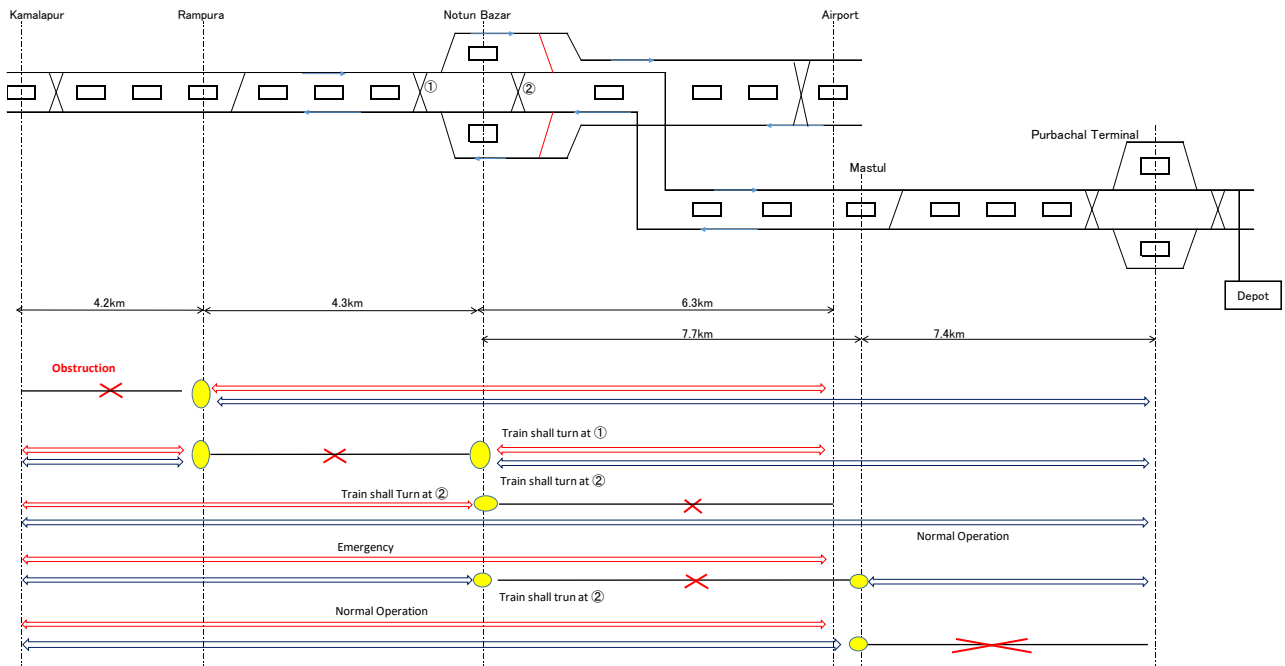


Source: JICA Study Team

Figure 4.8.4 Peak Hour Diagram 2035 (8 Cars)

4.8.7 Operation during an Emergency

As shown in Figure 4.8.5, it is possible to minimize train operation troubles by providing a crossover line for use during an emergency such as a train failure.



Source: JICA Study Team

Figure 4.8.5 Operation during an Emergency

4.8.8 Comparison of MRT Line 6 and MRT Line 1 Operation Plans

Table 4.8.12 shows the comparison of the operation plan of MRT Line 1 with the operation plan of MRT Line 6.

Table 4.8.12 Comparison with MRT Line 6

		Line 6	Line 1	
Gauge		1,435	1,435	
Train Operation				
1	Route Length (Km)	19.8	Kamalapur \$ Purbachal Terminal 23.5	Kamalapur \$ Airport 14.8
2	Running	Left Side	same as on the left	
3	Operation hour	Summer (Mar. ~ Sep.) 5:30~24:00 Winter (Oct. ~ Feb.) : 6:00~23:30	5:30~24:00	
4	Headway	Peak 4'30"(2021), 3'45"(2026) Off-peak 7'00"(2021)	Peak 2'00"(2025 6Cars) 2'30"(2025 8Cars) 1'50"(2035 8Cars) Off-peak 4'00"(2025 6Cars) 5'00"(2025 8Cars) 4'00"(2035 8Cars)	
5	Congestion ratio	180%	same as on the left	
6	Speed	Design Max. Speed: 110km/h Operation Max. Speed: 100km/h	- ditto - - ditto -	
7	Depot	Located adjacent to Uttara North station	Located near Purbachal Terminal station	
	Emergency Route	Single Crossover: Pallabi Station, Kawran Bazaar Station, Agargaon Station	Single Crossover; Rampura, Mastul Crossover; Notun Bazar	
	Intersection Station	-	Notun Bazar Station	
	Terminal Station	Motilheel: Island platform serving 2 Uttara North: 2 Sides platform serving 2	Kamalapur: Island platform serving 2 tracks Airport: Island platform serving 2 tracks Purbachal Terminal: 2 Sides platform serving 3 tracks	
Support Systems of Train Operation				
8	Block system of signaling	CBTC Moving Block	same as on the left	
9	Signal appearance type	Cab signal	- ditto -	
10	Automatic Train Protection	CBTC system	- ditto -	
11	Train Operation Control System	CTC from OCC	- ditto -	
Station and Facilities of Station				
12	Number of stations	Elevated; 16	Elevated; 7 Underground; 2	Underground; 12
13	Platform Length type and width	170m	same as on the left	
		Side; 7~10m Island; 10m	Side; 7~10m Island; 11m	
14	PSD(Platform Screen Door)	Half Height PSD	Full Height PSD (Underground) Half Height PSD (Elevated)	
Passengers Demand Forecast				
15	Design PHPDT	Year2021	22,372	
		Year2026	27,433	
		Year2051	60,979	
Rolling Stock				
16	Train formation	6 Cars (8 Cars)	same as on the left	
17	Train Composition	4M2T (6M2T)	- ditto -	
18	Carrying capacity	6 Cars Congestion ratio 180% 1,738pax. (2,332pax)	- ditto -	
19	Required number of trains	24 sets in 2026	25 sets	
20	Capacity of EMU			
	T	End Car	Seated	45
			Standing	108
			Total	153
	M	Middle Car	Seated	54
			Standing	111
Total			165	
6 car formation		4M2T	966	same as on the left
8 car formation		6M2T	1,296	

Source: JICA Study Team

4.9 Rolling Stock Plan

As MRT is the high-speed public transportation system which transports many passengers, safety assurance is essential. The rolling stock equipment and facilities should have high reliability to prevent train derailment and collision accidents. Furthermore, the rolling stock should be safe and comfortable with long-life utilization to transport the passengers on the Dhaka MRT system throughout the specified design life.

4.9.1 Outline

The specifications of the rolling stock shall move existing systems to a common architecture with Dhaka Line 6 as much as possible. High capacity, high reliability trains shall be supplied to accommodate the passenger demand and the system availability requirements. A train configuration is to be employed to minimize components and weight and maximize redundancy, namely:

- (a) The rolling stock shall be specified a proven design validated by statistical reliability data from revenue operation;
- (b) As the trains run underground, it must satisfy the fire protection standards; and
- (c) The rolling stock shall be specified to withstand the effects of high temperature and high humidity, with every consideration for the environmental conditions including the climate and pollution levels at Dhaka.

4.9.2 Design Criteria

1) Line Profile of Dhaka Line 1

The train operates following track and weather conditions.

Line profile of Dhaka Line1

Table 4.9.1 Line Profile of Dhaka Line1

No.	Item	Specification
1	Truck Gauge	1,435mm
2	Minimum curve radius on a main track	160 m
3	Steepest gradient in a running area of Rolling Stock	35/1000
4	Design speed	110km/h
5	Maximum train operating speed At the elevated section and At the underground section	100km/h 90km/h
6	The train loading for civil structure	16 tons/Axle

Source: JICA Study Team

Weather Condition

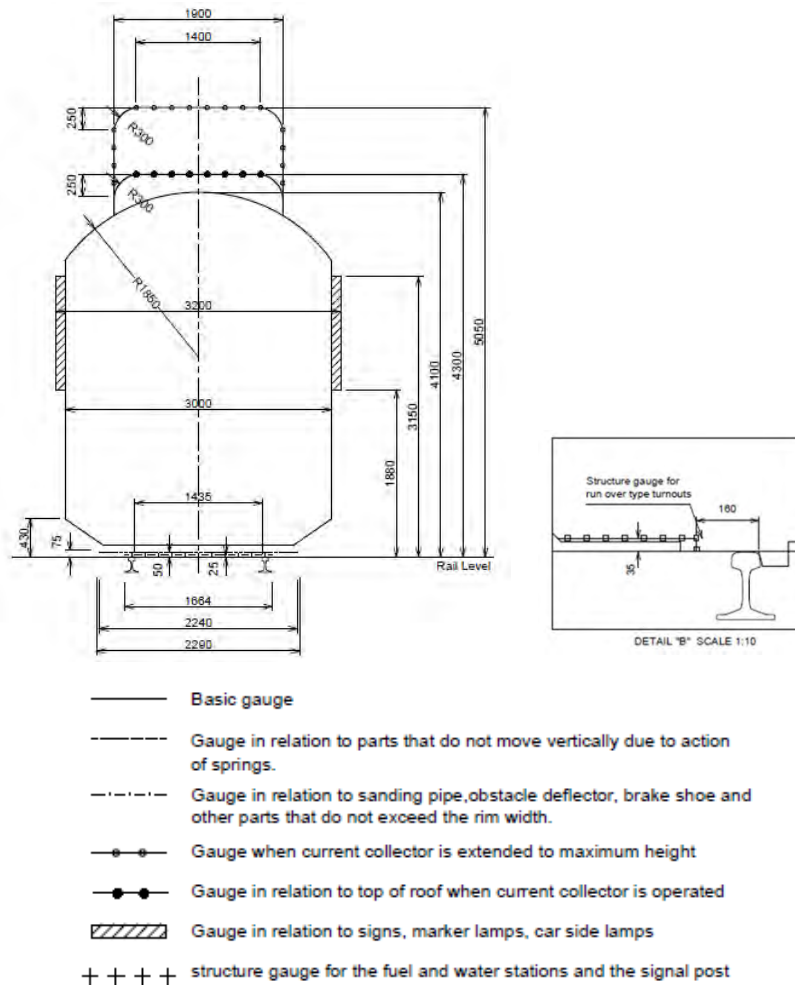
Table 4.9.2 Weather Condition

No.	Item	Specifications
1	Ambient Temperature	Maximum temperature record: 41°C
		Average maximum reading: 36 °C
		Minimum temperature record: 5°C
		Maximum Variation during 24 hours: 22 °C
2	Relative Humidity:	During June to November: 100 %
		During December to May: 75 %
3	Rainfall:	Varies, but normally 3050mm during the year, 80% of which usually occurs during the period from June to October (monsoon season).
		Maximum Rainfall during 24 hours: 630mm
4	Maximum wind velocity	140km/h

Source: JICA Study Team

2) Rolling Stock Gauge

The car body should comply with the Rolling Stock Gauge, and it should keep a sufficient gap with the Structure Gauge, shown in the following figure, so that even when in motion at maximum operational speed, the car body never infringes on the Structure Gauge.



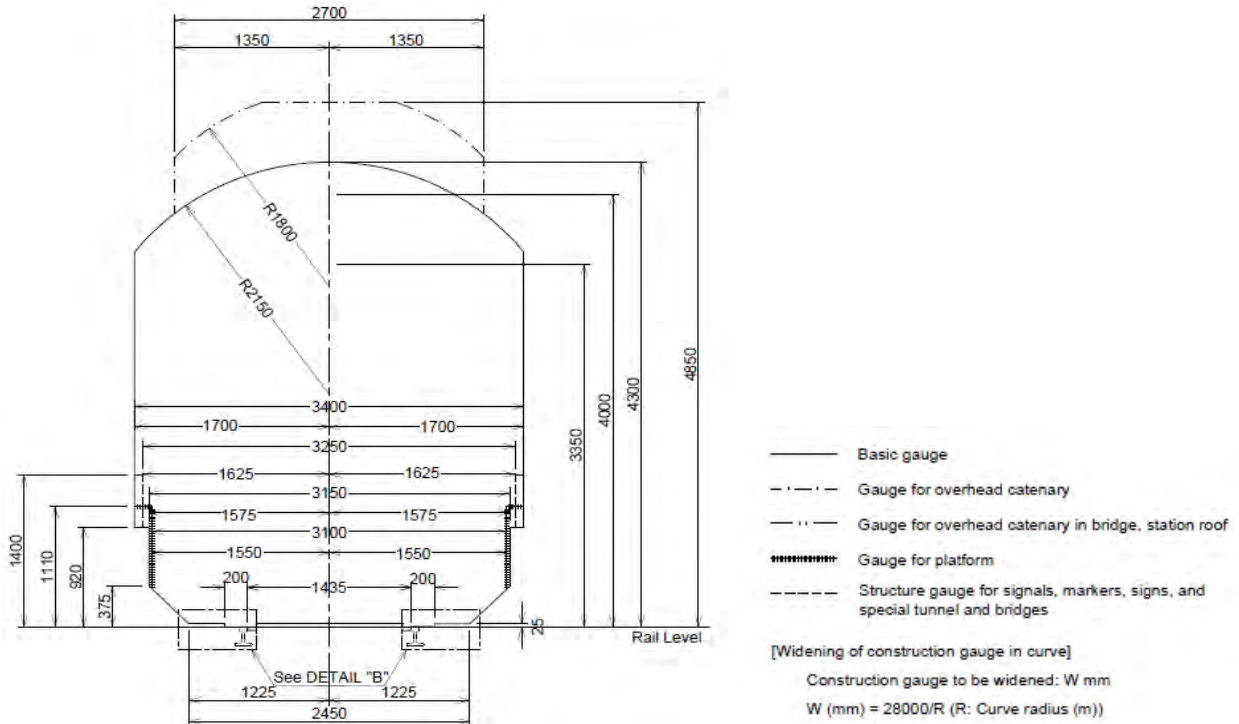
Source: Technical standards for the MRT in Bangladesh

Figure 4.9.1 Rolling Stock Gauge (On straight track in the stopped state)

3) Structure Gauge

Structure Gauge for the elevated section

Structure Gauge is the space the vehicles can pass safely any structures should be got rid of within the gauge. Due to daily train operation, track alignment may be changed. Adequate maintenance input is inevitable. Structure Gauge shown Fig 4.9.2 was provided by Technical Standards for the Metrorail in Bangladesh, December 2014, DTCA & JICA.

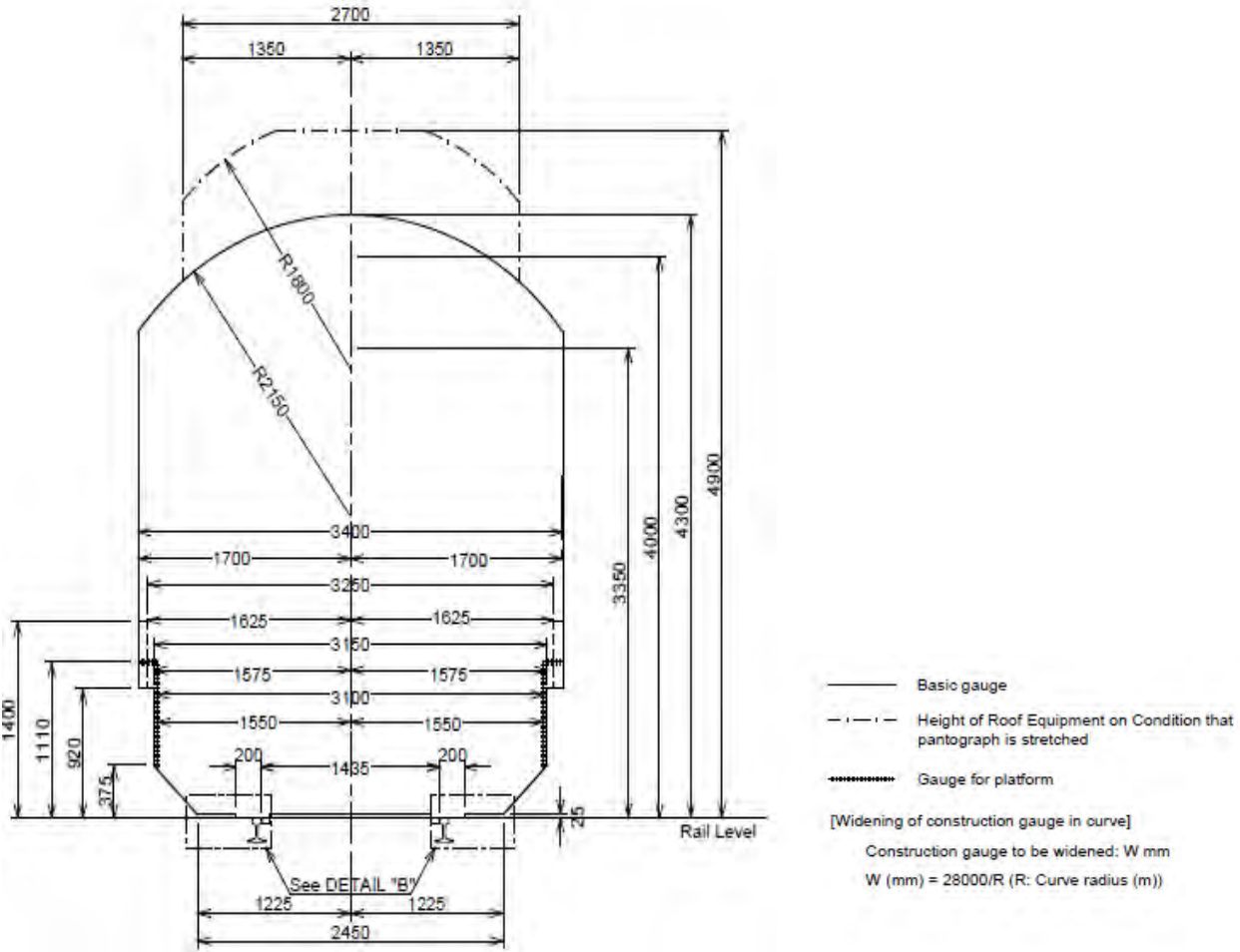


Source: Technical standards for the MRT in Bangladesh

Figure 4.9.2 Structure Gauge for straight lines at the elevated section

4) Structure Gauge for the underground section

The construction cost of the structure to be built at the underground section is roughly proportional to the section size of the structure. For this reason, the Structure Gauge for the underground section is reduced in size at the upper and lateral side compared to the Structure Gauge for the elevated section.



Source: JICA Study Team

Figure 4.9.3 Structure Gauge for straight lines at the underground section

5) System General Requirements

Reliability, Availability, Maintainability

A quality management system based on ISO 9001 shall be followed.

Reliability target

The Mean Distance between Failure (MDBF) shall be more than 120,000km per train for failures causing train service disruptions of 30 minutes or more and service withdrawal.

Availability target

Availability target shall not be less than 95%. The coaches in cleaning & scheduled maintenance will be excluded from availability calculation.

Maintainability:

The cars shall be maintenance friendly and shall require minimum maintenance.

Design Life

The train design life, during which the train is to provide continuing service under all operating conditions, is a minimum of 30 years.

Maximum Axle Load

The maximum axle load of a car is 15.2 tons with maximum passenger loading at (AW3) condition.

Fire safety and Emergency system

The rolling stock shall comply with the Technical Standard for the MRT in Bangladesh. The car body structure and the materials of the interior and exterior of rolling stock are prescribed for fire safety and emergency in this MRT technical standard. Emergency evacuation systems are also prescribed such as evacuation in case of fire.

Overhead Contact System(OCS) Power Supply

The rated voltage is DC 1,500V, and the contact wire height above the rail is within the pantograph working range of 4300mm to 5200mm at the elevated section. This is within the pantograph working range of 4300mm to 4900 mm at the underground section.

Train Protection system

The train is provided with Cab signalling under the control of an Automatic Train Protection (ATP) system. Additionally, an Automatic Train Operation (ATO) system under ATP control is provided. Manual operating capability is also required. In all ATO or manual operating modes, ATP is to remain operative.

Train information system

The train information system (TIS) has the multi-train control functions of Fault log, Data transmission of wayside and Passenger services. It should connect with the on-board subsystems.

On-board service facilities

On-board service facilities are provided for passengers including air-conditioning, public address, and information display.

Propulsion system

(a) Traction Motor

- AC 3 phase cage type induction motor mounted on bogie frame.
- The traction motor provides tractive effort and braking effort (regenerative braking).
- Rated voltage: 1,100V, Capacity: Around 220kW. This item shall be reviewed later depending on line profile of Dhaka Line 1 and operating condition i.e., running curve calculation.

(b) Traction inverter

- Variable Voltage Variable Frequency (VVVF) control traction inverter

- Input voltage: DC 1,500V (minimum 900V, maximum 1,800V)
- Output voltage: AC 3-phase from 0 to 1,100V (rms) at DC 1,500V input.

6) System Specific Requirements

Codes and Standards

Technical standards for the MRT in Bangladesh, Japanese standards and International standards shall provide the 'base line' for the minimum standards for design, manufacturing, installation, testing and commissioning and hand over. The main codes, standards and specifications applicable for the Rolling Stock are listed below:

Table 4.9.3 Codes and Standards

No.	Item	Codes and Standards
1	Design of Rolling Stock	UIC - 605-1 - International union of railways codes JIS E7103 - Rolling stock -- General requirements of car body for passenger car JIS E 7106:2006 Rolling stock -- General requirements of car body structures for passenger car JIS E4047 - Design methods for arc welded joints of steel for railway rolling stock
2	RAMS	IEC 62278 - Railway applications - Specification and demonstration of reliability, availability, maintainability and safety (RAMS)
3	Electromagnetic Compatibility	EN 50121, Railway Applications -- Electromagnetic Compatibility JIS E4018- Railway rolling stock -- Measuring methods of leakage magnetic field
4	Electrical	IEC 60034-25 - Guide for the design and performance of cage induction motors specifically designed for inverter supply (2007) EN 50155 -- Railway applications -- Electronic equipment used on Rolling Stock IEEE Std. 16-2004, Standard for Electrical and Electronic Control Apparatus on Rail Vehicles IEEE Std. 1476-2000, Passenger Train Auxiliary Power Systems Interfaces IEEE Std. 1478-2001, Environmental Conditions for Transit Rail Car Electronic Equipment JIS E6102- AC traction motors for rolling stock
5	Fire Safety	Technical Standards for the MRT in Bangladesh, Section 9.19 Ministerial Ordinance to Provide Technical Regulatory Standards on Railways of Japan
6	Lighting	JIS E4016 Illuminance for Railway Rolling Stock
7	Overhead Catenary System	EN 50163: railway applications supply voltages of traction systems
8	Ventilation and Air Conditioning System	JIS E4015- Measuring methods for air conditioning and heating temperature of railway rolling stock JIS E4024 - Railway rolling stock -- Test methods of ventilation
9	Wheels and Axles	JIS E4501 - Railway rolling stock -- Design methods for strength of axles JIS E5402-1 - Railway rolling stock -- Solid wheel -- Part 1: Quality requirements JIS E4504 - Wheel sets for railway rolling stock -- Quality requirements
10	Noise and Vibration	ANSI S1.4, Specification for Sound Level Meters IEC 61373, Railway Applications - Rolling Stock Equipment - Shock and Vibration Tests JIS E4021 - Railway rolling stock -- Test methods inside noise
11	Testing	IEC 61133 - Railway applications - Rolling stock - Testing of rolling stock on completion of construction and before entry into service JIS E4041 -- Testing of Rolling on Completion of Construction and before entry into service

Source: JICA Study Team

7) Train performance

The following conditions shall be applicable to the 8-car train formation:

- (a) The train is capable to achieve a speed of 100km/h on clean, dry, level, well maintained tangent track on the elevated section with half worn wheels and AW3 loading throughout the complete train.
- (b) Propulsion and brake performance requirements are met using the following conditions: half worn wheels and AW3 loading throughout the complete train.

Table 4.9.4 Performance requirements of Propulsion and Brake System

No.	Item	Specification
1	Maximum acceleration	Greater than 0.92m/s ²
2	Degraded operation (Motor Cut out Operation)	Start and accelerate with AW3 load on a 35/1000 gradient by the two motor cars
3	Abnormal operation (Rescue Operation)	An AW0 loaded train shall be able to push another AW3 loaded train at least 1000 meters from stopped condition on a 35/1000 gradient
4	Maximum deceleration of Electrical braking	Greater than 0.97m/s ²
5	Minimum operating speed of Regenerative brake	Not fade at any speed above 8 km/h
6	Maximum Service brake deceleration	More than 0.97m/s ²
7	Maximum emergency brake deceleration	More than 1.25m/s ²
8	Jerk Control	Not exceed 0.7 m/s ³ except emergency brake
9	Accuracy of Station Stopping	Stopping within 350 mm of the designated station stopping point with service braking in Automatic Train Operation (ATO) mode.

Source: JICA Study Team

8) Subsystem Part Configuration

Car body

The outline of Car body is shown in the following table:

Table 4.9.5 Outline of Car body

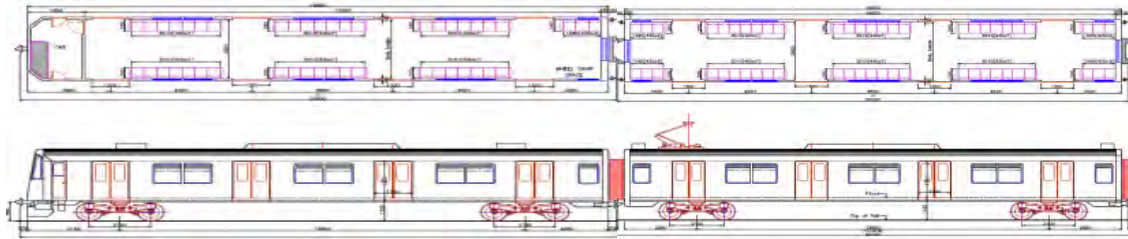
No.	Item	Specification
1	Body Length of Middle car	19,500mm
2	Body Length of End car	19,800mm
3	Body Width	2,950mm
4	Body roof Height above Rail Level	3,650mm
5	Air-condition height above Rail Level	4,100mm
6	Floor height (above rail level):	1,150mm
7	Maximum Gap between Platform edge and Car body entrance floor	70mm
8	Longitudinal compressive load at coupling point	490kN (50t)
9	Car body material	Stainless steel or aluminium alloy

Source: JICA Study Team

Body length

The body length of the intermediate car (M) is 19,500mm. The body length of the leading car (Tc) is 19,800mm. The maximum length of a 6-car train (coupler face to coupler face)

shall be 121m. When the 8-car train is introduced, the maximum length, coupler face to coupler face, is 161m.



Source: JICA Study Team

Figure 4.9.4 Conceptual diagram of the leading car and the intermediate car

Passenger comfort

(a) Passenger entrance doors

Each car has four sets of power operated bi-parting, pocket type sliding entrance doors on each side. Door opening width of the entrance door is 1400mm and Door height is 1850 mm.

(b) Gangways

Gangways are to be provided on each car. Gangway doors are provided between cars. The gangway between coaches is approximately 900mm wide. The gangway at the end of the Tc cars is approximately 650mm (not less than 600mm) wide.

(c) Dropping window

Dropping windows of 400mm height have an opening area greater than 8% of the total floor area. This opening dimension will provide the expected passenger comfort in case of power failure. The fully opening area is placed at 1,350 mm above the body floor. The passenger must not be able to touch the platform screen door frame placed on the platform through this opening.

(d) Passenger seats

Longitudinal seats for three and seven persons are used; the seat space per person is 430mm wide and 550mm deep.

(e) Hand grips and Overhead racks

Hand grips, poles, hanging straps and overhead racks are provided.

(f) Train communication equipment

Table 4.9.6 Train Communication Equipment

No.	Item	Specification
1	PA system	Two exterior speakers on each side wall of car body
2	Passenger emergency communication system	Four call stations in each car at door bays
3	PID system	Display for End and Side Destination, Passenger Saloon
4	End destination display	Illuminated with three colours LED
5	Side destination display	Illuminated with three colours LED
6	Passenger saloon display	Each side door, multi colours with high resolution LCD
7	Door chime	Passenger Doors

Source: JICA Study Team

Lighting

The interior lighting is designed to give an even light distribution without glare. The lighting level is more than 200 lux over the whole saloon at height of 0.85m above floor.

Bogie

The principal data of bogies shown in the table below.

Table 4.9.7 Principal Bogie Data

No.	Item	Specification
1	Gauge	1,435mm
2	Distance between two bogies	13,800mm
3	Bogie wheel Base	2,100mm
4	Wheel Diameter	860mm (New), 780mm (Fully Worn)

Source: JICA Study Team

Driving cab

The cab environment is designed ergonomically and allows all drivers to operate the train comfortably and efficiently. The cab design maximizes outward visibility to provide the driver full observation of track area and station platform area.

Table 4.9.8 Main Equipment of the Driving Cab

No.	Item
1	Operating devices for control facilities
2	Operating devices for service brake devices
3	Transmitting devices and receiving devices for signal and communication.
4	Speedometer
5	Aspect facilities of onboard signal equipment
6	Operating device for raising and lowering the pantograph
7	Transmitting devices and receiving devices for security communication.
8	Warning generating devices and transmitting devices for alarm signal facilities
9	Horn activation device
10	Pressure gauge including pressure of main air tank piping
11	Receiving devices for emergency communication devices
12	Door closed and locked confirmation device for passenger doors

Source: JICA Study Team

Brake system

The brake system comprises regenerative and pneumatic friction braking. Motor bogie is Tread brake with composite brake blocks and Trailer bogie is Disc brake. The braking system is fail-safe.

(a) Brake control scheme and Service brake

The brake control scheme consists of electro-pneumatic service brake with blending control between electric and air braking. In case the train separates, the brake system detects the separation and operates the emergency brake.

(b) Parking brake

Parking brake is the spring applied parking brake. There is a spring applied air-release parking brake on trailer cars with driving cabs.

(c) Security brake

There is a security brake that operates automatically in case the service brake fails.

(d) Electric brake

The electric brake takes priority over the friction brake to use the regenerative energy and minimize friction brake wear.

Coupler Devices

- (a) Front of leading cars (both ends of the train) is a semi-automatic tightlock coupler and draw-gear.
- (b) Inter mediate portion between cars is semi-permanent couplers.
- (c) There are electric couplings for train control and communication between cars and between trains for shunting and/or emergency operation.

Pantograph

- (a) A single-Arm type pantograph is used. This type is widely used in the world as standard system.
- (b) The pantograph has sufficient current capacity to supply the propulsion power for eight traction motors and the auxiliary power for four cars of an 8-car train.

Auxiliary power supply system

- (a) Characteristics of Auxiliary Power Supply Unit (APU)

Table 4.9.9 APU Specifications

No.	Item	Specification
1	Control Method	Constant Voltage / Constant Frequency
2	Output Voltage	Three-phase AC 380V 50Hz
3	Basic design of APU	Approximately 260kVA x 2 sets/train(6 cars)

Source: JICA Study Team

(b) Redundancy system of auxiliary supply

In case one APU fails, the remaining APU provides power subject to reduced operating load requirements.

Table 4.9.10 Auxiliary Machine Load

No.	Item	Quantity/train	Specification
1	Air Conditioner	6 cars	Capacity 50,000kcal/h(58.1kW) x 2 sets/car, Input power:38kVA x 2 80kw/car
2	Motor driven air compressor	2 sets	Capacity 2000l/min/set, Input power: 2kW/set
3	Lighting	6 cars Train set	40Wlight x 16 sets = 0.64kW/car And other lights: 2 kW/train
4	Battery charging system	2sets	Around 15kW/set

Source: JICA Study Team

Air-Conditioning

- (a) All saloon air conditioning units are of the self-contained package type.
- (b) Their refrigerant shave zero ozone depletion potential indexes in compliance with the Montreal Protocol, for the life of the train. Coolant of non-pollution refrigerant, R407C, is preferable.
- (c) Inside saloon temperature is 24°C and 60% Relative Humidity (R.H) is maintained under the outside conditions of 41°C, 98% R.H.

Data Recorder

The data recorder accurately records selected operation data of the train pertinent to investigation of an accident/incident. Two data recorders are installed in each driver's cab.

4.9.3 Passenger Capacity

1) Passenger capacity

The passenger capacity at AW1, AW2 and AW3 of 6- and 8-car train is as follows:

Table 4.9.11 Passenger Capacity of Each Train Formation

No.	Item	6-car train (Pax)	8-car train (Pax)
1	AW1	306	414
2	AW2	966	1,296
3	AW3	2,308	3,088

Source: JICA Study Team

4.9.4 Train formation

1) Train configuration

A 6-car train system consists of four-motor cars and two-trailer cars. The train configuration for six cars is as follows: Trailer car with driving cab (Tc) + Motor car (M) + Motor car (M) + Motor car (M) + Motor car (M) + Trailer car with driving cab (Tc).

i.e.: Tc – M – M – M – M – Tc

An 8-car train is introduced into operation at some time in the future. The additional two-trailer is inserted in the existing 6-car composition. The train configuration for eight cars is as follows: Trailer car with driving cab (Tc) + Motor car (M) + Motor car (M) + Trailer car (T) + Trailer Car (T) + Motor Car (M) + Motor Car (M) + Trailer Car with driving cab (Tc).

i.e.: Tc – M – M – T – T – M – M – Tc

4.9.5 Integrity with MRT Line 6

1) Comparison of Rolling Stock of Dhaka MRT Line 1 and Line 6

All facilities of Dhaka MRT Line 6 are planned at the elevated sections, and the facilities of Line 1 consist of the elevated sections and the underground sections. For these reasons, there is a difference between the fire safety standard and Structure gauge.

a. Fire safety standard at the underground sections

The technical standards for the rolling stock of the MRT in Bangladesh are the same as the fire protection standards in the underground section of Japan.

The fire protection standards for rolling stock cover requirements to provide safety from fire such as the use of non-combustible materials for the car body and installation of the gangway. The rolling stock for Line 1 is compliant with the technical standards for the MRT, same with the rolling stock of Line 6.

b. Structure Gauge for the underground section

Structure Gauge for the underground section is applicable to the underground stations and the tunnel sections. Depending on the Structure Gauge for the underground section, the items in the following table are affected:

Table 4.9.12 Countermeasures Against Structure Gauge for the Underground Section

Item	Rolling stock for Line 1	Rolling stock for Line 6
Working height of pantograph at the elevated sections	5,200mm	5,200mm
Working height of pantograph at the underground sections	4,650mm	Not applicable
Structure of the side windows	Not allowing passengers to extrude their bodies from windows.	Not allowing passengers to extrude their bodies from windows.
Maximum speed Elevated sections Underground sections	100km/h 90km/h	100km/h Not applicable

Source: JICA Study Team

The pantograph operates in a wide range at the elevated section, so it can be used at the underground section. The specification of the side window will not allow passengers to squeeze their bodies through the opening. The maximum operating speed is assumed to be 90 km/h because the underground section is an obstructed area.

4.10 Rolling Stock Depot Plan

4.10.1 Track Layout of the Rolling Stock

1) Basic Idea of the rolling stock depot

In general, the Rolling Stock Depot tracks are divided into three groups in accordance with the functions required from the depot, namely, storage track group, inspection and light repair track group and heavy repair track group.

It is important to properly arrange these three track groups according to their functions. The following are the basic considerations in designing the track layout in the Depot:

- (a) Existing buildings and other facilities will not be affected in case of future expansion.
- (b) The train movement remains efficient and smooth ("Entering the depot" → "Inspection and repair" → "Storage").
- (c) There should be a track for pulling up Rolling Stock for shunting in order to avoid conflict with other trains to be worked on such as those for wheel surface grinding work, inspection and light repair work and heavy repair work.
- (d) Arrange buildings and offices considering the character and the scale of the depot.

2) Number of Required Train Sets

The required number of train sets is discussed in Section 4.8.4, Operation Plan. In accordance with said operation plan, the following rolling stock is assigned to the Depot:

Table 4.10.1 Required Number of Trains and Train Sets According to the Operation Plan

Year	Number of cars per train	Required number of trains (Train set)	Total number of Cars
2025	8	25	200
2030	8	31	248
2035	8	36	288

Source: JICA Study Team

3) Number of Stabling Tracks

As discussed above, the required number of train sets is estimated at 25 sets for 2025, 31 sets for 2030, and 36 sets for 2035.

Two train sets will be at the depot for washing, inspection and/or repair work. Therefore, the number of train sets that should be kept at storage tracks is shown in Table 4.10.2.

In 2035, 32 train sets ($40 - (6 + 2) = 32$) need to be kept at storage track at the maximum.

Table 4.10.2 Number of Train Sets Kept at Storage Track

Year	Total number of train sets	Number of train sets kept	
		At storage track	In other tracks
2025	25	23	2
2030	31	29	2
2035	36	34	2

Source: JICA Study Team

The space needed between storage tracks is 4m, but it is necessary to widen it to 4.5m every three or four tracks in order to install the pole for supporting the overhead wire.

4) Inspection and light repair track

On this track, daily, periodical and extraordinary inspections and light repair works are carried out. Daily inspection takes about one hour. The periodical inspection and light repair are called monthly inspection (in JR, these works are performed every three months), which covers the renewal of consumables; it takes about 8 hours. An example of monthly inspection track facility is shown in Photo Figure 4.10.1 below. For the monthly inspection work, two tracks are needed and more than one track is needed for the extraordinary inspection work. There should be a shed constructed for these 3 tracks. The distance between both tracks is 6m.

5) Cleaning Track

The cycle of the Rolling Stock washing work is about once a week, and it takes 2~3 hours each time. Assuming that the Rolling Stock washing work is once a week and the capacity of the Rolling Stock washing per track per day is four train sets, the following calculation can be made: $36 \text{ train sets (total)} / 7 \text{ days} = 5.1 \text{ train sets/day}$. Thus, two washing tracks are needed.

The track space for the washing tracks is 6m in consideration of the washing work area. An example of rail car wash facility is shown in Figure 4.10.2 below.

6) Automatic washing track

Car washing by washing machine is carried out once every 2-3 days. In consideration of the maintenance of the automatic washing machine, a bypass track should be constructed. The train will use the bypass track when the washing machine is not operated.

An example of the automatic washing machine is shown in Figure 4.10.3 below. It would be effective to install the access track into the depot.

7) Wheel truing track

The cycle of the wheel truing depends on the train's kilometreage, but the normal practice is every eight months or so. When a flat spot in the wheel is observed, wheel truing for the whole bogie wheels is carried out; one wheel truing takes about 30 minutes. This has an impact on the train operation schedule as the track requires one train set length. An example of the wheel truing machine is shown in Figure 4.10.4 below.



Source: JICA Study Team

Figure 4.10.1 Example of rail car repair track



Source: JICA Study Team

Figure 4.10.2 Example of rail car wash track



Source: JICA Study Team

Figure 4.10.3 Example of automatic rail car washing machine



Source: JICA Study Team

Figure 4.10.4 Example of Wheel surface grinding machine for wheel truing

8) Workshop

In the workshop, the examination for essential parts and the examination for whole Rolling Stock should be done. The examination for essential parts means the examination for the equipment which relates to car movement, and the examination for whole Rolling Stock means examinations for all parts of the Rolling Stock, i.e., an over haul. The examination of the bogie is performed at the stage of the examination for essential parts and the contents of its examination are overhauled. The respective number of days for both examinations is one month per train set.

The cycle of the examination for essential parts is every 2~4 years, but basically this examination is performed based on the train's kilometreage, while the cycle of the examination for whole Rolling Stock is every 6~8 years.

Assuming that the cycle of the examination for whole Rolling Stock is every eight years and the examination for essential parts is performed two times between examinations for whole Rolling Stock, one train set enters the workshop three times every eight years.

As an annual average, fifteen train sets($40\text{train sets} \times 3 \div 8\text{years} = 15\text{ train sets/year}$) enter the workshop. Assuming that there is only one heavy repair track in the workshop, the utilization rate of this track becomes 125%($15\text{train sets/year} \times 1\text{month} \div 12\text{months/year} \times 100$

= 125%). Therefore, two heavy repair tracks shall be provided because the utilization rate by only one heavy repair track is over 100%.

In the workshop, a track for full inspection of trains before leaving the workshop, a track for disassembling and assembling and a temporary repair track are needed. The full inspection track should have an overhead wire and a pit facility. The track for disassembling and assembling will facilitate the lifting of rolling stock bodies and also the pit facility.

In the latest workshop, like the picture shown in Figure 4.10.5, inspection and repair work are performed in the condition of lifting whole Rolling Stock bodies and turn table is used for pulling out old bogies and fixing new bogies or repaired bogies like Figure 4.10.6.



Source: JICA Study Team

Figure 4.10.5 An example of the device which can inspect and maintain the parts by lifting all the car bodies at the same time



Source: JICA Study Team

Figure 4.10.6 Turntable for the bogie

The temporary repair track has pit and two tracks are required as two Rolling Stocks separated from train set.

Therefore, in the workshop, one track for full train inspection, two tracks for disassembling and assembling, and two temporary repair tracks shall be installed.

9) Testing Track

Before leaving the workshop, the repaired train shall have an operational test on the testing track, which preferably should be as long as possible. If the track is not less than 500m, as minimum testing of a braking test, acceleration and deceleration test, shall be implemented.

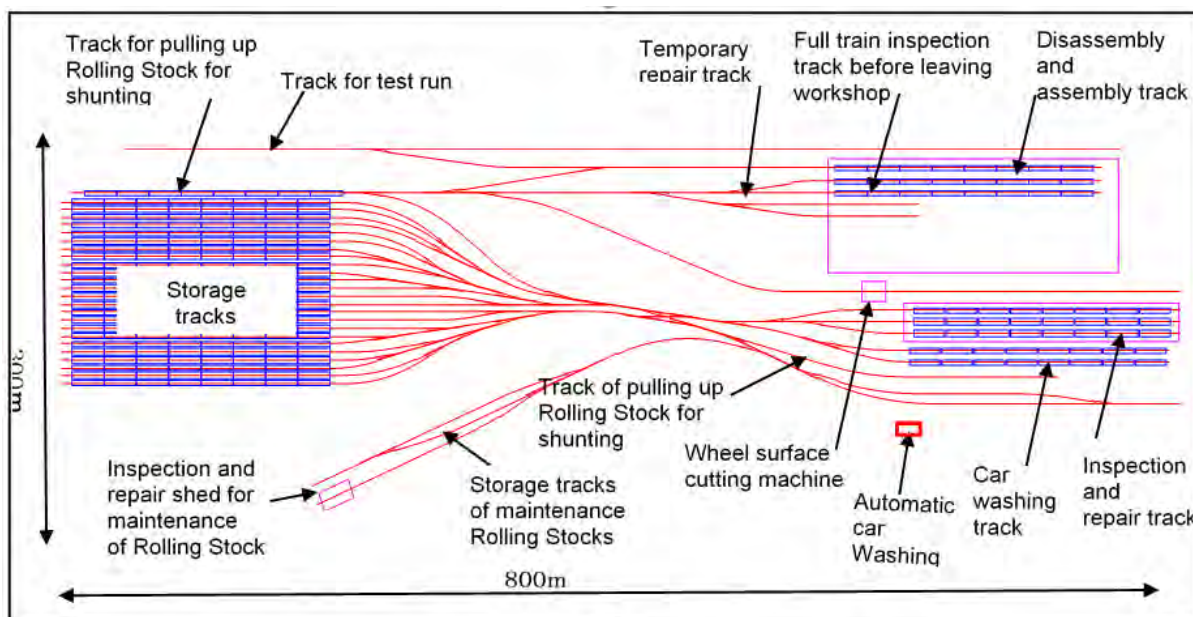
10) Facility Maintenance Vehicle

For the track maintenance, equipment such as track measuring machine, rail grinding wagon, multiple tie tamper and hopper wagon are needed, while for the electrical facility, several pieces of equipment such as an overhead wire measuring machine, a wagon for transporting the overhead wire roll, and a motor car for pulling trolleys are needed.

Storage tracks to keep these maintenance equipment shall be provided and a shed for inspecting these maintenance equipment is also required in the depot.

11) General layout of the depot

The basic track and facility layout in the depot is shown in Figure 4.10.7 below. According to site condition, area availability modification were made to the basic track and facility layout.



Source: JICA Study Team

Figure 4.10.7 General Layout of the Depot

12) The required area of the depot

The required area of the depot, computed as $300\text{m} \times 800\text{m} = 240,000 \text{ m}^2$, is 24 hectares.

4.10.2 Location of the Rolling Stock Depot

1) Basic idea for location of Rolling Stock depot

Technically, the basic idea for selecting the location of Rolling Stock depot is as follows.

- (a) To look for an area that is near to the station as much as possible in order to reduce the loss of out-of-service operation;
- (b) To design the approach which will allow direct entry to the depot from the departure and arrival track of the station and reduce to the utmost time loss such as longer turn back work.
- (c) To select the route to the Rolling Stock depot which reduces the obstacle time of the train operation on commercial rack. Particularly, in case of the electric car operation, the obstacle time of crossing the main track is long and much time for changing the driver's cab at the turn back point and for the push operation will be needed. Therefore, it is important to select the track layout in which these problems are solved.
- (d) To acquire the land of the Rolling Stock depot as easily as possible, because a considerably large area is necessary for the land of the Rolling Stock depot.

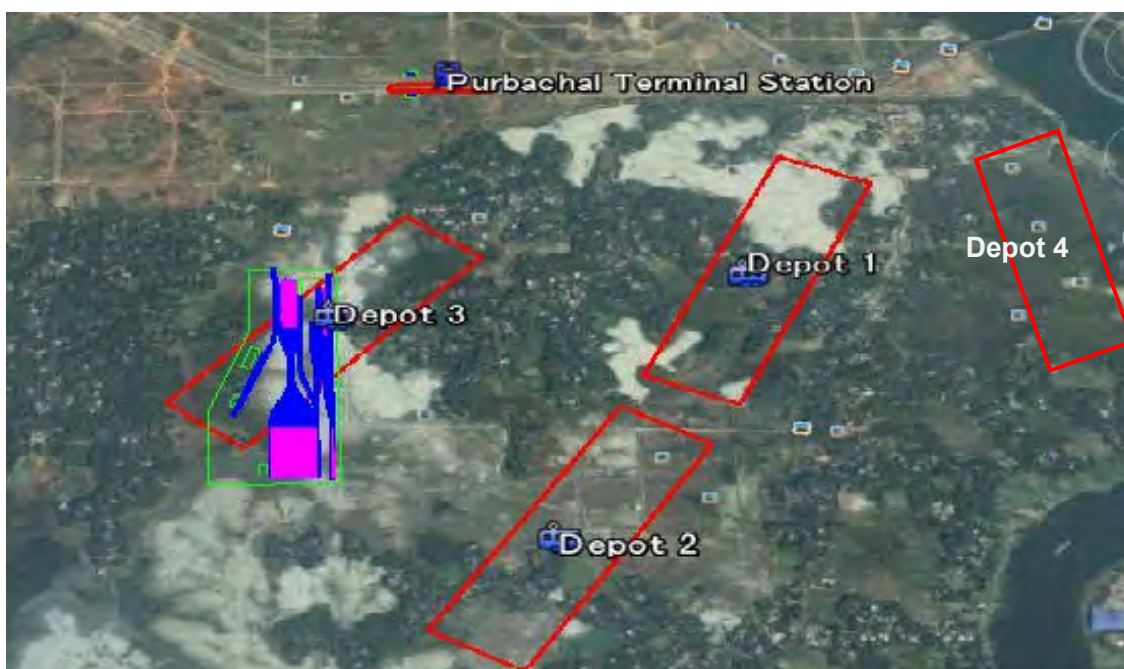
2) Consideration of alternative

Taking the above into consideration, JICA Study Team examined and proposed four candidates for Rolling Stock Depot for Dhaka MRT Line 1, as shown in Figure 4.10.8. The figure shows the relation of the positions among Depot 1 (Option1), Depot 2 (Option 2), Depot 3 (Option 3) and Depot 4 (Option 4).

From the viewpoint of train operation, in Options 1, 2 and 4, no turn back operation of the train and no change of driver's cab are expected. So, it may be said that these candidates are the most desirable ones. In the case of Option 3, the train approaches the depot from the front point of Purbachal Terminal Station. So, Option 3 has more time-loss than the other candidates.

On the other hand, as a result of discussion with a local stakeholder, the environmental study group of the JICA Study Team informed the technical team that there are a lot of inhabitants in Option 1 and Option 2 areas, and it seems land issue will affect the project schedule. Thus, JST Environmental study group recommended the candidate site near Option 3 and Option 4 where inhabitants are fewer compared with the Option 1 and Option 2 areas, and land acquisition is relatively easy.

JST made several general layout drawings for option 3 and 4. Followings are as of results of the study. Figure 4.10.9 shows location connect line of Option 3. General layout is shown in Figure 4.10.10.



