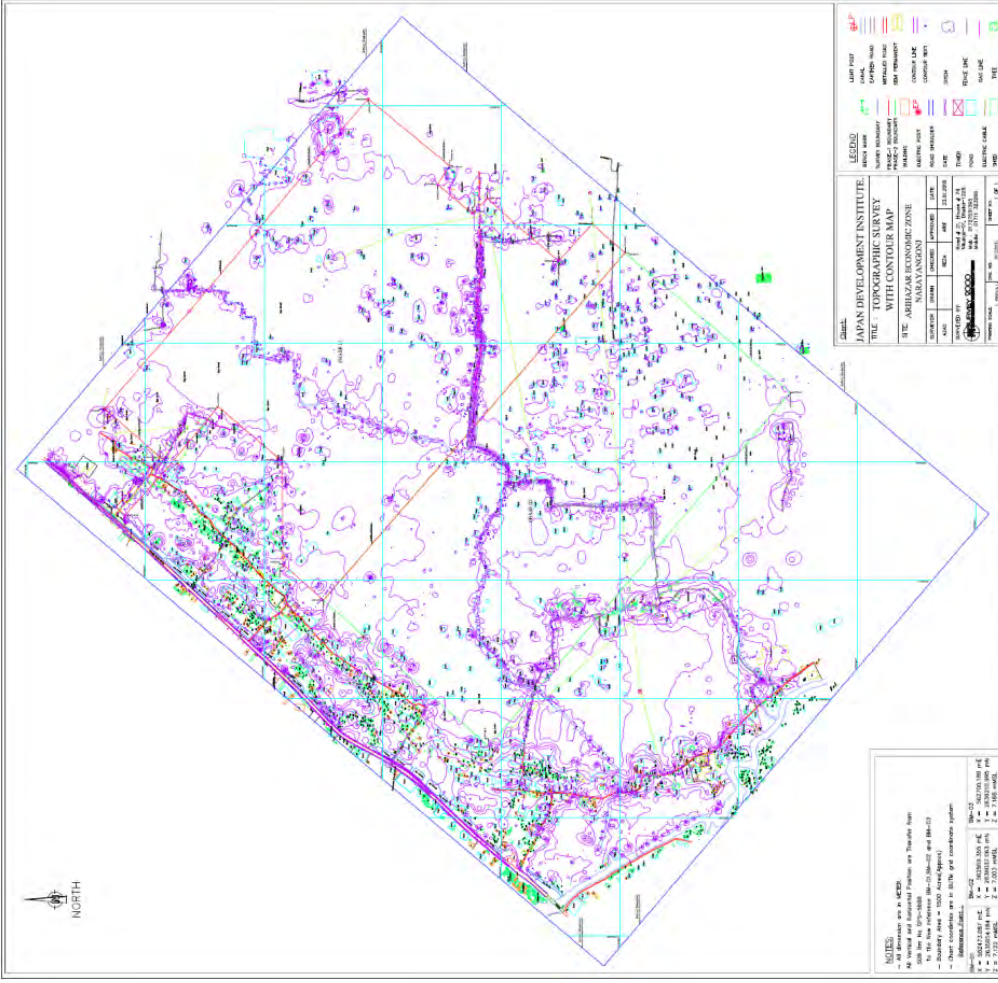
Topographic survey was conducted for the proposed economic zone area as well as for other areas required for other infrastructure such as canal and retention pond with a total of about 600 ha.

All survey data for the Araihaazar EZ development and the expandable area were summarized in the topographic map with the scale of 1: 1,000, shown in Figure-S 2.1-3.



Source: JICA Study team

Figure-S 2.1-2: Superimposed cadastral map with boundaries of AEZ



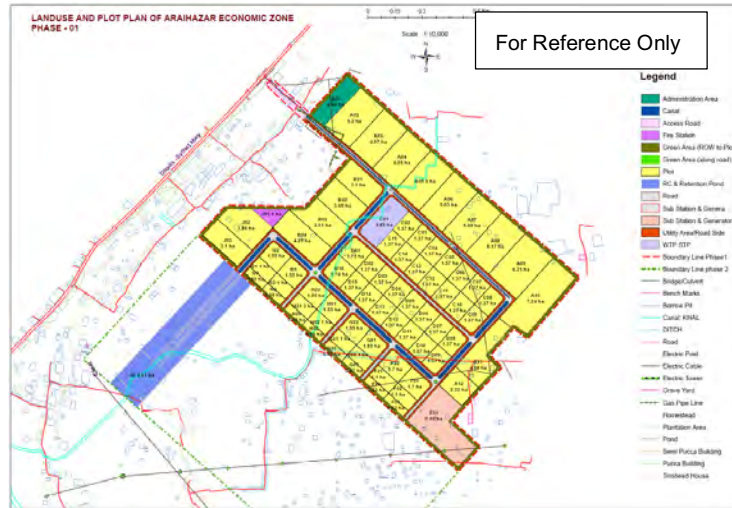
Source: JICA Study team

Figure-S 2.1-3: Topographical map for Araihaazar EZ

### 2.1.3 Review of the master plan for Araihaazar EZ

The Araihaazar site for EZ development has been selected on the basis of comprehensive evaluation from two candidate sites, Araihaazar and Nayanpur proposed as the priority development sites through the previous study for the Project for Development of Economic Zone and Capacity Enhancement of Bangladesh Economic Zones Authority (BEZA).

The master plan proposed in the previous study has been reviewed since possible location for the first phase of Araihaazar EZ development has been shifted as described in Clause 2.1.1. Then the land use plan along with infrastructure planning for the Phase-1 EZ development (192 ha) is prepared as in Figure-S 2.1-4.



Source: JICA Study team

Figure-S 2.1-4: Land use plan for Phase-1 Araihaazar EZ development

The land use allocation of the Phase-1 Araihaazar EZ development is shown in Table-S 2.1-1.

Table-S 2.1-1 Land use allocation plan of Araihaazar EZ development

Land Use Plan		Phase-1		0 thers
		Area (ha)	Ratio (%)	Area (ha)
1.	Factory Lots	145.19	75.81	
2.	On-site Infrastructure	46.32	24.19	
2.1	Administration Area	2.66	1.39	
2.2	Inner Road	10.12	5.28	
2.3	Utility Area	10.66	5.57	
2.4	Retention Canal	5.08	2.65	
2.5	WTP & STP (CTP)	3.49	1.82	
2.6	Fire Station & Gas Station	1.00	0.52	
2.7	Green Area	13.31	6.95	
3.	Off-site Infrastructure			27.66
3.1	Access Road			1.54
3.2	Retention Canal & Retention Pond w/Pump Station			18.57
3.3	Power Station & Sub-Station			7.55
Total		191.51	100.00	27.66

source: JICA Study Team

## 2.2 Water source and soil investigation

### (1) Outline

#### 1) Contents of the survey

Survey items are “Existing well survey”, “Drilling of test well”, “Pumping test”, “Water quality analysis at laboratory” and “Soil investigation” as shown in Table-S 2.2-1.

Table-S 2.2-1: Contents of the survey

Survey item	Quantity and location	Contents	Method
<b>Existing well survey</b>	55 wells in and around EZ	Well inventory	Interview
		Water quality (As, Fe)	Field kit
		Water quality (pH, EC, ORP, Temperature)	Portable meter
		Groundwater level	Measuring tape
<b>Drilling of test well</b>	3 sites in EZ	Drilling	Rotary machine drilling (300m×2, 120m×1)
		Disturbed sample	Every 2m
		Geophysical logging	Resistivity, Self-potential, Gamma ray
		Well installation	6 inch steel casing and stainless screen, Gravel packing, Cement sealing
<b>Pumping test</b>	3 sites at test well in WZ	Preliminary Test	at least 2 hours
		Step Drawdown Test	2 hours × 5 steps
		Constant Discharge Rate Test	48 hours
		Water Level Recovery Test	24 hours or longer
		On site water quality check (As, pH, EC, ORP, Temperature)	Field kit and Portable meter
<b>Water quality analysis at laboratory</b>	3 sites at test well in EZ	Arsenic	AAS
		Chloride	Titrimetric
		Hardness	Titrimetric
		Iron	AAS
		Manganese	AAS
		pH	pH meter
<b>Soil investigation</b>	14 sites in EZ	Drilling	40 m depth at 4 sites 30 m depth at 10 sites
		Undisturbed sample	Hydraulic thin-walled sampler
		Standard penetration Test	Every one meter
		Static water level measurement	Measuring tape
		Laboratory test	ASTM standard

source: JICA Study Team

## (2) Survey result

### 1) Existing well survey

Existing well survey was carried out to know the water quality of existing tube wells (TWs) surrounding of EZ area in Duptara and Satgram Unions of Arahazar Upazila. There were 38 shallow tube wells (STWs) and 17 deep tube wells (DTWs). The depth of STWs and DTWs were in the range of 30 to 300 feet and 520 to 980 feet respectively. Among the 55 TWs surveyed, 14 (25.5%) belonged to some institutions like schools, madrasahs, mosques and so on and the remaining 41 TWs (74.5%) were owned personally.

Six (6) parameters of TW water were tested in situ using the portable meter for pH, EC, ORP, Temperature and HACH field kit for Arsenic and Iron. Result of the water quality test in the field is shown in Table-S 2.2-2.

Table-S 2.2-2: Result of the water quality test in the field

Parameter	BDS	Shallow TW				Deep TW			
		Min	Max	Exceed BDS		Min	Max	Exceed BDS	
				Number	(%)			Number	(%)
pH	6.5 - 8.5	6.6	7.8	0	0	6.6	7.5	0	0
EC ( $\mu\text{S}/\text{cm}$ )	-	265	3050	-	-	225	2005	-	-
ORP (mV)	-	-156	132	-	-	-125	32	-	-
Arsenic (mg/L)	0.05	0	0.1	2	3.6	0	0.01	0	0
Iron (mg/L)	0.3 – 1.0	0	7	11	20	0	5.5	7	7.86
Temperature ( $^{\circ}\text{C}$ )	-	27.3	29.5	-	-	27.6	29.6	-	-

BDS: Bangladesh drinking water standard

## 2) Pumping test

Pumping test consists of four tests such as Preliminary test, Step drawdown test, Constant discharge rate test and Water level recovery test. Result of the Step drawdown test shows that the good capacity of aquifer, and constant discharge rate were also analyzed using the Thiem equation method.

## 3) Water quality analysis at laboratory

Laboratory test for water quality was carried out at the DPHE central laboratory in Dhaka. As the result of the water quality analysis at laboratory, some of parameters exceed the Bangladesh drinking water standard, especially Iron concentration at certain location is more than ten time of the standard. This tendency is same as the result of the Existing well survey as mentioned above. It should be considered to use treatment process of Iron and Manganese for water supply in EZ area.

## 4) Soil investigation

Outline of the survey results reveals that many soft clayey layers with low N-value have been confirmed at most of sites.

## Water supply plan

### (1) Water Sources analysis

As the results of the pumping tests, more than 100m<sup>3</sup>/hr is technically available to pump up from deep aquifer. From the perspective of environmental issue, a permissible yield should be considered in that less than 2-3 m drawdown of groundwater level will be acceptable depending on the statistic water level at existing well. The groundwater discharge range should be considered from 1,200 to 1,800 m<sup>3</sup>/day at each production deep well.

From the water quality aspect, treatment process of Iron and Manganese should be considered in order to supply safe water in EZ area.

Table-S 2.2-3: Analysis of the circle of influence under TW-1 condition

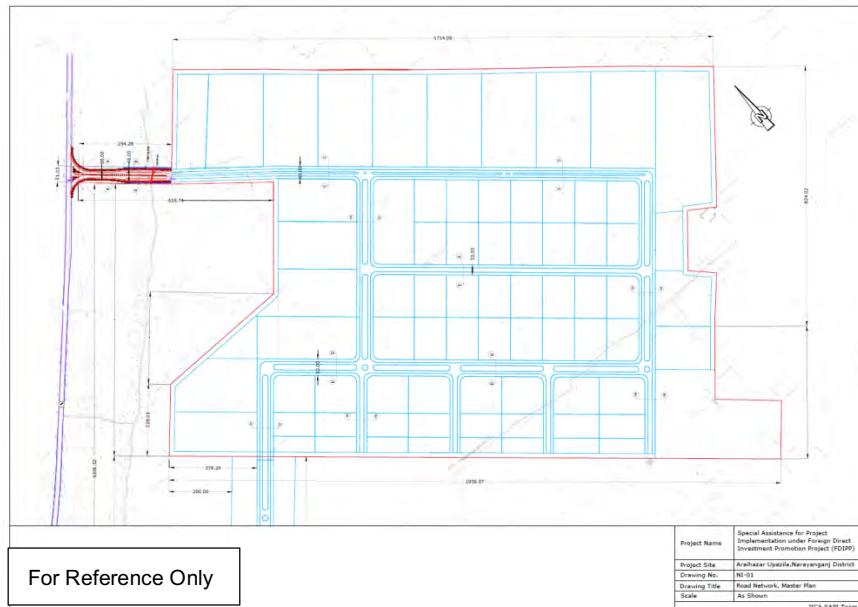
Discharge (m <sup>3</sup> /d)	Calculated drawdown of groundwater level (m) at distance from pumping well						
	0m	10m	50m	100m	200m	500m	1000m
1,200	6.35	3.54	2.45	1.99	1.53	0.91	0.45
1,400	7.42	4.13	2.87	2.33	1.78	1.07	0.52
1,600	8.48	4.72	3.28	2.66	2.04	1.22	0.60
1,800	9.54	5.31	3.69	2.99	2.29	1.37	0.67
2,000	10.60	5.90	4.10	3.32	2.55	1.52	0.75
2,200	11.66	6.49	4.51	3.66	2.80	1.68	0.82

source: JICA Study Team

## 2.3 On-site basic infrastructure plan

### 2.3.1 Internal road plan

The internal road network plan for Phase-1 is shown in Figure-S 2.3-1.

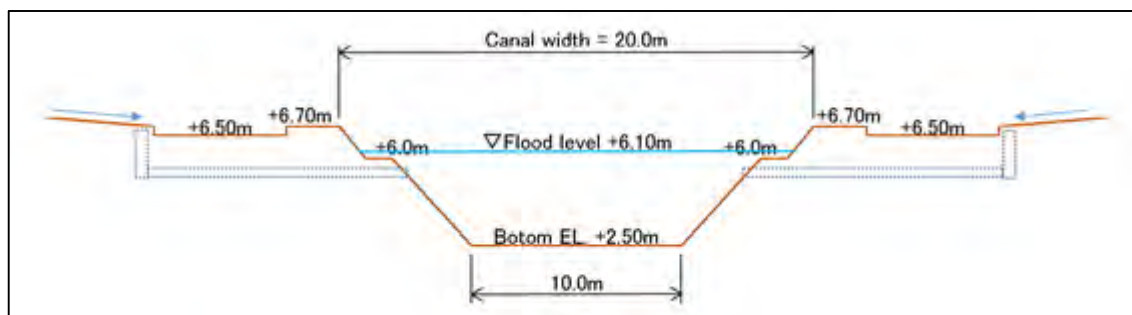


source: JICA Study Team

Figure-S 2.3-1 Internal road network plan in Araihaazar EZ

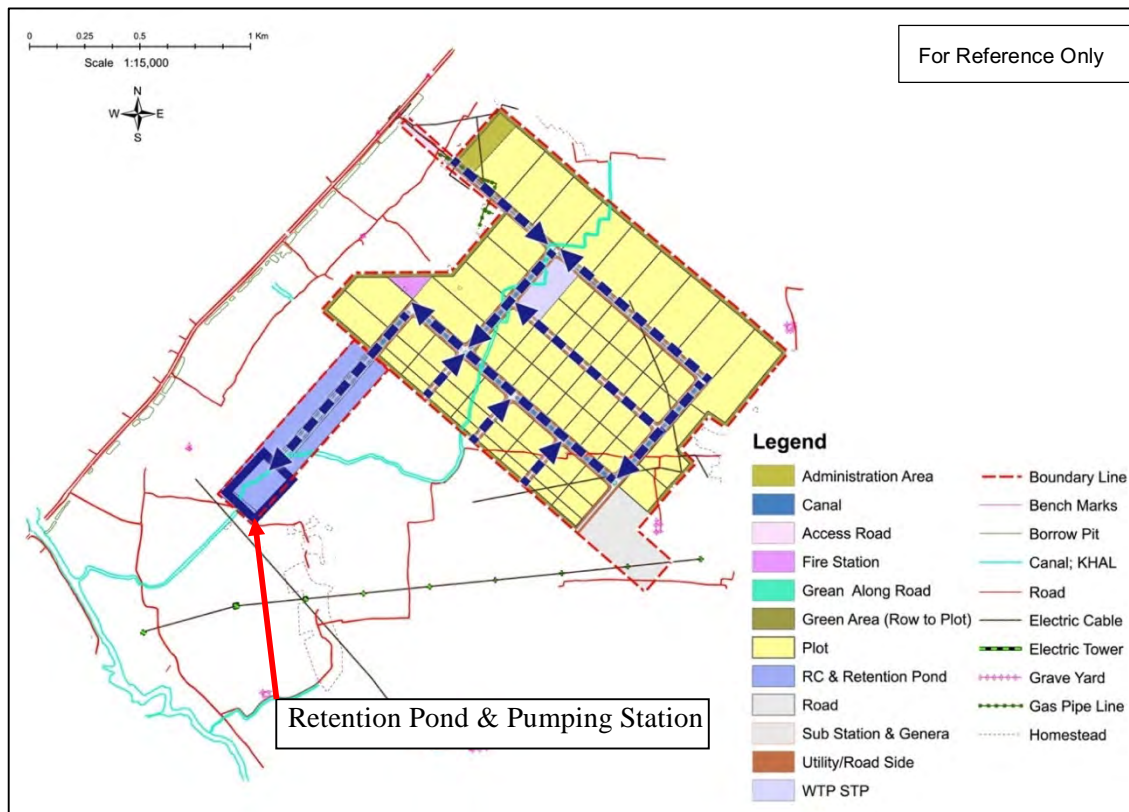
### 2.3.2 Rainwater drainage plan

Rainwater drainage ditches will be located on both sides of internal roads and drain rainwater to the canal located along the 52m main road. A retention pond is planned to be located at the terminal of the canal, and it will have adequate storage enabling it to perform the flow regulating functions, reducing the impact of the change in the runoff rate associated with land development, and also part of the pump drainage functions during flooding.



source: JICA Study Team

Figure-S 2.3-2 Schematic plan for main road canal in Araihaazar EZ



source:

JICA Study Team

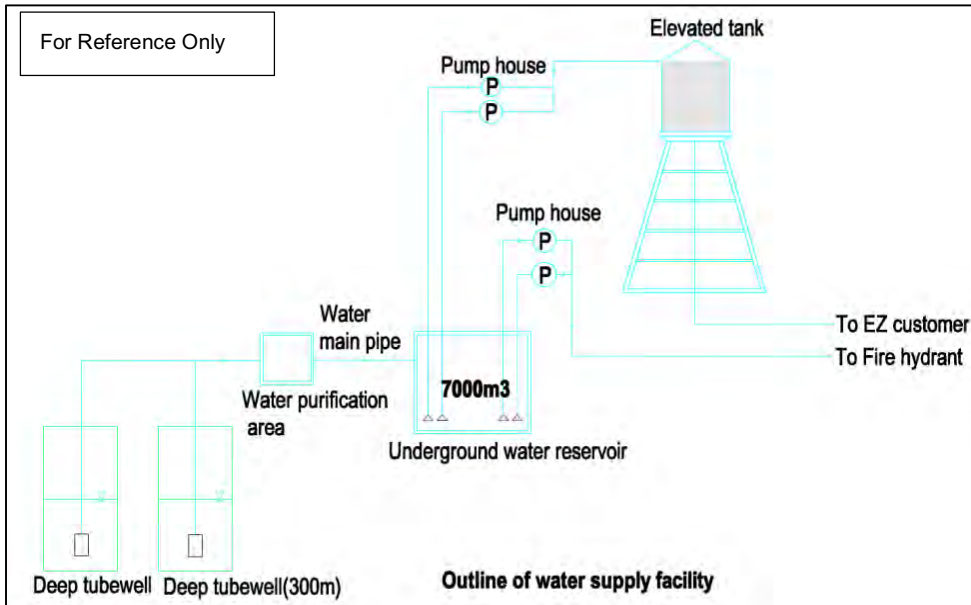
Figure-S 2.3-3 Rainwater drainage plan in Araihaazar EZ

### 2.3.3 Water supply plan

The unit quantity of water used is assumed to be  $35\text{m}^3/\text{day}/\text{ha}$  for the entire development area, in view of targeted industries in the Araihaazar EZ. The total quantity of water required is calculated to be  $7,000\text{m}^3/\text{day}$  for the 200ha EZ development.

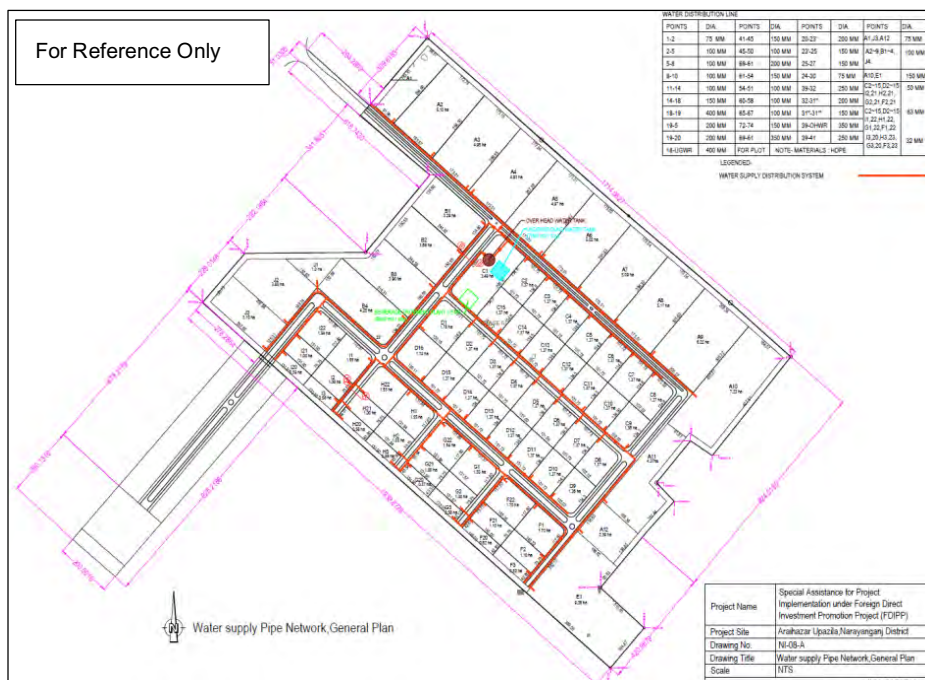
Water supply facilities are schematically shown in Figure-S 2.3-4. The capacity of the water storage tank will be equivalent to one day's water requirement of  $7,000\text{m}^3$ . Capacity of an elevated water tank will ensure supply for about 1 hour. Assuming that one fire hydrant will cover an area with a radius of about 100m, fire hydrants will be installed at intervals of about 150m.

Water distribution pipelines are shown in Figure-S 2.3-5.



source: JICA Study Team

Figure-S 2.3-4: Schematic diagrams of water supply facility in Araihaazar EZ



source: JICA Study Team

Figure-S 2.3-5: Water distribution pipelines

### 2.3.4 Sewerage plan

The capacity of the wastewater treatment facilities will be set to treat 80% of the quantity of water supplied, and in the future, also to treat the wastewater from the expanded area. The wastewater treatment process will be the activated sludge or other method that can ensure treated water quality allowed to be discharged.

Domestic wastewater of each tenant factory (kitchen and toilet wastewater) is treated by the central processing facility in Phase-1 area. Industrial wastewater from each tenant factory should be processed to an acceptable drainage level at each plant ETP facility. Wastewater pipelines are shown in Figure-S 2.3-6.

### 2.3.5 Gas distribution plan

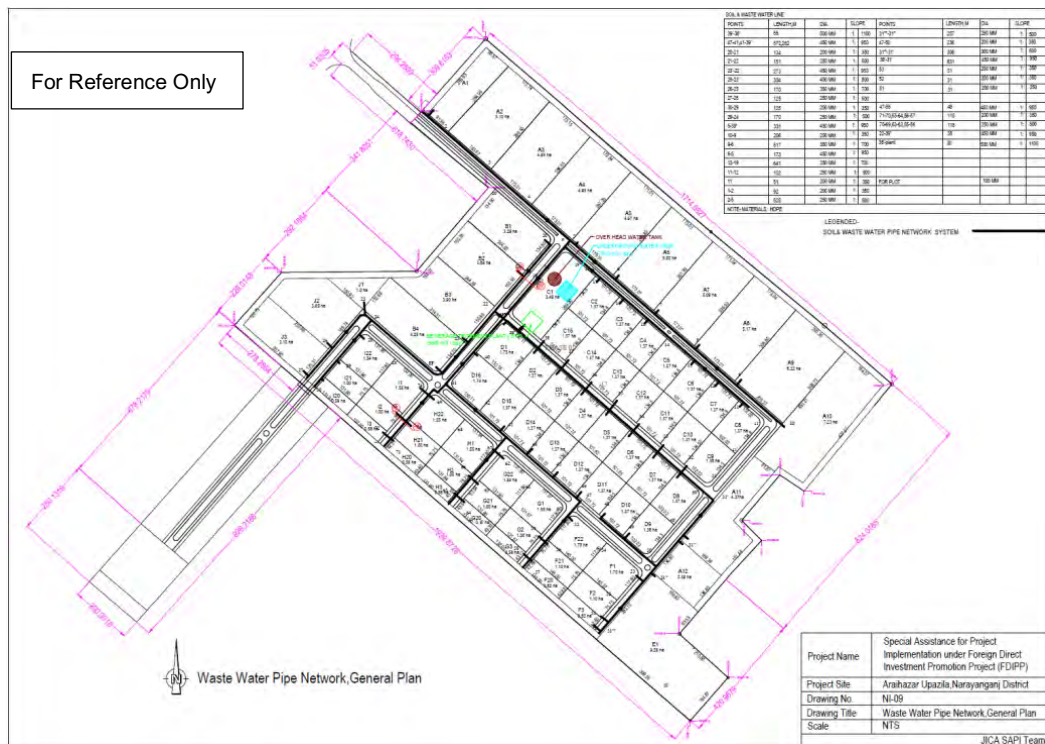
In the EZ area, gas supply facilities including a gas station will be installed in the fire station area in Phase-1. Gas distribution pipelines are shown in Figure-S 2.3-7.

### 2.3.6 Power distribution plan

Electric power is distributed to each lot by 11kV cables from the planned power station. Power distribution lines are shown in Figure-S 2.3-8.

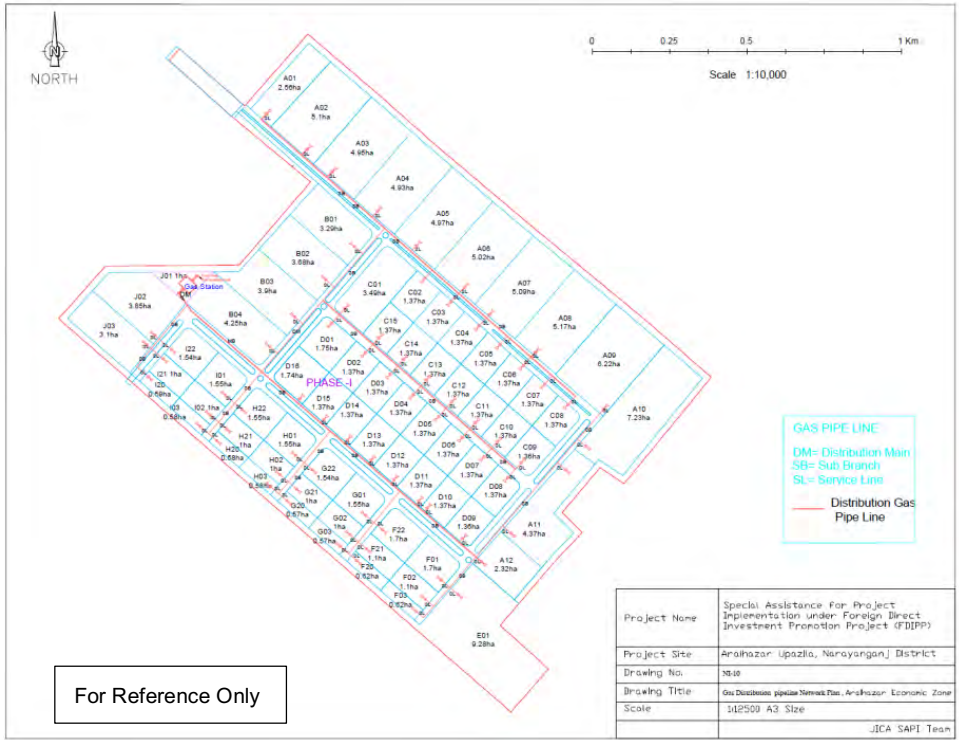
### 2.3.7 Telecommunication distribution plan

Telecommunication lines are distributed to each lot by optical fiber cables from the exchange station in the administration area. Internet distribution system is shown in Figure-S 2.3-9.



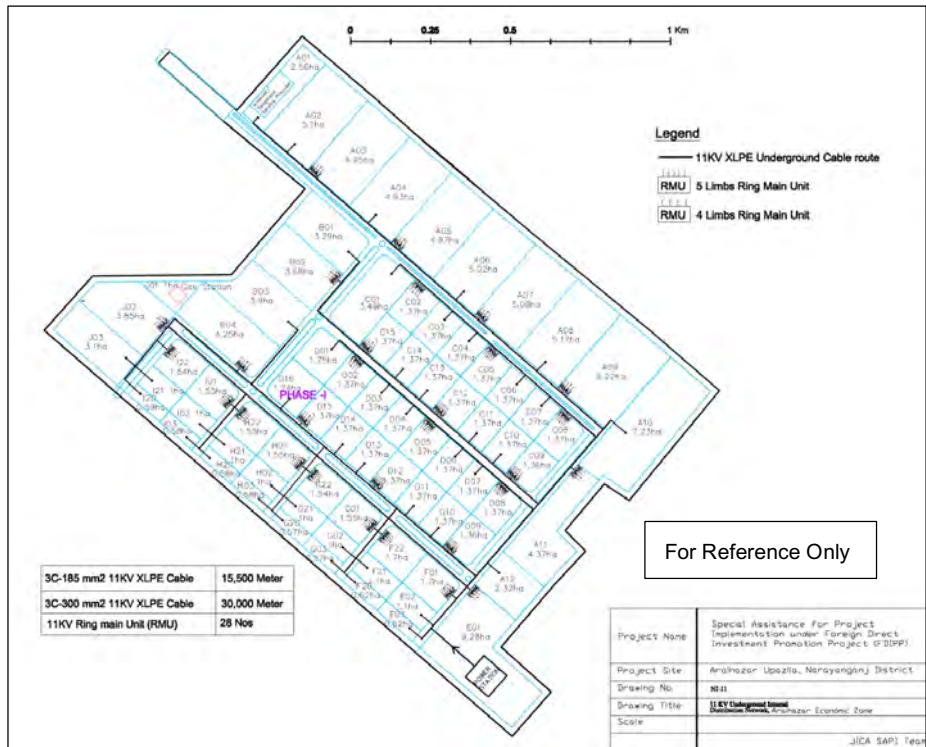
source: JICA Study Team

Figure-S 2.3-6: Wastewater pipelines



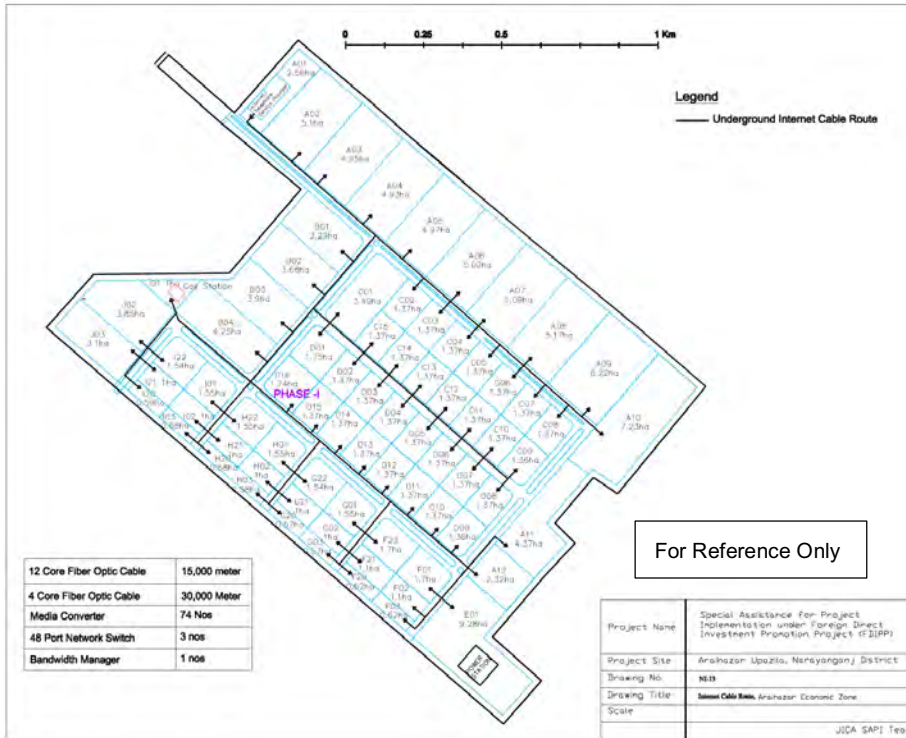
source: JICA Study Team

Figure-S 2.3-7: Gas distribution pipelines



source: JICA Study Team

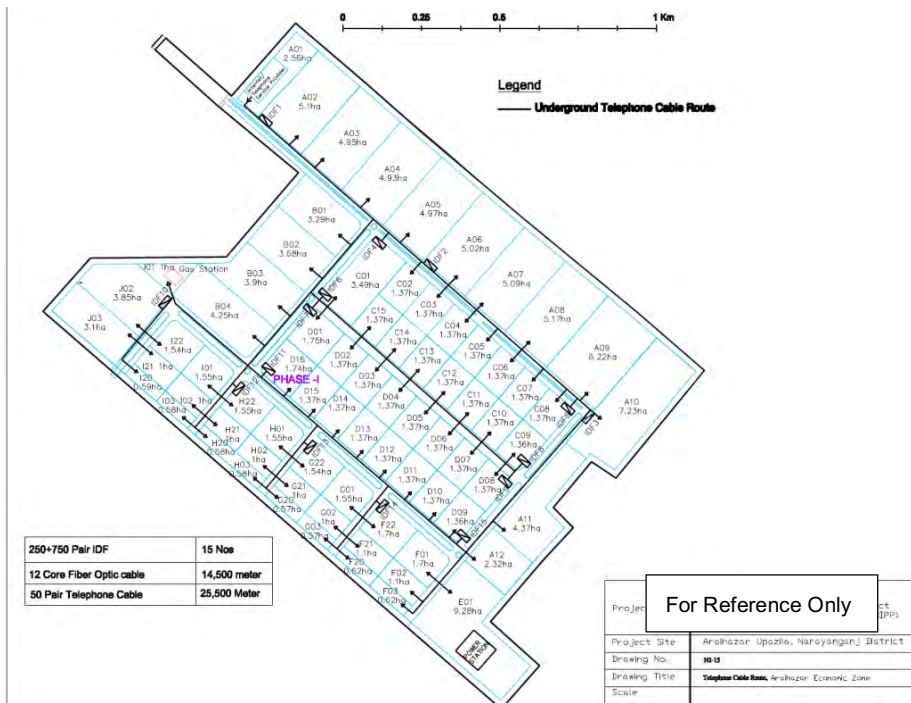
Figure-S 2.3-8: 11kv power distribution line



source: JICA Study Team

Figure-S 2.3-9: Internet distribution system

Telephone distribution system is shown in Figure-S 2.3-10.



Source: JICA Study Team

Figure-S 2.3-10: Telephone distribution system

## 2.4 Off-site basic infrastructure sub-projects


### 2.4.1 Land development

#### (1) Land development plan

The land development elevation for Araihaazar EZ development has been decided by having conducted surveys of the high water level of the site and the difference between calculated probability water level and the terrain elevation obtained by other methods, such as digital mapping, together with a planning policy.

According to the results of these surveys, the past average flood water level of Araihaazar was + 6.3 m. The past flood water levels of Araihaazar was affected by the high water level of the nearby rivers, and can be treated as a static water surface for simplicity.

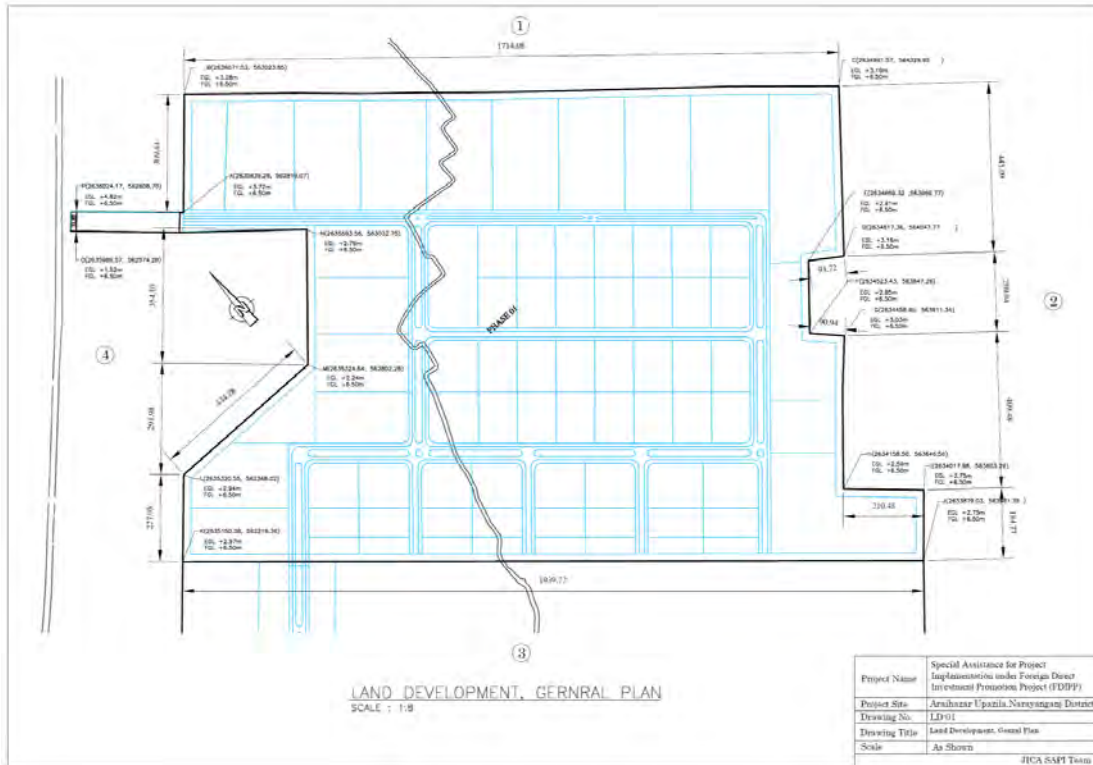
Table-S 2.4-1: Flooding trace survey of Araihaazar

	Survey point No.	Trace water level high (MSL±0.00 m)
	Fmh 1	+6.0
	Fmh 2	+6.5
	Fmh 3	+6.5
	Fmh 4	+5.8
	Fmh 5	-
	Fmh 6	+6.3
	Fmh 7	-
	Fmh 8	+6.3
	<b>Average water level</b>	<b>+6.3</b>

Position of Flooding Trace Survey Points of Araihaazar - Source: Previous survey by JICA

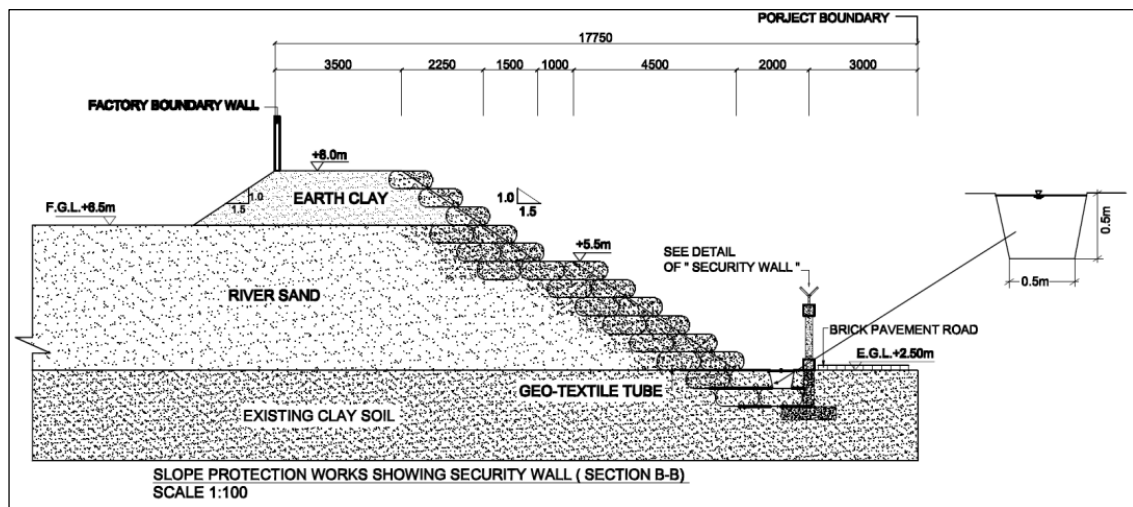
#### (2) Land development design

Land gradient is designed according to the land development plan as shown in Figure-S 2.4-1 and Figure-S 2.4-2.



Source: JICA Study Team

Figure-S 2.4-1: Land development plan



Source: JICA Study Team

Figure-S 2.4-2: Land development typical section

### (3) Construction plan

Approximately 9,000,000 m<sup>3</sup> dredged material will be required to develop the project site.

#### Proposed borrow site for dredged materials

The study team has identified candidate sites for loading dredged material for the land reclamation based on hearing from local consultants and local dredging contractors. Approximately 1,000,000 m<sup>3</sup> sand would be dredged from each borrow site.

**Transportation of dredged materials**

Sand materials are dredged from the river bed at the Meghna River by pumping up. The dredged material will be transported using sand carrier vessel from the loading point through the Sitalakhya River to nearby Atlapur Bazar of Rupganj.

**Pumping of dredged sand materials**

Dredged sand will be pumped out from the sand carrier vessel to 12-inch pipeline up to the EZ site.

**Construction equipment and schedule**

Dimensions of construction equipment and schedule are given in detail in this report in that preparatory works for sand filling is estimated to be 2 months. Final compaction works, dewatering and demobilization is estimated to be 2 months in the end. The construction period for land development works as a whole is estimated to be 30 months.

Land development for Stage-1 (Zone E and Zone D) with 100 ha is scheduled for first 16 months, and land development for Stage-2 (Zone C, Zone B and Zone A) with 100 ha is for latter 14 months as shown in Figure-S 2.4-3.



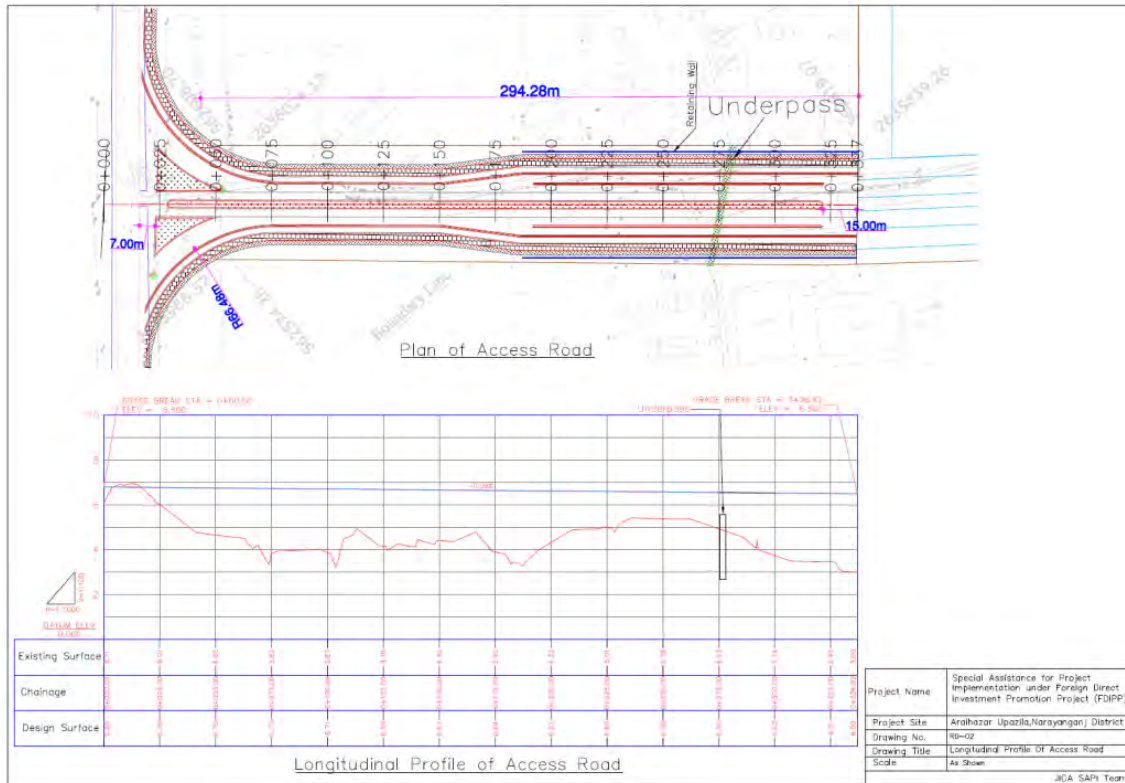
Source: JICA Study Team

Figure-S 2.4-3: Land development plan

**2.4.2 Access road**

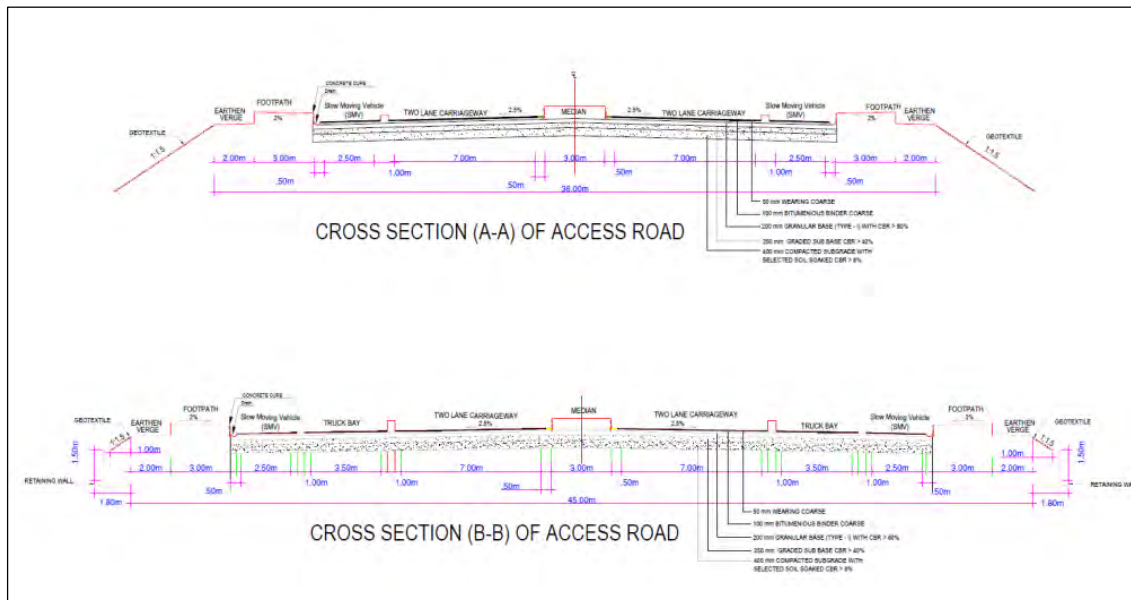
The access road is planned directly connecting from the national highway No.2 (Dhaka-Sylhet Expressway) to the Araihaazore EZ with approximate length of 337 m.

The access road is designed with two lanes on each side including a median strip, sidewalks and space for utilities (gas transmission, telecommunication, etc.). The plan and profile, and cross sections of the access road as well as the underpass are shown in Figure-S 2.4-4 and Figure-S 2.4-5, and Figure-S 2.4-6.



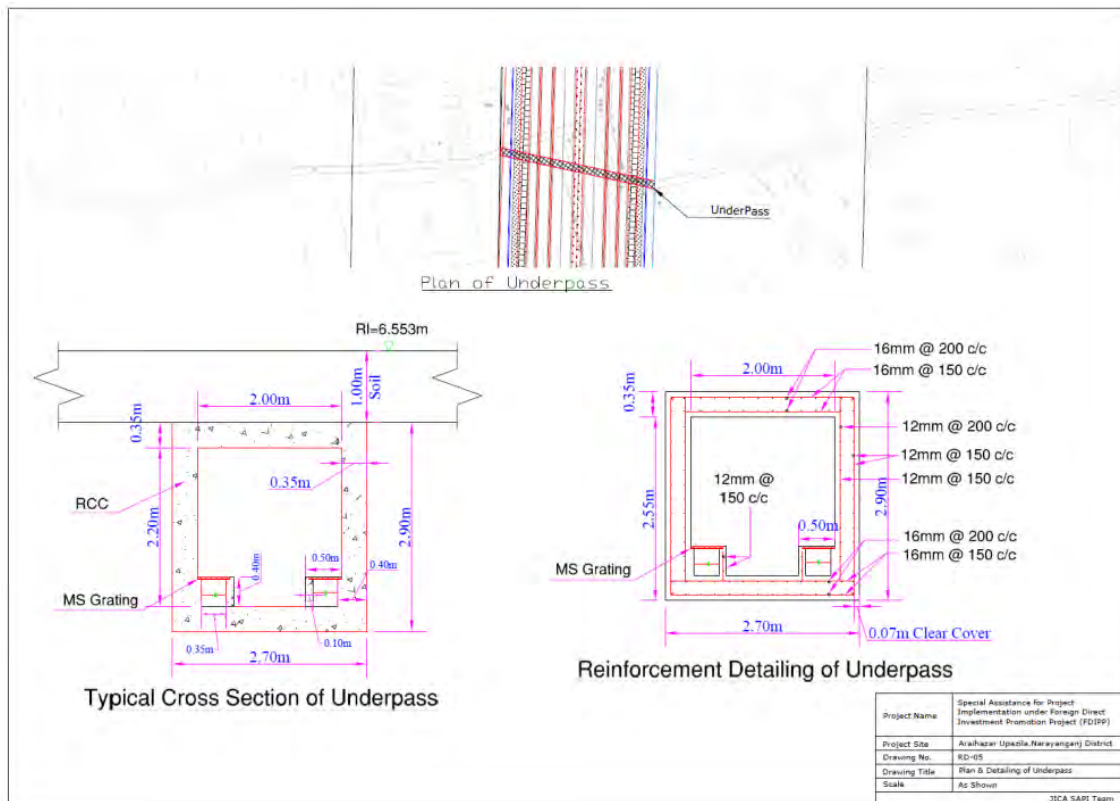
Source: JICA Study Team

Figure-S 2.4-4: Plan and profile of access road



Source: JICA Study Team

Figure-S 2.4-5: Cross sections of access road



Source: JICA Study Team

Figure-S 2.4-6: Details of underpass culvert

### 2.4.3 Retention canal and retention pond with pumping station

The land use for the retention pond is planned with 4.32 ha and 8.66 ha in the case of 200 ha and 400 ha development respectively, and it will regulate the amount of increase in the runoff rate, assumed to be 0.6 from areas for factory use land and 0.3 from agricultural fields. If the water level outside the surrounding levee is close to 5m, discharge by natural flow will be difficult, and therefore the gate of the surrounding levee will be closed and the system is switched over to pump drainage. The study of pump capacity assumed the scale capable of withstanding the largest rainfall of 115mm in three (3) hours that occurred on July 18, 2005.

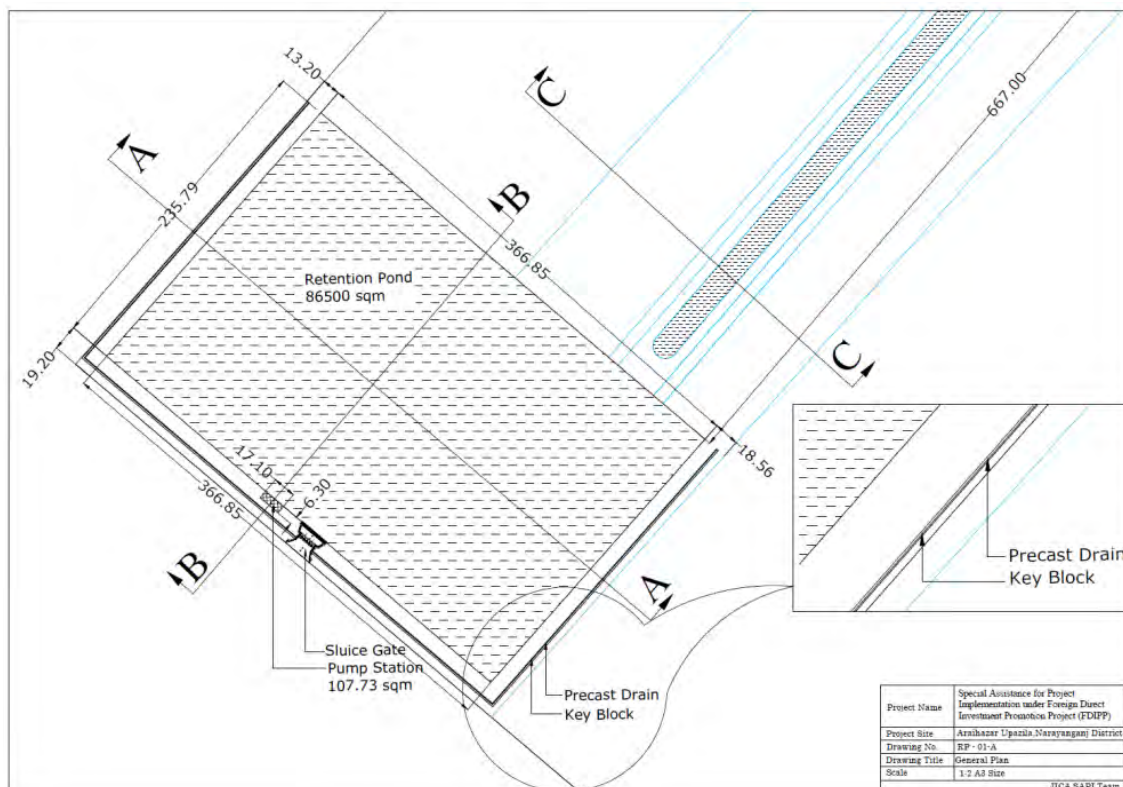
The plan of retention canal, the plan of retention pond and typical section of retention pond are shown in Figure-S 2.4-7, Figure-S 2.4-8 and Figure-S 2.4-9 respectively.



Source:

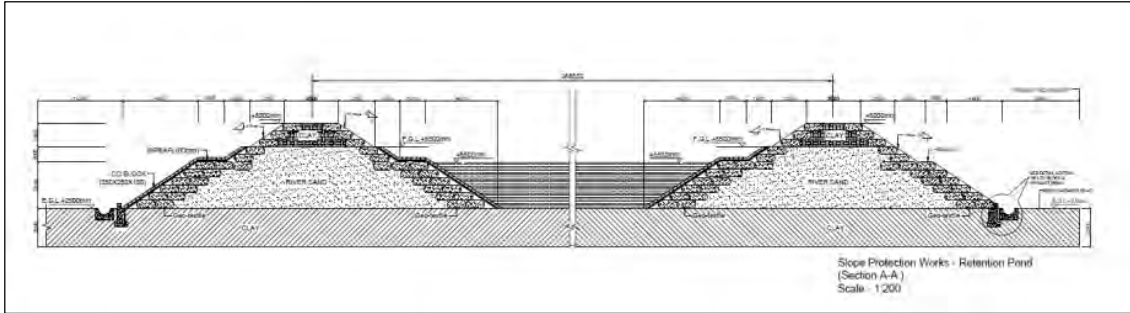
JICA Study Team

Figure-S 2.4-7: Plan of retention canal and retention pond



Source: JICA Study Team

Figure-S 2.4-8: Plan of retention pond



Source: JICA Study Team

Figure-S 2.4-9: Typical section of retention pond

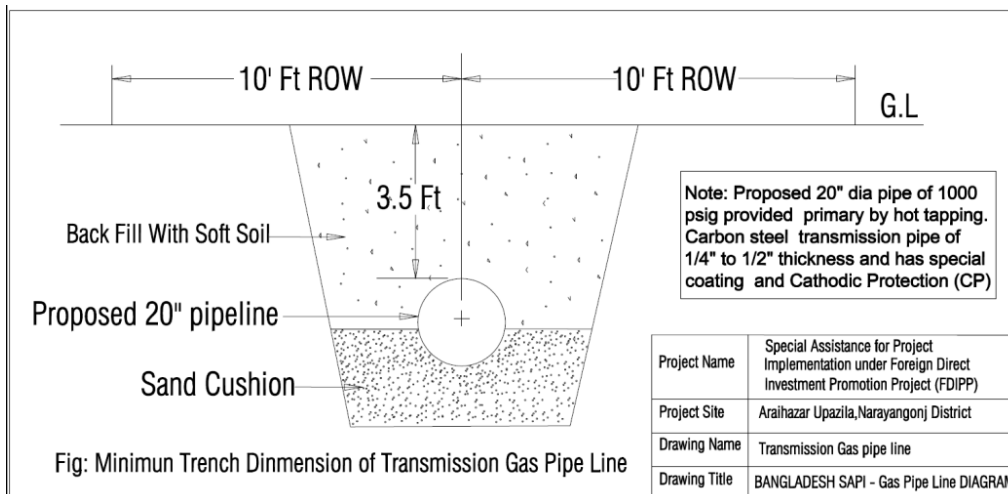
#### 2.4.4 Gas transmission plan

Gas demand for industry and power use in Araihaazar EZ is forecasted by year as follows:

Year wise Gas Demand (MMCFD)										
Year	1	2	3	4	5	6	7	8	9	10
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Power	0	5	10	10	10	15	15	20	20	20
Industry	5	10	15	20	25	30	35	40	45	50
Total	5	15	25	30	35	45	50	60	65	70

Source: JICA Study team

Based on the above gas demand forecast, Titas Gas Transmission and Distribution Company Limited (TGTDC) has proposed to newly construct 20" diameter with 1,000 psig transmission lines from the Horipur TBS to the Dighibarabo CGS (about 6 km length). A new CGS/TBS is also to be constructed at the AEZ site, connecting from existing 20" transmission lines running through the AEZ area. The typical section of gas transmission pipeline is shown in Figure-S 2.4-10.

