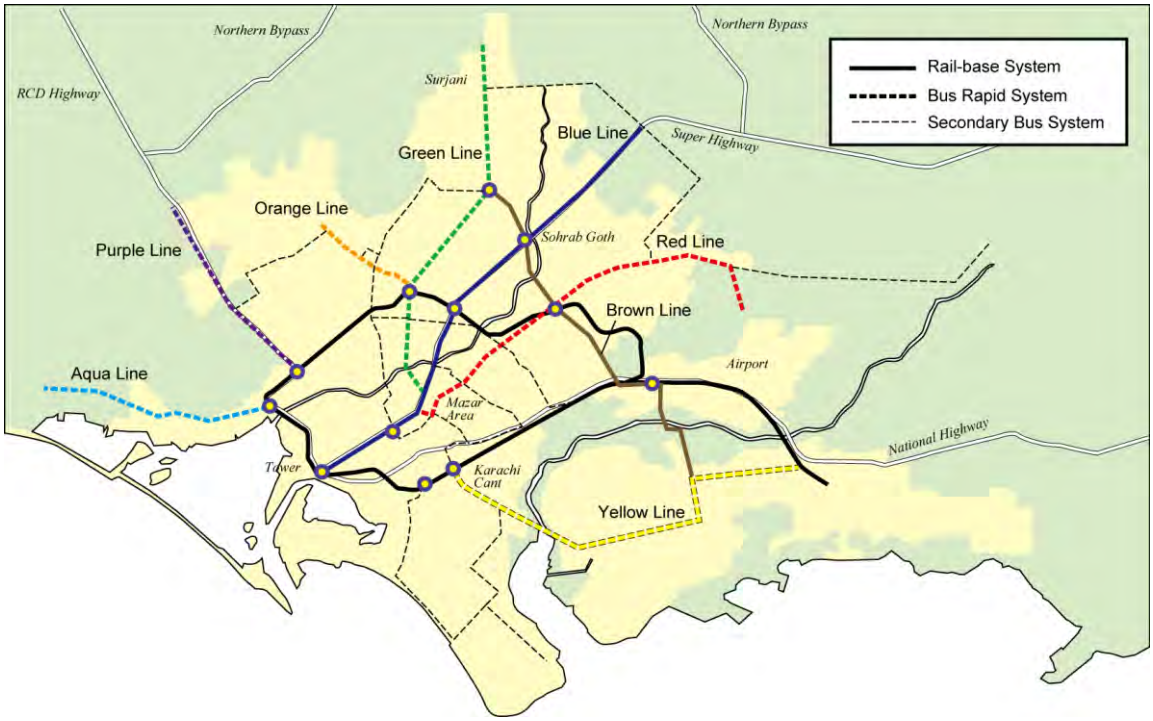
APPENDIX-1 PRE-FEASIBILITY STUDY OF BLUE LINE

1. Outline of Blue Line

1.1 Blue Line in Master Plan Network

The master plan network in KUTMP 2030 is shown in Figure A1-1-1. Blue Line is proposed as Railed-base system.