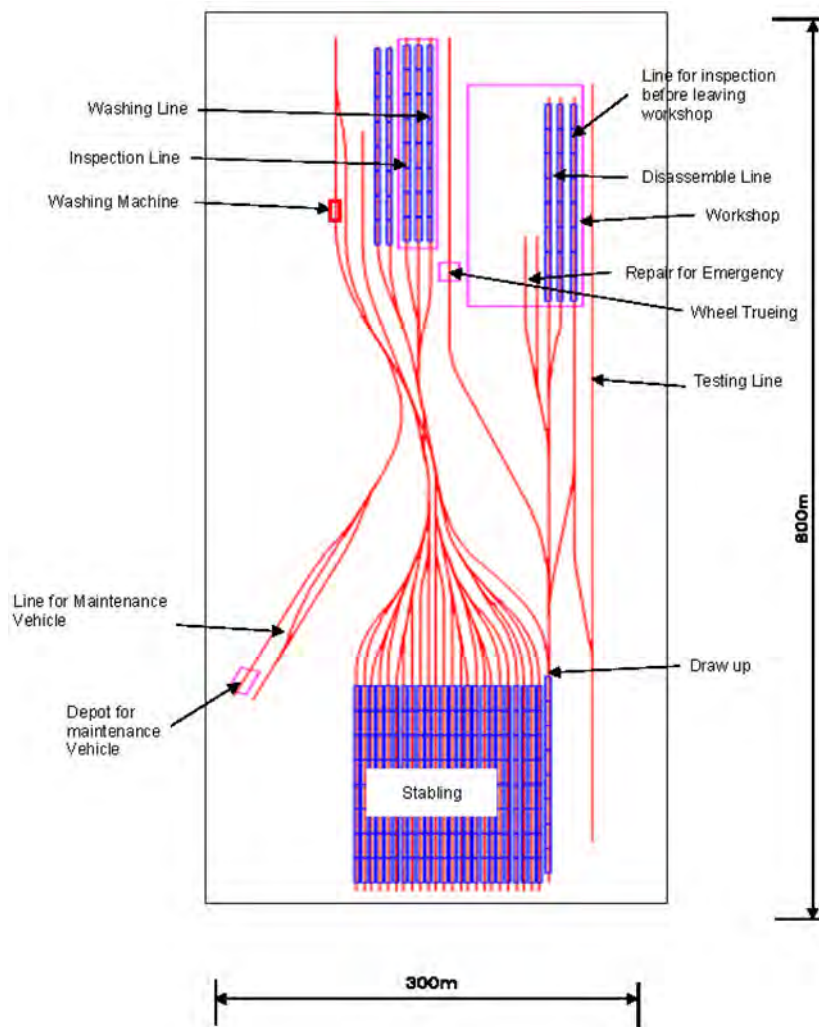
Source: JICA Study Team

Figure 4.10.8 Rolling Stock Depot Location Alternatives



Source: JICA Study Team

Figure 4.10.9 Approach Track Connected between Terminal and Depot (Option 3)



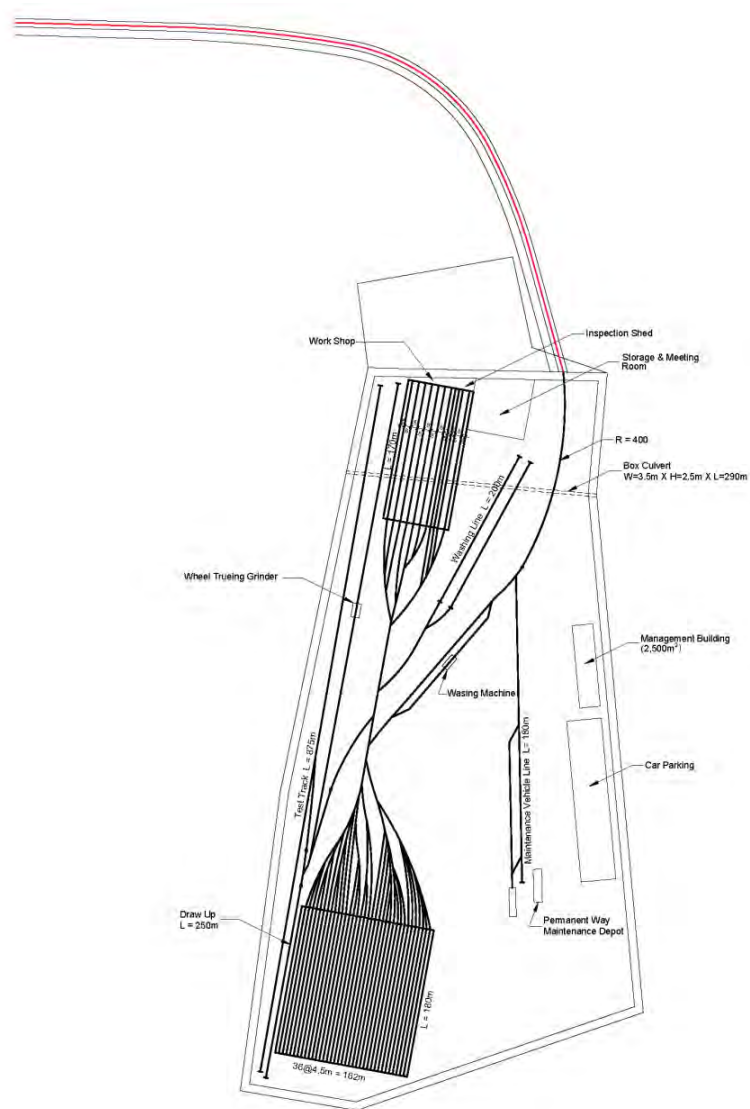
Source: JICA Study Team

Figure 4.10.10 General Layout of the Option 3



Source: JICA Study Team

Figure 4.10.11 Approach Track Connected between Terminal and Depot (Option 4)



Source: JICA Study Team

Figure 4.10.12 General Layout of the Option 4

At northern area there is the Padoma Oil Company's land. JST planned the approach track avoiding such private land.

As a result of the discussion with counterparts (DTCA), the JICA Study Team recommended that the Rolling Stock depot be established in Option 3 or 4. In the following Table 4.10.3 and Table 4.10.4, which compares the two options, the land area of Option 4 is 31.1 ha as given by DTCA.

Table 4.10.3 Comparison between Option 3 and Option 4 (1)

Subject		Depot for Line 1	
		Option 3	Option 4
Number of Car Assigned		Year 2025 200, Year 2035 288	Year 2025, 200, Year 2035, 288
Number of Stabling Lines		32	36 (Year 2025, 24)
Draw up line		1	1
Manual Washing Line		2 Platforms	2 Platforms
Painting		—	—
Inspection		3	3
Testing Line		1 (about 480m)	1 (875m)
Automatic Car Washing		1	1
Workshop	Inspection before leave workshop	2	2
	Disassemble and Assemble	1	1
	Repair for Emergency	2 (pit of 2 cars length)	2 (pit of 2 cars length)
Wide	Area	240,000m ² (24ha.)	311,000m ² (31.1ha.)
Possibility of future expansion		Capacity of Workshop further 8 trains. Space is sufficient	

Source: JICA Study Team

Table 4.10.4 Comparison between Option 3 and Option 4 (2)

Subject	Option 3	Option 4
Area (ha)	24.0	31.1 (Available)
Attraction to Commercial line	When enter the Commercial Line small restriction is expected	Free from commercial operation
Stabling Capacity	Depot Stabling Line 34 Lines, one Inspection line, one washing line Total 36 Trains	
Stabling at Station	Possible to Zero	
Approach Line	Western side of P. East Station crosses with Commercial Line. Grade separation structure shall be required	For future extension, draw-up line shall be lower level and approach line shall pass over them
Affection to Community (Refer to Chapter 5)	No	There is 3.5m wide partially paved road in depot area New box culvert width 3.5m shall be provided.
Construction Cost	Crossing commercial line viaducts shall be construct Long approach line is needed	Approach viaduct is shorter than Option 3. Box Culvert is required Box culvert is required
Other specific		Material for Embankment shall be transported by Sitalakhya River, refrain number of trucks for material transportation Imported Materials such as Rolling Stock shall be transported by ship cargo.
Others	Sufficient Land for Sub-station, Mosque, Car Parking, Environment Control Plan etc.	

Source: JICA Study Team

As a result of comparison study between Option 3 and 4, JST recommends option 4 due to easy approach to/from Depot. In addition to this large land may be used for future MRT line 1 expansion.

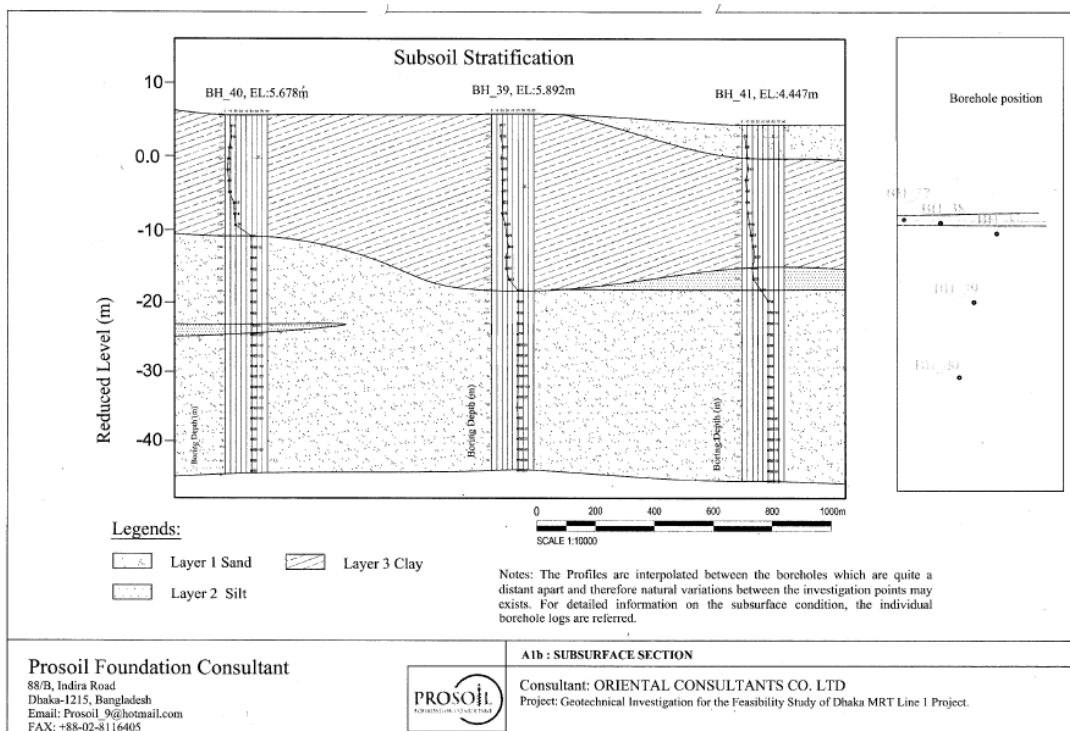
In order to keep existing road during/after MRT Line 1 depot, prior to embankment, new box culvert which inner size is width 3.5m and height 2.5m shall be built along the existing road.

4.10.3 Geological Feature and Ground Improvement

In general, at present, it is very difficult to acquire a large area of land such as that for the rolling stock depot near an urbanized area. This could lead to settling for an area where unstable soil condition is possible to construct the depot. As of the time of this report, the detailed geological survey for Option 4 is yet to be finished.

According to the data from a geological survey carried out near the recommended Rolling Stock depot location, there is a layer of soft sand from the ground level to around 5m below, and a layer of soft clay of around 10m thickness under the soft sand layer. There is a relatively tight sand layer under the soft clay layer as shown Figure 4.10.13.

Therefore, a detailed geological survey should be carried out at the detailed design stage, and appropriate ground improvement plan should be examined. In addition, the drainage plan of the Rolling Stock depot in case of heavy rain should be examined.



Source: JICA Study Team

Figure 4.10.13 Geological Survey Data Near the Rolling Stock Depot

Embankment

JST proposes a 3m high embankment since the depot Option 4 is located near the river and soil condition is thought to be not tight enough to bear the Depot facility. About 720,000m³ of soil is needed to build a 24ha depot. The following studies are requested in the detailed design stage:

- Embankment Material quality, quarry, transportation of material

- Method of embankment and ground improvement
- Mitigation impact to present Environment including at quarry

4.10.4 Environmental Consideration

There are four potential environmental impacts caused by the following:

1. Wastewater from car washing
2. Rubbish from cars
3. Noise from train
4. Settlement due to pumping water

Waste water from car washing shall be cleaned in a wastewater treatment facility provided at the depot and discharged into the river together with rain water. Prior to disposal, the water shall be regularly tested in accordance to the Laws Regulating the Environment in Bangladesh and the Environment Conservation Rules 1997. Detailed discussion with related agency shall be held.

With regards rubbish from rolling stock, this shall be handled together with the rubbish from the offices.

In the early morning, many trains shall leave the depot to the Terminal Station, and some noise is expected. But the depot is built on a 3m high embankment and approach track also runs 3m high. Thus, expected noise level is quite low. But in the design stage, countermeasures will be studied such as large curvature approach track, speed restriction, and noise barrier.

The Study Team thinks that ground settlement at outside the depot is very rare because the car washing tracks locate far from the residential area. But a more detailed study shall be carried out in the Detailed Design stage.

4.10.5 MRT Comparison between Line 1 & 6

Table 4.10.5 shows comparison between MRT Line 1 & 6.

Table 4.10.5 Comparison between Line 1 & 6

Categories		Line 1	Line 6
Number of Assigned Trains and Cars		25 fleets, 200 cars in 2026, 36 fleets, 288 cars in 2035	36 fleets, 288 cars
Stabling Line		36 lines	18 lines (1 line stables 2 fleets)
Draw-up for shunting		1 line	1 line
Washing Line		2 lines and 1 washing machine line	1 line
Painting Line		–	1 line
Inspection Line		3 lines	5 lines
Testing Line		1 line (900m)	1 line (1,000m)
Automated Train Washing Line		1 line	1 line
Workshop	Inspection and Repair	2 lines	2 lines (For 8 cars x 2 lines) 4 lines (For 4 cars x 4 lines)
	Inspection before dispatch	1 line	
	Dismantle	2 lines	
	Temporarily/Emergency	2 lines with 40m (pit length 2 cars)	

Categories		Line 1	Line 6
Required Area	Depot Area	311,000m ² (31.1ha)	220,000m ² (22ha)
Possibility of expansion		Work shop capacity to handle is about 8 fleets 8 stabling lines will be laid between Testing Line and stabling lines	

Source: JICA Study Team

4.11 Project Implementation Plan

4.11.1 Project implementation schedule plan

The target date of inauguration is end of 2026 due to a strong requirement from the Project counterpart.

The schedule is shown in Figure 4.11.1. It shows that the critical works of substructure and tunnel are at least 48 months and continuously finishing works and M&E work will be implemented. There is a possibility for tight schedule against civil works and another possibility of overlapping railway work and civil works.

Details of the schedule will be described later.

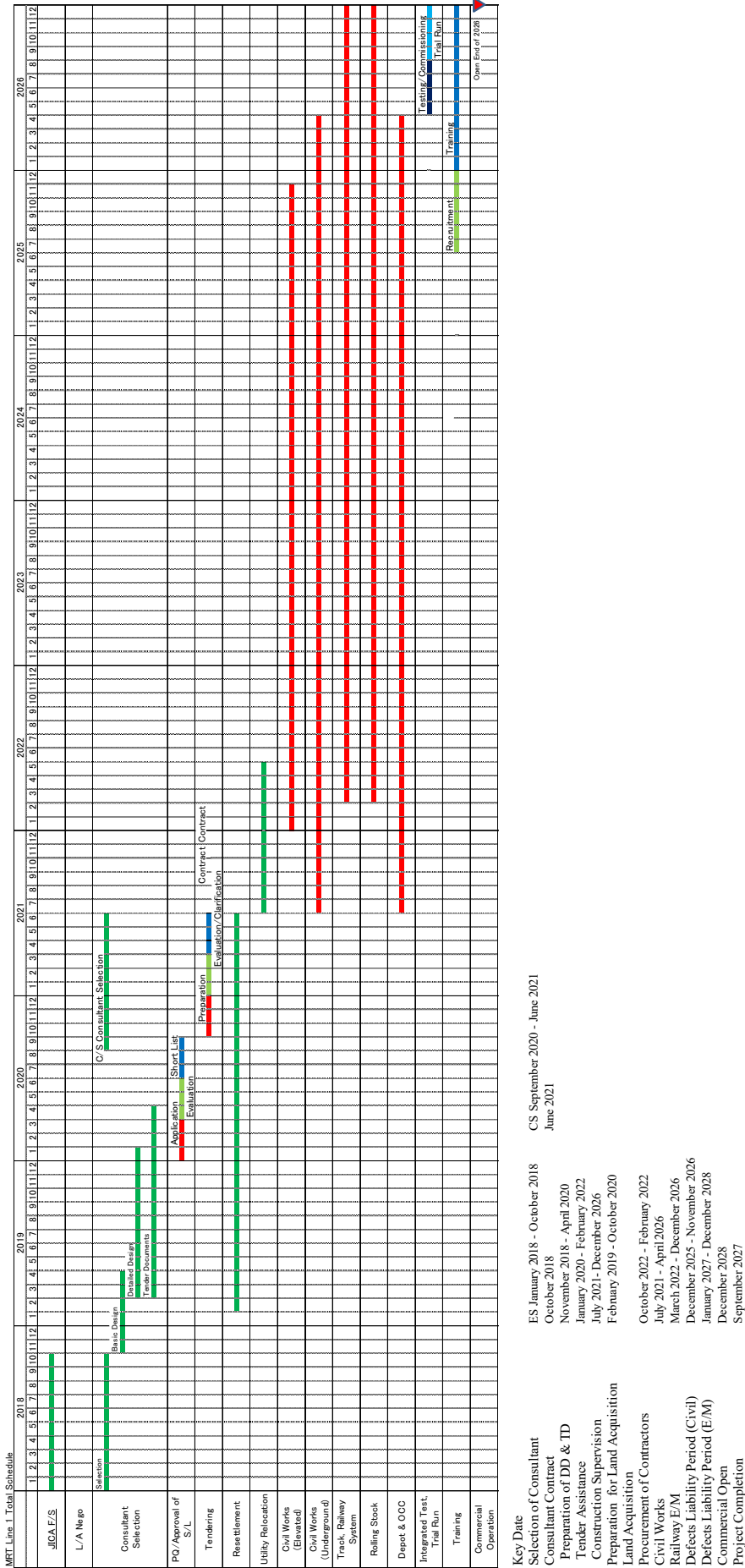


Figure 4.11.1 Schedule of Inauguration at End of 2026

Source: JICA Study Team

To compare construction of tunnel work with elevated section work, the latter is rather easy since it enables control over scheduling with manpower flexibility (number of workers to hire).

Moreover the elevated section is located in the suburbs, so there is not so much traffic. Therefore, tunnel work is assumed as the critical pass all over the construction.

When drawing up the overall schedule, the following items should be considered critical:

- It will probably take eight months to remove an obstruction underground. But If the proprietor of an obstruction underground agrees to have it removed before the start of construction, the eight months is deducted.
- Construction schedule of station, launching and arrival shaft with open cut method is assumed at eleven months, and at the time, the road will be covered up by road deck panels to keep traffic flowing.
- TBM drilling work performs ten rings forward per day, but eight rings are adapted in this planning. Length of one segment ring is 1.2m.
- TBM drilling work commences from launching shaft and reaches arrival shaft adjacent to next station, The TBM machine is lifted up to the ground and transported to the opposite side of the station. After that, the TBM machine is re-fabricated there. This cycle presumes two months.
- When TBM reaches the arrival shaft, casting inverted concrete is implemented within one month.
- Inverted concrete is casted by civil contractor, but the track bed concrete is casted by the railway system contractor (package 9).
- After casting the inverted concrete, the track laying work will be commenced two months later.
- The following track laying work and overhead catenary wiring work will then commence.

JST recommend to adopt an SMW method to construction of launching shaft because about one month earlier TBM can start excavation work. Details are discussed in 5.2 of Chapter4. Details shall be referred 4.5.2, Cut and Cover Method for Station Box, and discussion in 15.2 of Chapter 4.

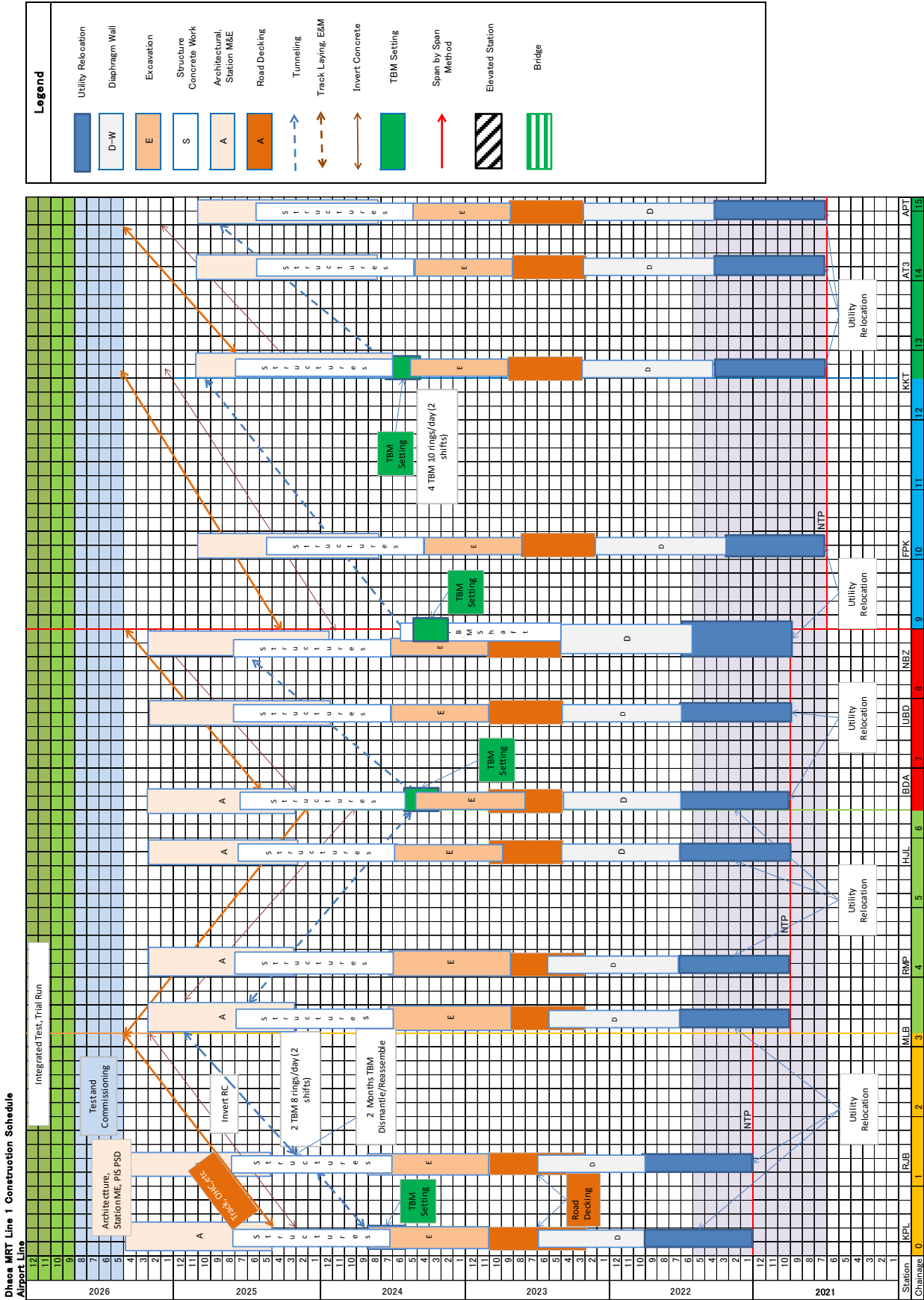


Figure 4.11.2 Integrated Section Construction Schedule (1)

Source: JICA Study Team

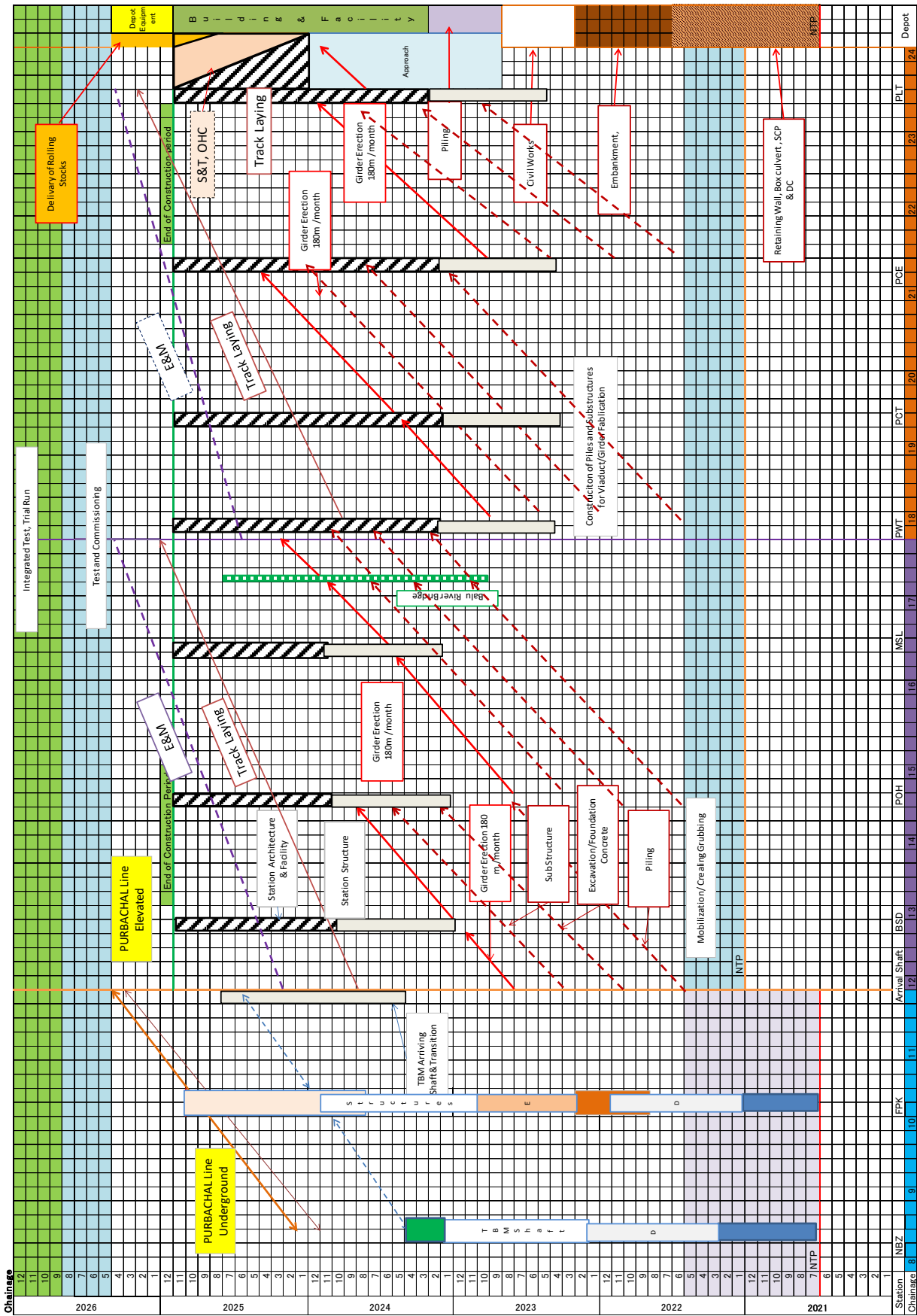


Figure 4.11.2 Integrated Section Construction Schedule (2)

Source: JICA Study Team

Assumed key dates are as shown in the table below.

Table 4.11.1 Key Dates

Key Event	Date
Preparation of DD & TD	November 2018- April 2020
Tender Assistance	January 2020 - February 2022
Construction Supervision	July 2021- December 2026
Land Acquisition	February 2019- October 2020
Procurement of Contractors	October 2022 – February 2022
Civil Works	July 2021- April 2026
Railway E/M	March 2022 – December 2026
Defects Liability Period (E/M)	January 2027- December 2028
Commercial Open	31 December 2026
Project Completion	31 December 2028

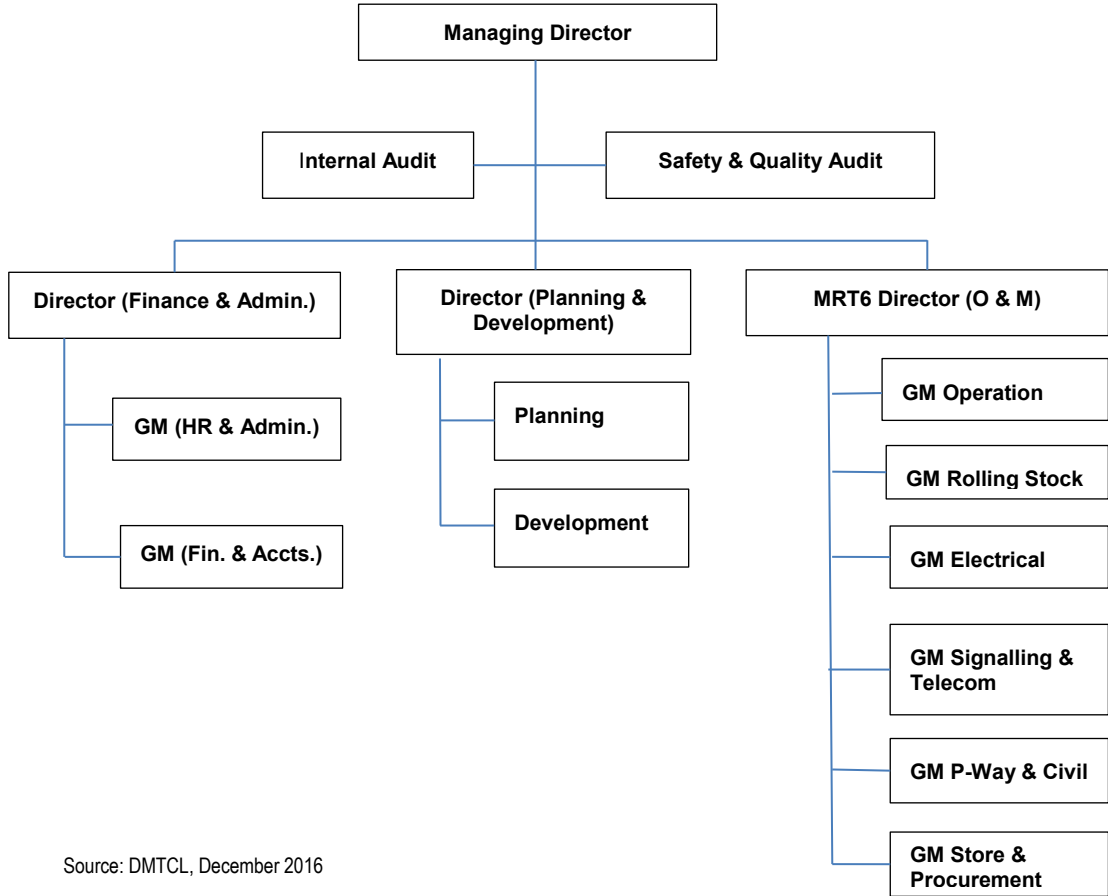
Source: JICA Study Team

4.12 Operation and Maintenance Systems

4.12.1 Examination of Operation and Maintenance Systems

Operation and Maintenance for MRT Line 6 is conducted by the DMTCL (Dhaka Mass Transit Company Limited). MRT Line 1 and Line 5 can be examined by either same organization with MRT Line 6 or different organization with MRT Line 6. From the efficient operation point of view, it should be considered as same organisation with MRT Line 6. DMTCL will be conducted operation and maintenance for both of MRT Line 1, Line 5 and Line 6.

Operation and Maintenance organization for MRT Line 6 is divided into 2 major sections, which is consisting of HDQs function and MRT Line 6 operation and maintenance function. DMTCL for MRT Line 6 is shown in Figure 4.12.1.



Source: DMTCL, December 2016

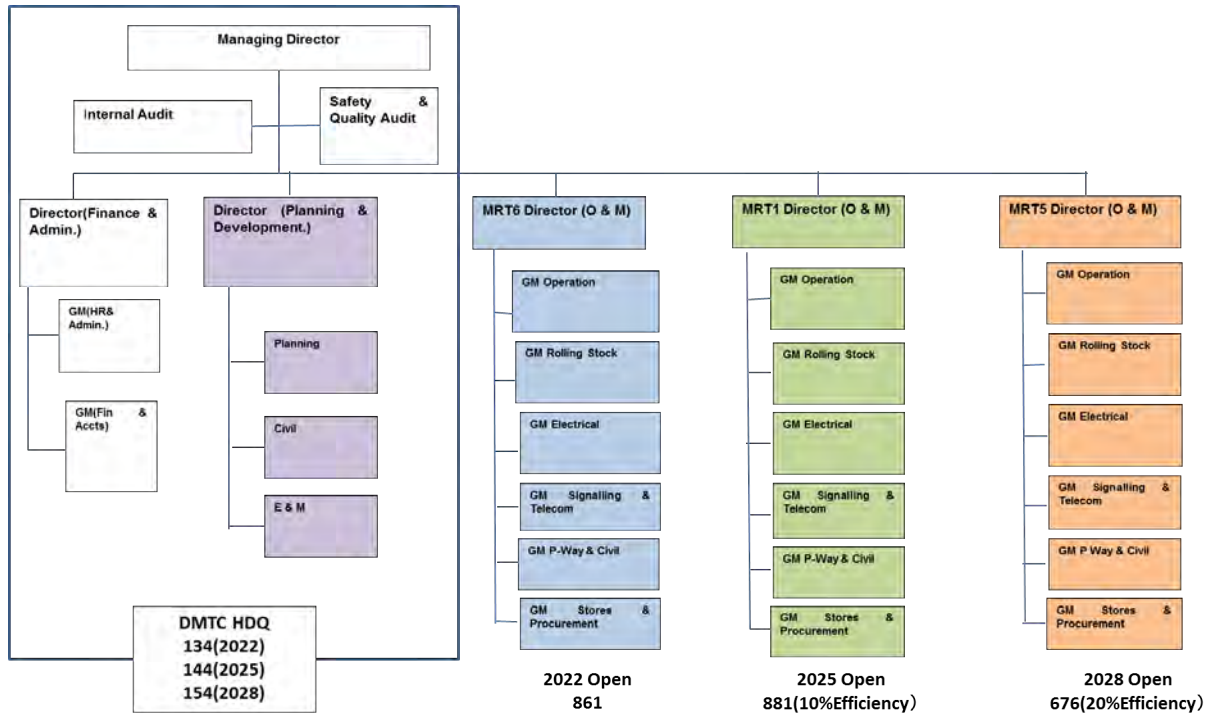
Figure 4.12.1 DMTCL Organization for MRT Line 6

Personnel of MRT Line 6 are considered as follows.

According to the recruitment plan until 2023, HDQs are 170, outsourced personnel are 110, and in total the number will be 280. Operation and Maintenance section for MRT Line 6 will be 861 staff and 824 outsourced personnel, in total 1,685.

Operation and Maintenance organization for MRT Line 1 and Line 5 are considered by DMTCL same as MRT Line 6. HDQs of DMTCL should be strengthened at Planning & Development Dept. and own operation and maintenance section for MRT Line 1 and Line 5 should be established separately.

New DMTCL will be shown in Figure 4.12.2.



Source: JICA Study Team

Figure 4.12.2 New Organization of DMTCL at the operation of MRT Line1 and Line 5

4.12.2 Local Budget of Executing Agency

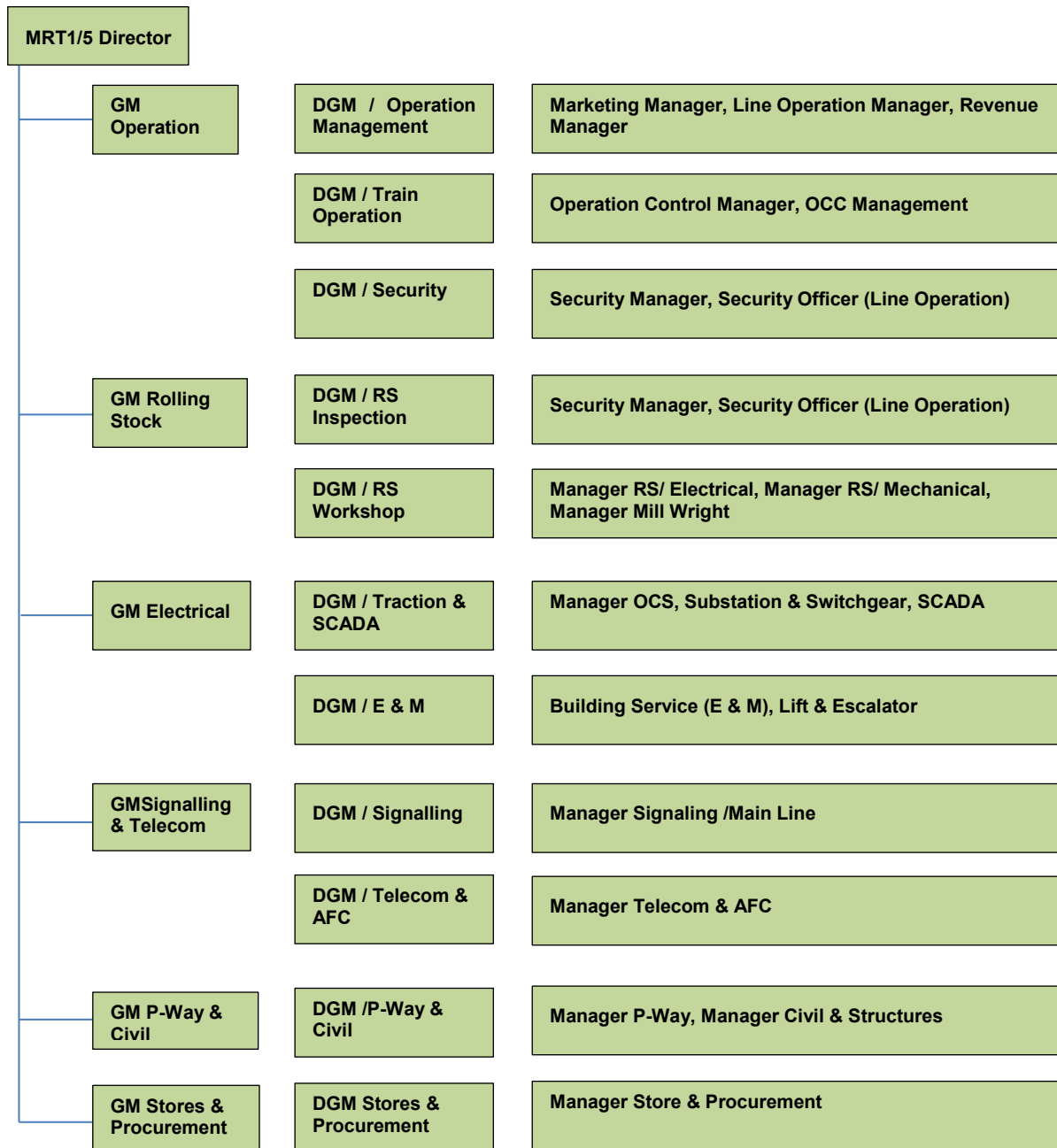
Local Budget for construction of MRT will be covered by Ministry of Finance and Ministry of transport. Local Budget will be transferred from those Ministries to Executing Agency DMTCL.

A huge budget is necessary to establish a new government railway operating company which is Dhaka Metro Transport Company Limited (DMTCL). Bangladesh Government would secure enough budgets to recruit necessary staff of DMTCL.

4.12.3 Operation and Maintenance for MRT Line 1, Line 5 and Line 6

Staff of own operation and maintenance section for MRT Line 1 and Line 5 will be employed around 700~800 each.

The Operation and Maintenance section for MRT Line 1 and Line 5 is almost same as MRT Line 6. The function of each Operation and Maintenance department is described as follows.



Source: JICA Study Team

Figure 4.12.3 Operation and Maintenance Section for MRT Line1, Line 5 and Line 6

4.13 Recruitment Plan of DMTCL Staff

The considered management organization for MRT Line 1 and Line 5 is the same as that for Line 6. The opening schedule of MRT Line 6 will be in 2023, MRT Line 1 will be in 2026 and MRT Line 5 will be in 2028. The number of personnel for MRT Line 1 and MRT Line 5 is calculated on the basis of the number of personnel of MRT Line 6.

The staffing of MRT Line 1 and MRT Line 5 is considered by the efficiency rating according to the operating practice and experience of MRT Line 6 in some years. Line 1 is considered to have a 10% rating and Line 5 is considered to have a 20% rating according to the years of experience, and HQ personnel are considered to increase by ten people for planning and accounting sections in each of Line 1 and Line 5.

Recruitment Plan for MRT Line 1 and Line 5 is shown in Table 4.13.1. It indicates that staff should be recruited two years before the commencement year and should start training according to the plan. (Note: In Operating and Maintenance section for MRT Line 6, the number of outsourced personnel is 830 broken down as follows: ticketing machine 150, cleaning 280, security 300, car drivers 40 and workers 60.)

Yearly recruitment plan for MRT Line 6, Line 1 and Line 5 is shown in Table 4.13.2.

Table 4.13.1 Calculation of Personnel for MRT Line 1 and Line 5

Department	Sub department	MRT Line 6		MRT Line 1		MRT Line 5	
		Con.	No.	Con.	No.	Con.	No.
Operation	Operation	16 St.	134	19St.	159	14 St.	117
	OCC	1	25	1	25	1	25
	Driver	24 Trains	96	31 Trains	124	30 Trains	120
	Security	16 St.	39	19	34	14 St.	25
Rolling Stock	RS Inspection	24	28	31	36	30	35
	Inspection Shed	24	50	31	65	30	63
	RS Workshop	1	146	1	146	1	146
Electrical	OCS	1	38	1	38	1	38
	Sub Station	16	28	19	33	14	25
	SCADA-OCC	1	20	1	20	1	20
	E&M (Station)	16	89	19	106	14	78
Signal & Telecom	Signal	16	49	19	58	14	43
	Telecom & AFC	16	50	19	59	14	44
P-Way & Civil	P-Way & Depot	1	30	1	30	1	30
	Civil Structure	16	25	19	31	14	22
Total			861		987		845
10% Efficiency					881		760
20% Efficiency					783		676

Table 4.13.2 Yearly Recruitment Plan of DMTCL for MRT Line 6, Line 1 and Line 5

Fiscal Year	HDQ			Operation and Maintenance			Total				DMTCL Total	
	Manager	Staff	Sub Total	Manager	Staff	Sub Total	Manager		Staff		合計	
							Single Year	Accumulation	Single Year	Accumulation	Single Year	Accumulation
2017	39	17	56	82	0	82	120	120	17	17	138	138
2018	22	25	47	25	79	104	47	167	104	121	151	289
2019	0	13	13	28	40	68	28	205	53	174	81	370
2020	13	5	18	65	229	294	78	273	234	408	312	682
2021	0	0	0	67	174	241	67	340	174	582	241	923
2022 (2023)				17	55	72	17	357	55	637	72	995
MRT6 Total	74	60	134	284	577	861		357		637	995	
2023		10	10						10	10	10	1,005
2024				142	298	440	142	142	298	308	440	1,445
MRT1 Total		10	10	284	597	881		284		607	891	
2025		10	10						10	10	10	1,896
2026				142	196	338	142	142	196	206	338	2,234
2027				142	196	338	142	284	196	402	338	2,572
MRT5 Total		10	10	284	392	676		284		402	686	

Source: JICA Study Team

5 Environmental and Social Considerations

5.1 Project Component which Affects Environmental and Social Considerations

This project is a railway in Dhaka Metropolitan Area (DMA). The objective of the project is to satisfy the traffic demand in DMA, to contribute an economic development, and to mitigate air pollution.

Table 5.1.1 Project Components

Construction of alignment	Viaduct and substructure	Total length: 31.2km (including overlapping section and supplementary track) Length between stations: 17.5km (Underground: Kamalapur Station ~ Airport Station, Future Park Station ~ Bashundhara Station) 10.7km (Viaduct: Bashundhara Station ~ Purbachal Terminal Station)
Construction of stations	Underground structure and viaduct structure including entrance and exit, elevator and ventilation facility	19 stations
Depot	Ground leveling, construction of depot and maintenance facility, and approach	38.993 ha: 25 ha for Depot, 13.993 ha for Construction Yard (South of Purbachal Terminal Station)
Others	Construction yard	Unfixed

Source: JICA study team

Figure 5.1.1 Route of MRT Line 1



Source: JICA study team

Construction works and the existence and operation of the project may cause negative impact on the environment and social matters and would require land acquisition and involuntary resettlement in Right of Way (ROW).

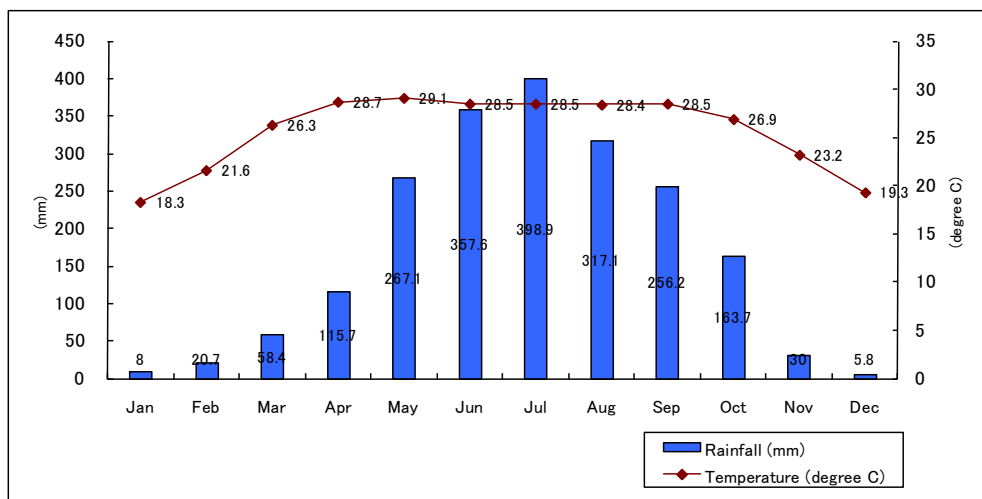
Accompanied with the project, it is expected that the vicinity of stations will be developed. However, since it is due to private developers, as of now, prediction and evaluation of the environment is difficult. Therefore, the evaluation of the development of the surroundings is out of the environmental and social considerations of the project.

As cumulative impacts caused by the project, some traffic projects planned in Dhaka may cause negative impacts. The cumulative impacts are examined on 6.6.2. Operation of borrow pits, quarry sites and construction yards have potential negative impacts, however as of now the location of the facilities are unfixed. Therefore the mitigation policies of negative impacts are examined in this study.

5.2 Environmental and Social Baseline

5.2.1 Location and Climate

The climate of Dhaka is categorised as tropical monsoon of Keppen climate classification. The annual average temperature is 25 degrees Celsius; the annual precipitation is approximately 2,000mm. Seasons are divided to hot and rainy season (May to October), cool and dry season (November to February), and hot and dry season (March to April). Eighty percent of the annual precipitation is observed during May to September (see Figure 5.2.1). Because water levels of rivers rise in the rainy season, high intensity rain often causes inundation in Dhaka city.



Source: <http://www.worldclimate.com/>

Figure 5.2.1 Monthly average precipitation and temperature

5.2.2 Topography and Geology

RAJUK area including the project area is formed with an alluvial plain including highland swamp, lowland and natural bank. Swamp and wetland distribute in urban Dhaka and the vicinity.

Low lying swamps and marshes located in and around the city are other major topographic features. The elevation of DCC area varies from 2 to 13 m above the mean sea level. Most of the developed areas in RAJUK area are at an elevation of 6 to 8 meters above the mean sea level.

Part of the RAJUK area is covered by Pleistocene Madhupur Clay and Holocene sediments of the Ganges- Brahmaputra floodplain. The Madhupur Clay is situated in north-west part and lies elongated from the middle of the north to south of the project area and these are oxidized Pleistocene sediments. In the east, south and western half of the RAJUK area are

covered by the Ganges-Brahmaputra floodplain sediments.

Regarding the seismology, the National Seismic Zoning Map (Geological Survey of Bangladesh (GSB)) divides the country into three regions (see Figure 5.2.2). The city of Dhaka falls within the medium-risk zone (zone 2). In the medium risk zone, shocks of moderate intensity are possible, with a probable maximum magnitude of 6-7 on the Richter scale.



Source: Ministry of Power, Energy & Mineral Resources Division

Figure 5.2.2 National Seismic Zoning Map of Bangladesh

5.2.3 Hydrology

1) Hydrology in/around Dhaka city

Dhaka is surrounded with tributary rivers of three major rivers (Ganges River, Brahmaputra River and Meghna River). The water levels of rivers around of Dhaka city are linked to those of the major rivers, and rise up to 5.0~6.0m during rainy seasons, 1.0~2.0m during dry seasons.

2) Current condition of groundwater in Dhaka city

The groundwater extraction from groundwater table is an important water source in Dhaka city. Since most of the water resource in Dhaka depends on the extraction of groundwater, this extraction causes a drop of groundwater level. In addition, developments such as roads, buildings and embankment by rapid expansion of urban area are hampering groundwater cultivation from rainfall and rivers¹. Water network formed by lakes, canals and small rivers have not only function of urban drainage against flood but also cultivation of underground water. However, recent disordered developments had these water bodies dropped sharply, and caused to deteriorate the function of groundwater cultivation.

¹ Dhaka Structure Plan 2016-2035 (draft) 11.3.4 Ground Water Depletion

3) Depletion of groundwater in Dhaka city

In Dhaka city, groundwater is pumped up from approximately 100m to 300m below the ground level. The level of the groundwater tends to decline year by year. In future, a lot of well may become to be unable to use, and cost of water supply may raise.

5.2.4 Wetland characteristics

1) Function of wetland

The wetland distributed on the low land around Dhaka city plays important roles of control and environment protection.

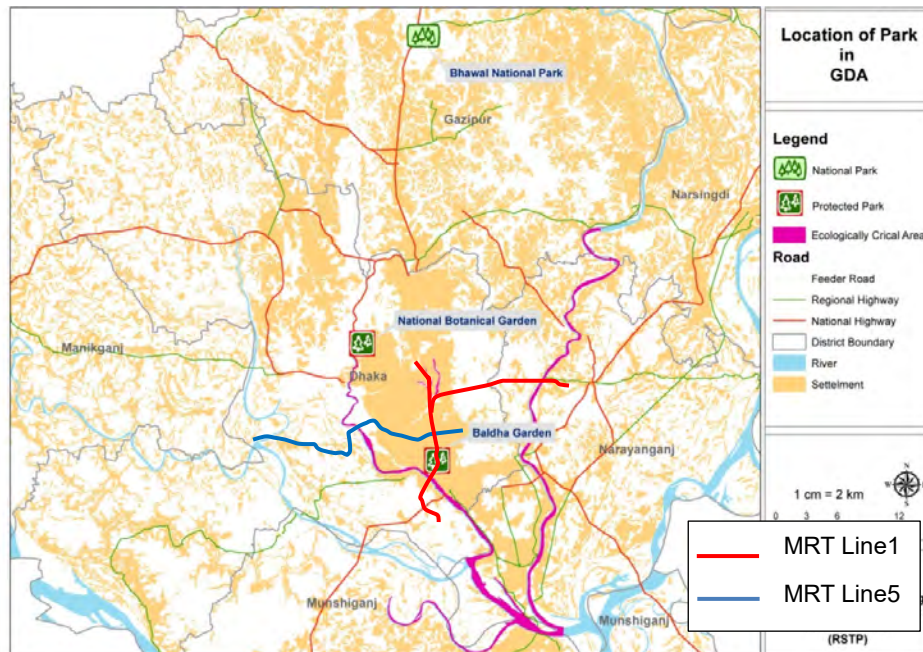
- (a) Water retention for flood water
- (b) Drainage of rain water from urban district
- (c) Recharge of groundwater
- (d) Preservation of ecological system and biodiversity
- (e) Contribution to local economy: it is utilized as fertile rice paddies in dry seasons, or fishing ground in rainy seasons.
- (f) Field of recreation activities

2) Wetland loss

In 1960, the area of the open water body was about 2,952 ha, which became about 1,991 ha in the year 2008. The amount of the open water body reduction is 961 ha. From 2005 to 2011 in just six years, the wetlands adjacent to Dhaka shrank from 5.85 km² to 3.95 km² when local water bodies and lowlands were converted to commercial, industrial and residential zones. If the current trend continues, experts said, by the year 2037 all wetland of Dhaka will disappear, posing a serious threat to the city's existence.