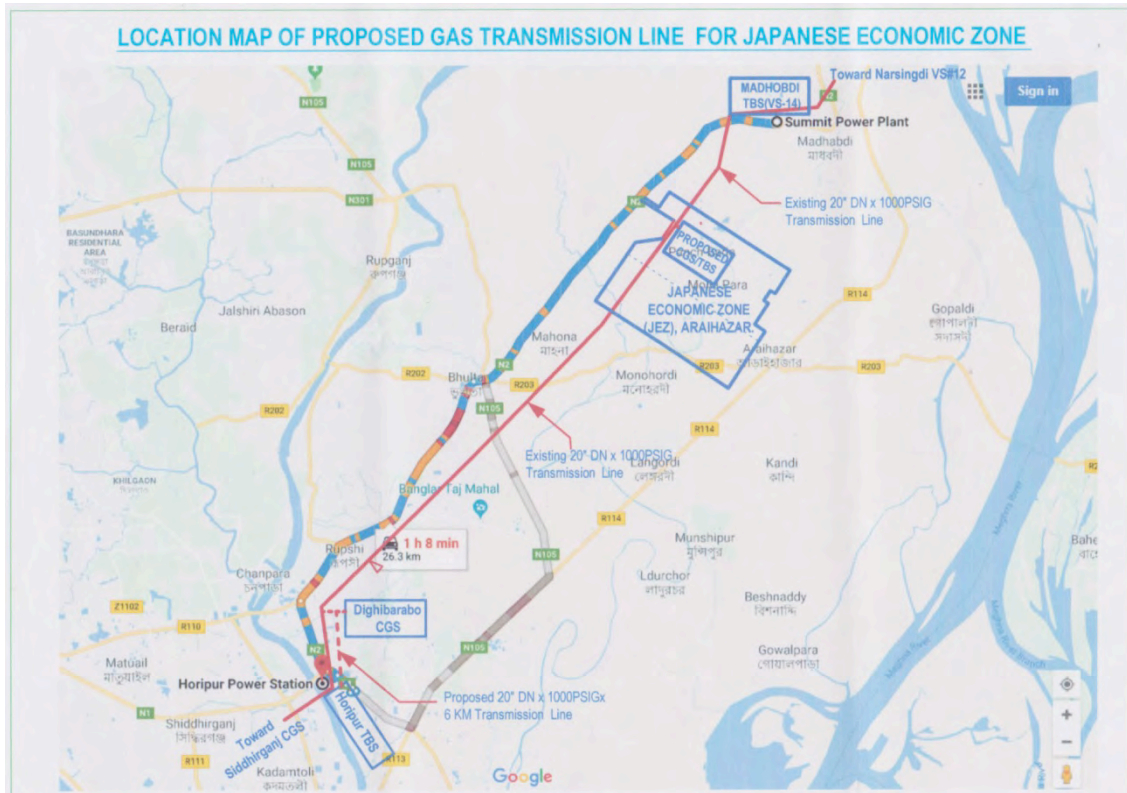


Source: JICA Study Team

Figure-S 2.4-10: Typical section of gas transmission pipeline

The schematic gas transmission plan is shown in Figure-S 2.4-11. For construction of new gas transmission pipelines from the Horipur TBS to the Dighibarabo CGS (about 6 km length), the route survey was carried out by JICA study team through August to November of 2018 and the route alignment of gas pipelines has been proposed to TGTDC as shown in Figure-S 2.4-12. Detail design shall be conducted in 2019 by TGTDC upon payment is provided from BEZA. Topographic drawing is available

in Appendix 7.



Source: Google Map - image has been partially modified by survey team

Figure-S 2.4-11: Gas transmission plan



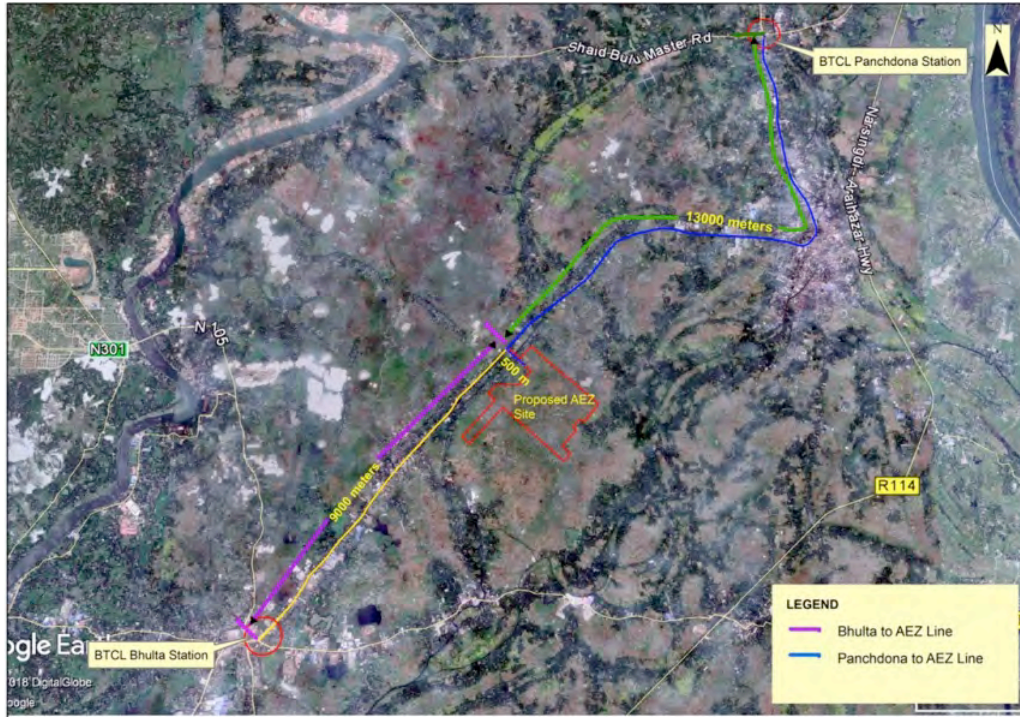
Source:

JICA Study Team

Figure-S 2.4-12: Alignment of new gas transmission pipeline

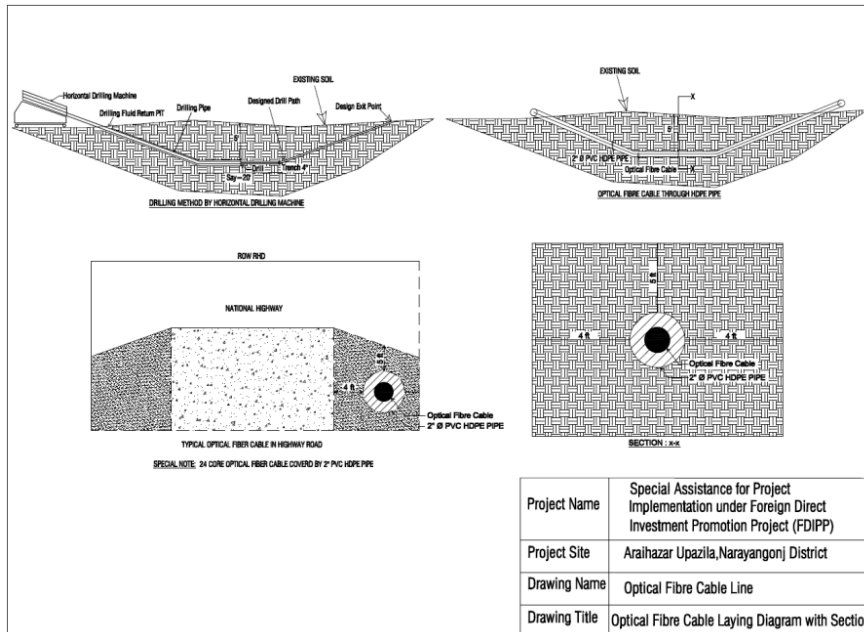
### 2.4.5 Telecommunication supply plan

Bangladesh Telecommunication Company Limited (BTCL) undertook field evaluation to determine the alignment and installation method of the telecommunication line. BTCL is currently preparing construction schedule and cost estimate. As the lines are laid along the national highway, land acquisition works are not required. The telecommunication supply plan is shown in Figure-S 2.4-13. The typical section of telecommunication optical fiber cables for construction is shown in Figure-S 2.4-14.



Source: Google Earth-image has been partially modified by study team

Figure-S 2.4-13: Telecommunication Supply Plan



Source: JICA Study Team

Figure-S 2.4-14: Typical section of telecommunication optical fiber cables

#### **2.4.6 Preparation of bidding documents for land development**

JICA SAPI team has supported BEZA to prepare the draft bidding documents for land development works, since JICA has decided to support BEZA to develop land works for 200ha EZ and related off-site infrastructure by additional loan.

Draft bidding documents for ICB (International Competitive Bidding) for land development for Araihaazar EZ are prepared for the works as follows:

- Land development works
- Access road works
- Retention canal, retention pond and pumping station

For preparation of bidding documents, following technical issues are reviewed and discussed:

##### (1) Two-envelop bidding

For an international competitive bidding (ICB) for land development works including access road works, and retention canal, retention pond and pumping station, two-envelop bidding is to be adopted with the following reasons:

- Large scale works for more than 8,000,000m<sup>3</sup> sand filling,
- To employ experienced and excellent contractor for technically complex works for sand dredging, transport, filling and compaction, and soil investigation analysis and soil improvement works,
- To employ experienced contractor for management and coordination with other contractors for gas transmission pipeline and gas station, telecommunication optic fiber cables, power station and related facilities, and on-site infrastructure works for SPC.

##### (2) Sand filling construction method

Sand filling construction method is carefully studied and proper specifications for sand filling and compaction is prepared. Before handover works, additional filling at the settlement area shall be required to be the designated final ground level (FGL). These filling costs for the allowance and additional filling such as loose sand material rate to filled material, transportation loss of material, compaction loss of material and initial consolidation settlement loss of material shall be included in the unit rates of filling work. Any loss and reducing ratio and consolidation of filled material would not be added for BOQ and contract cost.

##### (3) Geotechnical investigation and analysis

Since soft silty layer has been found in the first soil investigation, the additional soil investigation were carried out. Based on the additional soil investigation and analysis, the following countermeasures are recommended:

- Geotechnical investigation with analysis plan and expected soil improvement shall be studied during construction by the contractor. The cost is included in the item “Geotechnical investigation (SPT) and laboratory tests (consolidation tests) and analysis report” in SPECIFIED PROVISIONAL SUMS in BOQ of the Contract,
- Soil improvement works might be carried out based on the result of the geotechnical investigation. The cost for soil improvement works is included in the item “Soil improvement works” in SPECIFIED PROVISIONAL SUMS in BOQ of the Contract.

##### (4) Environmental management

During the design and execution of the land development works, the Contractor shall strictly conform to all requirements relating to the environmental protection as per the Sub-Clause 4.18 of the General Conditions of the Contract and detailed in this Works Requirements. The Contractor shall also strictly

conform to all applicable Bangla environmental protection/management-related Laws and all current national/state codes and standards established by the concerned authorities, and other government agencies for environmental protection-management.

The Environmental Management Plan (EMP) and the Environmental Monitoring Plan (EMoP) as per the approved EIA and additional requirement by JICA are described in “ENVIRONMENTAL MANAGEMENT” in the Specifications of the Contract.

(5) Site safety and security management

In Bangladesh, special countermeasures for site safety and security management for the Contractor’s works are required. Those requirements are described in “SITE SAFETY AND SECURITY REQUIREMENT” in the Specifications of the Contract.

## 2.5 Power generation, transmission, substation and distribution system plan

### 2.5.1 Power generation

(1) Initial planning

The original requirement of a power station was planned to be the total capacity of a Gas Turbine Combined Cycle (GTCC) on ISO conditions (ambient temperature 15deg, relative humidity 60%) with approximately 60MW consisting of 45MW Gas Turbine (GT) and 15MW Steam Turbine (ST). The GTCC capacity becomes approximately 50MW on Bangladesh site conditions (35deg, 70%).

(2) The issue of low electricity quality (big frequency and voltage fluctuation) of the grid system

By having conducted two surveys on frequency and voltage at 230kV Ghorasal Substation and 132kV Bhulta Substation, the following points were confirmed.

- a) Frequency fluctuation is quite big, therefore, not suitable for most of manufacturing processes.
- b) 230kV voltage level is adequate and fluctuation is also smaller than 132kV voltage level. That is because 230kV system is upper system than 132 kV system, not because of improvement.

(3) Issue of low power demand at initial stage of EZ operation

During planning of Power station, it turned out that power demand of EZ is quite small, 5MW or less at initial stage of EZ operation.

Table-S 2.5-1 Power demand forecast (source: JICA Consulting Team)

Year	2022	2023	2024	2025	2026	2027	Total
Land	25	25	25	30	30	25	160
Power	5	5	5	6	6	5	32
Total(MW)	5	10	15	21	27	32	32

On the other hand, generators should run generally on half load or more for the following reasons.

- a) Gas turbine (GT) -- In case of low load, NOx level of exhaust gas becomes high.
- b) Gas engine (GE) – In case of low load, Gas engine operation becomes unstable.
- c) Diesel engine (DE) – In case of low load, Diesel engine becomes fouled/dirty.

Frequent maintenance is required.

(4) Selection of generation systems

Consequently, the following generation system is proposed.

1) Initial generation systems

- a) GT: 1 set of approximately 31MW GT on ISO conditions (ambient temperature 15deg, relative humidity 60%) which becomes approximately 25MW GT on Bangladesh site conditions (35deg, 70%). Gas fuel only.
- b) GE: 2 sets of 6MW GE
- c) DE: 1 set of 3MW DE: used for the following occasions;  
For starting GT during black out / Emergency power supply / Shortage of fuel gas supply / Continuous power supply during low power demand of EZ operation, etc.

Total capacity of Power plant is approximately 46MW on ISO conditions i.e. and 40MW on Bangladesh site conditions.

## 2) Future expansion

- a) The initial plan of a GTCC system will be a near future plan by adding Steam turbine (ST) and Heat recovery steam generator (HRSG) for better energy efficiency (by BEZA).
- b) Gas engines and Diesel engine can also compose a Co-generation system as a future plan for better energy efficiency depending on steam/hot water demand of factories in the EZ (by BEZA).
- c) Before the EZ power demand reaches full capacity of power plant, 5-10 years later, Phase-2 Power plant expansion (GTCC 50MW) should be planned (by BEZA).

### **2.5.2 Transmission, substation and distribution**

#### (1) 11kV and 33kV distribution systems

Initial planning and survey were performed on 11kV and 33kV distribution systems of the Rural Electrification Board (REB) in July 2017, but it turned out that REB 11kV and 33kV systems don't have enough capacity of 60MVA for the increased Economic Zone (EZ) area of 200ha which was original 100ha.

#### (2) 132kV and 230kV transmission systems

For securing enough capacity for the EZ, PGCB agreed, as an exceptional case considering it as a government project of EZ by BEZA, that the EZ would receive power from the 230kV transmission line having enough capacity since the 132kV transmission line may not have enough capacity considering the Phase 2 expansion.



Source: Google Earth: partially modified by PGCB and Study team

Figure-S 2.5-9: 132kV and 230kV transmission lines  
 Green line: 132kV transmission line, Red line: 230kV transmission line,  
 Yellow line: Dhaka-Sylhet National Highway N2, Blue line: proposed EZ boundary

Based on further survey on the 230kV transmission line and associated towers, discussion on their locations was made with the PGCB Transmission Line Design as per Figure-S 2.5-10.

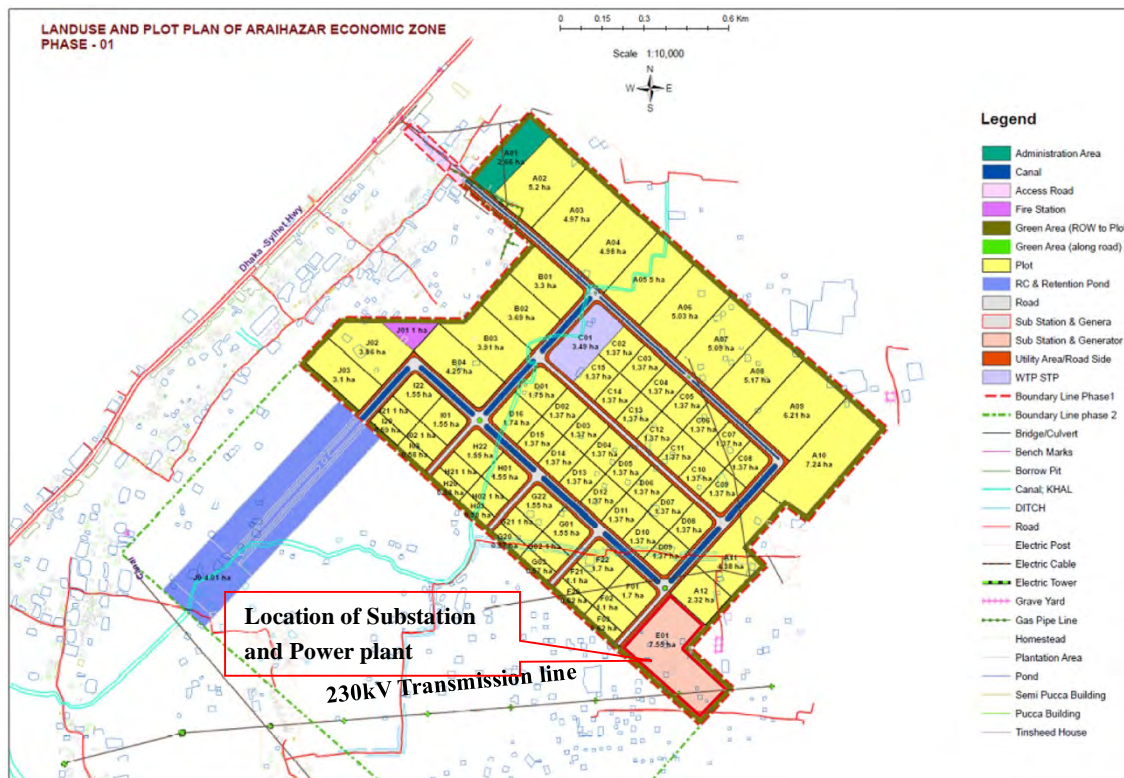


Figure-S 2.5-10: The proposed location of the substation and the power plant

### (3) Substation and distribution

230kV incoming/outgoing and bus bar circuits will be controlled and operated by PGCB after construction. Characteristics are a loop circuit and double bus bar system. Future expansion of Phase 2 is also considered.

## 2.5.3 Operation and maintenance of the Power plant and the Substation

### (1) Operation of the Power plant and the Substation

As described above, grid frequency fluctuation level is high and not suitable for almost all manufacturing processes, even though 230kV grid voltage level is considered to be good. High/low voltage level can be adjusted by transformers in substations and voltage fluctuation can be reduced by adding on-load tap-changers on transformers. But frequency fluctuation countermeasures can be taken only in power plants.

Considering the current grid situation, good quality electricity should be supplied to factories in the EZ from the Power plant, not from the grid. That means the “Power plant should be considered as a main supply to the EZ, not as a back-up purpose for grid power.”.

Since power demand of the EZ is small in the beginning of the EZ operation, a small capacity DE will supply power to the EZ during the period. In accordance with power demand increase, medium capacity GEs, then a large capacity GT will supply power to the EZ accordingly. Generators not supplying power to the EZ should supply power to the grid for the sale of electricity. For this purpose, all generators of GT, GE, and DE are equipped with change-over circuits for supplying power to the EZ or grid connection.

### (2) Operator of the Power plant and the Substation

For securing long term steady operation of the Power plant and the Substation, operator should be public body, not private company.

### (3) Maintenance of the Power plant and the Substation

For securing long term steady operation of the Power plant and the Substation, proper maintenance of machinery and equipment is essential. Typical maintenance schedules for Gas turbine, Gas engine and Diesel engine are addressed in this report.

### (4) Issues of viability and sustainability of the Power Plant

#### 1) Fuel gas price issue

There are two types of Gas Price applied to Power Plant: that is;

a) Gas for Power

b) Gas for Captive Power: much expensive.

- If “Captive Power” price would be applied, average power generation cost would be around Tk. 9.0/kWh. And if “Power” price applied, the cost would be around Tk. 7.3/ kWh.

- The Developer is requesting BEZA to sell the electricity by the same price with National Grid, which is around Tk. 8.2. Therefore, in order to make the Power Plant financially feasible, Gas Price for “Power” must be applied for AEZ.

#### 2) Electricity selling quantity and price issue

As described, power demand of EZ in its early stage is quite small, so BEZA should be allowed to sell all the remaining electricity to the National Grid for the better utilization of Power Plant. At the early stage, around 80%-90% of the electricity may be sold to the National Grid.

Selling amount should be flexible depending on the demand of the EZ. For example:

-For the 1 – 3 Years: 30 MW will be sold to Grid;

- For the 4 – 6 Years: 15 MW will be sold to Grid;
- For the 7 Years and after: No selling to the National Grid.

Power Purchase Cost should be also discussed so that the Power Plant will not be in deficit.

- 3) Operation and maintenance (O&M) body issue  
Operation and Maintenance (O&M) should be delegated to public power authorities such as Rural Power Company Limited (RPCL) or B-R Powergen Ltd. for securing long term operation.
- 4) Other issues
  - a) Connecting Point to National Grid  
The Power Plant and Substation should be connected 230 kV Transmission Line near Araihaazar Economic Zone. And it should be allowed to use electricity from the 230kV when the Power Plant fails to supply electricity to EZ because of some problems.
  - b) Continuous Gas Supply  
Sustainable Gas Supply should be promised by Gas authorities at any time.
- 5) Current situation

BEZA, as of August 2018, is making efforts to solve above issues, coordinating related authorities such as Ministry of Energy and Power, PDB, REB, B-R Powergen, PGCB, Petrobangla, Titas Gas.

However, BEZA has not been able to come to official agreement for any term. It should be noted that unsuccessful negotiation with the relevant authorities regarding the gas price and PPA could result in a possible cancellation of the proposed power generation plan and JICA may remove some portions of the loan agreement for FDIPP since the proposed power generation plan would not be financially feasible. Thus, it is advised that BEZA shall take further actions to officially reach an agreement with the authorities.

## 2.6 Overall implementation schedule

The overall procurement plan for basic infrastructure sub-projects and related consulting services for Foreign Direct Investment Promotion Project (FDIPP) is tabulated in Table-S 2.6-1.

Table-S 2.6-1 Total procurement plan for Foreign Direct Investment Promotion Project

### A. Procurement of Consultants

Package No.	Description of Procurement Package as per DPP (SERVICES)	Unit	Quantity	Procurement method and type	Contract Approving Authority	Source of Fund	Estimated Cost (Taka in Lac)	Indicative dates		
								Invitation for tender	Signing of Contract	Completion of Contract
1	2	3	4	5	6	7	8	9	10	11
PS-1	Consulting service for basic infrastructure development under Foreign Direct Investment promotion project (FDIPP)	MM	F-310 MM (21 nos.) L-413 MM (22 nos.)	QBS	CCGP	JICA	11976.77	August- 2018	December- 2018	June- 2023

### B. Procurement of Contractors

Package No.	Description of Procurement Package as per DPP (WORKS)	Unit	Quantity	Procurement method and type	Contract Approving Authority	Source of Fund	Estimated Cost (Taka in Lac)	Indicative dates		
								Invitation for tender	Signing of Contract	Completion of Contract
1	2	3	4	5	6	7	8	9	10	11
WD-1	Land development	m <sup>3</sup>	7900000	OTM (ICB)	CCGP	JICA	97939.84	October 2018	June, 2019	June, 2022
	Access road	m <sup>3</sup>	337				1537.05			
	Retention canal, Retention pond and pumping station	m <sup>3</sup>	171400				6451.44			
WD-2	Gas Transmission pipeline	km	6	Delegated (OTM/LCB)	CCGP	JICA	19673.69	Jan, 2019	July, 2019	Jun-2022
WD-3	Telecommunication Supply System	km	23	Delegated (OTM/LCB)	Ministry/ Division	JICA	2885.47	Jan, 2019	July, 2019	Jun-2022
WD-4	Power station, Sub- station& transmission line	Mw	46	Delegated (OTM/ICB)	CCGP	JICA	61876.48	October 2018	June, 2019	June, 2022

## 2.7 Project Cost estimate

Project cost is estimated separately for the offsite infrastructure construction executed by BEZA of Bangladesh government using Japan's ODA Loan and the onsite infrastructure construction executed by the SPC. Based on the conditions given in detail in this report, project costs of both offsite and onsite infrastructure construction project are estimated based on the own analysis and assumption made by JICA Study Team.

### 2.7.1 Araihaazar Economic Zone

Based on the land use plan and infrastructure plans described in Chapter 2.3 (On-site infrastructure sub-projects), the cost of developing Araihaazar EZ was calculated as given in Table-S 2.7-1.

Table-S 2.7-1 Cost estimate for onsite infrastructure Project for Araihaazar EZ

Item		Local Portion (BDT)	Foreign Portion (JPY)	Total Cost (BDT)
A.	Construction Cost	1,217,435,564	2,002,909,638	2,668,819,360
	(0) Temporary Work/ Mobilization	25,953,200	57,498,000	67,618,417
	(1) Land Development	0	0	0
	(2) Road	473,859,476	432,913,074	787,564,602
	(3) Drainage	119,154,300	109,397,248	198,427,668
	(4) Water Supply	18,567,495	102,282,478	92,685,232
	(5) Sewerage System	115,487,766	106,030,951	192,321,788
	(6) Power Distribution	56,920,923	313,559,425	284,137,898
	(7) Telecom. Distribution	6,242,460	34,387,745	31,161,116
	(8) Gas Distribution	5,665,145	29,658,716	27,156,969
	(9) WTP, WWT and CETP	335,296,000	692,640,000	837,209,043
	(10) Administration Buildings	60,288,800	124,542,000	150,536,626
B.	Site Expense/General Expense	216,789,381	895,668,285	865,824,370
C.	Contingency & Tax	390,026,939	1,296,404,505	1,329,450,494
D.	Consultants Services	95,604,117	307,214,222	318,223,118
TOTAL		1,919,856,001	4,502,196,650	5,182,317,342

Source: JICA Study Team

## 2.7.2 Off-site infrastructure sub-project

The costs of off-site infrastructure sub-projects for Araihaazar EZ have been estimated in Table-S 2.7-2.

Table-S 2.7-2 Cost estimate for offsite infrastructure Sub-projects for Araihaazar EZ

No.	Sub-Project	Unit	Quantity	Construction Cost (BDT)	Total Cost (Including Contingency & Tax)
1	Land development (Sand fill volume)	m3	7,824,000	8,944,119,000	10,285,737,000
2	Access road (Length)	m	337	152,444,000	184,076,000
3	Retention canal, Retention pond with Pumping station (Retention capacity)	m3	171,400	344,006,000	415,387,000
4	Gas transmission pipeline (including CGS/TBS) (Pipe length)	km	6	1,184,869,000	1,362,599,000
5	Telecommunication supply line (including telephone exchange station)	km	23	288,547,000	331,829,000
6	Power Station, Sub-station and transmission line	MW	46	6,187,648,000	7,471,585,000
<b>Total</b>				<b>17,101,633,000</b>	<b>20,051,213,000</b>

Source: JICA Study Team

## 2.8 Economic and Financial analysis

The economic and financial analyses are undertaken by JICA Study Team for the project. The Araihaazar economic zone (EZ) with the power generation, distribution and transmission system also constitutes the project to be evaluated. Internal rate of return (IRR) and net present value (NPV) calculated by cash flow analysis are used as evaluation indices. This calculation is based on the own analysis of JICA Study Team.

### 2.8.1 Araihaazar Economic Zone

JST analyzed three alternatives with Alternative 1 as the base case.

- Alternative 1: Construct all onsite and offsite infrastructure except for the power station. The target area shall be 191.51 ha.
- Alternative 2: Construct all onsite infrastructure. The target area shall be 191.51ha.
- Alternative 3: Construct all onsite and offsite infrastructure except for the power station. The target area shall be 400 ha.

#### (1) Financial analysis

##### 1) Preconditions

- Project period: EZ development will begin in 2018. The project period shall be 48 years until 2065 for the eight years construction period and 40 years of repayment period of the loan.
- Implementation schedule: As shown in Table-S 2.8-1.

Table-S 2.8-1: Schedule of construction, land lease sales and utility demand increase

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Construction cost disbursement	7.4 %	25.1 %	36.4 %	9.6 %	6.6 %	6.6 %	4.5 %	3.8 %				
Land lease schedule					8%	12%	21%	12%	17%	30%		
Administration					25%	100 %	100 %	100 %	100 %	100 %	100 %	100 %
EZ operation + Utility demand forecast							8%	12%	41%	53%	70%	100 %

Source: JICA Study Team

- Revenue: Revenue from EZ operation comprises land lease, water supply and drainage services and management fee.
- Land acquisition cost: Land required for the EZ project is provided from BEZA. SPC and BEZA sign a concession agreement and SPC will pay 7% of the lease sales revenue to BEZA as a concession fee. Therefore, the concession fee is taken to represent land acquisition cost of the EZ project.
- Exchange rate: The exchange rate follows the appraisal of the JICA ODA loans project (2018 version). All calculations are expressed in US dollars (USD).

#### 2) Project investment cost

The project investment cost of Alternative 1 is USD 313.49 million (BDT 25,268 million) in total.

#### 3) Project revenue

In accordance with the Master Plan of EZ land use, out of the total site area of 191.51 ha, 145.19 ha (75.81%) is set for factory lots. Schedule of lease contracts of factory lots, demand for water supply and drainage and EZ maintenance and management are as shown in Table-S 2.8-1.

#### 4) Result of financial analysis of base case

Among the profit-making business of the EZ, the water supply and drainage services and the EZ maintenance and management fee were set as shown in Table-S 2.8-2.

Table-S 2.8-2: Pricing for water supply and drainage services and EZ maintenance and management

	Unit price	Demand
Water supply	33.21 BDT/ m <sup>3</sup>	(Factory lot) 50 or 60m <sup>3</sup> / ha/ day depending on industries (Others) 35 m <sup>3</sup> / ha/ day
Drainage	38 BDT/ m <sup>3</sup>	(Factory lot) 45 or 54 m <sup>3</sup> / ha/ day depending on industries (Others) 31.5 m <sup>3</sup> / ha/ day
EZ maintenance and management	0.8 USD/ m <sup>2</sup> / year	191.51 ha

(Source) JST based on the Project for Development Study and Capacity Enhancement of Bangladesh Economic Zone Development Plan Authority

To set the land lease price, analysis was conducted in the following two ways.

a. Financial analysis of land lease market price

Data of ASEAN countries and India are used as reference prices of similar land lease.

b. Setting up the lease price with loan repayment ability and recoverable cost

For this EZ project, onsite and offsite facilities constitute indivisible components of the business, but offsite infrastructure development is implemented by the Bangladeshi government and on-site development is carried out by the Bangladesh government and private developers. Therefore, the onsite investment by the Bangladesh government and private developers should ensure the profitability at 75 USD / m<sup>2</sup> for 50 years as set above.

As a result of these, the charge setting of USD 75/m<sup>2</sup> for 50 years is considered. Thus the cash flow will be more than USD 1 million per year even during the principal and interest repayment period. Therefore, it was confirmed that there is no problem in terms of loan repayment.

5) Financial analysis of alternatives

Financial analysis for Alternative 1, Alternative 2 and Alternative 3 are shown in Table-S 2-8-4.

Table-S 2.8-4: FIRR and NPV at lease value of 75USD/ m<sup>2</sup>/ 50 years

Alternatives	FIRR (%)	NPV (USD million)
1. Develop all the infrastructure (200ha)	-0.61	-56.54
2. Develop onsite infrastructure (200ha)	1.05	4.69
3. Develop all the infrastructure (400ha)	1.05	8.99

Source: JICA Study Team

6) Sensitivity analysis

Sensitivity analysis was performed to see effects of uncertain factors surrounding the project. Several uncertain factors in this project are examined, then the results are obtained as in Table-S 2.8-5.

Table-S 2.8-5: Result of EZ sensitivity analysis

	Pessimistic case			Optimistic case		
		IRR	NPV (USD million)		IRR	NPV (USD million)
<b>Alternative 1 (Base case: Construct all infrastructure (200 ha))</b>						
Occupancy rate	-10%	-1.01%	-71.29	-	-	-
Land lease price	△10%	-0.82%	-65.73	+10%	-0.39%	-47.36
Construction cost	+10%	-1.19%	-84.02	△10%	0.09%	-27.83
Operation start	+1 year	-0.62%	-58.59	△1 year	-0.55%	-52.45
Inflation rate	+5%	Unmeasurable	-165.34	△5%	0.43%	-17.51
<b>Alternative 2 (Construct on-site infrastructure (200ha))</b>						
Occupancy rate	-10%	0.56%	-10.81	-	-	-
Land lease price	△10%	0.76%	-4.50	+10%	1.35%	13.87
Construction cost	+10%	0.42%	-16.33	△10%	1.86%	27.72
Operation start	+1 year	0.97%	2.40	△1 year	1.20%	9.03
Inflation rate	+5%	-3.15%	-73.14	△5%	2.01%	34.20
<b>Alternative 3 (Construct all infrastructure (400 ha))</b>						
Occupancy rate	-10%	0.54%	-21.86	-	-	-
Land lease price	△10%	0.74%	-9.86	+10%	1.37%	27.83
Construction cost	+10%	0.33%	-37.45	△10%	1.80%	50.71
Operation start	+1 year	0.98%	4.81	△1 year	1.20%	17.39
Inflation rate	+5%	Unmeasurable	-167.35	△5%	2.10%	72.01

(Source) JICA Study Team

**(2) Economic analysis****1) Preconditions**

- “With-project” and “Without-project”: In the case of "with-project", the EZ is developed as planned, and factories on the site are maintained and operated. On the other hand, in the case of "without-project", the EZ is not developed, and agriculture will continue on the planned development site as it does at present.
- Project conditions: project life, implementation schedule, revenue and exchange rate are the same as determined in the financial analysis.

**2) Economic effect of the EZ project**

Economic benefits may be defined by either "incremental added value produced from the EZ" or "export increase and import reduction by products produced by industrial estates". Since the former is more measurable with available data, "incremental added value to be realized from the EZ" is used as the economic benefit in this analysis.

**3) Project economic costs**

Economic costs consist of economic investment costs required to develop the EZ and opportunity costs of the land that should be used otherwise.

**a. Estimation of economic investment costs**

Economic costs are calculated based on financial expenses, excluding price escalation and transfer items associated with land and tax, then it was obtained to be USD 293.07 million (BDT 23,622 million).

**b. Land opportunity cost**

If the EZ is not developed, agriculture will be continued in the planned development area. In this case, the added value of agriculture produced in the proposed EZ site is regarded as the land

opportunity cost. As a result of its calculation, the opportunity cost of land in the planned EZ development area was calculated to be USD 27.5 million (BDT 2,218 million).

4) Project economic benefit

The added value generated from the EZ is calculated from (1) calculation of added value per worker in the manufacturing industry and estimation of its increase, and (2) the number of workers at the EZ.

As a result of calculation, the added value per worker in 2024, assumed year to start operation, will be USD 4,730 (BDT 380,441). After 2025, it was assumed to increase at the annual rate of 3%, reflecting technological development to be induced by the EZ development.

As for the number of employees per manufacturing it was calculated to be 13,257 people provided 71 enterprises are assumed to locate in the EZ.

5) Measurement of economic benefit

Based on the (1) value added per capita in the manufacturing industry and (2) the number of workers in EZ as calculated above, net added value generated from the EZ is determined from 2024 to 2065, when the EZ is operating. The added value will increase from USD 5.02 million (BDT 403 million) in 2024 at 8% operation to USD 210 million (BDT 16,946 million) in 2065.

6) Result of economic analysis

The results of the economic analysis are shown in Table-S 2.8-6.

Table-S 2.8-6: Result of the EZ economic analysis

Alternative plan	EIRR (%)	NPV (USD million)
1. Develop all the infrastructure (200ha)	15.70	103.05
2. Develop onsite infrastructure (200ha)	17.27	130.59
3. Develop all the infrastructure (400ha)	17.89	286.74

(Source) JICA Study Team

7) Sensitivity analysis

Sensitivity analysis was conducted as done for the financial analysis in (1) 6) above. Several cases were examined with uncertain factors in economic analysis, then the results of the sensitivity analysis were obtained.

Table-S 2.8-7: Sensitivity analysis result of EZ economic analysis

	Pessimistic case			Optimistic case		
		IRR	NPV (USD million)		IRR	NPV (USD million)
<b>Alternative 1 (Base case: Construct all infrastructure (200 ha))</b>						
Added value increase rate	1%	14.77%	67.15	5%	16.66%	152.44
Operation start	+1 year	14.61%	74.13	△1 year	17.01%	135.47
Construction cost	+10%	14.96%	87.60	△10%	16.53%	118.49
Inflation rate	+5%	15.05%	87.71	△5%	16.28%	114.88
<b>Alternative 2 (Construct on-site infrastructure (200ha))</b>						
Added value increase rate	1%	16.40%	94.69	5%	18.17%	179.98
Operation start	+1 year	16.01%	101.58	△1 year	18.80%	163.10
Construction cost	+10%	16.49%	117.84	△10%	18.16%	143.33
Inflation rate	+5%	16.59%	117.87	△5%	17.89%	140.67
<b>Alternative 3 (Construct all infrastructure (400 ha))</b>						
Added value increase rate	1%	17.04%	213.09	5%	18.77%	388.08
Operation start	+1 year	16.56%	227.28	△1 year	19.51%	353.38
Construction cost	+10%	17.09%	262.34	△10%	18.80%	311.14
Inflation rate	+5%	17.20%	261.68	△5%	18.52%	306.09

Source: JICA Study Team

### (3) Conclusion

In the base case, FIRR (negative 0.61%) fell below the capital opportunity cost (0.9%). However, since the EIRR (15.70%) exceeds the social discount rate (12%), the project is considered to contribute to the economy of Bangladesh. In addition, from the economic point of view, added value generated from indirect employment accompanying the EZ development is also expected. It is expected, therefore, that the government's financial support for the project is justifiable as the project will contribute to economic growth in Bangladesh.

### 2.8.2 Power generation, distribution and transmission system

JST analyzed two alternatives with Alternative 1 as the base case.

- Alternative 1: Construct a power station offsite of the EZ. Fuel is purchased at the gas price for tenants (2,937 USD / MMCF).
- Alternative 2: Construct a power station offsite of the EZ. Fuel is purchased at the gas price for the national grid (990 USD / MMCF).

#### (1) Financial analysis

##### 1) Preconditions

Preconditions for financial analysis of power plant were set as follows.

- Project period: The start of development of the power plant will be set to be in 2020. The project period was set to be 41 years up to 2060 from the loan term of 40 years including the repayment period.
- Implementation schedule: As shown in Table-S 2.8-8.

Table-S 2.8-8: Construction schedule of power plant

	2020	2021	2022
Construction	40%	40%	20%

Source: JICA Study Team

- Revenue: Part of the power is sold to the EZ, and the surplus is all purchased by the national grid.
- Land acquisition cost: Land required for the power plant project is provided from BEZA. Power plant will pay 7% of the lease sales revenue to BEZA as a concession fee. Therefore, concession fee is taken to represent land acquisition cost of the power plant project.
- Exchange rate: The exchange rate follows the appraisal of the JICA ODA loans project (2018 version). All calculations are expressed in US dollars.

## 2) Project investment cost

The project investment cost of Alternative 1 is USD 90.1 million (BDT 7,261 million) in total.

## 3) Project revenue

The power plant preferentially feeds the industrial park and surplus electricity is sold to the national grid. Selling price is assumed to be the same for both the industrial park and the national grid.

## 4) Result of financial analysis of base case

### a. Setting up the power selling price with loan repayment ability and cost recovery

When examining the power selling price, consideration on loan repayment is taken. As a result, the power selling price satisfying the repayment ability and capable of recovering cost was found to be 0.16 USD/ kWh (12.9 BDT/ kWh). When conducting cash flow analysis with this power selling price, FIRR is calculated to be 22.66%, and NPV is USD 576.09 million (BDT 46,432 million). The calculated FIRR is higher than the capital opportunity cost (0.9%).

### b. Financial analysis of power selling market price

Analysis was conducted using the average market price in Bangladesh. According to interviews with related organizations, the selling price to industrial parks and the selling price to the national grid is in the range of 0.10 - 0.12 USD/ kWh (8.2 - 9.84 BDT/ kWh). Based on this, the power selling price was set to 0.11 USD/ kWh (9 BDT/ kWh). As a result, FIRR was calculated to be 6.98% and NPV was USD119 million (BDT 9,621 million). The calculated FIRR is higher than the capital opportunity cost (0.9%), so the investment is considered financially viable.

## 5) Financial analysis of alternatives

Financial analysis was conducted for both Alternative 1 and Alternative 2. The results are shown in Table-S 2-8-9 and Table-S 2-8-10.

Table-S 2.8-9: FIRR and NPV at power selling price ensuring repayment ability,

Alternatives	Power selling price(USD/kWh)	FIRR (%)	NPV (USD million)
1. Purchase gas at a price for tenants	0.16	22.66	576.09
2. Purchase gas at the price for the national grid	0.14	20.62	510.01

Source: JICA Study Team

Table-S 2.8-10: FIRR and NPV at power selling price of 0.11USD/ kWh (9 BDT/ kWh)

Alternatives	FIRR (%)	NPV (USD million)
1. Purchase gas at a price for tenants	6.98	119.37
2. Purchase gas at the price for the national grid	10.37	205.52

Source: JICA Study Team

#### 6) Sensitivity analysis of power plant financial analysis

Sensitivity analysis was performed to see the effects of uncertain factors surrounding the project. Several cases were examined with uncertain factors for this project. The results of the sensitivity analysis are shown in Table-S 2.8-11.

Table-S 2.8-11: Sensitivity analysis result of power plant financial analysis

	Pessimistic case			Optimistic case		
		IRR	NPV (USD million)		IRR	NPV (USD million)
<b>Alternative 1 (Base case: Fuel is purchased at the gas price for tenants)</b>						
Gas price fluctuation (annual rate)	+5%	Unmeasurable	-65.44	△5%	8.85%	189.59
Construction cost	+10%	6.23%	111.81	△10%	7.86%	126.92
Operation start	+1 year	6.43%	113.36	△1 year	7.45%	125.22
Inflation rate	+5%	Unmeasurable	-357.76	△5%	10.56%	263.47
<b>Alternative 2 (Fuel is purchased at the gas price for the National Grid)</b>						
Gas price fluctuation (annual rate)	+5%	8.80%	125.09	△5%	11.09%	230.68
Construction cost	+10%	9.42%	197.97	△10%	11.50%	213.08
Operation start	+1 year	9.42%	196.89	△1 year	11.21%	214.04
Inflation rate	+5%	Unmeasurable	-115.00	△5%	12.61%	303.86

Source: JICA Study Team

## (2) Economic analysis

### 1) Preconditions

- “With-project” and “Without-project”: In the case of "with-project", the power plant is developed as planned, and the factories are maintained and operated. In the case of "without-project", the power plant is not developed, and agriculture will continue on the planned development site as it does at present.
- Project conditions: project life, implementation schedule, revenue and exchange rate are the same as in the financial analysis in (1) above.

### 2) Economic effect of the power plant project

Supplying stable electric power to the EZ is the main objective of this power plant project, but surplus electricity contributes to the increase of domestic total power supply. Economic analysis was conducted by converting the selling price of electricity produced from this project into economic price. Economic costs and benefits were set, considering the assumed power selling price, taking the above-mentioned market price as the lower limit of willingness to pay.

### 3) Project economic cost

Economic costs consist of economic investment costs required to develop the power plant and land opportunity costs.

#### a. Estimation of economic investment costs

SCF and CFL were set under the same condition as the EZ project. As a result, the economic cost was calculated to be USD 86.4 million (BDT 6,960 million).

#### b. Land opportunity cost

If the power plant is not developed, agriculture will be continued in the planned development area. The planned area of the power station is 9.28 ha. As a result of calculating added value generated by agriculture under the same condition as the EZ indicated in 2.8.1 (1) 3), land opportunity cost was calculated to be USD 1.03 million (BDT 84 million).

### 4) Project economic benefit

The economic benefits of the project consist of economic prices of electricity sales to the industrial estate and electricity sales revenues of surplus electricity. In order to calculate the economic prices, 0.11 USD / kWh (9 BDT / kWh) set as the market price in the financial analysis was used. It was set to 0.10 USD / kWh (8.73 BDT / kWh) by multiplying the above price by SCF (0.97).

### 5) Measurement of economic benefit

Economic benefits in the power plant project calculated from the above 4) were USD1,335 million (BDT 107,613 million).

### 6) Result of economic analysis

The results of the economic analysis are shown in Table-S 2.8-12.

Table-S 2.8-12: Result of the power plant economic analysis

Alternative plan	EIRR (%)	NPV (USD million)
1. Purchase gas at a price for tenants	10.32	- 8.62
2. Purchase gas at the price for the national grid	13.48	7.91

Source: JICA Study Team

### 7) Sensitivity analysis

Sensitivity analysis was conducted as done for the financial analysis in (1)6) above. The uncertainty factors are the same as set in (1) 6). The results of the sensitivity analysis are shown in Table-S 2.8-13.

Table-S 2.8-13: Sensitivity analysis result of power plant economic analysis

	Pessimistic case			Optimistic case		
		IRR	NPV (USD million)		IRR	NPV (USD million)
<b>Alternative 1 (Base case: Fuel is purchased at the gas price for tenants)</b>						
Gas price fluctuation (annual rate)	+5%	4.04%	-23.26	△5%	11.80%	-1.14
Construction cost	+10%	9.38%	-14.65	△10%	11.45%	-2.60
Operation start	+1 year	9.38%	-14.37	△1 year	11.16%	-4.18
Inflation rate	+5%	Unmeasurable	-39.25	△5%	13.15%	6.73
<b>Alternative 2 (Fuel is purchased at the gas price for the National Grid)</b>						
Gas price fluctuation (annual rate)	+5%	12.55%	2.67	△5%	13.88%	10.26
Construction cost	+10%	12.30%	1.72	△10%	14.82%	13.76
Operation start	+1 year	12.04%	0.21	△1 year	14.78%	14.17
Inflation rate	+5%	7.63%	-12.58	△5%	15.17%	18.13

Source: JICA Study Team

### (3) Conclusion

Base case FIRR (6.98%) exceeds the capital opportunity cost (0.9%). However, due to the recent rise in domestic natural gas prices in Bangladesh, it should be noted that the prices may increase at annual rate of 5-10%. In the sensitivity analysis, when the domestic natural gas price rose by 5% per year, FIRR was unmeasurable and NPV was negative USD 65.44 million (negative BDT 5,274 million). On the other hand, in Alternative 2, FIRR was 8.8% and NPV was USD 125.09 million (BDT 10,081 million), when the domestic natural gas price rose by 5% per year.

Regarding EIRR, in the base case, the calculated EIRR (10.32%) was lower than the social discount rate (12%). Taking into account the rising domestic natural gas price in the same way as above, EIRR is calculated to be 4.04% and NPV USD negative 23.26 million (BDT negative 1,874 million) for the base case, and EIRR 12.55% and NPV USD 2.67 million (BDT 215 million) for Alternative 2.

### **3 Technical assistance for Environmental and Social Impact Assessment**

This Chapter presents Environmental and Social Impact Assessment (EIA) and Resettlement Action Plan for all infrastructure development of FDIPP. Due to the complexity of the development of AEZ, 2 separate EIAs studies and 2 separate RAPs have been conducted in order to assess comprehensive impacts and to cover and identify all the project affected people (PAPs).

Thus, this chapter is sub-divided into the following 4 sections;

**3.1: EIA (EIA 1) for the development of on-site and off-site (or peripheral) infrastructure.**

**3.2: RAP (RAP 1) for the development of the economic zone, including the power plant affected area.**

**3.3: EIA (EIA 2) for the construction of Gas Transmission Pipeline from Horipur to Dighiborabo as well as the power plant (including the sub-station and transmission system) which will be located adjacent to AEZ premises. RAP for the affected people for the power plant is covered in 3.2 because the land acquisition is planned together with the economic zone.**

**3.4: RAP (RAP 2) for the construction of Gas Transmission Pipeline from Horipur to Dighiborabo.**

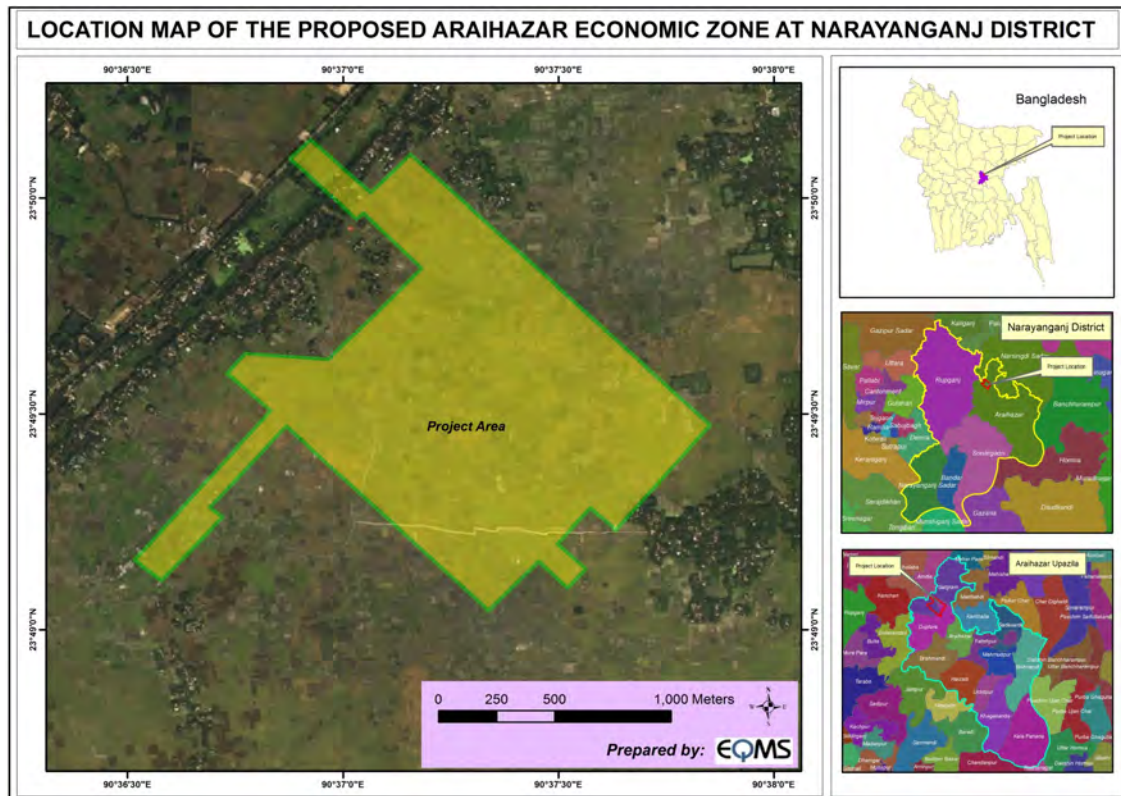
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#### **3.1: EIA for the development of on-site and off-site (or peripheral) infrastructure.**

In this section, EIA study for the development of on-site and off-site (or peripheral) infrastructure are presented. EIA report was submitted to DoE and BEZA already obtained an approval (ECC) for EIA 1. EIA 1 has been disclosed in the website.

#### **Location**

The site is located Araihasar Upazila in Narayanganj District. The site belongs to 2 unions: Satgram and Duptara, as shown in Figure-S 3.1-1.



Source: JICA Study Team

Figure-S 3.1-1: Map of project site

### Environment of the project site

The Majority of the project site is agricultural land. During EIA study, it was confirmed that there is no protected area, historical or cultural heritage, or ecologically critical area in the close proximity that could be affected by the project.

### Project components

The Project components that were assessed in EIA 1 are;

- Internal Roads
- Power Distribution
- Water/Sewage pipeline
- Gas distribution pipeline
- Internal Telecommunication line
- Land filling (Land development) work
- Access Road
- Canal / Retention Pond
- External Telecommunication line

### Legal Framework

This project followed both National Environmental legislations of Bangladesh and JICA's Environmental and Social Consideration guideline.

- Environment Conservation Act, 1995 (subsequent amendments in 2000 and 2002)
- Environment Conservation Rule, 1997 (subsequent amendments in 2002 and 2003)
- International Treaties
- Environmental Clearance from DoE, Bangladesh

According to the Section 12 of the Environment Conservation Act 1995, no project will be established or undertaken without obtaining permission, in the manner prescribed by the Environment Conservation Rules 1997, an Environmental Clearance Certificate from the Director General. Therefore, every development projects/industries which are specified under the Schedule-1 of the Environment Conservation Rules 1997 require obtaining site and environmental clearance from the Department of Environment.

Additionally, since the development of the EZ is a Category A project by JICA's definition, JICA established a designated advisory committee that consisted of external environmental and social experts, who were selected as per the characteristics of the project, in order for JICA to provide project specific environmental and social assessments and suggestions to this EIA study.

### Summary of impact/ PAPs

Table-S 3.1-1: Summary of Impact

Descriptions	Unit	Quantity
Land required for the project	Ha.	218.84
Affected Households	Nos.	1714
Households losing structures	Nos.	11
PAPs losing land	person	6343
Affected Living & Commercial Structures	sft	6282.95
<b>Affected Secondary Structures</b>		
Tube – Well	No.	12
<i>Pucca</i> Latrine with safety tank	No.	1
Slab Latrine	No.	8
Tin Made Boundary Wall	rft	265
Affected Trees	Nos.	1055
Identified Vulnerable Households	Nos.	150
Identified Sharecropper	Nos.	23

Source: JICA STUDY TEAM survey, December 2017

### Environmental Impact Assessment

The EIA study, based on the screening and scoping, review of proposed civil works, review of similar environmental assessment reports, baseline monitoring and stakeholder consultations, has assessed 30 major environmental and social concerns that are expected from the project.

Detailed assessment is available in the main body of the report but major findings and impacts are summarized below;

#### Impact of Dredging and Land Development work;

Since the land development of the proposed EZ will be the focal activity of this project due to the significant amount of sand requirement by dredging, the impact to the sediment and its ecosystem of Meghna river, the dredging site are expected to experience adverse impacts of the project.

Similarly, large volume of sand and water will be released at the project site for the land development, and impact on surrounding area, lands, water bodies can also be affected if no proper major is taken.

Land acquisition:

In terms of social consideration, this project requires land acquisition of 218.84 ha which account for displacement of 11 households and land acquisition of 1714 households.

### **Environmental Management/Mitigation Plan and Monitoring Plan**

In accordance with the environmental impact assessment mentioned above, in order to mitigate the identified impact by the project, environmental management and mitigation plans (EMP) and monitoring plan (EMoP) have been presented in this report and BEZA carries responsibility to comply with these measures. Mitigation measures and monitoring plan have phase specific plans; Pre-construction phase, Construction phase, and Operation phase.

Tentative cost for mitigation measures and monitoring plans are also made available in this report.

In addition, DoE has informed BEZA to comply with the regulations and instructions that are listed in the letter of the approval of the EIA 1. These requirements shall be reflected on bidding documents (specifications) when BEZA procures contractors for the construction works of infrastructures.

### **Institutional arrangement of EMP and EMoP**

Implementation mechanisms of EMP and EMoP have been determined and illustrated in 3.1.10. The supervising proponent of overall EMP and EMoP is BEZA and BEZA shall require the contractors and external consultants to practice the EMP and EMoP, and will need to ensure that reporting shall be prepared and submitted to JICA quarterly for EMP and EMoP.

BEZA is required to cooperate with relevant public agencies for construction of each infrastructure respectively and supervise their implementation of EMP and EMoP.

During operation phase, BEZA, as project proponent, will be accountable for enforcing EMP and EMoP to its tenants, and monitor its tenant to comply with regulation and standards set forth by DoE or international standards if otherwise mentioned.

### **Public Consultation Meetings**

Public consultation meetings (PCM) were held in order to inform the public about the project and to examine feedback and concerns of the public and reflect them in the project planning. In the initial stage, a PCM was organized and project information and the expected impact were made available to the public. Focus group discussions were also organized in order to reach out to groups of project affected people including a number of PAPs.

During 2nd PCM (also called “information disclosure meeting”), more details were disclosed along with the resettlement action plan which discussed land acquisition and compensation issues.

The most frequently asked and critical concern raised by the public was the compensation for the land because at the time the cut-off date, the old land law (ARIPPO 1982), which was considered to have insufficient compensation rate, was in effect. The new land law (ARIPA 2017) would provide twice the amount of the old land law.

It was later announced by BEZA that even though the new land law (ARIPA 2017) does not officially apply to the project in accordance with the cut-off date, BEZA agreed to make an additional (top-up) assistance for the compensation so that all the compensation payment will match with that of the new land law and the amount would surpass the replacement costs in order to meet the requirement by JICA.

### **3.2: Social Impact Assessment for the EZ site.**

#### **Land acquisition requirement**

The project site was selected based on JICA's previous study from 2015 to 2017. The required number of resettlements or displacements was taken into consideration when selecting the site. In effort to minimize the number impact, the boundary of the EZ was drawn to avoided as much settlements as possible.

Proposed EZ project requires 218.84 ha lands for acquisition. A total of 1,714 households consisting of 6,343 population will be affected from this land acquisition. 11 households will lose their residential structures and land.

Besides land acquisition, other associate structures such as 12 tube-well, 1 Pucca Latrine with safety tank, 8 Slab Latrine, 3 motor/water pump and 265 rft tin made boundary wall will be affected. A total of 1,055 trees including 349 Fruit bearing, 127 Timber, 253 Banana and 326 Bamboo with different sizes will be affected as well.