5.2.5 Natural park, sanctuaries and other conservation sites

Based on Bangladesh Wildlife Preservation Order 1973, Protected Areas (PAs) is classified into national parks, wildlife sanctuaries, game reserves and private game reserves. The protected areas in GDA are shown on Figure 5.2.3. In GDA, there is Bhawal National Park which is the only national park in GDA. In/around the project sites, there is no protected area such as natural park, sanctuary and conservation site. National Botanical Garden and Baldha Garden is botanical gardens which are located on over 2km from the project sites.



Source: The Project on the Revision and Updating of the Strategic Transport Plan for Dhaka, 2nd Draft Final Report, February 2016, JICA

Figure 5.2.3 Natural Preservation Areas in GDA

5.2.6 Environmentally critical area

The 1995 Bangladesh Environment Conservation Act includes provision for Ecologically Critical Area (ECA) declarations by the director general of the Department of the Environment in certain cases where the ecosystem is considered to be in danger of reaching a critical state. ECA is an area that “has been already quite polluted, and should prevent more pollution”, and does not prohibit development. Wild reserves and cultural heritage reserves are designated under Bangladesh Wildlife Preservation Order and Forest Act. In ECA, GOB restricts activities and process of manufacture in the view of preventing deterioration of the environment. In RAJUK, there are five ECA including one lake (Gulshan Banani-Baridhara Lake) and four rivers (Buriganga, Turag, Balu and Shitalakshya). (see Figure 5.2.3) MRT Line1 crosses Balu river by viaduct structure.

5.2.7 Ecosystem

1) Ecosystem

The ecosystem of Bangladesh is categorized territorial ecosystem and aquatic ecosystem. The territorial ecosystem includes forest and hill ecosystems, agro-ecosystem and homestead ecosystem; while seasonal and perennial wetlands, rivers, lakes, coastal mangroves, coastal mudflats and chars, and marine ecosystem fall into the aquatic category. In RAJUK area, there are Moist Deciduous Forest (Sal Forest ecosystem), Agro-ecosystem and Homestead ecosystem.

In the project sites which are urbanized, the only Agro-ecosystem, Homestead ecosystem and wetland ecosystem are still existed in Purbachal area of Line1.

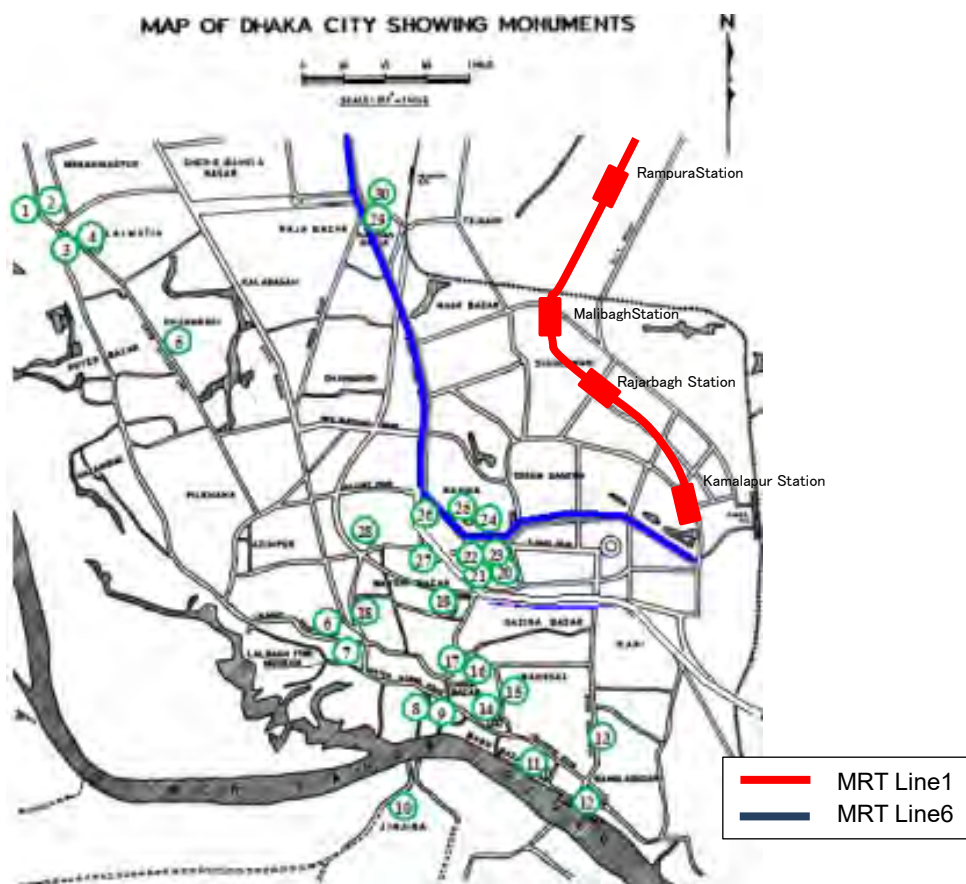
2) Endangered species

Bangladesh possesses extremely various species. As of July 2014, International Union for Conservation of Nature designates 106 animal species and 16 plant species as Critically Endangered(CR), Endangered(EN) and Vulnerable(VU).

5.2.8 Cultural Heritage

In RAJUK area, seventy four archaeological heritages including the followings are preserved. Major archaeological heritages in Dhaka city are shown below.

- | | |
|--|--|
| 1. Sat Gumbad Mosque | 16. Baoli |
| 2. Unknown Tomb near Sat Gumbad Mosque | 17. Kartalab Khan Mosque |
| 3. Alakuris Mosque | 18. Dhakeswari Temple |
| 4. Dara Begum's Tomb | 19. Hussaini Dalan |
| 5. Old Eidgah | 20. Fazlul Huq Hall |
| 6. Khan Muhammad Mridha Mosque | 21. Curzon Hall |
| 7. Lalbagh Fort | 22. Dhaka City Corporation |
| 8. Bara Katra | 23. Musa Khan Mosque |
| 9. Chhoto Katra | 24. Greek Memorial |
| 10. Kadamtali Circle | 25. Tomb and Mosques of Haji Khawaja Shahbaz |
| 11. Ahsan Manzil | 26. Salimullah Hall |
| 12. Northbrook Hall | 27. Dara Begum's Tomb |
| 13. St. Mary's Cathedral | 28. BUET |
| 14. The American Church | 29. Khwaja Ambar Mosque |
| 15. Sitara Mosque | 30. St. Augustin Church |



Source: Department of Archaeology, Bangladesh

Figure 5.2.4 Archaeological Heritage in Dhaka city

Since the archaeological heritages concentrate on the south of the city, it seems that there are no heritages affected directly in/along the project. In this survey, cultural heritage in/around the project site is confirmed.

5.2.9 Pollution Control

1) Air Pollution

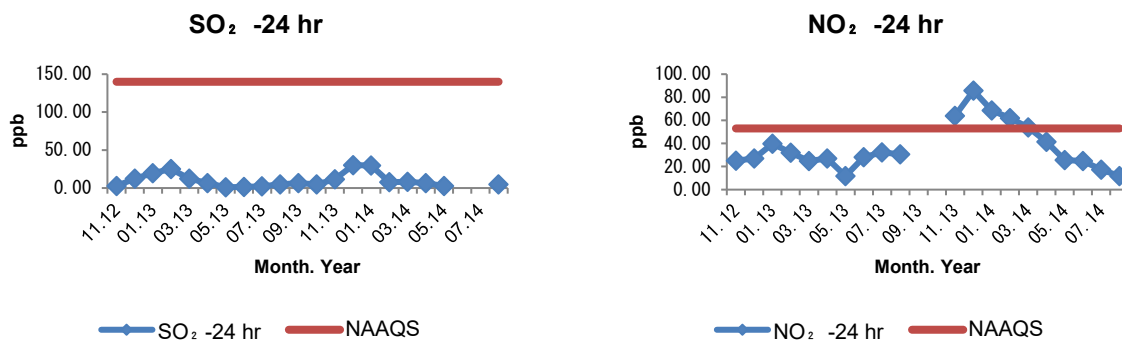
Deterioration of the air quality is one of the major environmental issues in Dhaka. Major pollutants are NO_x, SO₂, PM, PM₁₀ PM_{2.5} CO, O₃ and Lead. Major origins of air pollutants are vehicles and traditional brick manufacturers. A lot of the brick manufactures around Dhaka city operates during dry season (November to April). The emissions including SO₂, NO_x and organic hydrogen worsen the air quality. Table 5.2.1 shows National Ambient Air Quality Standards (NAAQ) in Bangladesh with WHO Guidelines.

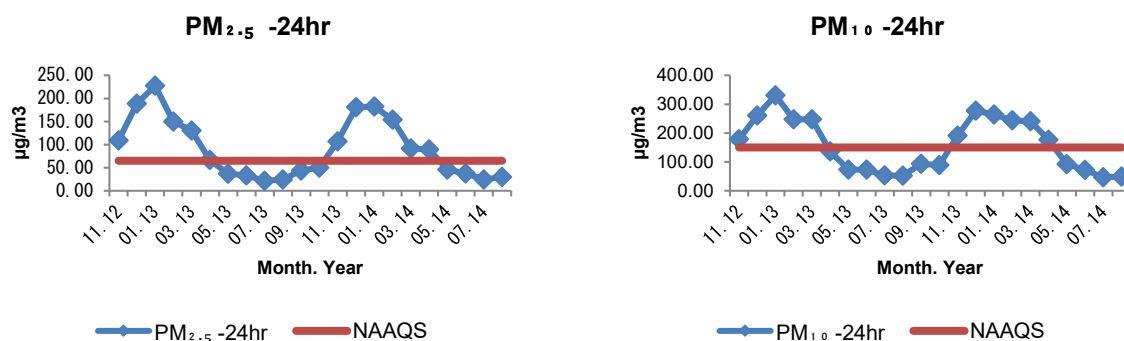
Table 5.2.1 National Ambient Air Quality Standards (NAAQ) in Bangladesh

Air Pollutants	Unit	Measurement Time	Standards	WHO Guidelines
CO	mg/m ³	8 hours(a)	10 (9 ppm)	10
	mg/m ³	1 hour(a)	40 (35 ppm)	30
Pb	µg/m ³	Annual	0.5	0.5
NO _x	µg/m ³	Annual	100 (0.053 ppm)	40 (as NO ₂)
	µg/m ³	Annual (b)	50	20
PM ₁₀	µg/m ³	Annual (b)	50	20
	µg/m ³	24 hours (c)	150	50
PM _{2.5}	µg/m ³	Annual	15	10
	µg/m ³	24 hours	65	25
O ₃	µg/m ³	1 hour (d)	235 (0.12 ppm)	-
	µg/m ³	8 hours	157 (0.08 ppm)	100
SO ₂	µg/m ³	Annual	80 (0.03 ppm)	-
	µg/m ³	24 hours (a)	365 (0.14 ppm)	20

Source: Statutory Rules and Order No. 220, GOB (2005); Air Quality Guidelines for Europe, 2nd ed., WHO (2005); and Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide, WHO (2006).

Figure 5.2.5 shows concentrations of the air pollutants on the vicinity of the project site by Clean Air and Sustainable Environment Project. The concentrations of the air pollutants change seasonally. The concentration rises during the dry season (December to February) and declines during the rainy season (May to September). Particularly the concentration of PM is high.





Source: The Project on the Revision and Updating of the Strategic Transport Plan for Dhaka, 2nd Draft Final Report, February 2016, JICA

Figure 5.2.5 Concentrations of Air Pollutants measured on November 2012 to August 2014 (Darus-Salam)

2) Noise

Noise level is high in Dhaka city. This is a major issue for citizens. In most area of the city noise level exceeds standards. Table 5.2.2 shows the noise standard of Bangladesh and WHO Guidelines.

Table 5.2.2 Noise Standard of Bangladesh and WHO Guidelines

Category of Area	Noise Standard of Bangladesh *1 (LAeq: dBA)		Guidelines of Community Noise (WHO, 1999)	
	Daytime (6:00-21:00)	Night (21:00-6:00)	Daytime (7:00-22:00)	Night (22:00-2:00)
Silent zone	45	35	-	-
Residential area	50	40	55	45
Mixed area	60	50	-	-
Commercial area	70	60	70	70
Industrial area	75	70	70	70

Source: Study Team

Note: 1)noise standards of ECR, 1997

Table 5.2.3 shows noise levels which were measured around the project site. Totally the noise levels are high. Particularly in areas except residential area high noise exceeding 80dB(A) were observed. The high noise is originated by horn of vehicles, demonstration parade and audio player.

Table 5.2.3 Noise Levels around the Project Site

Locations	Noise Level (dBA)
Sayedabad Bus Terminal	106
Mowchak	103
Gulistan	90
Sapla Chattar Motijheel	89

Source: Dey, A. R., N. Kabir and D. Efrogson, 2010, Noise Pollution in Dhaka: Current Situation and Suggestions for Action.

3) Water Quality

There are lots of rivers, canals and wetlands which contribute formation of water environment. On the other hand, recent rapid increase of population makes water pollution severe. Table 5.2.4 shows results of water quality survey around the project area and standards of water quality of Bangladesh. No.2 and No.3 which are small river and drainage in urban area are highly polluted.

Table 5.2.4 Results of water quality survey around the project site (2010)

No.	Location	Date	pH	Dissolved Oxygen (DO) ppm	Chemical Oxygen Demand (COD) ppm	Total Suspended Solid (TSS) g/l	Total Coliform number/100ml
1	Pond in Northern Pallabi	2 Oct.	7.5	5.8	45.6	288	500,000
2	Mirpur Khal	2 Oct.	7.3	0.6	164.0	636.4	500,000
3	Begunbari Drain	2 Oct.	7.6	1.4	141.6	502.1	1,100,000
1	Pond in Northern Pallabi	12 Dec.	7.6	7.2	64	149	1,000
2	Mirpur Khal	12 Dec.	7.7	Under DL*	480	392	910,000
3	Begunbari Drain	12 Dec.	7.7	Under DL*	448	367	960,000
Bangladesh Standard for Inland Surface Water Quality (Water usable by various process)			6.5-8.5	5 or more	Not yet set	Not yet set	5,000 or less

*: Detection Limit

Source: Preparatory Survey on Dhaka Urban Transport Network Development Project – Phase II

4) Ground Water

Bangladesh had used surface water including lake and river and drinking water. However, because water pollution created difficulty to utilize, utilization of groundwater has been developed since 1970. Meanwhile, arsenic pollution for groundwater has become a serial problem since 1990. A cause of the pollution still has not been clear. Now 270 districts are arsenic contaminated areas. Approximately 30 million persons has been affected by arsenic contaminated water.

GOB has taken emergency measures for arsenic mitigation, and adopted National Policy for Arsenic Mitigation and the implementation plan in 2004. However, since alternative water sources are limited safety supply of drinking water is still significant issues. There are lot of unresolved issues including care for arsenic poisoning and negative impacts to foods.

There are no standards of underground water quality in Bangladesh.

5.2.10 Basic Information on Social Economy

1) Population and Social Economy

Though issues are arisen due to so many populations in Bangladesh (according to the World Development Index of World Bank it is reported that the census shows 142.5 million in 2011 and expected to increase 156.6 million in 2015), the country is persisting a development which aims at building a prosperity and pluralistic society. According to WB, though the income per capita is 1,096 UDS (actual achievement in 2014), however, annual economic growth rate is more than 6% in a past decade and Gross Domestic Product (GDP) has achieved 195.1 billion USD (reported by WB in 2015). Considering it was 65.1 billion USD in 2004, it has rapidly grown up four times in a decade.

The prime of economic development is export industry. Specially, export of texture is ranked second, subsequently to China. The break down presents 21.6 billion USD owed to the production of knitwear and ready-made clothes which occupies 80% of total export amount. Other industries are pharmaceutical, shipbuilding, chinaware, leather goods and home electric appliances. In addition, Bangladesh has extremely fertile soil in terms of the primary industry, and rice, jute, tea, cotton and sugar cane are cultivated as cash crop. The fishery and marine products is ranked fifth in the world. Last, overseas remittances by migrant

workers are brought up 14 billion USD (actual achievement in 2014). Economic share by sectors are agriculture: 16%, industry: 28% and services: 56% (WB's report in 2013), respectively.

The GDA which includes target area of the Study is the most developed area and its Gross Regional Domestic Product (GRDP) is approximately 25% of GDP. From sector point of view, the weight of agriculture is decreasing however industry is increasing. Furthermore, from census point of view, population in GDA is 23,459,577 which occupy 16.29% of Bangladesh.

Table 5.2.5 District Based Population and Area

District	Area (km ²)	Population		Annual Average growth rate
		2001	2011	
Dhaka	1,463.6	9,036,647	12,043,977	2.91%
Gazipur	1,806.4	2,143,200	3,403,912	4.73%
Mnikganj	1,383.7	1,343,749	1,392,867	0.35%
Mushiganj	1,004.3	1,353,483	1,445,660	0.66%
Narayanganj	684.4	2,300,514	2,948,217	2.51%
Narsingdi	1,150.1	1,983,449	2,224,944	1.15%
Total	7,492.5	18,161,042	23,459,577	2.59%

Source: Census (2011) , Area: STATISTICAL YEAR BOOK BANGLADESH 2015

As described above, in GDA it is assumed that the population is 23.48 million in 2011 will increase 32.59 million in 2025. Rapid increase makes Dhaka disordered and high-density city which is one of the fragile against disaster due to low quality buildings. In addition, influx from rural district to urban area is in progress which increase low income (6,000 taka per year) group, expansion of slum area, traffic congestion, insufficient power supply and expansion of environmental pollution.

The present urban transport significantly depends on traffic transport. Traffic volume exceeds its capacity and severe traffic congestion arises because the various kinds of transportation system are running together such as, automobile, bus, rickshaw etc. Accordingly, many problems such as, increase of trip hour, deterioration of transport efficiency, increase of traffic accidents, increase of fuel consumption and public nuisance by air pollution/health hazard are arisen.

Poverty rate shows those who are living under poverty line against whole population. According to Bangladesh Bureau of Statistic in 2011, poverty rate was 31.5% which consist of 35.2% in rural district and 21.3% in urban. On the other hand, poverty rate in 2005 was 40.0% which consist of 43.8% in rural district and 28.4% in urban. That is to say between 2005 and 2015, poverty rate decreased 8.5% in Bangladesh which consist of 8.6% in rural and 7.1% in urban. Considering the poverty rate was 56.7% between 1991 to 1992, it decreased 25.2% in the past decade.

Table 5.2.6 GRDA in GDA

	Nominal GRDP (million USD)						Average Annual Growth Rate	
	1995		1999		2005		1995-1999	1999-2005
	million USD	Percent (%)	million USD	Percent (%)	million USD	Percent (%)	AAGR (%)	AAGR (%)
Bangladesh	39,065	100.0	45,447	100.0	59,748	100.0	3.1	5.6
GDA	9,206	23.6	10,762	23.7	15,004	25.1	3.2	6.9
Dhaka	5,714	14.6	6,742	14.8	9,497	15.9	3.4	7.1
Gazipur	1,132	2.9	1,309	2.9	1,850	3.1	2.9	7.2
Manikganji	342	0.9	401	0.9	503	0.8	3.2	4.6
Munshiganji	325	0.8	372	0.8	465	0.8	2.7	4.6
Narayanganji	1,097	2.8	1,246	2.7	1,751	2.9	2.6	7.0
Narsinghdi	596	1.5	692	1.5	938	1.6	3.0	6.3

Source: Growth, Income Inequality and Poverty Trends in Bangladesh: Implications for Development

Strategy by Center for Policy Dialogue (CPD)

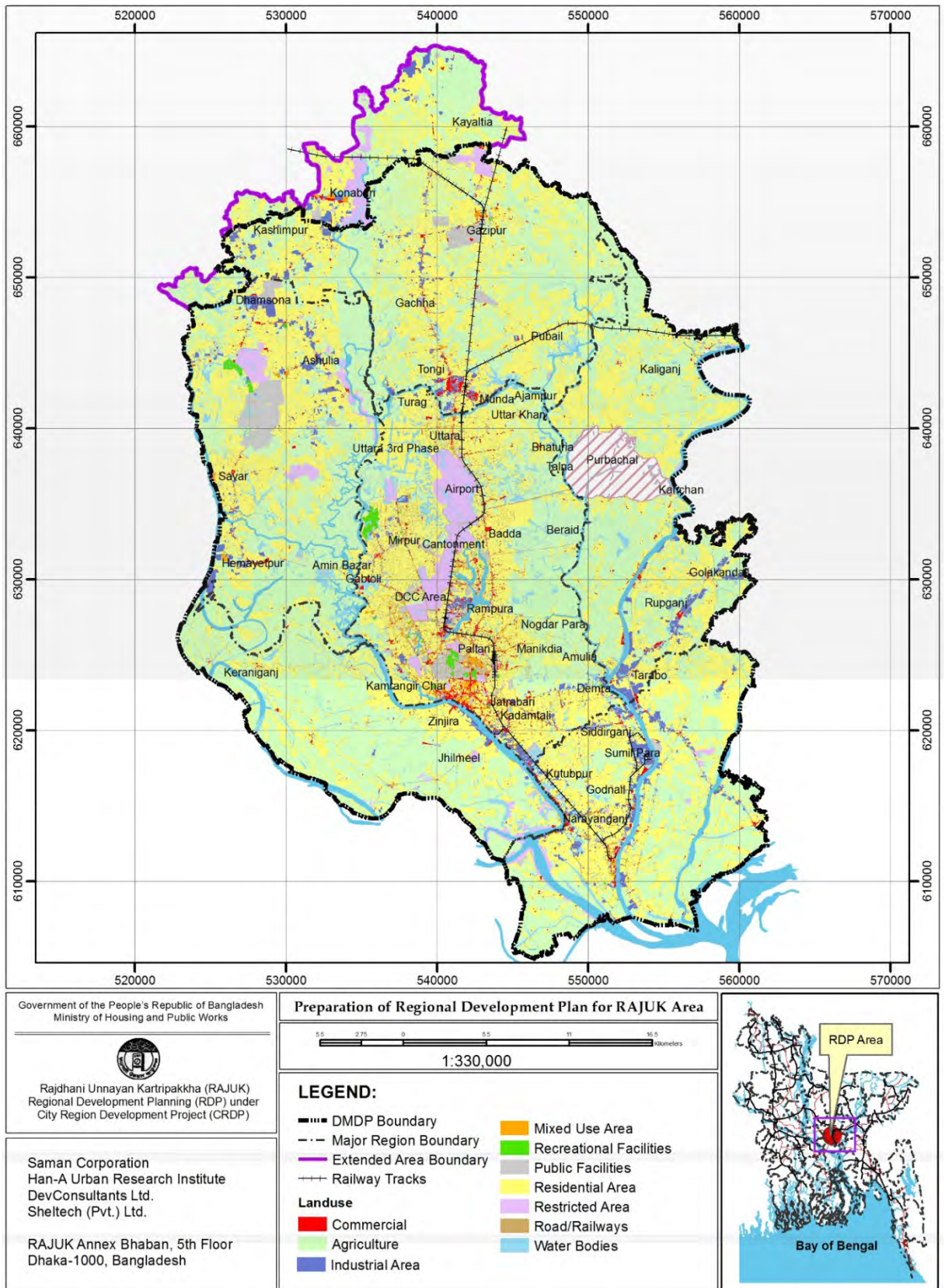
According to Rushidan I. Rahman and Rizwanul Islam (2013), Female labour force participation in Bangladesh: trends, drivers and barriers, ILO Asia-Pacific Working Paper Series, thanks to the economic development female participation rate in urban was 20.5% in 1995/96, then increased 27.4% in 2005/06 and 34.5% in 2010/11. Female participation rate in Dhaka was 36.4% in 2010/11. In this country, there had been a custom called Purda which requires female group “to stay within home and do not go to work outside home”, however, because of increase of female participation and extension of educational opportunity, this custom has changed in urban especially, and liberalization of movement of female is expected to increase more in future.

The detail on female participation will be studied at project area, however, according to the site reconnaissance and opinion by executing agency, the trend will basically be same as in whole country.

2) Land-use

In the jurisdiction of RAJUK, the land-use has changed related to the progress of urbanization of Dhaka. Especially, the 209,969 hectare of water body in 1967 decreased 5,520 hectare, approximately one fourth of year 2010. These conversions were happened due to the absence of land-use management, incomplete urban planning which cause the expansion of urban poor and flood disaster. Same urbanization is extending to the north: Savar Ashulia and Ultra, specifically.

RAJUK is divided in Dhaka Central, North, East, West, South and South-West areas and out of 152,000 hectare North occupy 23%, Dhaka Central occupy 20% and West occupy 17%. From land-use point of view, agricultural land is 40% and extended to North and West. Residential land is second rank which occupy 37% and extended to Dhaka central and North. Commercial land and mixed land-use have same tendency like residential land. On the other hand, many Industry lands are situated in North and South. The land-use map under jurisdiction of RAJUK is attached in Figure 5.2.6.



Source: Regional Development Planning (RDP) Survey Report (RAJUK, 2014)

Figure 5.2.6 Land-use Map Prepared by RAJUK

3) Assumed Land Acquisition and Resettlement

Land acquisition and Resettlement on MRT Line 1 is assumed in Table 5.2.7.

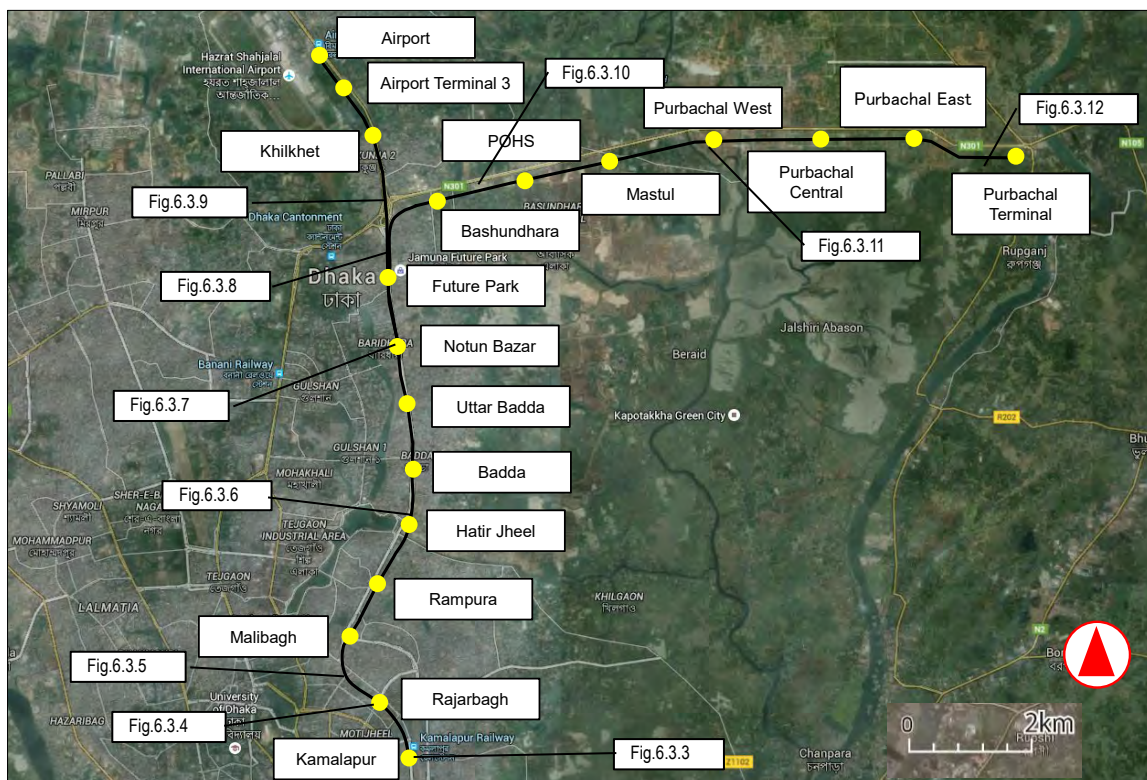
Table 5.2.7 Assumed Land Acquisition and Resettlement

MRT	Elevated • Tunnel Section	Station	Depot	Access to Depot	Construction Yard
Line 1	Elevated section : Structure of metro will be built within the ROW which belong to Road and Highway Department (RHD). Therefore, further land acquisition will not be required. However, for the construction of exit, entrance and ventilation duct etc. some extent of private land acquisition will be required.	Land acquisition on private land and resettlement related to the station construction are assumed as follows. Land acquisition: 0.23 hectare Resettlement: 421 households	Presently it is a land for private (tentatively) use. Assumed land acquisition and resettlement are; Land acquisition: 38.003 hectare Resettlement: 698 households	Assumed Land acquisition: Included in Depot Resettlement: Included in Depot	Review on proposed site and size are on-going.

Source: JICA Study Team

5.2.11 Environmental Conditions of the Project Site

MRT Line1 connects south north corridor and east in Dhaka. The line goes within ROW of existing roads between Rajarbagh – Malibagh, and Future Oark – Bashundhara, and out of ROW except those sections. There is no facility which is source of pollution such as factories within the ROW.



Source: JICA Study Team

Figure 5.2.7 Route of MRT Line1

Kamalapur Station (see Figure 5.2.8) which is located at south point is close to Kamalapur Station of Bangladesh National Railway. The alignment goes under Outer Circular Road from here to Rajarbagh Station. (See Figure 5.2.9) Medium-rise housings, government facilities and commercial facilities (shops) stand along the alignment.



Source: JICA Study Team

Figure 5.2.8 Surroundings of Kamalapur Station



Source: JICA Study Team

Figure 5.2.9 Surroundings of Rajarbagh Station

The area between Rajarbagh Station and Rampura Station where medium high rise commercial buildings are standing is much crowded. This section will require underground structure because viaduct road is being developed. (Figure 5.2.10)

The area from here to Future Park is mixed area of medium high rise offices, commercial buildings and houses. Major intersections on the alignment such as Notun Bazar (Figure 5.2.12) congest. The Line1 crosses and connects with the Line 5 at Notun Bazar Station(Figure 5.2.12).



Source: JICA Study Team

Figure 5.2.10 Surroundings of Rajarbagh Station – Malibagh Station



Source: JICA Study Team

Figure 5.2.11 Surroundings of Hatir Jheel Station



Source: JICA Study Team

Figure 5.2.12 Surroundings of Notun Bazar Station



Source: JICA Study Team

Figure 5.2.13 Surroundings of Future Park Station

The alignment from Future Park station (Figure 5.2.13) diverges airport and east (Purbachal area). Interchange road called Kuril Flyover is developed around the divergence (Figure 5.2.14). The Line1 requires underground structure or high-rise structure which exceeds the existing structure.

The alignment goes through Purbachal Express Highway which has vast ROW, and reaches Purbachal Terminal Station at east end point. Medium and high rise building is being developed from Future Park Station and Bashundhara Station (see Figure 5.2.15).



Source: JICA Study Team

Figure 5.2.14 Surroundings of Kuril Station



Source: JICA Study Team

Figure 5.2.15 Surroundings of Bashundhara Station

The vicinity of the alignment to Purbachal Terminal Station consists of swamp, forest and agricultural area. On the other hand, the area is being developed. (Figure 5.2.16) Depot site is planned in the south of Purbachal Terminal Station. Here is vacant, agricultural and developed land. (See Figure 5.2.17)



Source: JICA Study Team

Figure 5.2.16 Developing Purbachal Area



Source: JICA Study Team

Figure 5.2.17 Surroundings of Depot Site of Line1

5.3 Legal and Institutional Framework Regarding Environmental Consideration

5.3.1 Legal Framework

1) Relevant Laws on Environmental Protection

Table 5.3.1 shows major environmental laws and legislations of Bangladesh.

Table 5.3.1 Relevant Laws on the Environment

Law, Policy	Outlines
Environmental Policy 1992	Basic policy of the environment in Bangladesh. The policy is formed by environmental policy, legal framework in 15 sectors. This policy shows a basis of EIA implementation.
Environmental Action Plan	It was established in 1992. The plan shows a tangible action plan of Environmental Policy 1992, and designates relevant agencies. The publication of white paper on the environment is stipulated on this plan.
National Environment Management Action Plan	It was established in assistance with UNEP in 1995. Purposes of the plan are: understanding of important environmental issues relevant to Bangladesh, mitigation of environmental deterioration, protection of biodiversity, promotion of sustainable development and action of improving life quality. Not only government agencies NPO and residents proceeded the formulation of the plan.
Bangladesh Environment Conservation Act	It was established by Ministry of Environment and Forests in 1995 as substitute of Environment Preservation Act. The act covers fundamental domains of environmental preservation.
The Environmental Conservation Rules	The rule stipulates the environmental standards including air quality, water quality, industrial waste water, exhaust gas, noise and odor. Submission of project plan, EIA, and environmental management plan is stipulated in the rule.
Environmental Court Law	It was established in 2000. The law stipulates a legal procedure on pollution.

Source: METI, MRI (2012)

2) Policy on Climate Change

Bangladesh is one of vulnerable areas on flood. Rise of sea level caused by climate change becomes factor that expands flood damage. Moreover, the increase of drought and cyclone may become significant issues on social and economic activities in Bangladesh.

Bangladesh is a party of United Nations Framework Convention on Climate Change (UNFCCC). Under the framework of UNFCCC, Bangladesh formulated Bangladesh Climate Change Strategy and Action Plan. The action plan which consists of 6 items builds adaptation and durability against climate change aiming action during 10 years (2009-2018).

- Security of food, social security and health control
- Comprehensive disaster control

- Fundamental facility management
- Study relevant to climate change, and improvement of knowledge
- Mitigation of GHG emission, and low carbon development
- Capacity building, expansion of relevant facilities

As tackling reduction of greenhouse gasses, GOB signed Joint Crediting Mechanism (JCM) which is a promoting mechanism of low carbon technique by Japan in 2013. Under the mechanism, Bangladesh is introducing energy saving and technique and renewable energy technique of Japan.

In Intended Nationally Determined Contributions, GOB is aiming to 20% reduction of GHG emission of energy, traffic and industrial sectors by 2030. Since the MRT Line1 and Line5 projects will reduce the emission of GHG by modal shift from vehicles to railway, the projects contribute the policy of climate change of Bangladesh.

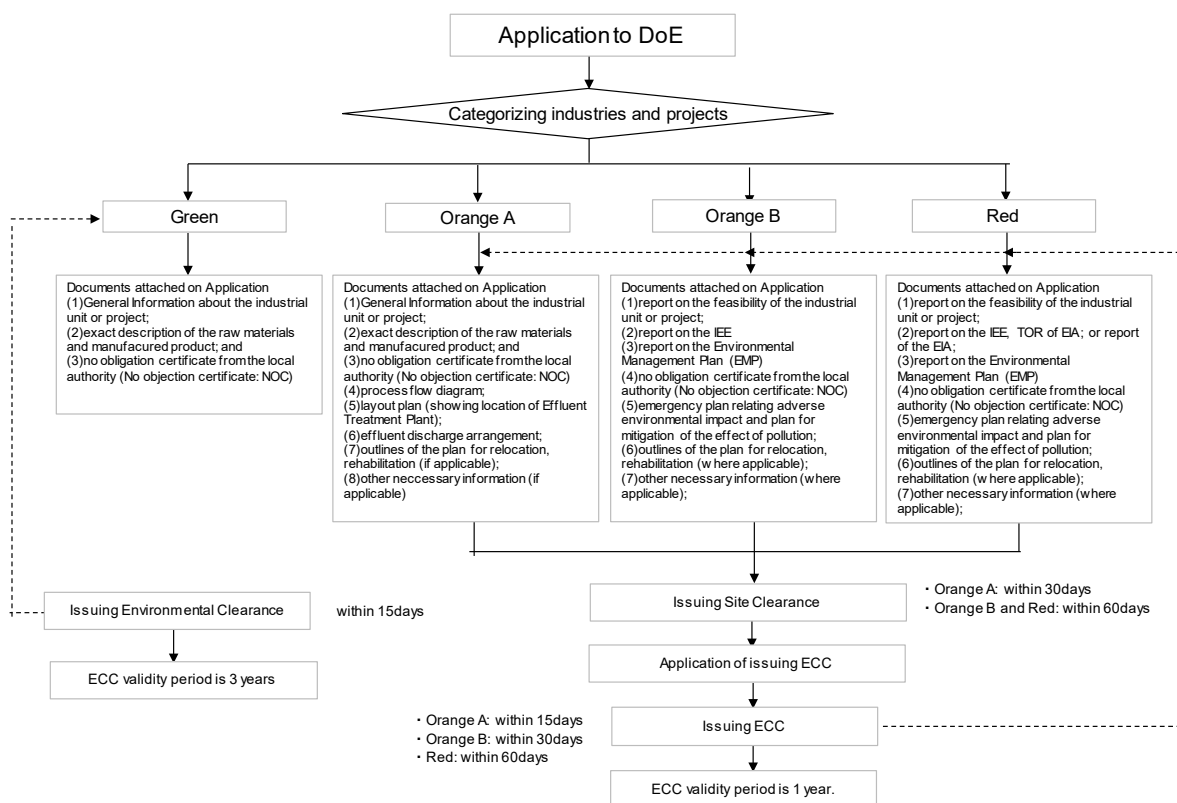
5.3.2 Institution of EIA

Bangladesh stipulates EIA system on the Environmental Conservation Act (ECA: 1995) and Environmental Conservation Rules (ECR: 1997). GOB has promoted a lot of industrial policy to solve poverty and employment issues. However, developments without an environmental consideration caused deterioration of the environment. Under this lesson, the said legislations were established for the purpose of environmental conservation.

5.3.3 EIA Procedure

Implementation of whole industries and projects needs ECC issued by DoE. (ECA, Section12) Industries, activities and projects are categorized Green, Orange A, Orange B and Red with magnitudes of negative impacts and location, and needs procedure along each activity. Projects categorized Green are small scale and environmentally insignificant. Orange A, Orange B and Red categories include large and environmentally significant project. Red projects are the most environmentally significant project.

Green and Orange A projects require submission of summary report of the project and approval of local government. Orange B and Red projects require Initial Environmental Examination (IEE) and Environmental Management Plan (EMP) in addition to above.



Source: Environmental Profile of Bangladesh (11,2016, Japan Bank International Cooperation)

Figure 5.3.1 Flow of ECC acquisition

5.3.4 EIA Projects and Report

Red category projects require EIA. The Red projects are shown on Table 5.3.2.

Table 5.3.2 Red Category Projects

1. Leather processing (tannery)	26. Asbestos	51. Hospitals
2. Formaldehyde	27. Fibreglass	52. Ship manufacturing
3. Urea fertiliser	28. Pesticides, fungicides and herbicides	53. Tobacco (processing/cigarette/bin-making)
4. T.S.P. fertiliser	29. Phosphorus and its compounds/derivatives	54. Metallic boat manufacturing
5. Chemical dyes, polishes, varnishes and enamels	30. Chlorine, fluorine, bromine, iodine and their compounds/derivatives	55. Wooden boat manufacturing
6. Power plants	31. Industrial gases (excluding nitrogen, oxygen and carbon dioxide)	56. Refrigerator, air conditioner/air cooler manufacturing
7. All mining projects (coal, limestone, hard rock, natural gas, mineral oil, etc.)	32. Waste incinerators	57. Tyres and tubes
8. Cement	33. Other chemicals	58. Board mills
9. Fuels (oil refineries)	34. Ordnance factory	59. Carpets
10. Artificial rubber	35. Nuclear power	60. Engineering works (capital above 10 hundred thousand taka)
11. Paper and pulp	36. Alcoholic beverages	61. Repairing of motor vehicles (capital above 10 hundred thousand taka)
12. Sugar	37. Non-metallic chemicals not listed elsewhere	62. Water treatment plants
13. Distillery	38. Non-metals not listed elsewhere	63. Laying down/replacement/expansion of sewerage pipelines
14. Fabric dyeing and chemical processing	39. Industrial estate	64. Laying down/replacement/expansion of water, power and gas distribution lines
15. Caustic soda, potash	40. Basic industrial chemicals	65. Exploration/extraction/distribution of mineral resources
16. Other alkalis	41. Non-iron basic metals	66. Construction/reconstruction/expansion of flood control embankment, polder, dike, etc.
17. Iron and steel manufacturing	42. Detergent	
18. Raw materials for medicine and basic drugs	43. Landfilling by household/industrial/commercial waste	
19. Electroplating	44. Sewage treatment plants	
20. Photo films, photo paper and photo chemicals	45. Lifesaving drugs	
21. Chemicals derived from petroleum or		

coal 22. Explosives 23. Acids and their salts (organic and inorganic) 24. Nitrogen compounds (cyanide, cyanamide, etc.) 25. Production of plastic raw materials (PVC, PP/iron, polystyrene, etc.)	46. Animal glue 47. Rodenticide 48. Refractories 49. Industrial gas (nitrogen, oxygen, carbon dioxide) 50. Batteries	67. Construction/reconstruction/expansion of roads (regional, national and international) 68. Construction/reconstruction/expansion of bridge (length 200 m or more) 69. Muriate of potash (manufacturing)
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Source: Schedule-I, Rule7(2) of Environment Conservation Rules 1997

In infrastructure projects, construction of flood control embankment, polder, road and bridge (length is 200m and more than). Although a railway project is not included in the table, MRT Line1 and Line5 projects fall into Red category because the project has viaduct which length is more than 200m.

Project proponents submit required documents to a Division Office of DoE. The red category projects are required the following documents.

- (1) Feasibility study of the project
- (2) IEE, TOR of EIA, flow of EIA and EIA report
- (3) EMP report
- (4) No objection certificate of local governments
- (5) Emergency plan against significant negative impacts, and mitigation plan
- (6) Outlines of involuntary resettlement and rehabilitation plan
- (7) Others

5.3.5 Stakeholder Meetings and Disclosure of Information

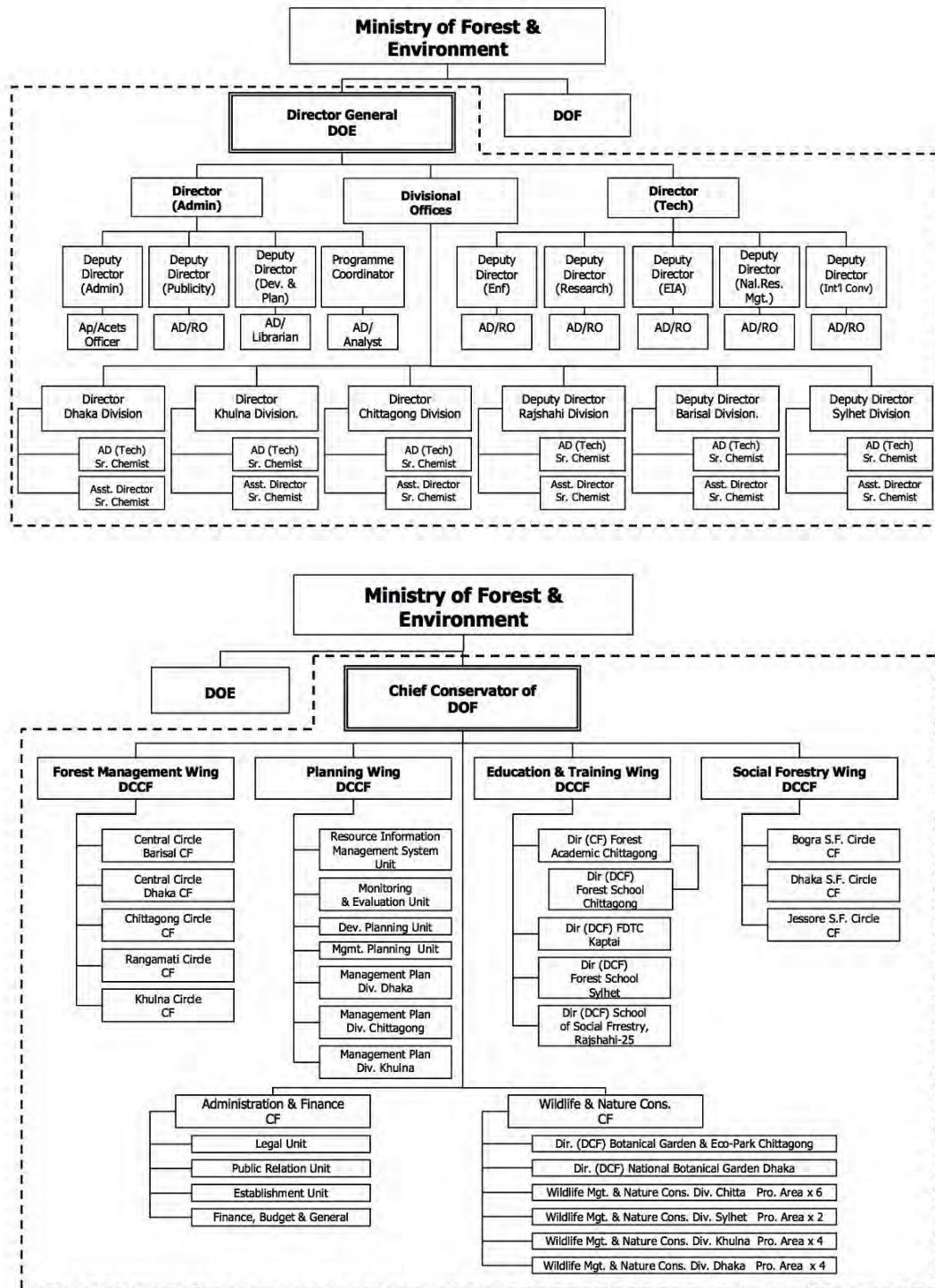
The matters of stakeholder meetings and disclosure of information have not been described in relevant legislations. These should be coordinated to JICA Guidelines.

5.3.6 Relevant Authorities of EIA

DoE completely involves the process to ECC issue. Project proponents requires to acquire No-objection certificate (NOC) of local governments and submit with an ECC application.

An ECC application is submitted to a Division Office of DoE who is responsible for the project location. After receiving the application, the Division Office appraises the application. As needed, central office of DoE can appraise.

Environmental administration in Bangladesh is handled by DoE and Department of Forest (DoF) under MoEF. DoE mainly handles the procedure of EIA: MoF handles forest reservation and biodiversity.



Source: Profile on Environmental and Social Considerations in Bangladesh (July 2012, JICA)

Figure 5.3.2 Organogram of DoE and DOF

5.3.7 Comparison of JICA Guidelines and EIA System of Bangladesh

Table 5.3.3 shows the comparison of policies of JICA Guidelines and EIA system of Bangladesh, gaps and policies of gap filling.

Table 5.3.3 Comparison of JICA Guidelines and EIA System of Bangladesh

	Policies of JICA Guidelines	EIA System of Bangladesh	Policies of Gap Filing
Basic Matters	<p>Environmental impacts that may be caused by projects must be assessed and examined in the earliest possible planning stage. Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan.</p> <p>(JICA Guidelines Appendix1 1.1)</p>	<p>Regarding selection of project site, comparison of alternatives is recommended.</p> <p>(EIA Guidelines for Industries, DoE, 1997)</p>	<p>Institution of Bangladesh does not obligate the comparison of alternatives. Based on the policy of JICA Guidelines, alternatives and mitigation measures that minimize negative impacts are examined and reflect to the project.</p>
Disclosure	<p>EIA reports must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to local residents, written materials must be provided in a language and form understandable to them;</p> <p>EIA reports are required to be made available to the local residents of the country in which the project is to be implemented. The EIA reports are required to be available at all times for perpetual by project stakeholders such as local residents and copying must be permitted.</p> <p>(JICA Guidelines Appendix1, 2)</p>	<p>There is no description on written language of EIA report.</p> <p>There is no description of disclosure of EIA report.</p>	<p>Explanation is done by language which is available to local persons (Bengal).</p> <p>That the EIA report is available at all times is proposed to the counter parts.</p>
Social Acceptability	<p>For projects with a potentially large environmental impact, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans may be examined. The outcome of such consultations must be incorporated into the contents of the project plans.</p> <p>(JICA Guidelines, Appendix1. 5.Social acceptability)</p> <p>In preparing EIA reports, consultations with stakeholders, such as local residents, must take place after sufficient information has been disclosed.</p> <p>Consultations with relevant stakeholders, such as local residents, should take place if necessary throughout the preparation and implementation stages of a project. Holding consultations is highly desirable, especially when the items to be considered in the EIA are being selected, and when the draft report is being prepared.</p> <p>(JICA Guidelines, Appendix 2)</p> <p>Multiple alternatives must be examined in order to avoid or minimize adverse impacts and to choose better project options in terms of environmental and social considerations.</p>	<p>There is no description about public participation on the EIA system in Bangladesh.</p>	<p>On the explanation before the EIA survey, draft scoping and DFR stage, stakeholder meetings are held. Result of the meetings are incorporated in EIA report.</p>

	Policies of JICA Guidelines	EIA System of Bangladesh	Policies of Gap Filing
Items of Impact Assessment	<p>The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety.</p> <p>(JICA Guidelines, Appendix 1, Scope of Impacts to Be Assessed)</p>	<p>There is no tangible description of survey items in the EIA report.</p> <p>DoE presents TOR to each project. Based on the TOR, EIA study is conducted.</p>	<p>Based on the survey items on JICA Guidelines, scoping is conducted and survey items are decided.</p>
	<p>In addition to the direct and immediate impacts of projects, their derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined and assessed to a reasonable extent. It is also desirable that the impacts that can occur at any time throughout the project cycle should be considered throughout the life cycle of the project.</p>	<p>In the EIA system of Bangladesh, there is no description about derivative, secondary, and cumulative impacts.</p>	<p>As needed, derivative, secondary, and cumulative impacts with other projects are examined.</p>
Monitoring / Grievance Redress Mechanism	<p>Project proponents etc. should make efforts to make the results of the monitoring process available to local project stakeholders.</p> <p>(JICA Guidelines, Appendix 1, Monitoring 3)</p> <p>When third parties point out, in concrete terms, that environmental and social considerations are not being fully undertaken, forums for discussion and examination of countermeasures are established based on sufficient information disclosure, including stakeholders' participation in relevant projects. Project proponents etc. should make efforts to reach an agreement on procedures to be adopted with a view to resolving problems.</p> <p>(JICA Guidelines, Appendix 1, Monitoring 4)</p>	<p>On ECC acquisition, EMP report is required. However, there are no obligation of report and no penalty for violation.</p>	<p>There is no description about monitoring. On the EIA study, environmental management plan is formulated, and implementation of monitoring is proposed and agreed with the counterpart.</p>
Ecosystem and Biota	<p>Projects must not involve significant conversion or significant degradation of critical natural habitats and critical forests.</p>	<p>In Bangladesh, significant habitats are protected as reserves and activities in the reserves are restricted.</p>	<p>There may be no wild habitat in / around the project site.</p>
Indigenous Peoples	<p>Any adverse impacts that a project may have on indigenous peoples are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures must be taken to minimize impacts and to compensate indigenous peoples for their losses.</p>	<p>There is no ordinance on indigenous people.</p>	<p>In case that affected indigenous people are confirmed in this survey, effective measurements for protection of the indigenous people are examined in RAP study.</p>

Source: JICA Study team

5.4 Comparisons on Alternatives

5.4.1 Comparisons of public transportation projects on RSTP

The RSTP proposed traffic development policy in the view of future of Dhaka. One of the traffic policy is strength of public transportation including 5 MRTs and 2 BRTs. And based on results of demand forecast and conformity with urban development, MRT Line1 and Line5 were recommended as prioritised projects.

For these public transportation projects, in the view of the environmental and social considerations, comparisons of IEE level were examined based on a strategic environment assessment. (see Table 5.4.1)

MRT Line1 may cause negative impacts including noise and vibration on viaduct section, however has less impacts on the number of PAHs, preservation areas and biodiversity. Therefore MRT Line1 was selected as a priority project.

Table 5.4.1 Comparisons of public transportation projects on RSTP

Impact Items	MRT Line1	MRT Line 2	MRT Line 4	MRT Line 5	BRT Line 7		
Social Environment							
Land acquisition and Involuntary Resettlement	[All Elevated] In order to pass over Kuril Flyover and Moghbazar - Mouchak Link Flyover with elevated structure, a massive resettlement of affected persons due to additional ROW acquisition will be unavoidable. [Partial Underground] The tracks go partially underground in Kuril area and from Maribag to Kamulapur BR station and further Buriganga River.	[All Elevated] The route goes the narrow existing roads from Gabtali to Dhaka University. A large number of structures might be affected. The existing highway in Western Fringe area can accommodate the viaduct.	[All Elevated] The elevated structure will be built within the BR ROW. There are hundreds of informal settlers and illegal vendors in BR ROW. If the BR line will be double tracked, there might be no more informal settlers.	[All Elevated] The line 5 covers the center portion of Dhaka, congested area. Thus a large number of affected structures are expected. Eastern Fringe Area is not heavily populated. [Partial Underground] The tracks go partially underground at the section from Kachukhet to Notun Bazar (under cantonment), and from Dhanmondi to Bashundahara City.	[At Grade] Since there is no existing roads. The 60m width of ROW acquisition will be needed.		
Number of Affected Households	Elevated 500	Underground 100	1,100	500	Elevated 620	Underground 120	1,000
Number of Affected Persons ¹	Elevated 2,500	Underground 500	5,500	2,500	Elevated 3,100	Underground 600	5,000
Natural Environment							
Protected Area	The line will not go through any protected area.	The line will not go through any protected area.	The line will not go through any protected area.	The line will not go through any protected area.	The line will not go through any protected area.		
Biodiversity (wetland)	Because the line will go through the existing road and BR ROW in the built-up area, wetlands will not be directly affected. There are some small swamps along the track around Tongi to Gazipur and Purbachar areas.	The line will go through the existing road in the built-up area from Gabtali to Kamalapur. From Gabtali to Hemayetpur the highway is surrounded by wetland. The wetland might be affected during construction.	The line will go through the existing BR ROW in the built-up area. There will be no impacts on wetlands.	Because the line will go through the existing road in the built-up area, there will be no direct impacts on wetlands. The route will extend to the Eastern Fringe area, therefore, wetland and agricultural land will be reclaimed.	Since the route will go through the wetland and agricultural land in Eastern Fringe area, a significant impact on biodiversity will be expected.		
Flood Risk	The line will go through the existing road. The risk of flooding is low.	The line will pass through the flood flow zone in the western side of Dhaka city. There will be a high risk of inundation.	The line will go through the existing BR ROW. The risk of flooding is very low.	The route will extend to the Eastern Fringe water retention area. There will be a high risk of inundation.	Since the route will go through the flood flow zone and water retention area in Eastern Fringe, there will be a high risk of flooding.		

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Impact Items	MRT Line1	MRT Line 2	MRT Line 4	MRT Line 5	BRT Line 7
Pollution Control					
Noise and vibration	Because the line will go through the existing road and BR ROW in the built-up area, mitigation measures to abate the noise and vibration levels should be considered especially for sensitive receptors at the elevated section.	The line will go through the existing road in the built-up area of Dhaka CBD and Savar, mitigation measures to abate the noise and vibration levels should be considered especially for sensitive receptors.	Because the line will go through the BR ROW in the built-up area, the mitigation measures to abate the noise and vibration levels should be considered especially for sensitive receptors.	The line will go through the existing road in the built-up area, mitigation measures to abate the noise and vibration levels should be considered especially for sensitive receptors at the elevated section. There might be lesser impacts in the Eastern Fringe area.	There are a few communities in the Eastern Fringe area. Noise and vibration will not cause a significant impact.
Air Pollution	Because the line will go through the built-up area, dust generated during construction will cause a nuisance along the route, especially for residential areas.	The line will go through the built-up area of Dhaka CBD and Savar, dust generated during construction will cause a nuisance along the route, especially for residential areas.	Because the line will go through the BR ROW in the built-up area, dust generated during construction will cause a nuisance along the route, especially for residential areas.	The line will go through the built-up area dust generated during construction will cause a nuisance along the route, especially for residential areas. There might be fewer impacts in the Eastern Fringe area.	There are a few communities in the Eastern Fringe area generated during construction will not cause a significant impact.
Water pollution	Since the route will not pass through the wetland, turbid water will not directly deteriorate water quality of the wetland.	Water quality of wetland will be likely to be deteriorated by suspended solids discharged from construction sites.	Since the route will not pass through the wetland, turbid water will not directly deteriorate water quality of the wetland.	Water quality of wetland in the Eastern Fringe area will be likely to be deteriorated by suspended solids discharged from construction sites.	Water quality of wetland in the Eastern Fringe area will be likely to be deteriorated by suspended solids discharged from construction sites.
Overall Assessment	<p>O: The lowest number of affected households both all elevated case and partial underground case</p> <p>O: Less impact on protected area and biodiversity</p> <p>O: Low risk of flooding</p> <p>X: Impact due to noise and vibration at the elevated section.</p> <p>The smallest number of affected households and fewer impacts on natural environment. Recommended as a priority project from the viewpoints of environmental and social considerations.</p>	<p>X: The largest number of affected households</p> <p>X: Impact on biodiversity in the wetland</p> <p>X: Risk of flooding</p> <p>X: Impact due to noise and vibration</p> <p>The largest number of affected households and moderate impacts on natural environment. The BRT should be considered for the short to midterm term plan in CBD.</p>	<p>△: A large number of informal settlers occupy the BR ROW.</p> <p>O: Less impact on protected area and biodiversity</p> <p>O: Low risk of flooding</p> <p>X: Impact due to noise and vibration</p> <p>A large number of informal settlers occupy the BR ROW. If the BR line will be double tracked, then the plan has to be reconsidered. Fewer impacts on natural environment.</p>	<p>O: The second lowest number of affected households in the partial underground case.</p> <p>X: Impact on biodiversity in the wetland</p> <p>X: Risk of flooding</p> <p>X: Impact due to noise and vibration</p> <p>The second lowest number of affected households. The extension to the Eastern Fringe will cause a significant impact on natural environment and increase the risk of flooding.</p>	<p>X: The second largest number of affected households</p> <p>X: Impact on biodiversity in the wetland</p> <p>X: Risk of flooding</p> <p>O: Impact due to noise and vibration</p> <p>The large number of affected households. A significant impact on natural environment. The risk of flooding is very high. The eastern fringe road should be carefully planned to minimize the environmental impacts.</p>

Source: The Project on the Revision and Updating of the Strategic Transport Plan for Dhaka, 2nd Draft Final Report, February 2016, JICA

5.4.2 Comparisons of Alternatives on MRT Line1

Comparisons on alternatives on MRT Line 1 are described as the followings.

1) No Action Option

No action option is a case that MRT Line1 is not implemented. In DMA, chronic traffic congestion has become significant problem. Expected population increase and economic growth will cause expansion of traffic congestion, deterioration of environment and economic loss.

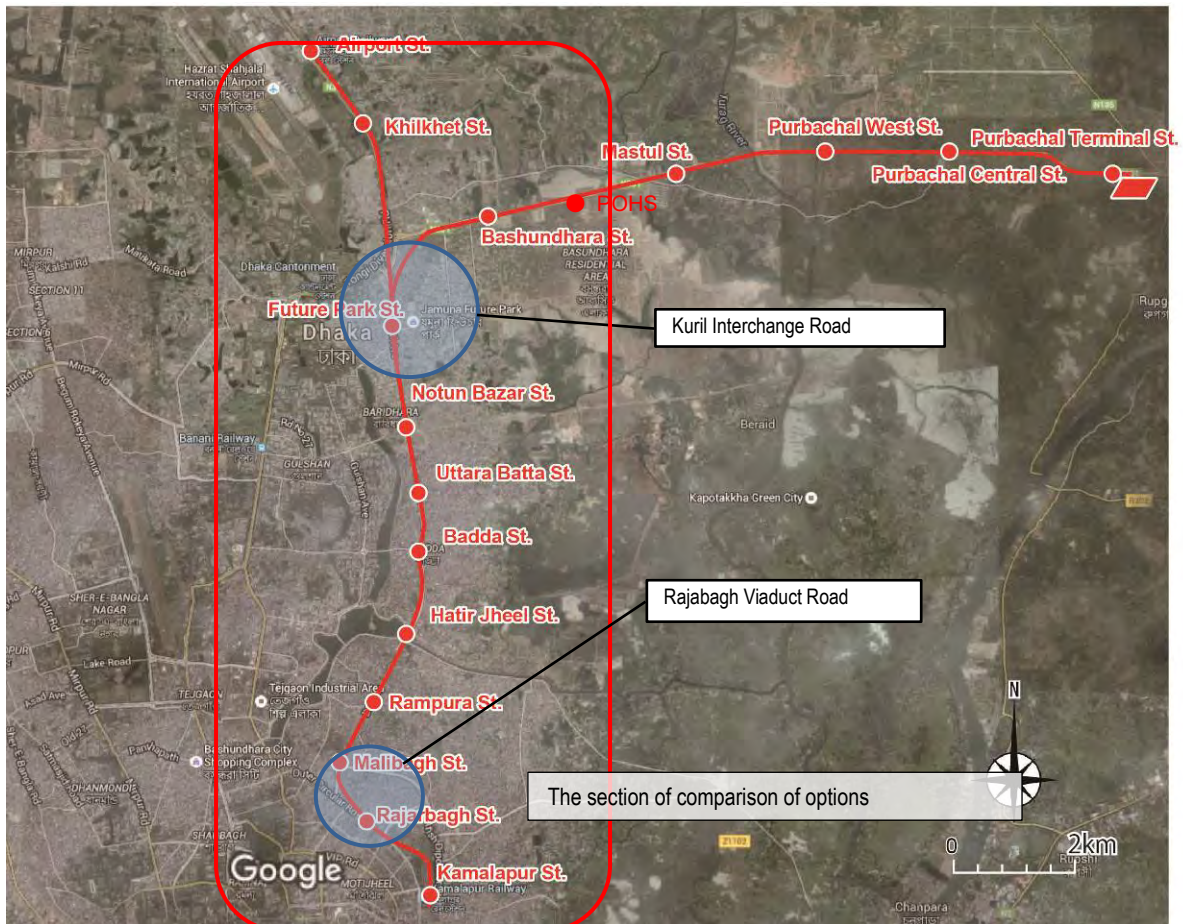
In case that MRT Line1 and Line5 are not implemented, no land acquisition and involuntary resettlement are expected. However sustainable growth of local industry will be hampered. The environment of the area will deteriorate further by the traffic congestion and air pollution.

2) Comparison of Structure Types

As structures of urban railway, there are (1)at grade, (2)viaduct, (3)underground (tunnel). Because the project runs in a density area, at grade structure is excluded.

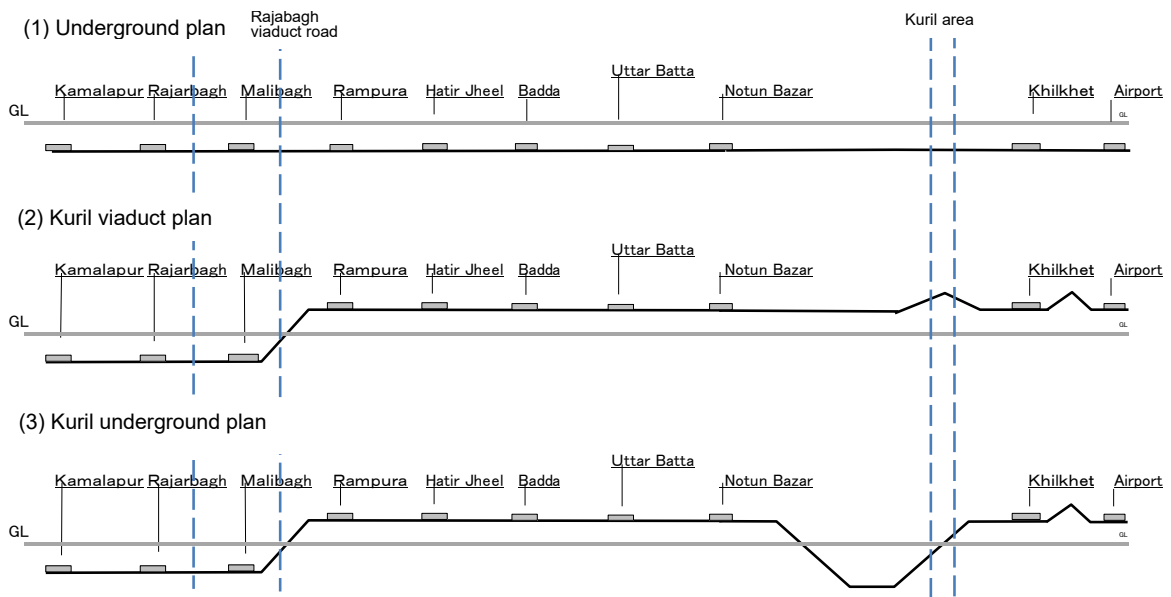
Since Purbachal Line is constructed on the existing wide road, there are no alternatives except viaduct structure. On the other hand, structure of Airport Line should be discussed considering the conditions along the alignment. The section between Kamalapur and Malibagh which is a control point because of a construction of viaduct road needs underground structure. On Kuril area, the existing viaduct road should be considered. Based on these points, the study team proposed and compared following three structures of the Airport line.

- (1) Underground plan
- (2) Kuril viaduct plan
- (3) Kuril underground plan



Source: JICA Study Team

Figure 5.4.1 Scope of Kuril viaduct plan and Kuril underground plan



Source: JICA Study Team

Figure 5.4.2 Structure of the Options

The project is a railway project which goes through the urban areas in Dhaka city. Therefore main evaluation items are; deterioration of living environment, pollution, mitigation of land acquisition and involuntary resettlement, construction costs, and construction methods.

The results of the comparison are shown on Table 5.4.2.

- (1). Underground Plan has a priority on difficulty and safety of construction, traffic regulation, the least resettlement, and the least negative impacts on the environment including noise and landscape. On the other hand, construction cost is most expensive, excavation soil is most, and risk of inundation is highest.
- (2). Kuril Viaduct Plan has a priority on construction cost. Because the underground section is shortest, excavation soil and the risk of inundation least. On the other hand, the plan needs transit structure on the center of the city, and causes more negative impacts on land acquisition and resettlement, and noise and landscape along the viaduct section.
- (3). Kuril Underground Plan needs three transit structures in the center of the city. Therefore negative impacts on land acquisition and resettlement and traffic on construction are maximum. Other negative impacts are evaluated as middle of (1) and (2).

As a result of comparing three alternatives, the study team recommended (1) Underground Plan which has a priority on land acquisition, environmental impacts and difficulty of construction.

Table 5.4.2 Comparison of Structures of MRT Line1

Options Items	1) Underground Plan	2) Kuril Viaduct Plan	3) Kuril Underground Plan
Construction/Project			
Length	Underground: 17.2km Viaduct: 12.9km	Underground: 3.5km Viaduct: 26.6km	Underground: 7.8km Viaduct: 22.3km
Stations	16 (Viaduct 5, Underground 11)	16 (Viaduct 13, Underground 3)	16 (Viaduct 12, Underground 4)
Social Environment			
Land Acquisition and Involuntary Resettlement	Land Acquisition and Involuntary Resettlement	Land Acquisition and Involuntary Resettlement	Land Acquisition and Involuntary Resettlement
Number of PAHs	⊙: 115	○: 129	○: 133
Dividing of local community	⊙: Underground structure does not divide local communities.	⊙: Underground and viaduct structures do not divide local communities.	⊙: Underground and viaduct structures do not divide local communities.
Natural Environment			
Preservation Area	○: The alignment does not run in preservation areas.	○: The alignment does not run in preservation areas.	○: The alignment does not run in preservation areas.
Biodiversity (Wetland)	○: The alignment goes through the center of Dhaka city. There are no wetland and biodiversity area.	○: The alignment goes through the center of Dhaka city. There are no wetland and biodiversity area.	○: The alignment goes through the center of Dhaka city. There are no wetland and biodiversity area.
Damage to the project by inundation	○: Because there is a possibility of inundation from an entrance and exit, appropriate measures are required.	⊙: Because there is a possibility of inundation from an entrance and exit, appropriate measures are required. There has no expectation of inundation on viaduct stations.	⊙: Because there is a possibility of inundation from an entrance and exit, appropriate measures are required. There has no expectation of inundation on viaduct stations.
Landscape	⊙: Negative impacts on landscape are least.	△: High rise viaduct exceeding the existing viaduct has the most negative impacts among three	○: Although viaduct structures are installed, the viaduct is lower than Kuril viaduct. The option has less negative impacts than Kuril viaduct

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Options Items	1) Underground Plan	2) Kuril Viaduct Plan	3) Kuril Underground Plan
		options.	plan.
Ecologically Critical Area (ECA)	○: There are no ECA along the Airport Line.	○: There are no ECA along the Airport Line.	○: There are no ECA along the Airport Line.
Pollution Control			
Noise and Vibration	◎: Noise around construction sites of stations is expected. However, it is expected less than the other options. Negative impacts by the railway operation are least.	○: Noise by construction of stations and viaducts is expected. Affected area is wider than the underground plan. Railway operation causes noise along viaduct section.	○: Noise by construction of stations and viaducts is expected. However, affected area is narrower than Kuril viaduct plan. Railway operation causes noise along viaduct section.
Air Pollution	◎: Air pollution around construction sites of stations is expected. However, it is expected less than the other options.	○: Because construction areas are wide, negative impacts of air pollution is expected to be wider than the underground plan.	○: Although the plan is expected to affect wider than the underground plan, negative impacts are limited than Kuril viaduct plan.
Groundwater	△: Because underground section is longest, it is expected that negative impacts on groundwater is most.	◎: Because underground section is shortest, it is expected that negative impacts on groundwater is least.	○: Although the plan has a longer underground section than Kuril viaduct plan, it is expected that negative impacts is less than the underground section.
Waste	△: Volume of excavation soil is most.	○: Volume of excavation soil is least.	○: Volume of excavation soil is less than Kuril viaduct plan.
Engineering			
Construction Cost	△: 380 billion JPY	◎: 290 billion JPY	○: 300 billion JPY
Feature of Structure	Whole section of Airport section is underground. Purbachal section is viaduct. Notun Bazar station is a junction.	Three stations on the south side (Kamalapur, Rajarbagh, Malibagh) are set on underground considering the existing flyover and commercial activities along the alignment. A station at the Klyle flyover requires high rise structure over 30m above the ground.	Three stations on the south side (Kamalapur, Rajarbagh, Malibagh) and Kuril area are set on underground. Moreover, the section of Kuril area is set on underground to avoid the construction of huge viaduct.
Difficulty of Construction	○: Construction work is a kind of common construction technique. However, the construction needs expert workers. Because there is no experience in Bangladesh, technical training for workers is required. Regarding procurement of materials, launching of plant is required. High technique of tunnel excavation is required to avoid the structures around Kuril area.	△: Transition structure at narrow space is required. To build viaduct, considerations for road traffic and safety for public is required. Regarding procurement of materials, launching of plant is required. High technique of tunnel excavation is required to avoid the structures around Kuril area.	△: Transition structure at narrow space is required. To build viaduct, considerations for road traffic and safety for public is required. Regarding procurement of materials, launching of plant is required. High technique of tunnel excavation is required to avoid the structures around Kuril area.
Traffic	◎: Although lane control is needed, the option has the least negative impacts on the traffic around the project site.	△: Lane control during the construction of viaduct will cause traffic congestion.	○: Lane control during the construction of viaduct will cause traffic congestion. However, impacts will be less than Kuril viaduct plan.

Options Items	1) Underground Plan	2) Kuril Viaduct Plan	3) Kuril Underground Plan
Liquefaction by earthquake	⊙: Less damage by liquefaction is expected.	○: Liquefaction may damage footings of viaduct	○: Liquefaction may damage footings of viaduct
Safety	⊙: Because there is no railroad crossing, traffic accident is not expected.	⊙: Because there is no railroad crossing, traffic accident is not expected.	⊙: Because there is no railroad crossing, traffic accident is not expected.
Total Evaluation	⊙: Although construction cost is most expensive, magnitude of resettlement is least and change of environment is small. Therefore it is most suitable for the project. Risk of inundation is avoidable by appropriate measures.	△: Although construction cost is most minimum, pretty resettlement and change of environment is expected. Therefore the option is inferior to the underground plan.	○: The plan has shorter viaduct section than Kuril underground plan, and is superior to the underground plan in the view of construction cost. However, the plan is inferior to the underground plan in the social views. Risk of inundation is avoidable by appropriate measures.

Note ⊙: most suitable ○: suitable △: required more considerations

Length of line, number of stations and construction costs is as of alternative comparison, and different from as of now.

Source: JICA Study Team

3) Comparisons of Alternative Depot Sites

Policy of selecting location of depot site are followings:

- (a) Near stations, less operation loss of crew members and rolling stocks
- (b) Less idleness of loading and unloading
- (c) Shorter approach to depot site
- (d) To secure vast land
- (e) Less negative impacts on natural environment, land acquisition and resettlement

The project is a railway connecting urban areas in Dhaka. In the view of cost of land acquisition and avoidance of large scale resettlement, Purbachal area where is undeveloped is most suitable (e). On the other hand, even in Purbachal area, development is progressing. Based on suitable area in Purbachal recommended by the counterpart, the study team proposed and compared four options. (Figure 5.4.3) Those options are located close areas, and the natural environment of four options is almost same. It is estimated that construction plans of the options is almost similar too. On the other hand,

Option 1 does not need switchback, and has a priority on smooth access to depot site. However, land acquisition and resettlement are more than other options. And it is expected that public facilities such as mosque, school and cemetery are affected. Generally the mosque is one of facilities that are difficult to move. And it is expected that land acquisition is hampered.

Option 2 does not need switchback as same as Option 1, and has a priority on smooth access to depot site. However, as same as Option 1, land acquisition and resettlement are more than other options. And it is expected that public facilities. Since an approach is longer than Option1, negative impacts on the environment is more than Option 1.

Option 3 needs switchback on the access to the depot site, and effectiveness of the operation is inferior to other options.

On the time of this comparison, it has been confirmed that land of Option 3 is owned by 4 private developers. (referred to 6.15.4) The counterpart was consulting with them about land acquisition, however, land acquisition has not agreed. Therefore, new option, Option

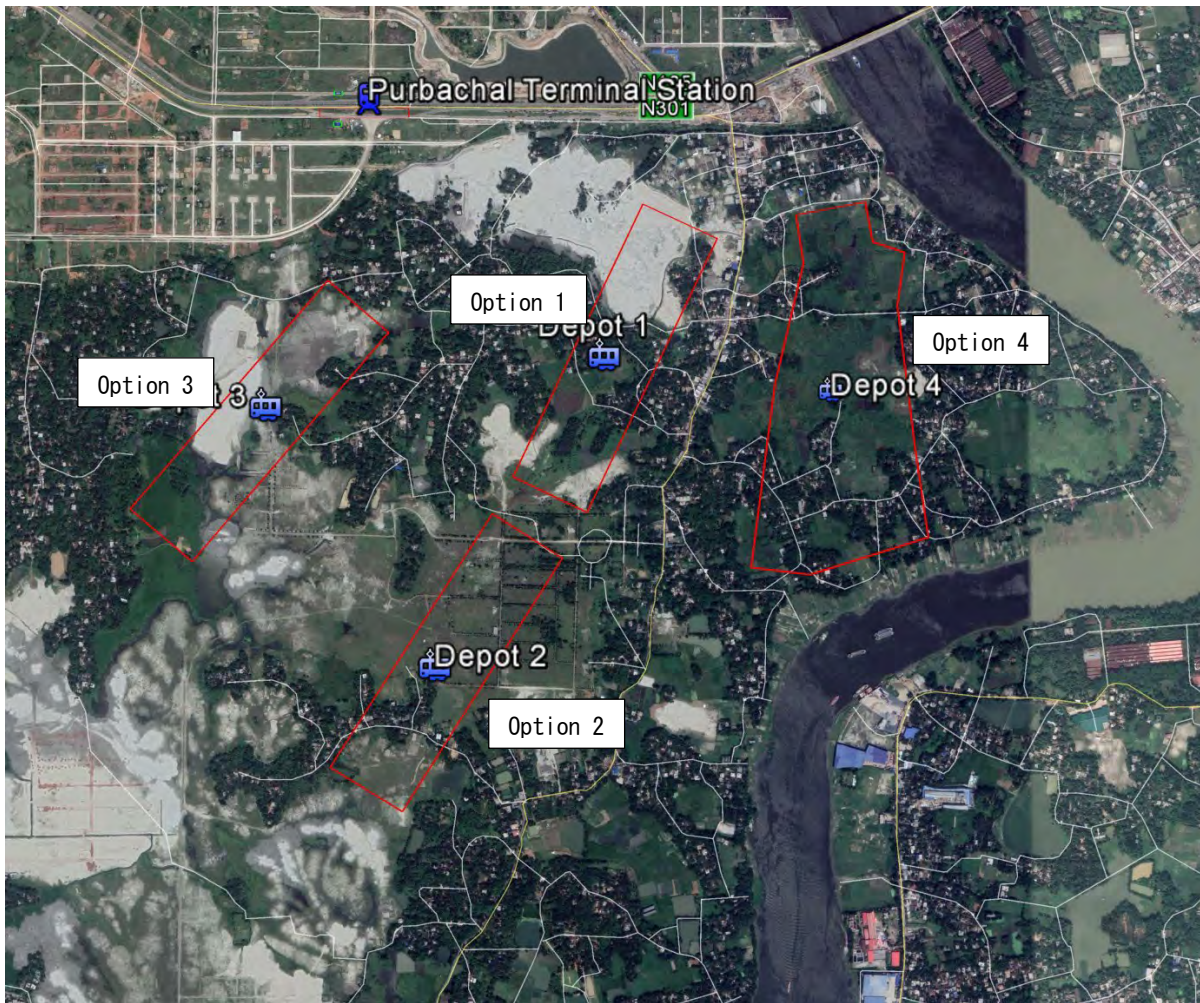
4 came to be studied. Option 4 is located on the east of other 3 options. Option 4 has an operational advantage as same as Option 1, 2. Finally the study team conducted environmental baseline survey and RAP survey and examined feasibility on the environmental and social considerations.

Considering merits on the operation and the negative impacts on land acquisition and resettlement, the study team was recommending Option 4 as the most feasible option.

Table 5.4.3 Comparisons of Depot Site Options

	Option 1	Option 2	Option 3	Option 4
Construction / Project				
Costs	◎ : Because the approach is shorter, costs is cheaper.	○: Because the approach is longer, costs is more expensive than Option 1.	○: Because the approach is longer, costs is more expensive than Option 1.	◎ : Because the approach is shorter, costs is cheaper.
Operation	◎ : Because of no switchback, operation is smooth.	◎: Same as Option 2.	○: Because switchback is required, operation is more difficult than other options.	◎ : Because of no switchback, operation is smooth.
Social Environment				
Land Acquisition and Resettlement	△: It is expected large scale of land acquisition and resettlement is required. Public facilities such as mosque, school and cemetery are affected.	△: Same as Option 1	○: It is expected that resettlement is less than other options.	△: It is expected large scale of land acquisition and resettlement is required.
Pollution Control				
Noise and Vibration	◎: Because approach is shorter, negative impacts of noise and vibration is less than other options.	○: Because approach is longer, negative impacts of noise and vibration is more than other option 1.	○Because approach is longer, negative impacts of noise and vibration is more than other option 1.	◎: Because approach is shorter, negative impacts of noise and vibration is less than other options.
Total Evaluation	△: Because it is expected that land acquisition and resettlement is difficult in spite of priority of other items, it is difficult to select.	△: Because it is expected that land acquisition and resettlement is difficult in spite of priority of other items, it is difficult to select.	○: Because it is expected that land acquisition and resettlement are easier.	○: Though large scale of resettlement is anticipated, however land acquisition might be easier than Option 3.

Source: JICA Study Team



Source: JICA study team prepared based on Google Earth

Figure 5.4.3 Options of Depot Site

5.5 Scoping of EIA

5.5.1 Scoping Matrix

Based on the comparisons of the alternatives, scoping of Line1 projects are carried out.

The study team confirmed current situation of the environment and social matters in/around the site of MRT Line1 by field reconnaissance, and developed a draft scoping of the MRT Line1 including pollution control, natural environment and social environment. A draft scoping is shown on Table 5.5.1.

Table 5.5.1 Draft Scoping (MRT Line1)

No	Items	Evaluation		Reason of evaluation
		Before/ under construction	Operation	
Pollution Control				
1	Air Pollution	B-	B+	Construction Phase: ·Construction works and operation of construction equipment will generate dust and exhaust gas. Operation Phase: ·Air pollution will be mitigated by reducing traffic congestion.
2	Water pollution	B-	B-	Construction Phase: ·Turbid water derived from construction sites may deteriorate water quality of rivers. Operation Phase: ·Waste water from stations and maintenance facility may deteriorate water quality of rivers.
3	Soil pollution	B-	B-	Construction Phase: ·Bad maintenance construction machinery and vehicles may cause soil contamination by leak of oil. Operation Phase: ·Maintenance facility of depot may cause soil contamination by leak of oil.
4	Waste	B-	B-	Construction Phase: ·Construction works will cause waste including excavated soil. Operation Phase: ·Illegal dumping from stations and depot may cause negative impacts on the environment.
5	Noise and Vibration	B-	B-	Construction Phase: ·Construction works will cause noise and vibration. Operation Phase: ·Driving of trains may cause noise around viaduct sections.
6	Ground subsidence	C	C	Construction /Operation Phase: ·Appropriate methods should be selected to avoid ground subsidence in case of soft soil.
7	Offensive odors	D	D	Construction / Operation Phase: ·In terms of the project character (railway), offensive odors are unlikely to occur.
8	Bottom sediment	B-	D	Construction Phase: ·Turbid water from the construction activity may deteriorate bottom sediment of rivers.
Natural Environment				
9	Protected areas	D	D	Construction / Operation Phase: · The Project site and the vicinity include no protected areas.
10	Ecosystem	B-	B-	Construction Phase: ·Vegetation and wetland may be lost by construction works. ·Agricultural ecosystem will be lost or disturbed by construction activity. Operation Phase: ·Activity of depot may have negative impacts on the ecosystem.
11	Hydrology	C	C	Construction / Operation Phase: ·Piers in river may cause negative impacts on a flow of the river.

No	Items	Evaluation		Reason of evaluation
		Before/ under construction	Operation	
12	Groundwater	B-	D	Construction / Operation Phase: ·Excavation and installation of underground structure may cause negative impacts on groundwater level and quality.
13	Geographical features	B-	D	Construction Phase: ·Excavation and installation of underground structure may cause collapse of ground.
Social Environment				
14	Resettlement/ Land Acquisition	A-	D	Pre-Construction Phase: ·Large scale land acquisition and resettlement is anticipated (115 households including 12 residents). Operation Phase: ·Additional physical resettlement and land acquisition will not be required for this Project.
15	Poor people	A-	A-	Construction Phase: ·Poor who are living in the project sites may be affected. Operation Phase: · In case of no mitigation measures, poverty may Poverty of poor who are resettled involuntarily may become severe.
16	Ethnic minorities and indigenous peoples	C	C	Construction / Operation Phase: ·Impacts is unclear as of now.
17	Local economies, such as employment, livelihood, etc.	B-/B+	C	Construction Phase: ·Involuntary resettlement may cause negative impacts on Rikisya or taxi. On the other hand, construction work will increase employment. Operation Phase: ·Rikisya and taxi will be used as para transit from stations.
18	Land use and utilization of local resources	B-/B+	B+	Construction Phase: ·Development of the depot will change current land use. Operation Phase: ·Effective use of land will accelerate undeveloped suburb.
19	Water usage	C	C	Construction / Operation Phase: ·Impacts is unclear as of now.
20	Existing social infrastructures and services	C	C	Construction / Operation Phase: ·Impacts is unclear as of now.
21	Social structure such as social capital and local decision-making institutions	C	C	Construction / Operation Phase: ·Impacts is unclear as of now.
22	Misdistribution of benefits and damages	B-	B-	Construction Phase: ·There may be misdistribution between affected households and no-affected households. Operation Phase: ·Since the vicinity of stations has convenience, misdistribution of benefits and damages is expected.
23	Local conflicts of interest	B-	B-	Construction Phase: ·Implementation of land acquisition and payment of compensation may cause local conflicts of interest Operation Phase: ·Since the vicinity of stations has convenience, local conflicts of interest.

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No	Items	Evaluation		Reason of evaluation
		Before/ under construction	Operation	
24	Cultural heritage	C	C	Construction / Operation Phase: ·Impacts is unclear as of now.
25	Landscape	B-	B-	Construction Phase: ·Small scale and short duration impacts are expected. Operation Phase: ·In case that viaduct exceeds other structures, the viaduct may cause negative impacts on landscape
26	Gender	C	C	Construction / Operation Phase: ·Impacts is unclear as of now.
27	Children's rights	C	C	Construction / Operation Phase: ·Impacts is unclear as of now.
28	Infectious diseases such as HIV/AIDS	B-	D	Construction Phase: ·Infection risks of HIV/AIDS may be increased among construction workers. Operation Phase: ·Since the Project aims improvement of urban traffic, the project will not directly concern spread of infection risks of HIV/AIDS.
29	Working conditions (including occupational safety)	B-	B-	Construction Phase: ·Inappropriate safety measures of contractor will deteriorate occupational safety. Operation Phase: ·Inappropriate safety measures of railway operator will deteriorate occupational safety.
Others				
30	Trans-boundary impacts or climate change	B-	B+/-	Construction Phase: ·Operation of construction machinery and vehicles will occur greenhouse gas (CO2). Operation Phase: ·Modal shift to from vehicles to railway will reduce greenhouse gas.
31	Accidents	B-	B-	Construction Phase: ·There is a risk of accident on construction activity. Operation Phase: ·Collision of vehicle and viaduct, and accident in depot are expected.
32	Risk of flood	C	C	Construction / Operation Phase: ·Although the project site may not be flood prone areas, flood risk should be confirmed.

A+/-: Significant positive/negative impact is expected.

B+/-: Positive/negative impact is expected to some extent.

C: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)

D: No impact is expected

* Impact Items refer to "JICA Guidelines for Environmental and Social Considerations April 2010"

Source: JICA Study Team

5.5.2 TOR of EIA

Based on the draft scoping, the study team prepared TORs of EIA of MRT Line1 which are shown on Table 5.5.2.

Table 5.5.2 TOR of EIA of MRT Line1

Category	Items	Before/during Construction	Operation	Survey Items and Methods of Survey and Forecast	Methods of Evaluation
Pollution Control	Air Pollution	B-	B+	Current condition of air quality by field survey Outlines of construction works Air quality estimation on construction	Comparison with air quality standards of Bangladesh Considerations on vulnerable facilities including school and hospital (PM2.5 and PM10)
	Water pollution	B-	B-	Current condition of water quality of rivers and lakes in/around the project site by review of existing materials and field survey Review of plan of the project and past examples of other projects	Comparison with water quality standards of Bangladesh, and evaluation of turbid water derived from the implementation of the project
	Soil pollution	B-	B-	Outlines of construction works Review of past examples of other projects Review of depot plan of the project in the view of possibility of oil leak	Evaluation of the possibility of oil leak, and study of mitigation plan
	Waste	B-	B-	Review of estimated volume of excavation soil and construction waste Review of operation plan of the project and other project Review of disposal measures	Evaluation of possibility of pollution by excavation soil and construction waste Study of mitigation plan in case that high pollution is expected comparing other projects
	Noise and Vibration	B-	B-	Current condition of noise by field survey Review of construction works Estimation of construction noise by noise transmission models Estimation of railway noise on viaduct sections by noise estimation model of railway	Comparison with noise standards of Bangladesh or other countries Study of mitigation plan if needed
	Ground subsidence	C	C	Review of construction plan and geological survey	Confirmation of taking appropriate measures to avoid ground subsidence on soft ground
	Bottom sediment	B-	D	Review of construction works Estimation of an influx of turbid water and oil leak	Study of mitigation plan in case that an influx of turbid water and oil leak
Natural Environment	Ecosystem	B-	B-	Current condition of fauna and flora in/around the depot site by existing materials and field survey Estimation of area where trees and vegetation are cleared based on construction plan	Estimation of environmental impacts Study of mitigation plan if needed
	Hydrology	C	C	Review of the project plan Confirmation of structures installed in crossing rivers	Confirmation of appropriate measures for river flow in case that structure is installed in rivers
	Groundwater	B-	D	Current condition of groundwater level and quality around the project site by existing geological survey Review of the project plan and construction plan Estimation of impacts on groundwater level	Comparison with water quality standard of Bangladesh Study of mitigation plan if needed
	Geographical features	B-	D	Review of existing geological survey Review of construction plan of the project Estimation of negative impacts on geographical features	Study of mitigation plan if structures around the project site is expected to affect

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Category	Items	Before/during Construction	Operation	Survey Items and Methods of Survey and Forecast	Methods of Evaluation
Social Environment	Resettlement/ Land Acquisition	A-	D	Current condition of PAPs by census and socio-economic survey Collecting opinions of the PAPs by consultation meetings, focus group discussion and interviews Estimation of negative impacts on the PAPs Discussion with counterparts and review of other countries examples on property rights	Development of policies of land acquisition and resettlement Preparation of RAP
	Poor people	A-	A-	Estimation of negative impacts on poor people included in the PAPs	Study of mitigation measures for the poor people included in the PAPs
	Ethnic minorities and indigenous peoples	C	C	Existence of ethnic minorities and indigenous peoples by RAP survey	Study of mitigation measures if needed
	Local economies, such as employment, livelihood, etc.	B-/B+	C	Current condition of livelihoods of the PAPs Estimation of negative impacts to employment and livelihoods of the PAPs Collecting opinions of rikisha and taxi drivers by stakeholder meetings	Preparation of entitlement, compensation policy
	Land use and utilization of local resources	B-/B+	B+	Review of existing materials including land use plan Collecting information by field reconnaissance	Estimation of impacts based on review of the project plan and opinions on the public consultation meetings
	Water usage	C	C	Review of existing materials on ground water usage around the project site Field survey on ground water usage around the project site Review of construction plan and project plan	Study of mitigation measures if significant negative impacts are expected
	Existing social infrastructures and services	C	C	Review of existing materials on existing social infrastructures and services Review of the project plan	Evaluation of impacts on existing social infrastructures and services based on current condition of existing social infrastructures and services
	Social structure such as social capital and local decision-making institutions	C	C	Review of existing materials and hearing on social structure such as social capital and local decision-making institutions Review of the project plan	Comparison with current condition of social structure and the project plan
	Misdistribution of benefits and damages	B-	B-	Review of the project plan	Evaluation on misdistribution of benefits and damages by project implementation
	Local conflicts of interest	B-	B-	Economic status of PAPs by the RAP study Confirmation of local conflicts of interest by hearing	Consideration avoiding significant gaps between PAPs and non PAPs on the preparation of RAP Comparison of PAPs income before/after resettlement
	Cultural heritage	C	C	Existence of cultural heritage in/around the project site by review of maps and existing materials Field reconnaissance	Evaluation of negative impacts and study of mitigation measures in case that there is a cultural heritage in/around the project site
	Gender	C	C	Ratio of widow households in poor households Necessity of special assistance on the widow households Review of the gender action plan which is developed in this preparation survey	Considerations on women and traffic disadvantaged on the project plan
	Children's rights	C	C	Existence of school around the project site by review of maps Review of the project plan in terms of blocking school-commuting roads	Evaluation of negative impacts on school-commuting roads

Category	Items	Before/during Construction	Operation	Survey Items and Methods of Survey and Forecast	Methods of Evaluation
	Infectious diseases such as HIV/AIDS	B-	D	Current condition of prevalence of infectious diseases such as HIV/AIDS in Bangladesh by review of existing materials Review of other projects on prevalence of HIV/AIDS by influx of construction workers	Evaluation of the prevalence of HIV/AIDS on the construction stage of the project
	Working conditions (including occupational safety)	B-	B-	Safety measures on the project by review of the project plan	Evaluation of safety on construction work in the light of other projects Evaluation of safety on the operation of the project in the light of other projects
	Trans-boundary impacts or climate change	B-	B+/-	Construction machinery which discharges greenhouse gas on the construction activities Estimation of greenhouse gas reduction by the implementation of the project	Confirmation of the reduction measures on the construction plan Evaluation of reduction effects of greenhouse gas on the project
Others	Risk of flood	C	C	Review of existing materials relevant to flood around the project site Review of the project plan	Confirmation of appropriate measures in case that there is food risk

A+/-: Significant positive/negative impact is expected.

B+/-: Positive/negative impact is expected to some extent.

C: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)

D: No impact is expected

* Impact Items refer to "JICA Guidelines for Environmental and Social Considerations April 2010"

Source: JICA Study Team

5.6 The Results of the EIA Survey

5.6.1 Results of the Survey of Each Items

Regarding the raised items on the TOR of EIA, the results of the EIA survey are shown below.

1) Air Pollution

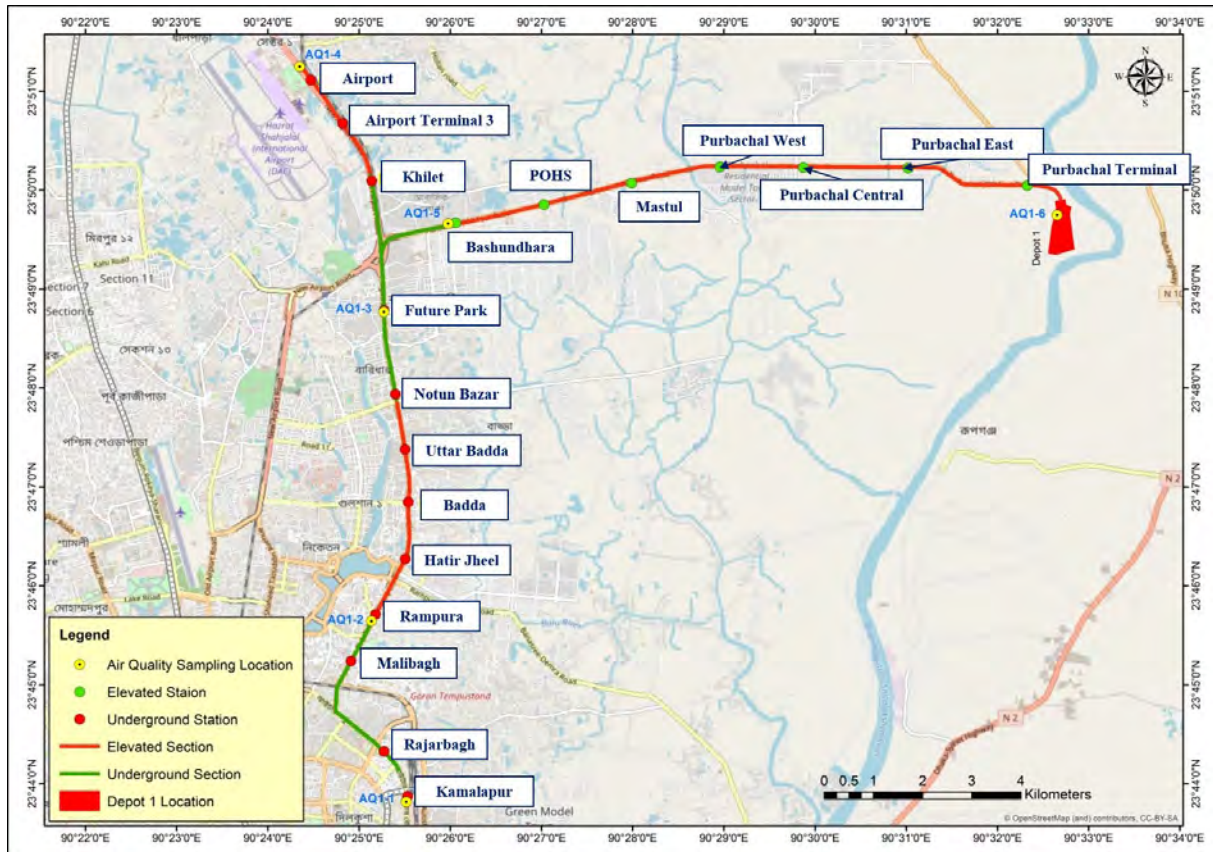
Air quality survey was conducted on the locations along the MRT Line 1. Five survey points were allocated along the MRT Line 1 alignment. Table 5.6.1 and Figure 5.6.1 show the survey points.

Table 5.6.1 Air Quality Sampling Location of MRT Line 1

No.	Location	Geographic Coordinate
AQ1-1	Kamlapur Station	23°43'48.99"N 90°25'31.01"E
AQ 1-2	Rampura Station	23°45'38.70"N 90°25'8.10"E
AQ 1-3	Jamuna Future Park Station	23°48'46.1"N 90°25'16.2"E
AQ 1-4	Airport Station	23°51'14.9"N 90°24'20.9"E
AQ 1-5	Bashundhara Station	23°49'39.7"N 90°25'58.5"E
AQ 1-6	Depot Site of Line 1	23°49'44.8"N 90°32'39.2"E

Source: JICA Study Team/EQMS

Figure 5.6.1 Air Quality Sampling Location of MRT Line 1



Source: EQMS

The subjects of survey are seven parameters (PM₁₀, PM_{2.5}, SO₂, NO₂, CO, Pb and O₃) including national ambient air quality standards (NAAQS) of Bangladesh.

Results of the survey are illustrated in Table 5.6.2. To summarize, concentration of the particulate matters are high in the project area. The value of PM₁₀ and PM_{2.5} on the airport line including Kamalapur, Rampura, Jamuna Future Park and Airport station are higher than the NAAQS. NO₂ of Kamalapur, Rampura and Jamuna future park stations are also higher than the NAAQS.

Air pollutions of survey points are dominated by PM₁₀ and PM_{2.5}. Because on major roads in Dhaka city, a lot of construction work is being conducting, even paved roads are very muddy. Considering low concentrations of other pollutants, the high concentration of PMs is estimated to be derived from road dust.

WHO Guidelines recommends lower concentration of contaminants. Comparing the WHO Guidelines, concentrations of PM₁₀ and PM_{2.5} highly exceed on the whole locations.

Table 5.6.2 Ambient Air Quality of MRT 1

Location	Present Concentration in $\mu\text{g}/\text{m}^3$						CO (ppm)
	PM10	PM2.5	NO ₂	SO ₂	O ₃	Pb	
Kamlapur Station	310.7	125.4	112.6	21.2	20.6	0.07	4.9
Rampura Station	286.5	108.5	107.1	22.8	15.6	0.05	1.7
Future Park Station	231.2	95.7	103.4	17.0	13.4	0.03	0.8
Airport Station	275.6	103.6	98.4	17.6	10.2	0.04	0.6
Bashundhara Station	123.4	58.4	43.2	11.3	6.6	BDL	0.1
Depot Site of Line 1	92.3	52.2	30.6	9.8	4.5	BDL	0.1
NAAQS (ECR1997)	150	65	100	365	157	0.5	9
WHO Guideline	50	25	40	20	100	0.5	10

Source: EQMS Laboratory, Sampling Date: 28th February, 2017 to 5th March, 2017, Analysis date: 1st-15th March, 2017

Note: BDL- Below Detection Limit



Exceeding Standard Level

As the results of the baseline survey show, concentrations of PM2.5 and PM10 along the project area are high comparing the national standard of Bangladesh. Main cause of the air pollution can be dust of road surface. Some construction works including earth work may cause dust. However, mitigation measures against the dust such as water spray on the construction works should be introduced.

(1) Negative Impact of Dust caused by Construction Work

As mentioned above, main factor of air pollution in Dhaka is dust. On stakeholder meetings, some concerns about dust of construction work were raised. On the project, operation of construction machinery will generate dust. Based on simple prediction method of dust generation, study team examined negative impacts of dust falling around the project sites. As a prediction method, the prediction method by National Institute for Land and Infrastructure Management (NILIM), Japan was referred. On some typical construction work, volume of falling dust is estimated as table and meets criteria. The criteria is to secure living environment against spike tire dust in Japan.

Table 5.6.3 Estimated falling dust on typical construction work

Construction Work	Unit of falling dust near construction (t/km ² /8h)	Working day per month	Falling dust per month (t/km ² /month)	Criteria (t/km ² /month)
Embankment	0.04	30	1.2	20
Slope forming	0.07	30	2.1	
Piling (Earth Drill)	0.02	30	0.6	

Note: criteria: guideline on spike tire dust (NILIM)

Because estimated volume of falling dust is comparatively low, it is estimated that negative impacts are not significant. However, estimation of dust caused by construction work has uncertainty. Therefore, appropriate mitigation measures are essential.