#### **Eligibility and entitlement**

The following items have been identified as eligible for compensation and special assistances / allowances.

- Loss of Agricultural Land
- Loss of Homestead, Commercial Land and Common Property Land
- Loss of Water Bodies (Ponds, Both Cultivated and Non-Cultivated)
- Loss of All Types of Structures With or Without Title to Land
- Loss of crops grown in the acquired areas without lease agreement, informally Without Title to Land
- Loss of Trees With or Without Title to Land
- Loss of Income from sharecropping and fishing (non-title holders)
- Grants to Vulnerable Ahs
- Unforeseen Adverse Impacts

Other assistances, grievance mechanism and institutional framework are also discussed in the main content of this report.

#### **Institutional mechanism and Grievance mechanism**

BEZA has established a Project Management Unit (PMU), headed by a Project Director (PD) who is responsible for the overall execution of the Project. BEZA shall implement resettlement activities as per the RAP prepared by JICA consultants, and shall assign social expert(s) for execution. BEZA is required document progress of RAP in quarterly reports and submit it to JICA and PMO.

BEZA has established Grievance Redress Mechanism (GRM), as described in 3.2.6, to resolve social and environmental concerns linked to the project and ensure greater accountability of the project authorities towards all project affected persons (PAPs). Grievances may include the following issues;

- Dispute over APs not enlisted in the original IOL or census.
- Losses not identified correctly.
- Compensation/assistance not as per entitlement matrix.
- Delay in disbursement of compensation/assistance.
- Disputes over ownership
- Improper distribution of compensation/assistance in case of joint ownership

## Schedule

A tentative schedule of the resettlement action plan was presented in the table in 3.2.10. However, the procedures for disbursement of the compensation and other activities may influence the actual progress of the overall schedule. BEZA shall inform JICA about the progress in quarterly reports.

No construction work cannot be

## Cost

The total estimated cost to be incurred for implementation of the RAP for the EZ project site is about BDT 4,823,744,801. Summary of the costs is presented below.

Table-S 3.2-1: Summary of Cost

SL No.		Compensation and Assistance Head	Estimated Cost (in BDT)
Replacement Cost for Land, Structures and Tress			
A	1	Replacement Value for Land	4,676,974,275
B	2	Compensation for Structures (Residual additional 50%)	5,400,000
C	3	Compensation for Tress	1,573,690
Sub Total			4,683,947,965
Resettlement Assistance and Allowances			
D	1	Relocation allowance for crops and fish	34,488,700
	2	Land Development Assistance	4,400,000
	3	Transfer Grants (TG)	94245
	4	Reconstruction Grants	125,660
	5	Re-Installation of Utilities	110,000
	6	Grants to Vulnerable Households	2,250,000
	7	Grants to Sharecroppers	345,000
	8	Training Allowance for Vulnerable Households	900,000
	9	Skill development training cost under ILRP	2,500,000
Sub Total			45,213,605
Estimated Cost			4,729,161,570
Contingency at 2%			94,583,231
Grand Total			4,823,744,801

Source: JICA Study Team

Apart from the compensation, the RAP has made adequate provision of income and livelihood restoration program (ILRP). The skill development programs will be provided to PAPs who will require new employment opportunities. BEZA must ensure that sufficient job opportunities will be made available to the eligible PAPs and they are given priority to the jobs.

## Accountability

### ➤ Public Consultation Meetings

1st public consultation meeting at scoping phase was organized on 22 November 2017 at the Purinda Bazar Government Primary School located at very convenient location. JICA consultants and BEZA officials presented the scope and the affected area of the project and expected impact.

In the 2nd PCM, details of compensations and assistances, entitlement, and payment mechanism was

explained to the PAPs. Female participation was encouraged for the 2nd meeting and 61 males and 69 females attended the meeting. The participant expressed their interest in job opportunities

➤ **Focus Group Discussion**

Focus group discussions were conducted by JICA consultants in order to reach out to vulnerable groups and specific group of PAPs who required special attention or consideration. FGDs also helped female PAPs who did not attend the PCM.

**Issues**

The most frequently asked and critical concern raised by the public was the compensation rates. This was due to the fact that at the time the cut-off date, the old land law (ARIPO 1982), which was considered to have insufficient compensation rate, was in effect. The new land law (ARIPA 2017), which would provide twice the amount of the old land law, was enacted after the cut-off date. JICA and BEZA considered that the difference between the old land law and the new land law

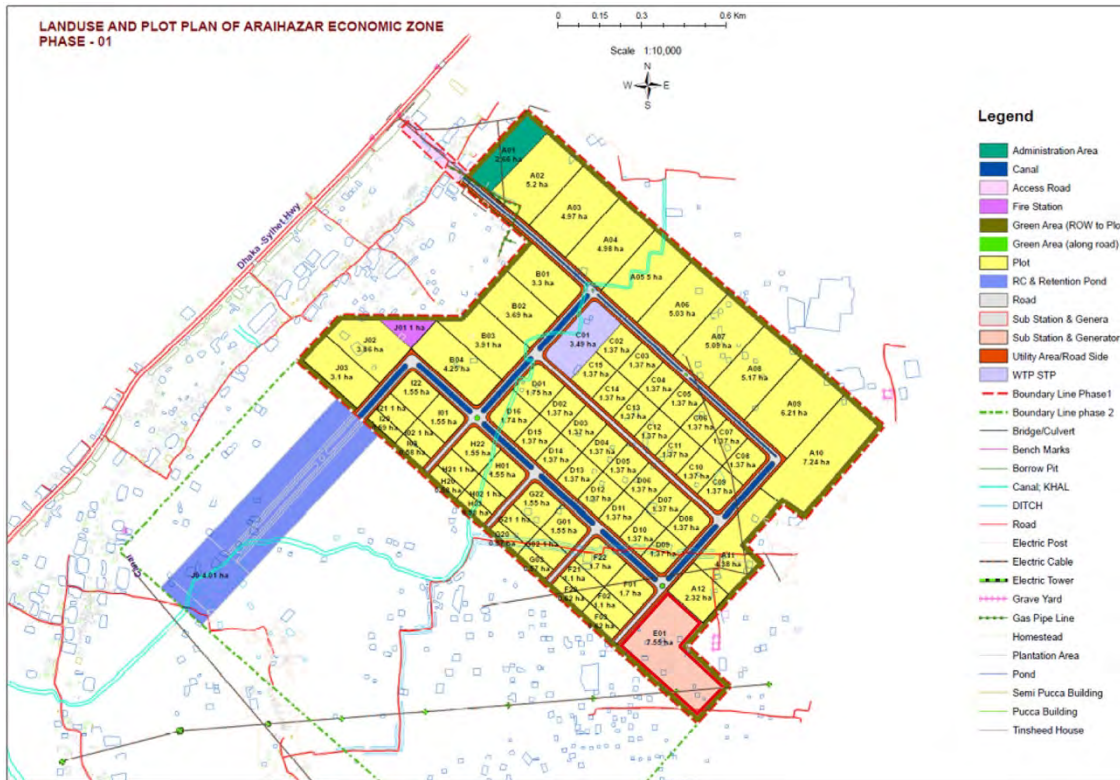
It was later announced by BEZA that even though the new land law (ARIPA 2017) does not officially apply to the project in accordance with the cut-off date, BEZA agreed to make an additional (top-up) assistance for the compensation so that all the compensation payment will match with that of the new land law and the amount would surpass the replacement costs in order to meet the requirement by JICA.

### 3.3: EIA (EIA 2) for gas transmission line and power generation (including the power plant, sub-station and transmission system).

#### Location

##### Power Plant (including substation and transmission line):

The site is located in adjacent zone of Araihasar Upazila in Narayanganj District as shown in Figure-S 3.3-1. The land designated for the power plant, substation and transmission line is indicated in pink with Red line at the Southern corner of the EZ boundary.

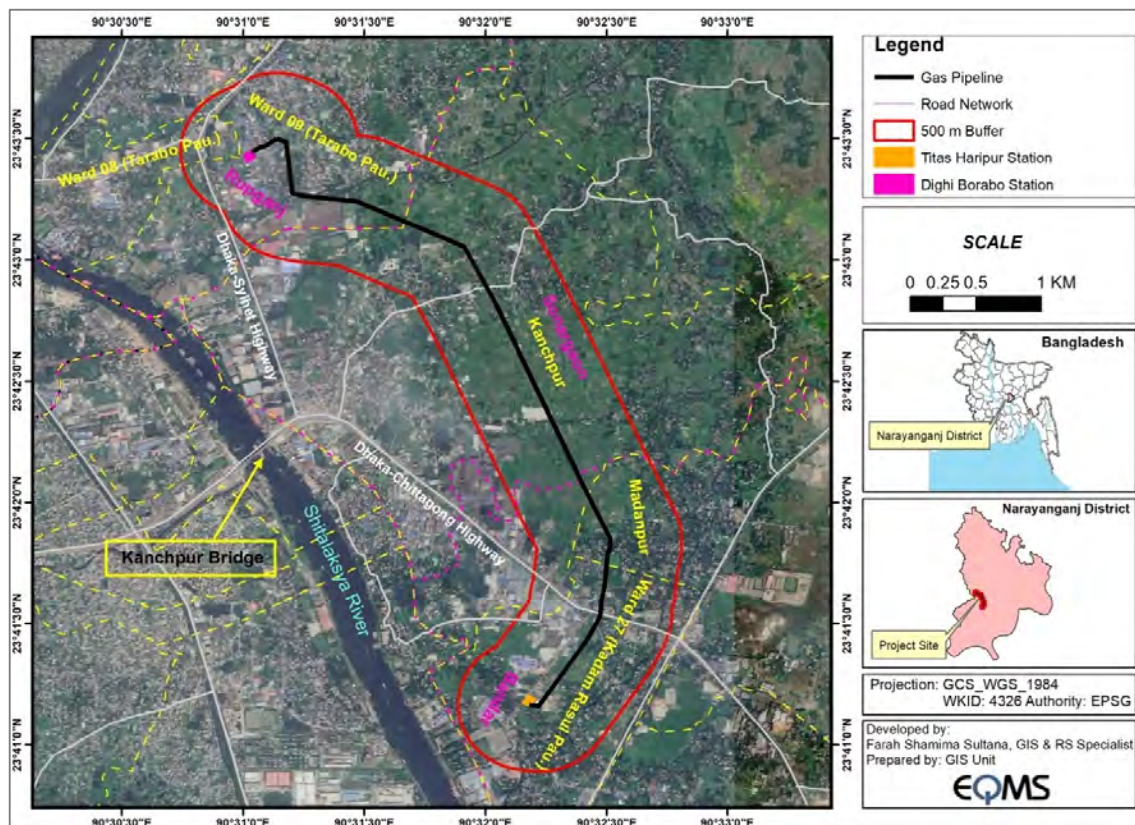


Source: JICA Study Team

Figure-S 3.3-1: The location of the substation and the power plant

##### Gas Transmission Line:

The proposed alignment stretches over 3 unions: Rupganj, Sonargaon, and Bandar, in Araihasar. Location maps are shown in Figure-S 3.3-2.



source: google map (partially modified by SAPI survey team)

Figure-S 3.3-2: Location map of the proposed Gas transmission line and surrounding area

### Environment of the project site

The Majority of the project site is agricultural land. During EIA study, it was confirmed that there is no protected area, historical or cultural heritage, or ecologically critical area in the close proximity that could be affected by the project.

### Project components

The project components that were assessed in EIA 2 are;

- **Power plant, including substation and transmission line.**

The following combination of generation systems was selected;

- GT: 1 set of approximately 31MW GT on ISO conditions (ambient temperature 15deg, relative humidity 60%) which becomes approximately 25MW GT on Bangladesh site conditions (35deg, 70%). Gas fuel only.
- GE: 2 sets of 6MW GE
- DE: 1 set of 3MW DE

Total capacity of Power plant is approximately 46MW on ISO conditions and 40MW on Bangladesh site conditions.

- **Gas transmission line that will connect Horipur TBS and Dighiborabo CGS.**

### Legal Framework

EIA 2 followed both National Environmental legislations of Bangladesh, which were already presented in 3.1 (EIA 1) and JICA's Environmental and Social Consideration guideline.

In addition, following relevant national policies and Acts were taken into consideration in EIA 2;

- Power System Master Plan, 2016 and 2010
- Policy Guideline for Small Power Plant (SPP) in private sector, 1998 (revised 2008)
- Private Sector Power Generation Policy of Bangladesh 1996 (Revised 2004)
- Electricity (Amendment) Act, 2012
- Bangladesh Natural Gas Safety Rules (1991)
- Bangladesh Energy Regulatory Commission Act, 2003 (Amended 2005, 2010)

### **Environmental Impact Assessment**

Assessment was made in accordance with the TOR approved by DoE as well as with JICA's environmental and social consideration guideline.

### **Power plant**

Soil pollution, water pollution, air pollution and noise pollution are considered to have negative impacts along with other less negative impacts. However, the report suggests that none of these impacts can be critical or serious threat to the environment nor the society if proper measures are taken and the monitoring plan is carried out as per EIA 2 report.

Land acquisition for the power plant, substation and transmission line is approximately 9.28 ha and it is included as a part of the land acquisition of the EZ site and the details were already discussed in 3.1 and 3.2.

### **Gas transmission line**

The construction work of installation of gas transmission line will mainly be earth work which consists of removal of soil for pipeline installation and backfilling of soil. In some areas, removal of structures will be required which will disrupt the lives of people who reside or make living at the affected area. Impacts will be caused by these construction works.

For construction work, "land acquisition" and "land requisition" are required for securing Right of Way (RoW) and space for storing construction materials and maneuvering of machineries and labors during construction period.

## Summary of impact/ PAPs

Table-S 3.3-1: Summary of Impact by Gas transmission line

Assessed and Type of Impact		Unit	Total
Amount of Land to be Acquired		Acre	8.86
Amount of Land to be requisitioned		Acre	8.11
Households to be Affected		Nos.	253
Households to be resettled		Nos.	12
Populations to be Affected			
Male	609	Nos.	1092
Female	483		
Structures to be Affected			
Pucca	4,711	sft	1373.97
Semi-Pucca	10,082		
Timade	458		
Secondary/Associated Structures		Nos.	18
Trees to be Affected		Nos.	225
Vulnerable Households		Nos.	58
Share Croppers		Nos.	1
Wage Loser		Nos.	52
Business/Enterprise Affected		Nos.	3
Impact on renting Opportunity		Nos.	3

Source: JICA STUDY TEAM survey, December 2017

### Environmental Management/Mitigation Plan and Monitoring Plan

In accordance with the environmental impact assessment mentioned above, in order to mitigate the identified impact by the project, environmental management and mitigation plans (EMP) and monitoring plan (EMoP) have been presented in this report and BEZA carries responsibility to comply with these measures.

Mitigation measures and monitoring plan have phase specific plans; Pre-construction phase, Construction phase, and Operation phase. Tentative cost for mitigation measures and monitoring plans are also made available in this report.

In addition, DoE shall inform BEZA to comply with the regulations and instructions that are listed in the letter of the approval of the EIA 2. These regulations and requirements shall be reflected on bidding documents or specifications in detail design when BEZA procures contractors for the construction works of infrastructures. The regulations and requirements also shall be carried out during operation phase.

### Institutional arrangement of EMP and EMoP

Implementation mechanisms of EMP and EMoP have been determined and illustrated in 3.3.10. The supervising proponent of overall EMP and EMoP is BEZA and BEZA shall require the contractors and external consultants to practice the EMP and EMoP, and will need to ensure that reporting shall be prepared and submitted to JICA quarterly for EMP and EMoP.

BEZA is required to cooperate with relevant public agencies for construction of each infrastructure respectively and supervise their implementation of EMP and EMoP.

During operation phase, BEZA, as project proponent, will be accountable for enforcing EMP and EMoP to the power plant operator, who is yet to be determined as of February 2019.

### **Public Consultation Meetings**

In the scoping phase, PCM was organized at 3 project affected areas and project information and the expected impact was made available to the public. 1 was held for the power plant site, and the other 2 PCMs were held to cover larger population of the affected persons at and around the gas transmission line site. Focus group discussions were also organized in order to reach out to specific groups of project affected people including.

A 2nd PCM (also called “information disclosure meeting”), more details shall be disclosed along with the resettlement action plan which discussed land acquisition and compensation issues. However the 2nd PCM is yet to be organized as of February 2019.

## **3.4: Social Impact Assessment for the gas transmission line.**

### **Land acquisition requirement**

According to “Natural Gas Safety Rules 1991” decreed by Ministry of Power, Energy and Mineral Resources, section 31 states that the “safe distance” must be maintained to secure Right of Way for gas transmission line. It is also confirmed by TITAS that land acquisition of 20 feet (10feet on both sides) along the transmission line is mandatory. Similarly, additional 20 feet on one side of RoW is required for land requisition which will be used temporarily during construction phase and will be returned to the land owners after construction and restoration to the original condition. In some areas where structures or houses already exist, land requisition can be avoided in order to minimize impact.

At first, TITAS proposed BEZA to utilize the existing RoW for an old existing gas pipeline in order to minimize land acquisition. However, the existing RoW was found to be unfeasible by route survey conducted by JICA consultants because there would be a significant number of resettlements and removals of businesses, loss of jobs, replacements of residential houses. Many of them are illegal constructed structures in spite of the safety requirement.

After a series of discussion and assessment between the JICA consultants and TITAS engineers, an alternative route was proposed to TITAS and BEZA by JICA’s consultant based on the field survey in order to minimize impact and the number of resettlements. The proposed alignment was accepted by TITAS and BEZA. Topographic maps and data have been submitted to TITAS for detailed design and further assessment by engineers.

The Gas Transmission Line project requires a total of 8.86 acres of land in five mouza. Entire land is privately owned and need to be acquired. Land acquisition process is yet to start and it will take few months. A total of 253 households with populations of 1092 will be affected by the project due to the land acquisition.

The project requires a total of 8.11 acres of additional land to be requisitioned temporarily to facilitate construction works. Requisitioned land will be returned to the land owner after the land is restored to the original state.

### **Eligibility and entitlement**

The following items have been identified as eligible for compensation and special assistances / allowances.

- Loss of Agricultural Land
- Loss of Homestead, Commercial Land and Common Property Land
- Loss of Water Bodies (Ponds, Both Cultivated and Non-Cultivated)
- Loss of All Types of Structures With or Without Title to Land
- Loss of Trees With or Without Title to Land
- Loss of Income from sharecropping and fishing (non-title holders)
- Loss of Wage (Factory and Shop workers)
- Loss of Income from Business
- Loss of Income from House Rent
- Temporary Loss of Land in Requisition Process
- Grants to Vulnerable Ahs
- Unforeseen Adverse Impacts

### **Institutional mechanism and Grievance mechanism**

BEZA has established a Project Management Unit (PMU), headed by a Project Director (PD) who is responsible for the overall execution of the Project. BEZA shall implement resettlement activities as per the RAP prepared by JICA consultants, and shall assign social expert(s) for execution. BEZA is required document progress of RAP in quarterly reports and submit it to JICA and PMO.

BEZA has established Grievance Redress Mechanism (GRM) to resolve social and environmental concerns linked to the project and ensure greater accountability of the project authorities towards all project affected persons (PAPs). At least one representative of TITAS must be the member of the committee.

### **Schedule**

A tentative schedule of the resettlement action plan was presented in the table in 3.4.10. However, the procedures for disbursement of the compensation and other activities may influence the actual progress of the overall schedule. BEZA shall inform JICA about the progress in quarterly reports.

No construction work cannot be

### **Cost**

Necessary fund needed for meeting the compensations and other benefits will be provided by BEZA, based on the agreement agreed by BEZA and JICA. The total estimated cost to be incurred for acquisition and implementation of the RAP is about BDT 1,067,705,226. The breakdown is shown in the table below.

Table-S 3.4-1: Summary of cost

SL No	Description of Cost	Estimated Cost in BDT	Estimated Cost In US\$
1	Estimated Cost for Compensation of Acquired Land	692,650,436	8,446,957
2	Estimated Cost for Compensation of Acquired Structures	35,020,346	427,077
3	Estimated Cost for Compensation of Acquired Trees	4,414,000	53,829
4	Estimated Cost for Compensation for crops/fish stock	545,296	6,650
5	Estimated Cost for Transfer and reconstruction Grant	4,045,000	49,329
6	Estimated Cost for transitional Allowances (special allowances for VHs, wage losers and business profit losers)	5,184,000	63,220
7	Estimated cost Land Requisition	228,782,037	2,790,025
	Total Estimated Cost	970,641,114	11,837,087
	Administrative Cost of DC and Contingency at 10% of total budget	97,064,111	1,183,709
	<b>Grand Total</b>	<b>1,067,705,226</b>	<b>13,020,795</b>

Source: JICA Study Team

### Accountability

#### ➤ Public Consultation Meetings

Initial PCM was conducted at the gas transmission project site. PCM was held at 2 locations in order to ensure adequate access to the meetings for the PAPs since the affected area stretches up to 5 km. One was organized on 24th at Tarabo Municipality office and the other was held on 30th October 2018 at Dewabag Mosque premises.

As of February 2019, BEZA has not held PCM for information disclosure regarding detailed compensation and payment procedures for PAPs. For detailed information disclosure phase, PCM should be held at 2 locations as is the case for the initial PCM.

#### ➤ Focus Group Discussion

Focus group discussions were conducted by JICA consultants in order to reach out to vulnerable groups and specific group of PAPs who required special attention or consideration. FGDs also helped female PAPs who did not attend the PCM. For this particular project, there are number of wage losers or factory workers among the PAPs thus multiple FGDs were organized for those workers.

### Issues

Some businesses will be affected and disruption to their business or factory operation is expected during the construction period. During PCMs and FGDs, many workers and business owners expressed their concerns about their business losses. BEZA and consultants responded that any wage or profit loss, incurred costs or negative impacts caused by the project shall be compensated. BEZA explained that agricultural land can be restored after the construction so that the land can be used for agricultural purpose again.

## 4. Other Remarks and Studies

### 4.1. Solid waste management plan

JICA consultants estimated the waste generation estimation for AEZ as shown in the table below. The total industrial generation is 5,128 ton/year, of which the non-recyclable hazardous and non-hazardous waste are 1,237 ton and 840 ton respectively.

Table-S 4.1-1: Summary of Waste Generation Estimation for AEZ (ton and percentage)

	Non HW (ton/year)	HW (ton/year)	Total (ton/year)
Generation	3,891	1,237	5,128
Recycling	3,050	9	3,059
Non-recycling	840	1,229	2,069

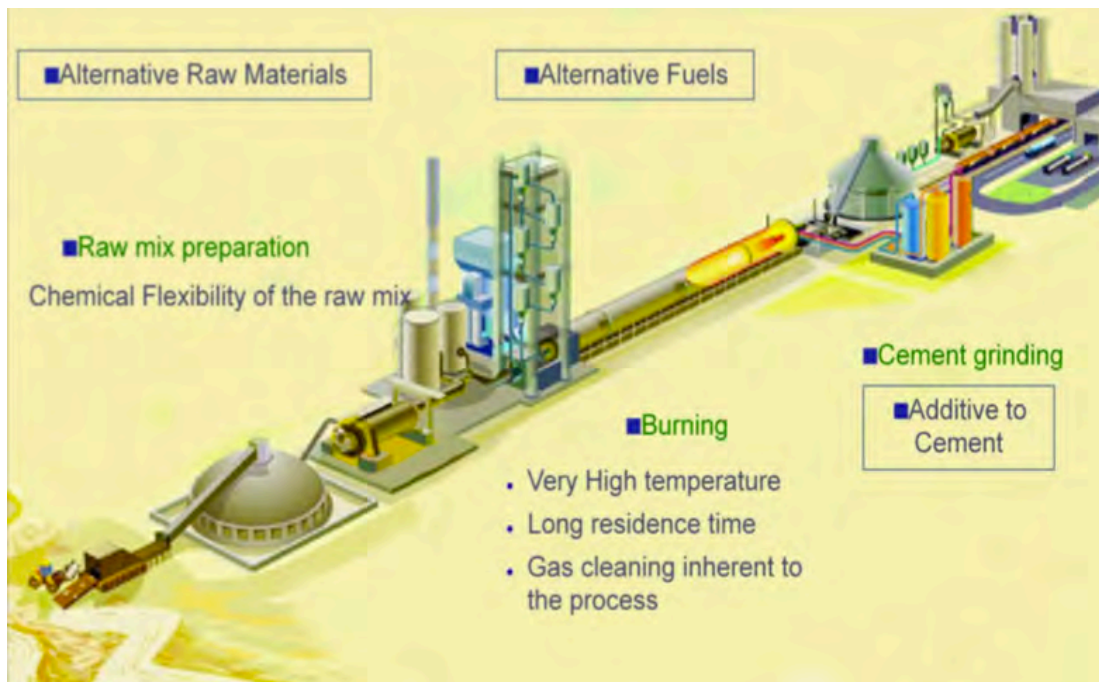
	Non HW	HW	Total
Generation	76%	24%	100%
Recycling	78%	1%	60%
Non-recycling	22%	99%	40%

Source: calculated by JICA Study Team

For the solid waste management for AEZ, JICA consultants have presented two realistic options for short term as well as several future options.

#### 1) Option for Hazardous Waste: Waste Co-processing at Clinker (Cement) Factory

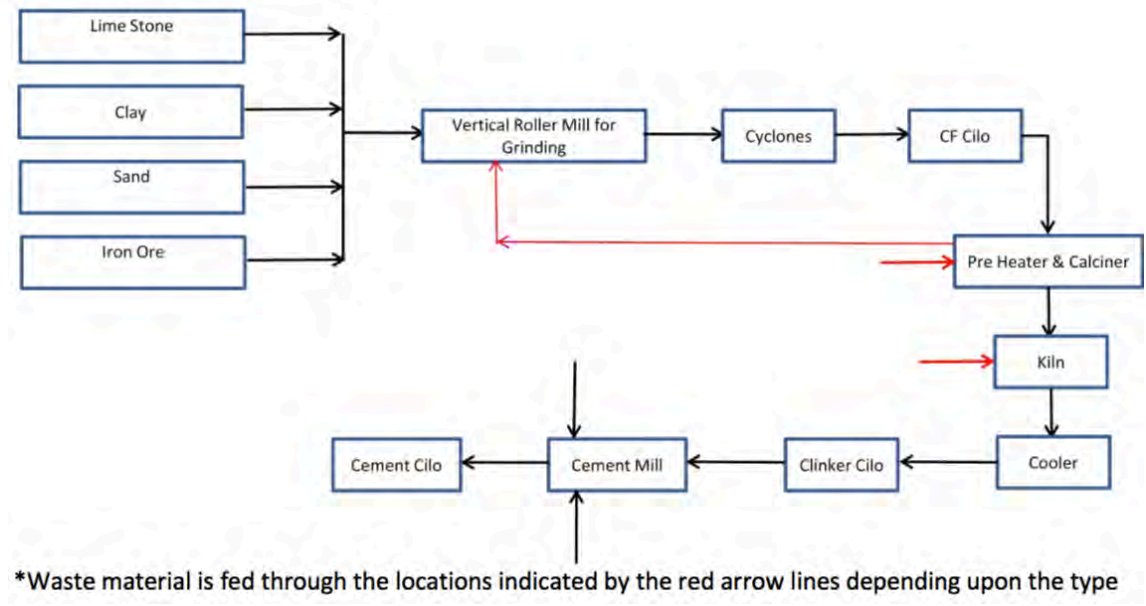
LafargeHolcim Bangladesh Limited, which is one of the two integrated cement production facilities operating in Bangladesh, currently provides Waste Co-processing Service. Their cement (clinker) factory in Chattak, Sunamganj district has a closed cycle process without residual or waste/byproduct as shown in the figure below.



Source: LafargeHolcim Bangladesh Limited

Figure-S 4.1-1: A Closed Cycle Process Without Residual or Waste/Byproduct

Through co-processing facility, the industrial waste is fed with the raw materials in the kiln where due to high temperature and high residence time, the complete combustion is ensured with no residual waste as cement process generates neither ash nor other waste/by product. Combustion ashes, made up mainly of the same elements as Cement (CaO, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, Fe<sub>2</sub>O<sub>3</sub>) are used in its composition.



Source: LafargeHolcim Bangladesh Limited

Figure-S 4.1-2: Material Flow at LafargeHolcim Co-processing Plant



Figure-S 4.1-3: Location of Lafarge-Holcimfactory in Chattak, Sunamganj District  
The location of the cement factory is Chattak, Sunamganj district, which is about 235km from AEZ.

The co-processing capacity is currently 1,000ton/year, which is low due to its relatively manual operation. The capacity shall be increased up to 5,000ton/year from late 2018 by automation. The indicative treatment charge in 2017 ranged from \$150/ton to \$1,000/ton. Some of the examples are listed below.

- Non-Hazardous Waste (Non-HW) from the food industry: 150\$/ton
- Hazardous Waste (HW) from the pharmaceutical industry: 550\$/ton
- HW from Agrochemical industry: 600\$/ton
- HW from Petro:500\$/ton

The average transportation cost is 21-25\$/ton (250\$/10-12ton truck) from Dhaka district to Chattak factory. It receives untreated waste water from agro chemical industry as well as sludge from textile, pharmaceutical and oil & gas exploration industries. The company's global guideline permits receiving waste containing Cr less than 1000 ppm and other metals (As, Ni, Co, Mn, Zn, Pb, Sb, V, Be) less than 10,000 ppm. The unacceptable waste for the company is as follows.

- Radioactive waste
- Asbestos-containing waste
- Explosives and ammunition/weapons
- Self-reactive/thermally unstable compounds/organic peroxides exhibiting explosive properties
- Anatomical and infectious health care waste
- Electronic fraction of electrical and electronic waste (e-waste)
- Whole batteries as a targeted material stream
- Waste of unknown or unpredictable composition

The company currently has such customers as Syngenta Bangladesh, Chevron, Nestle Bangladesh, Novartis Bangladesh, SanofiAventis, GSK, Renata, Bayer CropScience, Unilever, P&G, CocaCola etc.

Generally, the waste co-processing capacity of a clinker factory is at least 1 percent of the clinker production capacity, which is 1.4 million ton in case of LafargeHolcim's Chattak factory. Therefore, they could eventually expand their co-processing capacity up to 14,000 ton or more. This is large enough for AEZ. Besides, there is another clinker factory, Chattak Cement Factory Ltd., which is a subsidiary of Bangladesh Chemical Industries Corporation. This company has the clinker production capacity of 230,000 ton per year. Therefore, their potential co-processing capacity is 2,300 ton per year or more.

In Southeast Asia countries, it is normal to transport hazardous waste for a long distance, due to the limited number of treatment facilities. It is sometimes more than 1,000km in the case of Indonesia. Current indicative treatment costs of co-processing are relatively high in Indonesia. There should be the possibility of reducing the treatment cost if a waste treatment company undertakes the pre-treatment process, such as consolidating, sorting, blending, etc.

## **2) Option for Non-Hazardous Waste: Matuail Landfill Expansion Site of Dhaka South City Corporation**

For non-hazardous waste of AEZ, it is desirable for tenant factories to dispose the waste at a nearby waste treatment site as it can save the transportation cost. However, there is no public waste treatment facility in Narayanganj district. The nearest waste treatment site is the Matuail Landfill Site of Dhaka South City Corporation (DSCC), located in the east of Dhaka city as shown in the map and photos below. The distance from AEZ to the Matuail Landfill Site is about 23km by trucks.

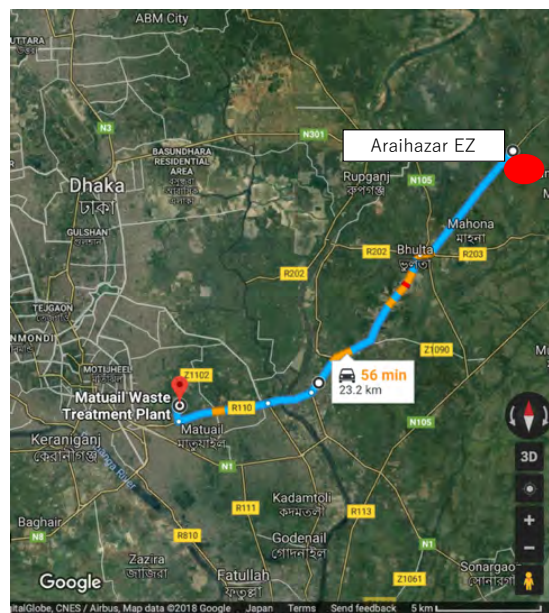
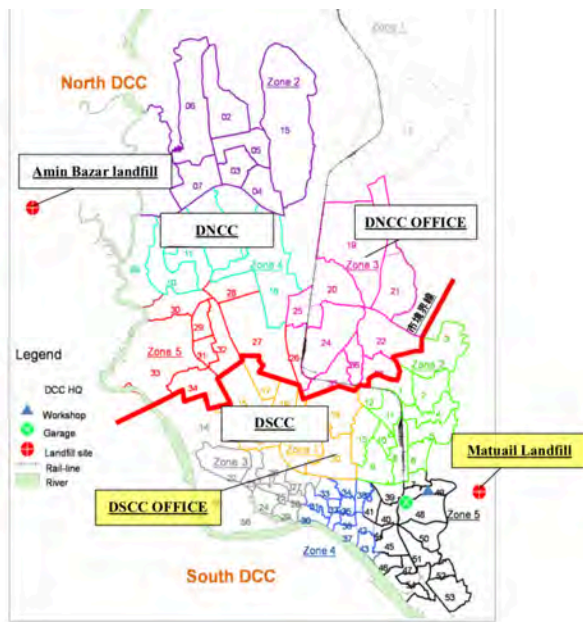


Figure-S 4.1-4: Locations of Matuail Landfill Site in Dhaka City

Source: JICA project team of “Project for Strengthening of solid waste management in North and South Dhaka City and Chittagong City” and Google map

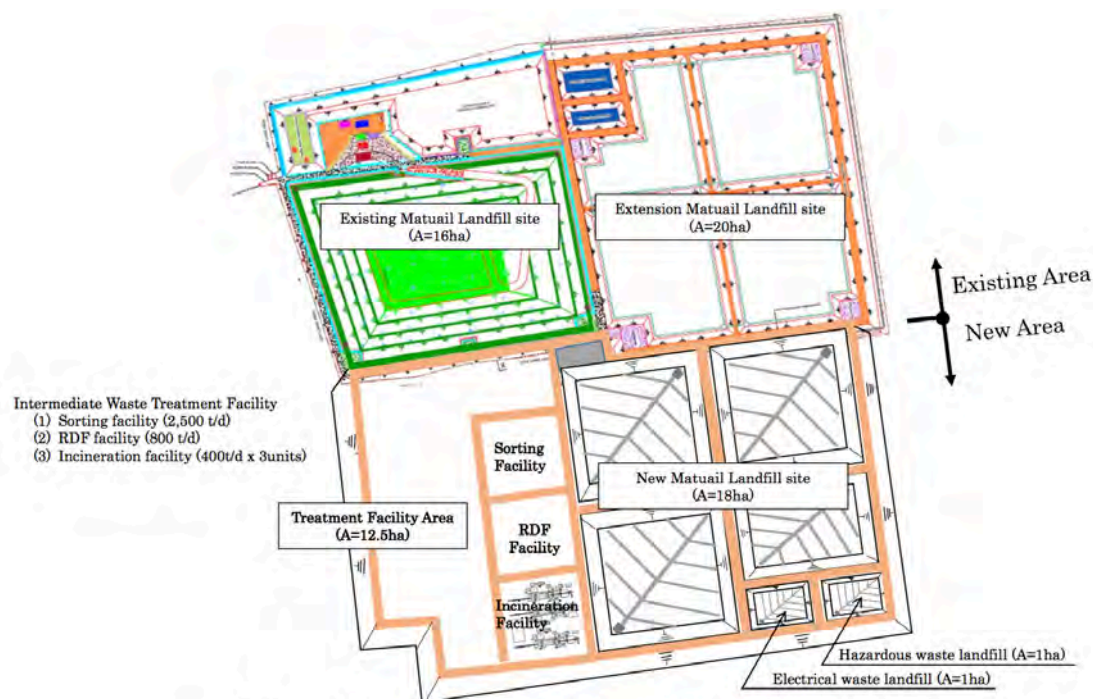


Photo: Matuail Landfill Site



Photo: Waste Collection Truck

The existing area of the Matuail Landfill Site is 36 ha. For the Matuail Landfill Site, DSCC has an expansion plan (18ha) in the adjacent land. The construction work of the expansion takes about 2 years, starting from the mid of 2018. The budget for the expansion plan has already been approved. Details of the expansion plan are illustrated in the following figure and table.



**Image of Layout Plan on New Matuail Waste Treatment Complex**

Figure-S 4.1-5: Image of Layout Plan on New Matuail Waste Treatment Complex

Source: JICA project team of “Project for Strengthening of solid waste management in North and South Dhaka City and Chittagong City”

Table-S 4.1-2: Budget for Expansion of Matuail Landfill Site

No.	item	Size and Quantity	Cost (Lac Tk)
1	Land Acquisition		
(1)	New final disposal site	20 ha	31,733.50
(2)	Incinerator and RDF Facility	12.5 ha	19,732.46
2	Construction		
(1)	New final disposal site	20 ha	9,637.19
(2)	Land grading for Incinerator and RDF Facility	12.5 ha	2,990.00
(3)	Safe closing of existing landfill site	41 ha	2,766.35
3	Procurement of landfilling equipment		
(1)	Dump truck	4 units	340
(2)	Bulldozer	2 units	1,140.00
(3)	Excavator	3 units	1,245.00
(4)	Wheel loader	3 units	1,050.00
(5)	Fuel and oil	1 unit	1,400.00
4	Consulting service	1 unit	413.43
Total			72,448.50

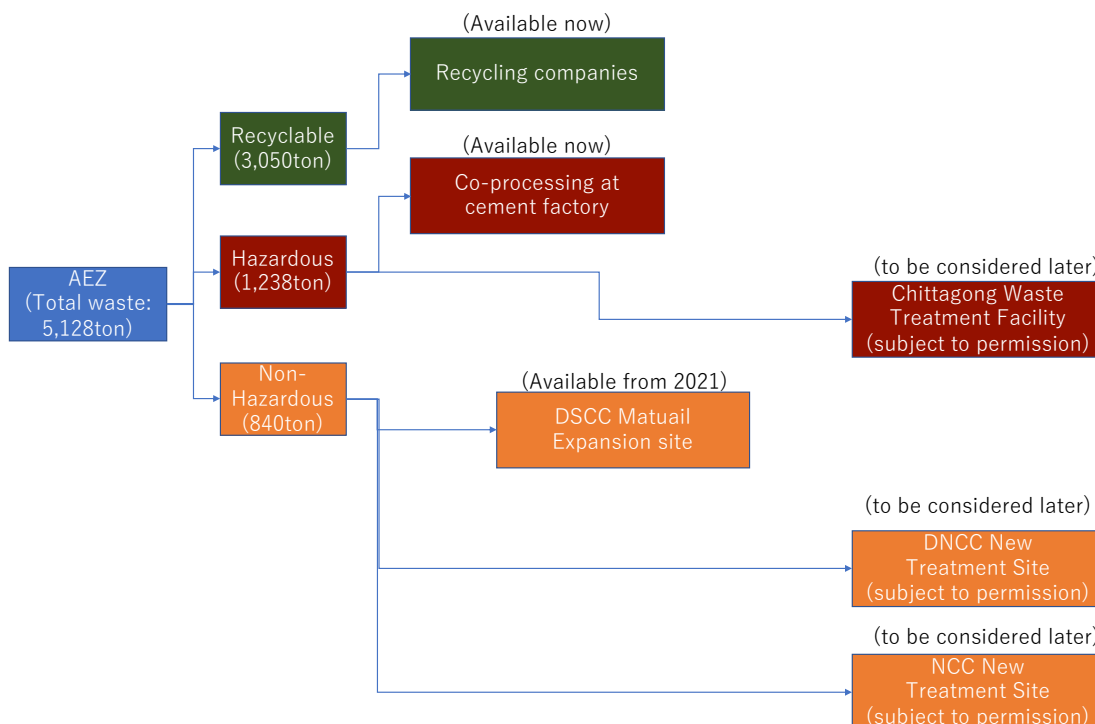
Source: JICA project team of “Project for Strengthening of solid waste management in North and South Dhaka City and Chittagong City”

However, the collection of “waste from outside Dhaka city” and “Industrial wastes” are not DSCC’s ordinary duty. Therefore, BEZA submitted a special request to DSCC for accepting AEZ’s waste in this expansion site. As a result, DSCC has agreed to accept the waste under the following conditions.

- ① Type of waste: non-hazardous
- ② Expected years of acceptance: from Year 2021 to Year 2024 (if necessary, extension shall be discussed)
- ③ Quantity of waste: up to 1,000 ton/year
- ④ Disposal site: Matuail Landfill site (the expansion site)

DSCC has also agreed to dispose the waste at a non-profit level of disposal charge, which shall be proposed by DSCC later. As an example of disposal cost in Dhaka, the Savar Tannery Estate’s case can be referred. According to RMG Bangladesh’s website (<https://rmgbd.net/>), the Savar Tannery Estate authority is supposed to dump solid waste of tanneries to Amin Bazar landfill site for the time-being. This is a result of discussions between the Savar Tannery Estate authority and Dhaka North City Corporation (DNCC) although Savar is outside the waste collection coverage area of Amin Bazar landfill site, which is under the control of DNCC. The Savar Tannery Estate authority agreed to pay BDT 1,000 per ton of waste to DNCC in addition to mandatory certificate from the Bangladesh University of Engineering and Technology that the waste is free from chromium and lead.

Base on the consideration on types of waste, costs and treatment methods, the following industrial waste management is recommended for AEZ. Both short and mid/long-term recommendations are proposed below.



Source: prepared by JICA Study Team

Figure-S 4.1-6: Recommendation on AEZ Waste Management in Short Term

#### • **Short-term recommendation**

Out of the 5,128 ton of AEZ waste, 3,050 ton of recyclable waste is assumed to be collected by local recycling companies. The remaining 2078 ton of waste is divided into 1,238ton of hazardous waste and 840 ton of non-hazardous waste. The non-hazardous waste is expected to be accommodated by nearby landfill sites of city corporations such as DSCC. These city corporations may be preferable in terms of transportation and treatment cost rather than a remote treatment facility. The DSCC Matuail expansion site may be the most prospective option out of the three city corporations. BEZA may negotiate with other city corporations later once their new landfill sites become operational. A definitive option for hazardous waste is currently limited to co-processing at the cement factory. The Chittagong treatment facility is also expected to accommodate the waste of the AEZ once it becomes operational in future.

Basically, it is the responsibility of the tenant companies to manage the industrial waste under applicable laws and regulations. Individual industrial waste management plans shall be prepared by individual tenant companies in their EIAs. The AEZ operator will monitor their proper management by the authorized records such as in/out material inventories, invoices and certification by the authorized waste management agencies.

#### • **Long term recommendation**

There is an obvious limitation in the availability of industrial waste management facilities around the AEZ as well as in the whole county at present. In a long term viewpoint, it is necessary to consider Potential Option 4 or 5. NCC's planned facility is basically limited to the waste generated in Narayanganj city (not in whole Narayanganj district), and DSCC and DNCC are also originally limited to the waste generated inside Dhaka city. Although DSCC agrees to accept waste from AEZ for the initial stage, it should be considered as a temporary destination of waste.

Therefore, it is recommendable for BEZA and Bangladesh Government to conduct a feasibility study to set up a comprehensive industrial waste treatment complex not only for AEZ but also for other private and public economic zones and businesses in Narayanganj district and surrounding areas with collaboration among relevant local authorities and other regulatory agencies. The comprehensive industrial waste treatment complex would enable the lowering of the cost of industrial waste management for the AEZ tenants and sustain the economically viable operation for the operators/owners of the complex.

## **4.2. Waste water standard and enforcement for AEZ**

### **(1) International Standard**

Inadequate treatment of waste water could have short-term and long-term adverse impact on surrounding environment thus enforcement of appropriate waste water treatment and setting practical standards are mandatory measures in development of economic zones where multiple industries and companies concentrate in single zone.

For AEZ, domestic wastewater of each tenant factory (kitchen and toilet wastewater etc) will be treated by the central processing facility in the EZ. In regards to industrial wastewater from AEZ as well as each tenant factory, "Two-step" waste water treatment could be most suitable for AEZ. First-step would be primary treatment or pre-treatment which should be carried out by tenant companies in accordance with industry-specific standards set forth by SPC. These standards must be met at the point of discharge from each tenant factory before discharge of wastewater into a sewage treatment plant (STP) or a central effluent treatment plant (CETP) as "inlet water". STP/CETP shall functions as secondary-treatment of waste water which should conform to international/ASEAN standards for outlet water quality before discharging water to outside AEZ.

JICA requested BEZA to refer to international standards such as IFC-EHS Guideline and/or ASEAN's industrial wastewater standards, and BEZA agreed to the request during JICA's mission in June 2018.

Over the past few decades, a large number of economic zones have been developed in ASEAN nations and each nation or each economic zone may have its own standards and there is no single universal waste water standard in ASEAN.

Due to the excessive number of wastewater standards exist in ASEAN, this report has narrowed the selection down to few ASEAN countries which are generally considered to be preferred destinations among Japanese investors for many years, thus some countries are omitted due to their immaturity of economic zone development. In these selected countries, their wastewater standards are currently being practiced and it can be said that they have been proven feasible and manageable.

As JICA has requested BEZA, AEZ could refer to these ASEAN standards even though some parameters may not be applicable in the context of Bangladeshi economic zones.

Along with ASEAN standards, IFC-EHS standards can be examined as reference but there are discrepancies for some parameters between IFC-EHS standards and that of ASEAN's thus appropriate standards may need to fill these gaps during planning.

BEZA/SPC must determine feasible and acceptable but also effective and reliable waste water quality standards and monitoring plan before a detailed design of a wastewater treatment plant starts.

## (2) Monitoring and enforcement

BEZA/SPC should carry responsibility to enforce its tenant factories to comply with the standards respectively and to take necessary measures for monitoring. Thus, it can be suggested that the standards and responsibilities of each tenant should be fully understood and agreed at the time of lease agreement.

In some economic zones, each tenant, EZ operators or SPCs requires all tenants to install wastewater quality monitoring device whose data will be automatically provided to the operators or SPCs so that any violation of the regulation that occur at pre-treatment phase is detected immediately by the operators.

## (1) Penalties on violation

BEZA/SPC should set and enforce penal regulation on violation or breach of given standard against its tenant companies. This also should be clarified at the time of lease agreement.

Penalties could include; temporal stoppage of utility (power, water, gas) provision, imposing fines (financial penalty), temporal suspension of operation etc. Severity or terms of penalties may use other foreign economic zones as a reference but too severe penalties that lack practicality may affect the overall operation of the EZ.

## 4.4. Security Measures Situation of EPZs

Most of Japanese manufacturing companies have located their factories in Export Processing Zones (EPZs). Bangladesh currently has 8 EPZs where about 518 companies with 487,000 workers are located. So far, no serious incidents at the 8 EPZs have been occurred since the 2016 terror. For considering the security measures for Araihasar Economic Zone, the security measures taken by the existing EPZs is an important reference and give us a hint for the security measure to be taken for the proposed Araihasar EZ.

**The security measures taken previously by existing 8 EPZs are as below.**

- Boundary wall surrounding the EPZ site.
- Gate check for vehicle and visitors by security officers.

- 24 hours security staffs at the gate checking all vehicles and visitors.
- Periodical Security patrol check (Mainly night time: 1-2 times)

**Since the 2016 terror incident, BEPZA has improved security measures as below.**

- Introduction of CCTV cameras for 24 hours surveillance.
- Introduction of metal detector and mirror for checking the bottom of cars.
- A hot line with special security office and local police for security issues.
- Employing woman security officers for security body check for women.
- Increased security staffs at the gate, frequent patrol of local police officer, and security patrol of foreign worker's residence area.

### **Security Measures Situation of EZs**

Since the new Economic Zone (EZ) has been introduced since 2010 and already 3 EZs are opened and operating, now improved security measures are proposed by BEZA and the following measure are being implemented.

- (1) Boundary walls plus 24 hours video surveillance camera system. Using the new technology seems to be effective tool to increase security.
- (2) Issuing and checking of ID cards for workers and EZ staffs).
- (3) 24 hour security checks at the gate and periodical patrol (every 4 hours) of the EZ site. More frequent patrol is also improving the security.
- (4) Regular visit by local police officers to EZs and set up a hotline with local police station for emergency situation. In order to increase security of EZs, additional support from the police is considered securing safety of potential investors.
- (5) If an escort by police officers is requested by a foreign company, BEPZA & BEZA can dispatch police escorts.

### **Proposed Security Measures for Araihaazar Economic Zone**

**Option 1:** In case that Security Level 2 remains when the Araihaazar EZ will be open in 2021 or 2022

As long as the country security level remains at level 2, similar security measures discussed above are recommended to Araihaazar Economic Zone. Strengthened security measures by the SPC of the Araihaazar EZ plus additional security measures of Special Security Agent may be assigned at Entrance of the EZ and a hot line with Police and Military security force may be recommended.

**Option2:** In case that Security Level 2 is lowered to Level 1 when the Araihaazar EZ is open in 2021 or 22

If the security situation improves to a normal level, the security measures can be normalized without special security measures taken by the EZ



# Chapter 1 Technical assistance for formation of SPC and related capacity development

## 1.1. Review of the related legal documents

For the formation of SPC in relation to BEZA and BIFFL’s delivery of the PPP projects, there is the legal procedural framework for their engagement and modality to follow as an internal regulation. However, before entering to review and associated suggestions to the related legal documents, the overview of legal framework surrounding PPP projects is discussed.

### 1.1.1. PPP legal framework

Legal framework on the Economic Zone development in Bangladesh is built under the umbrella of the Bangladesh Economic Zone Act, 2010, whereas legal system on the PPP projects in Bangladesh is built upon the Public Private Partnership (“PPP”) Act, 2015, in that the organization and the role of the regulatory agency and related government offices responsible for the PPP projects are defined with the purposes of the PPP projects in the outline. For the Economic Zone development through PPP, in particular, although the specific nature of a PPP such as the sectoral coverage, classification, and participation scheme of the government were separately defined in the Policy and Strategy for PPP, 2010, there was a circumstance that practical policies and guidelines for the selection of Zone Developer had been not defined hence the Policy was repealed, then the Procurement Guideline for PPP Projects, 2018, and the Policy for Implementing PPP Projects through Government to Government (G2G) Partnership, 2017 as well as the Guidelines for Unsolicited Proposals, 2018 are prepared to provide the code of conducts for engagement of a Zone Developer and modalities for delivery of the EZ projects in the PPP approach. Consequently, these Acts, Policies<sup>1</sup> and Guidelines are forming a legal system pertaining to the development and operation of Economic Zones under PPP at each level and every norm holds a legal binding force.

Table 1-1: PPP Legal System

Act	Public Private Partnership (“PPP”) Law, 2015
Policy	Policy and Strategy for PPP, 2010 (Repealed and Replace by PPP Law, 2015) Policy for Implementing PPP Projects through Government to Government (G2G) Partnership, 2017
Guidelines	Guideline for VGF for PPP Project, 2012 Guideline for PPPTAF, 2012 & Scheme for PPPTAF, 2012 Procurement Guideline for PPP Projects, 2018 Guidelines for Unsolicited Proposals, 2018

### 1.1.2. Standpoints of BEZA’s legal documents on equity investment

As the stand point of BEZA, although there is no separate rules or policies being set forth under the Bangladesh Economic Zones Act, 2010 on whether BEZA can be an equity investor on any projects,

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<sup>1</sup> The Policy and Strategy for PPP, 2010 is repealed and replace by PPP Law, 2015 but in case of any incomplete work in relation to these Guidelines, PPP Policy is still applicable as if it has not been repealed.

however, the Act was amended in 2015 and provided that Government of Bangladesh (GoB) itself or through nominated agencies can enter into a partnership or joint venture with any other country or their nominated companies for the establishment and maintenance of the economic zones, although there is still no specific provision for equity investment in particular.

Bangladesh Economic Zones Act, 2010 and subsequent amendments say nothing specifically on whether BEZA can be an equity investor, however, the Public-Private Partnership Act, 2015 keeps specific provision under Section 16, in that the GoB can finance PPP projects against loans and equity. In addition, Rule 5.5 of Policy for Implementing PPP Projects through Government to Government (G2G) Partnership, 2017 states that GoB may take equity stakes or provide debt financing to the Project Company directly, through a public-sector authority, state owned entity and/or special purpose entity.

The provisions of PPP Act shall apply to BEZA because any Act of laws passed by the Parliament unless specifically exempted shall apply to all concerned authorities/people. Though the Act was passed to establish Public-Private Partnership Authority, the Act also intends to provide a legal framework for all sort of PPP projects. Thus, BEZA is deemed to be allowed to inject equity investment in the Economic Zone projects which engage PPP involvements.

### **1.1.3. Review on Equity Investment Policy (Draft) of BIFFL**

Whereas Bangladesh Infrastructure Finance Fund Limited (hereinafter referred to as BIFFL) has separate and specific policies for credit as well as equity investment<sup>2</sup> for the project, and it is deemed to be applied for the Economic Zone projects in any cases.

In the drafted equity investment policy, importance of infrastructure for national wealth is emphasized, and inadequate investment is stated as a reason of not being able to realize infrastructure development (1.1). PPP program, which is utilized to draw resources from the domestic private and foreign sources, is proposed to address the issue of shortcoming on infrastructure investment, and its target is set to realize 35-40% of GDP to be allocated into infrastructure development. In this line, the government of Bangladesh initiated the PPP budget, which aims to provide support for upfront development of PPP projects, and create a mechanism for targeted subsidies and set long term financing of PPP projects. As a legal framework, the Government of Bangladesh has already approved 'Policy & Strategy for PPP, 2010', 'Guidelines & Scheme for PPPTAF 2012' and 'Guidelines for VGF for PPP Projects', in order to provide transparent and exhaustive legal coverage for the private sector to finance, build, operate and collect revenues or service payment on the PPP projects. Consequently, BIFFL is formed as a special purpose vehicle to finance infrastructure projects in the country (1.2).

The main objective of BIFFL is set to provide predominantly long-term financing for PPP projects through issuance of bonds and debt instruments and equity offerings. Also, vision, mission, goal, and funding scheme are stated in the policy (1.3 to 1.8).

After general description about equity investors was described in that it will expect a return typically over a 3 to 8 year period in the form of dividends (where appropriate) and from the sale of their share of the business when the business 'exits' via trade sale or flotation, BIFFL's policy for investment as

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<sup>2</sup> Equity investment policy for BIFFL is under preparation as of January 2018.

well as the nature (2.1) and objectives (2.2) of guideline are described in that guideline shall describe the details on fundamental of equity backed finance, risk management policies, outline general principles that are designed to govern the implementation of Equity investment procedures and risk analysis/ risk grading and mitigation systems (2.1 and 2.2). Basic policy and criteria of eligible equity investment are described then categorical description of favored as well as restricted infrastructure projects are also stated (2.3 to 2.6).

Procedure for screening investment proposals to qualify equity investment is stated in that the proposed projects are supposed to be evaluated from the perspective of financial benchmarks, management benchmarks, management benchmarks, and environmental & social benchmarks (2.6). Types of equity investment, which shall be eventually approved by the Board of Directors based on the recommendation of the Management Committee (MANCOM), are stated into two holds; Investment through Ordinary Shares and Investment through Preference Shares. Also the policy of limiting and diversifying investment exposure and portfolio is set in the document (2.10) along with the characteristics of equity investment to be considered as general terms and conditions to the investee company (2.11).

The schedule of administrative fees and charges are also described to define these pricing and characteristics in the document (2.12). The process of equity investment is described in the manner differentiating stages into approaching by the investee company/evaluating the business plan, initial enquires and negotiation, due diligence, final negotiation and completion, investment monitoring, and exit (2.13).

Internal key protocol for processing/assessing investment applications till sanctioning equity investment is stated along with the detail information to be evaluated within the investment team as per the following diagram (3.0).

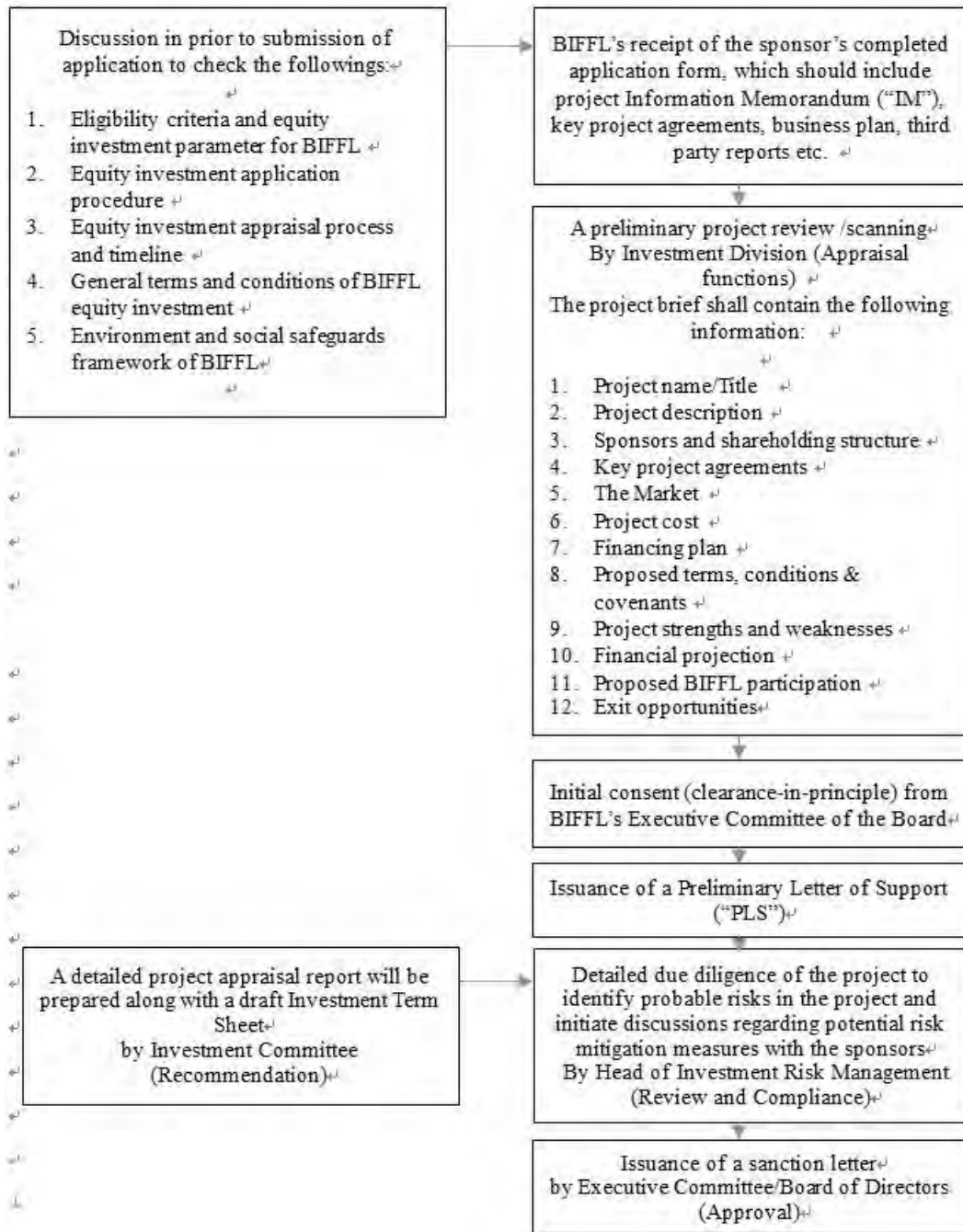


Figure 1-1: Equity investment procedures and risk analysis / risk grading and mitigation systems

Remarks for administrators to check risk factors to be involved in investment project from various perspectives (3.1) as well as legal endorsement (3.2) are stated. In addition, methodologies of financial analysis of the investment project are also described (3.3).