2) Water Pollution

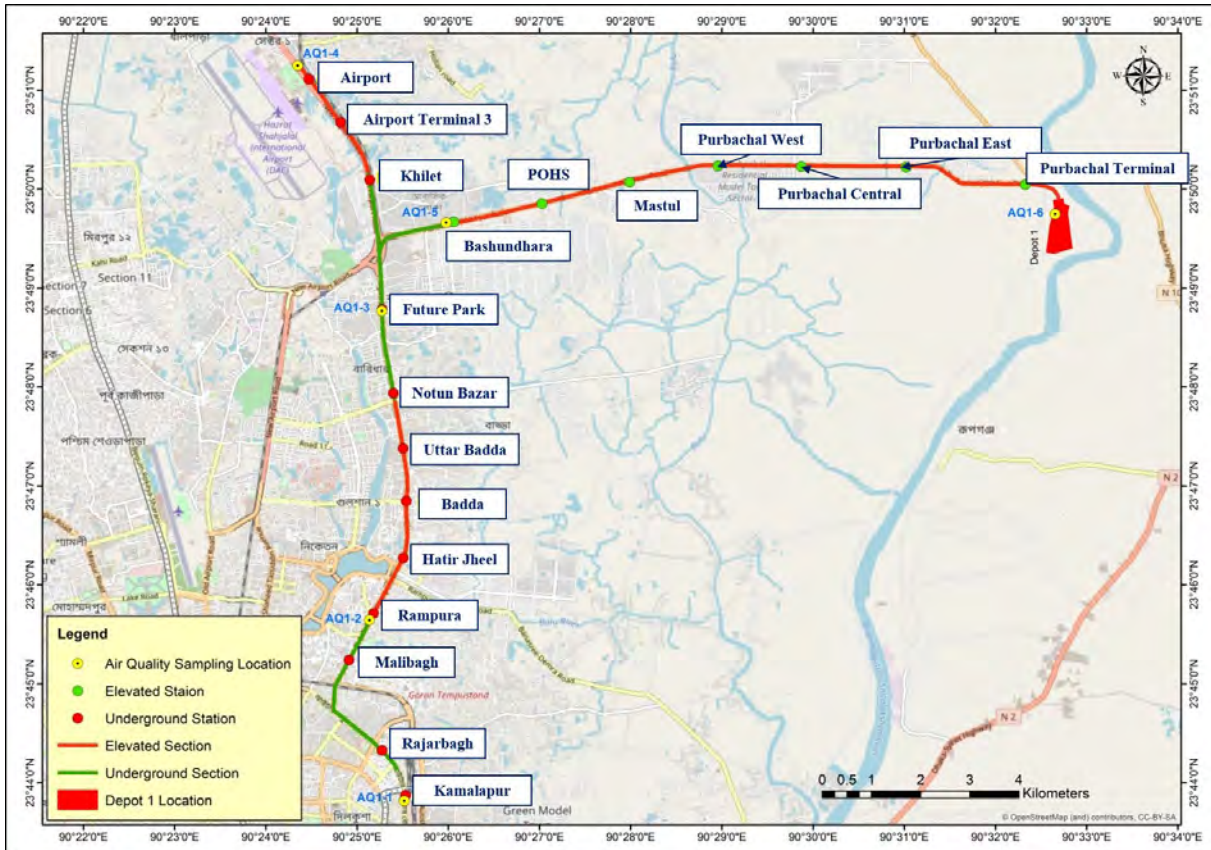
To understand current conditions of surface water quality along the MRT Line 1, water quality survey was conducted. Surface water samples were taken from 3 different locations for river and pond along the MRT line 1. Surface water sample were collected on 19th to 22nd March 2017, 4th March 2018 (SW1-3). Detail Sampling Locations are provided in the following Table 5.6.4 and depicted in Figure 5.6.2.

Table 5.6.4 Surface water Sampling Location of MRT Line 1

No.	Location	Geographic Coordinate
SW1-1	Hatirjheel Canal	23° 46.033'N 90° 25.481'E
SW1-2	Balu River	23° 50.251'N 90° 29.235'E
SW1-3	Depot Site of Line 1	23°49'44.1"N 90°32'34.9"E

Source: JICA Study Team

Figure 5.6.2 Surface and Ground Water Sampling Location of MRT Line 1



Source: JICA Study Team

Results of the survey are shown on Table 5.6.5. To summarize, surface water quality are nearly same as “water usable by fisheries, various process and cooling industries” or “Water usable for irrigation“ of Bangladesh standard. The Bangladesh standards have no criteria of COD and TSS (SS). Comparing the Japanese standard of water quality, it is nearly same as Category D (industrial or agricultural use) or Category E (industrial use). Among 3 locations, water quality of Hatirjheel Canal is worst. Even SW1-2 which is designated as ECA is same as f category. Since concentration of DO is very low, it is crucial condition for aquatic organism.

Table 5.6.5 Surface Water Quality Analysis Result

Parameter	Unit	SW 1-1	SW 1-2	SW 1-3	Standard for Inland Surface Water*					
					a	b	c	d	e	f
Colour	Hazen	1.1	1.3	3.2	-	-	-	-	-	-
Temperature	°C	26.9	28.7	28.5	-	-	-	-	-	-
pH	-	7.37	8.43	7.42	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
DO	mg/l	1.5	3.2	2.4	6 or above	5 or more	6 or more	5 or more	5 or more	5 or more
BOD	mg/l	24	12	7	2 or less	3 or less	6 or less	6 or less	10 or less	10 or less
COD	mg/l	88	44	32	-	-	-	-	-	-
TSS	mg/l	46	31	15	-	-	-	-	-	-
Coliform (Faecal)	N/100ml	1080	996	33	50 or less	200 or less	5000 or less	---	5000 or less	1000 or less

*Note: a- Source of drinking water for supply only after disinfecting
b- Water usable for recreational activity
c- Source of drinking water for supply after conventional treatment
d- Water usable by fisheries
e- Water usable by various process and cooling industries
f- Water usable for irrigation

Source: JICA Study Team, EQMS laboratory and Department of Public Health and Engineering Lab; Analysis date: 22/03/2017- 30/04/2017 and 30/04/2017-22/05/2017

The alignment of the project passes through some water bodies including ECA (Balu river, Turag river). Water quality of the water bodies are level to meet industrial use. The alignment passes through the water bodies by underground or bridge. There will be no pier in river. Therefore, the project will not directly affect the water bodies.

However, in case that structures including viaduct are constructed near the water bodies, influx of turbid water is expected. According to review of detail design, appropriate mitigation measures and monitoring should be taken as needed.

On the operation phase, the operation of the depot generates drainage water. Discharge of untreated drainage water may deteriorate water bodies. In this project, wastewater of toilet and cleaning of stations is treated by septic tank, and discharged water bodies.(4.4.2 3)) On the depot, wastewater including cleaner and oil is generated. The wastewater is collected in the depot, treated to meet the standards of water quality of Bangladesh, and discharged. Moreover, the drainage water is monitored regularly. Therefore, the drainage water will cause no deterioration of water quality around the depot.

3) Soil Pollution

On construction work of the project, some construction machinery will operate. Bad maintenance machinery has a possibility of oil leak. The machinery should be maintained appropriately. Since the structure of the project is almost underground, the project will generate a lot of excavation soil. Because there is no facility discharging pollutants such as factory in the project site, there is few possibilities to spread highly polluted soil to other areas. The depot construction of the project needs a lot of soil to form embankment. In case that the filling soil is contaminated, contaminants can scatter around the depot site. Therefore, when the project receives the soil, no contamination of the soil should be confirmed.

4) Waste

(1). Excavation Soil

Since the structure of the project is almost underground, the project will generate a lot of excavation soil (approximately 2.4 million cubic meters). There are no acts and regulations on soil disposal in Bangladesh. Although Dhaka City also has no regulation of disposal of

excavation soil, disposal and reuse are promoted as followings.

- (1). Applicants dealing soils register to Dhaka city (with desirable spec of soil).
- (2). Dhaka city selects receivers of soil from the registered applicants, and informs soil owners of it.
- (3). Soil owners disposes spoiled soils to designated dumping sites.

The study team interviewed RAJUK² about procedures of soil dumping. They mentioned that RAJUK does not secure soil dumping site, and the project proponents should consult with National Housing Authority, brick factory's owners³ and developers. Moreover they informed that there is a development plan of filling soil on the east of Dhaka city to prevent flood disaster.

Regarding soil disposal, the project will require disposal to approved site by the government to contractors. Moreover, following policies are taken to reuse the excavation soil as possible. Tangible measures will be examined on construction plan of detail design.

- (1). Excavation soil that is good conditions is stocked temporarily, and reused on the project as filling soil.
- (2). Reuse for other projects or Use as pre-load material of extension of the depot site.

(2) Waste

Regarding waste disposal, to use disposal sites which are managed by Dhaka city⁴, project proponents acquire a permit from Dhaka city and pay for disposal. Private disposal sites⁵ also are available under an agreement.

Construction work of the project generates wastes: the operation of the project generates wastes from stations and the depot site. Hazardous waste must not be generated. Trash box will be installed at the stations. The waste of the project is disposed and reused appropriately under consultation with Dhaka city and a permit.

5) Noise and Vibration

For the purpose of understanding noise environment along the MRT Line1, an ambient noise survey was conducted. Nine survey points were allocated along the MRT Line 1 alignment. Table 5.6.6 and Figure 5.6.3 show the survey points.

The survey points are chosen in such a way that a representative data could be recorded all over locations.

Table 5.6.6 Noise Level Sampling Location of MRT Line 1

No.	Location	Geographic Coordinate
NL1-1	Kamlapur Station	23°43'49.48"N 90°25'30.93"E
NL1-2	Rajarbagh Station	23°44'21.0"N 90°25'15.0"E
NL1-3	Rampura Station	23°45'38.6"N 90°25'08.0"E
NL1-4	Badda Station	23°46'52.1"N 90°25'31.9"E
NL1-5	Notun Bazar Station	23°48'00.6"N 90°25'23.8"E
NL1-6	Jamuna Future Park Station	23°48'47.21"N 90°25'15.77"E
NL1-7	Airport Station	23°51'12.7"N 90°24'23.2"E

² Ashraf Islam, Project Director, Detailed Area Plan, RAJUK

³ It is estimated that they supposed reuse as materials of brick.

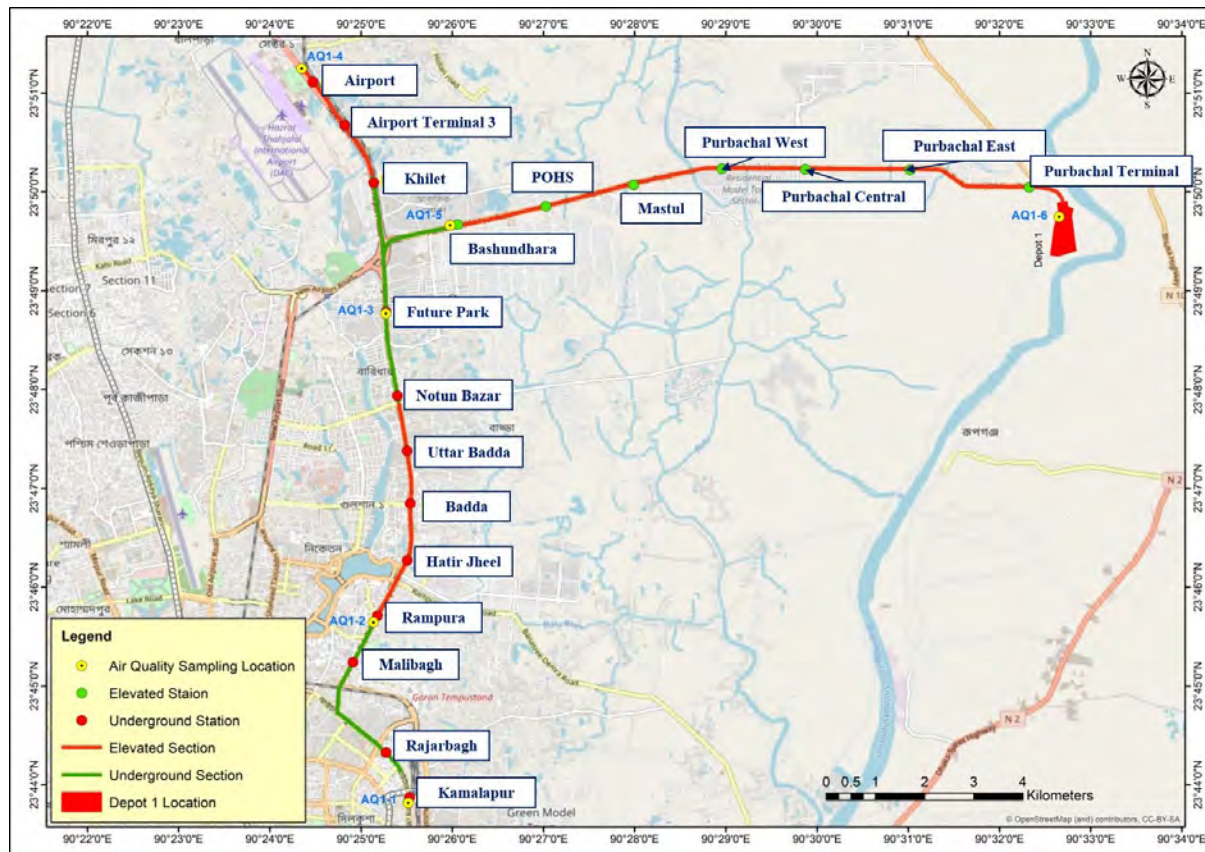
⁴ Matuali (south of Dhaka city), Amin Bazar (west of Dhaka)

⁵ It depends on a land use plan.

No.	Location	Geographic Coordinate
NL1-8	Bashundhara Station	23°49'39.2"N 90°25'56.1"E
NL1-9	Depot Site of Line 1	23°49'43.2"N 90°32'41.1"E

Source: JICA Study Team

Figure 5.6.3 Noise Level Monitoring Location of MRT Line 1



Source: JICA Study Team

Results of the ambient noise survey are shown on Table 5.6.7.

Table 5.6.7 Noise Level Analysis of the MRT Line 1

Code	Lmax	Lmin	Leq _{day}	Leq _{night}	L90	L50	L10	Area Setting*	Standard**	
									Day	Night
NL1-1	92.9	57.4	70.8	66.8	62.5	65.5	71.1	Commercial	70	60
NL1-2	83.2	42.6	68.3	63.0	59.4	63.7	69.9	Commercial	70	60
NL1-3	91.8	60.1	70.5	65.2	63.3	66.6	71.4	Commercial	70	60
NL1-4	84.8	61.2	71.7	65.9	62.4	66.8	72.5	Commercial	70	60
NL1-5	86.0	58.4	70.8	63.5	61.2	64.1	71.3	Commercial	70	60
NL1-6	87.3	63.1	70.4	64.7	60.2	63.8	70.2	Commercial	70	60
NL1-7	83.7	61.8	69.7	67.6	60.4	64.6	70.1	Commercial	70	60
NL1-8	79.4	49.3	65.7	56.4	56.9	59.4	66.3	Commercial	70	60
NL1-9	65.8	39.4	53.7	44.7	42.8	48.2	54.7	Residential	55	45

Source: JICA Study Team (Monitoring Date: 28th February, 2017 – 10th March, 2017)

* Area setting (according to the ECR, 1997)

**Standard according to the ECR, 1997 and subsequent amendment in 2006



Exceeding Standard Level

Generally, ambient noise levels along the Airport Line are high and exceed standards of the ECR. It is estimated due to the urban activity including huge number of vehicle operation

because the area is located along major roads.

Since the area along the project is almost commercial zone, ambient noise level is comparatively high.

On construction stage, some construction machinery will be operated. On the centre of Dhaka, the structure is underground, along the locations of the station have construction work above ground. Because basically the construction work will be conducted at the centre of road, noise damping by distance will be kept. Moreover, mitigation measures such as installation of noise barrier are hoped.

In this survey, no tangible construction plan is examined. On detail design stage, construction noise should be examined again.

On operation stage, railway noise will be expected on viaduct sections. There are no regulations or guidelines of railway noise in Bangladesh. Considering the railway noise guideline of Japan, the installation of noise barrier will reduce the noise, meet the criteria of the guidelines.

Depot site and station facilities such as ventilator may generate noise. Because tangible design has not examined yet, it should be examined on the detail design stage.

Regarding vibration, it is estimated that there are no negative impacts around the project site because there is no factory generating significant vibration. Construction work of the project, especially pile driving and earth work, may cause negative impacts of vibration around the project site. MRT Line 6 project which is going in advance is examining compensation for vibration grievance around the project site. The project adopts low vibration methods on pile driving and earth work as possible, and carry out monitoring of vibration.

On the operation stage, negative impacts of tunnel vibration are expected. However, instances of Japan show that observed vibration is below the threshold (55 dB). Therefore it is expected that negative impacts is negligible.

(1) Construction Noise

Noise level along the project site will increase due to construction activities. Most of the noise will be contributed by operation of heavy equipment and machineries. On the underground sections where are dense areas, construction work of alignment is carried out underground. Therefore, there is no noise problem on the construction work of alignment. On the other hand, because construction work of station and viaduct section are carried out on ground, there are concerns of negative impacts of noise. Study team shows an estimation of construction noise below.

- Prediction model: distance damping model of sound
- Condition of prediction: Noise source locates on the centre of road. Observed point is set on a road side. (Distance between noise source and observed point is 10m.) Installation of temporarily wall (h=3m) is assumed as mitigation measures.
- Noise source: Expected typical construction activities are set. (NILIM)

Results of the prediction are shown on Table 5.6.8.

Table 5.6.8 Results of Prediction of Construction Noise

Construction Work		Distance from the Edge of the ROW to Receiving Point (m)				Noise standard of Bangladesh Day time 6:00-21:00 Night: 21:00-6:00 (Leq: dBA)
Type	Power Level (dB)	0	5	10	15	
Without temporary wall						
D-wall	107	79.0	75.5	73.0	71.0	Residential area: 50/40 Mixed area: 60/50 Commercial area: 70/60
Pile drivers (earth drill)	106	78.0	74.5	72.0	70.0	
Pile drivers (hydraulic pile hammer)	135	107.0	103.5	101.0	99.0	
Excavation	119	91.0	87.5	85.0	83.0	
Asphalt pavement	108	80.0	76.5	74.0	72.0	
With temporary wall (3.0m)						
D-wall	107	60.0	57.5	55.0	53.0	Residential area: 50/40 Mixed area: 60/50 Commercial area: 70/60
Pile drivers (earth drill)	106	59.0	56.5	54.0	52.0	
Pile drivers (hydraulic pile hammer)	135	88.0	85.5	83.0	81.0	
Excavation	119	72.0	69.5	67.0	65.0	
Asphalt pavement	108	61.0	58.5	56.0	54.0	

Source: JICA Study Team

On the condition without temporary wall, generally noise levels are expected to be high. Temporary wall installed near the noise source has remarkable effect to reduce the construction noise. The temporary wall should be introduced as noise mitigation measures. It cannot be compared the prediction and the standards directly because the noise standard of Bangladesh evaluates by Leq. Leq depends on level and duration of noise. In case that the machinery operates 8 hours per day, the noise level is deducted approximately 3 dB, in case of 1 hour per day, approximately 12dB from the figure of Table 5.6.8.

Therefore operation hour of machinery should be shorten as possible by rational construction management. Since the standards of night time is 10 dB lower than daytime, the impacts at night are more. On the residential area such as Purbachal area, night time construction work on the ground should be avoided.

(2) Railway Noise

The Purbachal Line of MRT Line 1 takes viaduct structure. The operation of railway may cause noise impacts along the project site. Study team examined prediction of railway noise, evaluated and proposes noise mitigation measures based on a result of the prediction.

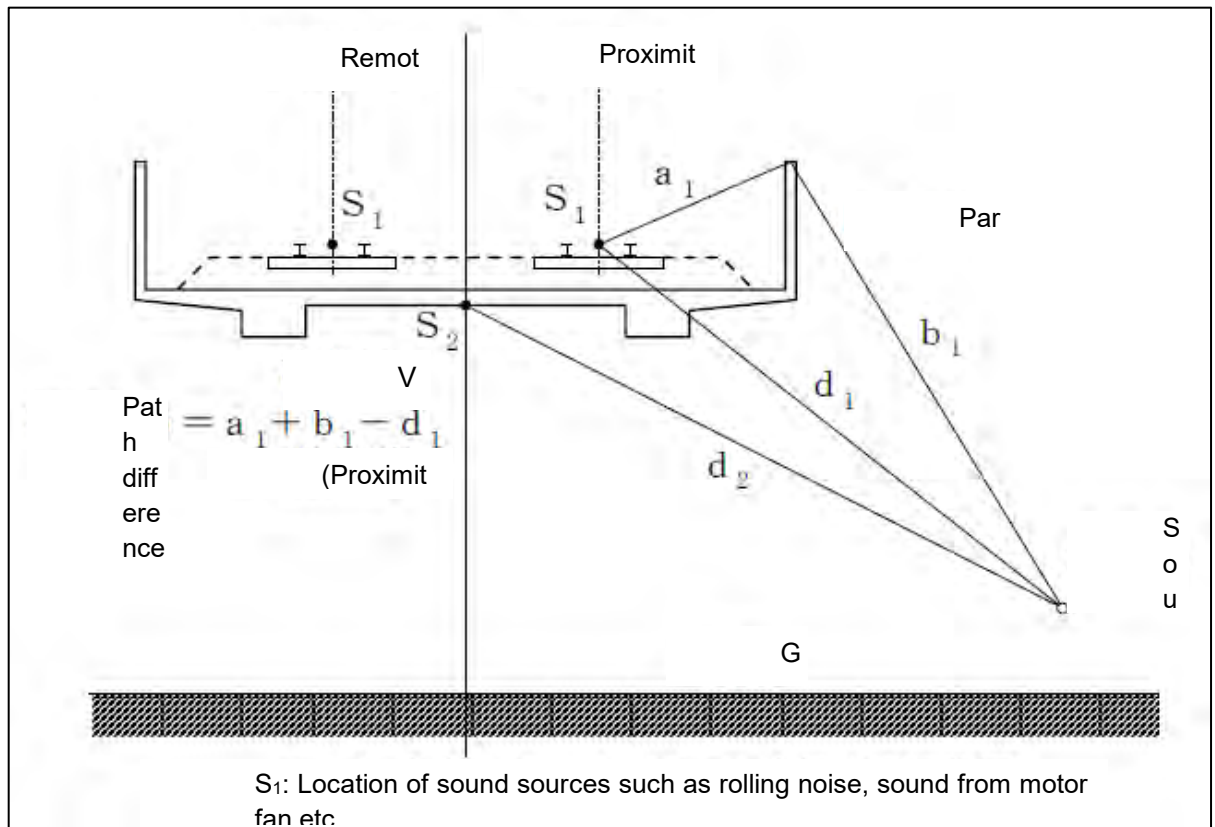
Based on section structure and train velocity, the maximum of the noise level at the time of the run of 1 train (L_{Amax}) is estimated firstly. Moreover single event sound exposure level (L_{AE}) is estimated from train transit time. Finally equivalent continuous sound pressure level (L_{Aeq}) by train number every train type of time zone is calculated.

- Prediction model

The prediction model by Japanese formula is applied. The noise by train operation compounds 3 main sound sources such as rolling noise of running train, structure sound from vibration of slab on concrete viaduct, and railway vehicle sound. The formula is calculated by combining these sound sources.

- Estimation of maximum value of noise level (L_{Amax})

The prediction formula for train length l m and train velocity V km/h indicates Formula 1 - 4 by definition of each variable shown in Figure 5.6.4.



Source: Proposal of a Prediction Model for Noise of Conventional Railway, Noise Control Engineering 20(3), 1996, Institute of Noise Control Engineering, Japan

Figure 5.6.4 Arrangement of Sound Source, Sound Receiving Point and Explanation of Path Difference

(a.1) Rolling noise

$$L_{Amax}(R) = PWL_R - 5 - 10 \log_{10} d_1 + 10 \log_{10} \left(\frac{\left(\frac{L}{2d_1}\right)}{1 + \left(\frac{L}{2d_1}\right)^2} + \tan^{-1} \left(\frac{L}{2d_1}\right) \right) + \alpha_1 \quad \text{--- Fomula 1}$$

Where, $L_{Amax}(R)$: maximum value of noise level (decibel)

PWL_R : Sound source power level (decibel)

$$PWL_R = 30.0 \log_{10}(V) + 42.6$$

D_1 : Distance between center of run orbit and sound receiving point (m)

L : Train length (m)

V : Train velocity (km/h)

α_1 : damping effect by balustrade (decibel)

(a.2) Structure sound

$$L_{Amax}(C) = PWL_C - 5 - 10\log_{10}d_2 + 10\log_{10}\left(\frac{\left(\frac{l}{2d_2}\right)}{1 + \left(\frac{l}{2d_2}\right)^2} + \tan^{-1}\left(\frac{l}{2d_2}\right)\right) + \Delta L_C \quad \text{---}$$

– Formula 2

Where, $L_{Amax}(C)$: Maximum value of noise level (decibel)

PWL_C : Sound power level of structure sound (decibel)

$$PWL_C = 72$$

d_2 : Distance between center of structure underside and sound receiving point (m)

ΔL_C : Correction value

$$r < 4h: \Delta L_C = 0$$

$$r > 4h: \Delta L_C = -10 \log_{10}(r/4h)$$

r : Horizontal distance between center of viaduct and sound receiving point (m)

h : Height of viaduct underside from ground (m)

(a.3) Maximum value of noise level (L_{Amax})

The maximum value of noise level for one (1) train formation is calculated by combining noise levels calculated by Formula 1 - 2.

$$L_{Amax} = 10\log_{10}\left(10^{\frac{L_{Amax}(R)}{10}} + 10^{\frac{L_{Amax}(C)}{10}}\right) \quad \text{--- Formula 3}$$

b. Relation between estimation of maximum value of noise level (L_{Amax}) and single event sound exposure level (L_{AE})

The relation between estimation of maximum value of noise level (L_{Amax}) and single event sound exposure level (L_{AE}) is calculated by using Formula 4.

$$L_{AE} = L_{Amax} + 10\log_{10}(l/(1000V/3600)) \quad \text{--- Formula 4}$$

c. Calculation of equivalent continuous sound pressure level (L_{Aeq})

$$L_{Aeq} = 10\log_{10}\left(\frac{1}{T}\sum_{i=1}^n 10^{L_{AEi}/10}\right) \quad \text{--- Formula 5}$$

Where, L_{AEi} : Single event sound exposure level by direction and train type (decibel)

N : Number of trains

T : Time for L_{Aeq} (second)

- Condition of prediction:

Section		Purbachal Line
Prediction year		2035
Train length		20m x 8 cars
Maximum operation speed		100km/h
Total number of operated train(on-way)		131 Day time(7:00~22:00) 110 Night time (22:00~7:00) 21
Structure	Width of viaduct	3m+4m+3m
	Height of rail	8m
	Truck	Slab
	Rail type	Long rail
Mitigation measures		Noise barrier H=1.0m, 1.5m

Criteria: Noise guideline values for the new project and large-scale modification of the conventional railway in Japan (Environmental Agency, 1995)

Results of the prediction are shown on Table 5.6.9.

Table 5.6.9 Prediction of Noise Level during Train Operation after

		Day time (7:00~22:00)	Night time (22:00~7:00)
Mitigation measures (Noise barrier)	No mitigation measures	68.2	63.2
	1.0m	55.9	51.0
	1.5m	55.4	50.4
Guideline values Noise guideline values for the new project and large-scale modification of the conventional railway in Japan (Environmental Agency, 1995)		60	55

Source: JICA Study Team

Without the mitigation measures, railway noise will exceed the guideline. With installation of noise barrier, railway noise is expected to meet the guideline. Since noise barrier is very common measures for noise mitigation, the installation of noise barrier is proposed as noise mitigation measures of the project.

6) Ground Subsidence

Based on geological survey, study team is examining suitable structure and construction method to secure ground stability. This F/S proposes shield tunnel boring for the alignment of underground, and open-cut method by D-wall for station structure. Details of structure and construction plan will be developed on D/D (detail design) study. Safety against ground subsidence should be continuously monitored on D/D study. On the construction, neighboring structures will be monitored to avoid negative impacts.

7) Bottom Sediment

As mentioned in "Water Quality", the alignment passes through the water bodies by underground structure or bridge. Therefore the project will not directly cause negative impacts to bottom sediment.

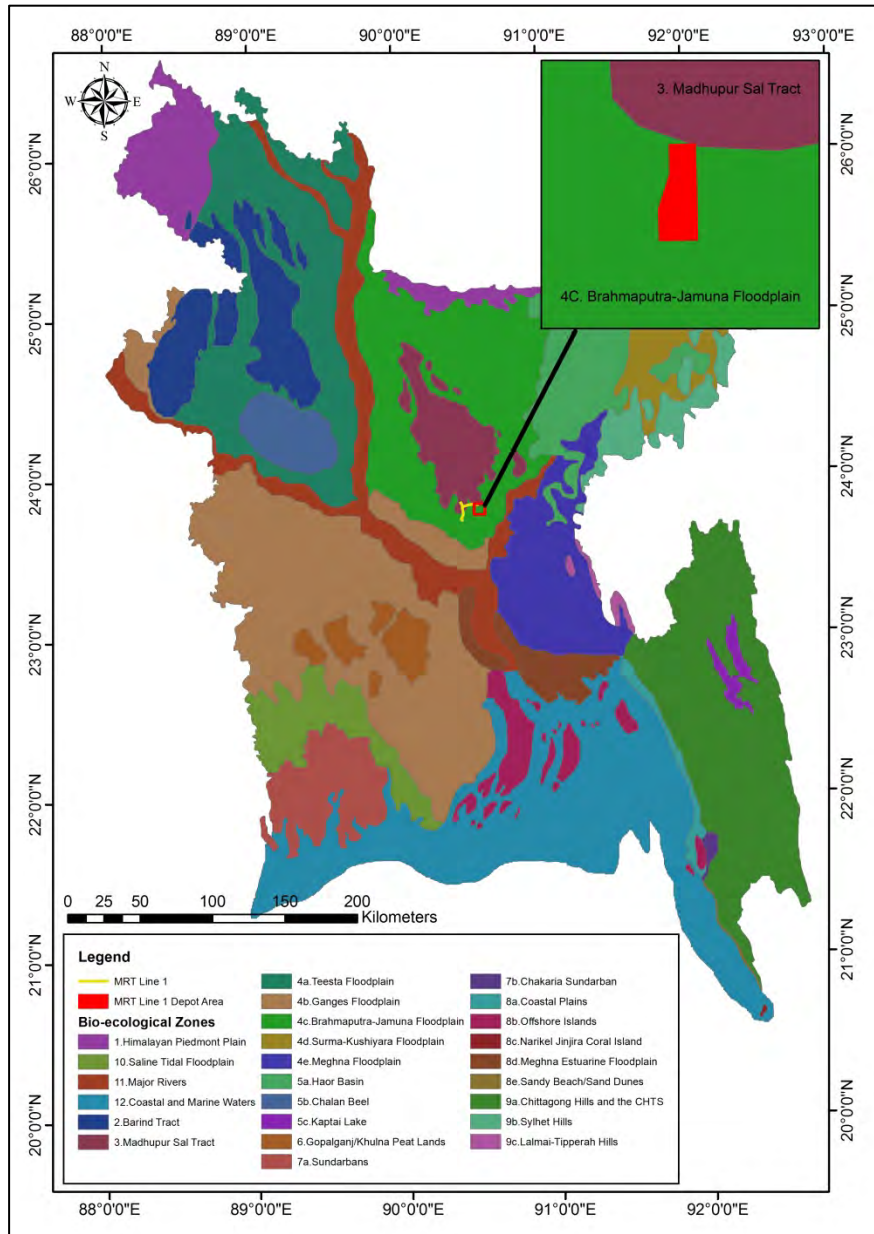
8) Ecosystem

(1) Ecosystem

In the project sites which are urbanized, the only Agro-ecosystem, Homestead ecosystem and wetland ecosystem are still existed in Purbachal area of Line1.

(2) Bio-Ecological Zone

Twenty-five bio-ecological zones have been delineated within Bangladesh by the IUCN. Six parameters were used to determine the areas including: physiography, soil, rainfall and temperature, floral distribution, faunal distribution and flood depth (IUCN 2002). The depot site falls in Brahmaputra-Jamuna Floodplain bio-ecological zone (Figure 5.6.5).



Source: IUCN, 2002

Figure 5.6.5 Depot Location in Bio-ecological Zones of Bangladesh

(3) Floral Component

Tree Species

In the depot site (Option 4), a total of 59 species of plant were found under 34 families. Among all Mimosaceae family has been found highest (five times) and Verbenaceae (one time) has been counted lowest. Myrtaceae and Rutaceae found 4 time each and Fabaceae, Anacardiaceae, Arecaceae and Moraceae have been found 3 times among the families.

Among the tree species 46% are fruits bearing, 15% medicinal, 13% timber, 10% flower and firewood bearing and 4% are fruit bearing. Mango (*Mangifera indica*), Bamboo (*Bambusa balcooa*), Jackfruit (*Artocarpus heterophyllus*), Banana (*Musa acuminata*) are the dominant species in the depot area. The checklist of tree species has been provided in Table 5.6.10.

Table 5.6.10 Tree Species in Deport Area

Sl#	Common Namer	Scientific Name	Family	Uses	Red Data Book of Bangladesh (National Herbarium Bangladesh 2001)
	Mango	<i>Mangifera indica</i>	Anacardiaceae	Fruit	NE
	Coconut	<i>Cocos nucifera</i>	Arecaceae	Fruit, Fiber	NE
	Bengal currant	<i>Carissa carandas</i>	Apocynaceae	Fruit	NE
	Sugar-apples	<i>Annona squamosal</i>	Annonaceae	Fruit	NE
	Indian date	<i>Phoenix sylvestris.</i>	Arecaceae	Fruit & Juice	NE
	Indian ash tree	<i>Lannea coromandelica</i>	Anacardiaceae	Firewood	NE
	Pinwheel flower	<i>Tabernaemontana divaricata</i>	Apocynaceae	Flower	NE
	Date palm	<i>Phoenix dactylifera</i>	Arecaceae	Fruit	NE
	Hog plum	<i>Spondias mombin</i>	Anacardiaceae	Fruit	NE
	Tree turmeric	<i>Berberis aristata</i>	Berberidaceae	Medicinal	NE
	Papaya	<i>Carica papaya</i>	Caricaceae	Fruit	NE
	Muskmelon	<i>Cucumis melo</i>	Cucurbitaceae	Fruit	NE
	Arjun tree	<i>Terminalia arjuna</i>	Combretaceae	Medicinal	NE
	Country-almond	<i>Terminalia catappa</i>	Combretaceae	Fruit	NE
	Elephant apple	<i>Dillenia indica.</i>	Dilleniaceae	Fruit	NE
	Velvet apple	<i>Diospyros discolor</i>	Ebenaceae	Fruit	NE
	Jolphai	<i>Elaeocarpus serratus</i>	Elaeocarpaceae	Fruit	NE
	Tamarind	<i>Tamarindus indica</i>	Fabaceae	Fruit	NE
	Asian pigeonwings	<i>Clitoria ternatea</i>	Fabaceae	Flower	NE
	Flame tree	<i>Delonix regia</i>	Fabaceae	Timber	NE
	Meda	<i>Litsea monopetala.</i>	Lauraceae	Medicinal	NE
	Itchtree	<i>Barringtonia acutangula</i>	Lecythidaceae	Timber	NE
	Giant crepe-myrtle	<i>Lagerstroemia speciosa</i>	Lythraceae	Timber	NE
	Teak	<i>Tectona grandis</i>	Lamiaceae	Timber	NE
	Henna tree	<i>Lawsonia inermis</i>	Lythraceae	Medicinal	NE
	Indian bay leaf	<i>Cinnamomum tamala</i>	Lauraceae	Medicinal	NE
	Tulasi	<i>Ocimum sanctum</i>	Lamiaceae	Medicinal	NE
	Pomegranate	<i>Punica granatum</i>	Lythraceae	Fruit	NE
	Jackfruit	<i>Artocarpus heterophyllus.</i>	Moraceae	Fruit, timber	NE
	Ear leaf acacia	<i>Acacia auriculiformis.</i>	Mimosaceae	Timber	NE
	West-indian mahogany	<i>Swietenia mahagoni</i>	Meliaceae	Timber	NE
	Neem	<i>Azadirachta indica.</i>	Meliaceae	Medicinal	NE
	Blackberry	<i>Syzygium cumini.</i>	Myrtaceae	Fruit, firewood	NE
	Areca palm	<i>Areca catechu.</i>	Mimosaceae	Timber	NE
	Water rose apple	<i>Syzygium samarangense</i>	Myrtaceae	Fruit	NE
	Banana	<i>Musa paradisiac.</i>	Mussaceae	Fruit	NE

Sl#	Common Namer	Scientific Name	Family	Uses	Red Data Book of Bangladesh (National Herbarium Bangladesh 2001)
	Weeping paperbark	<i>Melaleuca leucadendron.</i>	Mimosaceae	Timber	NE
	Guava	<i>Psidium guajava.</i>	Myrtaceae	Fruit	NE
	Raintree	<i>Samanea saman.</i>	Mimosaceae	Timber	NE
	White siris	<i>Albizia procera.</i>	Mimosaceae	Timber	NE
	Cool mat	<i>Schumannianthus dichotomus</i>	Marantaceae	Fiber	NE
	Cluster fig tree	<i>Ficus racemosa</i>	Moraceae	Fruit	NE
	Bodhi tree	<i>Ficus religiosa.</i>	Moraceae	Wild	NE
	Night-flowering jasmine	<i>Nyctanthes arbor-tristis</i>	Oleaceae	Flower	NE
	Otaheite gooseberry	<i>Phyllanthus acidus</i>	Phyllanthaceae	Fruit	NE
	Asian palmyra palm	<i>Borassus flabellifer</i>	Palmae	Fruit	NE
	Bamboo	<i>Bambusa balcooa</i>	Poaceae	Household	NE
	Burmese grape	<i>Baccaurea ramiflora</i>	Phyllanthaceae	Fruit	NE
	Sugarcane	<i>Saccharum officinarum</i>	Poaceae	Fruit	NE
	Pomelo	<i>Citrus maxima</i>	Rutaceae	Fruit	NE
	Lemon	<i>Citrus limon</i>	Rutaceae	Fruit	NE
	Bael	<i>Aegle marmelos</i>	Rutaceae	Fruit	NE
	Elephant-apple	<i>Limonia acidissima</i>	Rutaceae	Fruit	NE
	Indian plum	<i>Ziziphus mauritiana</i>	Rhamnaceae	Fruit	NE
	Bur flower-tree	<i>Neolamarckia cadamba</i>	Rubiaceae	Flower	NE
	Sapodilla	<i>Manilkara zapota</i>	Sapotaceae	Fruit	NE
	Eggplant	<i>Solanum melongena</i>	Solanaceae	Vegetable	NE
	Litchi	<i>Litchi chinensis</i>	Sapindaceae	Fruit	NE
	Golden dewdrop	<i>Duranta erecta</i>	Verbenaceae	Flower	NE

Note: NE: Not evaluated

Source: JICA Study Team

Fallow Land Vegetation

Fallow lands were dominated by herb species of Durba Grass (*Cynodon dactylon*), Taro (*Colocasia esculenta*) Shame plant (*Mimosa pudica*), Scutchgrass (*cynodon dactylon*), Black nightshade (*Solanum nigrum*), Spiny amaranth (*Amaranthus spinos*), Goma flower (*Leucas indica*), Hill glory bower (*Aleroden dronviscosum*), Native Gooseberry (*Physalis minima*), Nut Grass (*Cyperus rotundus*), Ironweed (*Vernonia cinerea*), Yellow fruit nightshade (*Solanum xanthocarpum*), Caesarweed (*Eurena lobata*), Rattlebox Plant (*Crotalaria pallida*), Diamond burbark (*Triumfetta rhomboidea*), Rough cocklebur (*Xanthium indicum*), Indian heliotrope (*Heliotropium indicum*).

Grass Land Vegetation

7 families have been recorded with 12 different species and Cyperraceae family has been found maximum three times among those species. The second dominating family was Poaceae which was found twice during the survey tenure. Among the common grasses species *Cyperus rotundus*, *Cynodon doctylon*, *Amaranthus philoveroides*, *Alternanthera sessilis*, *Alerodendron viscosum* and *Eurena loba* were notable.

Aquatic Vegetation

During the survey time different water bodies were found around the project area. The aquatic vegetation survey has been conducted by visual observation and consultation with local people as well as secondary information sources.

It has been found different aquatic plants in the study area. The ecology team has been considered these for aquatic vegetation survey. Direct counting method by visual

observation has been applied for the aquatic vegetation survey of this area.

A total number of nine aquatic plant species belonging to 8 families have found at the study area. Among them Convolvulaceae family have found maximum two times. But the population of Common water hyacinth was highest in and everywhere in the aquatic bodies of the study site. The checklist aquatic vegetation has been shown in the Table 5.6.11.

Table 5.6.11 Aquatic Flora in the Study Area

SI	Scientific Name	Family	Common name	Local visual status
	<i>Azolla</i> sp	Salviniaceae	Mosquito fern	C
	<i>Eichornia crassipes</i>	Pontederiaceae	Common water hyacinth	VC
	<i>Ipomea alba</i>	Convolvulaceae	Tropical white morning-glory	R
	<i>Ipomoea aquatica</i>	Convolvulaceae	River spinach	C
	<i>Hydrilla verticillata</i>	Hydrocharitaceae	Esthwaite waterweed	C
	<i>Calocasia esculenta</i>	Araceae	Taro	VC
	<i>Oxalis corniculata</i>	Oxalidaceae	Procumbent yellow-sorrel	C
	<i>Marselia</i> sp	Marsileaceae	Four-leaf clover	R
	<i>Enhydra fluctuans</i>	Asteraceae	Marsh herb	C

Note: Local Visual Status: C- Common, VC- Very Common, R- Rare
 Source: JICA Study Team

(4) Faunal Component

Birds (Avifauna)

A total of 31 species of birds were identified belongings to 11 families at the study area.

The highest number of birds dominated in the study area belonging to the family Corvidae. However, the birds belong to the family Accipitridae, Ardeidae has found as second dominated family among all. Homestead forest, grassland and bush, and some aquatic habitat of this area have supported the wild birds for feeding and roosting ground. All of the bird species found in this are least concern (LC) both locally and globally according to IUCN Red List 2015. A detail of bird's species checklist is shown in Table 5.6.12.

Table 5.6.12 Bird Species in the Depot Area

Sl. No	Common Name	Local Name	Scientific Name	Family	IUCN Global Status	IUCN BD Status
	Black kite	Bhubon chil	<i>Milvus migrans govinda</i>	Accipitridae	LC	LC
	Brahminy Kite	Shonkho Chil	<i>Haliastur Indus</i>	Accipitridae	LC	LC
	Indian pond heron	Kani Bok	<i>Ardeola grayii</i>	Ardeidae	LC	LC
	Cattle Egret	Goo Boga	<i>Bubulcus ibis</i>	Ardeidae	LC	LC
	Common King fisher	Chhoto Maachranga	<i>Alcedo atthis</i>	Alcedinidae	LC	LC
	White-throated kingfisher	Dhola gola Machranga	<i>Halcyon smymensis</i>	Alcedinidae	LC	LC
	Asian palm swift	Ashio Talbatashi	<i>Cypsiurus balasiensis</i>	Apodidea	LC	LC
	Ashy woodswallow	Metey Bonababil	<i>Artamus fuscus</i>	Artamidae	LC	LC
	Common lora	Fotikjol	<i>Aegithina tiphia</i>	Aegithinidae	LC	LC
	Spotted dove	Tila Ghughu	<i>Streptopelia chinensis</i>	Columbidae	LC	LC
	House Crow	Patikak	<i>Corvus splendens</i>	Corvidae	LC	LC
	Large-billed crow	Dar kak	<i>Corvus macrorhynchos</i>	Corvidae	LC	LC
	Rufous treepie	Harichacha,	<i>Dendrocitta vagabunda</i>	Corvidae	LC	LC
	Black Drongo	Kala Fingey	<i>Dicrurus macrocercus</i>	Dicruridae	LC	LC
	Bronze-winged	Jol Pipi	<i>Metopidius indicus</i>	Jacanidae	LC	LC

Sl. No	Common Name	Local Name	Scientific Name	Family	IUCN Status	Global Status	IUCN Status	BD Status
Jacana								
	Black hooded oriole	Halde Pakhi	<i>Oriolus xanthornus</i>	Oriolidae	LC		LC	
	Oriental magpie robin	Doel	<i>Copsychus saularis</i>	Muscicapidae	LC		LC	
	Asian Paradise Flycatcher	Dudhraaj	<i>Terpsiphone paradisi</i>	Monarchidae	LC		LC	
	Purple sunbird	Moutushi	<i>Nectarinia asiatica</i>	Nectariniidae	LC		LC	
	House sparrow	Pati choro	<i>Passer domesticus</i>	Passeridae	LC		LC	
	Black-rumped Flameback	Sonali kaththokra	<i>Dinopium benghalense</i>	Picidae	LC		LC	
	Fulvous-breasted woodpecker	Batabi Kathkurali	<i>Dendrocopos macei</i>	Picidae	LC		LC	
	Baya weaver	Babui	<i>Ploceus philippinus</i>	Ploceidae	LC		LC	
	Red-vented Bulbul	Bangla bulbul	<i>Pycnonotus cafer</i>	Pycnonotidae	LC		LC	
	Rose ringed parakeet	Sobuj Tia	<i>Psittacula krameri</i>	Psittacidae	LC		LC	
	Common myna	Salik/BhatSalik	<i>Acridotheres tristis</i>	Sturnidae	LC		LC	
	Asian Pied Starling	Gobrey shalik	<i>Sturnus contra</i>	Sturnidae	LC		LC	
	Chestnut-tailed Starling	Kath Shalik	<i>Sturnus malabaricus</i>	Sturnidae	LC		LC	
	Jungle Myna	Jhunti Shalik	<i>Acridotheres fuscus</i>	Sturnidae	LC		LC	
	Common Tailor Bird	Tuntuni	<i>Orthotomus sutorius</i>	Sylviidae	LC		LC	
	Oriental White eye	Shetakhi	<i>Zosterops palpebrosus</i>	Zosteropidae	LC		LC	

Note: LC-Least Concern
 Source: JICA Study Team

Amphibians and Reptiles

Two reptile species Bengal Monitor (*Varanus bengalensis*) and Spotted flapshell turtle (*Lissemys punctat*) were recorded by direct observation of the ecological team. But Focus Group Discussion (FGD) with local people provides some additional information about the availability of some other species. A total number of seven species of reptiles and three species of amphibians were recorded in the project area and among them Bengal Monitor is categorized as Near Threatened all rest of all are Least Concern according to the IUCN, 2015.

Table 5.6.13 List of Amphibians and Reptiles in Depot Area

Sl.#	Common Name	Local Name	Scientific Name	IUCN Status	Bangladesh Status
Reptiles					
	House gecko	Tiktiki	<i>Hemidactylus frenatus</i>	LC	
	Garden lizard	Roktochosa	<i>Calotes versicolor</i>	LC	
	Checkered keel back	Dora shaap	<i>Xenochrophis piscator</i>	LC	
	Common vine snake	Laudoga, sutanoli	<i>Ahaetulla nasuta</i>	LC	
	Bengal Monitor	Gui Shap	<i>Varanus bengalensis</i>	NT	
	Spotted flapshell turtle	Sundhi Kachim	<i>Lissemys punctat</i>	LC	
	Indian Roofed turtle	Kori kaitta	<i>Pangshura Tecta</i>	LC	
Amphibians					
	Asian Common Toad	Kuno bang	<i>Duttaphrynus melanostictus</i>	LC	
	Indian Bull Frog	Kola bang, Sona bang	<i>Hoplobatrachus tigerinus</i>	LC	
	Skipper frog	Katkati bang, Vensa bang	<i>Euphlyctis cyanophlyctis</i>	LC	

Note: LC-Least Concern, NT-Near Threatened
 Source: JICA Study Team

Mammals

As like as the herpetofaunal investigation the presence of Asiatic Golden jacked and Irrawadi squirrel has been confirmed by observing their nest and sign. Furthermore, Focus Group Discussion (FGD) with local people allows to get some more information about other species. As a result it has been recorded total six mammalian species at the study area. Mammals that has found were Common mongoose (*Herpestes edwardsii*), Common Indian field mouse (*Mus booduga*) and Indian Fruit Bat (*Pteropus giganteus*), Indian pipistrelle (*Pipistrellus coromandra*). All of them are least Concern according to the IUCN, 2015.

Fishes

Two fish ponds has found in the depot area. After consultation with the owner of the pond and fish cultivator some fish species has recorded to be found at the study area. Furthermore, A total of 14 fish species under different families have been reported. The list of fish species is provided in the Table 5.6.14 .

Table 5.6.14 List of Fish in Depot Area

SL	Local Name	Common Name	Scientific Name	Family	IUCN Status
	Koi	Climbing perch	<i>Anabus testudines</i>	Anabantidae	LC
	Potka	Ocellated Pufferfish	<i>Tetraodon cutcutia</i>	Ambassidae	LC
	Gulsha Tengra	Bleeker's Mystus	<i>Mystus bleekeri</i>	Bagridae	LC
	Choto Tengra	Tengara Catfish	<i>Mystus tengara</i>	Bagridae	LC
	Tengra	Striped Dwarf Catfish	<i>Mystus vittaus</i>	Bagridae	LC
	Kakila	Silver Needle Fish	<i>Xenentodon cancila</i>	Belonidae	LC
	Jat Punt	Spotfn Swamp Barb	<i>Puntius sophore</i>	Cyprinidae	LC
	Rui	Ruhu	<i>Labeo rohita</i>	Cyprinidae	LC
	Katol	Catla	<i>Catla catla</i>	Cyprinidae	LC
	Shol	Snakehead Murre	<i>Channa striatas</i>	Channidae	LC
	Taki	Spotted Snakehead	<i>Channa punctata</i>	Channidae	LC
	Shing	Stinging Catfish	<i>Heteropneustes fossilis</i>	Heteropneustidae	LC
	Khailsha	Banded Gouram	<i>Trichogaster fasciata</i>	Osphronemidae	LC
	Sucker Fish	Suckermouth catfish	<i>Hypostomus plecostomus</i>	Loricariidae	LC

Source: JICA Study Team

Most of the project area is developed area. On the other hand, the depot location is still undeveloped. As results of field survey on the depot location, various species were observed. However, no rare species such as "threatened" of IUCN Red List were observed.

Although the vicinity of the depot site is going to be developed, some natural environment may be still remained. Monitoring of the natural environment around the project site should be conducted continuously.

9) Hydrology

As mentioned in "Water Quality", the alignment passes through the water bodies by underground structure or bridge. Therefore, the project will not directly cause negative impacts to hydrology.

10) Groundwater

To understand current conditions of groundwater quality along the MRT Line 1, water quality survey was conducted. Ground water samples were taken from 9 existing wells along the MRT line 1. The ground water samples were collected on 19th to 22nd March 2017. Detail Sampling Locations are provided in the following Table 5.6.15 and shown in the Figure 5.6.2.

Table 5.6.15 Ground water Sampling Location of MRT Line 1

SL#	Location	Sampling ID	Geographic Coordinate
	Near the Rajarbagh ST (Navana Circular Heights)	GW1-1	23°44'25.60"N 90°25'11.40"E
	Near the Rampura ST. (Health Care Pharmaceutical)	GW1-2	23°45'33.60"N 90°25'9.30"E
	Near the Hatirjeel St	GW1-3	23°45'59.60"N 90°25'16.50"E
	Middle Badda Pump House	GW1-4	23°46'53.20"N 90°25'28.20"E
	Car Selection (Car House) near Notun Bazar Station	GW1-5	23°48'7.83"N 90°25'26.22"E
	Ground Water Sample Collected from Development and Properties limited	GW1-6	23°48'48.60"N 90°25'15.50"E
	Khilkhet Pump House	GW1-7	23°49'36.30"N 90°25'4.80"E
	Armed Police Battalion Water Pump, Zone-9.	GW1-8	23°51'22.6"N 90°24'22.1"E
	Depot site of line 1	GW1-9	23°49'44.3"N 90°32'40.8"E

Source: JICA Study Team

Results of the survey are shown on Table 5.6.16. In Bangladesh, there is no standard for groundwater. Whole parameter of whole locations meets the permissible limit in accordance with the Environmental Conservation Rules, 1997 (Standards for drinking water). As drinking water, the underground water keeps good condition.

In Bangladesh, arsenic contamination of groundwater is crucial problem. Fortunately, concentration of arsenic is very low comparing the standards. Even comparing Japan standards on underground water quality (0.01mg/l: MoE, J), it is still low.

Table 5.6.16 Ground Water Quality of MRT Line 1

Parameter	Unit	GW1-1	GW1-2	GW1-3	GW1-4	GW1-5	GW1-6	GW1-7	GW1-8	GW1-9	ECR, 1997 Standard
Water Level	m	487	365	183	300	215	245	487	243	50	-
Colour	Hazen	0.9	1.4	1.0	1.6	1.2	0.8	1.3	1.1	1.0	15
Temperature	°C	30	28.3	27.1	27.7	6.60	27.0	25.2	27.3	23.6	-
pH	-	6.20	6.81	7.0	6.62	6.43	6.43	6.36	7.3	7.6	6.5-8.5
Sodium	mg/l	29	32	39	19	15	39	15	14	26	200
Potassium	mg/l	1	3	1	2	2	2	2	2	4	12
Calcium	mg/l	18	35	2	7	4	10	7	7	18	75
Bicarbonate	mg/l	<LOQ	175	150	110	90	105	70	95	130	-
Chloride	mg/l	45	70	17	12	15	16	13	18	31	150-600
Sulfate	mg/l	1.0	24	1.0	1.0	1.0	1.0	1.0	3.0	2.0	400
Nitrate	mg/l	3.29	3.04	0.84	2.73	0.38	0.63	2.46	0.33	2.1	10
Nitrite	mg/l	0.08	0.15	<LOQ	<LOQ	<LOQ	0.07	<LOQ	<LOQ	0.02	<1.0
Arsenic	mg/l	0.002	0.002	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.05
Fecal Coliforms	N/100ml	0	0	0	0	0	0	0	0	0	0

Source: JICA Study Team, EQMS Laboratory and Department of Public Health and Engineering Lab; Analysis date: 22/03/2017- 30/04/2017 and 30/04/2017- 22/05/2017, 30/04/2017-22/05/2017(Depot)

Note: LOQ- Limit of Quantitation

Dhaka city depends on groundwater for water supply. The underground structure may cause negative impacts to the ground water.

Groundwater level along the project site is approximately -67~57m⁶. Water extraction in

⁶ Bangladesh Water Development Board

Dhaka is conducted below 100m of ground level. (see “Water Level” of Table 5.6.16) The railway level of the underground structure is about -10m to -30m. Therefore, the underground structure will not cause negative impacts to the groundwater.

11) Geographical Features

See “6) Ground Subsidence”

12) Resettlement and Land Acquisition

The project will have direct impact on 115 PAUs including 32 title holders from the station areas. The PAUs cover 12 residential households (HHs), 101 CBEs and one residential cum CBEs and 02 households losing other properties. In addition to the PAUs 23 CPRs are going to be affected.

All these losses will be compensated and it is expected that the APs will find their own place or means to resettle and rehabilitate them. Certainly the project will extend additional support to the vulnerable APs. Without RAP, restoration of livelihood would be very difficult for them.

A total of 25 ha land will be required to be acquired for the depot area to implement the project. However, it is estimated that additional 0.23 ha of land will be required in different pockets along the route, mainly in the station areas.

13) Poor People

It is defined that annual income less than Tk 60,000 is hard core poor in Bangladesh. Considering the economic condition of the project area, these 23% affected households may be considered as hard core poor. The hard core poor and poor households will get special assistance under the policy of RAP. Special assistance will be paid to those who are women headed, old aged and physically handicapped and supported income generation activities under LIRP.

14) Ethnic Minorities and Indigenous Peoples

More than 98% of the affected HHs are Muslim and rest are Hindu by religious believe. No other religious group of people was identified among the affected people in the project area.

In Bangladesh, the term “indigenous people” is a generic term that includes many different cultural categories including ethnic minorities, tribals, upajati, paharis and jhumias. However, the most commonly used and preferred term today is adibasi, or ethnic minority which encompasses all of the above under one “identity” as indigenous people who have distinct social origins and cultural lives. They constitute nearly 1.1% of the total population of Bangladesh, with a major concentration in the Chittagong Hill Tracts (CHT) area. Among the project affected people no ethnic minority people have been identified in the project area.

15) Local Economies, such as Employment, Livelihood, etc.

Many of the stations under this project are located nearer to the business center where people usually gather. This is why people who are living around the area have established business and some small shops by some arrangement or are just encroachers on government land, where they got the opportunity. It is found that more than 87% household heads are involved in business. The study identified 146 people to be affected by losing their income for displacement of commercial and business premises. They are the principal bread earner of their families. Majority of them (76%) are engaged in business, 1.7% in

service, 2.6% in household work, 7% are aged/retired and 1.7% household heads are involved in other type of occupation.

16) Land Use and Utilization of Local Resources

Almost total acquired area is rural in nature covering three types of land. Majority of the land is agriculture land followed by vita/homestead and rest is for khal (water body). However, majority of the land area where MRT routes would pass above and under the ground and the stations above and under the ground is owned by the government and mostly being used as road network in the city. Along these routes and station area most of the project affected units are business and commercial premises. People are having their livelihood and operating business by utilizing the road network facilities.

There are some green areas or some tree covered area in the project area. This area is again mostly around the depot area in Purbachal. The project will also require removal of approximately 126 thousand trees of various sizes and categories from the surveyed area. Majority are fruit bearing trees.

17) Water Usage

As mentioned on "Groundwater", the project will not cause negative impacts the groundwater which is origin of water supply in Dhaka. Therefore, the project will not cause negative impacts to water usage.

18) Existing Social Infrastructures and Services

The project area covers both the DNCC and DSCC of Dhaka district and Rupganj Upazila of Narayanganj district and administered by Mayors and Chairmen/Councilors as part of local government. However, for administration the project area is within Dhaka and Narayanganj Districts. In addition to Dhaka district administration many other agencies are involved like RAJUK, DWASA, PDB, RHD and others.

The alignment of MRT will cross existing power cable, drinking water pipe, and water drainage etc., further study aims to specify those utilities and to take actions to protect or divert them.

19) Social Structure such as Social Capital and Local Decision-Making Institutions

The society in Bangladesh in general is a traditional society. However, the city society has some unique characteristics like any other city dwellers with diversified social back ground of the migrant people coming from different areas of the country.

The identified 23 Common Property Resources (CPR) as social institutions or resources which are going to be affected by the project. The CPRs include mosque, madrasa, school/college, graveyard, offices etc.

20) Misdistribution of Benefits and Damages

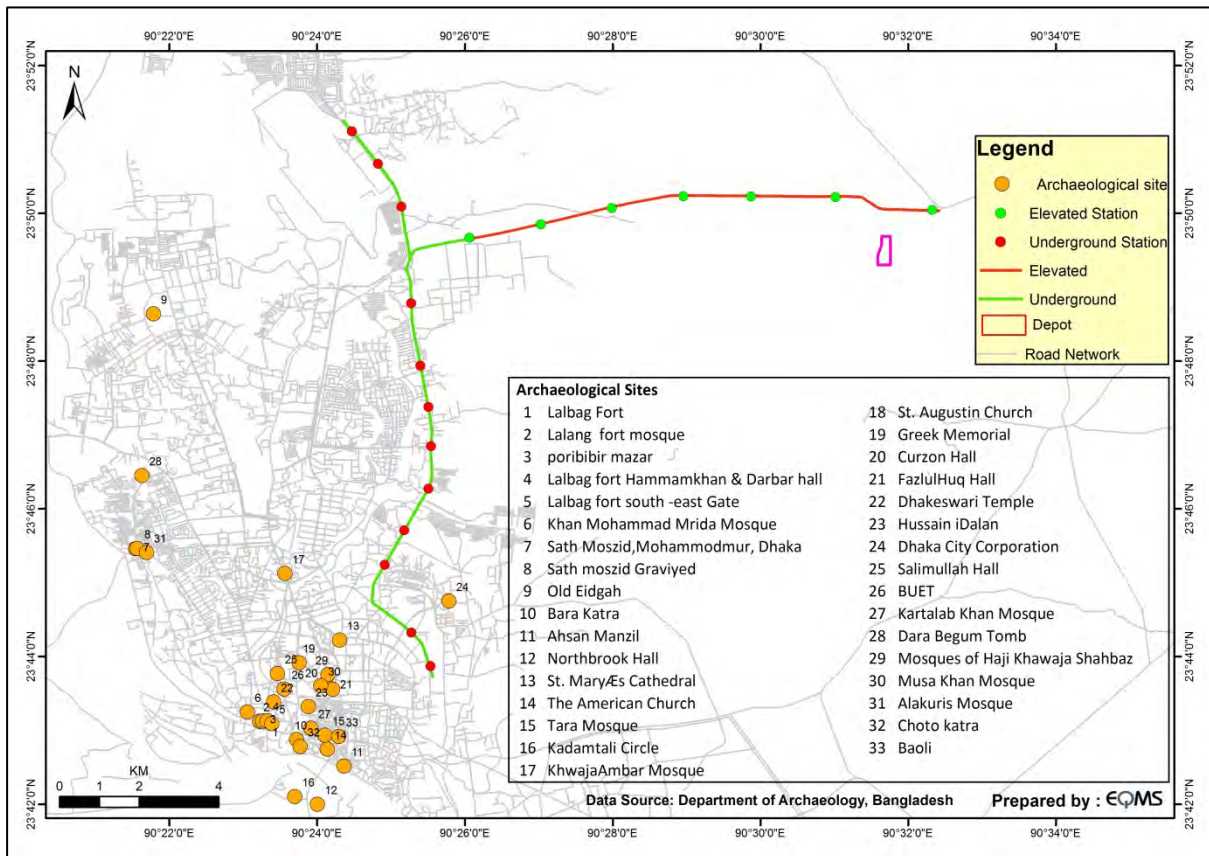
It is envisaged that the benefit of the MRT line will not be distributed evenly to all the people along the line equally. Certainly the people near the station area in general will be benefitted more. However, only the affected people will have to bear the burden of damages like loss of assets and livelihood. It is speculated that the economically solvent affected people will be able to recover their damages through receiving compensation and utilizing the locational opportunity of the new infrastructure provided by the project. But the vulnerable and marginal APs will be difficult without assistance and they need support on income generation activities under LIRP.

21) Local Conflicts of Interest

Local conflicts are mainly generated through abuse of power by some group of people or by some individuals. Local problems and conflicts are mainly resolved through local informal and formal groups with the help of representatives from local government and when necessary other respective agencies get involved.

22) Cultural Heritage

Dhaka has a lot of cultural heritage. However, the cultural heritages concentrated on the Old Dhaka area. As a result of the survey of secondary materials such as an official information (List of Monuments: Department of Archaeology), there is no cultural heritage around the project. The project will cause negative impacts to cultural heritages.



Source: Department of Archeology, Bangladesh

Figure 5.6.6 Archaeological Heritage in Dhaka city

23) Landscape

On the section of Purbachal Line, viaduct structure is adopted. Since the area is still undeveloped but developing area, viaduct may affect landscape.

On stakeholder meetings (second stage), the attendants of the meetings were asked about issues of landscape. However, there are no response. Because tangible design cannot be proposed on the F/S stage, landscape and design of the viaduct should be continuously consulted with stakeholders on D/D stage.

24) Gender

As a result of focus group discussion which targeted women group, their needs were specified as follows.

Design of Station

- Separate ticket booths for male and female passengers
- Separate washrooms for male and female passengers
- Separate prayer rooms (space) for male and female passengers
- Adequate lighting facilities
- Clean waiting room (space) and platform
- Installation of escalator/lift
- Installation of drinking water facility
- Allocation of vendor (small business) area (space) for women

Design of Rolling Stock

- Separate compartments for male and female passengers
- Reserved/priority seats for pregnant women, women with young children, children, elderly people and physically challenged passengers
- Adequate lighting

Construction

- Employment of women for construction work
- Equal pay/work/opportunities for male/female workers
- Employment of women for construction project related work (e.g.: supporting staff, cooking, cleaning, laundry, catering, etc.)
- Separate prayer rooms (space), washroom, changing rooms, dining space (different timing between male/female for lunch break) for male/female workers/staff
- Provision of training to raise awareness on gender
- Provision of training on prevention of HIV/AIDS

Operation

- Deployment of female staff for both ground operation and on board
- Setting affordable fares
- Setting time schedule to meet women's needs
- Keep clean (station, platform, train, etc.)
- Responding to gender issues, measures on sexual harassment and implementation of those

Others

- Concerning the resettlement plan, consideration should be given to the women so that they will also be able to obtain financial compensation
- In relation with the above, not only the financial compensation but provision of employment opportunities should be also considered
- During the planning stage, women's opinions should be heard as well as women's participation of decision making should be secured

25) Children's Rights

As a result of the survey of maps, it was confirmed that some universities scattered around the project site. Because the structures of the project are viaduct and underground, school-commuting roads will not be divided. However, on the construction stage, appropriate considerations to secure the school-commuting roads will be required on construction plan.

26) Infectious Diseases such as HIV/AIDS

HIV prevalence rate is less than 0.1% and it is still low in Bangladesh. However, the sufferers are sometimes found among sex workers in Mongra and Chittagong. It is reported that that risk due to the turn used needles is much higher than sexual intercourse.

Influx of construction workers by the project may trigger the prevalence of the HIV/AIDS. To avoid the prevalence of the HIV/AIDS, Appropriate education and enlightenment for the construction workers should be introduced on construction sites.

27) Working Conditions (including Occupational Safety)

It is necessary to secure the safety of workers, pedestrians and vehicular traffics in both in construction and operation phases. Many temporary shops and vendors are found in crowded streets. There might be a possibility that those shops have tendency the lack of consideration on occupational safety. The construction sites have to pay attention to those small shop workers.

28) Trans-Boundary Impacts or Climate Change

Construction machinery will temporarily increase greenhouse gas. Reducing the emission of greenhouse gas, the machinery needs to well maintain. And/or the introduction of energy saving machinery is desirable.

On the depot site, it is expected that approximately 126 thousand trees are logged. Tree cutting losses absorption of greenhouse gas. Because annual CO₂ absorption of a tree is roughly 80kg, totally CO₂ absorption of roughly 10 thousand ton is lost. It is equivalent to CNG of roughly 3.7 thousand ton. As mitigation measures, the study team proposes replanting for tree cutting.

Train operation generates modal shift from vehicle traffic to mass transit system. The operation of the railway can increase greenhouse gasses by power consumption generated by thermal power plants. However, because train operation is remarkably energy saving measures comparing vehicle traffic, the project will contribute to reduce the emission of greenhouse gas. The implementation of the project will decrease 63,421t of CO₂ emission a year.

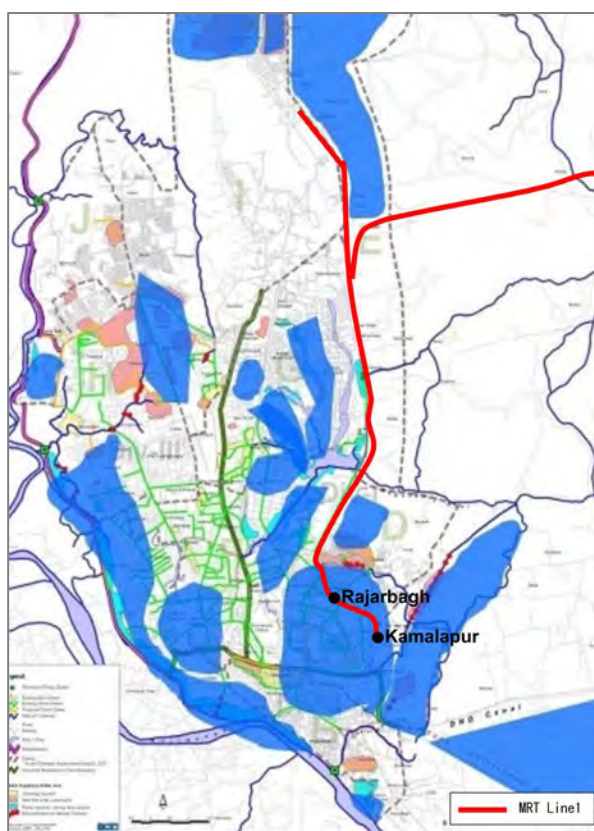
Table 5.6.17 Reduction Volume of CO₂ Emission by MRT Line 1

	Value	Unit
Emission reduction	63421	tCO ₂ /year
Baseline emission	141648	tCO ₂ /year
Number of passenger of the project activity in year y	371,205,000	passenger/year
Average trip distance of the passenger of the project activity in year y	9.8	km
CO ₂ emission factor per passenger kilometer for transport mode i	Auto Tempo	3.41945E-05 tCO ₂ /passenger-km
	Microbus	0.000117188 tCO ₂ /passenger-km
	Standard Bus	2.35647E-05 tCO ₂ /passenger-km
	Other1	0 tCO ₂ /passenger-km
	Other1	0 tCO ₂ /passenger-km
	Other1	0 tCO ₂ /passenger-km
Share of passengers by transport mode i in the baseline scenario in year y	Auto Tempo	7.289 %
	Microbus	15.729 %
	Standard Bus	76.982 %
	Other1	0 %
	Other1	0 %
	Other1	0 %
Project emission	78227	tCO ₂ /y
Annual electricity consumption associated with the operation of the project activity in year y	171550	MWh/year
CO ₂ emission factor of the grid electricity	0.456	tCO ₂ /MWh

Source: JICA Study Team

29) Risk of Flood

Dhaka city is flood prone area. (see 2.3.2 Hazards) On the past major inundations, a part of the project such as Kamalapur, Rajarbagh has been inundated. (Figure 5.6.7)



Source: RSTP, Figure6.28 The inundation map of Greater Dhaka, 2004, location of MRT Line5 is added.

Figure 5.6.7 Inundation Risk around MRT Line1 (location of inundation on September, 2004)

Flood disaster may cause inundation to underground structure of the project. And the project may also encourage flood disaster. Against the negative impacts of flood and inundation, the project proposes the following mitigation measures.

(1). Mitigation measures on the project

Against potential risk of flood hazard, the project will introduce the anti-inundation measures taken in subway projects in Japan such as the followings.

- Provision of waterproof door at entrance of tunnel
- Vent and ventilation shaft are closed automatically by water sensor. Vent is installed on high place.
- Provision of drain pump

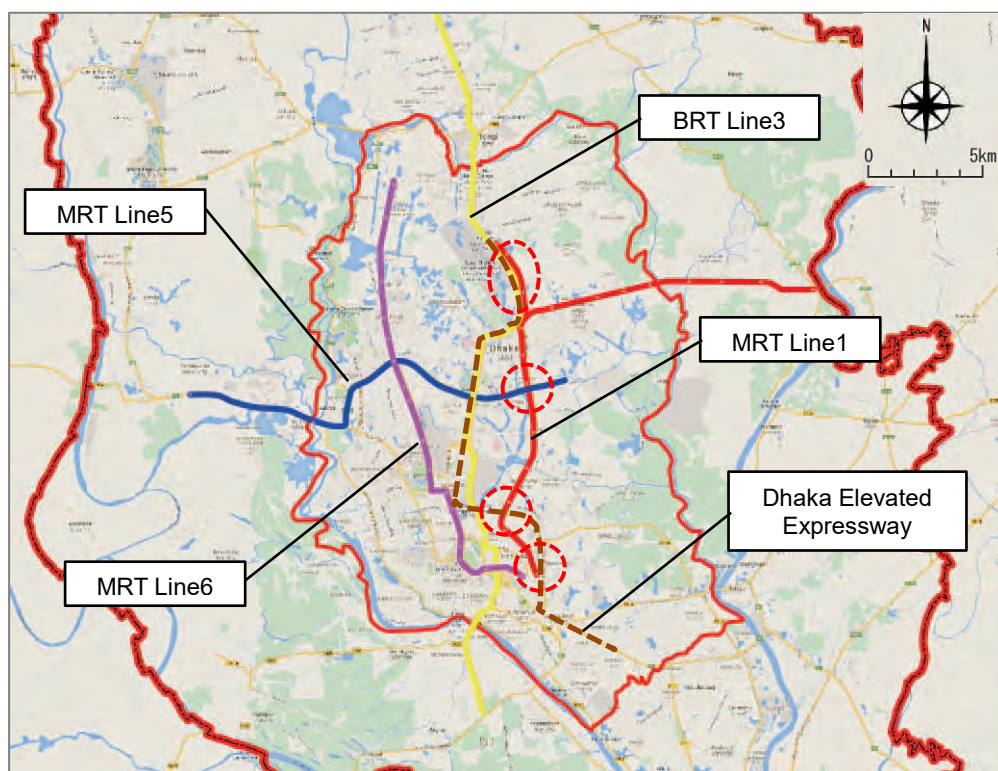
(2). Negative impacts by the project

Because of underground and viaduct structures, the alignment of the project does not hamper draining and flow of inundation, and does not encourage the flood disaster.

RSTP which is a basic plan of the project proposes the decentralization of urban areas. Backbone which supports the scenario is MRTs. The project is expected to connect suburb and urban areas effectively, and promote dispersion from inundation areas to suburb areas which is anti-disastrous.

5.6.2 Accumulated Impacts by other Projects

There are some major projects in Dhaka city. Due to overlapping with construction of other projects, it is expected that negative impacts increase. Particularly, it should be noted that negative impacts increase at crossing points or parallel sections especially on construction period. Therefore construction period of both projects needs to be confirmed. MRT Line 1 will cross Dhaka Elevated Expressway BRT Line3, LRT Line 5. (see Figure 5.6.8)



Source: JICA Study Team

Figure 5.6.8 Major Projects in Dhaka

1) Dhaka Elevated Express

Dhaka Elevated Express (DEE) is an elevated road project which connects Shahjalal International Airport, Mohakhali, Kamalapur and Dhaka Chittagong Highway. DEE crosses MRT Line 1 at Malibagh station, and parallels around International Airport.

DEE project is ongoing, and is going to reach the completion at December 2020. Since commencement of the construction work of MRT Line 1 is from the middle of 2021, construction work of both projects will not overlap. Therefore, accumulated impacts are not expected.

2) BRT Line 3

The route of BRT Line 3 is divided to North and South section. North section which ADB has sponsored connects Gazipur and Uttara. South section which WB has been sponsored connects Uttara (Airport) -Mohakhali – Ramna- Gulisthan -Keranigonj. A part of the south section of BRT Line 3 shares DEE route and MRT Line 1. Regarding BRT Line 3, some assessments on project feasibility are being conducted by project proponents and donors. Because BRT Line 3 will run existing road or proposed road, accumulated negative impacts will not significant even if construction works of the both projects overlap.

3) MRT Line 5

MRT Line 5 is an urban railway which connects the east and the west area in Dhaka city. MRT Line 5 crosses the project at the intersection at Natun Bazar. Natun Bazar station is a junction station with MRT Line 1 station. Stations of both projects adopt underground structure.

At present, Construction period of MRT Line 5 is from 2022 to 2027 to aim at the operation in 2028. Since the construction period of MRT Line 1 is from 2021, construction work of both projects may overlap. Natun Bazar is remarkably congested area. In case that construction work of both projects overlaps, negative impacts including deterioration of traffic congestion, air pollution and traffic noise are expected. To avoid accumulated negative impacts, construction schedule of both project should be sufficiently managed.

4) Cumulative impacts on the Operation Phase

The project connects MRT Line 5 at Natun Bazar Station. The junctions will make more liveliness. On the other hand, it is expected that traffic concentration to the junctions causes more congestion. On development around the junctions, considerations to avoid the congestion is required.

5.6.3 Traffic Management in Construction and Expected Negative Impacts

Construction of the alignment is almost carried out at underground. However, because underground stations are constructed by open-cut method, road traffic will be affected by restriction of lanes. During the construction of stations, traffic management will be conducted to minimize restriction of lanes and a part of construction work will be conducted at night to avoid road congestion. (see) As negative impacts by lane control, traffic congestion and pollution caused by the traffic congestion are assumed.

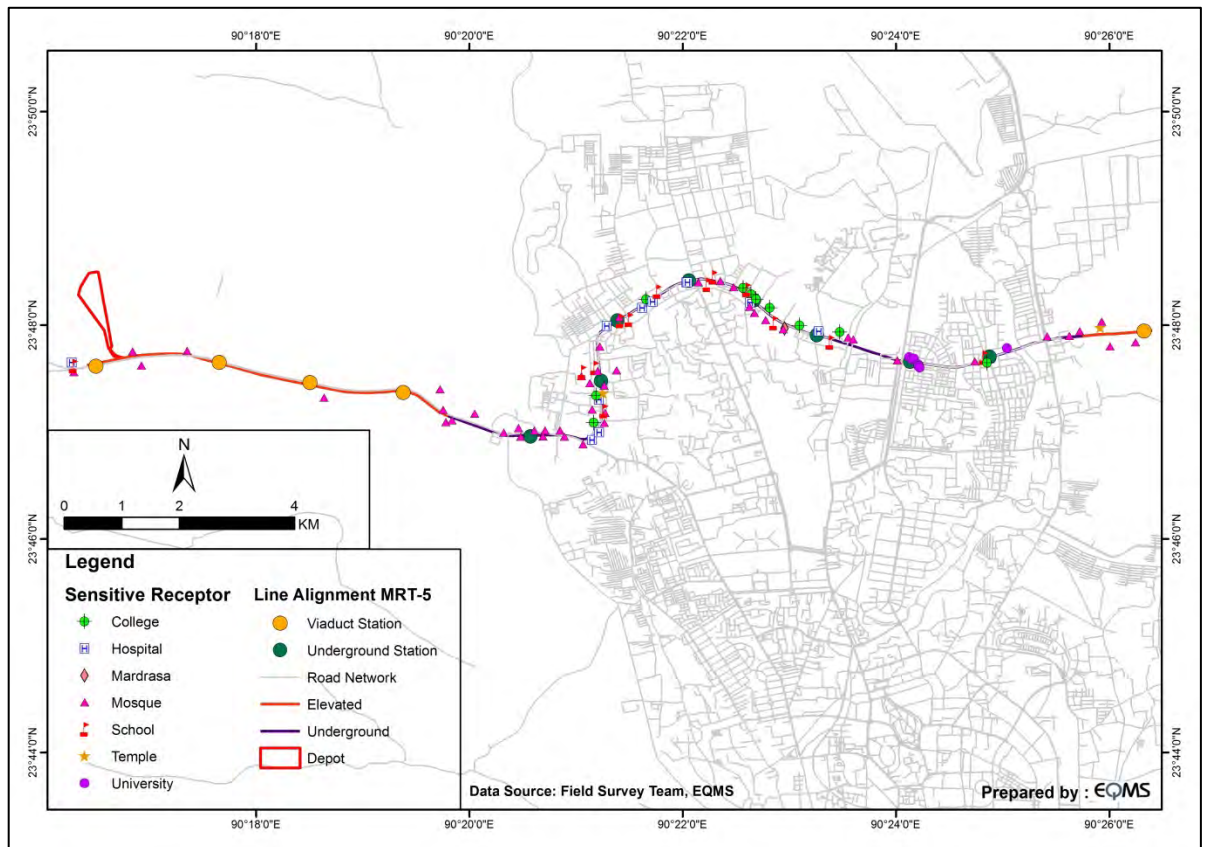
Regarding air pollution, because cause of the air pollution in Dhaka is thought of as dust, road congestion will not directly cause increase of dust. Regarding traffic noise, because it depends on traffic volume, traffic noise will not increase without increase of traffic volume.

5.6.4 Concentration of Vehicle Traffic around Stations

Because the project runs parallel to major roads, it is expected that the traffic volume of the major roads is reduced. On the other hand, it is also expected that vehicle traffic concentrates the new stations. In case that, noise and air pollution may be worsen. To handle the vehicle traffic smoothly and mitigate the negative impacts, appropriate developments around the stations are needed. In this study, suitable developments in front of / around the stations are studied.

5.6.5 Sensitive Facilities

The alignment of the project passes the urban area, and there is a lot of sensitive facilities along the alignment. Figure 5.6.9 shows locations of sensitive facilities such as educational, religious and medical institutes around the alignment of the project. Along the Airport line, Mosques are evenly scattering on the whole section. Comparing the religious facility, Educational and medical institutes are relatively few. Since the structure of the project is underground and viaduct, there is no possibility that the structure cuts access path to these facilities.



Source: JICA Study Team

Figure 5.6.9 Sensitive Facilities along MRT Line1

5.6.6 Considerations on Procurement of Materials

The project requires to procure general materials used on construction work. The quantity of concrete which is a main material is expected to approximately 180 thousand m³ (except pile work). Because aggregate which is raw materials of concrete is gathered from quarry sites, mass gathering of aggregate may cause negative impacts around quarry sites.

On the other hand, because Bangladesh is no mountainous, it is difficult to gather the aggregate, and depends on import from neighboring countries. The project also similar to other projects. (On the advance work of MRT Line 6 project, aggregate is imported from Thailand.) Because of import, it is out of object of EIA system of Bangladesh. (ECC for quarry site)

Regarding the considerations for material procurements including aggregate, the study team is consulting with the counterpart about the considerations including green procurements. On the consultation which is held on September 2017, this issue was discussed, and the counterparts mentioned that bidding documents can take the environmental considerations (green procurement) on the material procurement. The study team proposes procurement from quarry sites which acquire environmental permit on each country as essential conditions on procurement. About more considerations including the green procurement, consultation is continued with the counterpart.

Construction of the depot site needs filling soil of approximately 720 thousand m³. Because specifications of the filling soil are fixed by detail design, so far location of procurement is not able to be fixed. The counterpart describes this based on the detail design. MRT Line 6 procures filling soil for the depot site from Megna river and Sylheti (north east of Bangladesh). it is expected that the project also follows it.

5.6.7 Issues on Projects assisted by other Donors

Around Dhaka city, BRT Line 3 (north section: Gazipur – Airport) assisted by ADB is being implemented. As results of interview to the person in charge of environmental and social matters⁷, the following issues and problems were raised:

(Social Considerations)

- (1). In Dhaka city, land rights are very complicate. It is very difficult to find out true owners of lands.
- (2). It is difficult to acquire lands of apartments and commercial buildings. Power of land owners is very strong, and compensation cost is rocketing up.
- (3). Identification of squatters and hawkers is difficult because they are wandering.

(Environmental considerations)

There is no problem on environmental matters.

As above, BRT Line 3 project has mainly land acquisition and social issues.

⁷ Md. Momenu Islam Mridha, Project Manager, Greater Dhaka Sustainable Urban Transport Project

5.7 The Assessment of Impacts

Draft scoping and results of the survey are shown on Table 5.7.1.

Table 5.7.1 Draft Scoping (MRT Line1)

No	Items	Evaluation				Reason of evaluation
		Scoping		After survey		
		Before/ under construction	Operation	Before/ under construction	Operation	
Pollution Control						
1	Air Pollution	B-	B+	B-	B+	<p>Construction Phase:</p> <ul style="list-style-type: none"> Construction works and operation of construction equipment will generate dust and exhaust gas. Convergence with construction work of MRT Line5 will cause more negative impacts. <p>Operation Phase:</p> <ul style="list-style-type: none"> Air pollution will be mitigated by reducing traffic congestion.
2	Water pollution	B-	B-	D	B-	<ul style="list-style-type: none"> The project crosses the major water bodies by underground or viaduct structures. Therefore, there are few significant impacts of water pollution. However, to correspond uncertainty of construction plan, monitoring of the water pollution should be introduced. <p>Operation Phase:</p> <ul style="list-style-type: none"> Waste water from the depot and stations is treated to meet the standards of Bangladesh, and discharged. No mitigation measures may cause water pollution to water bodies.
3	Soil pollution	B-	B-	B-	B-	<p>Construction Phase:</p> <ul style="list-style-type: none"> Bad maintenance construction machinery and vehicles may cause soil contamination by leak of oil. In case that filling soil for embankment is contaminated, the vicinity of the depot site may be contaminated. In case that excavation soil is contaminated, there is a possibility of a spread of hazardous materials. <p>Operation Phase:</p> <ul style="list-style-type: none"> Maintenance facility of depot may cause soil contamination by leak of oil.
4	Waste	B-	B-	A-	B-	<p>Construction Phase:</p> <ul style="list-style-type: none"> Construction work will vast quantity of excavation soil. About suitable measure of the excavation soil should be proposed on D/D stage. <p>Operation Phase:</p> <ul style="list-style-type: none"> Illegal dumping from stations and depot may cause negative impacts on the environment.

No	Items	Evaluation				Reason of evaluation
		Scoping		After survey		
		Before/ under construction	Operation	Before/ under construction	Operation	
5	Noise and Vibration	B-	B-	B-	B-	Construction Phase: · Without mitigation measures, construction works will cause noise and vibration. Operation Phase: · Without mitigation measures, operation of trains may cause noise around viaduct sections.
6	Ground subsidence	C	C	B-	D	Construction /Operation Phase: ·Because appropriate methods will be adopted to avoid ground subsidence, there will be few negative impacts to ground subsidence.
8	Bottom sediment	B-	D	D	D	Construction Phase: · The project crosses the major water bodies by underground structure. Therefore, there are few significant impacts of water pollution.
Natural Environment						
10	Ecosystem	B-	B-	B-	B-	Construction / Operation Phase: ·There are no negative impacts to rare species. However, monitoring survey is recommended to minimize negative impacts to the ecosystem including Near Threaten species around the depot site. In case that some impacts are found, appropriate mitigation measures are examined and implemented. For logged trees found on the detail design phase, replanting is implemented and monitoring.
11	Hydrology	C	C	D	D	Construction / Operation Phase: · The project crosses the major water bodies by underground structure. Therefore, there are few significant impacts of water pollution.
12	Groundwater	B-	D	D	D	Construction / Operation Phase: ·Because extraction level of groundwater in Dhaka city is below underground structure of the project, there will be few impacts to groundwater. However, to correspond uncertainty of forecast, monitoring of the groundwater is proposed.
13	Geographical features	B-	D	D	D	Construction Phase: · Because appropriate methods will be adopted to avoid ground subsidence, there will be few negative impacts to ground subsidence.
Social Environment						

The Preparatory Study on The Dhaka Mass Rapid Transit Development Project (Line 1)
Final Report (Summary)

No	Items	Evaluation				Reason of evaluation
		Scoping		After survey		
		Before/ under construction	Operation	Before/ under construction	Operation	
14	Resettlement/ Land Acquisition	A-	D	A-	A-	Pre-Construction Phase: · A 38.99 ha of large scale land acquisition and 4,632 PAPs are assumed. Operation Phase: Impact will remain if RAP is not carried out appropriately. · Impact will be small when the prepared RAP is applied.
15	Poor people	A-	A-	A-	A-	Construction Phase: · Poor whose income is less than 60,000 BDT are living in the project sites are affected. Operation Phase: · Further impact will be mitigated by the prepared RAP.
16	Ethnic minorities and indigenous peoples	C	C	D	D	Construction / Operation Phase: · No ethnic minority or indigenous people is found, therefore Impacts is nil.
17	Local economies, such as employment, livelihood, etc.	B-/B+	C	D	D	Construction / Operation Phase: · Some extent of negative impacts are assumed, however those will be small because of the new business opportunity created by MRT.
18	Land use and utilization of local resources	B-/B+	B+	B+	B+	Construction / Operation Phase: · Some extent of negative impacts were assumed, however those will be very small.
19	Water usage	C	C	D	D	Construction / Operation Phase: · Because extraction level of groundwater in Dhaka city is below underground structure of the project, there will be few impacts to groundwater.
20	Existing social infrastructures and services	C	C	B-	B-	Construction / Operation Phase: · Gates and fence will be affected with some extent.
21	Social structure such as social capital and local decision-making institutions	C	C	D	D	Construction / Operation Phase: · Negative impacts to local administrations will be assumed very small.
22	Misdistribution of benefits and damages	B-	B-	B-	B-	Construction / Operation Phase: · Since the benefits will be not distributed evenly, misdistribution will arise among them.
23	Local conflicts of interest	B-	B-	D	D	Construction / Operation Phase: · Local conflict will be solved with the help of respective local agency, therefore impact will be very small.
24	Cultural heritage	C	C	D	D	Construction / Operation Phase: · There is no cultural heritage in/around the project site.

No	Items	Evaluation				Reason of evaluation
		Scoping		After survey		
		Before/ under construction	Operation	Before/ under construction	Operation	
25	Landscape	B-	B-	B-	B-	Before Construction / Construction Phase: •So far there is no concerns of stakeholders. However considerations on viaduct design is needed.
26	Gender	C	C	D	D	Construction / Operation Phase: Following measures will be taken in accordance with the Gender Action Plan. In construction phase: • Equal pay/work/opportunities for male/female workers. •Provision of separate toilet • Resettlement planning which consider gender issue. In operation phase: •Deployment of female staff • Separate compartment, reserved/priority seat for women • Equal pay/work/opportunities for male/female workers
27	Children's rights	C	C	D	D	Construction / Operation Phase: •There is a lot of educational facility. The structures of the project are underground and viaduct. Therefore school-commuting road will be divided by the project. However, on the construction period, considerations to secure the school-commuting road is required.
28	Infectious diseases such as HIV/AIDS	B-	D	B-	D	Construction Phase: •Infection risks of HIV/AIDS may be increased among construction workers. Operation Phase: •Since the Project aims improvement of urban traffic, the project will not directly concern spread of infection risks of HIV/AIDS.
29	Working conditions (including occupational safety)	B-	B-	B-	B-	Construction Phase: •Inappropriate safety measures of contractor will deteriorate occupational safety. Operation Phase: •Inappropriate safety measures of railway operator will deteriorate occupational safety.
Others						
30	Trans-boundary impacts or climate change	B-	B+/-	B-	B+	Construction Phase: •Operation of construction machinery and vehicles will occur greenhouse gas (CO2). Tree cutting loses absorption of CO2. By replanting, the loss is avoidable. Operation Phase: •Modal shift to from vehicles to railway will reduce greenhouse gas.

No	Items	Evaluation				Reason of evaluation
		Scoping		After survey		
		Before/ under construction	Operation	Before/ under construction	Operation	
31	Accidents	B-	B-	B-	B-	Construction Phase: -There is a risk of accident on construction activity. Operation Phase: -Collision of vehicle and viaduct, and accident in depot are expected.
32	Risk of flood	C	C	B-	B-	Construction / Operation Phase: -Because the project site has a risk of flood, detail of mitigation measures is examined on detail design phase.

A+/-: Significant positive/negative impact is expected.

B+/-: Positive/negative impact is expected to some extent.

C: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)

D: No impact is expected

* Impact Items refer to "JICA Guidelines for Environmental and Social Considerations April 2010"

Source: JICA Study Team

5.8 Mitigation Measures and Costs

Regarding the items which were evaluated as A-, B-, or C on the scoping matrix (Table 5.7.1), mitigation measures are shown on Table 5.8.1 and Table 5.8.2.

Table 5.8.1 Mitigation Plan and Cost on Construction Phase

No	Items	Mitigation Measures	Cost	Responsibilities of implementation
1	Air Pollution	<ul style="list-style-type: none"> Water spray on construction site to prevent dust generation Suitable and continuous maintenance of construction machinery to control exhaust gasses Installation of temporary walls on the construction sites Formulation of rational construction plan to reduce operation hours of construction machinery 	To be included in service fee of construction	Contractor (supervised by DMTCL)
2	Water pollution	<ul style="list-style-type: none"> Suitable and continuous maintenance of construction machinery to prevent oil leak Periodic monitoring water quality of crossing rivers 	To be included in service fee of construction Monitoring cost is shown on Table6.9.1.	Contractor (supervised by DMTCL)
3	Soil pollution	<ul style="list-style-type: none"> Suitable and continuous maintenance of construction machinery to prevent oil leak Check contamination of soil for the depot embankment Check contamination of excavation soil 	To be included in service fee of construction	Contractor (supervised by DMTCL)
4	Waste	<ul style="list-style-type: none"> Regarding disposal of the excavation soil, less negative impact measure will be studied and taken. 	To be including service fee of consultation	Contractor (supervised by DMTCL)

No	Items	Mitigation Measures	Cost	Responsibilities of implementation
5	Noise and Vibration	<ul style="list-style-type: none"> Suitable and continuous maintenance of construction machinery to control noise emission Installation of temporary walls on the construction sites to prevent noise propagation Formulation of rational construction plan to reduce operation hours of construction machinery Monitoring of construction noise 	<p>To be included in service fee of construction</p> <p>Monitoring cost is shown on Table6.9.1.</p>	Contractor (supervised by DMTCL)
6	Ground subsidence	<ul style="list-style-type: none"> Appropriate planning of construction plan on detail design phase Confirmation houses along the project site before construction work Monitoring of shoring on construction work 	<p>To be included in detail design fee</p> <p>To be included in construction cost</p>	Contractor (supervised by DMTCL)
10	Ecosystem	<ul style="list-style-type: none"> Monitoring of ecosystem around the depot site Tree planting to mitigate tree cutting 	<p>Tree planting cost: 63 million BDT</p> <p>Monitoring cost is shown on Table6.9.1.</p>	Contractor (supervised by DMTCL)
12	Groundwater	<ul style="list-style-type: none"> Monitoring of ground water level and quality during construction period and until one year after completion 	Monitoring cost is shown on Table6.9.1.	Contractor (supervised by DMTCL)
13	Geographical features	<ul style="list-style-type: none"> Same as No.6 Ground subsidence 		
14	Resettlement/ Land Acquisition	<ul style="list-style-type: none"> Appropriate implementation of land acquisition and resettlement based on RAP 	To be shown on RAP	DMTCL,
15	Poor people	Ditto	Ditto	DMTCL
22	Misdistribution of benefits and damages	Ditto	Ditto	DMTCL
25	Landscape	<ul style="list-style-type: none"> Information disclosure and continuous discussion with residents, and adoption of opinions of residence to secure landscape 	To be included in service fee of construction	DMTCL, Contractor
27	Children's rights	<ul style="list-style-type: none"> Information disclosure and continuous discussion with residents Preparation of construction plan to secure school-commuting roads 	To be included in service fee of construction	Contractor (supervised by DMTCL)
28	Infectious diseases such as HIV/AIDS	<ul style="list-style-type: none"> Education and enlightenment for construction workers to prevent prevalence of HIV/AIDS 	To be included in service fee of construction	Contractor (supervised by DMTCL)
29	Working conditions (including occupational safety)	<ul style="list-style-type: none"> Preparation of work safety plan and implementation 	To be included in service fee of construction	Contractor (supervised by DMTCL)
30	Trans-boundary impacts or climate change	<ul style="list-style-type: none"> Suitable and continuous maintenance of construction machinery to reduce fuel consumption Introduction of energy saving construction machinery 	To be included in service fee of construction	Contractor (supervised by DMTCL)
31	Accidents	<ul style="list-style-type: none"> Installation of suitable safety facility on construction site Suitable use of personal safety equipment to secure safety of workers Education and enlightenment for construction workers to prevent accidents 	To be included in service fee of construction	Contractor (supervised by DMTCL)

No	Items	Mitigation Measures	Cost	Responsibilities of implementation
32	Risk of flood	<ul style="list-style-type: none"> Preparation of hazard management plan to avoid flood damage on construction period 	To be included in service fee of construction	Contractor (supervised by DMTCL)

Source: JICA Study Team

Table 5.8.2 Mitigation Plan and Cost on Operation Phase

No	Items	Mitigation Measures	Cost	Institutional Responsibilities
2	Water pollution	<ul style="list-style-type: none"> Check of waste water from stations and maintenance facilities 	To be included in routine operation	DMTCL (Operator)
3	Soil pollution	<ul style="list-style-type: none"> Suitable and continuous maintenance of maintenance facility of depot to prevent leak of oil and other chemicals 	To be included in routine operation	DMTCL (Operator)
4	Waste	<ul style="list-style-type: none"> Enlightenment for users to prevent illegal dumping from stations Preparation of waste management plan including depot operation 	To be included in routine operation	DMTCL (Operator)
5	Noise and Vibration	<ul style="list-style-type: none"> Introduction of noise mitigation measures such as noise barrier on viaduct sections Suitable and continuous maintenance of rail structure to reduce noise generation 	To be included in the project cost to be finalized during D/D	DMTCL (Operator)
10	Ecosystem	<ul style="list-style-type: none"> Monitoring of ecosystem around the depot site Tree planting to mitigate tree cutting (4 trees per a logged tree) 	Replanting cost: To be shown on table 6.9.1.	DMTCL (Operator)
15	Poor people	<ul style="list-style-type: none"> Confirm APs if displacement is carried out appropriately in accordance with RAP. Confirm the present situation of APs 	DMTCL will hire outsourced monitoring firm.	DMTCL
23	Misdistribution of benefits and damages	<ul style="list-style-type: none"> Confirm APs if displacement is carried out appropriately in accordance with RAP. Confirm the conducted compensation and LIRP are appropriate or not. 	DMTCL will hire outsourced monitoring firm.	DMTCL
25	Landscape	<ul style="list-style-type: none"> Information disclosure and continuous public consultation, Mitigation plan to secure landscape to incorporate public opinions (on detail design phase) 	To be included in detail design fee	DMTCL
29	Working conditions (including occupational safety)	<ul style="list-style-type: none"> Preparation of operation plan to secure occupational safety 	To be included in routine operation	DMTCL (Operator)
31	Accidents	<ul style="list-style-type: none"> Preparation of operation plan to secure occupational safety 	To be included in routine operation	DMTCL (Operator)
32	Risk of flood	<ul style="list-style-type: none"> Development of safety management plan Maintenance of anti-flood facilities of alignment and stations 	To be included in routine operation	DMTCL (Operator)

Source: JICA Study Team

5.9 Monitoring Plan

5.9.1 Monitoring plan

In Bangladesh, there is no system of environmental monitoring and inspection. To prevent deterioration of environment and social situation, monitoring of environment and social items which were evaluated as possible negative impacts should be monitored, reported and inspected. Monitoring plans are shown on Table 5.9.1 and Table 5.9.2.