Organizational structure and each bodies' responsibility are also described (4.1), and the basic principle of operational behavior and job description of the key officers are stated (4.2), then procedural diagram after submission of investment application to BIFFL till final financial closing is depicted in the document (4.3).

In this policy, the issue of how to ensure internal control between documentations and actual disbursement of financial facilities as regulatory functions of investment administration within BIFFL (5.1) is addressed. Furthermore, a principle of legitimate documentation method, minimum requirements of its contents for investment facility as well as documents storage and processing are stated as a reference for BIFFL officers to follow (6.1), then sample forms of investment application letter together with Investment Application Form (Appendix-I), Standard Project Appraisal Report Outline (Appendix-II), and Template of Terms Sheet (Appendix-III) are attached in "Appendix 1" as a part of the policy.

#### **1.1.4. Standpoints of BIFFL's credit and equity investment policies**

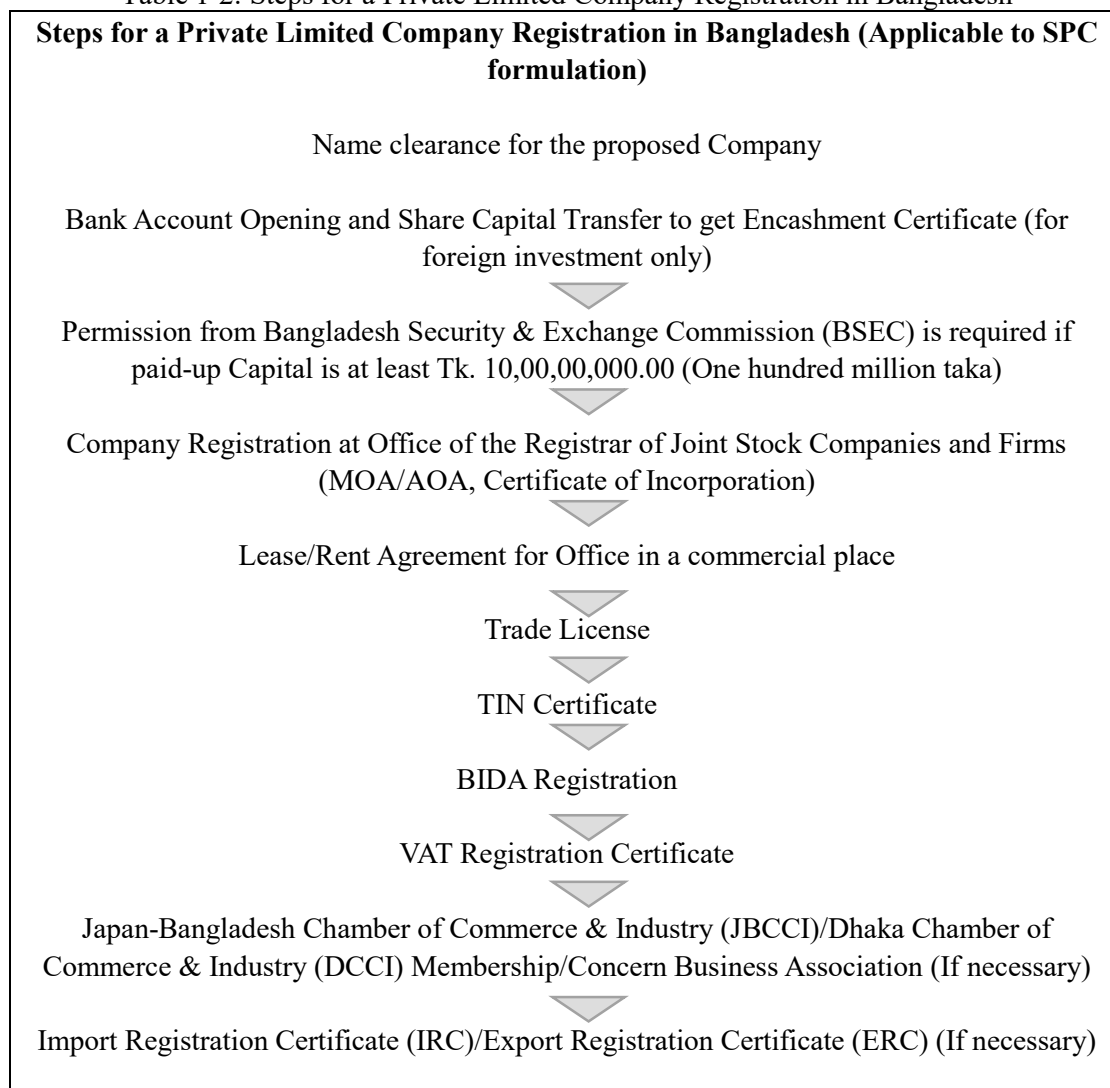
BIFFL is a financial institution incorporated under the Companies Act, 1994 as a public limited company. BIFFL has received license from Bangladesh Bank and it operates as a non-bank financial institution under the Financial Institutions Act, 1993. Since BIFFL is a non-banking financial institution operating in Bangladesh, the Equity Investment Policy and Credit Policy must comply with the provisions given in the Financial Institution Act, 1993 and Bangladesh Bank's guideline on Credit Risk Management, Internal Control and Compliance Framework and Asset Liability Management. After careful perusal of the said two policies on legal perspective, it can be said that there is no provision which is contradictory in nature with the governing laws of Bangladesh in these policies.

#### **1.1.5. Any legal steps for BEZA and BIFFL to undertake before signing the Shareholder's agreement for SPC formulation.**

Shareholders Agreement is an independent document, hence this is not dependent on any other agreements. However, incorporation of the project company, regardless of SPC or not, is dependent on the provisions of the shareholders agreement. It sets out the basis on which a company is established, giving such details as its name, ownership structure, management control and corporate matters, authorized share capital and the extent of the liabilities of its members. In most of the other agreements in such kind of project the project company is one of the parties. So, those agreements might be signed after incorporating the project company. However, no specific steps to be taken for entering into a shareholders' agreement since no company has been formed.

Nevertheless, BEZA and BIFFL must be eligible to undertake such activities as per their governing Acts and rules. BEZA is a statutory body governed by BEZA Act, 2010. BEZA Act, 2010 entitles BEZA to enter into such sort of shareholders agreement. Similarly, BIFFL is a company incorporated under the Companies Act, 1994. Its Memorandum of Association must have provision which entitles BIFFL to enter into such shareholders agreement. With regards to the information of required steps for establishment of a company in Bangladesh, the following table can be referred.

Table 1-2: Steps for a Private Limited Company Registration in Bangladesh



## 1.2. Suggestions to the related legal documents

Based on the reviews and observations shared between BEZA as well as BIFFL, JST prepared a key note suggestion for BEZA on the shareholder's agreement and offered proposition for BIFFL on the supplementary works for completion of the equity investment policy.

### **A key note suggestion on the shareholder's agreement for BEZA**

In the discussions, it was found that BEZA staff in charge of SPC formation already have good knowledge about the procedure of SPC establishment, and also the SPC operational mechanism under a certain agreement were in the process of discussion between a prospective Japanese Developer. Consequently, as the roles of JST, requests from BEZA to enlighten the key notes in relation to the Shareholder's Agreement were responded as under-:

Generally, a shareholders' agreement refers to an agreement between the shareholders of a company or between the company and the shareholders. It can be between a few or all of the members of the company. When such a contract is entered into, the articles of association may not be the final word on how the rights and obligations of the members and the company are allocated. A shareholder, as a result of his ownership of a share, can also agree to exercise the rights attached to the share in a particular way. Moreover, for having shareholder's agreement, certain advantages can be considered in that it shall provide easy way to achieve agreement and enforcement between shareholders, and it

is easier to alter the agreement than altering the articles of association, furthermore it is a private document and thus free from public scrutiny.

For the particular case of BEZA for the Economic Zone project, BEZA and a prospective Japanese Zone Developer might be the shareholders of the SPC. BEZA can agree with the Developer that they will exercise their votes in favor of the Developer if the Developer stands for election. Or, BEZA could agree to sell their shares to the Developer only, should they decide to sell them.

In a project financing scenario, Shareholder's Agreement is an agreement between the project sponsors to form a SPC in relation to the project development. Such an agreement will not be necessary in case the project vehicle is a partnership or a joint venture.

It is advisable that BEZA should also note that the Shareholder's Agreement will govern the relationship of the sponsors regarding the following areas:

- Injection of share capital
- Funding of the project company
- Voting requirements
- Resolution of disputes
- Dividend policy
- Management of the SPC
- Disposal and pre-emption rights

Accordingly, the following is the areas which shall be defined in general in a Shareholder's Agreement:-

1. **Definition and Interpretation:** List of definitions.
2. **Commencement and duration:** This will refer to when the agreement will come into effect. Since this is an agreement between the shareholders, duration refers to the time during which shareholders would be bound by the terms of this agreement. Under this section, the clauses will not refer to the length of time for operation of the project. This section will also include a termination clause referring to when the Shareholder's Agreement will cease to be effective.
3. **Purpose/business of SPC:** Under this section, the project for which the sponsors are coming together i.e. the purpose of the SPC will be described. In this case the object of the project company is the development of the Araihasar Economic Zone.
4. **Financial arrangement:** The clauses under this section will address how finance will be arranged initially by way of share subscription amongst the shareholders and also state how much each shareholder advance in return of such subscription. This clause will spell out the percentage of shares to be held by BEZA, BIFFL and a prospective Japanese Zone Developer and any other sponsors. Thus it is particularly important for equity investors. Under this heading the amount to be invested by way of equity by BIFFL and BEZA would be set out. This clause will also identify how the SPC will raise further capital for the project, whether by way of allotment of new shares or through debt financing, and also in case of new allotment, the process of such allotment shall be set out.
5. **Sponsors' Rights and Responsibilities:** This clause is important for sponsors of the project company who contribute more than just the equity investment. The terms under this section will specifically spell out such other roles to be played by each of the sponsors. For instance, the responsibilities of a prospective Japanese Zone Developer would include providing O&M services to the Company pursuant to an O&M services agreement. Also, whichever sponsor is agreed to be in charge of the management of the project, the project company will be identified as such in this part. The functions regarding the management of the project would be outlined as well. Other such functions would include obtaining environmental clearance certificate, land procurement, etc. A

more detailed sketch can be made of the roles and responsibilities after the prospective sponsors have negotiated and decided amongst themselves how much contribution they want to make and what roles they want to play.

6. **Board of the Company/SPC:** The clauses under this section will set out how the directors will be appointed and the composition of the Board. This is particularly important because the composition of the board will ultimately determine the power play and control of each of the sponsors involved in the project. The terms will also set out how the Board meetings are to be conducted and the voting arrangement, quorum requirements of board meetings, remuneration of directors, removal of directors etc.
7. **Management of the SPC:** This refers to the management of the project, the business plan, reserved matters which means activities that individual shareholder shall not undertake unless approved by the other shareholders and also the manner of giving shareholder approval.
8. **Distributions:** This refers to how all the amounts lawfully available for distribution by the company to the shareholders by way of dividend on the shares. It is also known as a profit sharing clause. This clause will identify the percentage of the net income to be distributed among each sponsor and unlike a regular company this will not only be based on the percentage of the equity investment but also can be based on other forms of participation. Generally, the return for the sponsors will be distributed once the senior lenders have received their repayment.
9. **Business Plan and Budgeting:** Under this section, the clauses will set out the annual budget for the project, the yearly fiscal reports, taxation issues, etc.
10. **Share Transfers:** This will set out the ways or means through which share transfer would be allowed, also the provisions on transfer notice but the terms will also set out when transfers will not be allowed, i.e. to any unsuitable third party or during the winding up of the company. There might even be a pre-emption clause where the party who wants to sell its shares would have to offer to the remaining shareholders.
11. **Warranties and undertaking:** The clauses under this section will refer to promises from each shareholder on matters such as the validity of the documents provided, status of each shareholder, whether they are duly incorporated or not, that they are not subject to any litigations, that the shareholders are tax compliant etc. Sometimes similar clauses are found under the heading of Conditions Precedent.
12. **Deadlock Resolution:** This clause will first define when a situation will be called a deadlock. A deadlock generally refers to a disagreement between the sponsors on a particular decision. A deadlock clause will include the method of dispute resolution, whether by way of negotiation or mediation, and also what should be done when no amicable settlement can be reached.
13. **Winding Up:** This is a very important section, as it sets out the process by which the SPC will be wound up or brought to an end at the instance of the shareholders, even before the completion of the project.
14. **Miscellaneous:** This section, like most other agreements, will include a host of random clauses which are important for the project and the shareholders. Such clauses can include, confidentiality agreement, governing law and jurisdiction, insurance, method of notices, process for amending the Shareholder's Agreement, non-competition clause etc.

## **Supplementary works for completion of the equity investment policy of BIFFL**

On the other hand, BIFFL has experience in financing various infrastructure projects, but has a limited experience in equity investment. Currently preparation of "Equity Investment Policy" addressing equity investment of BIFFL is being made and yet still on its way of completion. Consequently, this project is aiming to supplement to completion of the "Equity Investment Policy" related to BIFFL's investment activities.

As a method of giving provision for supplementary for completion of the Equity Investment Policy, compatibility with several other relevant Acts of Parliament of Bangladesh was scrutinized first. In light of Financial Institution Act, 1993, it was found that certain obligatory provisions should be provided in the policy by referring Section 15 of the Act stating restrictions regarding the business of financial institutions in that no financial institution shall be engaged in any wholesale or retail business including export and import trade otherwise than for the purpose of carrying on its financial business. Also Section 16 of the said Act provides restriction on investments in that no financial institution shall expend or use more than 25% of its paid up capital and reserves for the acquisition and holding of any kind of shares of financial, commercial, agricultural or industrial institutions or of any similar institution and shall, as fast as possible, sell to the institutions concerned the shares acquired in the interest of realizing the credits granted by it.

Moreover, in conformity with the Companies Act 1994, Equity Investment Policy should be able to undertake equity investment by way of ordinary shares as well as preference shares. Also as the law lays down several safeguards for equity investors such as quorum requirements (Section 85), procedures of appointment and removal of directors (Sections 90 to 110), conditions for reducing share capital (Sections 58 to 70), members' voluntary winding up (Sections 291 to 296), and also court protection for minority shareholders (Section 233), provisions of such norms must be taken into consideration before participating in equity investment.

Other specific safeguards include Section 52 of the 1994 Act which allows a company to arrange for different amounts being paid on shares, therefore, BIFFL can negotiate with the investee company and agree to an acceptable amount of dividend for its investment. Furthermore Section 153 of the Act limits the powers of a company to issue shares at a discount by setting the requirements of a resolution and permission of the court and also provides that the maximum rate of discount cannot exceed 10 (ten) percent at which the shares were issued. Also Section 155 of the Act, provides protection for shareholders by making it necessary for the company to offer to its shareholders when issuing further shares, in proportion to the capital paid up on the existing share held by such member.

In the view of settlement of dispute, in the drafted Equity Investment Policy there is no provision regarding how to settle disputes. In order to obviate the need for litigation and nurture a constructive and conducive atmosphere, a suitable Grievance Redress Mechanism should be established, which would reduce litigation and further it will create a healthy atmosphere among all the stakeholders.

In this line, all the concerned parties must have arbitration agreement between them or all the agreements such as Joint Venture Agreement, Power Purchase Agreement, Land Lease Agreement, Supplier Contract, Implementation Agreement, Investment Agreement etc. must have arbitration clause in it. As per the Arbitration Act, 2001 "Arbitration Agreement" means an agreement by the parties to submit to arbitration all or certain disputes which have arisen, or which may arise between them in respect of a defined legal relationship, whether contractual or not. The provisions shall apply to the arbitration proceedings in Bangladesh relating to the dispute arising out of that agreement. Section 45 of the Arbitration Act, 2001 gives recognition and enforcement of foreign arbitral awards.

In the field of environment issues, although it mentions about BIFFL's involvement in projects which has potential to improve the environment, this clause can be elaborated more. For instance, all the relevant projects obtaining environment clearance certificate can be mandatory. The Government of Bangladesh has framed out various laws and regulation for protection and conservation of natural environment and all the projects must abide by these laws. Bangladesh Environmental Conservation Act, 1995 (ECA, 1995) and Environment Conservation Rules 1997 (ECR, 1997) makes mandatory requirement of prior

environment clearance for certain category of project for conservation and improvement of environment and control and mitigation of pollution of the environment. Although standards are described under ECR, 1997, ECA also provides scope to ascertain responsibility for compensation in case of damage to ecosystem.

As for land related issues, acquisition of land is one of the key factors for infrastructure development. In this regard, The Land Acquisition Act, 1894 and The Acquisition and Requisition of Immovable Property Ordinance 1982 and subsequent amendments in 1994, 1995, 2004 are the governing laws to be observed in that the key principal is to provide appropriate compensation for the land acquired.

In the light of labor regime, BIFFL should invest in projects which has labor practice in accordance with Bangladesh Labour Act, 2006. Labor practice must protect the rights of employees to a fair wage, acceptable working condition and fair treatment in case of employment termination. Therefore, there must be a balance between providing good working environment and conditions that promote human rights and humane treatment of workers with the need to equally empowered employers to effectively deal with ineffective, inefficient and unproductive employees.

With regards to Investment Eligible Criteria, certain additional inputs can be provided in that the norms of cash flow projection and optimum cost of capital can be additionally provided so that more diligent project evaluation becomes possible.

Furthermore, risk assessment criteria are scattered in the exiting policy which can be organized in such a way so that these can be maneuvered for a specific project and investee. Also risk management structure can be specifically described in that Risk Management Committee should be separately nominated from Investment Committee, which is headed by CEO so that scope of segregation of duty can be secured (conflict of interest can be avoided).

The supplemental work for completion of Equity Investment Policy was made and revision of the policy was drafted as per the Appendix 1. Consequently, the drafted Equity Investment Policy for BIFFL was duly discussed and approved in the Board of Directors.

Updates on regulatory framework in relation to PPP Act, Policy and Guidelines (1.2)	Evaluation of equity investment parameters in more specific and comprehensive manner (ex. Voting right, participation in the Board of Directors/Board Observer, Debt-equity ratio, and information rights) (2.11)
Scope and restriction of investment in sectors of business as well in the shares (2.5)	Assessment measures on participating shareholders (3.1.2)
Additional benchmarks on project evaluations (ex. Cash Flow Projection, Optimum Cost of Capital, Commitment to Internal Control & Corporate Governance, and Social Cost Benefit Analysis) (2.6)	Assessment measures with regards to land acquisition (3.1.19)
Make mandatory requirement of prior environment clearance for certain category of projects (2.6.3)	Ways of assessing investment from additional perspectives (ex. Debt Service Analysis, Cost Structure Analysis, Cost Audit Report Analysis, Profitability Analysis, Market Performance Analysis, and Cash Flow Analysis) (3.1.25-27) (3.2.4-6)
Additional consideration in project evaluation on provision of good working environment and conditions that promote	Restructuring of Risk management committee, which needs to be presented in the structure as a separate committee (4.1)

human rights and humane treatment of workers (2.6.3)	
Procedure of settlement of dispute (2.6.3)	Restructuring of Head of the Risk Management committee, which can be other official/director/independent director other than CEO to reduce conflict of interest (4.1)

(Source: JICA Study Team)

### 1.3. Planning of workshops

The capacity development of Government agencies, namely, BEZA and BIFFL as prospective equity investors for the Economic Zones is one of focuses for this project, then series of workshops addressing issues related to SPC formation were planned. These workshops were designed to improve implementation capacity of BEZA and BIFFL, who are implementing agencies of Component 2 and 3 of “the Foreign Direct Investment Promotion Project”, and to assure that these two components will be carried out successfully.

In planning, under the management of JST, cooperation with the local company of NewVision Solutions Limited, having many experience of establishing companies in Bangladesh, was brought in. Also, expectations from participants on the workshops were well drawn by conducting orientation session whereby discussions were encouraged among BEZA and BIFFL as they grow a sense of partnership for jointly developing and managing the Economic Zone project in prior to the actual content making of the workshops on SPC formation.

The workshops are deemed to stimulate the debate by further examining the potentials of the SPC formation through the PPP model for meeting the investment challenge in an efficient, cost-effective way of the Economic Zones development and operation. In particular, a review of SPC formation highlights examples of best practices and developing trends. Finally, the benefits of PPPs as well as the main challenges facing the public and private sectors are explored along with practical solutions for delivering a PPP approach into the Economic Zones project.

The future looks promising for the Economic Zones project in Bangladesh, but throughout the workshops the participants were supposed to act to build on the discussions as to how to get the best out of working in partnership between private sectors in the future through SPC formation for the Economic Zones project.

Table 1-2: The following is the design concept of workshop planning

Scope of project	Capacity enhancement of BEZA and BIFFL staff Provision of legal and financial views on SPC formation Assistance for SPC formulation
Action Plan	Need to develop a comprehensive and effective methodology for ensuring the project requirements and outputs Fact finding of other existing cases Preparation of power point presentation
Outputs	Workshops Advisory service for SPC formation, in particular, Shareholder agreement and Equity Investment Policy (legal/financial)
Requirements of BEZA for capacity development	Practical knowledge sharing on shareholders’ agreement, SPC formulation and PPP projects. Theoretical explanation about SPC formulation Case study on PPP and G2G projects (Reasons for success, failure and underlying factors from the perspectives of EZ)

	Relationship and agreement between parties of PPP and G2G project (from the perspective of the Economic Zone) Responsibilities of stakeholders, nature, character and comprehensive ideas of SPC Why SPC formed, etc.
Requirements of BIFFL for capacity development	BIFFL is more interested in evaluation policy and guidelines. Project risk evaluation and evaluation model is of focus Practical & realistic evaluation model is expected Financial modeling for the Economic Zones (Profit & loss statement, Balance sheet, NPV, IRR etc.) Project evaluation criteria in general term SPC operation and participation
Dates of workshops	Title: “Theory”, 21 November, 2017 Title: “Parties concerned”, 21 November, 2017 Title: “Contractual relationship”, 19 February, 2018 Title: “Project Evaluation / Risk management”, 25 April, 2018 Title: “Project Operation”, 8 July, 2018

#### 1.4. Content of workshops

Each workshop was proposed to be 2-hour session in a day, and the venue was selected at convenient and availability base, either at BEZA or BIFFL conference room. The contents describing key points of each workshop session are summarized in the following sections.

##### **First session: “The theory of Infrastructure PPP project”**

Particulars	Details
Date	21 <sup>st</sup> November, 2017
Time	10:10-12:00
Place	BEZA Conference Hall
Number of participants	BEZA(18), BIFFL (7), JICA (2), Local consultant/coordinator (5): Total 32
Presenter	Sumiyuki Otsuki (Moderator/JICA Consultant), Zareen Rahman (Legal), Syed A. Mamun (Financial)

The following concepts in relation to “the theory of infrastructure PPP project” are addressed to the participants for understanding the key points as mentioned below.

##### **Purpose of learning Theory first for the Infrastructure PPP Project and Project Finance**

- In the beginning, a reason for leaning theory first was address for the participants in that the series of workshops are designed to provide participants with tools to face issues related to the particular/specific “Business Needs” of the projects and come up with “Creative ideas/business arrangements” which are still in conformity with the basic rules of the PPP/project finance.
- Also it was highlighted that enhancing capability of handling the projects with Tailor-made approach is of important, provided the good common sense of principles governing Infrastructure PPP projects are well understood.

### **What's to be discussed in the session**

- In this session, the concept of “Who will do what” in Infrastructure PPP projects was addressed in that definition, roles and responsibilities of parties to be involved in Infrastructure PPP projects were characterized by full comprehension of the issues involved.
- Then, it follows by introducing “What sorts of issues to be raised in Infrastructure PPP projects and project finance”.
- Also in order to define Infrastructure PPP projects, the way as to how viability/economic efficiency of the projects is going to be evaluated was addressed.

### **Public and Private Partnership Project**

- The definition of Infrastructure PPP projects was given and clarity of a question “Is EPC project included?” was well understood by the participants in relation to the parties to be involved in the Infrastructure PPP projects.
- Also the concepts of BOT and BLT were shared, and the roles and responsibilities of parties under these project scheme were depicted by referring the case studies of actual projects.
- In the Infrastructure PPP projects, one of the important principles of “Leave O&M to private businesses” was introduced, and reasons for adapting it was well addressed by referring the following merits of PPP scheme.

### **Merits of PPP scheme**

- From the standpoints of Infrastructure PPP projects, an important principle governing the concept of risks was well understood by the participant in that for a certain risk, a person who is most familiar with and capable of controlling the risk should take the risk at the lowest price.
- Moreover, the concept of "Market mechanism" enabling private businesses to provide services more efficiently (cheaply) than the public was well acknowledged by the participant in references to the case studies given in the presentation.
- But an issue of how to evaluate/calculate the increased efficiency in service delivery was raised and the following methodologies were practically introduced.

### **Merits to be measured by the Host country**

- As tools to measure the Value For Money (VFM), Public Sector Comparator (PSC) and Life Cycle Cost (LCC) were introduced.
- But the participants acknowledged that a wholistic evaluation must be employed for the norm of same quality, with less cost or higher quality, with same cost. Some case studies were referred in the presentation in that Hanif Flyover Project, Moghbazar-Mouchak flyover project, AMEZ project, and Haripur Power Project were introduced.
- Also, the concept of Additionality (which can save opportunity cost) was introduced.
- However, for forming SPC, the participants were well understood that business interest/profit needs to be secured at the same time in order to attract investment from Private Business Company to participate in the project.

## Why SPC is used for PPP Infrastructure project?

- The session was also devoted to clarifying if every sponsor need to form SPC for Project Finance.
- A reason why SPC was formed was addressed by referring the case defining limited liability of project company, which does not pose capital resources even if incremental operational cost was incurred.
- Also, the scope of such liabilities and default measurement was referred in relation to settlement by reduction of availability fee.
- A reason for transferring the facilities related to the project to the host country / off taker at the end of the project was explained in relation to the concept of limitation/cap of liability of the project company.

## Principles defining Infrastructure PPP project

- In summary, the following principles/theories were referred in the session for the participants to understand the Infrastructure PPP projects:-
  - ✓ For some risks, those that are most familiar with and control the risk can take the risk at the lowest price
  - ✓ “Owner-Operator”
  - ✓ “One Project One O&M Operator”
  - ✓ “Single Point Responsibility”
  - ✓ “Business performance and creditworthiness of Sponsor (O&M Operator)”
  - ✓ “Alternative Dispute Resolution”

## Source of Finance & MDRs

- In addition, differences between Corporate finance and Project finance were addressed.
- Then, “What is Being Financed?” was addressed by introducing some case studies.
- Examples of Minimum Development Requirements (MDRs) were also introduced.

## Second session: “Parties concerned”

Particulars	Details
Date	21 <sup>st</sup> November, 2017
Time	13:10-15:00
Place	BEZA Conference Hall
Number of participants	BEZA(18), BIFFL (7), JICA (2), Local consultant/coordinator (5): Total 32
Presenter	Sumiyuki Otsuki (Moderator/JICA Consultant), Zareen Rahman (Legal), Syed A. Mamun (Financial)

The following concepts are addressed in this session of “parties concerned” in Infrastructure PPP Projects to the participant for understanding the key points of the main theme of this session.

**What are roles and relations among the parties concerned in Infrastructure PPP projects, and do they depend on the degree/level of public sector involvement?**

→ Varies parties to be involved in Infrastructure PPP Projects are referred as follows, and each party's roles and responsibilities were introduced in detail in relation to each other.

- ✓ Host country/Off taker
- ✓ Sponsor
- ✓ Project Company (a stock company, limited liability company and/or partnership)
- ✓ O&M Operator
- ✓ EPC Contractor
- ✓ Senior Lender
- ✓ Independent Consultant/Engineer

**Why such roles and relation are defined?**

→ By introducing parties concerned in Infrastructure PPP Projects, reasons why the project company should be a SPC and what are the laws which the SPC shall abide by were explained.

→ As the standpoints of BEZA and BIFFL, legal barriers for them as the government agencies, as well as how law permits them to be the equity investors on PPP projects was clarified by referring relevant laws and policies of the Bangladesh government.

**How is the project performed under such project finance scheme?**

→ Under Infrastructure PPP Projects, it was understood by the participants that assets contributed by public sector and cash contributed by private sector into a SPC is deemed to be the sources of projects to develop and maintain the assets.

**What are typical SPC structures for PPPs under project finance scheme?**

→ The following diagram was referred for explaining the relations among the parties concerned in Infrastructure PPP Projects in general.

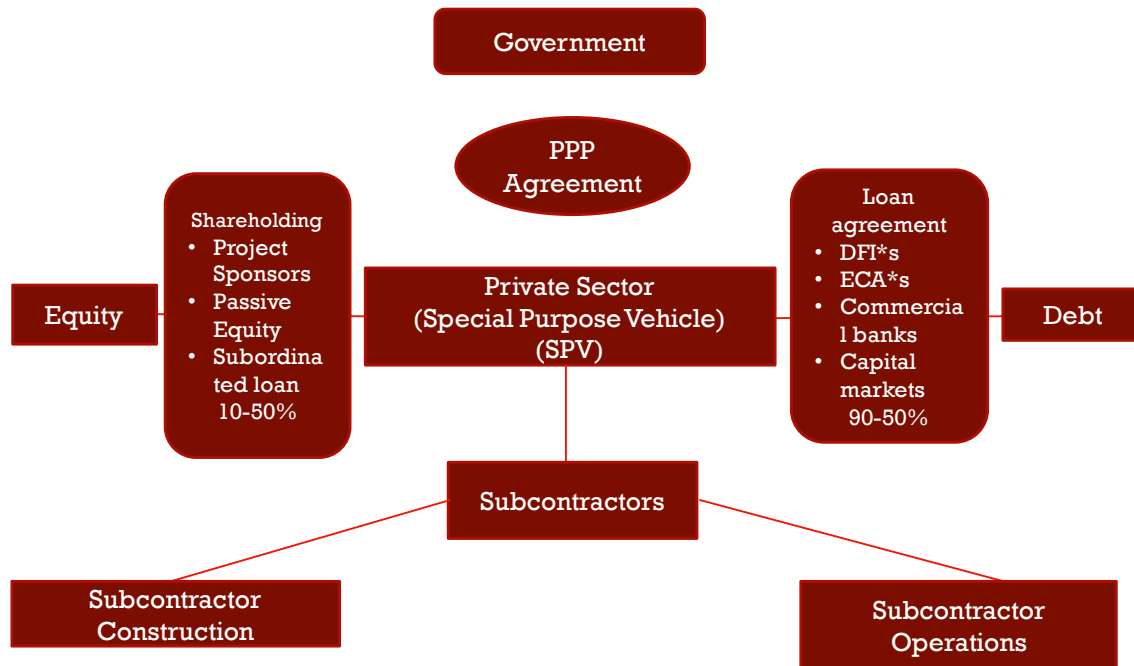


Figure 1-2: DFIs: Development Finance Institutions

### ECAs: Export credit agencies

#### The typical roles of SPC

- As the typical roles of SPC, the followings were introduced to the participants to acknowledge what they are supposed to partly perform in the Economic Zone project in their terms.
- ✓ Procurement of land and development of infrastructure
- ✓ Allocation of sites to individual units
- ✓ Liaison with central and local govt. – including release of funds
- ✓ Debt raising to achieve financial closure
- ✓ Providing and maintaining internal utilities & services by collecting service and user charges
- ✓ Debt servicing
- ✓ O&M of assets & common facilities

#### Third session: “Contractual relationship”

Particulars	Details
Date	19 <sup>th</sup> February, 2018
Time	10:00-12:00
Place	BEZA Conference Hall
Number of participants	BEZA (14), BIFFL (6), JICA (2), Local consultant/coordinator (5): Total 27
Presenter	Sumiyuki Otsuki (Moderator/JICA Consultant), Zareen Rahman (Legal), Syed A. Mamun (Financial)

The following concepts are augured in this session of “Contractual relationship” with regards to Infrastructure PPP Projects for participants to understand the key players and norms.

**For the PPP Infrastructure Project and Project Finance, what sorts of Agreements are going to be prepared?**

- There are two sets of Agreement; Project Agreements (Documents) and Financing Agreements (Documents), besides Shareholder/Sponsor Agreement (Documents).

**In what events are these Agreements supposed to be entered, and with whom?**

- Tangible project case studies were observed.

**What are key norms to be included in Agreements?**

- For instant for Senior Lender Agreement, from the viewpoint of repayment of senior loans, Conditions Precedent, Representations and Warranties, Covenants, and Event of Default are duly described.

**What is Security Package?**

- A set of Credit Enhancement measures, which include Sponsor Support, Debt Equity Ratio, Completion Guarantee and setting Security interest etc.

**What is Step-in Right in Project Finance?**

- Creating opportunities for rebuilding the project (Continuation of funds collection/making cash flow restart).

**How should security interest be set on assets in Project Finance?**

- Passive and active reasons for setting security interest on assets.
- Assets in this term can be referred to every items described in Project Agreements.
- How to transfer the assets with security interest from parties failed to manage the project to new project company.

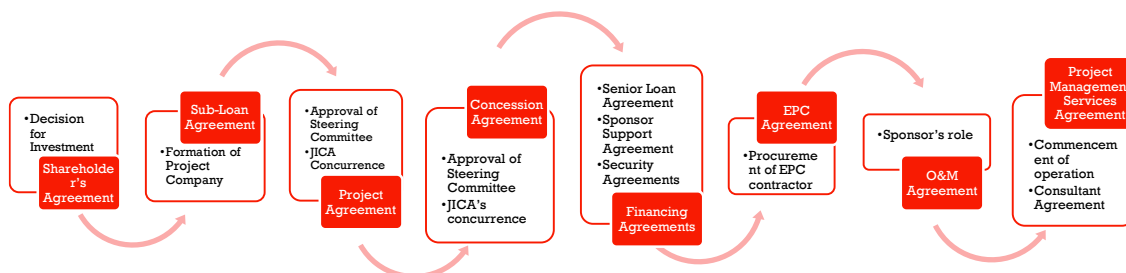
**Outline of Direct Agreement and its necessity**

- Direct Agreement is essentially meant to be made from the perspective of Security Interest for agreement on setting up security interest by project related parties concerning Project Agreements.
- Relation between Step-in right measures.

**How are Dispute resolution and Arbitration considered in the Agreements?**

- Protocol prescribed in the PPP Act on resolution shall be leant.
- The arbitration proceedings in Bangladesh relating to the dispute arising out of Arbitration agreement shall be addressed.

The following is the drawing and chart used in the workshop to explain the flow of project development and contractual relation among the key players in Infrastructure PPP projects.



## Contractual relationship

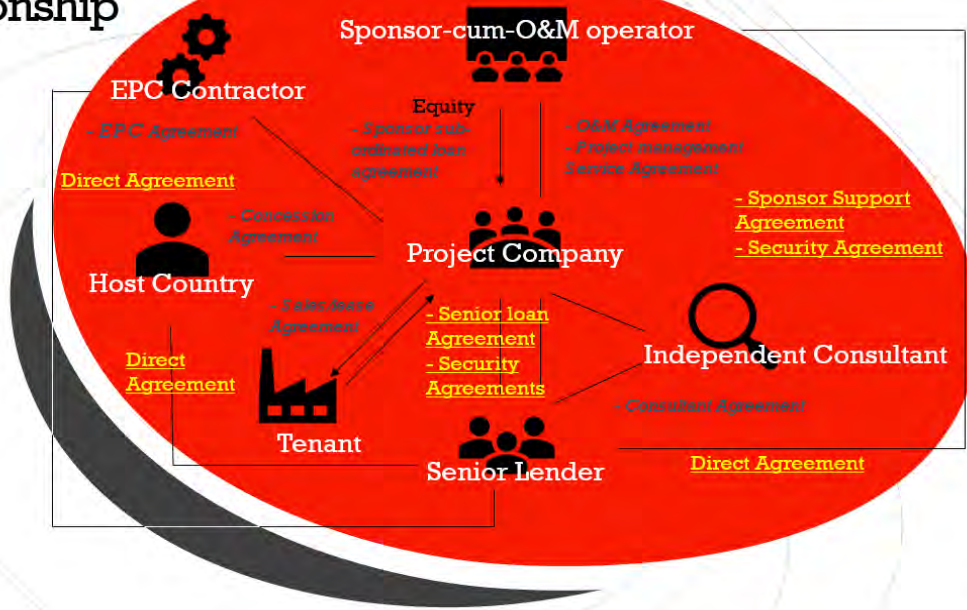


Figure 1-3: the flow of project development and contractual relation among the key players in Infrastructure PPP projects

### Forth session: “Project Evaluation / Risk management”

Particulars	Details
Date	25 <sup>th</sup> April, 2018
Time	10:00-12:00
Place	BEZA Conference Hall
Number of participants	BEZA (9), BIFFL (4), Local consultant/coordinator (5): Total 18
Presenter	Sumiyuki Otsuki (Moderator/JICA Consultant), Zareen Rahman (Legal), Syed A. Mamun (Financial)

The following table summarizes the key notes discussed in this session of project evaluation and risk management in relation to the EZ projects in Bangladesh.

Table 1-3: Key notes from the Forth session

Risks	Key Area	Scenario in Bangladesh	Measurements	Impact on Cash Flow
Land Related Risk	Site Selection	Scarcity of land creates complexity of site selection. Though government takes responsibilities in land selection & acquisition, the smaller geographical area escalates the price of land due to	Land acquisition can lead to lengthy disputes. Proper process of law must be ensured while acquiring. Acquisition and Requisition of Immovable Property Act, 2017 must be followed.	High
	Manner of Compensation (Land Related Lawsuit)		Land will be acquired by BEZA, under Section 19 of the BEZA Act.	
	Rigid Land Related Policy (Lease/sub-lease/resale)			

			increasing infrastructure development. In many cases, acquisition of agricultural land or residential areas increases the cost of land acquisition as well.	Proper compensation, as per the provisions of the 2017 Act must be provided. Disputes as to acquisition will be dealt with by way of arbitration under the 2017 Act and Arbitration Act., 2001 will not be applicable.	
Political & Policy Related Risk	Social Unrest		In case of acquisition of agricultural land and residential area for infrastructural development creates social dissatisfaction	Political strikes are one of the main political problem in Bangladesh. In 2012, many construction projects were severely delayed or cancelled due to continuous strikes.	
		Tenure of Ruling Party	Tenure of ruling party in Bangladesh is five years which depends on the democratic election process	Force Majeure – excusing a party from performing its obligations when prevented from doing so by events beyond its control.	
		Continuity of bureaucratic governance	Government has some initiatives to improve its bureaucratic system for development focus	Change in the ruling party and drastic cancellation of licenses and permits is another major risk faced in the past in Bangladesh.	Moderate
		Involvement of local politicians	As a democratic country, local politics and involvement of local politicians are critical factors for any project in Bangladesh	Caution against such a risk can be taken by Implementation Agreement (IA) with the host government and by taking undertakings from the government that licenses and permit will be granted in a timely fashion and be transferable to lenders.	
		Lack of appropriate assessment and planning of EZ license issuance	Efficient role of BEZA has created some good success stories	Political risk insurance for lenders before investing in countries with political instability.	
Foreign Exchange Risk	Foreign Borrowing	Currency	Due to the smaller capital market, foreign current borrowing is high in Bangladesh	In Bangladesh the foreign exchange market is floating and as such exchange rate can fluctuate, thus leading to revaluation risks. This can be crucial if loan is given in a particular currency and repayment is taken in another.	High
		Currency used in revenue & expense	Due to importing capital goods, expenses are exposed to FX risk. However, Floating FX rate	In order to avoid such a risk,	

		system in Bangladesh may affect overall cash flow of any project	loans disbursement and repayment should be in one single currency. Forward foreign exchange agreement is also possible where one party agrees to buy from another foreign exchange at a fixed rate at a future date, in order to avoid fluctuations. Unlikely, but the government might restrict access to particular foreign currency. This is known as the risk of convertibility. Private on shore foreign currency accounts can be maintained subject to permission of the Bangladesh Bank. Government guarantees to allow offshore foreign currency account can be take.
	Applicability of overseas escrow account	Using of escrow account & insurance companies are allowed in Bangladesh which assists to mitigate FX risks	
	Involvement of insurance companies		
Concession Risk	Business license issuance policy Availability of published guideline Standardization of application format Usability of on-line application and status monitoring	Due to the special authority like BEZA and relevant laws and guidelines, concession risk is lesser at now in Bangladesh compare to any time before. However, lower. However, lower global rank of Bangladesh (189th) enforcement of contract creates some concerns of concession risks	Licenses need to be obtained from various different public bodies, such as, BIDA, Bangladesh Bank, Department of Environment, etc. Concession or license is withdrawn Delay in giving the concession or license. Lenders should ensure that all licenses have been obtained before the financial close and that the terms of the licenses are such that they are easily transferrable in case the lenders want to exercise the step-in rights. Also, the licenses should not be revocable on the ground of the lenders enforcing their security of the loan. Concession should not be easily terminable, and the termination process should include sufficient compensation for the project

Moderate

company.

Construction Risks	Delay of commencement of the project due to unexpected events	Though labor cost is low, import dependency for capital goods increases the construction risks in Bangladesh. In addition, poor construction management creates concern about on time completion of construction work as well.	Construction cost overrun – to avoid this risk, the price of the construction should be fixed, in capable of being re-opened, and the price should be in one lump sum on completion. Thus, the risk shall be borne by the contractor. Delay in completion - fixed date for completion should be fixed. The force majeure events should be limited. Liquidated damages should be payable if completion is not achieved by a fixed date. Substandard quality of construction – The contractors should give extensive guarantees and if the contractor is to be released from liability of defects after a period, that period should be long.	High
	Construction cost overruns			
	Design deficiency			
	Faults related to geotechnical-conditions and construction works			
O&M Risk	Hike of Labor wage Dysfunction/ breakage of utility facilities Changes of surrounding environment (traffic, industrial waste management etc.)	Increasing trend of minimum wage in Bangladesh may be a concern of increasing operating cost. In addition, shortage of skill human resources to operate SEZ is another concern of the efficient management SEZ in Bangladesh.	Operational cost overruns Poorly managed project The operator should be efficient to manage the project. Penalties for the operator in case of failure to run project efficiently. There should be a strong termination clause for poor performance.	High
Utility Risk	Overreliance/lack of assurance on public utility services Failure to meet the specific requirement set forth in the internal rules Mismatch in designed utility specification between market (demand of industrial units)	Shortage of electricity and gas is the crucial problem at this moment in Bangladesh. The situation can be improved with importing gas and completing some on-going large power projects in upcoming days.	Shortage of supply – In of Bangladesh, electricity might be a problem. Supply guarantee/security of supply can be provided in supply contracts but there will not be 100% guarantee. Shortage of fuel supply should be kept as a force majeure clause.	High

Socio-Environmental Risk	<p>Disparity between nearby residents</p> <hr/> <p>Fail to attract high-quality investment and talents</p> <hr/> <p>Growth Model based on low technology and labor and resource intensive manufacturing</p>	<p>Due to the high density of population and highly dependency on agricultural land, any initiative of a project affects the living and profession of nearby residents of the project. In addition, bio-diversity of this small landscape can be significantly affected due to more number of projects</p>	<p>Liability for environmental damage which reduces bankability of the project – project plans and construction should follow the Equator principle and complying with the lenders’ internal environment safety policy.</p> <p>Lacking environmental clearances – obtaining all relevant permissions from the Department of Environment and complying with the terms of such permits.</p> <p>Litigations by environment related pressure groups – Following Equator principle and the lender’s guidelines will reduce scope for grievance for environmentalist groups.</p>	Low
Financing Risk	<p>Feasibility of the project</p> <hr/> <p>Inadequate assessment of physical, technical and financial conditions and prospects</p> <hr/> <p>Fault and false statement in the project application</p> <hr/> <p>Involvement of parties who are not familiar with the projects</p>	<p>Though Bangladesh has shortage of capital, its Stable credit worthiness and lower percentage of debt to GDP indicate its strength to borrow. However, weak financial structure and capital market leads the higher transaction cost which, in turn, increases cost of financing. In addition, lack of experience of marketing for SEZ may delay attracting investors which ultimately will affect the revenue flows of SEZ projects in Bangladesh.</p>	<p>Cost of finance increases</p> <p>Project company defaults in the repayment</p> <p>An undertaking from the SPC to provide regular updates on audit and accounts and having control over the loan accounts in order to keep track of the money spent by SPC;</p> <p>A greater variety of events of default and acceleration in the loan document and even a cross-default provision;</p> <p>Sufficient security and security trustee to enforce such security.</p> <p>Step-in-rights of the lenders to take control of the project when it is suffering.</p>	High

**Fifth session: “Project Operation”**

Particulars	Details
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Date	8 <sup>th</sup> July, 2018
Time	10:00-12:00
Place	BEZA Conference Hall
Number of participants	BEZA (19), BIFFL (6), JICA (1), Local consultant/coordinator (6): Total 32
Presenter	Sumiyuki Otsuki (Moderator/JICA Consultant), Zareen Rahman (Legal), Syed A. Mamun (Financial)

The following concepts are discussed in this session of “Project Operation” with regards to Economic Zone Projects for participants to understand the key activities of the Project Company..

#### **What makes a successful EZs under PPP?**

- Proper organization structure (Fulltime employee recruited by the organization, long-term experience/specialized expertise: Marketing, Construction and Engineering, Utility Provider Coordination, Environment protection, Public relations, Administration and Human resource development)
- Horizontal/vertical international specialization (Invitation of Anchor company and SME is the key to form a cluster)
- Proactive project finding, development and financing
  - ✓ IEAT, Thailand (Zone Authority)
  - ✓ Industrial Parks, Vietnam (Zone Cluster)
  - ✓ IL&FS, India (Financial Institution)
  - ✓ ZonesCorp, Abu Dhabi, UAE (Zone Authority)

#### **Ownership and Management**

- PPP project – joint ownership between the private and public sector.
- Concession agreement ultimately determines the ownership and control of the project.
- Shareholder agreement (SA) for the purpose of formation of the SPC – management of the SPC will be as per the terms of the SA.
- Operation and Management Agreement – once the project is completed, this agreement will govern who will be the operator and how will be operated.

#### **Required Organization Structure**

- The organizational structure of EZ project company for operation and management will be designed for achieving its objective to suffice the needs of the project.
- The manpower for the operation of an EZ project can be self-employed, however a certain operation and maintenance work can be also outsourced.

#### **Facilities and Services**

- Hard infrastructure & facilities
  - ✓ Electric Power Supply, Industrial Water Supply, Central Sewage Treatment etc.
- Why having Common facilities?
  - ✓ Ground water scarcity caused by excessive draw wells installed by each factory unit.
  - ✓ Economy of scale

- ✓ Concentration of generators of hazardous materials -> to ease management and regulatory control
- Suppose no guideline for requirement specifications on EMP and EMoP?
- ✓ No system/regulatory measure for treating sewage / effluent / hazardous solid waste in a collective manner in an Industrial Area / Zone
- An example of Effluent/Sewage/Solid Waste management
- Additional Support for SMEs

### **Economic Zone Marketing / Investment Promotion**

- Who conducts marketing
- ✓ Establishment of the Investment Promotion Dept.
- ✓ Preparation of the Investment Promotion Material such as; Investment Guide Book, Catalogues, New Letters, DVD, Home page and Q&A model
- ✓ Close contact with Oversea Embassy or Governmental organization/peer network
- Organization of promotional seminars
- ✓ Japanese developers, trading companies & consultants often jointly organize promotional seminars in Japan, by inviting governments and IZ authorities of partner countries.
- Importance of Anchor firm to create industrial agglomeration via supply chain

### **Economic Zone Business Models**

- Costs, fees and lease terms
- ✓ The business of industrial parks is a long span ranging from development, sales, service provision to tenants and infrastructure management. And, there are tendencies in nature either industrial plots are sold out in a short period of time or sold over a long time. It is difficult to follow a business plan on cash flow from initial investment to fund recovery.
- Rent or sale of Land and Buildings
- Land sale/lease ratio
- Sale of Services
- ✓ Real Estate related services
- ✓ Zone-specific services
- ✓ External Services

### **Land Allocation & Leasing Procedures**

- What are steps to allocate/lease Land to investors
- How long it takes
- Complexity to allocate/lease land

### **Collection System of Fees and Charge**

- Fee items consist of the following categories:
- ✓ Reservation fee
- ✓ Price for the right to utilize (Payment for land plot)
- ✓ Management fee
- ✓ Connection charge

- ✓ Water charge
- ✓ Power charge
- ✓ Rent for the premise; office space & factory
- ✓ Deposit for the factory

**Technical/Administrative Office Operation**

- Coordination with utility providers (Water and Power supply).
- Running operations of office space for leasing, restaurants, banking facilities, kiosk and first aid emergency (outsourcing may be common practice)
- Monitoring of waste water in monthly basis and associated penalty policy.
- Visitor center management
- Function of marketing and promotion
- Logistics services, manpower recruitment/training center, and trouble-shooting service (monthly tenants meeting), if any

**1.5. Assistance for conducting monitoring activities**

**Preparation of Quarterly Progress Report**

For ensuring smooth and successful operations by BEZA and BIFFL as the implementing agencies for the preparation of Quarterly Progress Report (QPR), JST aided the implanting agencies enable to submit the Report to JICA through PMO in timely and regular manner.

QPRs are deemed to be prepared separately by the Component 1, 2 and 3. And this JST’s feasibility study project is mainly linked with the activities of Components 2 and 3. In the content of QPR, the followings are supposed to be described.

1. Current progress status
2. Substantial progress during the Quarter
3. Progress status against Implementation Plan (monitoring)
4. Issues and Necessary Measures
5. Plan for the Next Quarter
6. Annexes

Once the implementation is under way, the role of the implementation agencies shifts to monitoring activities and the performance of interim evaluations. At the milestone points in the implementation plan, the implementation agencies should assess milestone status, provide feedback and solve problems. If delays detect, the Implementation agencies are deemed to reconstruct the project timeline and inform other implementation team members of any necessary changes in their deadlines.

Implementation problems and slippage of deadlines would often have cost implications. The Implementation agencies should therefore monitor actual costs or expenses against amounts budgeted. Cost monitoring should be integrated with other monitoring activities.

Moreover, it is highlighted that monitoring activities conformity with JICA Guidelines for Environmental and Social Considerations need to be described and status of the criteria and

procedures on environmental and social considerations are deemed to be connotated in QPRs. Moreover, submission of report on performance of SPC is required to furnish JICA with information of project performance.

## Chapter 2 DPP preparation support for basic infrastructure sub-projects for the EZ

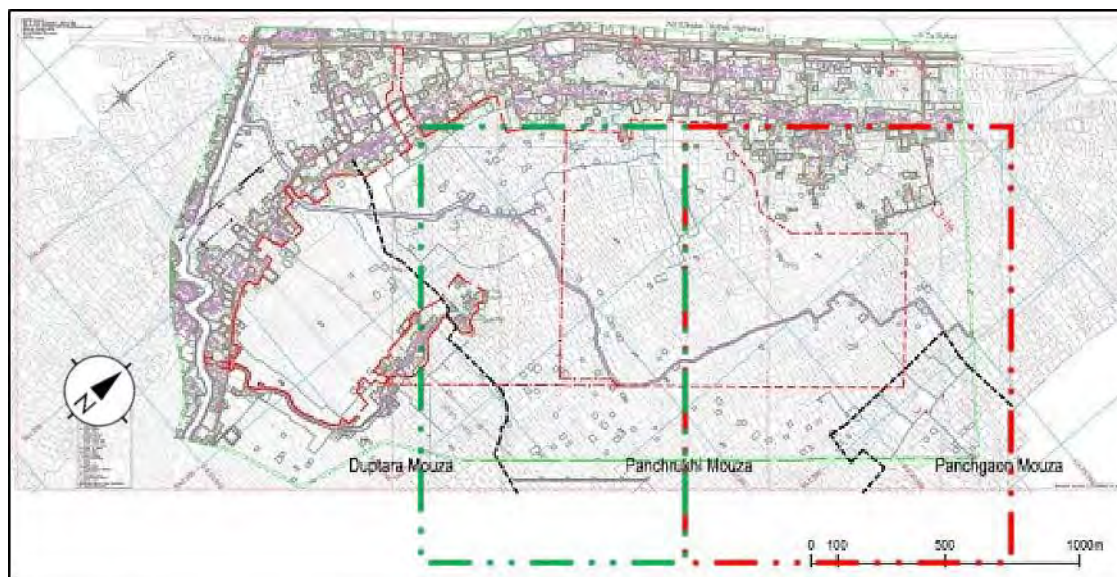
### 2.1 Review of the existing development plan of Araihaazar EZ

#### 2.1.1 Confirmation of location of Araihaazar EZ

In prior to this feasibility study by JICA Study Team (JST) conducted from July 2017 to December 2018 (also known as SAPI), JICA conducted initial studies “Project for Development Study and Capacity Enhancement of BEZA” through 2015 to 2017 to compare 13 EZ candidate sites. During the previous study, 7 criteria; “Location”, “Land information”, “Supporting context”, “Social/environmental assessment”, “Infrastructure”, “Natural disaster”, and “Government land price”, were applied to determine the most suitable location for FDIPP. Araihaazar and Nayampur were selected and further studies were conducted.

At the beginning of the JST’s Survey, the JST confirmed with BEZA the planned location of Araihaazar Economic Zone (EZ). The planned location for development of Araihaazar EZ is designated by BEZA from the view point of land acquisition situation in order to minimize the number of resettlement and affected households. The approximate boundary is shown in Figure 2.1-1 by the thick red two-dot chain lines for the Phase-1 development and the green two-dot chain lines for the future expansion area. The 200 ha area surrounded by thick red two-dot lines was assessed as superior for EZ development to the area of the thin red dashed lines proposed by the previous study because of economical land and infrastructure development due to its rectangular shape, provided that diversion canal for rainwater and treated wastewater is to be connected from the new 200 ha area for discharging to the river.

Source: JICA Study Team and the previous JICA study



“The future expansion area” refers to an area where the expansion of the EZ development may be possible as Phase-2. However, No concrete expansion plan has been made as of December 2018.

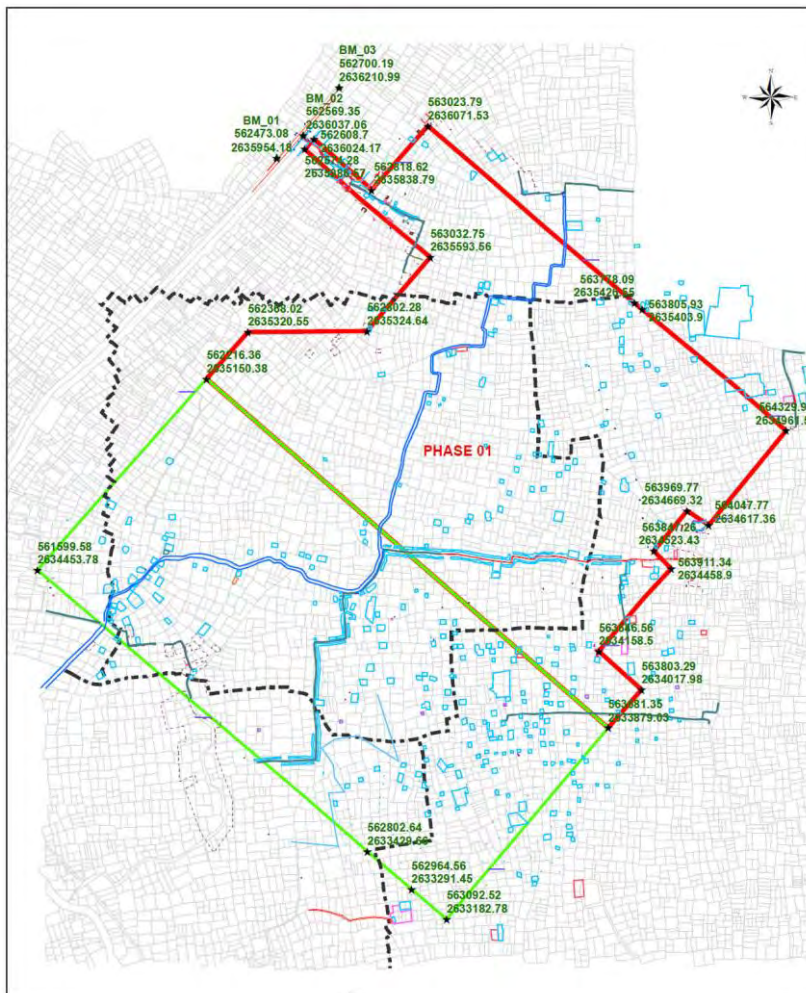
Figure 2.1-1: The proposed location of development of Araihaazar EZ

### 2.1.3 Topographic survey

Topographic survey was conducted for the proposed economic zone area as well as for other areas required for other infrastructure such as canal and retention pond with a total of about 600 ha in accordance with the following.