Table 5.9.1 Monitoring Plan and Cost on Construction Phase

No	Items	Method of monitoring	Locations	Frequency	Cost	Responsibilities of implementation
1	Air Pollution	Confirmation of mitigation measures on a construction plan	-	One time before commencement of construction work	To be included in consulting fee	Consultant (DMTCL)
		Confirmation of implementation of mitigation measures on field	Construction sites	During construction period	To be included in consulting fee	Consultant (DMTCL)
		Sample collection and laboratory analysis PM10, PM2.5, NOx	6 locations	Two times a year 24 hours	4,500,000B DT a year	Contractor (supervised by DMTCL)
2	Water pollution	Confirmation of mitigation measures on a construction plan	-	One time before commencement of construction work	To be included in consulting fee	Consultant (DMTCL)
		Confirmation of implementation of mitigation measures on field	Construction sites	During construction period	To be included in consulting fee	Consultant (DMTCL)
		Sample collection and laboratory analysis DO, COD, PH, TSS oil grease, and total coliform index.	3 locations	Two times a year	1,200,000B DT a year	Contractor (supervised by DMTCL)
3	Soil pollution	Confirmation of records of construction activities (regular maintenance of construction machinery)	Construction sites	During construction period	To be included in construction cost	Contractor (supervised by DMTCL)
		Referred to 6.9.2				
4	Waste	Confirmation of records of construction activities	Construction sites	During construction period	To be included in construction cost	Contractor (supervised by DMTCL)
5	Noise and Vibration	Confirmation of mitigation measures on a construction plan	-	One time before commencement of construction work	To be included in consulting fee	Consultant (DMTCL)

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No	Items	Method of monitoring	Locations	Frequency	Cost	Responsibilities of implementation
		Confirmation of implementation of mitigation measures on field	Construction sites	During construction period	To be included in consulting fee	Consultant (DMTCL)
		Noise measurements Vibration measurements	9 locations	One time a month 24 hours	5,000,000B DT a year	Contractor (supervised by DMTCL)
6	Ground subsidence	Confirmation of mitigation measures on a construction plan	-	One time before commencement of construction work	To be included in consulting fee	Consultant (DMTCL)
		Confirmation of implementation of mitigation measures on field	Construction sites	During construction period	To be included in consulting fee	Consultant (DMTCL)
		Confirmation of records of construction activities	Construction sites	During construction period	To be included in construction cost	Contractor (supervised by DMTCL)
10	Ecosystem	Survey of fauna and flora	Depot site	One time a year	1,000,000B DT a year	Contractor (supervised by DMTCL)
12	Groundwater	Sample collection and laboratory analysis Groundwater level and quality Colour, Temperature, pH, Sodium, Potassium, Calcium, Bicarbonate, Chloride, Sulfate, Nitrate, Nitrite, Arsenic, Fecal Coliforms	5 locations	One time a year 4 time a year for groundwater level	1,650,000B DT a year	Contractor (supervised by DMTCL)
13	Geographical features	Same as "6 Ground subsidence"				
14	Involuntary resettlement	Implementation record on land acquisition/resettlement	Implemented sites	During land acquisition and resettlement	Included in Consultant fee	I-NGO
15	Poor people	Yearly income of APs	Vulnerable people	Before and after resettlement	Included in Consultant fee	I-NGO
22	Misdistribution of benefits and damages	Yearly income of APs	Implemented sites	Before and after resettlement	Included in Consultant fee	I-NGO

No	Items	Method of monitoring	Locations	Frequency	Cost	Responsibilities of implementation
25	Landscape	Confirmation of records of public consultations	Along viaduct sections	During detail design	To be included in detail design fee	DMTCL
28	Infectious diseases such as HIV/AIDS	Confirmation of records of construction activities	Construction sites	During construction period	To be included in construction cost	Contractor (supervised by DMTCL)
29	Working conditions (including occupational safety)	Confirmation of safety plan of construction work	-	One time before commencement of construction work	To be included in consulting fee	Consultant (DMTCL)
		Confirmation of records of construction activities	Construction sites	During construction period	To be included in consulting fee	Consultant (DMTCL)
30	Trans-boundary impacts or climate change	(Maintenance of construction machinery) Confirmation of construction records	Construction sites	During construction period	To be included in consulting fee	Consultant (DMTCL)
		(Replanting) Confirmation of records of construction activities and field reconnaissance	Subject fields	After completion of replanting	To be included in consulting fee	Consultant (DMTCL)
31	Accidents	Confirmation of safety plan of construction work	-	One time before commencement of construction work	To be included in consulting fee	Consultant (DMTCL)
		(Implementation of safety plan) Confirmation of records of construction activities	Construction sites	During construction period	To be included in consulting fee	Consultant (DMTCL)
32	Risk of flood	Confirmation of safety plan	-	One time before commencement of construction work	To be included in consulting fee	Consultant (DMTCL)
		(Implementation of safety plan) Confirmation of records of construction activities	Construction sites	During construction period	To be included in consulting fee	Consultant (DMTCL)

Source: JICA Study Team

Table 5.9.2 Monitoring Plan and Cost on Operation Phase

No	Items	Monitoring Methods	Locations	Frequency	Cost	Responsibilities of Implementation
2	Water pollution	Sample collection and laboratory analysis DO, COD, PH, TSS oil grease, and total coliform index.	1 location around the drainage of the depot site	Two times a year	400,000BDT a year	DMTCL (Operator)
3	Soil pollution	(Depot site) Confirmation of maintenance records of maintenance facilities	Depot site	Every month	To be included in a project cost	DMTCL (Operator)
4	Waste	(Stations and depot site) Confirmation of operation records	Stations and depot site	Every month	To be included in a project cost	DMTCL (Operator)
5	Noise and Vibration	Noise measurements Vibration measurements	3 locations along the viaduct section	Yearly	150,000BDT a year	DMTCL (Operator)
10	Ecosystem	Survey of fauna and flora	Depot site	Yearly during two years after launching operation	1,000,000BDT a year	DMTCL (Operator)
12	Groundwater	Sample collection and laboratory analysis Groundwater level and quality Colour, Temperature, pH, Sodium, Potassium, Calcium, Bicarbonate, Chloride, Sulfate, Nitrate, Nitrite, Arsenic, Fecal Coliforms	5 locations	Yearly Quarterly for groundwater level)	1,650,000BDT a year	DMTCL (Operator)
15	Poor people	Yearly income of APs	Vulnerable people	Once	DMTCL	Out-sourced monitoring firm
22	Misdistribution of benefits and damages	Yearly income of APs	Implemented sites	Once	DMTCL	Out-sourced monitoring firm

No	Items	Monitoring Methods	Locations	Frequency	Cost	Responsibilities of Implementation
29	Working conditions (including occupational safety)	Confirmation of occupation safety plan	-	Before implementation of operation	To be included in a project cost	DMTCL
		Confirmation of operation records	-	During operation	To be included in a project cost	DMTCL
32	Risk of flood	Confirmation of safety management plan	-	Before implementation of operation	To be included in the project cost	DMTCL
		Maintenance for anti-flood facilities of the alignment and stations	-	During operation	To be included in the project cost	DMTCL

Source: JICA Study Team

5.9.2 Monitoring of Soil Contamination

Because the structure of the project is mostly underground structure, construction of the project generates vast quantity of excavation soil. In case that the excavation soil is contaminated, contaminants may scatter to other places. On the contrary, depot site needs vast quantity of soil for forming embankment. In case that the embankment soil is contaminated, the vicinity of the depot site may be contaminated. To prevent spread of contaminants, monitoring of soil contaminant should be conducted on carrying soil in and out,

1) Carrying out of Excavation Soil

(1) Soil Contamination Monitoring on Whole Section

On the whole construction section, excavation soils are sampled and analysed. Status of soil contamination is confirmed. (Frequency of sampling: roughly 1 sample / 200 thousand m³)

(2) Monitoring of Unnatural Soil Contamination

Sources of contaminants in ROW (such as factory) are found by map reading and field reconnaissance. For the source of contaminants, possible contaminants are identified by hearing survey from the land owners and residents around the site. In case that there is high probability of discharge of contaminants, soil contamination is monitored by sampling survey. (Frequency of sampling: roughly 1 sample / 1,000m²)

(3) Management of Contamination Soil

In case that results of monitoring show significant high concentration comparing standards, management and mitigation measures for disposal of contamination (such as containment, purification, elimination and etc.) is examined.

(4). Implementation and Management

Regarding soil contamination survey, DMTCL (consultant committed by DMTCL) instructs sampling locations considering the conditions of construction sites, and contractors carries out the survey. From the results of the survey, DMTCL assesses existence or nonexistence of soil contamination. In case that the site is contaminated, DMTCL and the contractor consult with Dhaka city and carry out it to appropriate sites.

2) Carrying in of Embankment Soil

(1) Identification of Origin of Soil

On borrow pits of filling soil, information such as location, status of land use, existence of contaminant source and land history are found by map reading, field reconnaissance and hearing survey.

(2) Confirmation of Soil Contamination

In case that no discharge of contaminants is confirmed as results of (1), natural soil contamination is confirmed by sampling survey. (Frequency of sampling: 1 sample / every site) In case that discharge of contaminants is confirmed, soil contamination is confirmed around the source of contaminants by sampling survey. (Frequency of sampling: roughly 1 sample / 1,000m²) If concentration of contaminants is remarkably high, no filling soil is acquired from the site.

(3) Implementation and Management

Regarding soil contamination survey of filling soil, DMTCL (consultant committed by DMTCL) confirms sites of filling soil materials, and assesses necessity of soil contamination survey. In case of necessity, the contractors carry out the soil contamination survey. DMTCL confirms the result of the survey, and assessed procurement from the site.

3) Contaminants and Standards

Soil contaminants which affect human health by intake are shown on Table 5.9.3. As criteria, soil contamination standards of Japan or other countries are referred.

Table 5.9.3 Example of Soil Contaminants

Category	Contaminants
Volatile Organic Compounds (VOCs)	chloroethylene carbon tetrachlorid 1,2-dichloroethene 1,1-dichloroethylene sys-1,2- dichloroethylene 1,3- dichloropropene dichloromethane tetrachloroethylene 1,1,1-trichloroethane 1,1,2- trichloroethane trichloroethylene benzene
Heavy Metal	cadmium and compounds hexavalent chrome cyanogen compound mercury and compounds selenium and compounds lead and compounds arsenic and compounds fluorine and compounds boron and compounds
Pesticide/PCB	simazine benthocarb thiuram PCB organic phosphorus

Source: Law of Soil Contamination Protect (Japan), Annex

5.9.3 Reporting and Inspection

Results of the monitoring survey need to be reported, and reflected to conservation of environment and social condition.

On the construction phase, most of the monitoring are implemented by contractors. The contractors compile monitoring reports from the results of the monitoring, and submit the reports to DMTCL. DMTCL submits the monitoring reports to JICA and relating donors. Moreover, DMTCL should share the reports with DoE. Although there is no legal basis of DoE's involvement to the monitoring, DoE's involvement is recommended to be inspected from specialist point.

On the operation phase, DMTCL (operator) has a responsibility of the implementation of the monitoring. DMTCL compiles monitoring reports from the results of the monitoring, and submit the reports to JICA and relating donors. As same as construction phase, DMTCL should share the reports with DoE.

Table 5.9.4 Monitoring report

	Construction Phase	Operation Phase
Preparation	By contractors	By DMTCL (operator)
Contents of report	Progress of construction works Results of monitoring Implementation status of mitigation measures Issues to be solved, and etc.	Progress of operation works Results of monitoring Implementation status of mitigation measures Issues to be solved, and etc.
Frequency	quarter during construction period	Half-yearly
Submission	To DMTCL DMTCL submits to JICA and relating donors, and shares with DoE	To JICA and relating donors DMTCL shares with DoE

Source: JICA Study Team

Monitoring schedule is shown on Table 5.9.5.

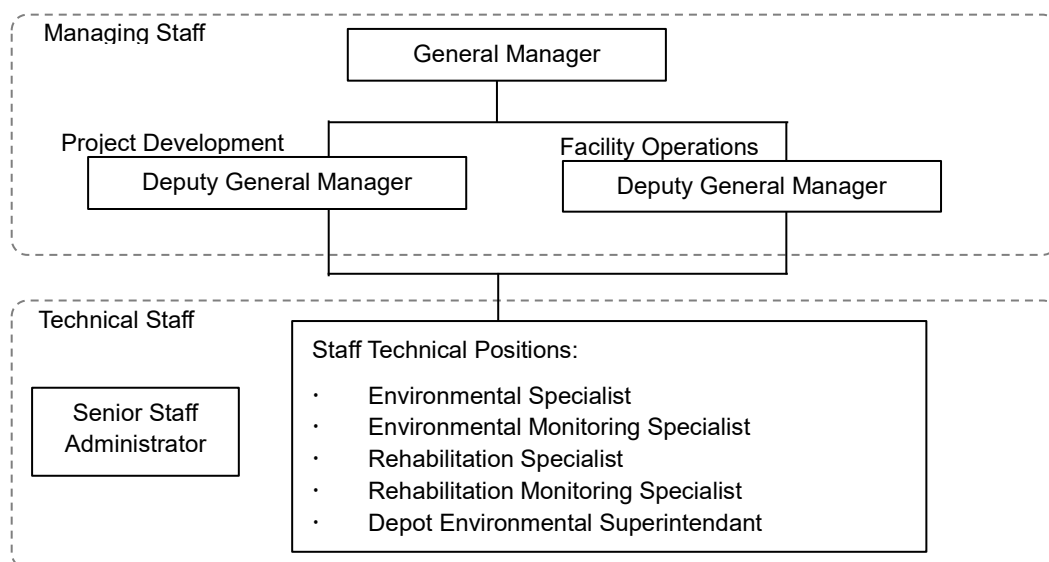
Table 5.9.5 Monitoring Schedule

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Project Implementation	F/S	▲EC	C/S B/D. D/D	Tendering	Construction	Construction	Construction	Construction	Construction	Commercial Operation	Commercial Operation
Monitoring of Environmental and Social Considerations		Review and revision of EIA report			Monitoring on construction stage	Monitoring on construction stage	Monitoring on construction stage	Monitoring on operation stage	Monitoring on operation stage	Monitoring on operation stage	Monitoring on operation stage

Project schedule is based on 4.10.3, Figure4.10.2.

5.9.4 Implementation Structure

Implementation structure of the environmental and social considerations for the project follows the operation of MRT Line 6. MRT Line6 organizes an operation section (referred to 4.11.1) in DMTCL (Dhaka Mass Transit Company Limited). ERD (Environment and Rehabilitation Division) prepared in this section handles the management of environmental matters except land acquisition and resettlement. Organization of ERD is shown on Figure 5.9.1. ERD conducts; instruction and supervision for environmental management of contractors; monitoring; and report to JICA. MRT Line 6 proposes procurement of environmental survey equipment for environmental management. However because an environmental survey requires special knowledge and technical skill, the study team recommends commission to consultants.



Source: Environmental Impact Assessment Main Report of Consultancy Services for Design, Construction Supervision, Procurement support and Management of Dhaka Mass Rapid Transit Development Project (January 2016, DMTCL)

Figure 5.9.1 Organization Chart of ERD

5.10 Stakeholder Meetings (EIA)

To collect opinions of the stakeholders including residents near the project site and reflect the opinions to the project, stakeholder meetings were held on 4 venues along the MRT Line 1 route. The stakeholder meetings have two stages. The first stage is meetings to explain the outlines of the project and EIA study. The second stage is meetings to explain the outlines of expected impacts by the project and mitigation measures.

5.10.1 First Stage Stakeholder meetings

Date/Venue/Number of participants	March 19, 2017 / Shahjadpur Bazar, Shahjadpur / 48 persons March 20, 2017 / Yusufganj high School and College, Purbachal / 30 persons March 29, 2017 / Bangamata Sheikh Fazilatunnesa Mujib Government Secondary School, Uttara, Dhaka / 41 persons March 30, 2017 / Purba Rampura High School, Rampura / 56 persons
Contents	Explanation of project outlines Project outlines, alignment, location of stations (explained by Google Earth) Explanation of EIA, scoping and potential environmental impacts Gathering of public opinions
Methods of inform of meetings	Informed through local politician, local governments, leader of women, NGO (disable, gender, minority and others), publicity on the street, visit to houses on the vicinity



Figure 5.10.1 First Stage Stakeholder Meeting (Rampura)

Table 5.10.1 Opinions on Stakeholder Meetings (First round)

Category	Comment/Question	Answer and Policy of Countermeasure
Planning	Shahjadpur is a densely populated place. A lot of people move everyday here. So we demand a station at our place shahjadpur bazaar.	We will recommend this issue to design team. They will consider it accordingly.
	It will be tough to mobilize from road to stations because of its higher depth and height.	We will recommend this issue to design team. They will consider it accordingly.
	Is there any plan of separate toilet/washroom for women in the metro rail and station?	Yes. We will recommend it in our EIA report.
	How many days will it take to start and complete?	It will take almost 4-5 years from beginning.
	Direction label/sign should be in Bengali so that people can easily understand how to travel.	Yes. We will recommend it in our EIA report.
	We need a station at our bazaar. (Purbachal)	It will be reviewed by the design consultant.
	How many days it will take to be completed?	It will take approximately 4-5 years to complete the total project from beginning.
	The total number of station need to be increased in metro rail line-1.	We will recommend it to the design team.
	I also demand a MRT from airport to kaliganj.	Design team will consider the alignment accordingly.
	Bangladesh is developed day by day and such kind of mega projects are the proof.	Yes, thank you for your complement.
	Want to know the process of Oxygen supply and Emanation of Carbon dioxide gas at the underground station.	Design team will be considered this issue during design the underground station
	I am interested to know about the financial issues like total budget, who will fund it, percentage of interest etc.	JICA will fund for the project. Total budget not yet finalized
	What kind of fuel will be used to run the Metro Rail? If the electricity supply turned off or failed then what will be the alternative plan?	Metro rail will be powered by electricity. There will be a backup plan to run the Metro rail to run the Metro Rail.
	How much earthquake resistance capacity has been considered to design the metro rail	Metro rail design not yet started. Now the feasibility study is going on. Earthquake resistance capacity will be considered during the details design stage.
Is there any disaster management plan? Is there any coordination among the different roads, flyover, and metro rail projects?	Yes, a detail disaster management plan will be prepared and followed accordingly The metro rail will be constructed after getting consent from different authorities related to the proposed alignment.	
Is there any chance of confliction with the existing flyovers?	No there is no chance of confliction with existing flyovers. Authority will design the project in collaboration with different agencies	
Construction	Excessive dust might be generated during construction phase. So it should be a major concern for authorities. And I hope our road side area will be beautified like Hatir Jheel by this project.	Yes, we will recommend it in our EIA report.
	During the construction period huge traffic congestion will be taken place so alternative traffic route need to be find out. Is there any possibility of ground water pollution?	Yes. We will recommend it in EIA report. There is no possibility of ground water pollution. Advanced technology will be used. All types of mitigation measures related to the environmental pollution will be recommended in EIA report
	What will happen if the place be flooded during tunnel construction?	It will cover in the Disaster Management Plan.
Environment	Is there any possibility of damage of nature in our area?	No. There are no possibilities of damage any properties in this area. All types of mitigation measures will recommend.
	Bangladesh needs information technology based educated society. So that people can easily take all types of advanced technology. About 0.5 million people live here (Daskhin Khan) and dust pollution will	Yes, authority will take step to mitigate all types of pollution. We will recommend suggestion in EIA report to control the dust and other pollution

Category	Comment/Question	Answer and Policy of Countermeasure
	make a hazardous situation for this people. So authorities should take step like water spray or any other to mitigate dust pollution.	
	Due to different types of environmental or other impact metro rail track need to be planned underground. How authority will mitigate the negative impact during the construction period of elevated section?	Mitigation measures for environmental impact will be recommended in the EIA report and authority will be followed strictly during the construction as well as operation period
Land Acquisition and Resettlement	If there will any damages or loss then authority should give proper compensation to the land and property loser.	Yes it will be compensated if there will any damages or loss. Updated technology will be used in this project so that no loss or damages expected.
	As far I understood almost 60 percent line will be constructed as a flyover in metro rail line 1. So I am scared about the land acquisition process.	Land acquisition team will clarify this issue.

5.10.2 Second Stage Stakeholder meetings

Date/Venue/Number of participants	July 23, 2017 / Ichapura Bazar, Purbachal / 28 persons July 27, 2017 / Kawlar, Hazicamp, Airport / 37 persons July 29, 2017 / 18 No ward, DNCC, Kalachadpur / 27 persons July 30, 2017 / N23 No ward, DNCC, Khilgaon / 32 persons
Contents	Explanation of project outlines Project outlines, alignment, location of stations (explained by Google Earth) Explanation of EIA, scoping and potential environmental impacts Gathering of public opinions
Methods of inform of meetings	Informed through local politician, local governments, leader of women, NGO (disable, gender, minority and others), publicity on the street, visit to houses on the vicinity



Figure 5.10.2 Second Stage Stakeholder Meeting (Airport)

Table 5.10.2 Opinions on Stakeholder Meetings (Second round)

Category	Comment/Question	Answer and Policy of Countermeasure
Planning	What kinds of fuel will be used for running the metro rail?	Metro rail will be run by electricity.
	Is there any possibility to crisis of Oxygen at the underground?	There will be ventilation system in the metro rail system which will maintain the oxygen supply.
	What will be the depth of underground tunnel of metro rail?	The average depths of the metro rail will 30 m. It might depend so much upon the control point. It will be finalized during the detail design stage.
	What will be the underground metro rail depth and its viaduct height?	The underground depth will be average 30 m. The viaduct section height will vary from 13-20m. It will be finalized during detail design stage.
	What is the main difference between elevated and underground sections?	For the elevated section traffic congestion will be a major concern and the width of present road will be reduced. No traffic congestion will occur for the underground section and no need to take land acquisition.
	Have any possibility to increase traffic congestion at the station section?	Overall traffic congestion will be reduced due to run of metro rail. Citizen of the city will move from one place to another within a short time. Traffic management plan will be followed to reduce the traffic congestion in the station area.
	Metro rail should be constructed as early as possible to reduce the huge traffic congestion in the city.	Thank you for your valuable comments.
	Development of communication system is the prerequisite for a country development. It's a great step to make metro rail in the city. Need more station for more benefit to the local people.	Thank you for your compliments.
	As early possible need to end the construction of the metro rail.	Thank you for your comments.
	How much earthquake resistance capacity has been considered to design the metro rail?	Earthquake resistance capacity will be considered in the final design of the metro rail.
	If flood occur in the underground section what will happen?	Flood management provision will keep in the design.
	If there is an accident in the underground section what step will be taken to manage?	An emergency management will be provided in the EIA report. Emergency exit point will be included in the final design.
	If there any alternative of electricity during the emergency case of metro rail operation?	Yes, alternative electricity source will be kept at the metro rail.
	To reduce the huge traffic congestion at Dhaka city, Metro rail will be the best option.	Thank you for your positive comment.
Govt. should be taken earlier to construct the Metro rail. It is one of the best ways to move fast from one side to other side of the Dhaka city. As the communication system increase, business will be increased, living standard will be changed. It will reduce the sufferings of people.	Thank you for your comments.	
Construction	Need proper monitoring at the construction phase to reduce traffic congestion	Traffic management plan will be prepared and followed accordingly.
Environment	What types of steps will be taken against air pollution?	Water will spray in the high dust generation area and details mitigation plan has been incorporated in the EIA report.
	What will be the major environmental pollution due to the metro rail construction	As the MRT 1 Line will be mostly underground so minimum environmental impact will be taken place. During construction, main environmental impacts will be dust pollution, noise pollution & vibration, traffic congestion. A comprehensive mitigation plan has been recommended in the EIA report to minimize the

Category	Comment/Question	Answer and Policy of Countermeasure
		environmental impact.
Land Acquisition and Resettlement	Is there any possibility to acquire the land?	Total 18.78 ha of land need to be acquired for depot area
	Is there any possibility to acquire the land except the depot area?	No, there is no possibility of land acquisition except the depot area.
	How much land will be acquired for this project?	Total 18.78 ha of land need to be acquired for the depot area.
	How much land will be acquired for this project?	Total 18.78 hectares of land need to acquire for MRT line-1.

5.10.3 Summary of Opinions of Stakeholders

Opinions of the stakeholders are classified into: planning, construction, environment, land acquisition and resettlement.

About the planning issues, there are questions on structure such as depth of underground, schedule of operation opening, disaster mitigation plan including earthquake and flood. Some participants proposed introduction of separate toilet for women and language of sign board. Since these are general matters adopted in other railway projects, opinions on the planning will be adopted (except installation of a new station).

A lot of participants raised concerns on construction phase including environmental issues. The concerns include pollution, especially dust control and groundwater pollution, construction management such as traffic control.

About the environmental issues, outline of negative impacts, impacts by construction and impacts on rivers were asked. The mitigation measures which are proposed must be implemented definitely.

About the land acquisition and resettlement, expected size of land acquisition and a level of compensation were asked. And appropriate and prompt compensation were requested. Based on RAP prepared on this study, land acquisition and resettlement must be implemented appropriately.

Among 8 stakeholder meetings, there are no clear objection. However some concerns about compensation for land acquisition and resettlement were raised.

Regarding the latest option of depot plan (Option 4), DMTCL held a stakeholder meeting for PAPs, and asked PAPs for understanding.

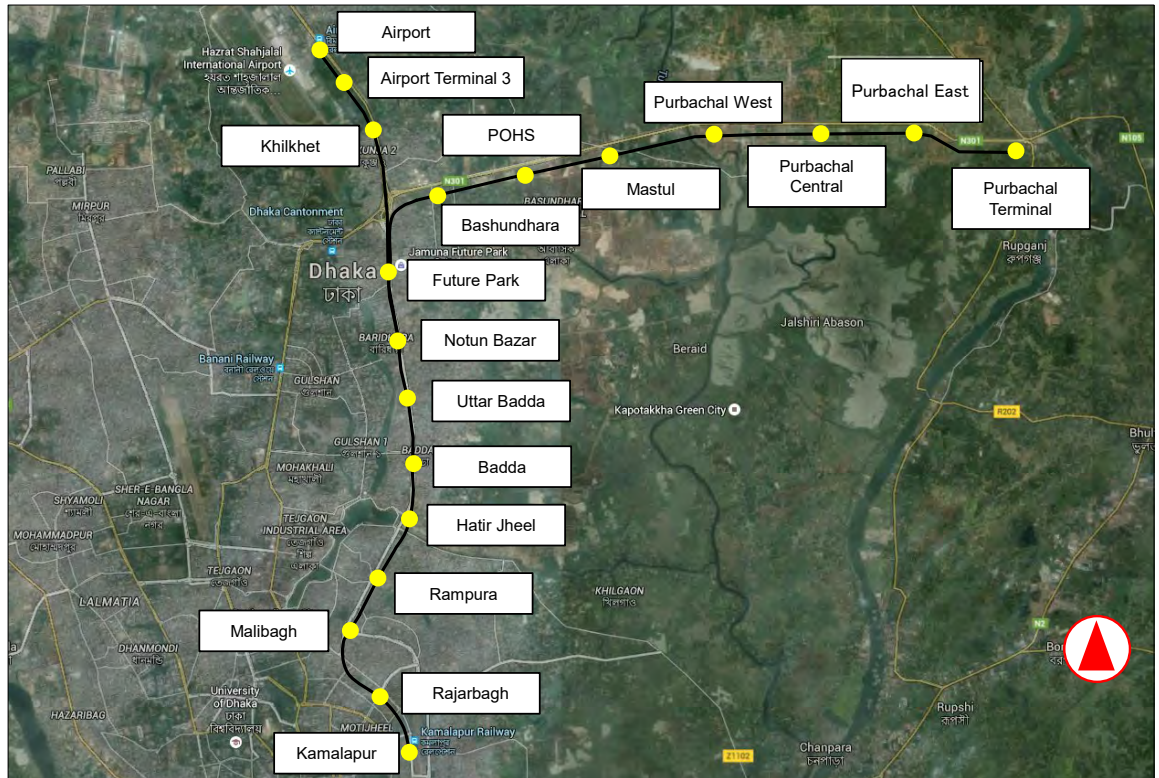
On the detail design phase, stakeholder consultation should be continued about more tangible project design. For example, although the project has a viaduct section, information on evaluation for "landscape" has not presented this study. On the detail design phase, based on more tangible design, agreement should be gotten.

5.11 Necessity of Land Acquisition and Resettlement

MRT Line 1 is consisted of 17.5 km long which connects from Kamalapur Station to Airport Station: southern and northern part of Dhaka City with 9 stations and Purbachal Line of 10.7 km long which connects from Future Park Station to Purbachal Station with 7 stations as subsidiary. (Total length including overlapping section and supplement track is 31.2km.) Whole Main Line will be underground and all stations of subsidiary line will be above ground. A total of 38.993 ha will be required for depot and ancillary facilities. The stations for both Main and Purbachal line will be built within right of way (ROW) and land acquisition is not required in principle, however, due to the construction of entrances/exits, cooling tower and ventilation duct a total of 0.23ha of private land is required, hence, displacement occurs. As

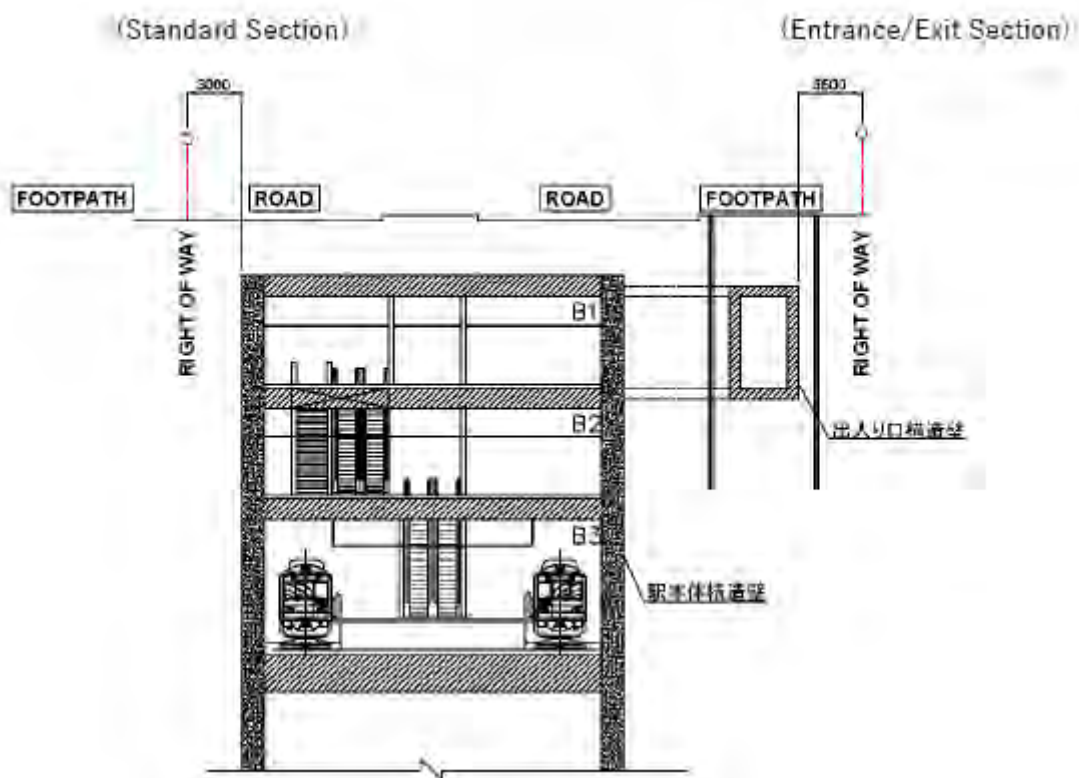
a result, 1,119 PAHs (513 of them are residential PAHs) and 4,632 PAPs will be affected.

During initial study of the project, comparisons of alternatives in the views of various criteria including mitigating land acquisition and involuntary resettlement were implemented. Major comparison items are structure type of track and location of depot site. The results of the comparisons are shown on article 5.4.2.



Source: Google Map is manipulated by JICA Study Team

Figure 5.11.1 MRT Line 1 Map



Source: JICA Study Team

Figure 5.11.2 Typical Cross Section of Underground Station

The number of affected PAPs might be more than 200; therefore the project will fall in **category A**: displaced population is more than 200 people and significant impacts are assumed, therefore, Resettlement Action Plan (RAP) is prepared in line with JICA's Guidelines.

The attached annexures are consisted of Annex-1: Form of Census and Inventory of Losses, Annex-2: Form of Questionnaire for Property Valuation and Others, Annex-3: List of PAHs, Land Owners, CPRs, Vulnerable and Wage Workers, Annex-5: TOR for RAP Implementing Agency, Annex-6: Minutes of SHM, Annex-7: TOR for External Monitoring Consultant and Annex-8: Gender, in the Report.

5.12 Legal Framework of Land Acquisition and Resettlement

5.12.1 Current Legislation on Land Acquisition and Resettlement

The current legislations governing land acquisition for Bangladesh are the Acquisition and Requisition of Immovable Property Ordinance 1982 and subsequent amendments during 1993 - 1994. The Ordinance requires that compensation be paid for (i) land and assets permanently acquired (including standing crops, fisheries, trees, houses); and (ii) any other damages caused by such acquisition. The Deputy Commissioner (DC) determines the market price of assets based on an approved procedure and in addition to that pays an additional 50 percent (as premium) on the assessed value as the market price established by the Land Acquisition Officer (LAO) which still remains much below the replacement value. The 1994 amendment made provisions for payment of compensation for crops to tenant cultivators. The Ordinance, however, does not cover project-affected persons without titles or ownership records, such as informal settlers/squatters, occupiers, and informal tenants

and lease-holders (without documents) and does not ensure replacement value of the property acquired. The act has no provision for resettlement assistance or transitional allowances for restoration of livelihoods of the non-titled affected persons. The Acquisition and Requisition of Immovable Property Ordinance (ARIPO, 1982) with its subsequent amendments will be applied for this project.

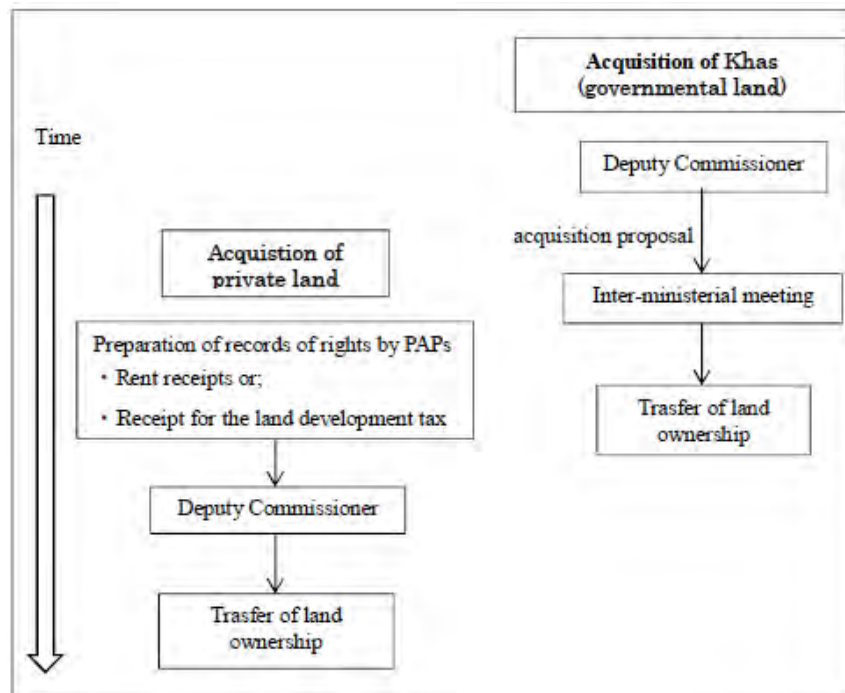
However, the ARIPO (1982) does not give any direction to compensate the subsurface property for imposing restriction in use. Though sub-surface easement had discussed in this Study it has concluded to deal it as examination issue in future due to the lack of relative legislation. The appropriate design measures would be taken in order may not to affect the structure above ground, however, when affects are confirmed due to the tunneling DMTCL will compensate in accordance with present law same as other domestic project.

1) Land Acquisition

The DC processes land acquisition under the Ordinance and pays compensation to the legal owners of the acquired land. The Ministry of Lands (MOL) is authorized to deal with land acquisition through the DCs. Khas (government owned) lands should be acquired first when a project acquires both khas and private land. If a project acquires only khas, the land will be transferred through an inter-ministerial meeting following the preparation of an acquisition proposal submitted to DC/MOL.

2) Land Ownership

The land owner has to establish ownership by producing a record-of-rights in order to be eligible for compensation under the law. The record of rights prepared under Section 143 or 144 of the State Acquisition and Tenancy Act 1950 (revised 1994) are not always updated and as a result legal land owners have to face difficulties in trying to “prove” ownership. The APs must also produce rent receipts or receipt for the land development tax, but this does not assist in some situations as a person is exempted from payment of rent if the area of land is less than 25 bighas (3.37 ha).



Source: JICA Study Team

Figure 5.12.1 Flow of Land Acquisition

3) Draft National Policy on Involuntary Resettlement

The Government of Bangladesh, funded by ADB, has prepared a draft national policy on involuntary resettlement that is consistent with the general policy of the Government that the rights of those displaced by a development project shall be fully respected, and persons being displaced shall be treated with dignity and assisted in such a way that safeguards their welfare and livelihoods irrespective of title, gender, or ethnicity, but it is yet to be enacted.

The draft Policy was submitted to the Government in November 2007. It was approved by the Ministry of Land on 1 January 2008 and was placed before the Cabinet later in February 2008. After cabinet approval, the draft Policy is going to be enacted as legislative resettlement rights by law in 2017, however, it is not enacted yet.

5.13 Gap between JICA's Guidelines and Related Ordinances in Bangladesh

5.13.1 Gap between JICA's Guidelines and related Ordinances in Bangladesh

The land acquisition law of Bangladesh, the Acquisition and Requisition of Immovable Property Ordinance (ARIPO) 1982 with subsequent amendments during 1993 – 1994 is followed for acquisition and requisition of properties required for the development project in Bangladesh, which is not consistent with the Government's commitment to reducing poverty. There are some gaps in the land acquisition law of Bangladesh and the JICA Guidelines for Environmental and Social Considerations (GESC, April 2010). Below is the comparative analysis between the GoB laws (ARIPO) related to land acquisition, compensation and involuntary resettlement and JICA's requirements as prescribed in the GESC 2010. The Table 5.13.1 describes the details.

Table 5.13.1 Gap and Gap Filling Measure

No.	JICA's Guidelines (2010)	GOB's Acquisition and Requisition of Immovable Property Ordinance (ARIPO) of 1982	Gaps Between JICA's Guidelines and ARIPO	Proposed Gap Filling Measures
1	Involuntary resettlement should be avoided wherever possible.	Not specified	The 1982 ordinance legislated nothing in this regard, while the JICA Guidelines require to avoid/minimize resettlement/loss of livelihood	Like other donor funded projects in Bangladesh, the approach of avoiding involuntary resettlement had already been taken by this project. The measure will be developed in design and implementation stages, furthermore.
2	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken.	Not specified for non-titled people	There are no provisions for compensation for non-titled residents in the Bangladesh ordinance, while JICA's Guidelines acknowledges all affected persons whether legally residing or not, are eligible for compensation.	Compensations are proposed even for non-titled people as follows. <ul style="list-style-type: none"> - Compensation for structures, trees - Structure transfer assistance - Structure reconstruction assistance - Moving assistance for residential house owner - Tenant moving allowance

No.	JICA's Guidelines (2010)	GOB's Acquisition and Requisition of Immovable Property Ordinance (ARIPO) of 1982	Gaps Between JICA's Guidelines and ARIPO	Proposed Gap Filling Measures
3	People who must be settled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.	Not specified for maintaining living standard of affected people at the same or above of pre-project levels.	There is no provision for maintaining living standard of affected people at the same or above pre-project levels in Bangladesh ordinance, while JICA's Guidelines require that no one is worse off as a result of resettlement and would maintain their living level at least at original levels	Assistances were proposed in the form of: <ul style="list-style-type: none"> - Grant for business loss - Compensation for loss of plant and fish-stock - Grant for loss of wage employment - Rental fee loss for displaced rented house owner - One time moving assistance for tenant business owner - Introduction of micro-credit - Provision of job training Provision of priority employment etc.
4	Compensation must be based on the full replacement cost as much as possible	Compensation is made based on the pre-determined government prices which are usually much lower than full replacement cost.	There are no related provisions in the Bangladesh ordinance, while JICA's Guidelines require that the replacement cost plus tax and remittance charge shall be included in compensation.	The resettlement plan addresses all these issues and spells out a mechanism to fix the full replacement costs as follows. District Commissioner: Pay compensation for PAPs based on ARIPO. DTCA: Pay compensation for PAPs the difference between full replacement cost and determined by DC.
5	Compensation and other kinds of assistance must be provided prior to displacement	Payment is made at a predetermined time, regardless of whether it is before or after the construction starts	Compensation and other assistance are made regardless of whether it is before or after construction, while JICA Guidelines requires to pay compensation prior to relocation	The resettlement plan addresses all these issues and spells out a mechanism for all the compensation to be paid prior to possession of the acquired land and prior to displacement
6	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public.	There is no provision for the formulation of RAP or public hearings. The Deputy Commissioner contacts the land owner through the land Acquisition Officer (LO), and if the landowner has no objection, confirms the compensation amount etc. and proceeds.	There is no provision for the resettlement plan that describes all features of resettlement requirements should be disclosed to the public.	The Resettlement Action Plan (RAP) prepared for this project with all features of resettlement requirements and mechanism of disclosure to the public is an integral part of F/S. DTCA is requested to disclose the RAP with their consensus.

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No.	JICA's Guidelines (2010)	GOB's Acquisition and Requisition of Immovable Property Ordinance (ARIPO) of 1982	Gaps Between JICA's Guidelines and ARIPO	Proposed Gap Filling Measures
7	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance.	The 1982 Ordinance has provisions to notify only the owners of property to be acquired	There is no provision in the law for consulting the stakeholders, but the land allocation committees at district, division and central government level are all involved.	The RAP for the project has been prepared by consultation process which involves all stakeholders (affected persons, government department/line agencies, local community, NGO, etc.), and the consultation will be conducted in continuous process at all stages of the project development, such as project formulation, feasibility study, design, implementation, and post-implementation, including the monitoring phase.
8	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people	There are no provisions	Requirements of JICA Guidelines are not specifically mentioned in the Bangladesh laws and rules	The RAP has been prepared based on the consultation process in local language. And participatory process involves questions and explanations on the components of RAP. The consultation will be a continuous process at all stages of the project development, such as project formulation, feasibility study, design, implementation, and post-implementation, including the monitoring phase.
9	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans	There is no provision for the monitoring related activities with the participation of affected people	There is no provisions in Bangladesh ordinances, while JICA Guidelines recommend participation of affected people in planning, implementation and monitoring of the RAP	The RAP has been prepared by following a consultation process with all stakeholders. The consultation will be a continuous process at all stages of the project development, such as project formulation, feasibility study, design, implementation, and post-implementation, including the monitoring phase.
10	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities	If PAPs have objection regarding the compensation amount, he should protest and entrust the matter to an Arbitrator. If he has to appeal against the Arbitrator's decision, then he should file a law suit and wait for the decision.	The law of Bangladesh states it should be settled through Arbitrator as court case, while JICA's Guidelines recommend to establishing an appropriate grievance redress mechanism for amicable settlement to minimize the legal confrontation.	The RAP for this project has made a provision for setting up a grievance redress mechanism accessible for all the affected people including non-titled affected people.

No.	JICA's Guidelines (2010)	GOB's Acquisition and Requisition of Immovable Property Ordinance (ARIPO) of 1982	Gaps Between JICA's Guidelines and ARIPO	Proposed Gap Filling Measures
11	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socio-economic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers or others who wish to take advantage of such benefit.	No such an activity is required	There is no provision in Bangladesh ordinances, while JICA Guidelines recommend identification of affected people in the least possible time preferably at the project identification stage.	This RAP has been prepared based on the data collected through conducting a census, socioeconomic survey for the displaced persons and making an inventory of losses. Video filming has also been recorded to the affected properties.
12	Eligibility of benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who do not have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying	There is no provision.	Requirement of JICA's Guidelines is not specifically mentioned in the Bangladesh laws and rules.	The RAP ensures compensation and assistance to all affected persons, whether physically displaced or economically displaced, irrespective of their legal status. Eligibility depends on the cut-off date, and affected persons listed before the cut-off date will be eligible for assistance.
13	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.	There is no provision.	Requirement of JICA Guidelines is not specifically mentioned in the Bangladesh laws and rules.	Though this option may be a difficult proposition given the lack of government lands and the difficulties associated with the acquisition of private lands, the resettlement plan proposes land-for-land compensation as its priority, if feasible. Attempts will be made to find alternate land for the loss of land, in case it is available and if it is feasible, looking at the concurrence of the host community and land value.
14	Provide support for the transition period (between displacement and livelihood restoration)	There is no provision for support for the transition period.	There is no provision in Bangladesh ordinances, while JICA Guidelines require providing support for the transition period.	The following are provided in the RAP: Transfer assistance for residential house owners Tenant moving allowance
15	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.	There is no provision either acknowledgment of or compensation to vulnerable groups	There is no provision in Bangladesh ordinances, while JICA Guidelines require providing special attention to vulnerable people and groups.	Vulnerable allowances were proposed to widowed, old, disabled and poor house head families such as : Special Assistance for Vulnerable households. Focus group discussion was held to cope with gender.

No.	JICA's Guidelines (2010)	GOB's Acquisition and Requisition of Immovable Property Ordinance (ARIPO) of 1982	Gaps Between JICA's Guidelines and ARIPO	Proposed Gap Filling Measures
16	For a project that entails land acquisition or involuntary resettlement of more than 200 people, a resettlement action plan is to be prepared	There is no provision	Requirement of JICA Guidelines is not specifically mentioned in the Bangladesh laws and rules	The RAP has been prepared since the displaced people in Line 5 are estimated to be more than 200.

Source: JICA Study Team

5.14 Census and Socio-economic Survey

5.14.1 Eligibility Criteria

The census and a socio-economic survey was carried out in March through April 2017, June 2018 for the depot site to provide requisite details on the Project Affected Units (PAUs) of MRT line 5 to further assess the magnitude of likely impacts and to identify measures for mitigation of adverse impacts. The survey included (i) full census and socioeconomic survey with structured questionnaire and inventory of losses (Annex-1), (ii) surveys for property valuation and other assets through structured questionnaire (Annex-2); (iii) Video filming of the affected properties and (iv) community based public consultation etc. The survey identified the households, commercial and business enterprises, land owners, sharecroppers, squatters, tenants and community properties on project right of way.

The census questionnaire incorporated the basic questions for identification of the affected unit, its owner/user, and types and extent of losses and other relevant data. These data are collected to prepare the Inventory of Losses (IOL) generated by the project.

The socioeconomic survey collected a wide range of data, for example, demography, age/sex distribution, education, occupation, income/poverty data, types of businesses, types and ownership status of affected structures and other assets.

5.14.2 The Project Area

The project area extends in both Dhaka North City Corporation (DNCC) and Dhaka South City Corporation (DSCC) and Savar Upazila starting from Dhaka Airport, extended towards south and ended at Kamalapur. One branch has extended towards west and ended in East Purbachal in Rupganj Upazila of Narayanganj District. Total length of the MRT Line 1 is 31.2 Km with 1 depot in Purbachal (tentative one). There are 19 stations which consist of elevated 7 and underground 12.

5.14.3 Profile of Affected Households

1) Population

A total of 4,632 people have been identified as affected by losing residential structure, commercial structure, trees, ponds and other minor infrastructures. Community properties (42) have not been considered in calculating population. A total of 513 households will be displaced from their residence. On the other hand 404 households will lose their commercial structure, 21 households will lose both homestead and CBE, 181 households will lose their trees or other minor structures like gates, drains, walls etc. Among the CBEs 272 are vendors or temporary shop owners will have to be displaced for the intervention of this project.

Out of the total affected population, 2,512 (54 %) are male and 2,120 (46 %) are female. Location wise number of affected male and female population is shown in Table 6.14.1.

Table 5.14.1 Number of Male and Female Population by Location

Location	Total HH	Population		
		Male	Female	Total Population
Airport	215	542	434	976
Airport Terminal-3	00	00	00	00
Khilkhet	01	03	02	05
Basundhara	04	11	11	22
POHS	00	00	00	00
Mastul	00	00	00	00
Purbachal West	00	00	00	00
Purbachal Central	17	36	26	62
Purbachal East	00	00	00	00
Purbachal Terminal	14	39	30	69
Depot Area	698	1503	1267	2770
Jamuna Future Park	07	18	12	30
Nuton Bazar	30	59	66	125
Uttar Badda	03	08	06	14
Badda	09	22	24	46
Hatir Jheel	05	13	13	26
Rampura	24	56	51	107
Malibag	12	28	33	61
Rajarbag	05	12	12	24
Kamlapur	75	162	133	295
Total	1119	2512	2120	4632

Source: Census & Socioeconomic survey, April 2017, and June 2018 for Depot area

2) Ethnicity and Religion

Based on findings of the survey, the Project will affect 1,119 households. Out of total 1,119 households 1,020 are Muslim and 99 are Hindu. No ethnic minority is found in the proposed project locations. Detail of households in terms of religion is shown in Table 5.14.2.

Table 5.14.2 Affected Households by Location and Religion

Location	Religion				Total (No)
	Muslim (No)	%	Hindu (No)	%	
Airport	202	93.95	13	6.05	215
Airport Terminal-3	0	0.0	0	00.0	0
Khilkhet	1	100.0	0	00.0	1
Basundhara	3	75.0	1	25.0	4
POHS	0	0.0	0	00.0	0
Mastul	0	0.0	0	00.0	0
Purbachal West	0	0.0	0	00.0	0
Purbachal Central	17	100.0	0	00.0	17
Purbachal East	0	0.0	0	00.0	0
Purbachal Terminal	14	100.0	0	00.0	14
Depot Area	621	88.97	77	11.03	698
Jamuna Future Park	7	100.0	0	00.0	7
Notun Bazar	30	100.0	0	00.0	30
Uttar badda	3	100.0	0	00.0	3
Badda	9	100.0	0	00.0	9
Hatir Jheel	3	60.0	2	40.0	5
Rampura	24	100.0	0	00.0	24
Malibag	12	100.0	0	00.0	12
Rajarbag	5	100.0	0	00.0	5
Kamalpur	69	92	6	8	75
Total	1020	91.15	99	8.85	1119

Source: Census & Socioeconomic survey, April 2017, and June 2018 for Depot area

3) Level of Education

The numbers of school going children are increasing. Today, almost all the young children are going to school, girl children are more advanced in this regard as the GOB is providing additional facilities to them. This is an urban area with good opportunity to go to school. Young generations irrespective of sex have much higher level of education than compared to the head (older members) of the household.

Table 5.14.3 Level of Education of the Head of the Households

Location	Level of Education						Total
	Illiterate	Class-I-V	Class VI-X	SSC & HSC	Graduate	Above Graduate	
Airport	1.86	33.95	50.23	11.16	1.86	0.93	100
Airport Terminal-3	0	0.0	0	00.0	0	00.0	0.00
Khilkhet	0.0	100.0	0.0	0.0	0.0	0.0	100.0
Basundhara	25.0	25.0	0.0	25.0	0.0	25.0	100.0
POHS	0	0.0	0	00.0	0	00.0	0.00
Mastul	0	0.0	0	00.0	0	00.0	0.00
Purbachal West	0	0.0	0	00.0	0	00.0	0.00
Purbachal Central	0.0	58.8	23.5	11.7	5.8	0.0	100.0
Purbachal East	0	0.0	0	00.0	0	00.0	0.00
Purbachal Terminal	7.1	64.2	28.5	0.0	0.0	0.0	100.0
Depot Area	4.15	46.85	30.66	8.31	3.87	6.16	100
Jamuna Future Park	14.2	28.5	14.2	42.8	0.0	0.0	100.0
Notun Bazar	3.33	20.0	30.0	13.33	0.0	33.3	100.0
Uttar badda	0.0	66.6	0.0	0.0	0.0	33.3	100.0
Badda	0.0	33.3	11.1	33.3	0.0	22.2	100.0
Hatir Jheel	0.0	40.0	20.0	20.0	0.0	20.0	100.0
Rampura	4.1	41.6	8.3	20.8	8.3	16.7	100.0
Malibag	0.0	25.0	33.3	33.3	0.0	08.3	100.0
Rajarbag	0.0	20.0	0.0	40.0	0.0	40.0	100.0
Kamalpur	24.0	46.67	20.0	4.4	1.33	4.0	100.0
Total	5.0 (56)	43.34(485)	32.44(363)	9.83(110)	3.13(35)	6.26(70)	100.00(1,119)

Source: Census & Socioeconomic survey, April 2017, and June 2018 for Depot area

4) Age and Occupation

The largest proportion of population is in age group of 15-29 (26.34 %) followed by age group of 30-44 (23.29 %) and up to 14 (24.44 %) irrespective of male and female population in all the locations. Population within the age group 45-59 is more than 16.08 % and above 60 is about 9.84 %. Table 5.14.4 shows in detail.

Table 5.14.4 Age Distribution of Affected Population by Location

Location	Age Group										Total	
	Up to -14		15-29		30-44		45-59		60 & Above			
	No	%	No	%	No	%	No	%	No	%	No	%
Airport	239	24.49	255	26.13	184	18.85	180	18.44	118	12.09	976	100
Airport Terminal-3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.00
Khilkhet	3	60.0	0	0.0	2	40.0	0	0.0	0	0.0	5	100.0
Basundhara	2	9.0	12	54.5	2	9.0	4	18.1	2	9.0	22	100.0
POHS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.00
Mastul	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.00
Purbachal West	0	0.0	0	00.0	0	00.0	0	0.0	0	0.0	0	0.00
Purbachal Central	14	22.5	18	29.0	17	27.4	12	19.3	1	1.6	62	100.0
Purbachal East	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.00
Purbachal Terminal	14	20.3	20	28.9	13	18.8	14	20.2	8	11.5	69	100.0
Depot Area	695	25.09	733	26.46	708	25.56	393	14.19	241	8.7	2770	100
Jamuna Future Park	9	30.0	7	23.3	8	26.6	5	16.6	1	3.3	30	100.0
Notun Bazar	33	26.4	27	21.6	27	21.6	26	20.8	12	9.6	125	100.0
Uttar badda	3	21.4	5	35.7	2	14.2	2	14.2	2	14.2	14	100.0
Badda	12	26.0	13	28.2	11	23.9	6	13.0	4	8.7	46	100.0
Hatir Jheel	7	26.9	8	30.7	4	15.3	4	15.3	3	11.5	26	100.0
Rampura	13	12.1	28	26.1	19	17.7	25	23.3	22	20.5	107	100.0
Malibag	13	21.3	17	27.8	12	19.6	12	19.6	7	11.4	61	100.0
Rajarbag	6	25.0	4	16.6	6	25.0	3	12.5	5	20.8	24	100.0
Kamalpur	69	23.39	73	24.75	64	21.69	59	20	30	10.17	295	100.0
Total	1132	24.44	1220	26.34	1079	23.29	745	16.08	456	9.84	4632	100.00

Source: Census & Socioeconomic survey, April 2017, and June 2018 for Depot area

5) Income and Poverty Dimensions

Poverty in Bangladesh is measured through per capita income or through Direct Calorie Intake (DCI) where persons having DCI of less than 2,122 kcal are considered to be living in poverty while a person having DCI of less than 1,805 kcal is considered to be in 'hard core poverty'. As per Statistical Year Book of Bangladesh 2010 average household size is 4.50 and 40.94% households earn maximum BDT 108,000 per year. Based on the census socioeconomic survey (March-April 2017 and June 2018) indicating yearly income and expenditure of the project affected households, it is found that about 10.9 % households earn less than Tk 108,000 per year (Table 5.14.5).

Table 5.14.5 Poverty Level and Annual Income (BDT) of Head of the Households

Location	Annual Income (BDT)					
	Up to 100,000	108,001-200,000	2,00,001-3,00,000	3,00,001-5,00,000	500,001-700,000	Above 7,00,000
Airport	14.88	15.35	49.3	5.12	3.72	11.63
Airport Terminal-3	00.0	00.0	00.0	00.0	00.0	00.0
Khilkhet	100.0	00.0	00.0	00.0	00.0	00.0
Basundhara	00.0	00.0	00.0	00.0	25.0	75.0
POHS	00.0	00.0	00.0	00.0	00.0	00.0
Mastul	00.0	00.0	00.0	00.0	00.0	00.0
Purbachal West	00.0	00.0	00.0	00.0	00.0	00.0
Purbachal Central	5.88	5.88	00.0	47.0	29.4	11.8
Purbachal East	00.0	00.0	00.0	00.0	00.0	00.0

Location	Annual Income (BDT)					
	Up to 100,000	108,001-200,000	2,00,001-3,00,000	3,00,001-5,00,000	500,001-700,000	Above 7,00,000
Purbachal Terminal	7.14	21.4	21.4	21.4	21.4	07.1
Depot Area	6.59	21.92	38.25	10.74	9.17	13.3
Jamuna Future Park	28.57	28.57	28.5	14.2	00.0	00.0
Notun Bazar	6.67	00.0	36.67	3.3	6.7	46.7
Uttar badda	33.3	00.0	0.0	66.6	00.0	00.0
Badda	66.6	00.0	0.0	11.1	00.0	22.2
Hatir Jheel	20.0	00.0	0.0	20.0	20.0	40.0
Rampura	54.2	4.17	08.3	08.3	0.00	25.0
Malibag	25.0	8.33	08.3	25.0	08.33	25.0
Rajarbag	40.0	00.0	00.0	40.0	0.00	20.0
Kamalpur	14.67	33.3	34.7	2.67	8.0	6.7
Total	10.9(122)	19.57(219)	37.35(418)	10.0(112)	8.13(91)	14.0(157)

Source: Census & Socioeconomic survey, April 2017, and June 2018 for Depot area

The survey identified 395 vulnerable households in the project area. These are almost all the project affected female headed households, households headed by elderly persons, disable persons, male headed household but under the poverty line. The vulnerable households of different locations are shown in the Table 5.14.6.

Table 5.14.6 Vulnerable Households in Percentage and by Location

Location	Vulnerability				Total
	Female Headed HHS	Elderly (<60yr.)	Disabled Male HHHs	Male Headed Households under poverty line	
Airport	2.17	10.87	6.52	00.0	00.0
Airport Terminal-3	00.0	00.0	00.0	00.0	00.0
Khilkhet	00.0	00.0	00.0	100.0	100.0
Basundhara	100.0	00.0	00.0	00.0	100.0
POHS	00.0	00.0	00.0	00.0	00.0
Mastul	00.0	00.0	00.0	00.0	00.0
Purbachal West	00.0	00.0	00.0	00.0	00.0
Purbachal Central	00.0	00.0	00.0	100.0	100.0
Purbachal East	00.0	00.0	00.0	00.0	00.0
Purbachal Terminal	00.0	66.6	00.0	33.3	100.0
Depot Area	61.3	19.54	0.77	00.0	00.0
Jamuna Future Park	33.3	0.0	00.0	66.6	100.0
Notun Bazar	28.57	7.14	00.0	7.14	100.0
Uttar badda	00.0	50.0	00.0	50.0	100.0
Badda	00.0	16.6	00.0	83.3	100.0
Hatir Jheel	00.0	00.0	00.0	00.0	00.0
Rampura	6.6	33.3	00.0	60.0	100.0
Malibag	00.0	57.1	14.2	28.5	100.0
Rajarbag	00.0	33.3	00.0	66.6	100.0
Kamalpur	38.71	9.68	6.45	9.68	100.0
Total	45.32(179)	17.72(70)	2.03(8)	8.61(34)	100.0(395)

Source: Census & Socioeconomic survey, April 2017, and June 2018 for Depot area

5.14.4 Scope of Land Acquisition

A total of 38.993 ha and 0.23 ha land will be required to be acquired for depot and pockets along the RoW to implement the project. The land for the depot area in Pitolganj, Rughanj are privately owned. This area is rural in nature. This patch of land is from two mouzas namely Brhamonkhali and Pitolgonj covering two types of land. Majority of the land is

agriculture land followed by vita/homestead. Out of the total land 17.23 ha is agricultural land and 21.763 ha in being used as vita or some kind of high land. In addition to this acquired land some government owned land will be used to construct the MRT - 1 line and its components. However, the distribution and ownership of the pockets of land is yet to be finalized. Mouza wise type of land use of total land to be acquired is shown in Table 5.14.7.

Table 5.14.7 Land Acquisition of the Project by Mouza and Type of Land

Name of Mouza	Type of Land (ha)		Total (ha)
	Agriculture	Vita	
Brhamonkhali	0.396	1.188	1.584
Pitalgonj	16.834	20.575	37.409
Total	17.23	21.763	38.993

Source: Census & Socioeconomic survey, April 2017, and June 2018 for Depot area

5.14.5 Displacement and Other Impacts

In addition to land acquisition, the project will have direct impact on 1,119 Project Affected Units (PAUs). These PAUs are from stations areas. It is to be mentioned here that there will not be any affected people in six proposed stations namely Airport Terminal-3, Bashundhara, POHS, Mastul, Purbachal West and Purbachal East and the depot area. The project work will affect 513 residential households, 404 Commercial & Business enterprises (CBEs) and 21 residential cum CBE and 181 household are going to lose varieties of assets and minor structures like wall, trees, drains etc. with a total population of 4,632. Out of 513 households 471 will be displaced due to loss of residential structure, 42 will be displaced from rented residential structure. The list of PAHs, land owners, CPRs, vulnerable and wage workers is attached in Annex-3. The location wise impact is presented in Table 5.14.8.

Table 5.14.8 Displacement of PAHs and Impacts by Location

Location	Location wise Number of PAHs						Total PAHs	Total Population
	Loss of Residence	Loss of Business	Loss of Business and Residence	Loss of Residence by Rented	Vendors on Govt. land	Others		
Airport	0	18	0	1	196	0	215	976
Airport Terminal-3	0	0	0	0	0	0	00	00
Khilkhet	0	0	0	0	1	0	01	05
Basundhara	0	4	0	0	0	0	04	22
POHS	0	0	0	0	0	0	00	00
Mastul	0	0	0	0	0	0	00	00
Purbachal West	0	0	0	0	0	0	00	00
Purbachal Central	0	1	0	0	16	0	17	62
Purbachal East	0	0	0	0	0	0	00	00
Purbachal Terminal	0	14	0	0	0	0	14	69
Depot Area	463	27	20	4	5	179	698	2770
Jamuna Future Park	1	2	0	1	3	0	07	30
Notun Bazar	0	14	0	0	16	0	30	125
Uttar badda	1	2	0	0	0	0	03	14
Badda	0	5	0	2	1	1	09	46
Hatir Jheel	0	4	0	0	0	1	05	26
Rampura	4	18	1	0	1	0	24	107
Malibag	1	10	0	0	1	0	12	61

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Rajarbag	1	2	0	0	2	0	05	24
Kamalpur	0	11	0	34	30	0	75	295
Total	471	132	21	42	272	181	1119	4632

Source: Census & Socioeconomic survey, April 2017, and June 2018 for Depot area

Among the Affected Units only 711 are title holders i.e. Owns the land and rest 408 are on government land. Total affected persons are 4,632. The affected households by legal status, type of loss and by location is shown in Table 5.14.9.

Table 5.14.9 Number of PAHs by Location on Private (Title-Holder) and Public Land (Non-Titled PAHs)

Name of Stations (Locations)	Title-holder PAHs					Non-title holder PAHs					Total PAHs	Total Population
	Residence	Business	Both	Others	Total	Residence	Temporary Shops	Rented Shops	Others	Total		
Airport	0	0	0	0	0	1	196	18	-	215	215	976
Airport Terminal-3	0	0	0	0	0	0	0	0	-	0	0	00
Khilkhet	0	0	0	0	0	0	1	0	-	1	1	05
Bashundhara	0	0	0	0	0	0	0	4	-	4	4	22
POHS	0	0	0	0	0	0	0	0	-	0	0	00
Mastul	0	0	0	0	0	0	0	0	-	0	0	00
Purbachal West	0	0	0	0	0	0	0	0	-	0	0	00
Purbachal Central	0	0	0	0	0	0	16	1	-	17	17	62
Purbachal East	0	0	0	0	0	0	0	0	-	0	0	00
Purbachal Terminal	0	14	0	0	14	0	0	0	-	0	14	69
Depot Area	463	17	20	179	679	4	5	10	-	19	698	2770
Jamuna Future Park	1	0	0	0	1	1	3	2	-	6	7	30
Notun Bazar	0	1	0	0	1	0	16	13	-	29	30	125
Uttar Badda	1	0	0	0	1	0	0	2	-	2	3	14
Badda	0	1	0	1	2	2	1	4	-	7	9	46
Hatir Jheel	0	0	0	1	1	0	0	4	-	4	5	26
Rampura	4	3	1	0	8	0	1	15	-	16	24	107
Malibagh	1	1	0	0	2	0	1	9	-	10	12	61
Rajarbagh	1	0	0	0	1	0	2	2	-	4	5	24
Kamlapur	0	1	0	0	1	34	30	10	-	74	75	295
Total	471	38	21	181	711	42	272	94	-	408	1119	4632

Source: Census & Socioeconomic survey, April 2017, and June 2018 for Depot area

A total of 1,376 structures of 67,098 sq. m of different categories will be affected of which 26,126 sq. meter pucca, and 18,722 sq. meter semi pucca, 17,270 sq. meter tin shaded, 4,051 sq. meter katcha, 702.87 sq. meter and 227 sq. meter tarpaulin covered (Table 5.14.10).

Table 5.14.10 Quantity of all Affected Structure (sq. meter) by Type and by Location

Station Name	Type of Affected Structure						Total
	Thatched	Katcha	Tin	Semi pucca	Pucca	Tarpaulin	
Airport	0.00	54.45	458.3	736.4	4703	11.15	5963
Airport Terminal-3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Khilkhet	0.00	0.00	5.95	0.00	0.00	0.00	5.95
Bashundhara	0.00	0.00	0.00	0.00	0.00	0.00	0.00
POHS	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mastul	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Purbachal West	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Purbachal Central	0.00	0.00	0.00	0.00	0.00	208	208
Purbachal East	0.00	0.00	0.00	0.00	0.00	0.00	00.00
Purbachal Terminal	0.00	147.6	0.00	0.00	0.00	0.00	147.6
Depot Area	642.48	3122.06	15975.6	16277.9	16750.3	0.00	52768.3
Jamuna Future Park	0.00	0.00	0.00	0.00	59.1	0.00	59.1
Notun Bazar	0.00	288	583.9	1554	2923	0.00	5349
Uttar Badda	0.00	33.46	29.56	0.00	0	0.00	63.02
Badda	0.00	0.00	6.69	0.00	232.3	0.00	239
Hatir Jheel	0.00	0.00	2.79	41.8	33.5	0.00	78.09
Rampura	0.00	0.00	0	33.5	510	0.00	544
Malibag	0.00	13.94	18.59	51.11	138.5	0.00	221.1
Rajarbagh	0.00	0.00	5.95	0.00	51.11	0.00	57.06
Kamalapur	60.39	391.8	182.2	26.96	725.3	7.43	1394
Total	702.87	4051.31	17269.53	18721.67	26126.11	226.58	67097.22

Source: Census & Socioeconomic survey, April 2017, and June 2018 for Depot area

The stations will be built within the ROW; however, for the construction of exit, entrance and ventilation duct etc. some extent of private land acquisition will be required. To minimise the affect due to the land acquisition, the final location of ancillary facilities will be fixed through perusal study in detailed design stage.

In addition to the project affected units or households 42 Common Property Resources (CRP) are going to be affected. The CPRs include mosque, madrasa, school/college, graveyard, offices etc. Among the CPRs office seems to be out numbered 55 % (Table 5.14.11). For repairing or re-establishment of these CPRs the community people will be consulted.

Table 5.14.11 Distribution of CPR by Location

Name of Stations (Locations)	Type of CPRs						Total
	Mosque	School/College	Madrasa	Grave Yard	Office ⁸	Others ⁹	
Airport	1	0	0	0	5	1	7
Airport Terminal-3	0	0	0	0	0	0	0
Khilkhet	0	0	0	0	1	0	1
Bashundhara	0	0	0	0	0	1	1
POHS	0	0	0	0	0	0	0
Mastul	0	0	0	0	0	0	0
Purbachal West	0	0	0	0	0	0	0
Purbachal Central	0	0	0	0	0	0	0
Purbachal East	0	0	0	0	0	0	0
Purbachal Terminal	0	0	0	0	0	0	0
Depot Area	1	0	1	2	2		6
Jamuna Future Park	0	0	0	0	0	2	2
Notun Bazar	2	0	0	0	5	2	9
Uttar Badda	0	0	0	0	1	0	1
Badda	0	0	0	0	2	0	2
Hatir Jheel	0	0	1	0	1	1	3
Rampura	0	0	0	0	0	1	1
Malibag	0	0	0	0	1	0	1
Rajarbagh	0	1	0	0	1	0	2
Kamalapur	1	0	0	0	4	1	6
Total	5	1	2	2	23	9	42

Source: Census & Socioeconomic survey, April 2017, and June 2018 for Depot area

5.14.6 AP Preference for Relocation

During the census survey as well as in stakeholder consultation meetings (SCM) and FGDs, the relocation choices of the affected persons were asked. The households to be relocated are homestead loser prefer to remain in the adjoining area of the project location to continue their present occupation. Almost all are demanding assistance from the project during relocation. Therefore the APs are encouraged for self-relocation to get mutual support of the kin groups.

More than 99.91 % of the affected PAUs preferred assistance as cash grant so that they can buy/shift their structure in new location and continue their livelihood. Rest of them wanted similar space for continuing their business. Details are shown in Table 5.14.12.

⁸ Airport, Roads and Highway Department, Limited Farm, Bank which will lose either boundary wall in the front or gate or secondary structure etc. None of CRP main building or office will be affected by the project

⁹ Nursery, Park, Shopping Mall, Trading Enterprize which will lose either boundary wall in the front or gate or secondary structure etc. None of CRP main building or office will be affected by the project

Table 5.14.12 Preference of CBEs for Relocation by Location in Percentage

Name of Stations (Location)	Preferred Compensation				Total	%
	Cash Compensation	%	Kind for kind	%		
Airport	215	100.00	0	00	215	100.00
Airport Terminal-3	0	00	0	00	0	0.00
Khilkhet	1	100.00	0	00	1	100.00
Bashundhara	4	100.00	0	00	4	100.00
POHS	0	00	0	00	0	0.00
Mastul	0	00	0	00	0	0.00
Purbachal West	0	00	0	00	0	0.00
Purbachal Central	17	00	0	00	17	0.00
Purbachal East	0	00	0	00	0	0.00
Purbachal Terminal	14	00	0	00	14	0.00
Depot Area	698	100.00	0	00	698	100.00
Jamuna Future Park	7	100.00	0	00	7	100.00
Notun Bazar	30	100.00	0	00	30	100.00
Uttar Badda	3	00	0	00	3	00
Badda	9	00	0	00	9	00
Hatir Jheel	5	100.00	0	00	5	100.00
Rampura	23	95.83	1	4.17	24	100.00
Malibagh	12	100.00	0	00	12	100.00
Rajarbagh	5	100.00	0	00	5	100.00
Kamalapur	75	100.00	0	00	75	100.00
Total	1118	99.91	1	0.09	1119	100.00

Source: Census & Socioeconomic survey, April 2017, and June 2018 for Depot area

DMTS is advised to apply the principle that the business of PAPs would be continued where PAPs' set-back is available without acquiring the additional land like in Purbachal or obtain a consensus from PAPs where set-back is not physically available due to a populated area. In the latter case DMTCL is recommended to conduct stakeholder meeting on compensation.

5.15 Eligibility Policy and Entitlement Matrix

5.15.1 Eligibility Criteria

All APs will be entitled to compensation and resettlement assistance based on severity (significance) of impacts. Nevertheless, eligibility to receive compensation and other assistance will be limited by the cut-off date. The cut-off date for compensation under law (Ordinance II of 1982 and its 1994 amendments) is considered for those identified on the project right of way land proposed for acquisition at the time of serving notice under Section 3 or joint verification by DC whichever is earlier. The cut-off date of eligibility for resettlement assistance under this RAP is the commencement date of the disclosure of entitlements and consultation meeting with the stakeholders which is the 2nd round stakeholder meetings in April 2017 for the APs staying on public lands. The absence of legal title will not bar APs from compensation and assistance, as specified in the entitlement matrix presented in Table 5.15.1.

DMTCL shall find a mechanism to purchase a subsurface easement from the property owners through one-time payment and make a deed agreement. In absence of any practice in Bangladesh examples from other countries like Philippines and Vietnam with similar legal strategy is being adopted in this project. For further study, the followings are extracted from the "Republic Act No. 10752", "Implementing Rules and Regulations of Republic Act (IRR)

10752, An Act Facilitating the Acquisition of Right-of-Way, Site or Relocation for National Government Infrastructure Projects” in Philippine, and “Circular37/2014/TT-BGTVT Regulating on Protection Area of Works, Safety Corridor of Urban Railway Transportation (1st of November, 2014)” in Vietnam which is attached in Annex-4.

5.15.2 Compensation and Entitlement Policy

An Entitlement Matrix has been prepared on the basis of census and socioeconomic survey conducted in 9th March to 4th April 2017. It identifies the categories of impact based on the census & SES and shows the entitlements for each type of loss. The matrix describes the units of entitlements for compensating the lost assets, and various resettlement benefits. Cash Compensation under law (CCL) for lost assets (land, tree, structure & other physical establishments) will be accorded to the owners through the DCs as per market value assessed through legal procedure. The resettlement benefit for indirect losses and difference between replacement value and the CCL will be paid by DMTCL through RAP Implementing Agency (IA).

Table 5.15.1 Compensation and Entitlement Policy

Item No.	Type of loss	Entitled Persons (Beneficiaries)	Entitlement (Compensation Package)	Implementation issues/Guidelines
1	Loss of homestead, commercial, Agriculture land, pond, ditches and orchards etc.	Legal owner(s) of land	i. Replacement value (RV) of land (Cash Compensation under Law (CCL) and additional grant to cover the current market price of land and stamp duty & registration cost @ 11.5% of CMP for land) to be determined by PVAC. ii. Compensation for standing crops to actual owners/ cultivators as determined by PVAC.	Assessment of quantity and quality of land by Joint Verification Survey Assessment of Market Value by Land Market Survey (LMS) Assessment of Cash Compensation under Law (CCL) Updating of title of the affected persons Payment of Cash Compensation under Law (CCL) APs will be fully informed of the entitlements and procedures regarding payments Additional cash grant to be paid to cover the replacement value of land compensation based on DC's CCL . Stamp duty and registration fees will be added with current market price (CMP) for land @ 11.5% of CMP to facilitate the APs in purchasing alternative lands.
2	Loss of access to cultivable land by owner cultivator/ tenant/ sharecropper	Tenants/ sharecropper/ Legal owner/ grower/ socially recognized owner/ lessee/ unauthorized occupant of land	Compensation for standing crops to owner cultivator/ sharecroppers or lessees as determined by PVAC. ii. Owner/grower to take away the crop	All the individuals identified by the JVS as tenants or sharecroppers of land Grant to be paid after taking possession of land and the legal /socially recognized owner is paid CCL for land and on certification of receipt by legal/socially recognized owner Additional cash grant to cover current market value of crop compensation as prescribed by PVAC in case of private owner himself cultivating crop Crop compensation and the crop will be shared between owner and sharecropper as per terms of sharecropping in case of privately owned land/socially recognized owner In case of dispute over verbal agreement on sharecropping, certification from the

Item No.	Type of loss	Entitled Persons (Beneficiaries)	Entitlement (Compensation Package)	Implementation issues/Guidelines
				elected representative will be considered as legal document
3	Loss of Trees/ Perennials/ fish stocks	1. Person with Legal Ownership of the land Socially recognized owner/ Unauthorized occupant of the trees/ fishes	i. Cash compensation at market rates for replacement of trees/ perennials/ fish stocks value ii. For fruit bearing trees- compensation for fruits @ 30% of timber value X 1 year iii. Compensation for fish stocks as determined by PVAC. iv. 5 saplings will be distributed free of cost among each affected household losing trees v. Owners will be allowed to fell and take away their trees, perennial crops/ fishes etc. free of cost without delaying the project works.	Assessment of loss and market value of affected trees Payment of CCL for trees Adequate compensation will be paid and the owner will be allowed to fell and take the tree free of cost Compensation for fruit will be paid for small, medium and large categories of trees. 5 saplings (2 fruit tree, 2 timber types and 1 medicinal tree) free of cost will be distributed among the tree losing households.
4	Loss of residential /commercial structure by owner(s)/ squatters	Legal Owners or squatters	i. Replacement value of structure at market price determined by PVAC. ii. Structure Transfer Grant (STG) @ Tk.12.50% of the replacement value of main structure iii. Structure Reconstruction Grant (SRG) @ Tk.12.50% of the replacement value of main structure. iv. One time Transfer Grant (TG) for portable materials at the rate of (a) BDT 3,000 (three thousand) for katcha structure and (b) BDT 5,000 (five thousand) for semi Pucca structure and BDT 7,000 (seven thousand) for Pucca structures v. Cost of transfer and reinstallation of the utility services like reinstallation of electricity connection, water supply line, telephone line etc. as grant @ 10% of CMP (5% for the structure to be demolished now and another 5% for its reconstruction) vi. For the legal owners Monthly Hiring Allowance (MHA) for the similar type of space in other structures for running their activities for a period up to 6 (six) months with the rate would be determined by DMTCL through market survey by the IA for various categories of structures like pucca, semi-pucca and katcha. Salvageable materials will be taken away by the owners within the stipulated time notified by DMTCL Owners to take away all salvage materials free of cost	a. Payment of CCL for the losses b. Verification of Joint Verification Survey (JVS) and other records c. APs will be fully informed about their entitlements and assisted to obtaining it.
5	Loss of access to Residential houses/ commercial structures (rented or leased)	Tenants of rented/ leased properties	i. House Transfer Grant (HTG) for shifting of furniture and belongings of residential structure (@ BDT 2,000 (two thousand) for katcha structure, BDT 4,000 (four thousand) for semi-Pucca structure and BDT 6,000 (six thousand) for Pucca structure to each shifting tenant. Stock Transfer Cost (STC) for commercial entities @BDT 5,000 (five thousand) for small	Verification of JVS and records Transfer grants will be paid on relocation from project site

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Item No.	Type of loss	Entitled Persons (Beneficiaries)	Entitlement (Compensation Package)	Implementation issues/Guidelines
			business; BDT 10,000 (ten thousand) for medium business and BDT 15,000 (fifteen thousand) for large business. One time cash grant for facilitating alternative housing/CBEs Tk. 5000 (Five thousand) per household or entity	
6	Loss of business by CBEs due to dislocation	Owner/operator of the business including vendors as recorded by JVS	i. CCL for business loss. ii. Businesses without any income tax payment record: Transition allowance (TA) for the permanent loss of business/income equivalent to 03 (three) months' income subsistence at the rate of BDT 5,000 (five thousand) for Small business, BDT 10,000 (ten thousand) for medium business and BDT 15,000 (fifteen thousand) for large business. iii. Business with records of income tax payment: TA equivalent to 3(three) months' income calculated on the basis of income tax payment record for the preceding year, not exceeding BDT 20,000 (twenty thousand) for Small business, BDT 50,000 (fifty thousand) for medium business and BDT 75,000 (seventy five thousand) for large business.	a. All persons recorded by the JVS b. Cash grant to be paid while taking possession of land c. Small business will be defined as having investment up to BDT 50,000 (fifty thousand), Medium business with investment between BDT 50,000 to BDT 250,000 and Large business will have investment above BDT 250,000 (two hundred fifty thousand)
7.	Loss of rental income	Owners of rental premises (residential, commercial) as recorded by JVS	i. Transition allowance (TA) for the loss of rental income equivalent monthly allowance for 3 (three) months for each affected rented out premises at the rate of (a) BDT 5,000 (five thousand) per month for katcha structure; (b) BDT 10,000 (ten thousand) per month for semi-Pucca structure (or Pucca structure less than 500 (five hundred) sft. and (c) BDT 15,000 (fifteen thousand) per month for Pucca structure/apartment.	a. All persons recorded by the JVS b. cash grant to be paid on relocation from project site
8.	Loss of Income and work days due to displacement	Employees identified by the Joint Verification Committee (JVC)	i. Cash grant to the affected employees/wage earners equivalent to 45 days wage @ BDT 400/per day for unskilled laborers and @ BDT 600/per day for skilled laborers. ii. Preferential employment in the project construction work, if available.	All persons recorded by the JVS Cash grant to be paid while taking possession Involvement of the incumbents in project civil works Training on income generating activities.
9.	Poor and vulnerable households	Poor and vulnerable households as identified by JVC	i. Additional cash grant of BDT 10,000 (ten thousand) for affected poor women headed households and other vulnerable households ii. Training on IGA for AP/ nominated by AP.	Identification of Vulnerable households Income restoration schemes for vulnerable households Arrange training on income generating activities
10.	Temporary impact during construction	Community / Individual	The contractor shall bear the cost of any impact on structure or land due to movement of machinery and in connection with collection and transportation of borrow materials. All temporary use of lands outside proposed RoW to be through written approval of the landowner and contractor. Land will be returned to owner rehabilitated to original preferably better standard.	Community people should be consulted before starting of construction regarding air pollution, noise pollution and other environmental impact The laborers in the camp would be trained about safety measures during construction, aware of health safety, STDs, safe sex etc. The contractor shall ensure first aid box and other safety measures like condoms at construction site.

Source: RAP

5.15.3 Income and Livelihood Restoration Strategy

Additional measures will be taken to provide appropriate support to the livelihood restoration aspects of AHs.

In compliance with the RAP, the updated RAP will identify resources, in addition to compensation, for income restoration assistance. This will be through linking resettlement activities with a Livelihood and Income Restoration Program (LIRP).

The RAP includes the following categories of AHs for income restoration and livelihood support:

- Vulnerable households to be relocated from the project right of way. Eligible members of such family will be identified during planning the LIRP.
- Vulnerable households having no adult male members to shoulder household responsibility (women headed households in particular). The women heading the household will preferably be the eligible member.
- Vulnerable households of the employees and daily wage earners of the affected businesses or their nominated representatives.
- Vulnerable households losing access to agriculture land including sharecropper, and leaseholders.
- Vulnerable households losing access to commercial land including business proprietorship.
- Vulnerable households losing more than 10% of their agricultural income due to acquisition of agricultural land.

For additional support to usual income restoration assistance as mentioned above, the RAP Implementing NGO (INGO)/IA will specifically undertake assessment of needs and skill base of vulnerable APs of ages between 15 to 60 years. The IA (NGO or Consulting Firm) will recommend the eligible members of affected vulnerable households with their relevant profile to the LIRP implementing organization through DMTCL. The short-term livelihood regeneration assistance under the RAP and long-term income generation program under the LIRP will be organized as follows:

Table 5.15.2 Livelihood Restoration Options

1. Eligible members of poor households to be relocated from the project right of way.	1.1 Short-term: Compensation for structure, shifting allowance, reconstruction assistance, cash assistance for loss of workdays due to relocation, and priority in employment in construction. 1.2 Long-term: Needs and capacity identification, human development and skill training, institutional support under the LIRP.
2. Eligible members from poor female headed households having no adult male members to shoulder household responsibility.	Similar to 1.1 and 1.2.
3. Poor and vulnerable employees of affected businesses.	3.1 Short-term: Subsistence for loss of income and employment. 3.2 Long-term: As 1.2 above.
4. Eligible members of poor households losing access to agriculture land including sharecroppers, and leaseholders.	4.1 Short-term: Compensation for crops. 4.2 Long-term: As 1.2 above.
5. Eligible members of poor households losing access to commercial land including business proprietorship.	5.1 Short-term: Compensation for loss of business income, shifting and reconstruction assistance. 5.2 Long-term: As per need, livelihood and income generating training and employment in project construction.
6. Eligible members of poor households losing more than 10% of their agricultural land.	6.1 Short-term: Compensation for crops, replacement value of land, assistance for land purchase, and employment in construction. 6.2 Long-term: As 1.2 above.

Source: RAP

5.15.4 Information on Depot

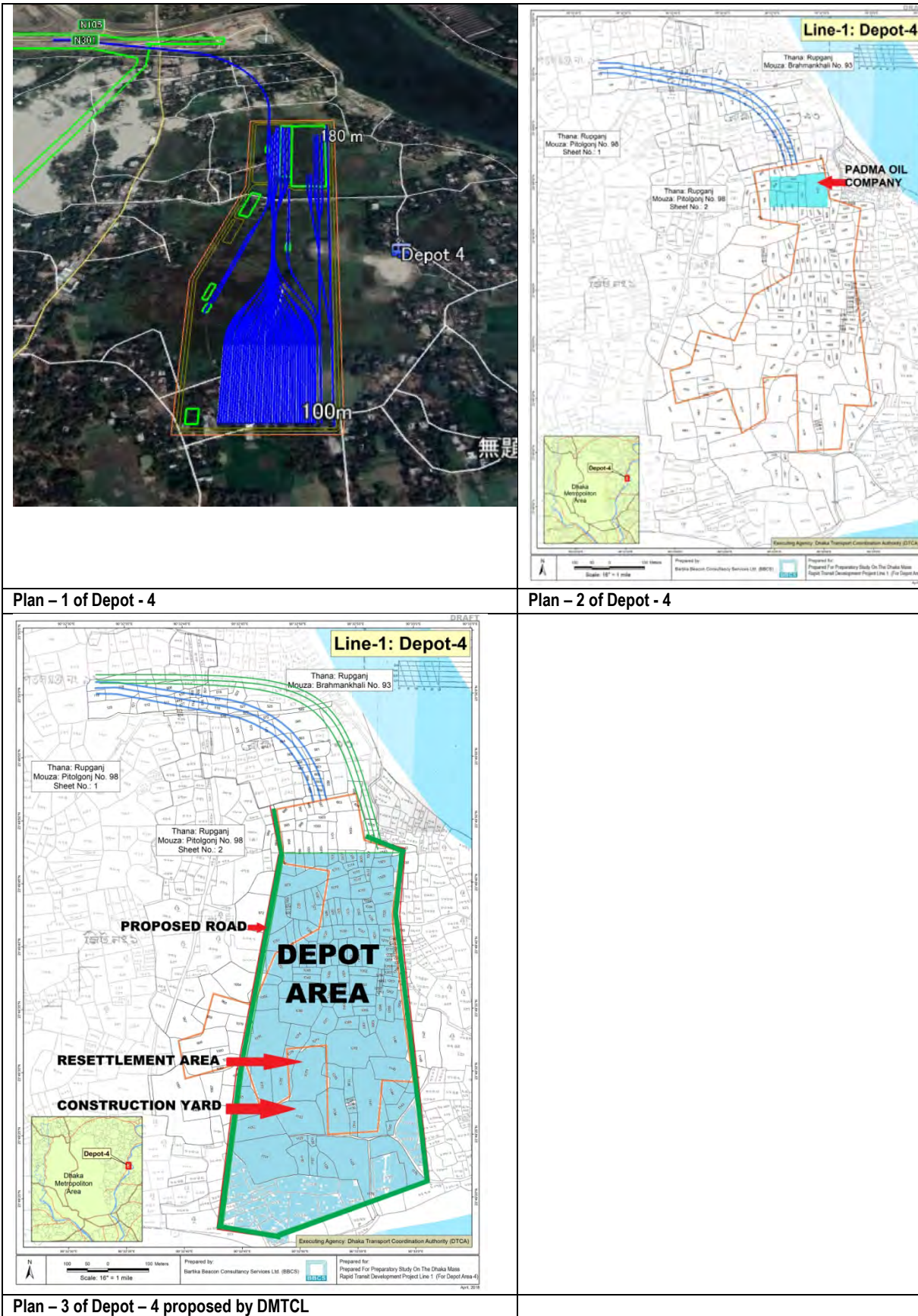
The JICA Study Team had provided a plan (Plan - 1 of Depot - 4) with which the sub-consultant proceeded to hold the SHM on 03 March, 2018 at the Pitolganj, Dakhil Madrasha premises. The DMTCL officials through agreed initially failed to turn up due to preoccupations as they said. About 100 people attended, the consultants described the purpose of the project, its benefits and loses to be sustained by the APs, compensation packages and methods of payment. The large majority expressed their views against shifting of the Depot in the new area and expressed that 3 sites were studied earlier and they looked lucrative by them why this shift which will impact on much larger land more APs. They vehemently expressed their dissatisfaction and did not appear to agree with the new site. The meeting could not be properly concluded and people attending started to diffuse out without signing the list of people attended and the SHM remained inconclusive.

In this circumstances, the JICA Study Team proposed a depot plan in zigzag shape which on mainly agricultural land and few households to be affected (Plan - 2 of Depot - 4) but DMTCL did not like it and came up with another plan (say Plan - 3 of Depot - 4) and the sub-consultant was advised to study the Plan - 3. After several efforts and assistance from DMTCL, SHM was repeated at the same location on 14 May, 2018. This time the Upazila Nirbahi Officer (UNO) of Rupgonj Upazila presided. In the meeting, situation improved but people were not unanimous but a good deal of change in opinion was observed to shift in favour of the acquisition. The people started expressing that they will cooperate if their household lands were spared. People appeared to express opinion in favour of the acquisition.

Some families are requesting alternative site to relocate, therefore, DMTCL must prepare the resettlement site which qualify the principle of JICA policies on involuntary resettlement as follows.

- ① Describe the selection method on resettlement site, detail of basic infrastructure which will be provided, transfer of ownership plan and resettlement schedule.
- ② Describe the considerations on host community such as; implementation of stakeholder consultation meeting with the host community, grievance redress mechanism and any measures necessary to augment services in the host community.
- ③ Describe the measures to prevent influx of ineligible persons to the selected site.
- ④ The replacement site must be comparable productive capacity and potential.
- ⑤ Compensation for PAPs those dependent on agricultural activities will be land-based whenever possible.
- ⑥ Provide resettlement schedule is subsequent to the basic infrastructure; electricity, drinking water, housing and school which will be prepared and secured

On 22nd September 2018, DMTCL managed to hold a SHM to gain PAPs' understanding. Approximately 430 persons including local elites, teachers, imams and PAPs took part in the SHM. Attendees generally expressed consent on the project implementation and land acquisition for the depot site. However, they ventilated their requests such as exclusion of involvement or hassle of intermediate broker (Dalal) on compensation payment, and compensation that they can remain close to their current living areas. The authorities including DMTCL agreed with their requests and promised to assist the PAPs in all respects.



Source: JICA Study Team

Figure 5.15.1 Depot

5.16 Grievance Redress Committee

The complex land record system in Bangladesh leaves considerable room for conflicts over titles to land and properties involving land, structures, trees, ponds etc. Grievances may also be aired about the road alignment and/or the valuation of land and/or other properties in determining compensation. There are established procedures in the LA Ordinance of 1982 regarding compensation for some of these grievances. But recourse to law is always a complicated process, which usually discriminates against the poor due to their lack of knowledge and resources for litigation and is always time consuming. There are grievances, which can be easily resolved out of court if the law is properly explained and fair play made clear. It is with these objectives that a Grievance Redress Committee (GRC) will be set-up in each union where land acquisition will be taking place.

GRCs will be formed at Ward level for any grievances involving resettlement benefits, relocation, and other assistance. A gazette notification on the formation and scope of the GRCs will be required from the MORTB. The GRC for each Ward will comprised of;

Executive Engineer, DMTCL - Convener

Area Manager, RAP Implementing Agency - member secretary.

UP Chairman - member.

One representative of APs – member

One UP member (female)- member

And the Procedures and Mechanism are presented in Table 5.16.1 and Figure 5.16.1, respectively.

Table 5.16.1 Grievance Redress Procedures

Step 1	The Implementing Agency informs DPs/APs about their losses and entitlements. If satisfied, the DPs/APs claims of resettlement payments forwarded to the EA. If confused,
Step 2	The DPs/APs approach the IA field level officials for clarification. The IA will clarify the DPs/APs about their losses & entitlements as per RAP. If resolved, the DPs/APs claim resettlement payments to the EA. If not resolved,
Step 3	The DPs/APs approaches to the GRC. IA staff assists the DPs/APs producing the complaints and organize hearing in 15-21 days of receiving the complaints.
Step 4	GRC to scrutinize applications, cases referred to DC through EA if beyond their mandate as per scope of work
Step 5	If within the mandate, GRC sessions held with aggrieved DPs/APs, minutes recorded. If resolved, the Project Director approves. If not resolved,
Step 6	The DP/AP may accept GRC decision. If not, he/she may file a case to the court of law for settlement.
Step 7	The GRC minutes, approved by the Project Director, received at Conveners' office back. The approved verdict is communicated to the complainant DP/AP in writing. The DP/AP then claims resettlement payments to EA

Source: JICA Study Team

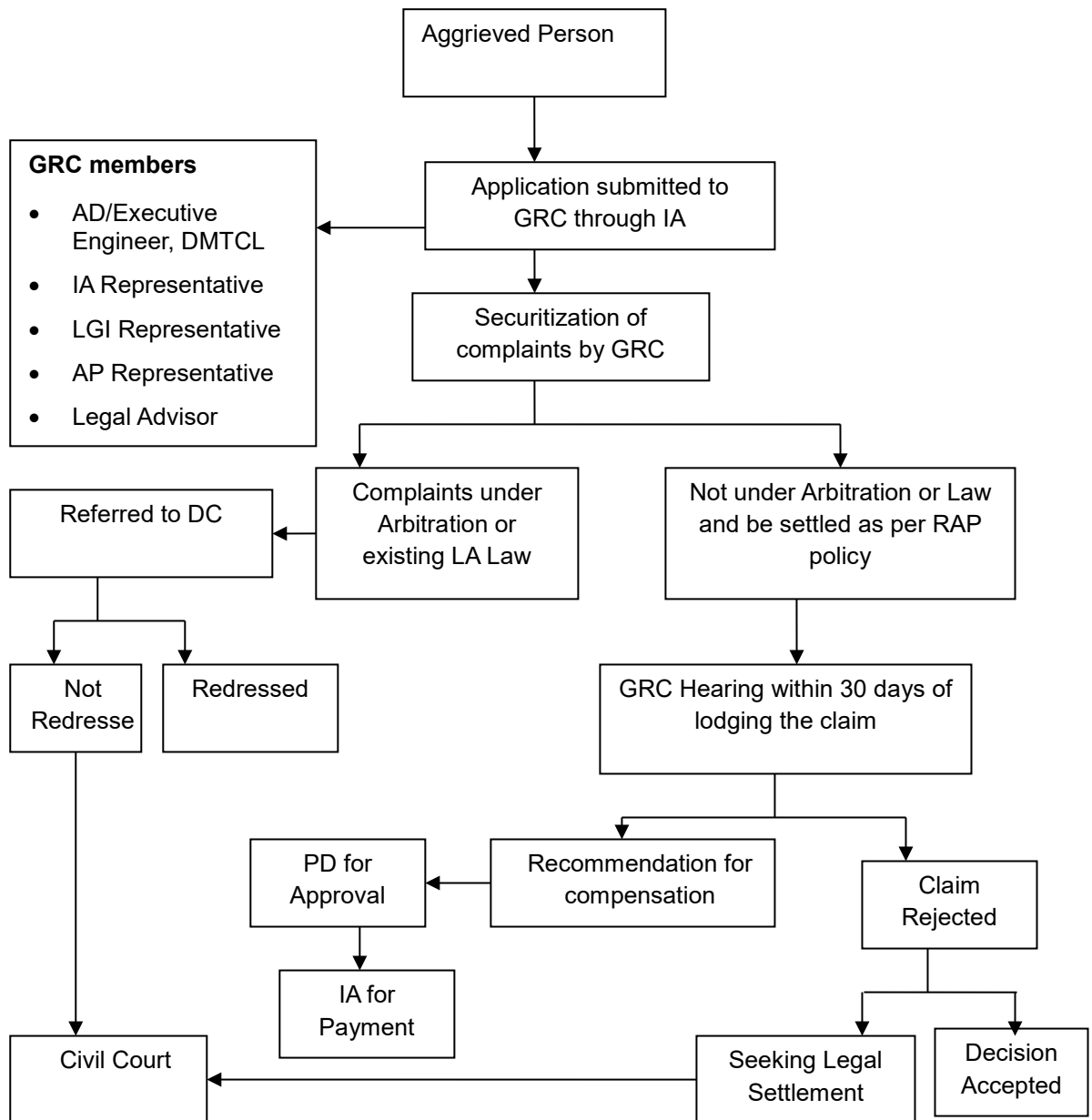


Figure 5.16.1 Grievance Redress Mechanism

Source: JICA Study Team

5.17 Implementation Organization

5.17.1 Implementation Organization

DMTCL will establish a Project Implementation Unit (PIU) headed by a Project Director (PD), at the project office that will be responsible for the overall execution of the Project. The PIU will consist of three units: Engineering Service Unit (ESU), Environmental Management Unit (EMU) and Resettlement Unit (RU) for total implementation of the project. The PD will work on deputation from RHD at the level of Superintending Engineer or Additional Chief Engineer. The project will be overseen by the PD, RHD. The RU will be responsible for the overall implementation, management and monitoring of the RAP of the project. RAP Implementing Agency (IA) plays an important role in the field level in coordination with the DC, RHD and consultants. Their main activities are;

(a) To create ID numbers for each affected person as identified during the Joint Verification survey by JVT for both title and non-title holders.

- (b) To assist the APs in preparing a record of rights to the property and receiving compensation under law (CCL) from DC office.
- (c) To form focus groups with the affected people based on homogeneity and/or proximity and hold meetings on a regular basis to let them know their rights and entitlements as prescribed in the RAP.
- (d) To form the union based resettlement advisory committee (RAC) to involve the local communities and APs in the implementation process.
- (e) To prepare payment debit vouchers and other documents and disburse account payee checks to the APs.

The implementation organizations and hierarchy involved in the implementation process are shown in Figure 5.17.1.

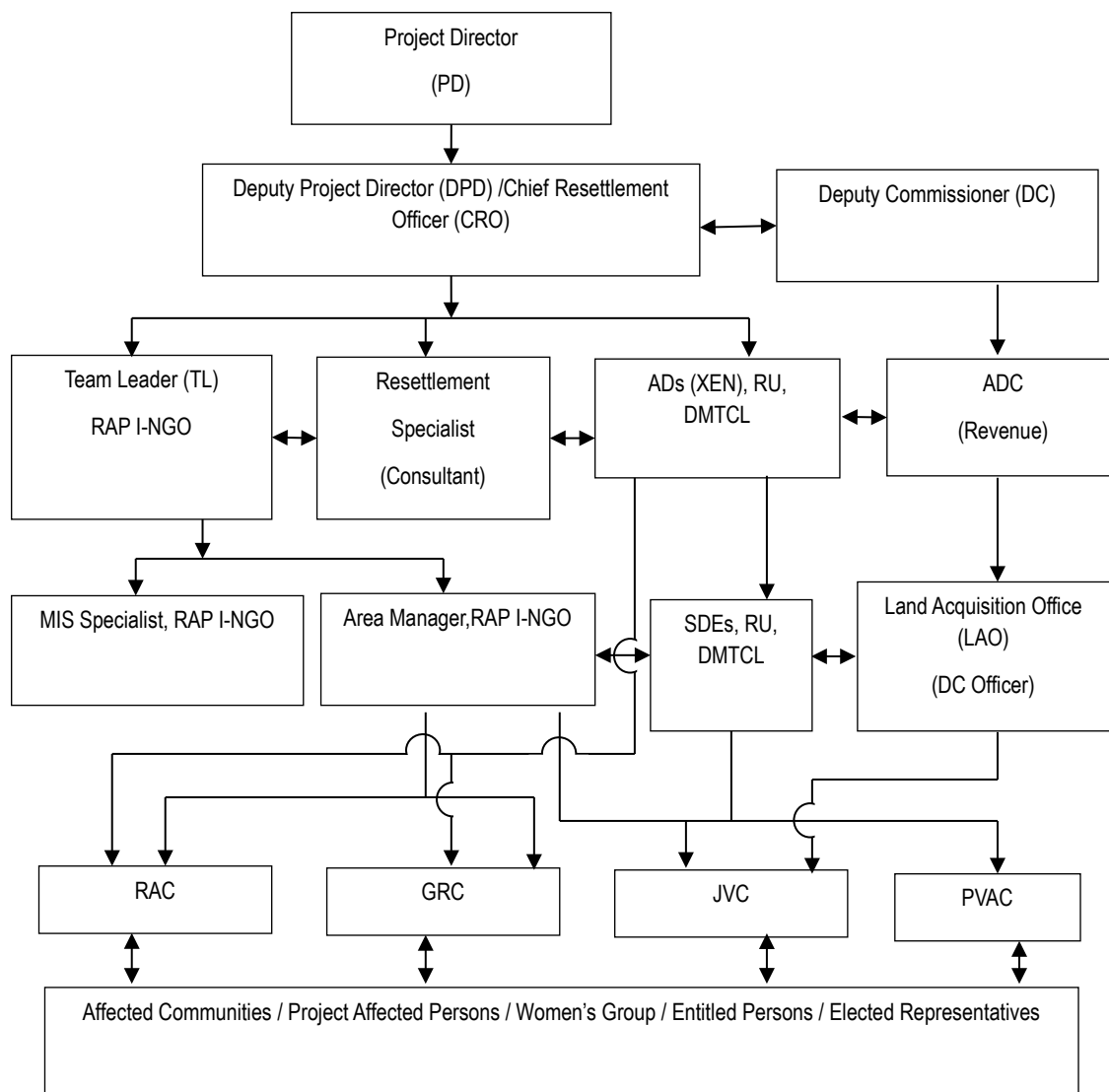


Figure 5.17.1 RAP Implementation Organogram

Source: JICA Study Team

5.17.2 Appointment of Implementing Agency (I-NGO)

DMTCL will appoint an experienced Implementing Agency (IA) through standard procurement system. The IA can be a Non-Government Organization (NGO) or Social Consulting Firm. This IA will be appointed for implementation of the RAP in the field level in coordination with DC, DMTCL and National Resettlement Consultant (NRS). The EA will contract out clearly defined tasks of the RAP with details Terms of Reference. A TOR is attached in Annex-5 of this document for the implementing agency.

5.18 Implementation Schedule

A time-bound implementation schedule for the RAP has been prepared in accordance with the project construction schedule. The overall schedule of implementation is based on the principle that people affected by the project are paid their due resettlement benefits prior to displacement. The Implementing Agency (IA) will assist the APs in the process of relocation and resettlement. Individual entitlements on household basis will be processed by the IA. Each EP will receive an ID card and an entitlement card. The ID card will be issued to the EPs as identified by the DC and/or Joint Verification Survey (JVS) with joint signature of the DMTCL and IA representatives. Photograph of the EPs will be attested by the concerned UP Chairman/Ward Commissioner and pasted on the ID card.

Implementation of RAP will be started before starting of the construction works and will continue up to one year after completion of the construction work for entertaining claims /grievances of the EPs regarding additional payment of compensation and other resettlement grants. However, some of the activities for RAP implementation may extend further. The preliminary time bound implementation schedule over a period of 26 months from May 2019 to June 2021 is presented in Table 5.18.1.

Restoration and rehabilitation of livelihood program is expected to start from December 2020.