- (1) EZ survey area : 200 ha within the thick red two-dot chain lines in Figure 2.1-1.
- (2) Others : 400 ha in total of the following areas required for off-site infrastructure development such as the access road from the national highway No.2 to the EZ area and an area on the southeast side of the EZ area including the river to accommodate the area for rainwater drainage and treatment. The topographic survey for about 600 ha was conducted to grasp the geographic situation of the entire area composed of EZ and surrounding area to suggest the suitable location of EZ and off-site infrastructure sub-projects.

The field works, including installation of the benchmark (BM), GPS surveying, boundary survey, leveling and topographic mapping were carried out during the period from November 2017 to January 2018. Boundary lines of the Phase-1 development and the future expansion area are shown in Figure 2.1-2 below with coordinates on the cadastral map.

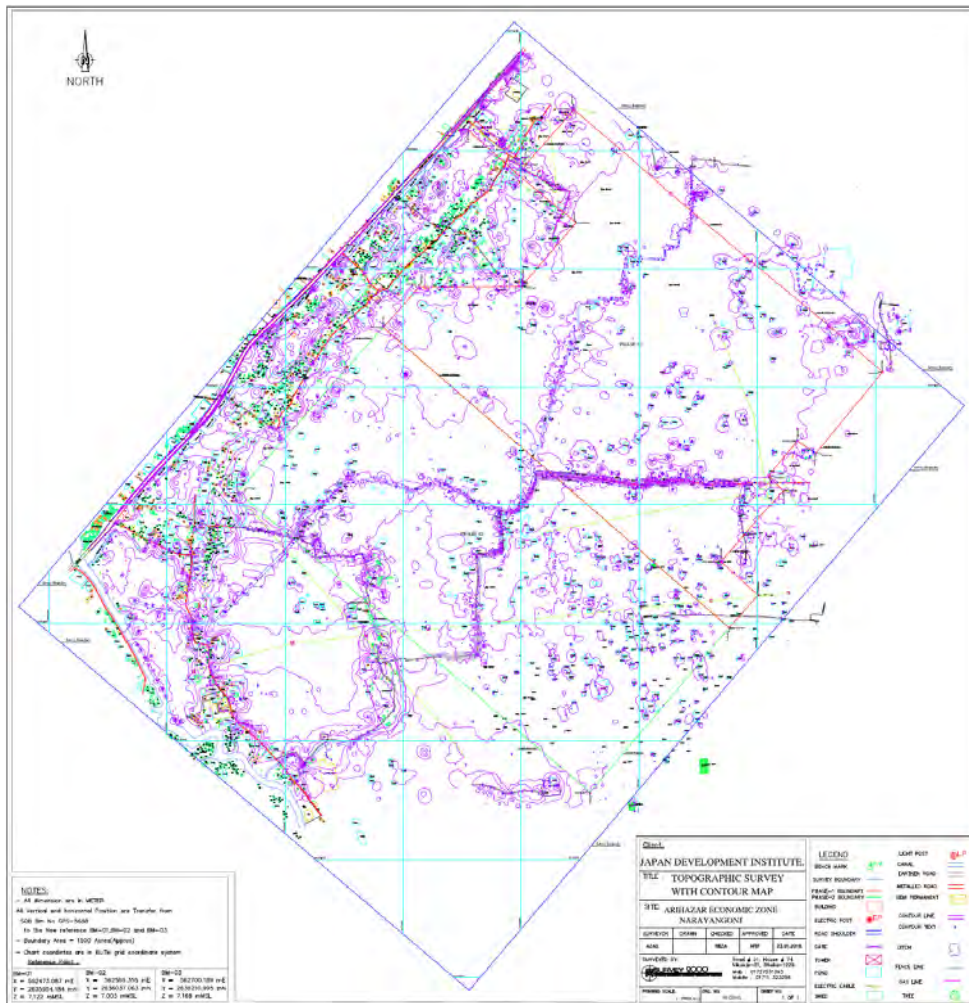


Source: JICA Study Team

Figure 2.1-2: Superimposed cadastral map with boundaries of the EZ

All survey data for the Araihaazar EZ development and the expandable area were summarized in the topographic map with the scale of 1: 1,000, shown in Figure 2.1-3.

The Araihaazar site at present is flat agricultural land with an elevation of MSL +2.5 m, which is submerged during the rainy season. Small water channels exist a few meters lower than the surrounding agricultural ground elevation. The channels have been used for transportation of agricultural products and fertilizers by small boat. The road elevation of the national highway No.2 is higher than the level of surrounding local land. The elevation of the site drops from MSL +10 m at the southwestern side of the bridge to MSL +EL. 7.0 m at the northeastern side. Rainwater inside the EZ site flows from the northeastern side to the southwestern side and drains into the southwestern side of the river connecting to the Meghna River. The elevation of the site is lower than flood levels observed in the past of surrounding large rivers such as the Meghna River and the Shitalakshya River.



Source: JICA Study Team

Figure 2.1-3: Topographical map for Araihaazar EZ

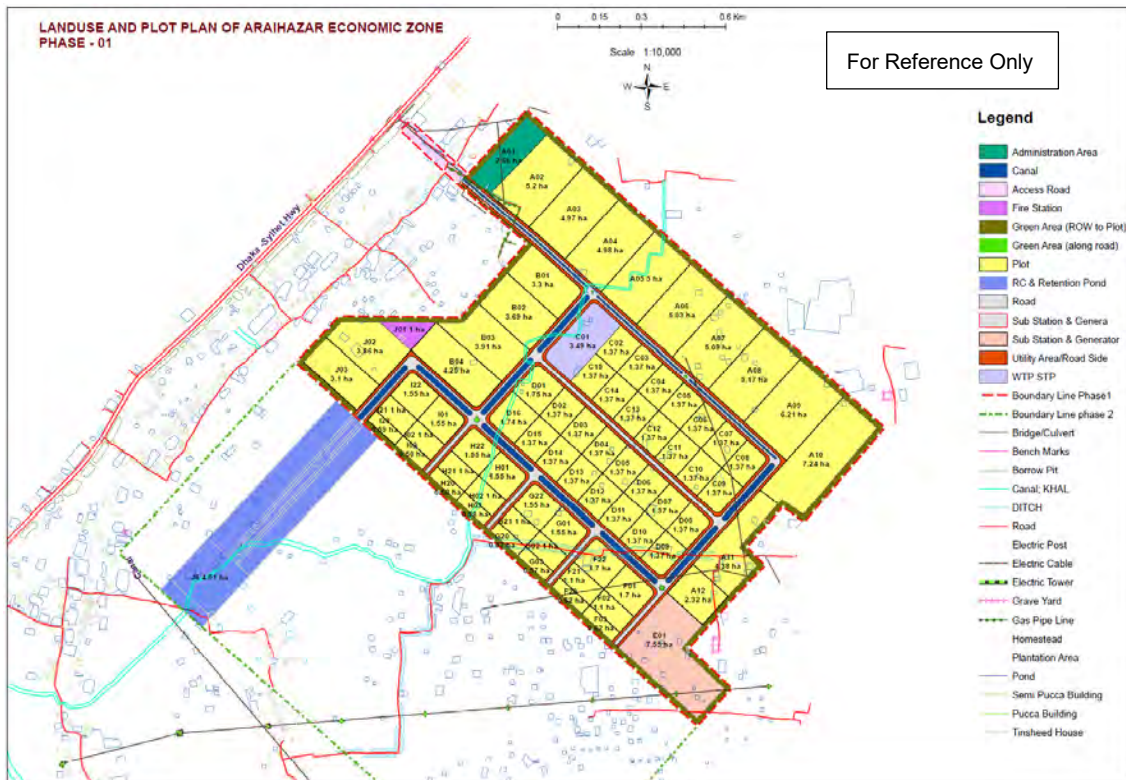
### 2.1.4 Review of the master plan for Araihaazar EZ

The Araihaazar site for EZ development has been selected on the basis of comprehensive evaluation from two candidate sites, Araihaazar and Nayanpur proposed as the priority development sites through the previous study for the Project for Development of Economic Zone and Capacity Enhancement of Bangladesh Economic Zones Authority (BEZA).

The master plan proposed in the previous study has been reviewed since possible location for the first phase of Araithazar EZ development has been shifted as described in Clause 2.1.1.

As for the infrastructure planning for the Phase-1 EZ development, the access road from the national highway, internal road network, rainwater drainage network, flood retention pond including pumping system, water supply system, wastewater treatment system, and electric, telecommunication and gas distribution networks have been planned in the EZ area.

The land use plan for the Phase-1 of Araithazar EZ development (192ha) is illustrated in Figure 2.1-4.



Source: JICA Study Team

Figure 2.1-4: Land use plan for Phase-1 Araithazar EZ development

The land use allocation of Araithazar EZ development is shown in Table 2.1-1. Outside of the EZ development area, the access road locates from the national highway to the EZ area, retention canals and retention pond with pumping house located in the expansion area, and the power station together with a sub-station locates in the southeastern area out side of the EZ development area are.

Table 2.1-1: Land use allocation plan of Araihaazar EZ development

Land Use Plan		Phase-1		Others
		Area (ha)	Ratio (%)	Area (ha)
1.	Factory Lots	145.19	75.81	
2.	On-site Infrastructure	46.32	24.19	
2.1	Administration Area	2.66	1.39	
2.2	Inner Road	10.12	5.28	
2.3	Utility Area	10.66	5.57	
2.4	Retention Canal	5.08	2.65	
2.5	WTP & STP (CETP)	3.49	1.82	
2.6	Fire Station & Gas Station	1.00	0.52	
2.7	Green Area	13.31	6.95	
3.	Off-site Infrastructure			27.66
3.1	Access Road			1.54
3.2	Retention Canal & Retention Pond w/Pump Station			18.57
3.3	Power Station & Sub-Station			7.55
Total		191.51	100.00	27.66

## 2.2 Water source and soil investigation

### 2.2.1 Outline

#### 1) Contents of the survey

The purpose of the water source and soil investigation is to obtain water quality, safe yield and aquifer characteristics of the test wells and geo-technical information for the pre-feasibility study on the EZ area. Survey items are “Existing well survey”, “Drilling of test well”, “Pumping test”, “Water quality analysis at laboratory” and “Soil investigation” as shown in Table 2.2-1.

Table 2.2-1: Contents of the survey

Survey item	Quantity and location	Contents	Method
<b>Existing well survey</b>	55 wells in and around EZ	Well inventory	Interview
		Water quality (As, Fe)	Field kit
		Water quality (pH, EC, ORP, Temperature)	Portable meter
		Groundwater level	Measuring tape
<b>Drilling of test well</b>	3 sites in EZ	Drilling	Rotary machine drilling (300m×2, 120m×1)
		Disturbed sample	Every 2m
		Geophysical logging	Resistivity, Self-potential, Gamma ray
		Well installation	6 inch steel casing and stainless screen, Gravel packing, Cement sealing
<b>Pumping test</b>	3 sites at test well in WZ	Preliminary Test	at least 2 hours
		Step Drawdown Test	2 hours × 5 steps
		Constant Discharge Rate Test	48 hours
		Water Level Recovery Test	24 hours or longer
		On site water quality check	Field kit and Portable meter

		(As, pH, EC, ORP, Temperature)	
<b>Water quality analysis at laboratory</b>	3 sites at test well in EZ	Arsenic	AAS
		Chloride	Titrimetric
		Hardness	Titrimetric
		Iron	AAS
		Manganese	AAS
		pH	pH meter
<b>Soil investigation</b>	14 sites in EZ	Drilling	40 m depth at 4 sites 30m depth at 10 sites
		Undisturbed sample	More than 40 samples at 4 sites
		Standard penetration Test	Every one meter
		Static water level measurement	Measuring tape
		Laboratory test	

Source: JICA Study Team

## 2) Schedule of the survey

Table 2.2-2: Schedule of the survey

Survey item		2017				2018				
		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Existing well survey	Field work	■								
Drilling of test well	TW-1 TW-2 TW-3			■	■	■	■	■		
Pumping test	TW-1 TW-2 TW-3						■	■	■	■
Water quality analysis at laboratory	TW-1 TW-2 TW-3						■	■		■
Soil investigation	Drilling Lab. test				■	■	■	■	■	

Source: JICA Study Team

### 2.2.2 Survey result

#### 1) Existing well survey

Existing well survey was carried out from 17 to 23 September 2017 to know the water quality of existing tube wells (TWs) surrounding of EZ area in Duptara and Satgram Unions of Araihaazar Upazila. The survey consists of collection of TW information and water quality test on site. Target TWs were randomly selected total 55 TWs which mixed shallow and deep TW. Village-wise number of TWs is summarized in Table 2.2-3.

There were 38 shallow tube wells (STWs) and 17 deep tube wells (DTWs) as detailed in Table 2.2-4. The depth of STWs and DTWs were in the range of 30 to 300 feet and 520 to 980 feet respectively. Among the 55 TWs surveyed, 14 (25.5%) belonged to some institutions like schools, madrasahs, mosques and so on and the remaining 41 TWs (74.5%) were owned personally.

Table 2.2-3: Village-wise number of TW spots

Duptara Union			Satgram Union		
Sl. No.	Village	No. of TWs	Sl. No.	Village	No. of TWs
1	Khan Para	2	1	Noagaon	5
2	Kumar Para	2	2	Panchrukhi	4
3	Manehar	1	3	Purinda	2
4	Panchbaria	4	4	Sanpara	8
5	Panchgaon	13	5	Tegpara	10
6	Raghabdi	2	-	-	-
7	Singrati	2	-	-	--
	Total	26		Total	29

Source: JICA Study Team

Table 2.2-4: Depth of surveyed wells

Type of well	Depth (feet)	Number	%
Shallow TW	30 - 90	7	18.4
	130 - 180	18	47.4
	205 -300	13	34.2
	Sub total	38	100.0
Deep TW	520 - 645	2	11.8
	700 - 750	6	35.3
	760 - 785	6	35.3
	800 -980	3	17.6
	Sub total	17	100.0
Total		55	

Source: JICA Study Team

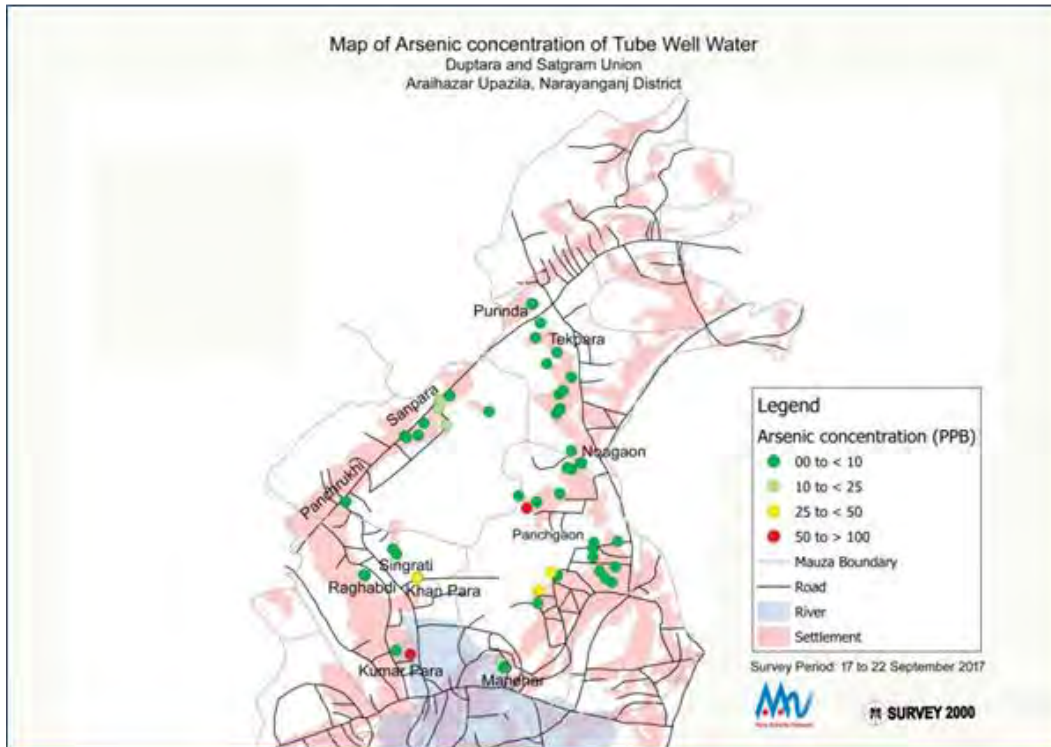
Six (6) parameters of TW water were tested in situ using the portable meter for pH, EC, ORP, Temperature and HACH field kit for Arsenic and Iron. Result of the water quality test in the field is shown in Table 2.2-5, Figure 2.2-1 and Figure 2.2-2.

Arsenic concentrations of 2 shallow tube wells slightly exceed the Bangladesh drinking water standard; 0.05 mg/L. In the water supply plan of the Araihaazar EZ, deep aquifer is target to use groundwater. It is sure that water quality of shallow aquifer has no impact to supply deep groundwater. Iron concentrations of 18 samples (32.5%) including 7 DTWs exceed the Bangladesh drinking water standard. Treatment process should be considered for the water supply plan for Araihaazar EZ.

Table 2.2-5: Result of the water quality test in the field

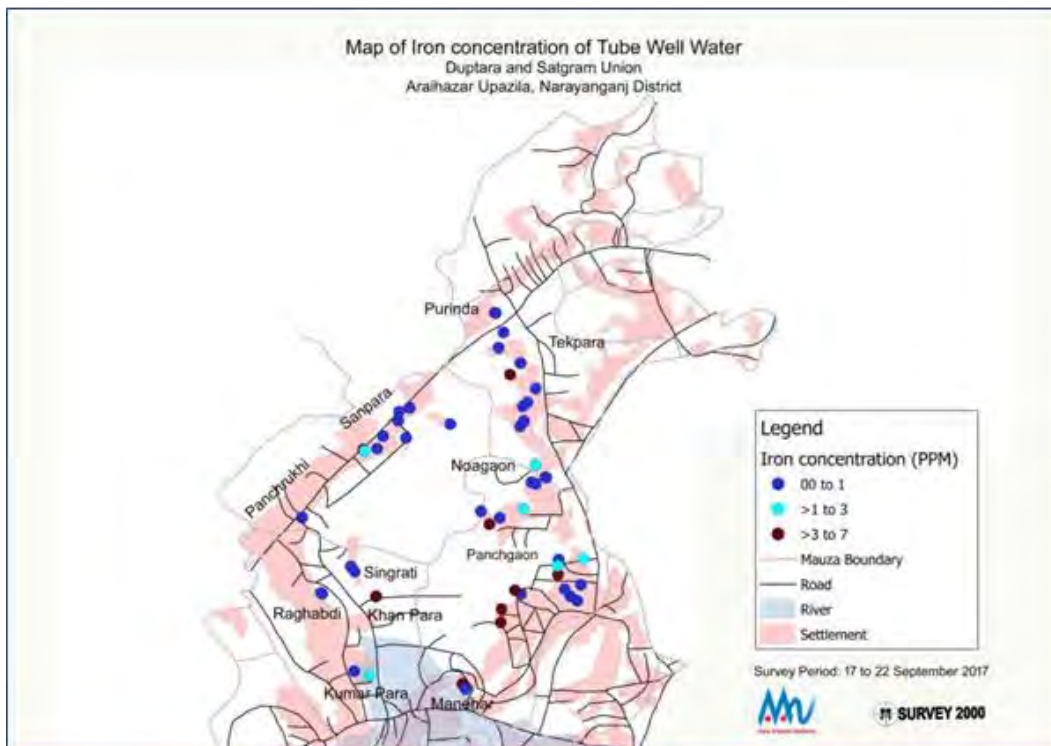
Parameter	BDS	Shallow TW				Deep TW			
		Min	Max	Exceed BDS		Min	Max	Exceed BDS	
				Number	(%)			Number	(%)
pH	6.5 - 8.5	6.6	7.8	0	0	6.6	7.5	0	0
EC ( $\mu$ S/cm)	-	265	3050	-	-	225	2005	-	-
ORP (mV)	-	-156	132	-	-	-125	32	-	-
Arsenic (mg/L)	0.05	0	0.1	2	3.6	0	0.01	0	0
Iron (mg/L)	0.3 – 1.0	0	7	11	20	0	5.5	7	7.86
Temperature ( $^{\circ}$ C)	-	27.3	29.5	-	-	27.6	29.6	-	-

BDS: Bangladesh drinking water standard



Source: JICA Study Team

Figure 2.2-1: Arsenic concentration of TW water



Source: JICA Study Team

Figure 2.2-2: Iron concentration of TW water

## 2) Drilling of test well

Progress of drilling include pumping test and water quality analysis at each site is shown in Table 2.2-6. Specification of test wells is shown in Table 2.2-7. Depth of the deep wells are 307m and 300m, and depth of the shallow well is 106m.

Location of test well is shown in Figure 2.2-3. Bore logs at each site are shown in Figure 2.2-4. There is widely distributed surface clayey layer with 14 to 28m thickness in the EZ area. Below the surface zone, there are mainly consist of fine to medium sand which intercalates thin silty layers. These layers are approximately divided into three aquifer zones such as “upper shallow aquifer”, “lower shallow aquifer” and “deep aquifer” as shown in Table 2.2-8. According to the result of existing well survey, it is thought that both upper and lower shallow aquifers are main targeted aquifers for domestic purpose. Some of the wells for public purpose are installed into the deep aquifer sounding of the EZ area. Photographs of drilling work at each site are shown in Figure 2.2-5 to Figure 2.2-7.

Table 2.2-6: Progress and plan of drilling work at each test well

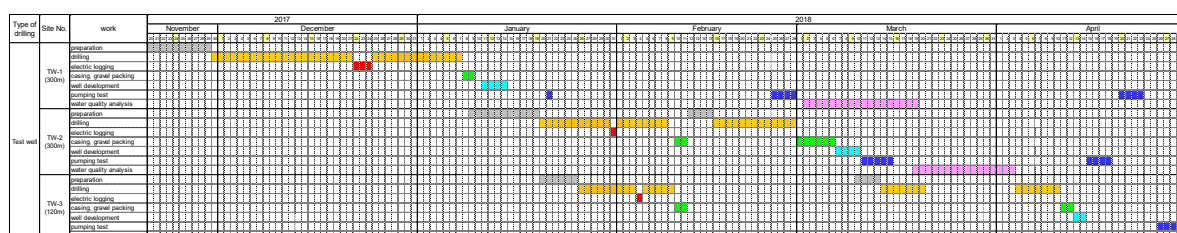


Table 2.2-7: Specification of test wells

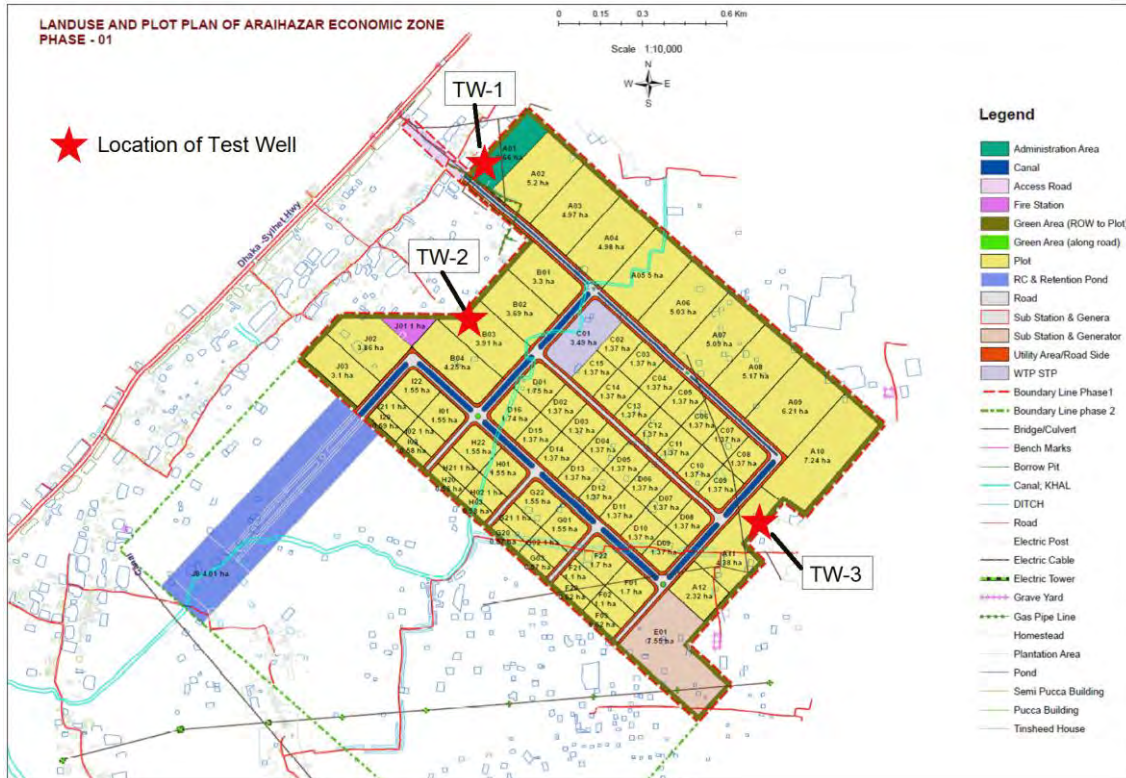
No.	Drilling depth (m)	Well depth (m)	Screen depth (m)	Diameter (inch)	Latitude	Longitude
TW-1	320	307	261-298	12 (0-80m) 6 (80-300m)	23.8329 N	90.6170E
TW-2	300	300	261-297	12 (0-80m) 6 (80-300m)	23.8281 N	90.6168 E
TW-3	116	106	78-103	12 (0-60m) 6 (60-108m)	23.8215 N	90.6273E

Source: JICA Study Team

Table 2.2-8: Characteristics of each aquifer

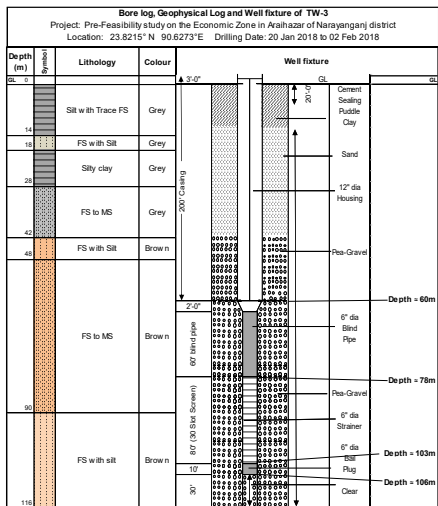
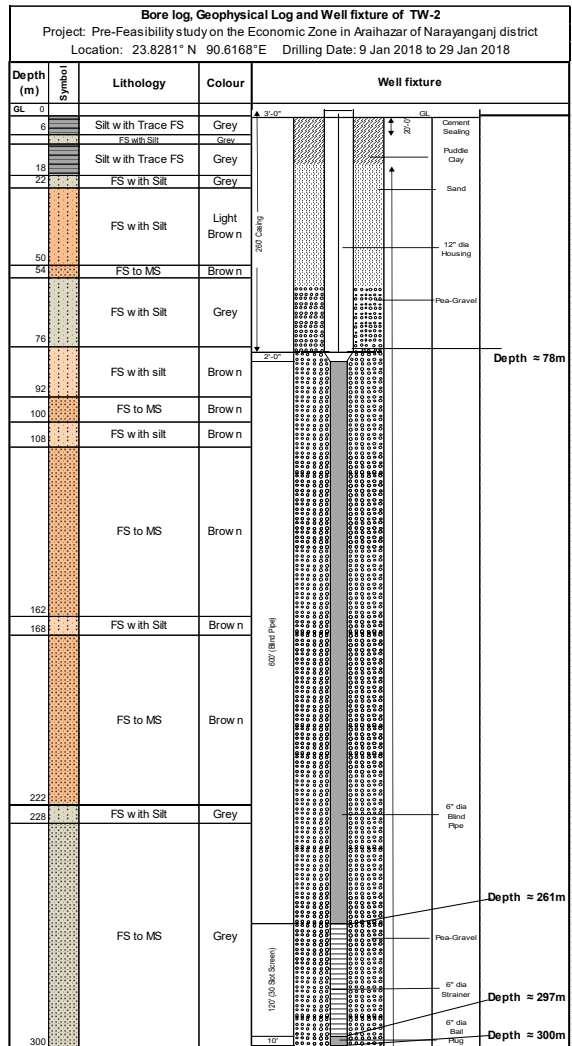
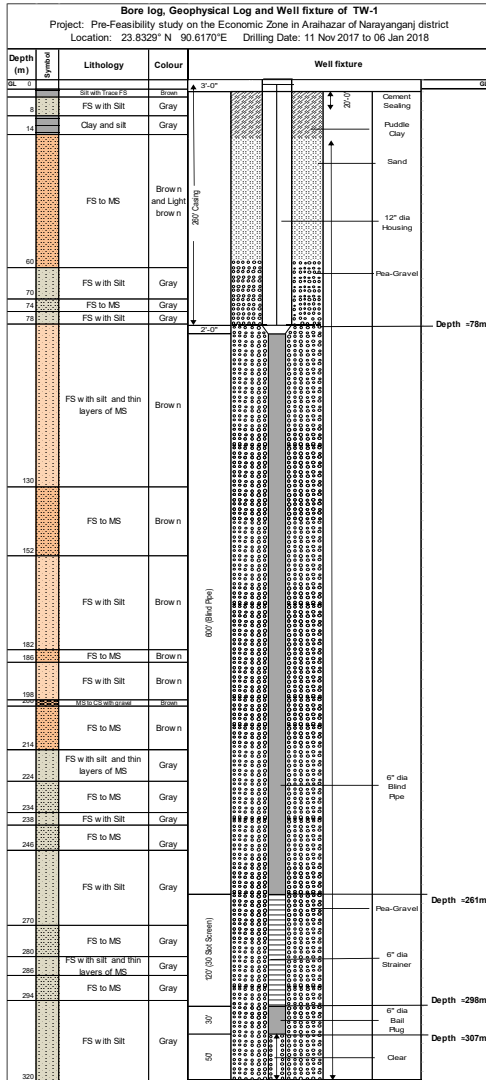
Aquifer	Depth (GL-m)	Thickness (m)	Main facies	Color
Upper Shallow	14 - 78	58 - 64	Fine sand mixed silt	Lite Brown
Lower Shallow	42 - 222	136 - 146	Fine to Medium sand mixed gravel	Brown
Deep	> 214 -	> 78	Fine to Medium sand mixed silt	Gray

Source: JICA Study Team



Source: JICA Study Team

Figure 2.2-3: Location of test well



Source: JICA Study Team  
**Figure 2.2-4: Bore log at each test well**



Figure 2.2-5: Photograph of drilling site at TW-1



Figure 2.2-6: Photograph of drilling site at TW-2



Figure 2.2-7: Photograph of drilling site at TW-3

### 3) Pumping test

Pumping tests were conducted at each sites. Pumping test consists of four tests such as Preliminary test, Step drawdown test, Constant discharge rate test and Water level recovery test.

Result of the Step drawdown test is shown in Table 2.2-9. Result of the Constant discharge rate test were analyzed using the Thiem equation method as shown in Table 2.2-10. Specific Capacity is one of the useful indicator for pumping capacity of each well. According to the both pumping test results, TW-1 is assumed the best capacity among three test wells, due to higher value of Specific Capacity at TW-1. Though screen was installed in same aquifer (depth), TW-2 has less capacity than TW-1. It suggests that aquifer capacity changes horizontally in same aquifer. For that reason pumping test should be conducted after installation of new production well in future. Detailed analysis for the water supply plan is described in Chapter 2.3.3 “Water supply plan”.

Table 2.2-9: Result of the Step drawdown test

Well No.	Step	Discharge (m <sup>3</sup> /hr)	GWL (-m)	Drawdown (m)	Specific Capacity (m <sup>2</sup> /d)
TW-1			8.93		
	1	65.0	16.3	7.37	211.68
	2	72.5	17.66	8.73	199.2
	3	85.5	19.53	10.6	193.68
	4	89.5	20.52	11.59	185.28
	5	109.0	23.75	14.82	176.4
TW-2			8.44		
	1	66.5	23.88	15.44	103.44
	2	71.5	25.81	17.37	98.88
	3	77.5	26.1	17.66	105.36
	4	86.5	30.16	21.72	95.52
	5	96.5	32.45	24.01	96.48
TW-3			7.79		
	1	36.5	35.23	27.44	31.92
	2	40.5	39.51	31.72	30.72
	3	45.0	44.12	36.33	29.76
	4	49.0	48.28	40.49	29.04
	5	50.5	51.52	43.73	27.6

Source: JICA Study Team

Table 2.2-10: Analysis of the Constant discharge rate test

No.	Discharge (m <sup>3</sup> /hr)	Drawdown (m)	T (m <sup>2</sup> /d)	K		Specific Capacity (m <sup>2</sup> /d)
				(m/d)	(cm/sec)	
TW-1	105.7	13.89	284.53	7.69	8.90×10 <sup>-3</sup>	182.63
TW-2	93.9	24.38	144.01	4.00	4.63×10 <sup>-3</sup>	92.44
TW-3	51.6	40.97	47.09	1.88	2.18×10 <sup>-3</sup>	30.23

Source: JICA Study Team

### 4) Water quality analysis at laboratory

Water quality analysis at laboratory was conducted at each site. Water samples were taken at the ending time of the constant discharge rate pumping test. Laboratory test for water quality was carried out at the DPHE central laboratory in Dhaka. As the result of the water quality analysis at laboratory, some of parameters exceed the Bangladesh drinking water standard, especially Iron

concentration at TW-2 is more than ten time of the standard. This tendency is same as the result of the Existing well survey as mentioned above. It should be considered to use treatment process of Iron and Manganese for water supply in EZ area.

Table 2.2-11: Summary of the water quality analysis at laboratory

No.	Screen depth (m)	Arsenic (mg/L)	Chloride (mg/L)	Hardness (mg/L)	Iron (mg/L)	Manganese (mg/L)	pH
TW-1	260-295	0.001	122	205	0.42	0.31	7.2
TW-2	260-295	0.001	250	550	3.27	0.68	7.3
TW-3	81-105	0.003	16	235	0.44	0.14	7.1
Bangladesh standard		0.05	150 - 600	200 - 500	0.3 - 1	0.1	6.5 – 8.5
WHO standard		0.01	250	-	0.3	0.4	-

Source: JICA Study Team

### 5) Soil investigation

Drilling works for the soil investigation were conducted at fourteen sites. Outline of the survey results are shown in Table 2.2-12. Many soft clayey layers with low N-value have been confirmed at most of sites as shown in Table 2.2-13 and Table 2.2-14.

Detailed analysis of soil tests at laboratory and proposed countermeasure are shown in Chapter 4.3 “Consolidation settlement analysis”.

Table 2.2-12: Outline of the drilling results for soil investigation

Bore hole No	Coordinates		Elevation (EL+m)	Depth (GL-m)	Groundwater level (GL-m)	Number of undisturbed sample
	Latitude	Longitude				
ST--01	23°49'53.99" N	90°37'7.28"E	3.74	40.0	0.50	6
ST-02	23°49'14.25" N	90°37'18.43" E	2.72	40.0	0.35	6
ST-03	23°49'9.85"N	90°36'58.87" E	2.45	40.0	0.23	4
ST-04	23°49'36.16" N	90°37'27.39" E	2.94	40.0	0.35	4
ST-05	23°49'56.68" N	90°37'15.57" E	2.98	30.0	0.15	6
ST-06	23°49'46.28" N	90°37'30.07" E	2.77	30.0	0.72	4
ST-07	23°49'35.84" N	90°37'44.57" E	3.00	30.0	0.30	6
ST-08	23°49'45.22" N	90°37'16.10" E	2.62	30.0	0.45	5
ST-09	23°49'26.94" N	90°37'36.46" E	2.85	30.0	0.50	5
ST-10	23°49'33.15" N	90°37'11.02" E	2.50	30.0	0.20	3
ST-11	23°49'25.83" N	90°37'18.89" E	2.50	30.0	1.00	4
ST-12	23°49'30.41" N	90°36'53.87" E	2.75	30.0	0.25	3
ST-13	23°49'23.41" N	90°37'5.37"E	2.53	30.0	0.30	3
ST-14	23°49'9.33"N	90°37'28.06" E	2.65	30.0	0.20	6

Source: JICA Study Team

Table 2.2-13: Outline of the drilling results for soil investigation (1)

dept h (m)	N value / soil type													
	ST-1		ST-2		ST-3		ST-4		ST-5		ST-6		ST-7	
1	5	silt	7	clay	2	clay	4	clay	4	clay	3	silt	2	silt
2	5	clay	3	silt	3	clay	7	silt	11	clay	5	silt	2	silt
3	5	silt	4	silt	3	silt	3	silt	8	silt	8	silt	5	silt
4	9	silt	3	silt	1	silt	9	silt	6	silt	5	silt	7	silt
5	7	silt	4	silt	11	silt	5	silt	3	silt	6	silt	8	silt
6	4	silt	4	silt	11	silt	12	silt	10	fs	8	silt	8	silt
7	4	silt	5	silt	11	silt	9	silt	10	fs	12	silt	7	silt
8	9	silt	6	silt	12	silt	10	silt	11	fs	16	silt	31	silt
9	12	silt	16	silt	14	silt	8	silt	7	fs	15	silt	3	silt
10	29	silt	4	silt	9	silt	3	silt	4	silt	3	clay	4	silt
11	22	silt	2	silt	4	silt	2	silt	4	silt	2	clay	10	silt
12	17	silt	1	silt	1	silt	2	silt	4	clay	8	clay	12	silt
13	26	clay	1	silt	1	silt	2	silt	13	clay	15	clay	14	silt
14	14	clay	1	silt	1	silt	1	silt	8	clay	8	silt	9	silt
15	23	clay	1	silt	1	silt	9	fs	9	clay	12	silt	12	silt
16	27	clay	1	clay	1	silt	3	silt	17	clay	20	silt	13	silt
17	15	clay	1	clay	1	silt	2	silt	15	clay	19	silt	9	silt
18	13	clay	1	clay	1	silt	3	silt	12	clay	25	silt	9	silt
19	23	clay	1	clay	1	silt	30	silt	26	silt	40	silt	11	silt
20	50+	silt	1	clay	1	silt	38	silt	23	silt	29	silt	19	silt
21	50+	fs	1	clay	1	silt	48	silt	30	silt	33	silt	23	clay
22	50	fs	1	clay	1	silt	50+	fs	36	silt	36	fs	50+	fs
23	29	fs	1	clay	1	silt	50+	fs	35	fs	41	fs	50+	fs
24	48	fs	1	clay	1	silt	46	silt	41	fs	38	fs	50+	fs
25	50	fs	1	clay	1	silt	50+	fs	46	fs	50+	fs	50+	fs
26	47	fs	1	clay	27	fs	50+	silt	43	fs	50+	fs	50+	fs
27	44	fs	1	clay	22	silt	50+	silt	46	fs	42	fs	44	fs
28	50	fs	1	clay	12	silt	50+	silt	50+	fs	40	fs	42	fs
29	50+	fs	33	silt	11	silt	50+	fs	50+	fs	45	fs	50+	fs
30	50+	fs	50	silt	42	fs	50+	fs	50+	fs	50+	fs	50+	fs
31	50+	fs	36	silt	29	silt	50+	fs	-	-	-	-	-	-
32	50+	fs	36	silt	26	silt	50+	fs	-	-	-	-	-	-
33	50+	fs	39	silt	24	silt	50+	fs	-	-	-	-	-	-
34	50+	fs	50+	silt	24	silt	50+	fs	-	-	-	-	-	-
35	50+	fs	50+	silt	22	silt	50+	fs	-	-	-	-	-	-
36	50+	fs	50+	silt	25	silt	50+	fs	-	-	-	-	-	-
37	50+	fs	50+	silt	24	silt	50+	silt	-	-	-	-	-	-
38	50+	silt	50+	silt	27	silt	50+	silt	-	-	-	-	-	-
39	50+	silt	50+	silt	20	silt	50+	silt	-	-	-	-	-	-
40	50+	silt	50+	silt	19	silt	50+	silt	-	-	-	-	-	-

\* N value 1 and 2: Red color, N value 3 to 5: Yellow color

Source: JICA Study Team

Table 2.2-14: Outline of the drilling results for soil investigation(2)

dept h (m)	N value / soil type													
	ST-8		ST-9		ST-10		ST-11		ST-12		ST-13		ST-14	
1	6	silt	7	silt	5	silt	6	silt	5	silt	7	clay	5	silt
2	3	silt	4	silt	6	silt	7	silt	7	silt	9	silt	7	silt
3	2	silt	3	silt	7	silt	4	silt	4	silt	8	silt	7	silt
4	3	silt	3	silt	5	silt	6	silt	15	silt	5	silt	8	silt
5	7	fs	6	silt	3	silt	12	fs	19	fs	4	silt	9	silt
6	5	fs	8	silt	4	silt	11	fs	18	fs	6	silt	9	silt
7	8	fs	9	silt	18	fs	15	fs	10	silt	8	silt	10	silt
8	15	silt	20	fs	16	silt	13	fs	11	silt	7	silt	8	silt
9	18	silt	21	fs	16	silt	8	silt	7	silt	36	fs	9	silt
10	3	clay	15	silt	20	fs	9	silt	5	silt	4	silt	31	silt
11	3	clay	12	silt	2	silt	10	silt	8	silt	2	silt	33	fs
12	6	clay	8	silt	1	silt	6	silt	5	silt	1	silt	6	silt
13	4	clay	3	silt	2	silt	2	silt	1	silt	1	silt	2	silt
14	8	clay	3	silt	2	silt	1	silt	2	silt	2	silt	3	silt
15	8	clay	2	silt	2	silt	1	silt	3	silt	1	silt	2	silt
16	9	clay	3	silt	2	silt	1	silt	1	silt	1	silt	1	silt
17	7	silt	2	silt	2	silt	1	silt	1	silt	2	silt	1	silt
18	7	clay	3	silt	3	silt	2	silt	2	silt	2	silt	2	silt
19	21	silt	5	silt	1	silt	2	silt	3	silt	3	silt	2	silt
20	19	silt	30	fs	1	silt	7	silt	2	silt	2	silt	3	silt
21	28	silt	40	fs	1	silt	8	silt	3	silt	3	silt	1	silt
22	14	clay	21	silt	4	silt	4	silt	4	silt	4	silt	2	silt
23	12	clay	15	clay	3	silt	5	silt	4	silt	5	silt	2	silt
24	44	fs	47	fs	4	silt	5	silt	5	silt	6	silt	2	silt
25	47	fs	50	fs	5	silt	31	fs	5	silt	5	silt	1	silt
26	48	fs	50+	fs	4	silt	31	fs	8	clay	9	clay	3	silt
27	50+	fs	44	fs	5	silt	40	fs	10	clay	8	clay	2	silt
28	50+	fs	45	fs	4	silt	44	fs	21	clay	16	clay	4	silt
29	50+	fs	50	fs	29	fs	41	silt	14	clay	14	clay	3	silt
30	50+	fs	50	fs	50+	fs	42	silt	13	fs	18	fs	4	silt

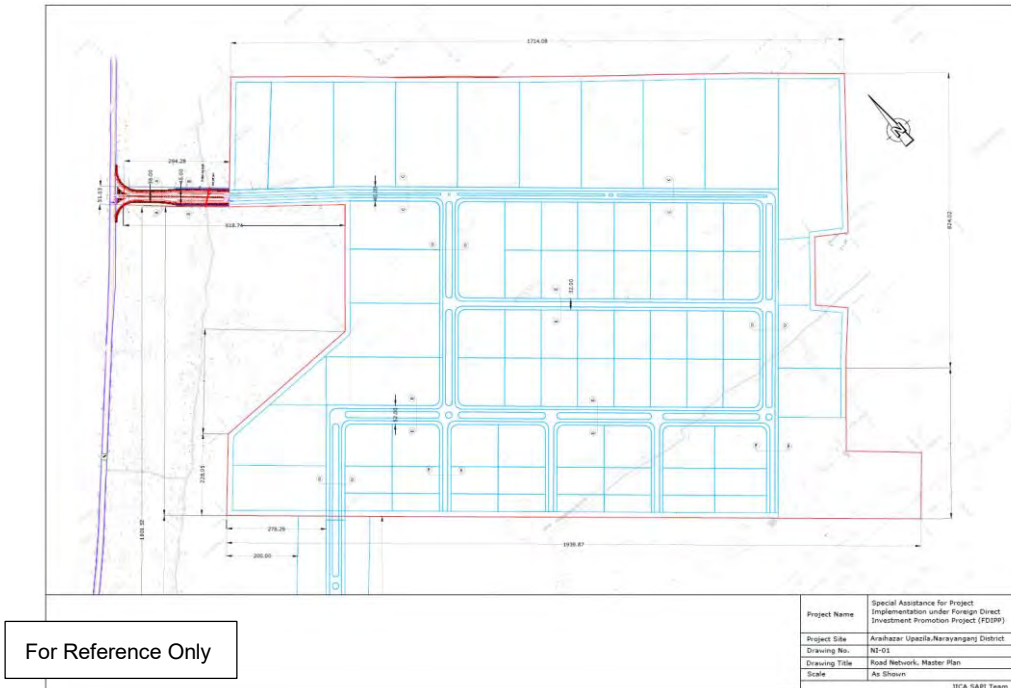
\* N value 1 and 2: Red color, N value 3 to 5: Yellow color

Source: JICA Study Team

## 2.3 On-site basic infrastructure plan

### 2.3.1. Internal road plan

All internal roads in the Araihaazar EZ area have four (4) lanes carriageway, with 2.5m shoulders on their sidewalk sides so that accidents and parking of trucks and other vehicles while waiting will not obstruct traffic. The internal road network plan for Phase-1 is shown in Figure 2.3-1.



For Reference Only

Source: JICA Study Team

Figure 2.3-1: Internal road network plan in Araihaazar EZ

Main road with canal (Section D-D) have a 20m width retention canal in the center, and the total road width is 52m. Main road without canal (Section C-C) and sub-road (Section E-E) have the ROW of 40m and 32m respectively. Internal road sections in Araihaazar EZ are shown in Figure 2.3-2.

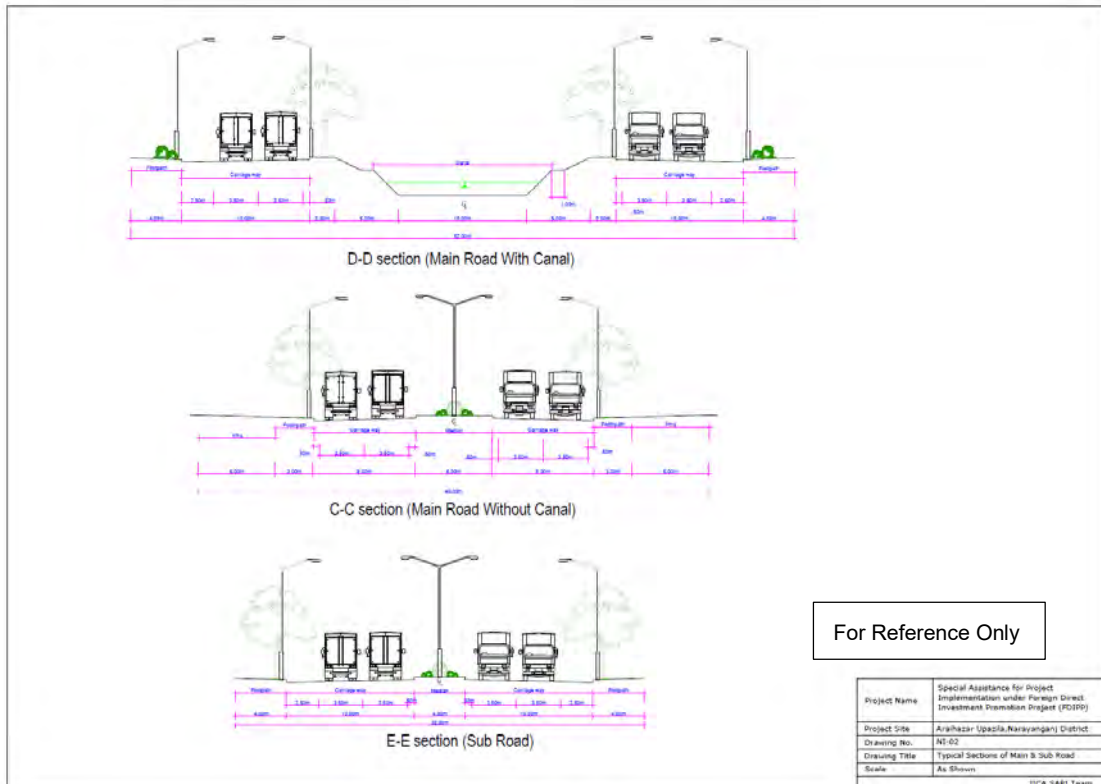


Figure 2.3-2: Internal road section in Araihaazar EZ

Internal road dimension and road area are shown in Table 2.3-1

Table 2.3-1: Road dimension in Araihaazar EZ

Road Type	Road Width (m)	Road Length (m)	Road Area (m <sup>2</sup> )
Main Road (w/canal)	52 m (including 20m canal)	3,536 m	183,872 m <sup>2</sup> (Water surface 70,720m <sup>2</sup> )
Main Road (w/o canal)	40 m	1,534 m	61,360 m <sup>2</sup>
Sub-Road	32 m	1,810 m	30,600 m <sup>2</sup>
Total		6,880 m	275,832 m <sup>2</sup>

Source: JICA Study Team

### 2.3.2. Rainwater drainage plan

Rainwater drainage ditches will be located on both sides of internal roads and drain rainwater to the canal located along the 52m main road. A retention pond is planned to be located at the terminal of the canal, and it will have adequate storage enabling it to perform the flow regulating functions, reducing the impact of the change in the runoff rate associated with land development, and also part of the pump drainage functions during flooding.

The rainwater drainage facility plan will apply the 10-year return period rainfall intensities shown in Table 2.3-2. The runoff rate from the site of each factory and other structure, is planned to be 0.6, assuming a building coverage ratio from 50 to 60%. The rainwater drainage facility gradient is

planned to be 0.1%.

Table 2.3-2: Rainfall intensity in Dhaka

Return Period	Rainfall Intensity (mm/hr) in given duration						
	15 min	30 min	1 hour	2 hour	3 hour	6 hour	12 hour
1.1	73.50	59.90	39.60	22.00	14.00	7.10	4.30
2	92.40	78.60	56.20	36.70	27.00	15.40	9.40
5	109.70	95.70	71.40	50.10	39.00	23.00	14.10
10	121.10	107.00	81.40	58.90	46.90	28.00	17.30
25	135.60	121.30	94.10	70.10	56.90	34.30	21.20
50	146.30	132.00	103.50	78.40	64.30	39.00	24.10

Source: Drainage Master Plan, Gazipur Pourashava, Final Report. LGED, UGII Project, January 2006

The flow rate to be carried downstream is the “50-year return period” rainfall, and the convergence time of flow from the furthest location for the 200ha planned area is assumed to be “1 hour”, and the rainfall intensity is calculated as about “100mm/hour.”

The planned flow rate is about 33.3m<sup>3</sup>/s according to the following formula.

$$Q = 1/3.6 \cdot f \cdot r \cdot A \quad (\text{rational formula})$$

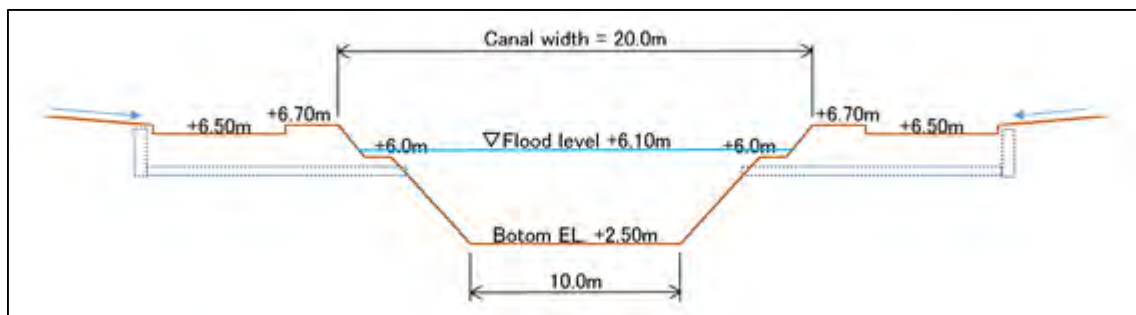
Q: flow rate (m<sup>3</sup>/s)

f: runoff coefficient

r: rainfall intensity

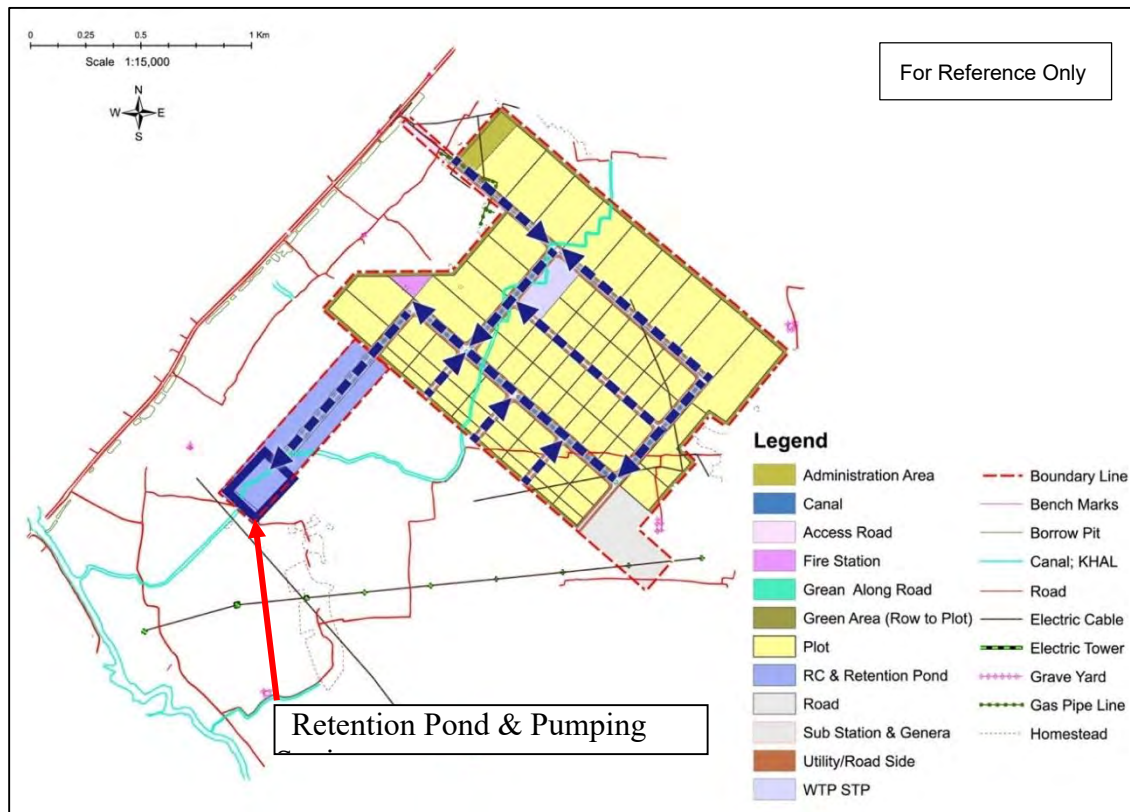
A: catchment area (km<sup>2</sup>)

The flow capacity of the planned canal is calculated, assuming the roughness coefficient is 0.035 and the water surface gradient is 0.02%, to be about 34.3m<sup>3</sup>/s when the water depth is 3.6m (meaning water surface elevation is EL.6.1m, if the canal bottom elevation is considered to be EL.2.5m), and it can accommodate the planned flow rate.



Source: JICA Study Team

Figure 2.3-3: Schematic plan for main road canal in Araihaazar EZ



Source:

JICA Study Team

Figure 2.3-4: Rainwater drainage plan in Araihaazar EZ

### 2.3.3. Water supply plan

The unit quantity of water used is assumed to be 35m<sup>3</sup>/day/ha for the entire development area, in view of targeted industries in the Araihaazar EZ. The total quantity of water required is calculated to be 7,000m<sup>3</sup>/day for the 200ha EZ development.

As shown in the result of the pumping test of the three (3) test wells (Table 2.3-3) conducted during the survey, about 5,000m<sup>3</sup>/day amount of water could be provided by utilizing deep ground water from test wells of TW-1 and TW-2. Another 2,000m<sup>3</sup>/day amount of water will be provided by utilizing deep ground water in the water supply facilities area.

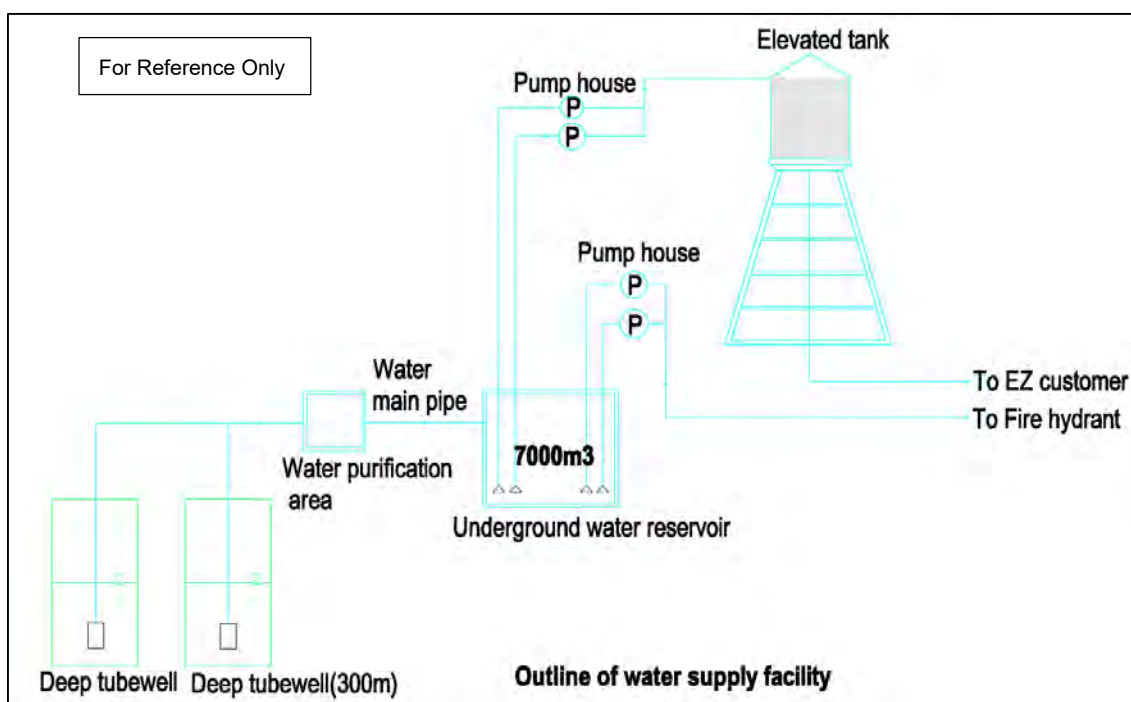
Water supply facilities are schematically shown in Figure 2.3-5. The capacity of the water storage tank will be equivalent to one day's water requirement of 7,000m<sup>3</sup>. Capacity of an elevated water tank will ensure supply for about 1 hour. Assuming that one fire hydrant will cover an area with a radius of about 100m, fire hydrants will be installed at intervals of about 150m.

Water transmission pipes from test wells are to be connected to the underground water reservoir, as shown in Table 2.3-3.

Table 2.3-3: Water transmission pipe

	Water Transmission Pipe	Pipe size	Pipe length
1	TW-1 ~ Water reservoir	200mm HDPE*	963 m
2	TW-2 ~ Water reservoir	200mm HDPE*	865 m
	Total		1,828 m

Source: JICA Study Team Note) HDPE: High Density Polyethylene Pipe



Source: JICA Study Team

Figure 2.3-5: Schematic diagrams of water supply facility in Araihaazar EZ

Water distribution pipelines are shown in Figure 2.3-6. The size and length of wastewater pipelines are tabulated in Table 2.3-4.



Source:

JICA Study Team

Figure 2.3-6: Water distribution pipelines

Table 2.3-4: Water distribution pipelines data

	Wastewater pipe	Pipe length
1	HDPE pipe: 300mm dia.	1,424 m
2	HDPE pipe: 250mm dia.	1,794 m
3	HDPE pipe: 200mm dia.	2,295 m
4	HDPE pipe: 150mm dia.	2,573 m
5	HDPE pipe: 100mm dia.	2,378 m
6	HDPE for hydrant: 100mm dia.	6,250 m
	Total	16,678 m

Source: JICA Study Team

Note) HDPE: High Density Polyethylene Pipe

### Water Sources analysis

The availability of water source was determined by both water quantity and quality which were analyzed based on the results of the pumping test for groundwater and the laboratory test.

As the results of the pumping tests, more than 100m<sup>3</sup>/hr is technically available to pump up from deep aquifer. From the perspective of environmental issue, a permissible yield should be considered to protect the safe groundwater level at existing wells around the EZ area. The circle of influence under TW-1 condition was analyzed using the Sichart formula as shown in Table 2.2-12. It is expected to keep less than 2m drawdown of groundwater level, less than 3m drawdown of groundwater level also will be acceptable depend on the statistic water level at existing well. According to the result of existing well survey, the nearest deep tube well from TW-1 is located to the distance of 100m, next one is located 200m. In that case, the groundwater discharge range should be considered from 1,200 to 1,800 m<sup>3</sup>/day at each production deep well.

From the water quality aspect, treatment process of Iron and Manganese should be considered in order to supply safe water in EZ area. Iron removal plants are constructed and operated in many purashava and city cooperation in Bangladesh. But Manganese treatment is not popular in Bangladesh. One research project under Unicef fund which implemented by Asia Arsenic Network had achieved good performance of Manganese removal for community based water supply in Bangladesh. Such technology and experience might be applied to water supply system in EZ area.

Table 2.3-5: Analysis of the circle of influence under TW-1 condition

Discharge (m <sup>3</sup> /d)	Calculated drawdown of groundwater level (m) at distance from pumping well						
	0m	10m	50m	100m	200m	500m	1000m
1,200	6.35	3.54	2.45	1.99	1.53	0.91	0.45
1,400	7.42	4.13	2.87	2.33	1.78	1.07	0.52
1,600	8.48	4.72	3.28	2.66	2.04	1.22	0.60
1,800	9.54	5.31	3.69	2.99	2.29	1.37	0.67
2,000	10.60	5.90	4.10	3.32	2.55	1.52	0.75
2,200	11.66	6.49	4.51	3.66	2.80	1.68	0.82

Source: JICA Study Team

#### 2.3.4. Sewerage plan

The capacity of the wastewater treatment facilities will be set to treat 80% of the quantity of water supplied, and in the future, also to treat the wastewater from the expanded area. The wastewater transport pipes on one side of the canal will be large enough to carry all the wastewater from the expanded area. The wastewater from the expanded area, however, will be pumped up by a relay pump at the end of the flow in the expanded area, and connected to the wastewater pipe for the initial development.

The wastewater treatment process will be the activated sludge or other method that can ensure treated water quality allowed to be discharged. National standards for discharge quality for industrial wastewater by parameter are shown in Table 2.3-6.

Table 2.3-6: Wastewater discharge quality standards for industrial water

**Table 3.3: National Standards – Waste Discharge Quality Standards for Industrial Units and Projects: Quality at Discharge Point**

Parameter	Unit	Location of Final Disposal		
		Inland Surface Water <sup>1</sup>	Public Sewer <sup>1</sup>	Irrigated Land <sup>1</sup>
Ammonia (free ammonia)	mg/L	5	5	15
Ammoniacal Nitrogen (as N)	mg/L	50	75	75
Arsenic (As)	mg/L	0.2	0.5	0.2
BOD <sub>5</sub> 20°C	mg/L	50	250	100
Boron (B)	mg/L	2	2	2
Cadmium (Cd)	mg/L	0.05	0.5	0.5
Chloride (Cl)	mg/L	600	600	600
Chromium (hexavalent Cr)	mg/L	0.1	1.0	1.0
Chromium (total Cr)	mg/L	0.5	1.0	1.0
COD	mg/L	200	400	400
Copper (Cu)	mg/L	0.5	3.0	3.0
Cyanide (CN)	mg/L	0.1	2.0	0.2
Dissolved Oxygen (DO)	mg/L	4.5-8	4.5-8	4.5-8
Dissolved Phosphorus (P)	mg/L	8	8	10
Electrical Conductivity	µMho/cm	1200	1200	1200
Fluoride (F)	mg/L	7	15	10
Iron (Fe)	mg/L	2	2	2
Lead (Pb)	mg/L	0.1	0.1	0.1
Manganese (Mn)	mg/L	5	5	5
Mercury (Hg)	mg/L	0.01	0.01	0.01
Nickel (Ni)	mg/L	1.0	1.0	1.0
Nitrate (N molecule)	mg/L	10.0	Undetermined	10.0
Oil and Grease	mg/L	10	20	10
pH		6-9	6-9	6-9
Phenol Compounds (C <sub>6</sub> H <sub>5</sub> OH)	mg/L	1.0	5	1
Radioactive Materials	As determined by Bangladesh Atomic Energy Commission			
Selenium (Se)	mg/L	0.05	0.05	0.05
Sulfide (S)	mg/L	1	2	2
Temperature – Summer	°C	40	40	40
Temperature – Winter	°C	45	45	45
Total Dissolved Solids (TDS)	mg/L	2100	2100	2100
Total Kjeldahl Nitrogen (N)	mg/L	100	100	100
Total Suspended Solids (TSS)	mg/L	150	500	200
Zinc (Zn)	mg/L	5.0	10.0	10.0

Notes: (1) *Land Surface Water* refers to any pond, tank, water body, water hole, canal, river, spring or estuary  
*Public Sewer* refers to any sewer connected with fully combined processing plant including primary and secondary treatment  
*Irrigated Land* refers to an appropriately irrigated plantation area of specified crops based on quantity and quality of wastewater

The scale of the wastewater treatment facilities will be set to treat the quantity of water supplied for domestic waste and toilet waste, and also to treat the wastewater from the tenant area. Domestic wastewater of each tenant factory (kitchen and toilet wastewater) is treated by the central processing facility in Phase-1 area. Industrial wastewater from each tenant factory should be processed to an acceptable drainage level at each plant ETP facility. After treating the wastewater, the tenant will send it to STP of EZ whose general flow chart for treatment is shown in Figure 2.3-7. When the wastewater is treated to the acceptable level, it will be released to the adjacent waterbody.

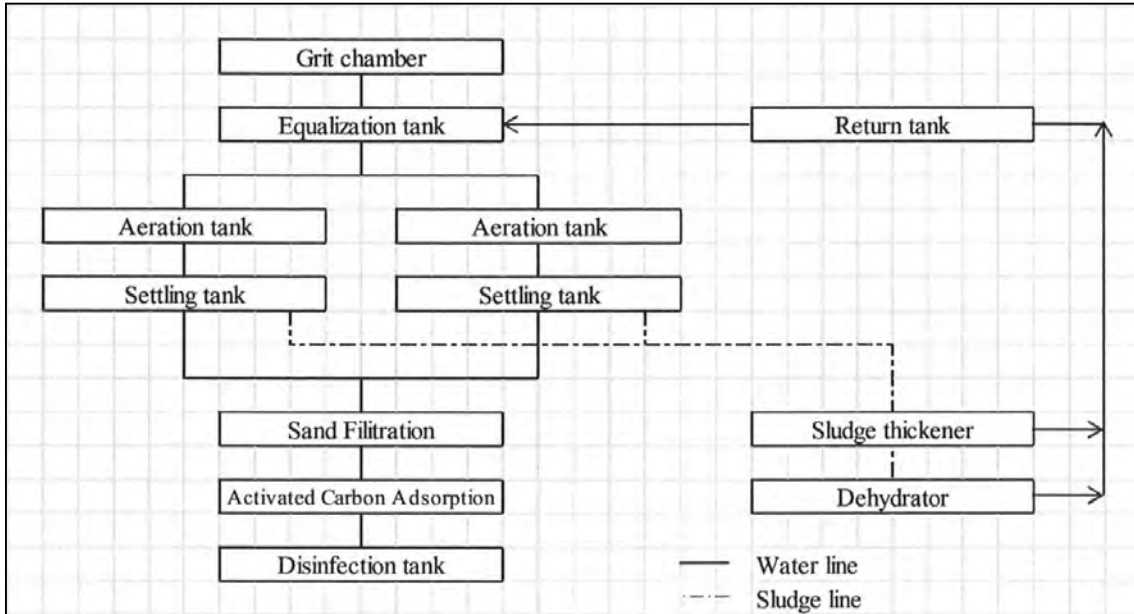
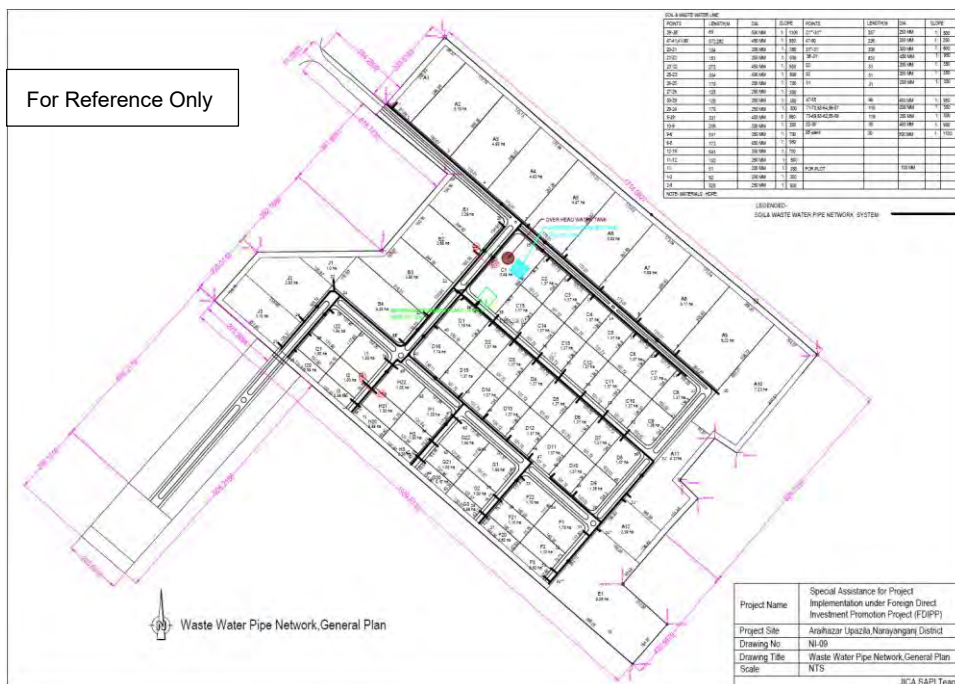


Figure 2.3-7: Flow chart for wastewater treatment system

Minimum diameter of 200mm, gradient of 0.1%, flow rate of at least 0.3m/s, and soil cover of at least 0.5m will be ensured for wastewater transmission pipes. Manholes for maintenance will be set at every 50m to 100m and at junction points. Wastewater pipelines are shown in Figure 2.3-8. The size and length of wastewater pipelines are tabulated in Table 2.3-7.



Source: JICA Study Team

Figure 2.3-8: Wastewater pipelines

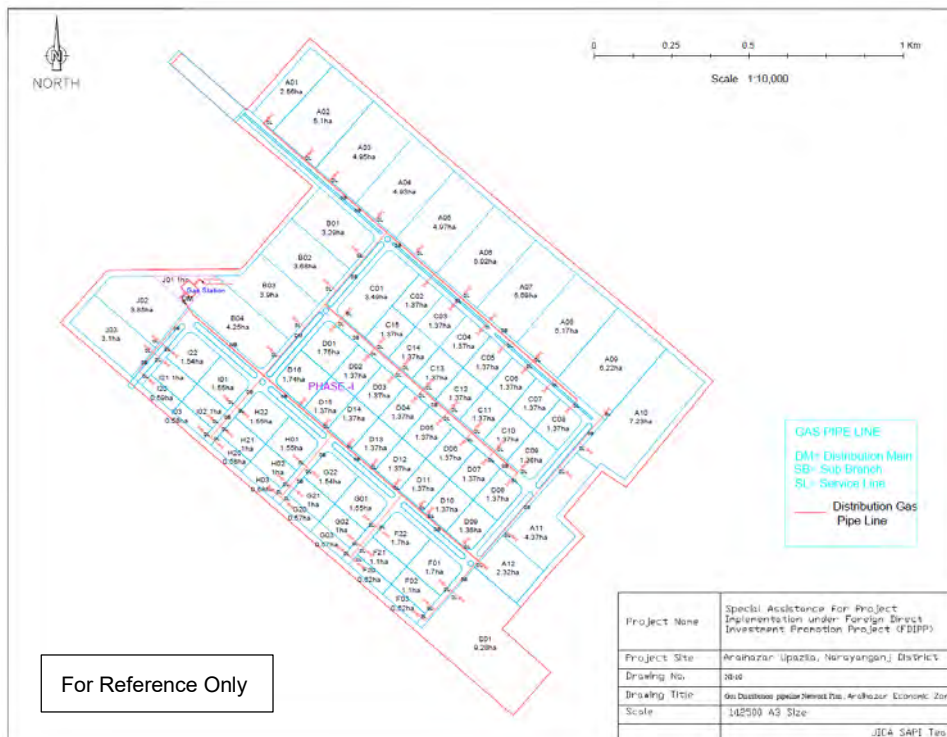
Table 2.3-7: Wastewater pipelines data

	Wastewater pipe	Pipe length
1	Concrete pipe: 200mm dia.	785 m
2	Concrete pipe: 250mm dia.	1,566 m
3	Concrete pipe: 300mm dia.	308 m
4	Concrete pipe: 350mm dia.	1,328 m
5	Concrete pipe: 400mm dia.	304 m
6	Concrete pipe: 450mm dia.	2,548 m
7	Concrete pipe: 500mm dia.	95 m
	Total	6,934 m

Source: JICA Study Team

**2.3.5. Gas distribution plan**

In the EZ area, gas supply facilities including a gas station will be installed in the fire station area in Phase-1. The use of gas in the EZ is predicted to be for general use, industrial use and power generation use. Gas will be distributed in 100-300mm diameter pipes from the gas station. Gas distribution pipelines are shown in Figure 2.3-9. The size and length of gas distribution pipelines are tabulated in Table 2.3-8.



Source: JICA Study Team

Figure 2.3-9: Gas distribution pipelines

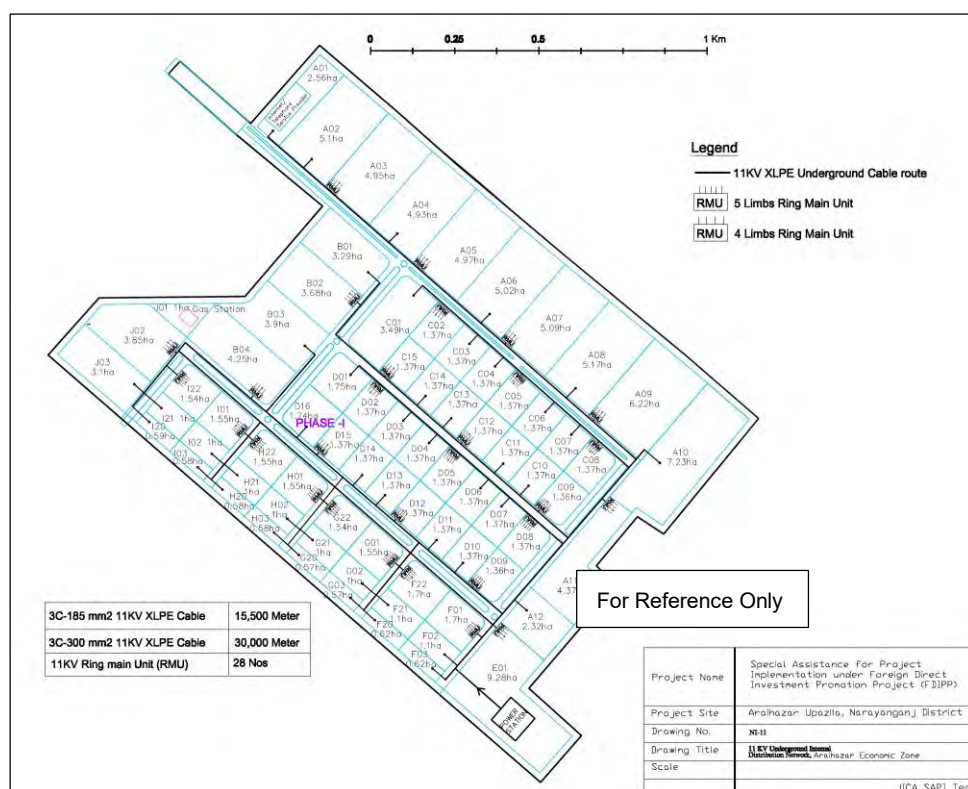
Table 2.3-8: Gas distribution pipeline data

	Gas distribution pipe	Pipe length
1	Black steel carbon pipe: 300mm dia.	2,592 m
2	Black steel carbon pipe: 250mm dia.	2,592 m
3	Black steel carbon pipe: 200mm dia.	762 m
4	Black steel carbon pipe: 150mm dia.	878 m
5	Black steel carbon pipe: 100mm dia.	1,760 m
	Total	8,584 m

Source: JICA Study Team

### 2.3.6. Power distribution plan

Electric power is distributed to each lot by 11kV cables from the planned power station. Power distribution lines are shown in Figure 2.3-10. Power distribution system including 11kV cable and related equipment is tabulated in Table 2.3-9.



Source: JICA Study Team

Figure 2.3-10: 11kV power distribution line

Table 2.3-9: Power distribution system data

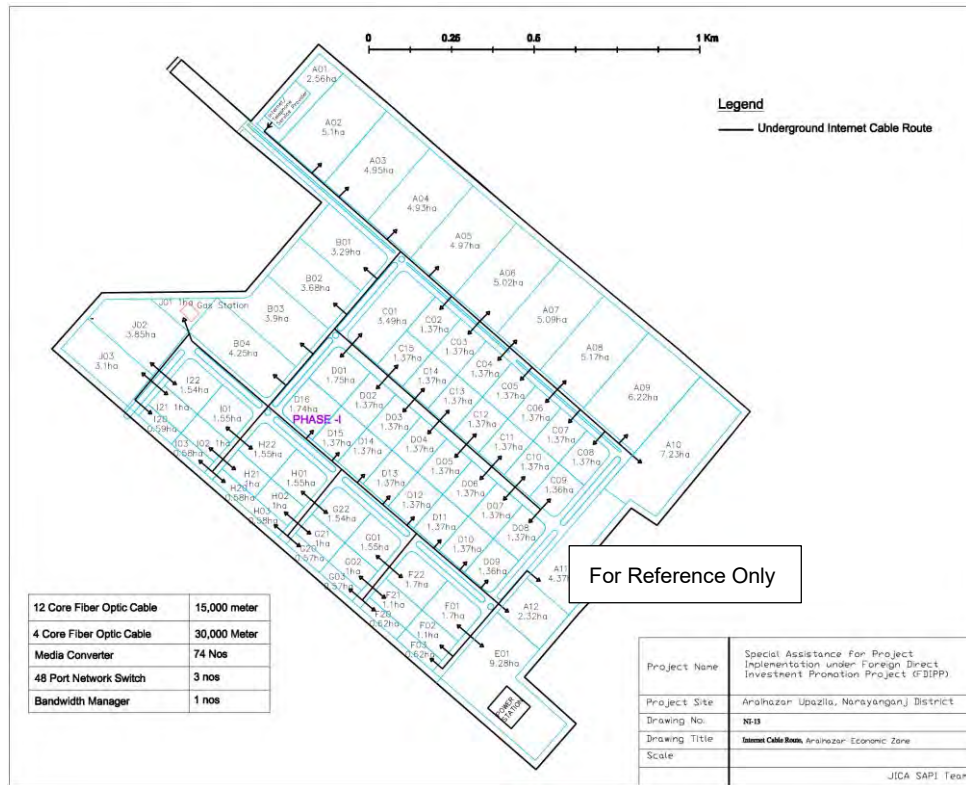
	Power distribution system	Quantity
1	3C-185mm <sup>2</sup> 11kV AC-XLPE* cable.	15,500 m
2	3C-300mm <sup>2</sup> 11kV AC-XLPE* cable.	30,000 m
3	11kV Ring Main Unit (RMU)	28 Nos

Source: JICA Study Team

Note) XLPE: Crosslinked Polyethylene

### 2.3.7. Telecommunication distribution plan

Telecommunication lines are distributed to each lot by optical fiber cables from the exchange station in the administration area. Internet distribution system is shown in Figure 2.3-11. Optic fiber cables and related equipment of internet distribution system are tabulated in Table 2.3-10.



Source: JICA Study Team

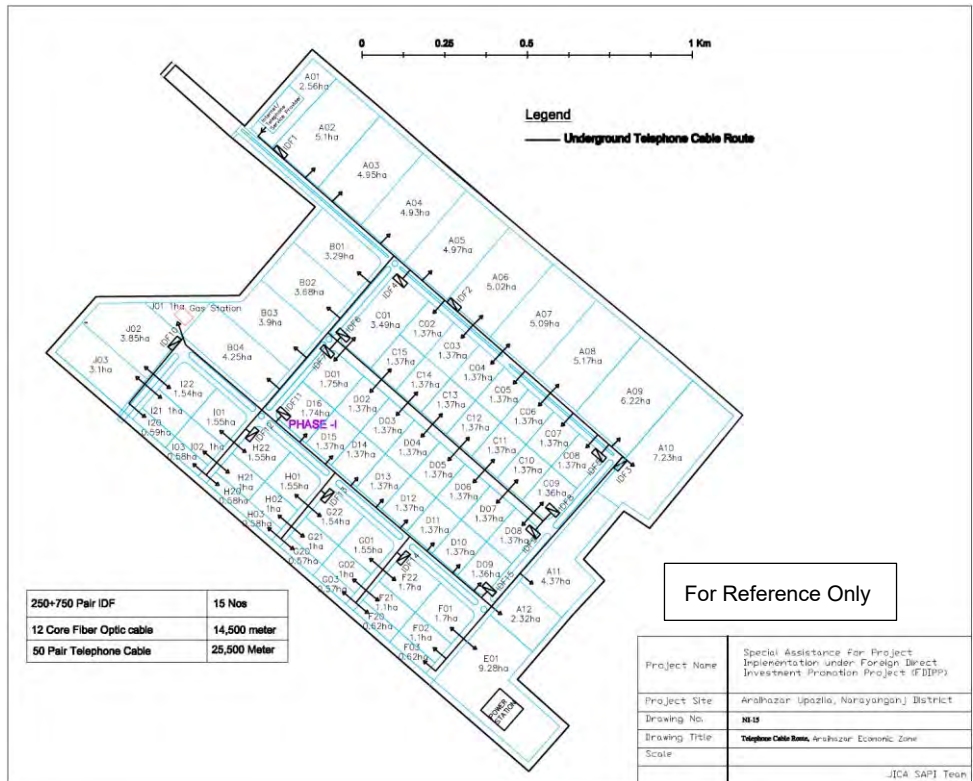
Figure 2.3-11: Internet distribution system

Table 2.3-10: Internet distribution system data

	Internet distribution system	Quantity
1	12-core optic fiber cable.	15,000 m
2	4-core optic fiber cable.	30,000 m
3	Media converter	74 Nos
4	48-port network switch	3 Nos
5	Bandwidth manager	1 no.

Source: JICA Study Team

Telephone distribution system is shown in Figure 2.3-12. Optic fiber cables and related equipment of telephone distribution system are tabulated in Table 2.3-11.



Source: JICA Study Team

Figure 2.3-12: Telephone distribution system

Table 2.3-11: Telephone distribution system data

	Telephone distribution system	Quantity
1	250+750 pair IDF*	15 Nos
2	12-core optic fiber cable.	14,500 m
3	50-pair telephone cable	25,500 m

Source: JICA Study Team>Note) IDF: Intermediate Distributing Frame

## 2.4 Off-site basic infrastructure sub-projects

### 2.4.1 Land development

#### (1) Land development plan

The land development elevation for Araihazar EZ development has been decided as follows:

The probable high water levels at existing gauge stations of Bangladesh are calculated for each defined return period of rainfall. Then the high water level of the site was calculated by the weighted average method, based on the calculated probable high water levels of three nearby national water stations.

The difference between calculated probability water level and the terrain elevation obtained by other methods, such as digital mapping, is the minimum value of land development height (thickness). The final site formation height is the sum of land development height, margin height for rainwater drainage, and freeboard.

#### <Planning policy>

- Maximum flood level is EL. 6.5m (see Table 2.4-1) and 100 year flood level is EL. 7.4m.
- The standard land development level is set at EL. 6.5m, where factory lot is not flooded even if maximum flood occurs or drain pumps not working.

- The top elevation of the bank is set at EL. 8.0m which corresponds to 100 year flood level plus 0.5m freeboard. When the water level is higher than the water level inside, water is drained by pumps.
- Surplus water shall be retained in the retention pond to accommodate the balance between runoff coefficients after the development (0.6) and before the development (0.3).

In order to confirm the real site flood levels of Araihaazar, face-to-face surveys were conducted for residents and upazilas of the candidate site in the previous study. The main target high water levels are obtained from hearing surveys to local residents (patriarchs) who experienced the 1988 and 1998 floods, and then converted to the altitude of digital mapping. According to the results of these surveys, the past average flood water level of Araihaazar was + 6.3 m. The past flood water levels of Araihaazar was affected by the high water level of the nearby rivers, and can be treated as a static water surface for simplicity.

Table 2.4-1: Flooding trace survey of Araihaazar

Survey point No.	Trace water level high (MSL±0.00 m)
Fmh 1	+6.0
Fmh 2	+6.5
Fmh 3	+6.5
Fmh 4	+5.8
Fmh 5	-
Fmh 6	+6.3
Fmh 7	-
Fmh 8	+6.3
<b>Average water level</b>	<b>+6.3</b>

Position of Flooding Trace Survey Points of Araihaazar	
--	--

Source: Previous survey by JICA

- (2) Land development design

Land gradient is designed according to the land development plan as shown in Figure 2.4-1 and Figure 2.4-2.

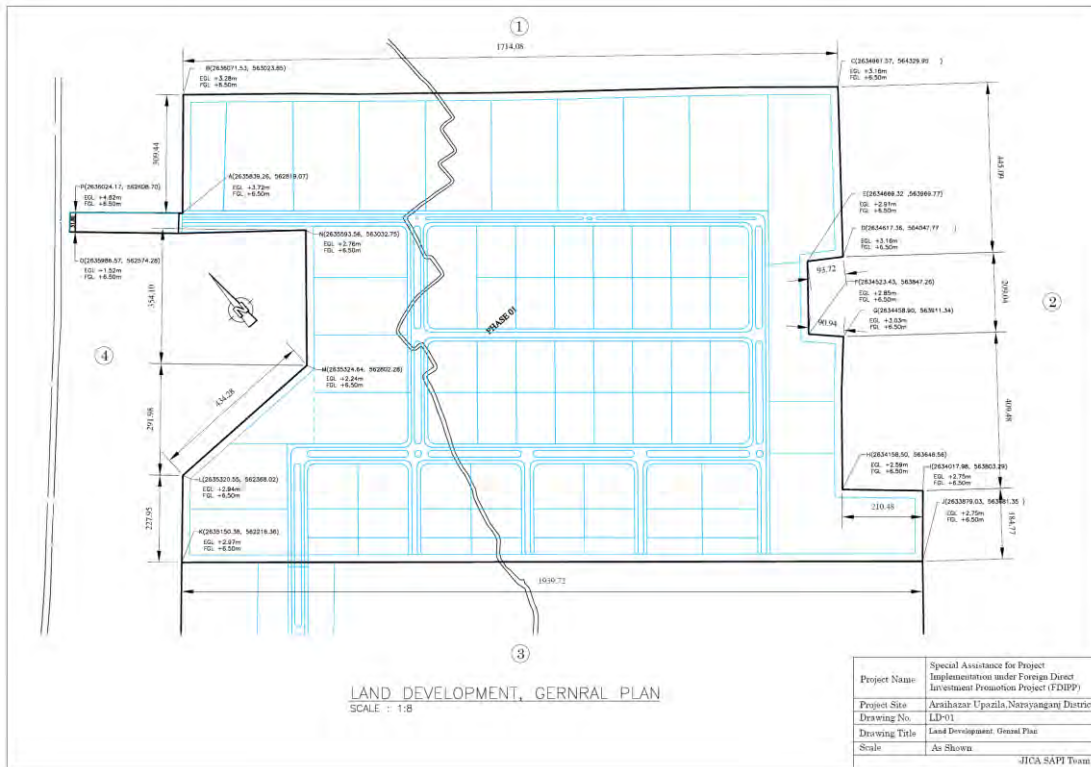


Figure 2.4-1: Land development plan

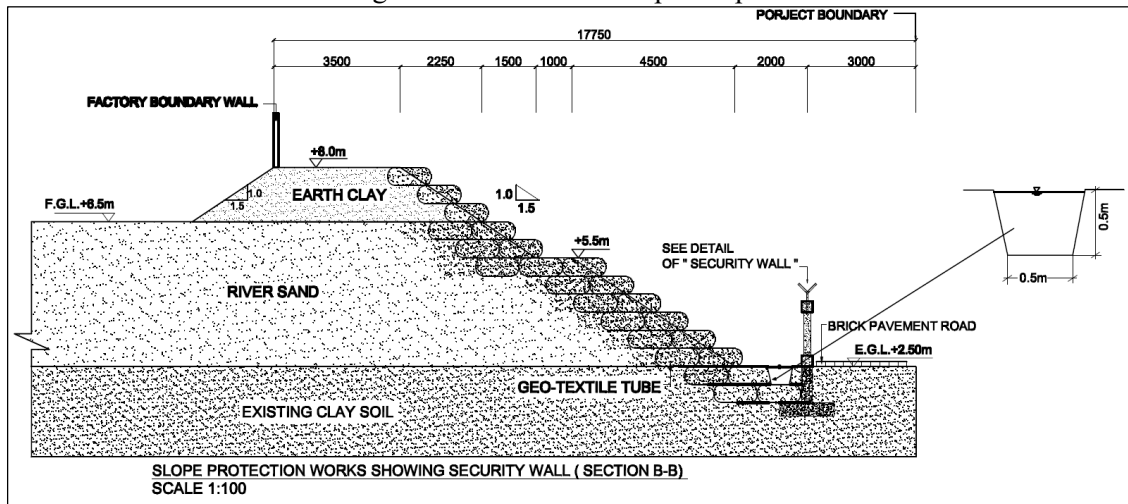


Figure 2.4-2: Land development typical section

(3) Construction plan

Approximately 9,000,000 m<sup>3</sup> dredged material will be required to develop the project site.

**Proposed borrow site for dredged materials**

JICA Study Team has identified candidate sites for loading dredged material for the land development based on hearing from local consultants and local dredging contractors. The site is situated along the Meghna River at northern side of the Meghna industrial area. Dredging depth will be assumed at 1-2 m. Figure 2.4-3 shows the candidate borrow sites for fill material. Approximately 1,000,000 m<sup>3</sup> sand would be dredged from each borrow site. Contractors will need to acquire permission by the Ministry of Communication each time they need to change their borrow sites.



**Figure 2.4-3** : Candidate borrow sites for fill material (approximately 1,000,000m<sup>3</sup>/site) Source: Google Earth-image has been partially modified by JICA Study Team.



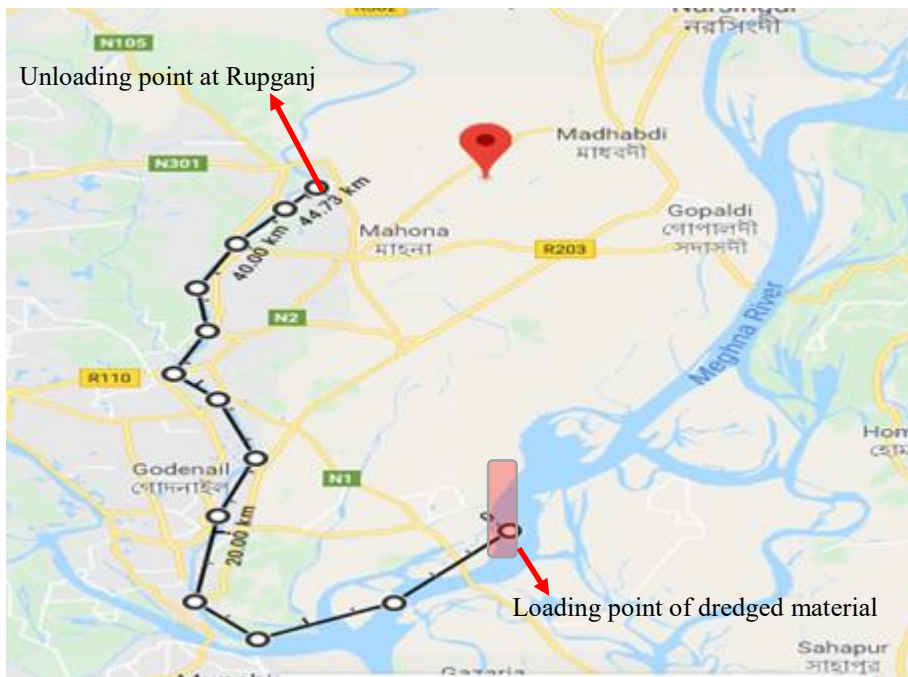
**Figure 2.4-3:** Candidate Borrow Sites at Meghna River

### Transportation of dredged materials

Sand materials are dredged from the river bed at the Meghna River by pumping up. The dredged material will be transported using sand carrier vessel from the loading point through the Sitalakhya River to nearby Atlapur Bazar of Rupganj. The distance between loading and unloading points is approximately 45 km. Dredging scenes and expected water transportation route are shown in photos below and in Figure 2.4-4, and unloading point is shown in Figure 2.4-5.

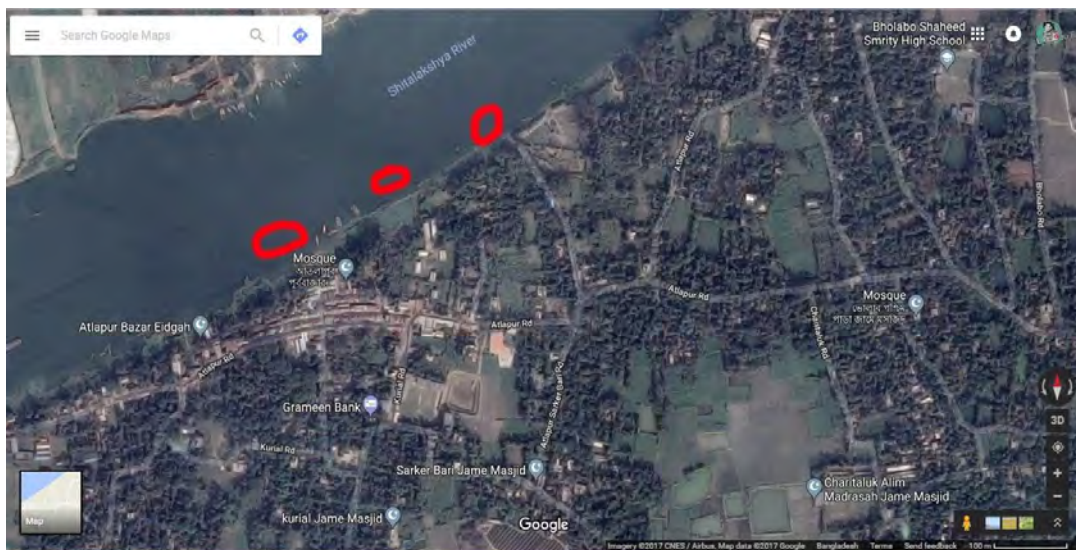


Dredging of fill material from the river bed at Meghna river by pumping up



Source: Google Map-image has been partially modified by JICA Study Team.

Figure 2.4-4: Transport route of dredged materials to the unloading point



Source: Google Map-image has been partially modified by JICA Study Team.

Figure 2.4-5: Unloading point nearby Atlapur Bazar at Rupganj of Narayanganj

### **Pumping of dredged sand materials**

Dredged sand will be pumped out from the sand carrier vessel to 12-inch pipeline up to the EZ site. Approximate alignment of the pipeline route is shown in Figure 2.4-6.



Source: Google Map-image has been partially modified by JICA Study Team.

Figure 2.4-6: Pipeline route from unloading point to the Araihasar EZ site

A booster pump will be set on the Sitalakhya River at the unloading point, and four boosters will be installed for each pipeline to carry out sand materials from unloading point to the EZ site, which is illustrated in Figure 2.4-7.

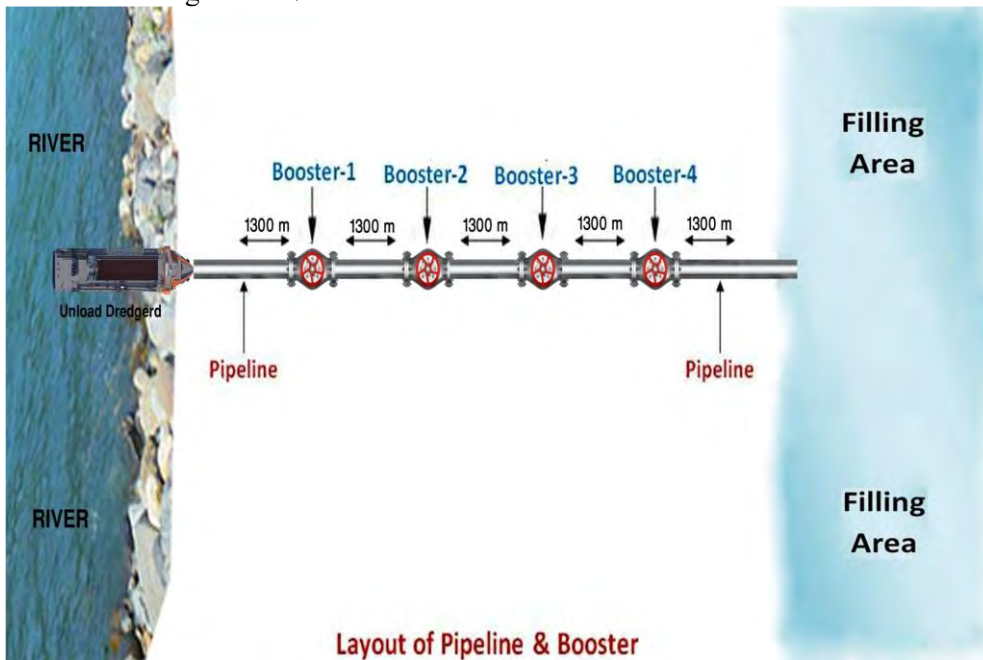


Figure 2.4-7: Construction method of sand pumping

### Example of temporary pipelines for pumping of sand material



Culvert bridge on Dhaka-Sylhet highway near EZ for temporary pipelines



### Construction equipment

Dimensions of construction equipment are estimated as follows;

- No. of lines = 12 pipelines
- Booster points = 4 nos/pipeline.
- 300mm (12inch) diameter pipelines: = 6,000 m – 7,000 m
- 1,200m<sup>3</sup>/day/line = 15,000m<sup>3</sup>/day

The images below show other land reclamation works for EZ development in Bangladesh.





### Construction schedule

The total land filling volume is calculated as follows:

- Land filling volume:  $200 \text{ ha} \times 4.0 \text{ m} \times 1.1 = 8,800,000 \text{ m}^3$
- Surplus filling for improvement of weak area:  $80 \text{ ha} \times 1.0 \text{ m} = 800,000 \text{ m}^3$
- Total sand filling volume:  $\doteq 9,600,000 \text{ m}^3$

Possible sand filling volume per year is as follows:

- $15,000 \text{ m}^3/\text{day} \times 25 \text{ days} \times 12 \text{ months/year} = 4,500,000 \text{ m}^3/\text{year}$

Construction period for sand filling works is calculated as follows:

- $9,600,000 \text{ m}^3 \div 4,500,000 \text{ m}^3/\text{year} = 2.13 \text{ years} \doteq 26 \text{ months}$

Preparatory works for sand filling is estimated to be 2 months. Final compaction works, dewatering and demobilization is estimated to be 2 months in the end.

The construction period for land development works as a whole is estimated to be 30 months.

Land development for Stage-1 (Zone E and Zone D) with 100 ha is scheduled for first 16 months, and land development for Stage-2 (Zone C, Zone B and Zone A) with 100 ha is for latter 14 months as shown in Figure 2.4-8.

It is advised by JICA advisory committee that the contractor should take adequate caution and notice of differences between rainy season and dry season. For example, navigation route may differ in rainy season and dry season. During rainy season or flooding, the contractor may need to refrain dredging activity in order to minimize impact on sediment and water turbidity and to reduce risk of any accident when water current is high.



Figure 2.4-8: Land development plan

### 2.4.2 Access road

The access road is planned directly connecting from the national highway No.2 (Dhaka-Sylhet Expressway) to the Araihaazar EZ with approximate length of 337 m.

The access road is designed with two lanes on each side including a median strip, sidewalks and space for utilities (gas transmission, telecommunication, etc.). They also have space for parking areas for container trucks under entry permission procedure and commuting vehicles near the EZ entrance gate. The plan and profile, and cross sections of the access road are shown in Figure 2.4-9 and Figure 2.4-10.

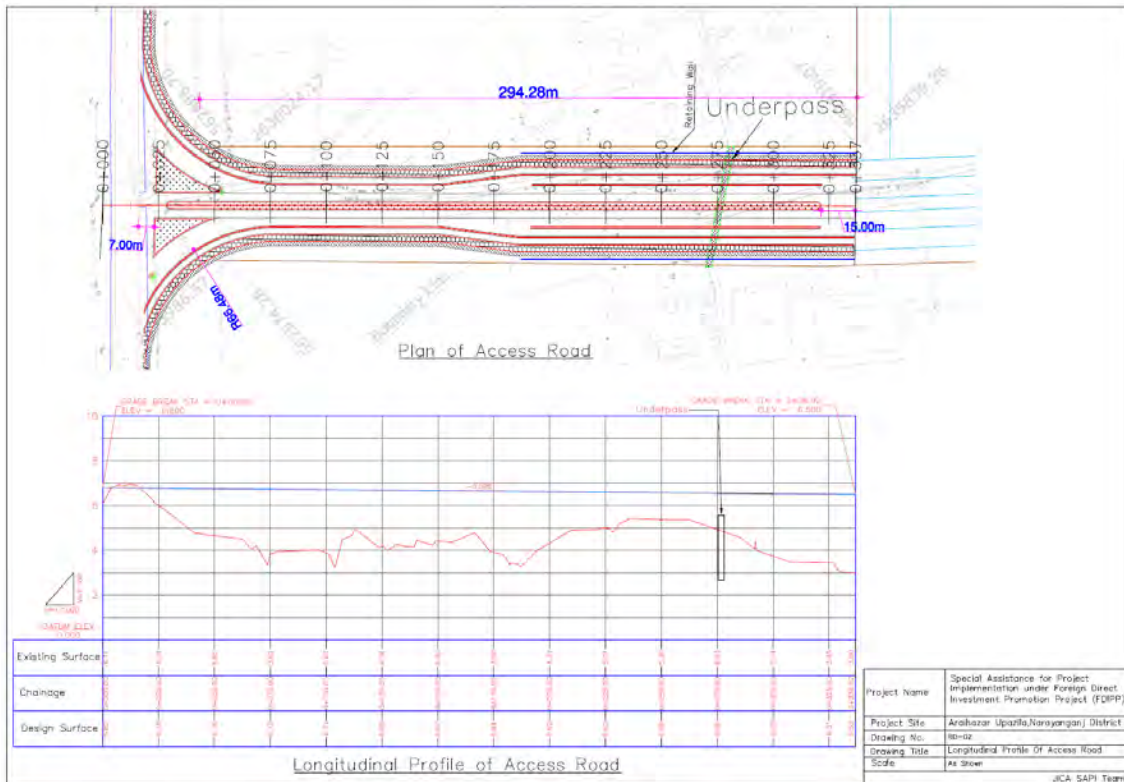


Figure 2.4-9: Plan and profile of access road

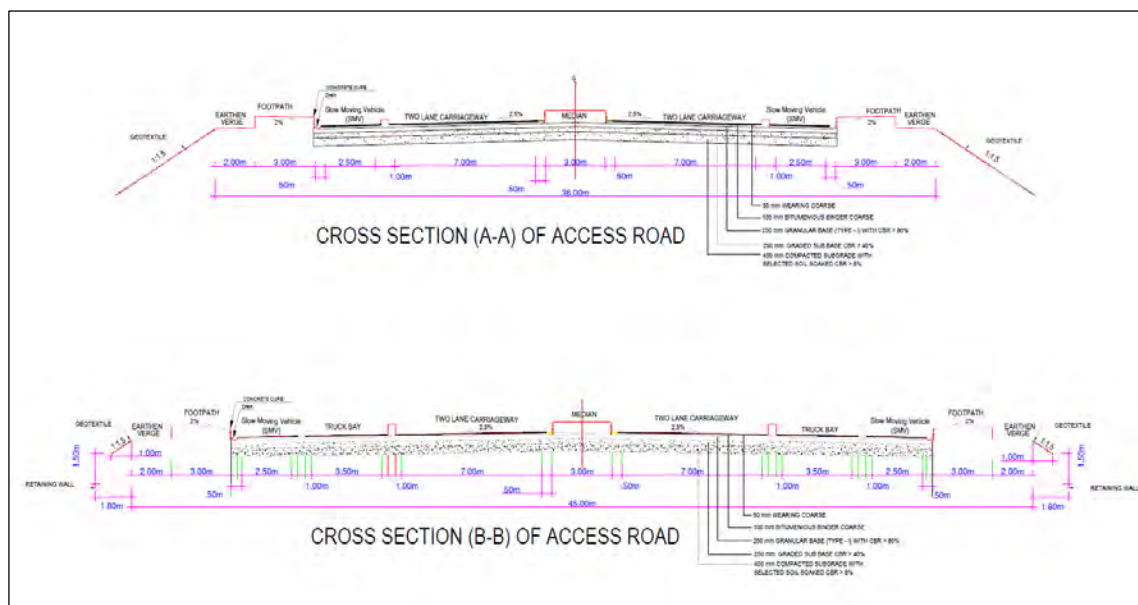


Figure 2.4-10: Cross sections of access road

The underpass is to be constructed for community moving cum local rainwater drainage at the point of 60 m from the EZ entrance. The details of the underpass culvert are shown in Figure 2.4-11.

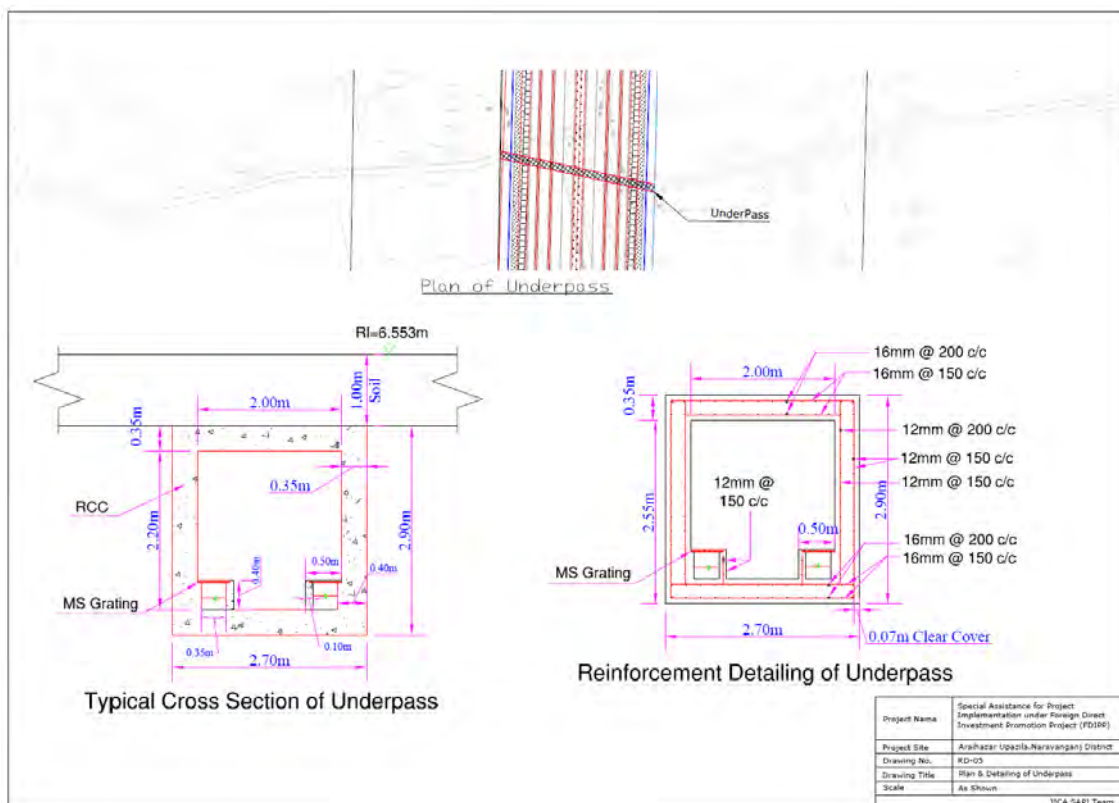


Figure 2.4-11: Details of underpass culvert

### 2.4.3 Retention canal and retention pond with pumping station

The land use for the retention pond is planned with 4.32 ha and 8.66 ha in the case of 200 ha and 400 ha development respectively, and it will regulate the amount of increase in the runoff rate, assumed to be 0.6 from areas for factory use land and 0.3 from agricultural fields.

Table 2.4-2: Araihazar retention pond data - 1

	Average water surface area (m <sup>2</sup> )	Effective depth of retention pond (m)	Retention capacity (m <sup>3</sup> )
Retention pond for 200 ha development	42,849	2	85,698
Retention pond for 400 ha development	85,698	2	171,396

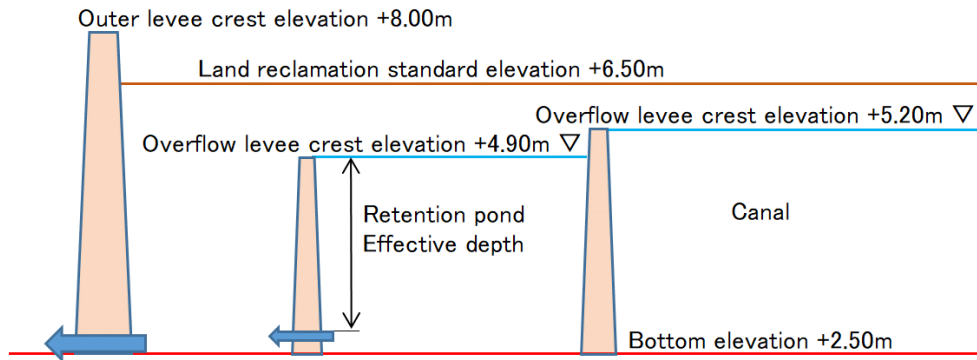


Figure 2.4-12: Cross-section of retention pond and canal

Table 2.4.3-2 Araihaazar retention pond data -2

	Concentration time (min)	Rainfall intensity (mm/hour)	Pre-development runoff (Runoff rate: 0.3)	Post-development runoff (Runoff rate: 0.6)
200ha development	60	100	16.67	33.33
400ha development	60	100	33.33	66.67

As shown below, if the convergence time of flow from the furthest location during each level of development is considered, the retention function will be one hour or longer, even in the event of the 50-year probability rainfall.

For 200ha development:

$$\text{Orifice discharge rate: } Q = (33.33 - 16.67) / 2 = 25 \text{ (m}^3/\text{s)}$$

$$\text{Retention capacity } t = 85,698 \text{ (m}^3) / 25 \text{ (m}^3/\text{s}) = 3,428 \text{ (sec) or about 57 minutes}$$

For 400ha development:

$$\text{Orifice discharge rate: } Q = (33.33 - 66.67) / 2 = 50 \text{ (m}^3/\text{s)}$$

$$\text{Retention capacity } t = 171,396 \text{ (m}^3) / 50 \text{ (m}^3/\text{s}) = 3,428 \text{ (sec) or about 57 minutes}$$

If the water level outside the surrounding levee is close to 5m, discharge by natural flow will be difficult, and therefore the gate of the surrounding levee will be closed and the system is switched over to pump drainage.

Table 2.4-3: Araihaazar regulating reservoir data -3

	Retention pond		Canal		Total stored (m <sup>3</sup> )
	Storage use depth	Stored (m <sup>3</sup> )	Storage use depth	Stored (m <sup>3</sup> )	
200ha development	1.5m (6.5~5.0m)	85,698	1.0m (6.5~5.5m)	43,290	128,988
400ha development	1.5m (6.5~5.0m)	171,396	1.0m (6.5~5.5m)	86,580	257,976

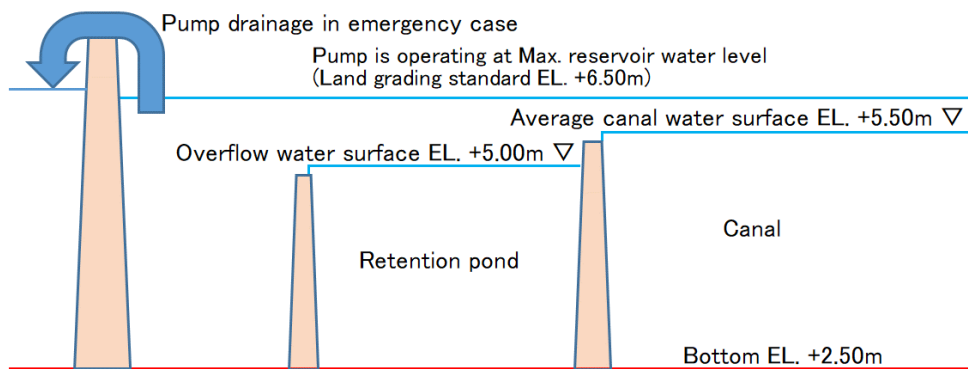


Figure 2.4-13: Retention pond and canal water levels during outer water flood at Araihaazar EZ (when pump is operating)

The study of pump capacity assumed the scale capable of withstanding the largest rainfall of 115mm in three (3) hours that occurred on July 18, 2005 (Source: Sherpur EZ final Report).

Table 2.4-4: Data for pump capacity required at Araihaazar

	3-hour runoff (m <sup>3</sup> )	Storage capacity (m <sup>3</sup> )	Required drainage quantity (m <sup>3</sup> )	Pump capacity (m <sup>3</sup> /s)
200ha development	138,000	128,988	9,021	0.83
400ha development	276,000	257,976	18,5024	1.67

Note: Pump capacity is assumed to be the scale permitting three hours of drainage.

The plan of retention canal, the plan of retention pond and typical section of retention pond are shown in Figure 2.4-14, Figure 2.4-15 and Figure 2.4-16 respectively.

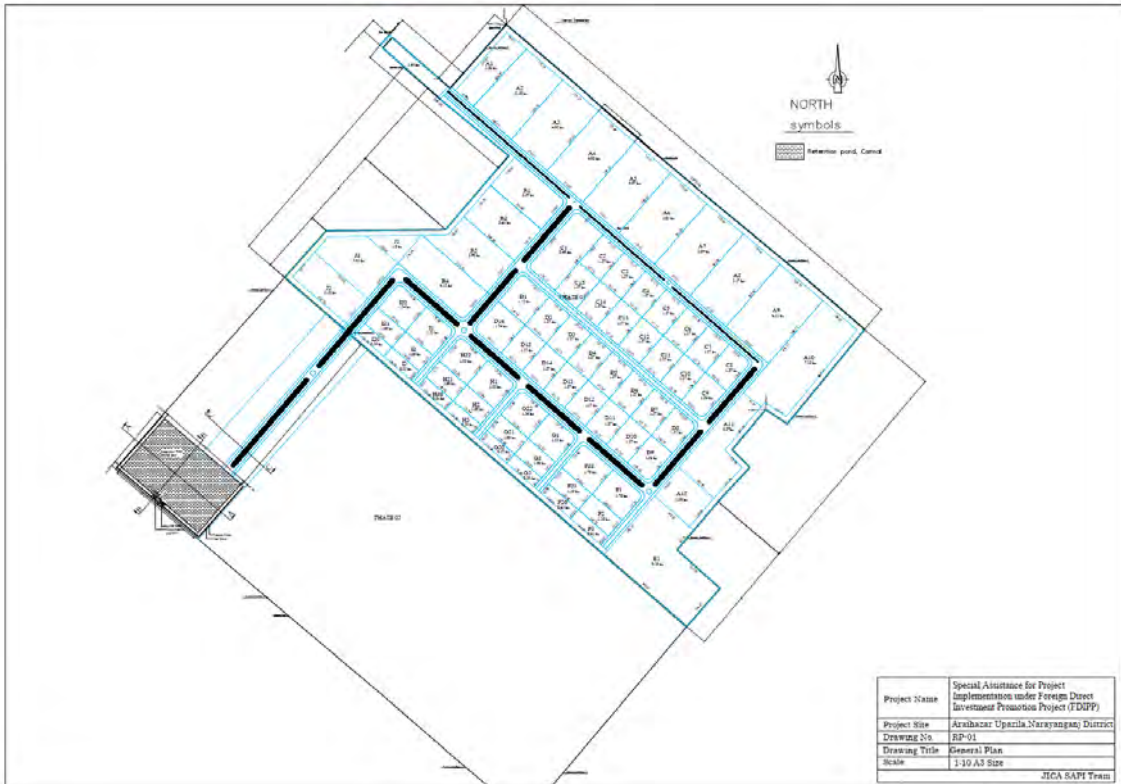


Figure 2.4-14: Plan of retention canal and retention pond

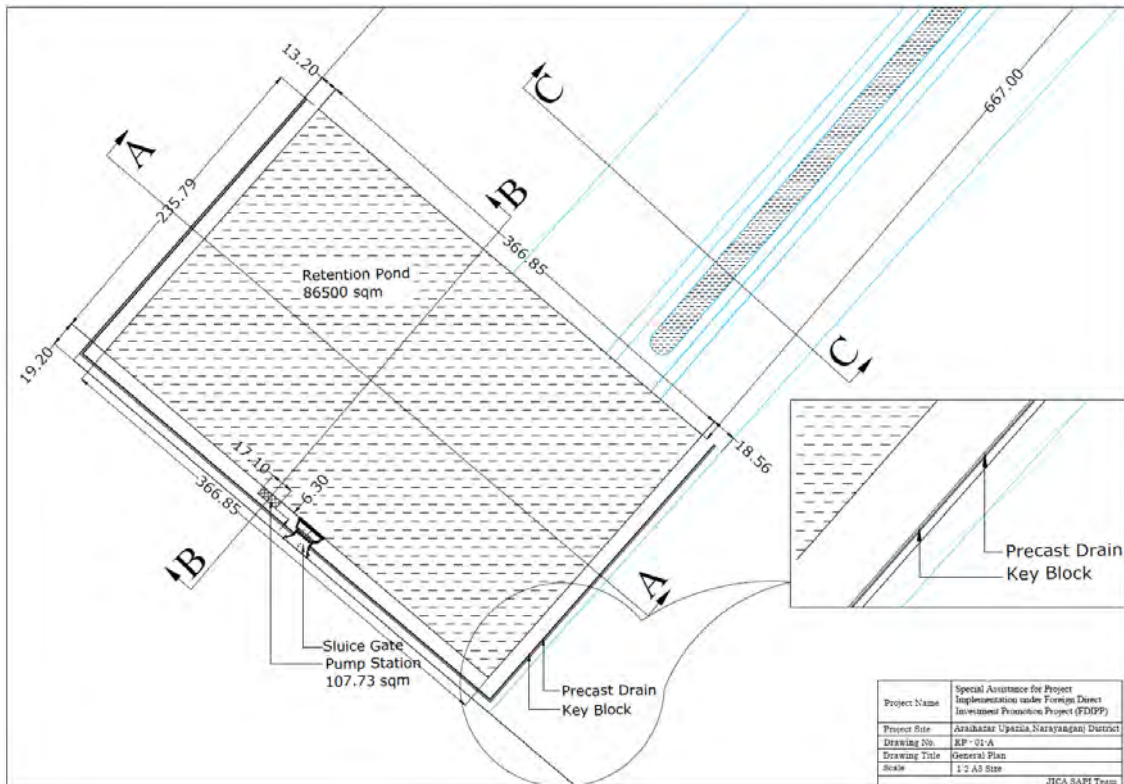


Figure 2.4-15: Plan of retention pond

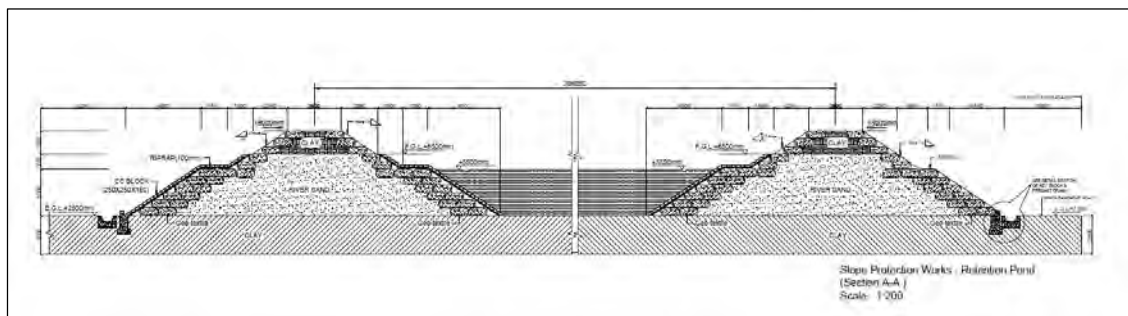


Figure 2.4-16: Typical section of retention pond

### 2.4.4 Gas transmission plan

Gas demand for industry and power use in Araihasar EZ is forecasted by year as follows:

Table 2.4-5: Gas demand forecast by year in Araihasar EZ

Year wise Gas Demand (MMCFD)										
Year	1	2	3	4	5	6	7	8	9	10
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Power	0	5	10	10	10	15	15	20	20	20
Industry	5	10	15	20	25	30	35	40	45	50
Total	5	15	25	30	35	45	50	60	65	70

Source: JICA Study Team

Based on the above gas demand forecast, Titas Gas Transmission and Distribution Company Limited (TGTDC) has proposed to newly construct 20” diameter with 1,000 psig transmission lines from the Holipur TBS to the Dighiborabo CGS (about 6 km length). A new CGS/TBS is also to be constructed at the AEZ site, connecting from existing 20” transmission lines running through the AEZ area. The typical section of gas transmission pipeline is shown in Figure 2.4-17. Filling depth is designed to be 3.5 feet. This depth was determined as per Section 33 of “Natural Gas Safety Rules 1991”. JICA Study Team has confirmed that other existing gas transmission lines, which have been in use over several decades, have about same filling depth and it is durable to bear weight of heavy rain fall or flooding during rainy season.

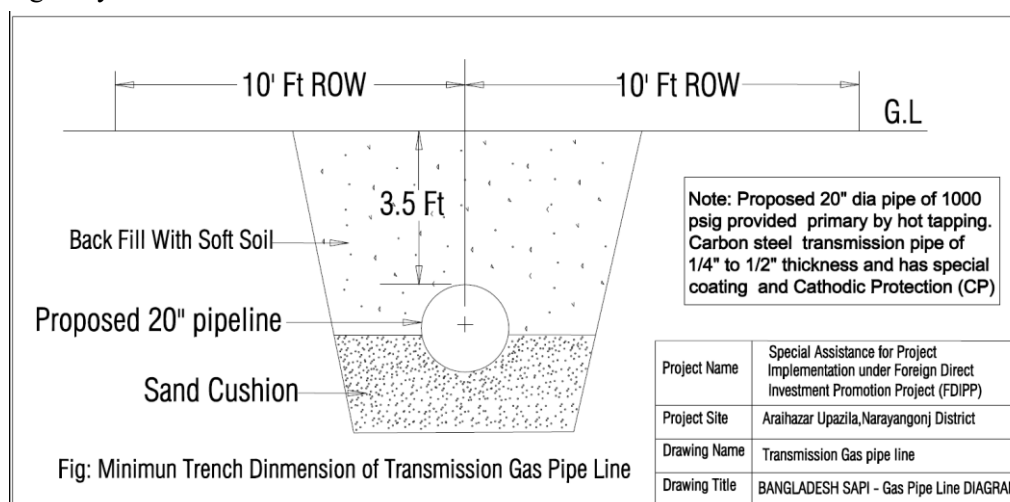
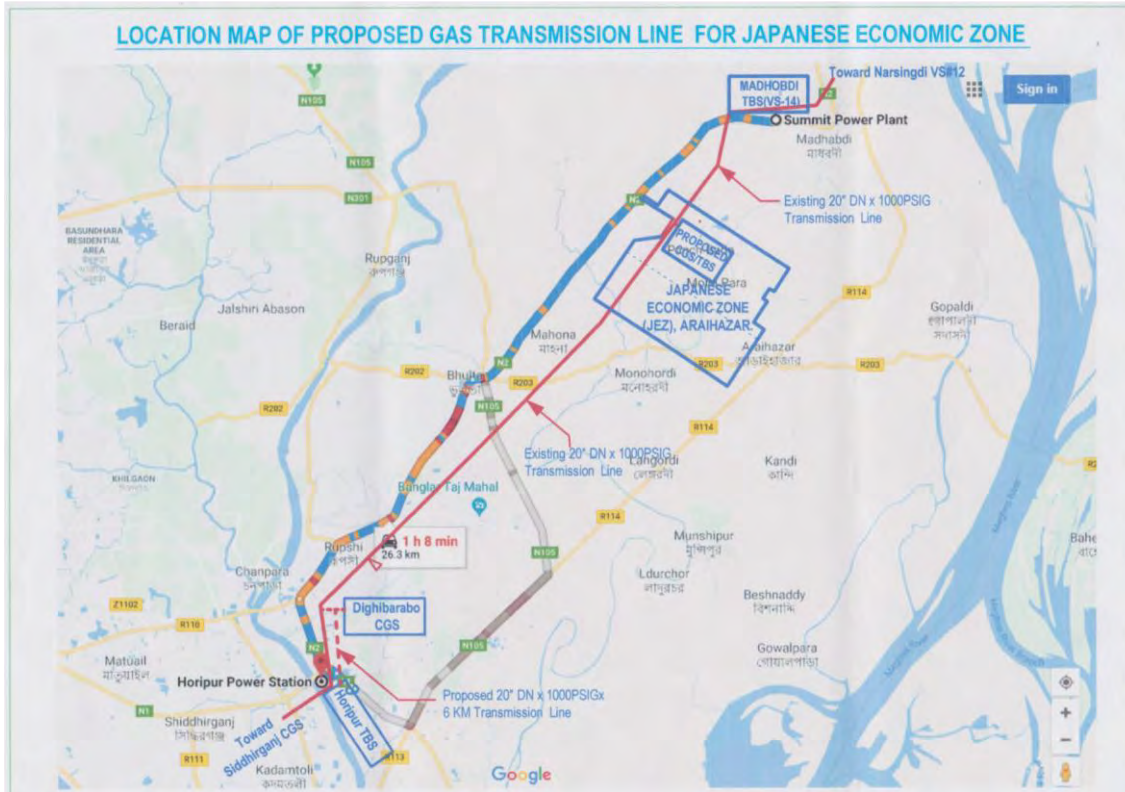


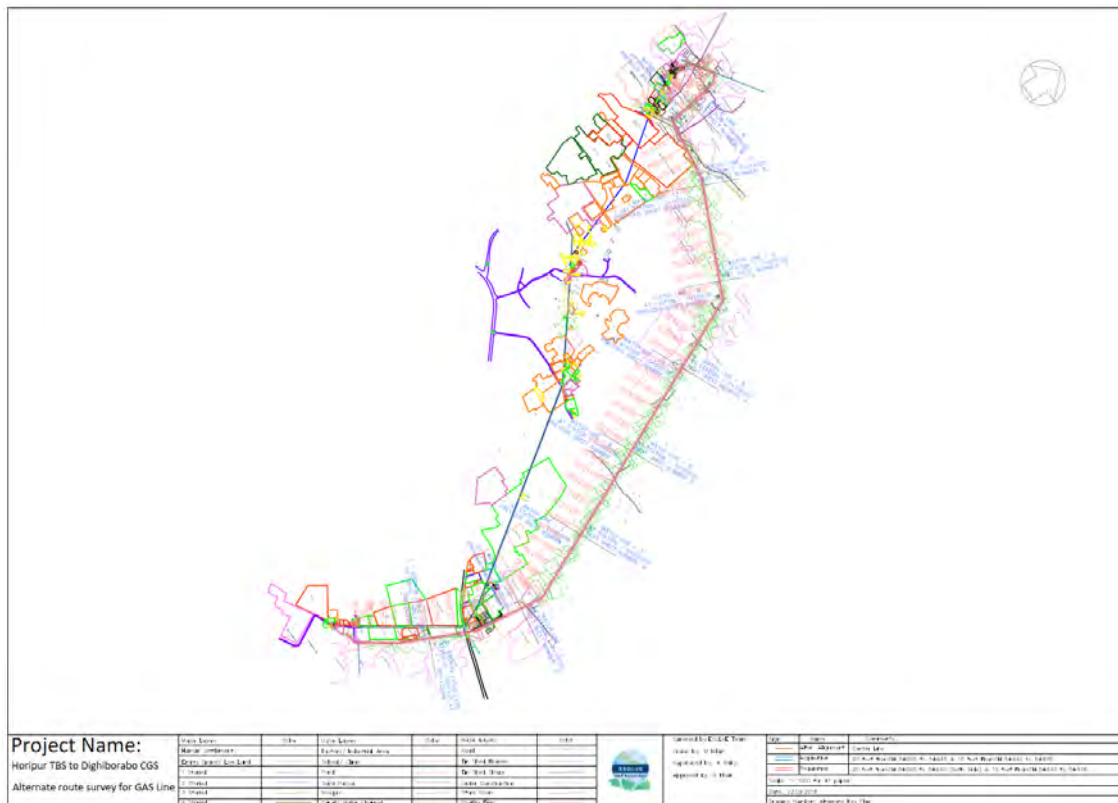
Figure 2.4-17: Typical section of gas transmission pipeline

The schematic gas transmission plan is shown in Figure 2.4-18. For construction of new gas transmission pipelines from the Holipur TBS to the Dighiborabo CGS (about 6 km length), the route survey was carried out by JST and the route alignment of gas pipelines is proposed in **Figure 2.4-19**.



Source: Google Map-image has been partially modified by JICA Study Team

Figure 2.4-18: Gas transmission plan



**Figure 2.4-19: Alignment of new gas transmission pipeline**

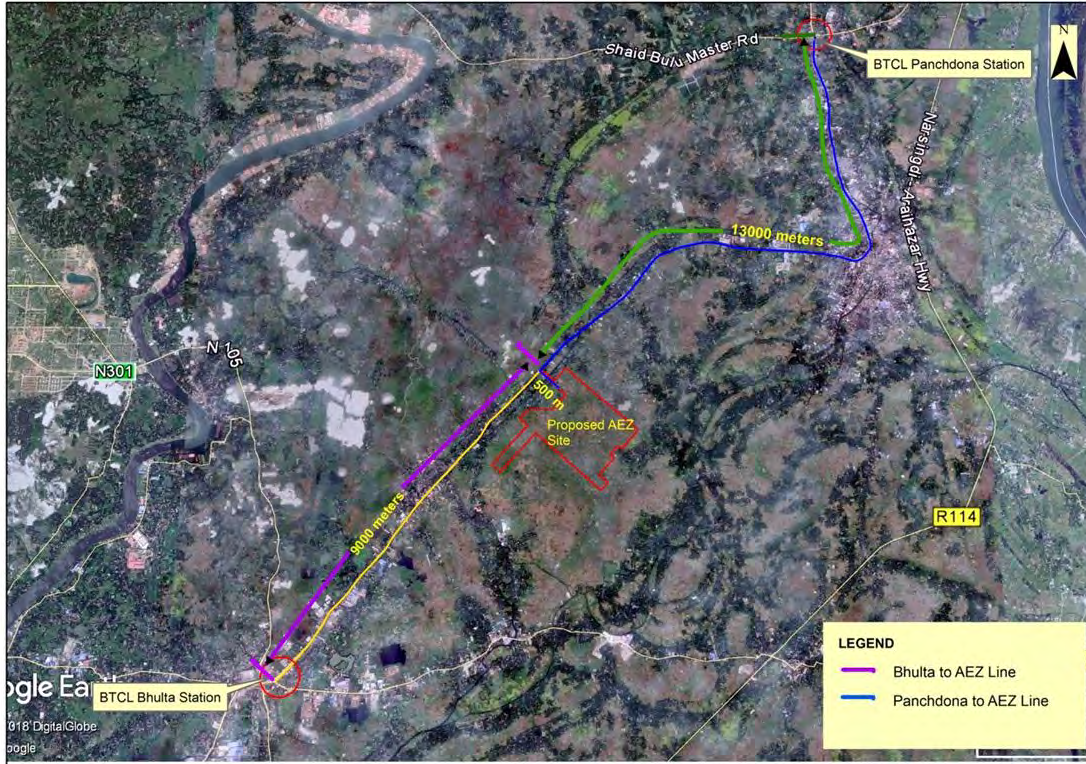
### 2.4.5 Telecommunication supply plan

Bangladesh Telecommunication Company Limited (BTCL) undertook field evaluation to determine the alignment and installation method of the telecommunication line. BTCL is currently preparing construction schedule and cost estimate.

The demand scenario for telephone lines and Internet in Arai hazar EZ is forecasted as follows:

- Telephone: 150 PRI (Primary Rate Interface)
- Internet: 20 Gbps bandwidth

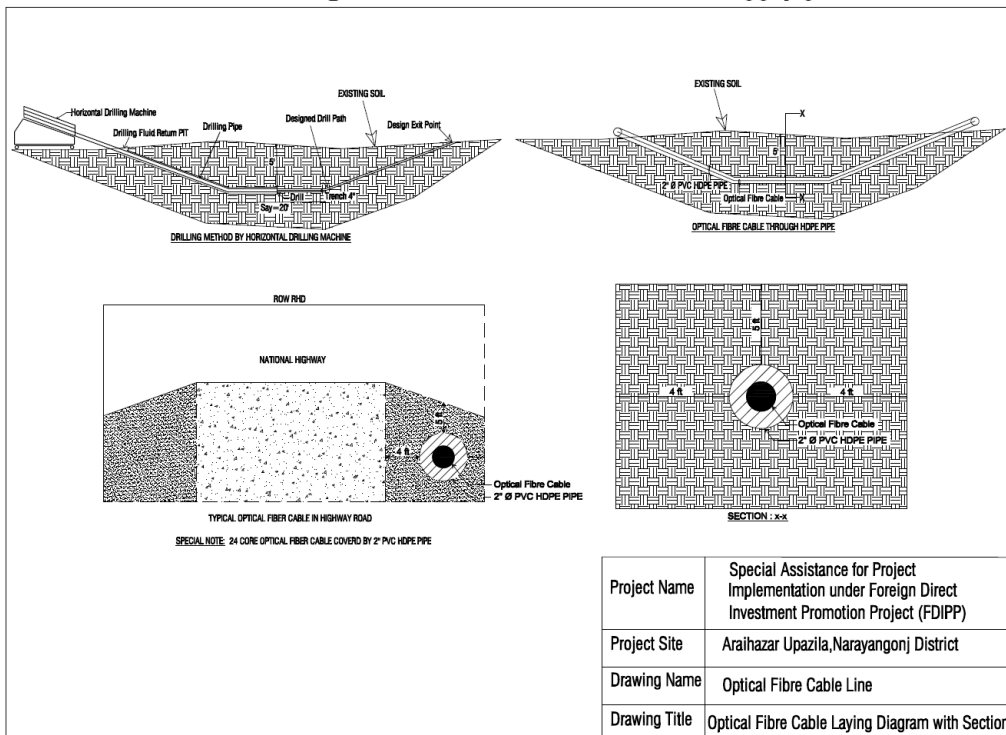
BTCL plans to install cable from two (2) telecommunication exchanges (stations): one from Bhulta located 9 km Southwest of the EZ site, and the other from Panchdona located 13 km Northeast of the EZ site. As the lines are laid along the national highway, land acquisition works are not required. The telecommunication supply plan is shown in Figure 2.4-20. The typical section of telecommunication optical fiber cables for construction is shown in Figure 2.4-21.



Source:

Google Earth-image has been partially modified by JICA Study Team

Figure 2.4-20: Telecommunication supply plan



Source: JICA Study Team

Figure 2.4-21: Typical section of telecommunication optical fiber cables

## 2.4.6 Preparation of bidding documents for land development

JST has supported BEZA to prepare the draft bidding documents for land development works, since JICA has decided to support BEZA to develop land works for 200ha EZ and related off-site infrastructure by additional loan.

Draft bidding documents for ICB (International Competitive Bidding) for land development for Araihaazar EZ have been prepared for the works as follows:

- Land development works
- Access road works
- Retention canal, retention pond and pumping station

For preparation of bidding documents, following technical issues have been reviewed and discussed:

- Two-envelop bidding
- Sand filling construction method
- Geotechnical investigation and analysis
- Environmental management
- Site safety and security management

### (1) Two-envelop bidding

For an international competitive bidding (ICB) for land development works including access road works, and retention canal, retention pond and pumping station, two-envelop bidding is to be adopted with the following reasons:

- Large scale works for more than 8,000,000m<sup>3</sup> sand filling,
- To employ experienced and excellent contractor for technically complex works for sand dredging, transport, filling and compaction, and soil investigation analysis and soil improvement works,
- To employ experienced contractor for management and coordination with other contractors for gas transmission pipeline and gas station, telecommunication optic fiber cables, power station and related facilities, and on-site infrastructure works for SPC,

The items for technical evaluation for bidding are as follows:

- Site organization
- Method statement
- Mobilization schedule
- Construction schedule
- Quality control plan
- Geotechnical investigation and analysis plan
- Safety plan
- Personnel
- Equipment

### (2) Sand filling construction method

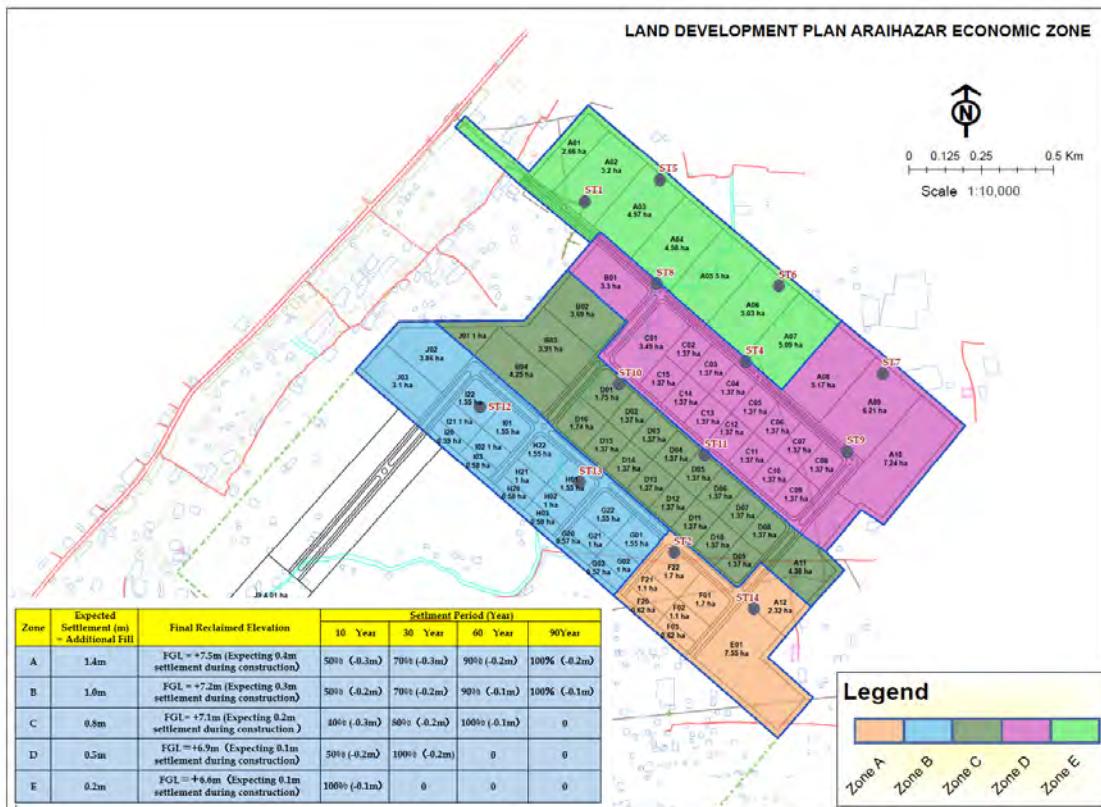
Sand filling construction method was carefully studied and proper specifications for sand filling and compaction has been prepared in “3.1 SAND FILLING” and “3.2 MECHANICAL COMPACTION OF FILLING SAND” in Appendix 3-1: “Specifications Part-1: Land Development”.

Specifications for settlement measurement for sand filling has been prepared in “2.9 SETTLEMENT MONITORING” in Appendix 3-1. Before handover works, additional filling at the settlement area shall be required to be the designated final ground level (FGL). These filling costs for the allowance and additional filling such as loose sand material rate to filled material, transportation loss of material, compaction loss of material and initial consolidation settlement loss of material shall be included in

the unit rates of filling work. Any loss and reducing ratio and consolidation of filled material would not be added for BOQ and contract cost.

Estimated average settlement value during and after construction

Zone	Expected Settlement (m) = Additional Fill	Final Reclaimed Elevation	Setlment Period (Year)			
			10 Year	30 Year	60 Year	90Year
A	1.4m	FGL = +7.5m (Expecting 0.4m settlement during construction)	50% (-0.3m)	70% (-0.3m)	90% (-0.2m)	100%(-0.2m)
B	1.0m	FGL = +7.2m (Expecting 0.3m settlement during construction)	50% (-0.2m)	70% (-0.2m)	90% (-0.1m)	100%(-0.1m)
C	0.8m	FGL= +7.1m (Expecting 0.2m settlement during construction )	40% (-0.3m)	80% (-0.2m)	100% (-0.1m)	0
D	0.5m	FGL= +6.9m (Expecting 0.1m settlement during construction)	50% (-0.2m)	100%(-0.2m)	0	0
E	0.2m	FGL= +6.6m (Expecting 0.1m settlement during construction)	100%(-0.1m)	0	0	0



(3) Geotechnical investigation and analysis

Since soft silty layer has been found in the first soil investigation, the additional soil investigations were carried out. Based on the additional soil investigation and analysis, the following countermeasures are recommended:

- Geotechnical investigation with analysis plan and expected soil improvement shall be studied during construction by the contractor. The cost is included in the item “PS700 1): Geotechnical investigation (SPT) and laboratory tests (consolidation tests) and analysis report” in SPECIFIED PROVISIONAL SUMS in BOQ of the Contract.

- Soil improvement works might be carried out based on the result of the geotechnical investigation. The cost for soil improvement works is included in the item “PS700 2): Soil improvement works” in SPECIFIED PROVISIONAL SUMS in BOQ of the Contract.

(4) Environmental management

During the design and execution of the land development works, the Contractor shall strictly conform to all requirements relating to the environmental protection as per the Sub-Clause 4.18 of the General Conditions of the Contract and detailed in this Works Requirements. The Contractor shall also strictly conform to all applicable Bangla environmental protection/management-related Laws and all current national/state codes and standards established by the concerned authorities, and other government agencies for environmental protection-management.

The Environmental Management Plan (EMP) and the Environmental Monitoring Plan (EMoP) as per the approved EIA and additional requirement by JICA are described in “2.8 ENVIRONMENTAL MANAGEMENT” and “APPENDIX 1: Environmental Protection Requirements” in Appendix 3-1: “Specifications Part-1: Land Development” The cost for EMP and EMoP is included in the item “PS600: Environmental management and monitoring”.

(5) Site safety and security management

In Bangladesh, special countermeasures for site safety and security management for the Contractor’s works are required. The specifications are described in “1.5 SITE SAFETY AND SECURITY REQUIREMENT”. The cost for the site safety and security is included in the items “PS200: Special Safety and Security Arrangement” and “PS500: Special Safety and Security Arrangement”

## 2.5 Power generation, transmission, substation and distribution system plan

### 2.5.1 Power generation

#### (1) Initial planning

The original requirement of a power station was to provide a back-up supply for the grid power and its capacity was to be 50MW. Therefore, a Gas Turbine Combined Cycle (GTCC) system was planned as below.

The total capacity of the GTCC on ISO conditions (ambient temperature 15deg, relative humidity 60%) is approximately 60MW consisting of 45MW Gas Turbine (GT) and 15MW Steam Turbine (ST). The GTCC capacity becomes approximately 50MW on Bangladesh site conditions (35deg, 70%).

#### (2) The issue of low electricity quality (big frequency and voltage fluctuation) of the grid system

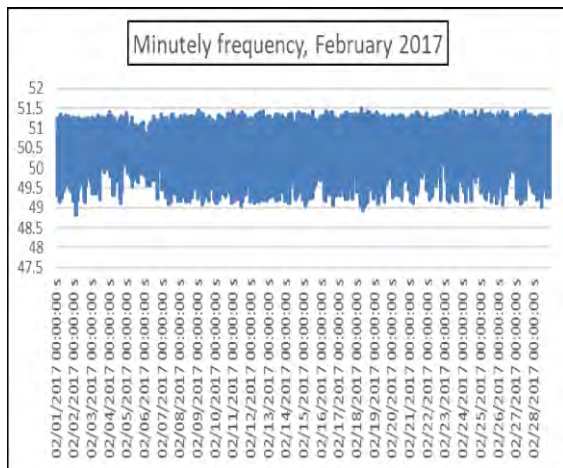
On the first survey in July 2017, a big frequency fluctuation and low voltage of the 230kV grid System was observed upon monitoring of the transmission company - the Power Grid Company of Bangladesh Ltd. (PGCB).

1) Obtaining one-year data (from July 2016 to June 2017) of frequency and voltage at 132kV Bhulta Substation near to Araihaazar Economic Zone (EZ) in August 2017, analyses were performed as follows (Figure 2.5-1 and Figure 2.5-2).

- Frequency: 48.89 – 51.48Hz, average 50.54Hz (Rated frequency: 50Hz): Feb. 2017,

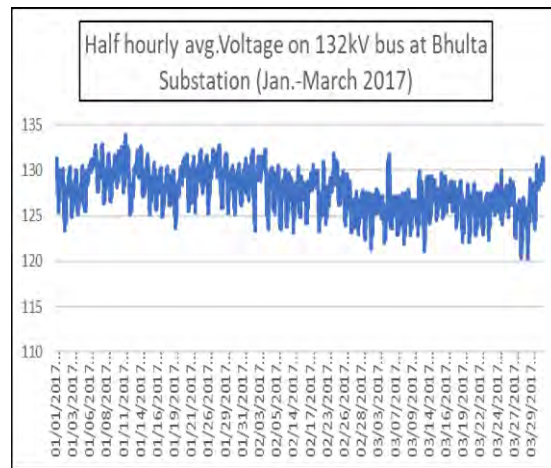
#### Big fluctuation

- Voltage: 120.4 – 133.8kV, average 127.7kV (Rated voltage: 132kV): Jan. – March 2017, Low level



MAX	51.475
MIN	48.887
AVG	50.542

Figure 2.5-2: Frequency data and analysis at 132kV Bhulta Substation  
Data source: NLDC/PGCB



MAX	133.82
MIN	120.42
AVG	127.68

Figure 2.5-1: Voltage data and analysis at 132kV Bhulta Substation  
Data source: NLDC/PGCB

Note: Above are typical of one year data (Some months' data are incomplete).

2) For reconfirmation, a second data collection of frequency and voltage at 230kV Ghorasal

Substation and analyses were performed in December 2017 as follows (Figure 2.5-3 and Figure 2.5-4).

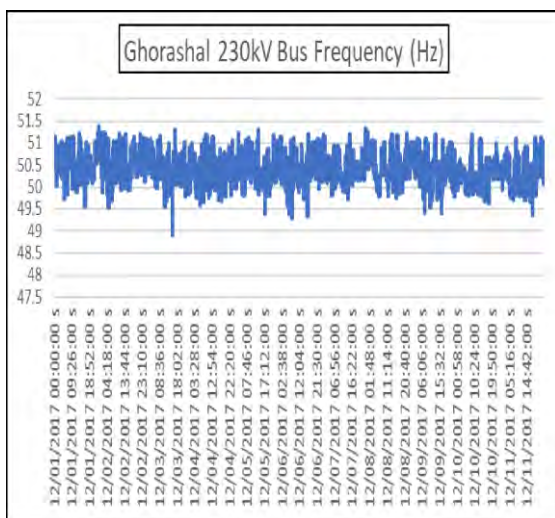
Note: 230kV Ghorasal-Rampura Transmission line just passes over the EZ.

- Frequency: 48.93 – 51.38Hz, average 50.40Hz (Rated frequency: 50Hz): Dec. 1--11, 2017

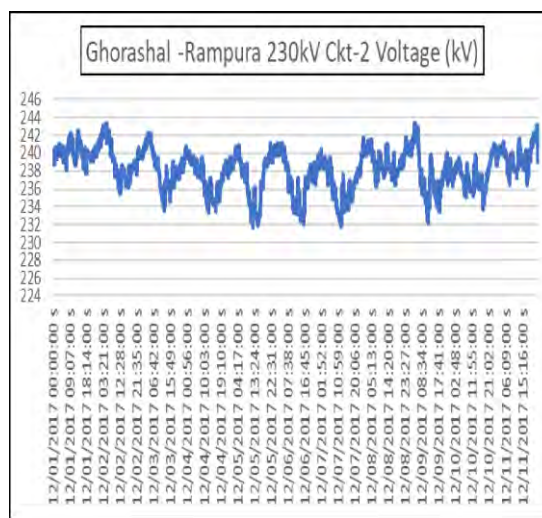
- Voltage: 231.7 – 243.3kV, average 238.2kV (Rated voltage: 230kV): Dec. 1--11, 2017

Upon comparing the results of the second analyses with that of the first analyses, the following points were confirmed.

- a) Frequency fluctuation is quite big, same as previous level, no improvement, therefore, not suitable for almost manufacturing processes.
- b) 230kV voltage level is adequate and fluctuation is also smaller than 132kV voltage level. That is because 230kV system is upper system than 132 kV system, not because of improvement.



Max	51.378
Min	48.933
Avg	50.401



Max	243.32
Min	231.70
Avg	238.17

Figure 2.5-3: Frequency data and analysis at 230kV Ghorasal Substation

Figure 2.5-4: Voltage data and analysis at 230kV Ghorasal Substation

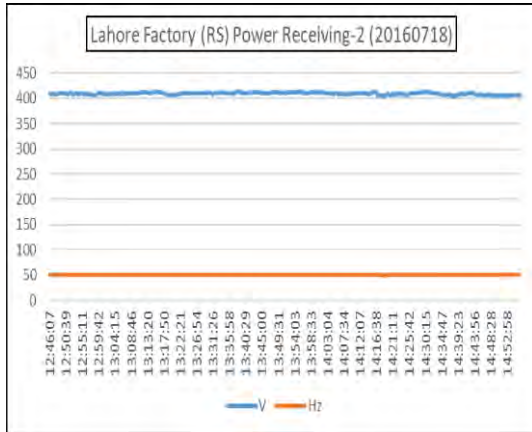
(Reference)

- Guideline/target of frequency fluctuation  
 Japan:  $\pm 0.2$  --  $\pm 0.3$ Hz (Depending on regions)  
 Europe:  $\pm 0.04$  --  $\pm 0.6$ Hz (Depending on regions)  
 North America:  $\pm 0.018$  --  $\pm 0.023$  (Depending on regions)
- Frequency fluctuation of  $\pm 0.2$  --  $\pm 0.3$ Hz is recommended for manufacturing processes. (Japan, Switzerland)

(Source: Tokyo Electric Power Company, The Institute of Electrical Engineers of Japan)

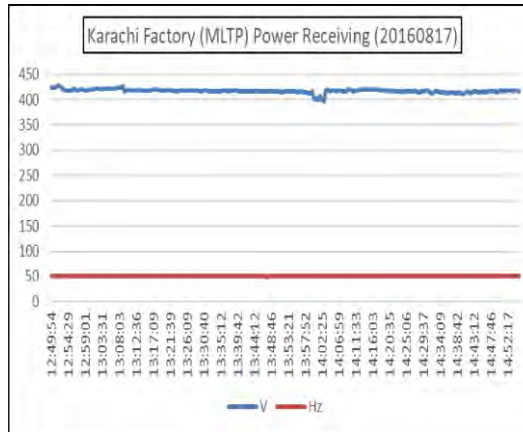
3) Other countries' data were surveyed as follows.

- a) Pakistani factories (400V system from grid)



	Volt	Hz
Max	414.1	50.49
Min	403.9	49.40
Avg	409.5	50.11

Figure 2.5-6 : Pakistan Lahore factory



	Volt	Hz
Max	427.1	50.61
Min	396.6	49.81
Avg	417.2	50.33

Figure 2.5-5: Pakistan Karachi factory

Source: Energy Efficiency Management Project for Industrial Sector in Pakistan (JICA)

The frequency of the Pakistani grid is quite stable and much better than that of the Bangladesh grid.

b) Frequency of Myanmar grid and Vietnam grid

Frequency data of Myanmar grid and Vietnam grid were also surveyed in respective industrial estates. Frequency situation of both grids were confirmed almost the same as that of the Pakistani grid. (The data of the Myanmar grid and the Vietnam grid are not shown here because the data are incomplete.)

**(3) Issue of low power demand at initial stage of EZ operation**

During planning of Power station, it turned out that power demand of EZ is quite small (Table 2.5-1), 5MW or less at initial stage of EZ operation.

Table 2.5-1: Power demand forecast (source: JICA Consulting Team)

Year	2022	2023	2024	2025	2026	2027	Total
Land	25	25	25	30	30	25	160
Power	5	5	5	6	6	5	32
Total(MW)	5	10	15	21	27	32	32

On the other hand, generators should run generally on half load or more for the following reasons.

- Gas turbine (GT) -- In case of low load, NOx level of exhaust gas becomes high.
- Gas engine (GE) – In case of low load, Gas engine operation becomes unstable.
- Diesel engine (DE) – In case of low load, Diesel engine becomes fouled/dirty.

Frequent maintenance is required.

**(4) Selection of generation systems and the operation of a power station**

**1) Initial generation systems**

Considering the above “(3) Issue of low power demand at initial stage of EZ operation,”

The following combination of generation systems was selected.

- a) GT: 1 set of approximately 31MW GT on ISO conditions (ambient temperature 15deg,

relative humidity 60%) which becomes approximately 25MW GT on Bangladesh site conditions (35deg, 70%). Gas fuel only.

b) GE: 2 sets of 6MW GE

c) DE: 1 set of 3MW DE: used for the following occasions;

For starting GT during black out / Emergency power supply / Shortage of gas fuel supply / Continuous power supply during low power demand of EZ operation, etc.

Total capacity of Power plant is approximately 46MW on ISO conditions i.e. 40MW on Bangladesh site conditions.

## **2) Future expansion**

a) The initial plan of a GTCC system will be a near future plan by adding Steam turbine (ST) and Heat recovery steam generator (HRSG) for better energy efficiency (by BEZA).

b) Gas engines and Diesel engine can also compose a Co-generation system as a future plan for better energy efficiency depending on steam/hot water demand of factories in the EZ (by BEZA).

c) Before the EZ power demand reaches full capacity of power plant, 5-10 years later, there is a possibility that Phase-2 Power plant expansion (GTCC 50MW) may be planned (by BEZA).

Future expansion is shown on next page.

## **(5) Fuel gas situation**

In Bangladesh domestic natural gas has been depleting and Importing Liquefied Natural Gas (LNG) was started in 2018. Since supplied fuel gas pressure for the Power plant is not known at this stage, capacity of fuel gas booster compressors cannot be specified. The fuel gas booster compressors are shown as “Optional” on Figure below: Plant Layout and Figure: KEY SINGLE LINE DIAGRAM. Cost information of the fuel gas booster compressors are not available because the details of the fuel gas compressors cannot be specified. In case supplied fuel gas pressure level is enough for the Power plant, the fuel gas booster compressors are not required.

Current natural gas analysis is shown on the next page; Titas Gas Trans. and Dis. Co. Ltd. Gas Analysis.

Titas Gas Trans. and Dis. Co. Ltd. Gas Analysis

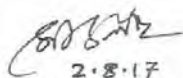
**Gas Analysis of DEMRA CGS, TGT&DCL**  
 sample no: 1  
 Sampling date: 22/07/2017 Time:12:30 hr. Analysis date: 23/07/2017  
 Sample Location: Titas-Demra CGS, Demra, Dhaka  
 Temperature: 22 °C  
 Pressure: 238 psig Sampled by : PMRE Dept., BUET  
 Client's ref: OCD/SCS/4441/1/736 Date: 10/07/2017

	% Mole	% Wt
Nitrogen	0.341	0.566
CO <sub>2</sub>	0.369	0.962
Methane	96.082	91.371
Ethane	2.278	4.060
Propane	0.515	1.346
i-Butane	0.149	0.512
n-Butane	0.088	0.304
i-Pentane	0.042	0.180
n-Pentane	0.028	0.118
Hexane	0.063	0.310
Heptane	0.038	0.216
Octane	0.005	0.033
Nonane	0.002	0.012
Decane+	0.001	0.008
<b>Total</b>	<b>100</b>	<b>100</b>

SG: 0.5825 Base condition: 60°F&14.696 psia  
 Ideal Density: 0.0445 lb/ft<sup>3</sup>  
 Mole Weight: 16.8701 gm/mol

Higher Heating Value: 1039.3209 BTU/SCF ( 60°F&14.696 psia)  
 Lower Heating Value: 937.0621 BTU/SCF

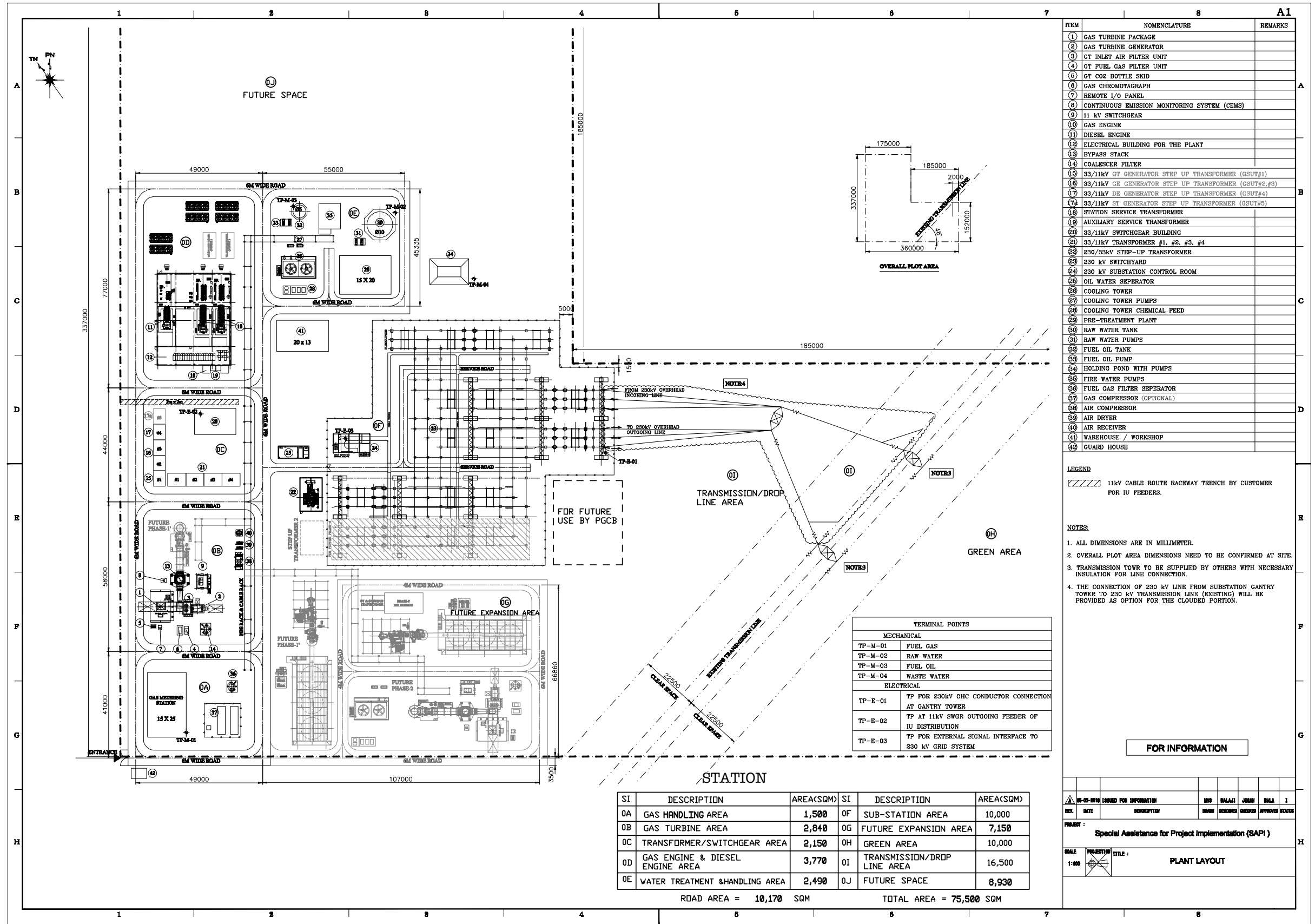
PMRE/263



2.8.17  
 Md. Mushahed Ullah  
 Principal Experimental Engineer  
 PMRE Department  
 Bangladesh University of Engineering and Technology (BUET)



Tel+Fax: 02-9613897



ITEM	NOMENCLATURE	REMARKS
01	GAS TURBINE PACKAGE	
02	GAS TURBINE GENERATOR	
03	GT INLET AIR FILTER UNIT	
04	GT FUEL GAS FILTER UNIT	
05	GT CO2 BOTTLE SKID	
06	GAS CHROMOTAGRAPH	
07	REMOTE I/O PANEL	
08	CONTINUOUS EMISSION MONITORING SYSTEM (CEMS)	
09	11 KV SWITCHGEAR	
10	GAS ENGINE	
11	DIESEL ENGINE	
12	ELECTRICAL BUILDING FOR THE PLANT	
13	BYPASS STACK	
14	COALESCER FILTER	
15	33/11KV GT GENERATOR STEP UP TRANSFORMER (GSUT#1)	
16	33/11KV GE GENERATOR STEP UP TRANSFORMER (GSUT#2,#3)	
17	33/11KV DE GENERATOR STEP UP TRANSFORMER (GSUT#4)	
18	33/11KV ST GENERATOR STEP UP TRANSFORMER (GSUT#5)	
19	STATION SERVICE TRANSFORMER	
20	AUXILIARY SERVICE TRANSFORMER	
21	33/11KV TRANSFORMER #1, #2, #3, #4	
22	230/33KV STEP-UP TRANSFORMER	
23	230 KV SWITCHYARD	
24	230 KV SUBSTATION CONTROL ROOM	
25	OIL WATER SEPERATOR	
26	COOLING TOWER	
27	COOLING TOWER PUMPS	
28	COOLING TOWER CHEMICAL FEED	
29	PRE-TREATMENT PLANT	
30	RAW WATER TANK	
31	RAW WATER PUMPS	
32	FUEL OIL TANK	
33	FUEL OIL PUMP	
34	HOLDING POND WITH PUMPS	
35	FIRE WATER PUMPS	
36	FUEL GAS FILTER SEPERATOR	
37	GAS COMPRESSOR (OPTIONAL)	
38	AIR COMPRESSOR	
39	AIR DRYER	
40	AIR RECEIVER	
41	WAREHOUSE / WORKSHOP	
42	GUARD HOUSE	

**LEGEND**  
 [Symbol] 11KV CABLE ROUTE RACEWAY TRENCH BY CUSTOMER FOR IU FEEDERS.

- NOTES:**
- ALL DIMENSIONS ARE IN MILLIMETER.
  - OVERALL PLOT AREA DIMENSIONS NEED TO BE CONFIRMED AT SITE.
  - TRANSMISSION TOWER TO BE SUPPLIED BY OTHERS WITH NECESSARY INSULATION FOR LINE CONNECTION.
  - THE CONNECTION OF 230 KV LINE FROM SUBSTATION GANTRY TOWER TO 230 KV TRANSMISSION LINE (EXISTING) WILL BE PROVIDED AS OPTION FOR THE CLOUDED PORTION.

TERMINAL POINTS	
<b>MECHANICAL</b>	
TP-M-01	FUEL GAS
TP-M-02	RAW WATER
TP-M-03	FUEL OIL
TP-M-04	WASTE WATER
<b>ELECTRICAL</b>	
TP-E-01	TP FOR 230KV OHC CONDUCTOR CONNECTION AT GANTRY TOWER
TP-E-02	TP AT 11KV SWGR OUTGOING FEEDER OF IU DISTRIBUTION
TP-E-03	TP FOR EXTERNAL SIGNAL INTERFACE TO 230 KV GRID SYSTEM

SI	DESCRIPTION	AREA(SQM)	SI	DESCRIPTION	AREA(SQM)
0A	GAS HANDLING AREA	1,500	0F	SUB-STATION AREA	10,000
0B	GAS TURBINE AREA	2,840	0G	FUTURE EXPANSION AREA	7,150
0C	TRANSFORMER/SWITCHGEAR AREA	2,150	0H	GREEN AREA	10,000
0D	GAS ENGINE & DIESEL ENGINE AREA	3,770	0I	TRANSMISSION/DROP LINE AREA	16,500
0E	WATER TREATMENT & HANDLING AREA	2,490	0J	FUTURE SPACE	8,930

ROAD AREA = 10,170 SQM      TOTAL AREA = 75,500 SQM

**FOR INFORMATION**

REV.	DATE	DESCRIPTION	BY	CHECKED	DATE

PROJECT : **Special Assistance for Project Implementation (SAPI)**

SCALE : 1:100      TITLE : **PLANT LAYOUT**

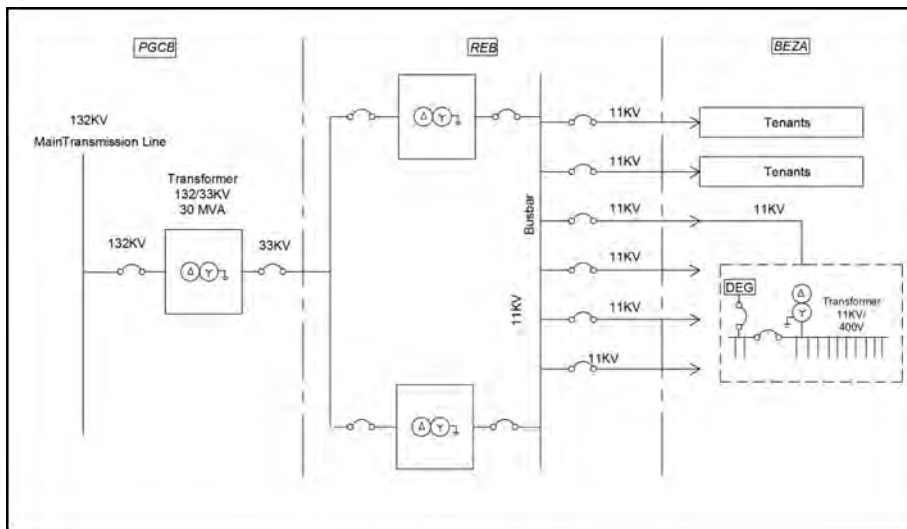
Figure 2.5-7: Plant Layout

## 2.5.2 Transmission, substation and distribution

### (1) 11kV and 33kV distribution systems

Initial planning and survey were performed on 11kV and 33kV distribution systems of the Rural Electrification Board (REB) in July 2017 based on “The People’s Republic of Bangladesh Project for Development of Economic Zones and Capacity Enhancement of Bangladesh Economic Zones Authority, Final Report (February 2017)”.

But it turned out that REB 11kV and 33kV systems don’t have enough capacity of 60MVA for increased Economic Zone (EZ) area of 200ha from original 100ha.



Source: JICA Study Team

Figure 2.5-8: Diagram of Electricity Distribution and Substation Systems, and the Responsibility Areas and Voltage Divisions of Each Electric Power Company and BEZA

Source: “The People’s Republic of Bangladesh Project for Development of Economic Zones and Capacity Enhancement of Bangladesh Economic Zones Authority, Final Report (February 2017)”

### (2) 132kV and 230kV transmission systems

For securing enough capacity for the EZ, a meeting was held with PGCB. PGCB agreed that the EZ would receive power from either a 132kV or a 230kV transmission line as an exceptional case considering it as a government project of EZ by BEZA. As common practice in Bangladesh, consumers receive power from distribution companies such as REB.

A brief survey of 132kV and 230kV transmission lines and towers was conducted at the end of July 2017. On the next visit in September 2017, PGCB System Planning Division advised that the EZ should receive power from the 230kV transmission line having enough capacity since the 132kV transmission line may not have enough capacity considering the possibility of Phase 2 expansion in the future .

(Note)

One major advantage of receiving power from 132kV and 230kV transmission lines is very less frequency of power outage due to planned load shedding. Planned load shedding due to shortage of electricity is conducted by distribution companies such as REB.

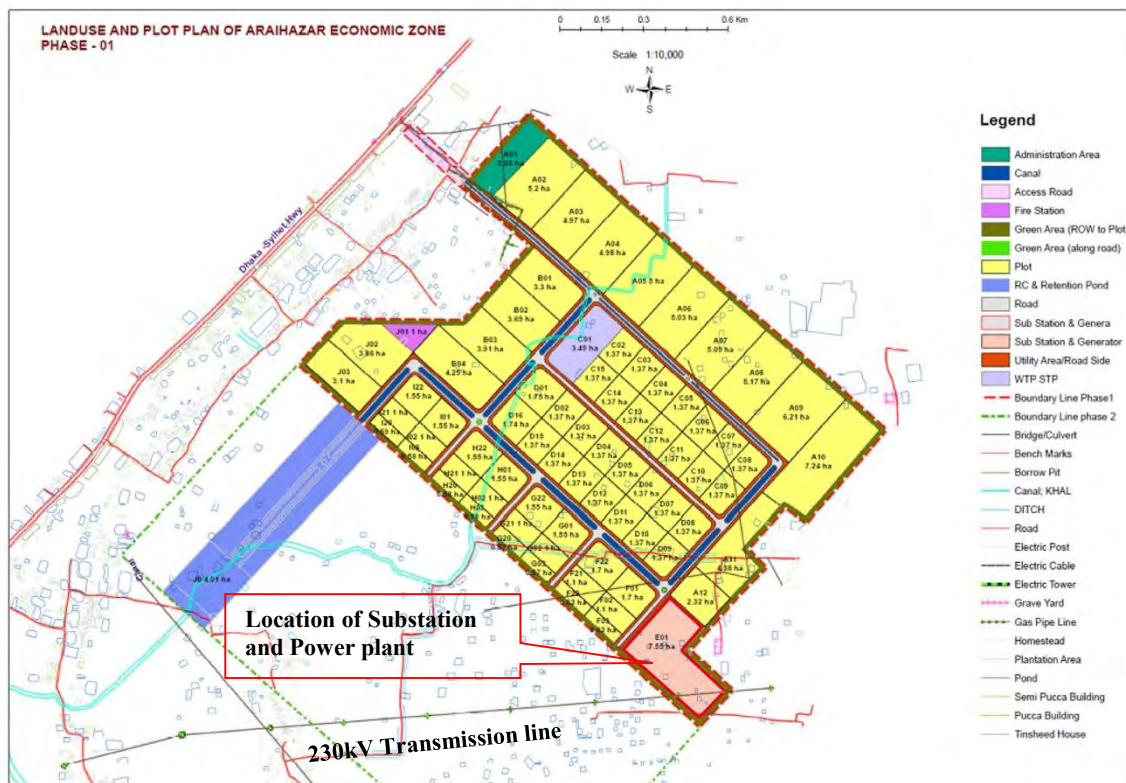


Source: Google Earth: partially modified by PGCB and JICA Study Team

Figure 2.5-9: 132kV and 230kV transmission lines

Green line: 132kV transmission line, Red line: 230kV transmission line,  
Yellow line: Dhaka-Sylhet National Highway N2, Blue line: proposed EZ boundary

Based on further survey on the 230kV transmission line and associated towers, discussion with the PGCB Transmission Line Design Division was conducted in October 2017. Considering transmission line extension to EZ Substation and fuel gas pipeline to Power station adjacent to the Substation, the location of the Substation and the Power station was decided (see Figure 2.5-10).



Source: JICA Study Team

Figure 2.5-10: The location of the substation and the power plant

As shown on the figures above, 230kV Transmission line passes over south corner of the location of the Substation. For connecting the new Substation with the 230kV Transmission line, branch towers and terminal towers will be newly installed.

### (3) Substation and distribution

According to PGCB request 230kV incoming/ outgoing and bus bar circuits are in accordance with PGCB standard circuits since 230kV incoming/outgoing and bus bar circuits will be controlled and operated by PGCB after construction. Characteristics are a loop circuit and double bus bar system. Future expansion of Phase 2 is also considered even though there has not been any concrete plan yet..

Power factor improvement capacitors are not planned since some of generators run during operation of factories in the EZ and supply reactive power for improving power factor.

Major equipment is shown in Figure 2.5-11: KEY SINGLE LINE DIAGRAM.

- 1) 230kV Switchgear: Air Insulated Switchgear (AIS)

(Gas Insulated Switchgear (GIS) is possible.)

Incoming/ outgoing and bus bar circuits are in accordance with PGCB standard circuits including circuit protection, metering, lightning arrestors, signal transmission, etc.

- 2) One set of main transformer: 230/33kV, 60/75MVA (Self cooling/ Forced fan cooling: ONAN/ONAF) with on-load tap changer.

In case of Y-Y connection, stabilizing winding will be installed.

Grounding: Neutral Grounding Resistor (NGR) method

3) 33kV metal-enclosed switchgear

a) Vacuum Circuit breakers (VCB) will be applied. VCB will be with Disconnecting Switch (DS) or of “Draw-out” type.

b) Feeders

- Power supply to the Economic Zone (EZ): 4 feeders and 1 spare feeder which may be used when expansion of the EZ should occur or during initial low power demand during the expansion.

- In-house power: 1 feeder, Load Break Switch (LBS) may be used instead of VCB.

- Generators: 4 feeders (Each generator feeder has changeover circuits of supplying good quality power to the EZ or selling electricity to the grid.) Provision for future installation of Steam Turbine (approximately 12MW) is also considered.

4) Distribution transformer for power supply to the EZ

33/11kV, 15/20MVA (Self cooling/ Forced fan cooling: ONAN/ONAF): 4sets

5) Transformer for in-house power (substation auxiliaries)

6) 11kV metal-enclosed switchgear for distribution to the EZ

a) Vacuum Circuit breakers (VCB) will be applied. VCB will be of “Draw-out” type.

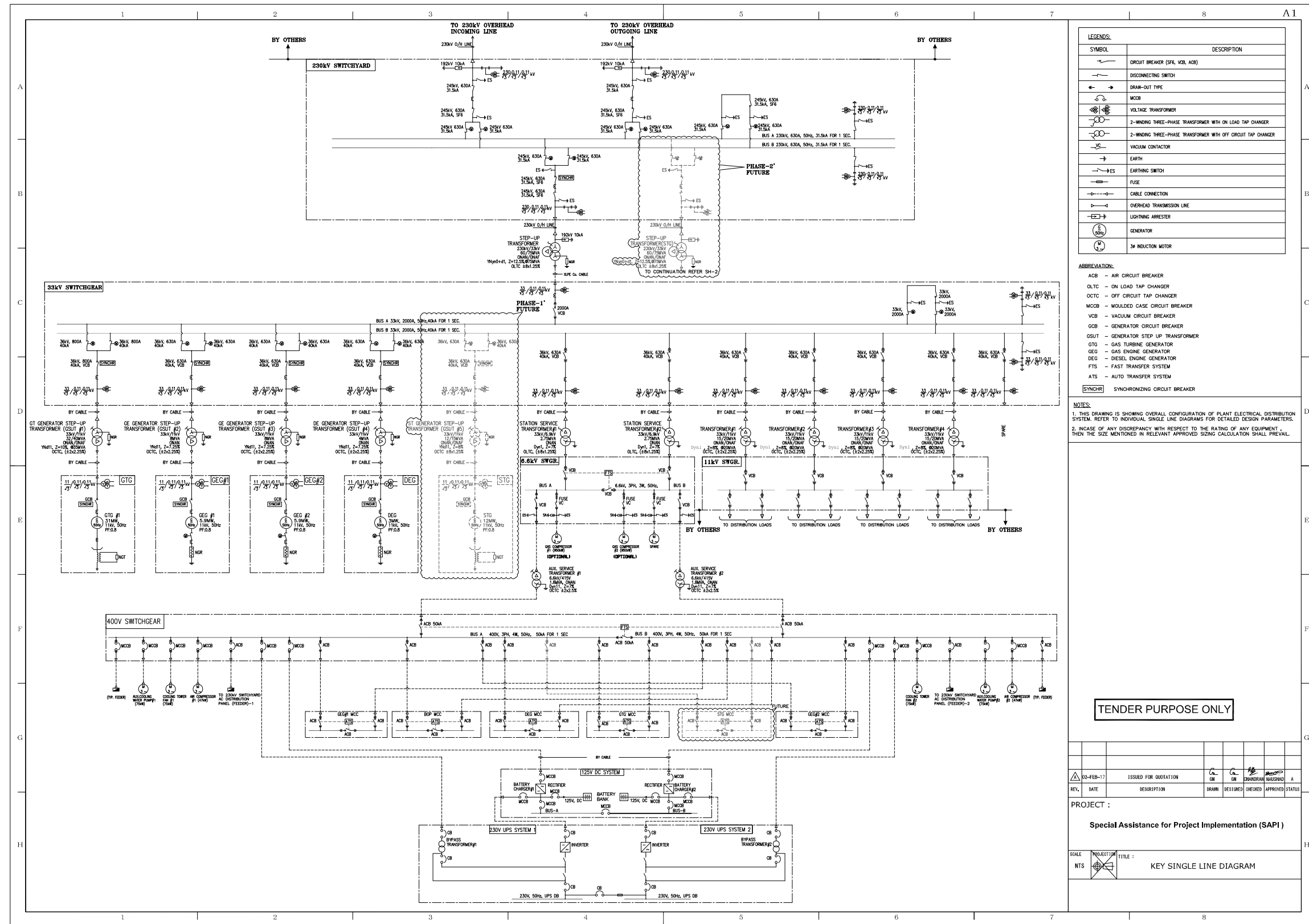
b) 2 feeders for each distribution transformer, total 8 feeders

(Notes)

1) The interface between On-site and Off-site is external cable terminals at 11kV Switchgears.

2) Underground ring-main loop circuit cabling systems are planned for distribution to the EZ by On-site developer

KEY SINGLE LINE DIAGRAM (Power Plant and Substation)



Source: JICA Study Team  
Figure 2.5-11: KEY SINGLE LINE DIAGRAM

### 2.5.3 Operation and maintenance of the Power plant and the Substation

#### (1) Operation of the Power plant and the Substation

As described in “2.4.1 (2) The issue of low electricity quality (frequency and voltage fluctuation) of the grid system,” grid frequency fluctuation level is high and not suitable for almost manufacturing processes, even though 230kV grid voltage level is considered to be good. High/low voltage level can be adjusted by transformers in substations and voltage fluctuation can be reduced by adding on-load tap-changers on transformers. But frequency fluctuation countermeasures can be taken only in power plants.

Considering the current grid situation, good quality electricity should be supplied to factories in the EZ from the Power plant, not from the grid.

That means the “Power plant should be considered as main supply to the EZ, not back-up purpose for grid power.” --- This is a big change from initial planning.

Since power demand of the EZ is small in the beginning of the EZ operation, a small capacity DE will supply power to the EZ during the period. In accordance with power demand increase, medium capacity GEs, then a large capacity GT will supply power to the EZ accordingly.

For instance, the following generation procedure may be followed in accordance with the EZ power demand increase.

- i) 1.5 – 3MW: 1 set of DE generation
- ii) 3 – 6MW: 1 set of GE generation
- iii) 6 – 9MW: 1 set of DE generation + 1 set of GE generation
- iv) 9 –12 MW: 2 sets of GE generation
- v) 12 – 15MW: 1 set of DE generation + 2 sets of GE generation
- vi) 15MW and above: 1 set of GT generation (+ 1 set of DE generation + 2 sets of GE generation in accordance with power demand)

Generators not supplying power to the EZ should supply power to the grid for the sale of electricity.

For this purpose, all generators of GT, GE, and DE are equipped with change-over circuits for supplying power to the EZ or grid connection. (See Fig. 2.4-10 KEY SINGLE LINE DIAGRAM.)

#### (2) Operator of the Power plant and the Substation

For securing long term steady operation of the Power plant and the Substation, operator should be public body, not private company.

In Bangladesh, Bangladesh Power Development Board (BPDB) is in charge of power development and operation of many big power plants. There are also six public operators of medium/ small power plants. One candidate of the operator for the proposed

Power plant (46MW) and the Substation (60/75MVA) is B-R Powergen Limited, subsidiary of BPDB (50%) and Rural Power Company Limited (RPCL: 50%).

#### (Reference)

B-R Powergen Ltd. is operating Kooda Power plant (150MW dual fuel: HFO/Gas) near Dhaka and proceeding Mirsarai 150MW dual fuel Power plant, Sreepur 150MW HFO Power plant, Madarganj 100MW Solar Power plant.

#### (3) Maintenance of the Power plant and the Substation

For securing long term steady operation of the Power plant and the Substation, proper maintenance of machinery and equipment is essential.

Typical maintenance schedules for Gas turbine, Gas engine and Diesel engine are shown as below.

1) Typical maintenance schedule for Gas turbine

1		Year		1st		2nd		3rd		4th		5th		6th		Total	
		Operating Hours		8000		16000		24000		32000		40000		48000			
Events	Frequency																
Semi-Annual / Annual Inspection (Bore Scope Inspection)	Every 6 months	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆			
	Down Time(day) (2shifts/day)	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1			13.5days
HPC Stage 3,4,5 VSV(Variable Stator Vane) Bushing Replacement	Every 12,500 operation hours			★				★				★				★	
	Down Time(day) (2shifts/day)			2				2				2			(To be performed as part of MOH)		6.0days
Hot Section Repair (Module Replacement)	Every 25,000 operation hours							◇									
	Down Time(day) (2shifts/day)							7									7.0days
Major Overhaul (In case Lease Engine is applied)	Every 50,000 operation hours															◆	
	Down Time(day) (2shifts/day)															8	8.0days
Down Time Total		2.5		4.5		11.5		2.5		4.5		9				34.5days	

2) Typical maintenance schedule for Gas engine

Maintenance Class	Operation Hours	Working Time	Maintenance Main Items
"B1" Maintenance	1,500 hr. to 2,000 hr.	1 days	- Tappet clearance <Check> - Prechamber retainer tightening torque <Check> - Ignition coil, plug cord <Check> - Spark plug <Replace>
"B2" Maintenance	4,000 hr.	1 days	- Filters <Cleaning> - Pilot check valve (inside of head) <Replace> - Each pickup clearances <Check> - Inspection B1
"C1" Maintenance	8,000 hr.	9 days	- SOGAV cartridge <Replace> - Cylinder head <Disassemble> - Prechamber nozzle <Check> - Cylinder liner <Check> - Terminal seal <Replace> - Air cooler <Cleaning> - Turbocharger <Check/Cleaning> - Air starter <Overhaul> - Inspection B2
"D1" Maintenance	16,000 hr.	12 days	- Intake Valve, Seat, Guide <Replace> - Exhaust Valve, Seat, Guide <Replace> - Pilot check valve (outside of head) <Replace> - Pistons and cylinder liners <Disassemble> - Piston rings <Replace> - Prechamber nozzle <Replace> - Big end bearings <Replace> - Main bearing (Only lower side) <Check*> - Small end bearings <Check> - Gearing <Check> - SOGAV <Replace> - Inspection C1
"C2" Maintenance	24,000 hr.	10 days	- Exhaust Expansion joint <Replace> - Turbocharger <Overhaul> - Inspection C1
"E1" Maintenance	32,000 hr.	14 days	- Crankpin bolts <Replace> - Piston crown bolts <Replace> - Thrust bearing <Replace> - Camshaft bearing <Check> - Cam roller <Replace> - Gearing bearing <Replace> - Air starter <Replace> - Torsional Damper <Check> - Plug cord <Replace> - Inspection D1

Note : Above table shall be expected in case of the conventional operation conditions of fuel, load, atmosphere, etc.

Check : Check and decide to replace if necessary

Check \* : Check a few of middle and decide to replace if necessary

3) Typical maintenance schedule for Diesel engine

Maintenance Class	Operation Hours	Maintenance Main Items
"B" Maintenance	3,500 hr. to 4,000 hr. (For 1 - 3 days)	- Fuel Injection Nozzle <Replace> - Filters <Cleaning> - Exhaust Valve <Check> - Intake valve <Check> - Cylinder Head <Disassemble>
"D1" Maintenance	8,000 hr. (For 10 - 13 days)	- Main Bearing <Check* > - Fuel Injection Pump <Check> - Air Cooler <Cleaning> - Turbo Charger <Overhaul/Check> - Governor <Overhaul> - Big-end Bearing <Check* > - Air Starter <Check> - Piston Ring <Replace> - "B" Maintenance
"D2" Maintenance	16,000 hr. (For 12 - 14 days)	- Piston <Check> - Intake Valve, Seat <Replace> - Exhaust Valve, Seat <Replace> - Small-end bearing <Check> - Big-end Bearing <Replace> - FIP Delivery Valve, Plunger Ass'y <Replace> - Main Bearing <Check> - Piston Pin <Check> - Governor Drive Bearing <Replace> - Ball Bearings <Replace> - "D1" Maintenance
"D3" Maintenance	24,000 hr. (For 12 - 14 days)	- Exhaust Expansion Joint <Replace> - Crank Pin Bolt <Replace> - Main Bearing <Replace> - "D1" Maintenance
"E2" Maintenance	32,000 hr. (For 15 - 17 days)	- Cam Shaft Bearing <Replace> - Thrust Bearing <Replace> - Governor Drive Gear <Replace> - Small-end bearing <Replace> - Torsion Damper <Check> - "D2" Maintenance

Note : Above table shall be expected in case of the conventional operation conditions of fuel, load, atmosphere, etc.

Check : Check and decide to replace if necessary

Check \* : Check a few of middle and decide to replace if necessary

(4) Issues of viability and sustainability of the Power Plant

1) Fuel gas price issue

There are two types of Gas Price applied to Power Plant: that is;

a) Gas for Power

b) Gas for Captive Power: much expensive.

- If "Captive Power" price would be applied, average power generation cost would be around Tk. 9.0/kWh. And if "Power" price applied, the cost would be around Tk. 7.3/ kWh.

- The Developer is requesting BEZA to sell the electricity by the same price with National Grid, which is around Tk. 8.2. Therefore, in order to make the Power Plant financially feasible, Gas Price for "Power" must be applied for AEZ.

2) Electricity selling quantity and price issue

As described, power demand of EZ in its early stage is quite small, so BEZA should be allowed to sell all the remaining electricity to the National Grid for the better utilization of Power Plant. At the early stage, around 80%-90% of the electricity may be sold to the National Grid.

Selling amount should be flexible depending on the demand of the EZ. For example:

- For the 1 – 3 Years: 30 MW will be sold to Grid;
- For the 4 – 6 Years: 15 MW will be sold to Grid;
- For the 7 Years and after: No selling to the National Grid.

Power Purchase Cost should be also discussed so that the Power Plant will not be in deficit.

3) Operation and maintenance (O&M) body issue

Operation and Maintenance (O&M) should be delegated to public power authorities such as Rural Power Company Limited (RPCL) or B-R Powergen Ltd. for securing long term operation.

4) Other issues

a) Connecting Point to National Grid

The Power Plant and Substation should be connected 230 kV Transmission Line near Araihasar Economic Zone. And it should be allowed to use electricity from the 230kV when the Power Plant fails to supply electricity to EZ because of some problems.

b) Continuous Gas Supply

Sustainable Gas Supply should be promised by Gas authorities at any time.

5) Current situation

BEZA, as of August 2018, is making efforts to solve above issues, coordinating related authorities such as Ministry of Energy and Power, PDB, REB, B-R Powergen, PGCB, Petrobangla, Titas Gas.

However, BEZA has not been able to come to official agreement for any term. It should be noted that unsuccessful negotiation with the relevant authorities regarding the gas price and PPA could result in a possible cancellation of the proposed power generation plan and JICA may remove some portions of the loan agreement for FDIPP since the proposed power generation plan would not be financially feasible. Thus, it is advised that BEZA shall take further actions to officially reach an agreement with the authorities.

## 2.6 Overall implementation schedule

The overall procurement plan for basic infrastructure sub-projects and related consulting services for Foreign Direct Investment Promotion Project (FDIPP) is tabulated in Table 2.6-1.

Table 2.6-1: Total procurement plan for Foreign Direct Investment Promotion Project

### A. Procurement of Consultants

Package No.	Description of Procurement Package as per DPP (SERVICES)	Unit	Quantity	Procurement method and type	Contract Approving Authority	Source of Fund	Estimated Cost (Taka in Lac)	Indicative dates		
								Invitation for tender	Signing of Contract	Completion of Contract
1	2	3	4	5	6	7	8	9	10	11
PS-1	Consulting service for basic infrastructure development under Foreign Direct Investment promotion project (FDIPP)	MM	F-310 MM (21 nos.) L-413 MM (22 nos.)	QBS	CCGP	JICA	11976.77	August- 2018	December- 2018	June- 2023

Source: JICA Study Team

### B. Procurement of Contractors

Package No.	Description of Procurement Package as per DPP (WORKS)	Unit	Quantity	Procurement method and type	Contract Approving Authority	Source of Fund	Estimated Cost (Taka in Lac)	Indicative dates		
								Invitation for tender	Signing of Contract	Completion of Contract
1	2	3	4	5	6	7	8	9	10	11
WD-1	Land development	m <sup>3</sup>	7900000	OTM (ICB)	CCGP	JICA	97939.84	October ,2018	June, 2019	June , 2022
	Access road	m <sup>3</sup>	337				1537.05			
	Retention canal, Retention pond and pumping station	m <sup>3</sup>	171400				6451.44			
WD-2	Gas Transmission pipeline	km	6	Delegated (OTM/LCB)	CCGP	JICA	19673.69	Jan ,2019	July ,2019	Jun-2022
WD-3	Telecommunication Supply System	km	23	Delegated (OTM/LCB)	Ministry/ Division	JICA	2885.47	Jan ,2019	July ,2019	Jun-2022
WD-4	Power station, Sub- station& transmission line	Mw	46	Delegated (OTM/ICB)	CCGP	JICA	61876.48	October ,2018	June, 2019	June , 2022

Source: JICA Study Team

The overall implementation schedule for Foreign Direct Investment Promotion Project (FDIPP) is shown in Table 2.6-2. The schedule remains tentative as the land acquisition and other factors may cause delay of the other activities.



## 2.7 Project cost estimate

Project cost is estimated separately for the offsite infrastructure construction executed by BEZA of Bangladesh government using Japan's ODA Loan and the onsite infrastructure construction executed by the SPC. All the cost estimates presented in this section was based on the own analysis and assumption made by JICA Study Team. Both of project costs (BEZA's portion and SPC's portion) are estimated based on the following conditions.

- 1) Project costs consist of mobilization/demobilization cost, direct construction cost, cost of temporary works, site expenses (%) and general expenses (%). For the mobilization/demobilization of the construction equipment, no imported special equipment is to be utilized in the project. All of the equipment would be secured in Bangladesh. Then, these costs are determined on the transportation, assembling/ disassembling of the equipment and the depreciation cost to be prepared onto the site.
- 2) Unit cost of the construction works is based on the unit price of manpower, material cost and equipment rental cost determined on the basis of the unit cost list issued by Ministry of Public Works in 2014. The unit cost is taken with about 8% inflation into account. If there was no unit rate of the imported material in the list, its cost is determined referring to the unit cost of import from Thailand.
- 3) Foreign exchange rate is adopted from JICA for project appraisal as of January 2018, which is (1US\$ = 80.60 BDT, 1BDT = 1.38JPY).
- 4) Price escalation for the construction cost is taken at 6%, considering past three years escalation of construction materials and manpower of the direct construction cost.
- 5) Physical contingency is applied at 4% of the direct construction cost for the public works project and 5% of the direct construction cost for the SPC project.
- 6) For the public works project, the managing expenses of the projects are adopted at 5% of the direct construction cost for the site managing expenses and 10% of the direct construction cost for the general managing expenses. For the SPC project, the managing expenses of the projects are adopted at 5% of the direct construction cost for the site expenses and 15% of the direct construction cost for the general expenses.
- 7) Land acquisition fee is not included into the project cost as the land acquisition is applied on a national budget.
- 8) For the public works project, the consultant fee for detailed design and construction supervision of the projects is adopted at 6% of the direct construction cost. For the SPC project, the consultant fee for detailed design and construction supervision of the projects is adopted at 8% of the direct construction cost. The contingency of the consultant cost is adopted at 5% of the consultant fee for the both projects.

Office expenses of the project for BEZA. : Managing cost and office expense of the projects for BEZA is estimated and applied into the project cost.

### 2.7.1 Araihasar Economic Zone

Based on the land use plan and infrastructure plans described in Chapter 2.3 (On-site infrastructure sub-projects), the cost of developing Araihasar EZ was calculated as given in Table 2.7-1.

Table 2.7-1: Cost estimate for onsite infrastructure Project for Araihaazar EZ

Item		Local Portion (BDT)	Foreign Portion (JPY)	Total Cost (BDT)
A.	Construction Cost	1,217,435,564	2,002,909,638	2,668,819,360
	(0) Temporary Work/ Mobi/Demobilization	25,953,200	57,498,000	67,618,417
	(1) Land Development	0	0	0
	(2) Road	473,859,476	432,913,074	787,564,602
	(3) Drainage	119,154,300	109,397,248	198,427,668
	(4) Water Supply	18,567,495	102,282,478	92,685,232
	(5) Sewerage System	115,487,766	106,030,951	192,321,788
	(6) Power Distribution	56,920,923	313,559,425	284,137,898
	(7) Telecom. Distribution	6,242,460	34,387,745	31,161,116
	(8) Gas Distribution	5,665,145	29,658,716	27,156,969
	(9) WTP, WWTP and GETP	335,296,000	692,640,000	837,209,043
	(10) Administration Buildings	60,288,800	124,542,000	150,536,626
B.	Site Expense/General Expense	216,789,381	895,668,285	865,824,370
C.	Contingency & Tax	390,026,939	1,296,404,505	1,329,450,494
D.	Consultants Services	95,604,117	307,214,222	318,223,118
TOTAL		1,919,856,001	4,502,196,650	5,182,317,342

Source: JICA Study Team

## 2.7.2 Off-site infrastructure sub-project

The costs of land development and related works for Araihaazar EZ have been estimated in Table 2.7-2.

Table 2.7-2: Cost estimate for land development and related works for Araihaazar EZ

ITEM NO.	PAY ITEM		LOCAL (BDT)	FOREIGN (JPY)	TOTAL (BDT)
<b>Part-1: Land Development</b>					
1000	GENERAL, MOBILIZATION & TEMPORARY WORKS		66,370,000	107,940,000	144,757,800
2000	EXCAVATION AND FILLING		6,838,312,344	1,035,799,171	7,590,526,702
3000	SOILING AND SLOPE PROTECTION		64,366,700	201,904,800	210,993,280
4000	OTHER RELATED FACILITIES		23,660,000	2,555,000	25,515,483
	Subtotal of Bills (Item No. 1000 to 4000)	A	6,992,709,044	1,348,198,971	7,971,793,264
TR	Total for Daywork	B	72,685,140	29,760,000	94,297,340
PS	Specified Provisional Sum	C	293,257,500	805,230,000	878,028,742
<b>BID PRICE-1 (D=A+B+C)</b>			<b>7,358,651,684</b>	<b>2,183,188,971</b>	<b>8,944,119,346</b>
<b>Part-2: Access Road</b>					
2000	EXCAVATION AND FILLING		46,351,398	7,020,846	51,450,052
A-1	ACCESS ROAD WORKS		79,607,191	21,822,775	95,455,248
A-2	STREET LIGHTENING		4,708,143	1,144,079	5,538,992
<b>BID PRICE-2 (G)</b>			<b>130,666,732</b>	<b>29,987,700</b>	<b>152,444,292</b>
<b>Part-3: Retention Canal, Retention Pond with Pumping Station</b>					
B-1	RETENTION CANAL		82,700,879	54,643,308	122,383,746
B-2	RETENTION POND		148,468,751	56,803,505	189,720,388
B-3	SLUIC		9,990,841	2,303,232	11,663,486
B-4	PUMPING STATION		2,317,621	535,370	2,706,415
B-5	OTHER RELATED FACILITIES		12,533,075	6,883,137	17,531,722
<b>BID PRICE-3 (H)</b>			<b>256,011,166</b>	<b>121,168,552</b>	<b>344,005,758</b>
<b>Sub Total of Part 1 - 3 (G=D+E+F)</b>			<b>7,745,329,582</b>	<b>2,334,345,223</b>	<b>9,440,569,395</b>
	Price Contingency (15% of A+E+F)	H	1,106,908,041	224,903,283	1,270,236,497
	Physical Contingency (10% of G+H)	I	885,223,762	255,924,851	1,071,080,589
<b>Sub Total (G+H+I)</b>			<b>9,737,461,386</b>	<b>2,815,173,357</b>	<b>11,781,886,482</b>
	VAT (7% of J)	K	681,622,297	197,062,135	824,732,054
	Income Tax (7.5% of J)	L	730,309,604	211,138,002	883,641,486
<b>TOTAL BID PRICE (J+K+L)</b>			<b>11,149,393,287</b>	<b>3,223,373,493</b>	<b>13,490,260,021</b>

Source: JICA Study Team

The costs of gas transmission pipeline and telecommunication line for Araihaazar EZ have been estimated in Table 2.7-3 and Table 2.7-4.

Table 2.7-3: Cost estimate for gas transmission pipeline for Araihaazar EZ

Sl no.	Description	BDT
1	Route survey	3,000,000
2	Land acquisition	782,500,000
3	Land Requisition	27,100,000
4	IEE and EIA	3,000,000
<b>A. Sub-Total</b>		<b>815,600,000</b>
5	Materials for line pipe, bends, fittings, valves, off take modification of CGS/TBS, New CGS/TBS, metering arrangement etc. and CD/VAT/Charges/ Fees etc.	756,600,000
6	Constructions of pipeline, off take modifications of CGS/TBS, New CGS/TBS, metering arrangement etc.	164,426,000
7	Civil work, CP and Road restoration charge etc.	17,500,000
<b>B. Sub-Total</b>		<b>938,526,000</b>
<b>Total A. + B.</b>		<b>1,754,126,000</b>
8	10% contingency	175,412,600
9	Consultancy fee (5% of material cost)	37,830,000
<b>Grand total</b>		<b>1,967,368,600</b>

Source: JICA Study Team

Table 2.7-4: Cost estimate for telecommunication supply line for Araihaazar EZ

Sl no.	Description	BDT
1	From Moghbazar to Narayangonj with process HDD of 24 Km ditance of 24 core optical fiber cable installation	40,643,000
2	From Narayangonj To BEZA with process HDD of 26 Km ditance of 24 core optical fiber cable installation	25,513,000
3	DWDM Equipment at Narayangonj, Narsingdi and BEZA Site	99,960,000
4	Telephone Exchange with MSPP MUX, Rectifier & Batteries	83,300,000
5	Router and Switch with Rectifiers and Batteries	39,131,000
<b>Grand total</b>		<b>288,547,000</b>

Source: JICA Study Team

### 2.7.3 Power generation, substation and transmission system plan

The costs of the proposed power station, substation and transmission system for Araihaazar EZ have been estimated in Table 2.7-5.

Table 2.7-5: Cost estimate for Power Station, Sub-station & Transmission Line

<b>(A) Power Station</b>				
No.	Item Description	Qty	Price (JPY/USD)	Amount (BDT)
1	Gas Turbine Generator Package	1set	¥2,190,000,000	1,586,957,000
2	Gas Engine Generator Package	2sets	¥1,334,160,000	966,783,000
	Diesel Engine Generator Package	1set		-
3	Engineering & BOP	1set	¥1,667,400,000	1,208,261,000
4	Civil/Architectural Works	1set	¥905,100,000	655,870,000
5	Erection & Commissioning Support	1set	¥684,340,000	495,899,000
<b>Sub-Total(A)</b>			<b>¥6,781,000,000</b>	<b>4,913,770,000</b>
<b>(B) Sub-station</b>				
No.	Item Description	Qty	Price (JPY/USD)	Amount (BDT)
1	Engineering & BOP	1set	¥813,500,000	589,493,000
2	Civil/Architectural Works	1set	¥199,500,000	144,565,000
3	Erection & Commissioning	1set	¥147,000,000	106,522,000
<b>Sub-Total(B)</b>			<b>¥1,160,000,000</b>	<b>840,580,000</b>
<b>(C) Transmission Line</b>				
No.	Item Description	Qty	Price (JPY/USD)	Amount (BDT)
1	Engineering & BOP	1set	US\$700,000	56,420,000
2	Supervision Charge (PCGB)	1set	US\$70,000	5,642,000
<b>Sub-Total(C)</b>			<b>US\$770,000</b>	<b>62,062,000</b>
<b>TOTAL (A + B + C)</b>			<b>¥8,026,470,000</b>	<b>5,816,412,000</b>
<b>Contingency</b>			<b>¥512,484,000</b>	<b>371,236,000</b>
<b>GRAND TOTAL</b>			<b>¥8,538,954,000</b>	<b>6,187,648,000</b>

Source: JICA Study Team

## 2.8 Economic and financial analysis

The economic and financial analyses are undertaken by JICA Study Team for the project. The objectives are to evaluate efficiency of resource allocation in view of the national economy for economic analysis, and profitability for financial analysis. The Araihaazar economic zone (EZ) with the power generation, distribution and transmission system constitutes the project to be evaluated. Internal rate of return (IRR) and net present value (NPV) calculated by cash flow analysis are used as evaluation indices. This calculation is based on the own analysis of JICA Study Team.

### 2.8.1 Araihaazar Economic Zone

JST analyzed three alternatives with Alternative 1 as the base case.

- Alternative 1: Construct all onsite and offsite infrastructure except for the power station. The target area shall be 191.51 ha.
- Alternative 2: Construct all onsite infrastructure. The target area shall be 191.51ha.
- Alternative 3: Construct all onsite and offsite infrastructure except for the power station. The target area shall be 400 ha.

#### (1) Financial analysis

##### 1) Preconditions

Preconditions for financial analysis of the EZ were set as follows.

- Project period: EZ development will begin in 2018. The project period shall be 48 years until 2065 for the eight years construction period and 40 years of EZ facilities life.
- Implementation schedule: As shown in Table 2.8-1.

Table 2.8-1: Schedule of construction, land lease sales and utility demand increase

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Construction cost disbursement	7.4 %	25.1 %	36.4 %	9.6 %	6.6 %	6.6 %	4.5 %	3.8 %				
Land lease schedule					8%	12%	21%	12%	17%	30%		
Administration					25%	100 %	100 %	100 %	100 %	100 %	100 %	100 %
EZ operation + Utility demand forecast							8%	12%	41%	53%	70%	100 %

Source: JICA Study Team

- Revenue: Revenue from EZ operation comprises land lease, water supply and drainage services and management fee.
- Land acquisition cost: Land required for the EZ project is provided from BEZA. SPC and BEZA sign a concession agreement and SPC will pay 7% of the lease sales revenue to BEZA as a concession fee. Therefore, the concession fee is taken to represent land acquisition cost of the EZ project.
- Exchange rate: The exchange rate follows the appraisal of the JICA ODA loans project (2018 version). All calculations are expressed in US dollars (USD).

## 2) Project investment cost

The project investment cost of Alternative 1 is USD 313.49 million (BDT 25,268 million) in total.

## 3) Project revenue

According to the Master Plan of EZ land use, of the total site area of 191.51 ha, 145.19 ha (75.81%) is set for factory lots. Schedule of lease contracts of factory lots, demand for water supply and drainage and EZ maintenance and management are as shown in Table 2.8-1.

## 4) Result of financial analysis of base case

Among the profit-making business of the EZ, the water supply and drainage services and the EZ maintenance and management fee were set as shown in Table 2.8-2.

Table 2.8-2: Pricing for water supply and drainage services and EZ maintenance and management

	Unit price	Demand
Water supply	33.21 BDT/ m <sup>3</sup>	(Factory lot) 50 or 60 m <sup>3</sup> / ha/ day depending on industries (Others) 35 m <sup>3</sup> / ha/ day
Drainage	38 BDT/ m <sup>3</sup>	(Factory lot) 45 or 54 m <sup>3</sup> / ha/ day depending on industries (Others) 31.5 m <sup>3</sup> / ha/ day
EZ maintenance and management	0.8 USD/ m <sup>2</sup> / year	191.51 ha

Source: JICA Study Team - based on the Project for Development Study and Capacity Enhancement of Bangladesh Economic Zone Development Plan Authority

To set the land lease price, analysis was conducted in the following two ways.

### a. Financial analysis of land lease market price

The land lease prices should be set considering potential competitors. However, since the land lease prices are individually set according to conditions such as development timing and area, it is impossible to determine exactly the transaction prices in time and in space. For setting EZ land lease price, the data in Table 2.8-3 for ASEAN countries, Myanmar and India may be used as reference prices of similar land lease.

Table 2.8-3: Land lease prices for Economic Zones in ASEAN countries, Myanmar and India

Country	Economic zone	Lease period (Year)	Land lease price (USD/m <sup>2</sup> )*
Myanmar		50	65-85
Vietnam	Vietnam Singapore Industrial Park I	50	55
Thailand	Amata Nakorn Industrial Park	Sale	144
Indonesia	MM2100 Industrial Park	30+20	200
Cambodia	Phnom Penh Special Economic Zone	50	65

India	Mahindra World City	99	140
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Source: JICA Study Team - based on the interview and the Project for Development Study and Capacity Enhancement of Bangladesh Economic Zone Development Plan Authority Table 4.9.2-8

The data for Vietnam and Thailand are used as the EZ benchmark prices. In Vietnam, there are cases where EZ in good locational condition is sold at prices in the range from 85 to 95 USD/ m<sup>2</sup> for 50 years. In addition, the price data of EZ in Myanmar are used as a reference as the investment environment is similar, and 75USD/ m<sup>2</sup> may be used. By applying this price, the FIRR was calculated to be negative 0.61% and the NPV was negative USD 56.54 million (negative BDT 4,557 million). This FIRR value is below the opportunity cost of capital (0.9%).

#### **b. Setting up the lease price with loan repayment ability and recoverable cost**

For this EZ project, onsite and offsite facilities constitute indivisible components of the business, but offsite infrastructure development is implemented by the Bangladeshi government and on-site development is carried out by the Bangladesh government and private developers. Therefore, the onsite investment by the Bangladesh government and private developers should ensure the profitability at 75 USD / m<sup>2</sup> for 50 years as set above. Analysis was conducted in consideration of the following two points.

- For the onsite infrastructure of this project, it is supposed that the entire investment amount will be capital subscription. Its shareholding ratios are 70% for private developers and 30% for the Bangladesh side. Equity capital equivalent of the Bangladesh side will be financed by JICA to the Ministry of Finance by equity back finance. Although the Ministry of Finance will finance BIFFL, the loan amount from JICA needs to be repaid without delay for both the principal and interests. The loan disbursement schedule was set to 1%, 1%, 22%, 32%, 24%, 20% respectively from 2018 to 2025 in accordance with the EZ on-site construction schedule in Table 2-8-1. The loan conditions from JICA to the Ministry of Finance are 0.01% interest, and 40 years of repayment period with 10 years of grace period. The loan conditions from the Ministry of Finance to BIFFL were set at 2% interest and 40 years of repayment period with 10 years of grace period. As for the offsite infrastructure, it is not included in the analysis of lease charge setting, since it is a public project in Bangladesh.
- From the aspect of financial sustainability, it is necessary costs are fully recoverable, including not only the investment and management and maintenance costs but also re-investment costs.

As a result of analysis considering the above, at the charge setting of USD 75/m<sup>2</sup> for 50 years, the cash flow will be more than USD 1 million per year even during the principal and interest repayment period. Therefore, it was confirmed that there is no problem in terms of loan repayment.

#### 5) Financial analysis of alternatives

Financial analysis was also conducted for Alternative 2 and Alternative 3 at the lease price set in 4). The results are shown in Table 2.8-4.

Table 2.8-4: FIRR and NPV at lease value of 75USD/ m<sup>2</sup>/ 50 years

Alternatives	FIRR (%)	NPV (USD million)
1. Develop all the infrastructure (200ha)	-0.61	-56.54
2. Develop onsite infrastructure (200ha)	1.05	4.69
3. Develop all the infrastructure (400ha)	1.05	8.99

Source: JICA Study Team

### 6) Sensitivity analysis

Sensitivity analysis was performed to see effects of uncertain factors surrounding the project. The following cases were set as uncertain factors in this project. The results of the sensitivity analysis are shown in Table 2.8-5.

- A case where the occupancy rate of factory lots is 90%
- Cases where the land lease price increases and decreases by 10% due to changes in market conditions
- Cases where project cost increases and decreases by 10%
- Cases where the operation start is earlier and later by 1 year
- Cases where the inflation rate increases and decreases by 5%

Table 2.8-5: Result of EZ sensitivity analysis

	Pessimistic case			Optimistic case		
		IRR	NPV (USD million)		IRR	NPV (USD million)
<b>Alternative 1 (Base case: Construct all infrastructure (200 ha))</b>						
Occupancy rate	-10%	-1.01%	-71.29	-	-	-
Land lease price	△10%	-0.82%	-65.73	+10%	-0.39%	-47.36
Construction cost	+10%	-1.19%	-84.02	△10%	0.09%	-27.83
Operation start	+1 year	-0.62%	-58.59	△1 year	-0.55%	-52.45
Inflation rate	+5%	Unmeasurable	-165.34	△5%	0.43%	-17.51
<b>Alternative 2 (Construct on-site infrastructure (200ha))</b>						
Occupancy rate	-10%	0.56%	-10.81	-	-	-
Land lease price	△10%	0.76%	-4.50	+10%	1.35%	13.87
Construction cost	+10%	0.42%	-16.33	△10%	1.86%	27.72
Operation start	+1 year	0.97%	2.40	△1 year	1.20%	9.03
Inflation rate	+5%	-3.15%	-73.14	△5%	2.01%	34.20
<b>Alternative 3 (Construct all infrastructure (400 ha))</b>						
Occupancy rate	-10%	0.54%	-21.86	-	-	-
Land lease price	△10%	0.74%	-9.86	+10%	1.37%	27.83
Construction cost	+10%	0.33%	-37.45	△10%	1.80%	50.71
Operation start	+1 year	0.98%	4.81	△1 year	1.20%	17.39
Inflation rate	+5%	Unmeasurable	-167.35	△5%	2.10%	72.01

Source: JICA Study Team

(2) Economic analysis

1) Preconditions

- “With-project” and “Without-project”: In the case of "with-project", the EZ is developed as planned, and factories on the site are maintained and operated. On the other hand, in the case of "without-project", the EZ is not developed, and agriculture will continue on the planned development site as it does at present.
- Project conditions: project life, implementation schedule, revenue and exchange rate are the same as determined in the financial analysis.

2) Economic effect of the EZ project

Economic benefits may be defined by either "incremental added value produced from the EZ" or "export increase and import reduction by products produced by industrial estates". Since the former is more measurable with available data, "incremental added value to be realized from the EZ" is used as the economic benefit in this analysis. Economic costs and economic benefits were illustrated as shown in Figure 2.8-1

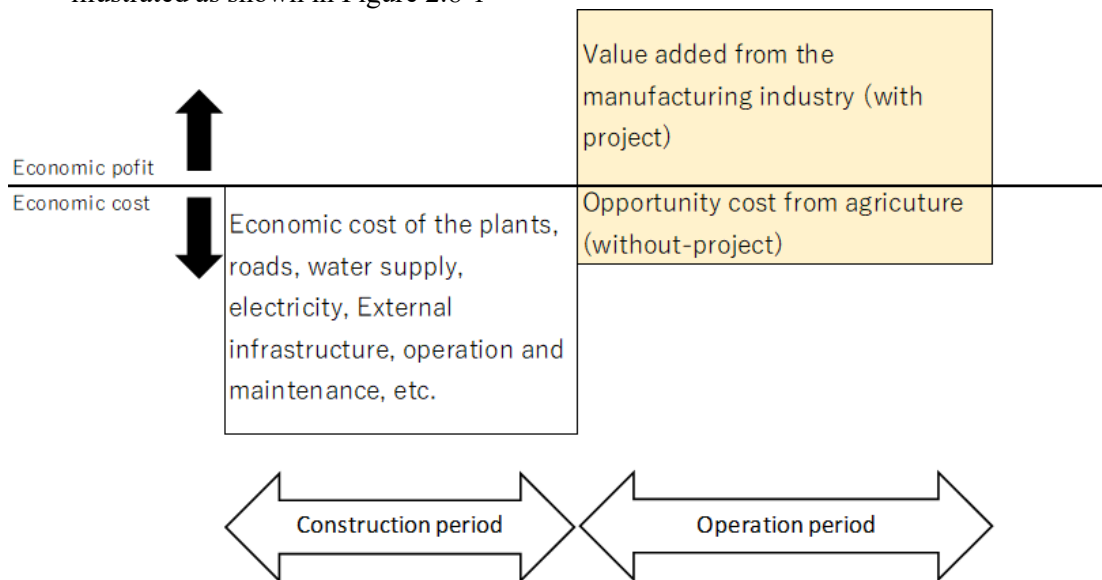


Figure 2.8-1: Conceptual diagram of EIRR cash flow

3) Project economic costs

Economic costs consist of economic investment costs required to develop the EZ and opportunity costs of the land that should be used otherwise.

a. Estimation of economic investment costs

Economic costs are calculated based on financial expenses, excluding price escalation and transfer items associated with land and tax. For the local currency portion, conversion from market prices to border prices was done by applying the standard conversion factor (SCF). Because the minimum wage is determined by the Labor Standards Law according to the Labor Standards Law, the wages of unskilled workers are distorted from the market value of unskilled

workers and wages, and therefore a separate conversion factor (CFL) is used for unskilled workers. SCF and CFL are assumed to be 0.97 and 0.95, respectively, the ratios used in a feasibility study of similar project by the World Bank (2014), are used. Based on the above, the economic cost is calculated to be USD 293.07 million (BDT 23,622 million).

**b. Land opportunity cost**

If the EZ is not developed, agriculture will be continued in the planned development area. In this case, the added value of agriculture produced in the proposed EZ site is regarded as the land opportunity cost. The added value of agriculture is USD 615 per capita according to the national statistical data of FAOSTAT (2010). The number of people employed at the planned development site (219.17 ha) including the offsite area is 735 from the ratio of agricultural land (7,669 thousand hectares) and agricultural population (25,727 thousand people) in Bangladesh as of 2010. The agricultural population has been projected over the project period based on the population projection of Bangladesh. As a result, the opportunity cost of land in the planned EZ development area was calculated to be USD 27.5 million (BDT 2,218 million).

**4) Project economic benefit**

The added value generated from the EZ is calculated from (1) calculation of added value per worker in the manufacturing industry and estimation of its increase, and (2) the number of workers at the EZ.

Calculation of added value per worker in the manufacturing industry and estimation of its increase

According to the Bangladesh Bank, the added value of the manufacturing industry from 2014 to 2016 increased from USD 19.177 billion (BDT 1,543 billion) to USD 23.503 billion (BDT 1,890 billion) annually at the annual rate of 10% more or less. Increases in added value over the project period were estimated based on the population projection of UN (2017), considering the population as a major factor to affect added value changes. As for the number of workers engaged in the manufacturing industry, the number of persons engaged in the manufacturing industry estimated by the World Bank survey (2012) was used. Based on it, the number of workers at the EZ during the project period was calculated based mainly on the population trend forecasting. As a result, the added value per worker in 2024, assumed year to start operation, will be USD 4,730 (BDT 380,441). After 2025, it was assumed to increase at the annual rate of 3%, reflecting technological development to be induced by the EZ development.

Setting of the number of workers at the EZ

From the data of the Bangladesh Bureau of Statistics (BBS, 2012), the number of employees per manufacturing enterprise was calculated using the information of "number of enterprises in the manufacturing industry" and "number of employees". Accordingly, the number of employees of 71 enterprises assumed to locate in the EZ was set to 13,257 people.

**5) Measurement of economic benefit**

Based on the (1) value added per capita in the manufacturing industry and (2) the number of workers in EZ as calculated above, net added value generated from the EZ is determined from 2024 to 2065, when the EZ is operating. The added value will increase from USD 5.02 million (BDT 403 million) in 2024 at 8% operation to USD 210 million (BDT 16,946 million) in 2065.

## 6) Result of economic analysis

The results of the economic analysis are shown in Table 2.8-6.

Table 2.8-6: Result of the EZ economic analysis

Alternative plan	EIRR (%)	NPV (USD million)
1. Develop all the infrastructure (200ha)	15.70	103.05
2. Develop onsite infrastructure (200ha)	17.27	130.59
3. Develop all the infrastructure (400ha)	17.89	286.74

Source: JICA Study Team

## 7) Sensitivity analysis

Sensitivity analysis was conducted as done for the financial analysis in (1) 6) above. The following cases were examined with uncertain factors in economic analysis. The results of the sensitivity analysis are shown in Table 2.8-7.

- Cases where the added value increase rate in manufacturing industry increases or decreases by 2% after all factories are in operation
- Cases where the operation start earlier and later by 1 year
- Cases where project cost increases and decreases by 10%
- Cases where the inflation rate increases and decreases by 5%

Table 2.8-7: Sensitivity analysis result of EZ economic analysis

	Pessimistic case			Optimistic case		
		IRR	NPV (Mil US\$)		IRR	NPV (Mil US\$)
<b>Alternative 1 (Base case: Construct all infrastructure (200 ha))</b>						
Added value increase rate	1%	14.77%	67.15	5%	16.66%	152.44
Operation start	+1 year	14.61%	74.13	△1 year	17.01%	135.47
Construction cost	+10%	14.96%	87.60	△10%	16.53%	118.49
Inflation rate	+5%	15.05%	87.71	△5%	16.28%	114.88
<b>Alternative 2 (Construct on-site infrastructure (200ha))</b>						
Added value increase rate	1%	16.40%	94.69	5%	18.17%	179.98
Operation start	+1 year	16.01%	101.58	△1 year	18.80%	163.10
Construction cost	+10%	16.49%	117.84	△10%	18.16%	143.33
Inflation rate	+5%	16.59%	117.87	△5%	17.89%	140.67
<b>Alternative 3 (Construct all infrastructure (400 ha))</b>						
Added value increase rate	1%	17.04%	213.09	5%	18.77%	388.08
Operation start	+1 year	16.56%	227.28	△1 year	19.51%	353.38
Construction cost	+10%	17.09%	262.34	△10%	18.80%	311.14
Inflation rate	+5%	17.20%	261.68	△5%	18.52%	306.09

Source: JICA Study Team

### (3) Conclusion

In the base case, FIRR (negative 0.61%) fell below the capital opportunity cost (0.9%). However, since the EIRR (15.70%) exceeds the social discount rate (12%), the project is considered to contribute to the economy of Bangladesh. In addition, from the economic point of view, added value generated from indirect employment accompanying the EZ development is also expected. It is expected, therefore, that the government's financial support for the project is justifiable as the project will contribute to economic growth in Bangladesh.

As mentioned above, the EZ project is implemented with both onsite and offsite facilities as inseparable components. Offsite facilities are maintained by the Bangladesh government, and onsite facilities are supposed to be constructed and operated by SPC through investment by the Bangladesh government and private developers. Therefore, the onsite profitability under Alternative 2 with FIRR 1.05% and NPV USD 4.69 million (BDT 378 million) confirms financial profitability of the onsite development; that is, the project is financially viable, generating sufficient revenues for commercial finance.

## 2.8.2 Power generation, distribution and transmission system

JICA Study Team analyzed two alternatives with Alternative 1 as the base case.

- Alternative 1: Construct a power station offsite of the EZ. Fuel is purchased at the gas price for tenants (2,937 USD / MMCF).
- Alternative 2: Construct a power station offsite of the EZ. Fuel is purchased at the gas price for the national grid (990 USD / MMCF).

### (1) Financial analysis

#### 1) Preconditions

Preconditions for financial analysis of power plant were set as follows.

- Project period: The start of development of the power plant will be set to be in 2020. The project period was set to be 41 years up to 2060 from the loan term of 40 years including the repayment period.
- Implementation schedule: As shown in Table 2.8-8.

Table 2.8-8: Construction schedule of power plant

	2020	2021	2022
Construction	40%	40%	20%

Source: JICA Study Team

- Revenue: Part of the power is sold to the EZ, and the surplus is all purchased by the national grid.
- Land acquisition cost: Land required for the power plant project is provided from BEZA. Power plant will pay 7% of the lease sales revenue to BEZA as a concession fee. Therefore, concession fee is taken to represent land acquisition cost of the power plant project.
- Exchange rate: The exchange rate follows the appraisal of the JICA ODA loans project (2018 version). All calculations are expressed in US dollars.

#### 2) Project investment cost

The project investment cost of Alternative 1 is USD 90.1 million (BDT 7,261 million) in total.

### 3) Project revenue

The power plant preferentially feeds the industrial park and surplus electricity is sold to the national grid. Selling price is assumed to be the same for both the industrial park and the national grid.

### 4) Result of financial analysis of base case

#### a. Setting up the power selling price with loan repayment ability and cost recovery

When examining the power selling price, the price that can repay concessional loan with interest rate 0.01%, loan period 40 years and grace period 10 years without delay can be analyzed. In consideration of recent rise in domestic natural gas price, analysis was conducted assuming the rate of increase at 5% annually. As a result, the power selling price satisfying the repayment ability and capable of recovering cost was found to be 0.16 USD/ kWh (12.9 BDT/ kWh). When conducting cash flow analysis with this power selling price, FIRR is calculated to be 22.66%, and NPV is USD 576.09 million (BDT 46,432 million). The calculated FIRR is higher than the capital opportunity cost (0.9%).

#### b. Financial analysis of power selling market price

Analysis was conducted using the average market price in Bangladesh. According to interviews with related organizations, the selling price to industrial parks and the selling price to the national grid is in the range of 0.10 - 0.12 USD/ kWh (8.2 - 9.84 BDT/ kWh). Based on this, the power selling price was set to 0.11 USD/ kWh (9 BDT/ kWh). As a result, FIRR was calculated to be 6.93% and NPV was USD119 million (BDT 9,621 million). The calculated FIRR is higher than the capital opportunity cost (0.9%), so the investment is considered financially viable.

### 5) Financial analysis of alternatives

Financial analysis was also conducted for Alternative 2 as done with the base case in 4). The results are shown in Table 2.8-9 and Table 2.8-10..

Table 2.8-9: FIRR and NPV at power selling price ensuring repayment ability

Alternatives	Power selling price (USD/kWh)	FIRR (%)	NPV (USD million)
1. Purchase gas at a price for tenants	0.16	22.66	576.09
2. Purchase gas at the price for the national grid	0.14	20.62	510.01

Source: JICA Study Team

Table 2.8-10: FIRR and NPV at power selling price of 0.11USD/ kWh (9 BDT/ kWh)

Alternatives	FIRR (%)	NPV (USD million)
1. Purchase gas at a price for tenants	6.98	119.37
2. Purchase gas at the price for the national grid	10.37	205.52

Source: JICA Study Team

## 6) Sensitivity analysis of power plant financial analysis

Sensitivity analysis was performed to see the effects of uncertain factors surrounding the project. The following cases were examined with uncertain factors for this project. The results of the sensitivity analysis are shown in

Table 2.8-11.

- a. Cases where gas price increases and decreases by 10%/ year
- b. Cases where project cost increases and decreases by 10%
- c. Cases where the operation start is earlier and later by 1 year
- d. Cases where the inflation rate increases and decreases by 5%

Table 2.8-11: Sensitivity analysis result of power plant financial analysis

	Pessimistic case			Optimistic case		
		IRR	NPV (Mil USD)		IRR	NPV (Mil USD)
<b>Alternative 1 (Base case: Fuel is purchased at the gas price for tenants)</b>						
Gas price fluctuation (annual rate)	+5%	Unmeasurable	-65.44	△5%	8.85%	189.59
Construction cost	+10%	6.23%	111.81	△10%	7.86%	126.92
Operation start	+1 year	6.43%	113.36	△1 year	7.45%	125.22
Inflation rate	+5%	Unmeasurable	-357.76	△5%	10.56%	263.47
<b>Alternative 2 (Fuel is purchased at the gas price for the National Grid)</b>						
Gas price fluctuation (annual rate)	+5%	8.80%	125.09	△5%	11.09%	230.68
Construction cost	+10%	9.42%	197.97	△10%	11.50%	213.08
Operation start	+1 year	9.42%	196.89	△1 year	11.21%	214.04
Inflation rate	+5%	Unmeasurable	-115.00	△5%	12.61%	303.86

Source: JICA Study Team

## (2) Economic analysis

### 1) Preconditions

- “With-project” and “Without-project”: In the case of "with-project", the power plant is developed as planned, and the factories are maintained and operated. In the case of "without-project", the power plant is not developed, and agriculture will continue on the planned development site as it does at present.
- Project conditions: project life, implementation schedule, revenue and exchange rate are the same as in the financial analysis in (1) above.

### 2) Economic effect of the power plant project

Power supply in Bangladesh has not kept pace with the demand, and a new additional power source is required. Supplying stable electric power to the EZ is the main objective of this power plant project, but surplus electricity contributes to the increase of domestic total power supply. Economic analysis was conducted by converting the selling price of electricity produced from this project into economic

price. Economic costs and benefits were set as shown in Figure 2.8-2, considering the assumed power selling price, taking the above-mentioned market price as the lower limit of willingness to pay.

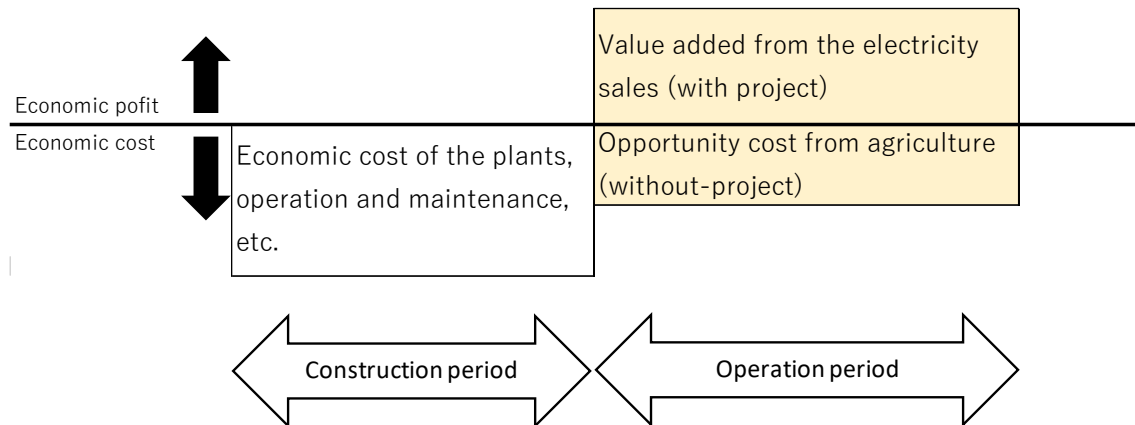


Figure 2.8-2: Conceptual diagram of EIRR cash flow

### 3) Project economic cost

Economic costs consist of economic investment costs required to develop the power plant and land opportunity costs.

#### a. Estimation of economic investment costs

SCF and CFL were set under the same condition as the EZ project. As a result, the economic cost was calculated to be USD 86.4 million (BDT 6,960 million).

#### b. Land opportunity cost

If the power plant is not developed, agriculture will be continued in the planned development area. The planned area of the power station is 9.28 ha. As a result of calculating added value generated by agriculture under the same condition as the EZ indicated in 2.8.1 (1) 3), land opportunity cost was calculated to be USD 1.03 million (BDT 84 million).

### 4) Project economic benefit

The economic benefits of the project consist of economic prices of electricity sales to the industrial estate and electricity sales revenues of surplus electricity. In order to calculate the economic prices, 0.11 USD / kWh (9 BDT / kWh) set as the market price in the financial analysis was used. It was set to 0.10 USD / kWh (8.73 BDT / kWh) by multiplying the above price by SCF (0.97).

### 5) Measurement of economic benefit

Economic benefits in the power plant project calculated from the above 4) were USD1,335 million (BDT 107,613 million).

### 6) Result of economic analysis

The results of the economic analysis are shown in Table 2.8-12.

Table 2.8-12: Result of the power plant economic analysis

Alternative plan	EIRR (%)	NPV (USD million)
1. Purchase gas at a price for tenants	10.32	- 8.62
2. Purchase gas at the price for the national grid	13.48	7.91

Source: JICA Study Team

### 7) Sensitivity analysis

Sensitivity analysis was conducted as done for the financial analysis in (1)6) above. The uncertainty factors are the same as set in (1) 6). The results of the sensitivity analysis are shown in Table 2.8-13.

Table 2.8-13: Sensitivity analysis result of power plant economic analysis

	Pessimistic case			Optimistic case		
		IRR	NPV (Mil USD)		IRR	NPV (Mil USD)
<b>Alternative 1 (Base case: Fuel is purchased at the gas price for tenants)</b>						
Gas price fluctuation (annual rate)	+5%	4.04%	-23.26	△5%	11.80%	-1.14
Construction cost	+10%	9.38%	-14.65	△10%	11.45%	-2.60
Operation start	+1 year	9.38%	-14.37	△1 year	11.16%	-4.18
Inflation rate	+5%	Unmeasurable	-39.25	△5%	13.15%	6.73
<b>Alternative 2 (Fuel is purchased at the gas price for the National Grid)</b>						
Gas price fluctuation (annual rate)	+5%	12.55%	2.67	△5%	13.88%	10.26
Construction cost	+10%	12.30%	1.72	△10%	14.82%	13.76
Operation start	+1 year	12.04%	0.21	△1 year	14.78%	14.17
Inflation rate	+5%	7.63%	-12.58	△5%	15.17%	18.13

Source: JICA Study Team

### (3) Conclusion

Base case FIRR (6.98%) exceeds the capital opportunity cost (0.9%). However, due to the recent rise in domestic natural gas prices in Bangladesh, it should be noted that the prices may increase at annual rate of 5-10%. In the sensitivity analysis, when the domestic natural gas price rose by 5% per year, FIRR was unmeasurable and NPV was negative USD 65.44 million (negative BDT 5,274 million). On the other hand, in Alternative 2, FIRR was 8.8% and NPV was USD 125.09 million (BDT 10,081 million), when the domestic natural gas price rose by 5% per year.

Regarding EIRR, in the base case, the calculated EIRR (10.32%) was lower than the social discount rate (12%). Taking into account the rising domestic natural gas price in the same way as above, EIRR is calculated to be 4.04% and NPV USD negative 23.26 million (BDT negative 1,874 million) for the base case, and EIRR 12.55% and NPV USD 2.67 million (BDT 215 million) for Alternative 2.

From the above, it can be said that the operation at the gas purchase price for tenants applied under the current system is not realistic from both the financial and the economic points of view. On the other hand, it can be said that both financial and economic viability becomes reasonable when the power plant is operated at the gas price for the national grid, although this is not accepted under the current tariff system. In implementing this project in Bangladesh, it is necessary to consider a special purchase price of gas for power plants serving both EZ tenants and the national grid.

In terms of cost recovery, it is necessary to set the power selling price to at least 0.16 USD / kWh in the base case and 0.14 USD / kWh in Alternative 2. Since the above price will exceed the market price in Bangladesh significantly, support from the government's general budget and other sources is necessary for implementation.