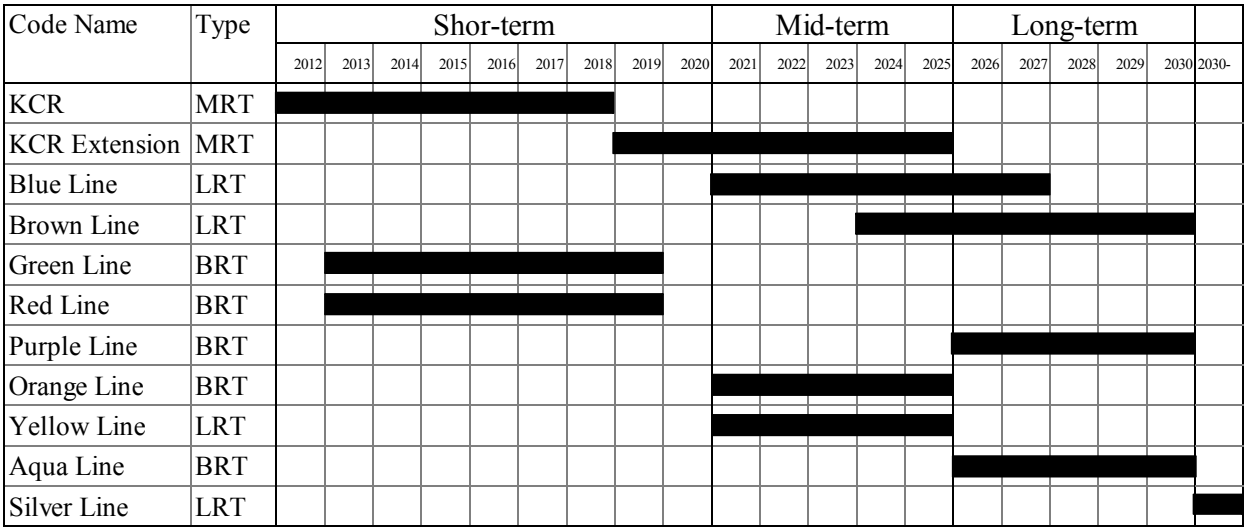


Source; KTIP

Figure A1-1-1 Master Plan Network in KUTMP 2030

1.2 Implementation Plan of Blue Line

Figure A1-1.2 shows the proposed schedule of mass transit lines in KUTMP 2030. It is assumed that a rail-base project takes seven years to be implemented, while BRT project takes five years.



Source: KTIP

Figure A1-1-2 Master Plan Schedule (Mass Transit Projects)

2. Purpose for Pre-Feasibility Study of Blue Line

2.1 Issues on Developing of Blue Line

According to the implementation plan of Blue Line in KUTMP 2030, following issues are pointed out against the implementation timing of LRT Blue Line.

1) The growth in population and the expansion in urbanized areas would certainly bring about a rapid increase in traffic demand in Karachi City.

2) There are only four years between construction commencement of LRT Blue Line and completion of Green and Red BRT line.

3) As a result of above 1) and 2), alternative public transportation system to LRT along Blue Line would be required before construction of LRT.

Thus, the JICA Study Team proposes an alternative plan along BRT divided into following two phases taking into account above mentioned matters.

- Phase-1; Adopting Semi-BRT system before construction of LRT Blue Line after completion of BRT Green Line and Red Line.

- Phase-2; Adopting LRT system after the commencement of LRT construction

2.2 Purpose for Pre-Feasibility Study of Blue Line

In case the alternative Blue Line plan is adopted, following issues are pointed out from the perspective of introducing space for both transportation system, tentative BRT system and LRT system.

1) BRT system would be required during only four years before construction of LRT system according to the implementation schedule. In addition to construction of BRT facility, removal of tentative BRT facility would also become an important issue so that tentative BRT facility should become removal easily.

2) A large space is required for the accommodation of LRT facility along the route permanently due to elevated structure or underground structure including station structure.

3) On the other hand, new flyovers would be designed and constructed in the near future as necessary countermeasure against rapid increasing traffic volume in Karachi.

JICA Study Team has carried out the study about necessary space for both transportation systems in different phases so that both systems would be easily introduced without any hindrance in the near future.

Purpose of this study consists of;

- Proposing introducing space, station locations and structures, and countermeasure against obstacles if any, for tentative BRT system of Blue Line as short-time.
- Proposing introducing space as elevated or underground, station locations and structures, transition section plan, terminal tower station, and countermeasure against obstacles if any, for LRT system of Blue Line

3. Study of Introducing Space for Blue Line

3.1 Introducing Space for BRT System during Short-term

3.1.1 BRT System of Blue Line as Short-Term

There are two major types of cross section design for BRT. One is to set the station at the center of the road, and another is at curb-side, which would determine the side of the door of BRT bus.

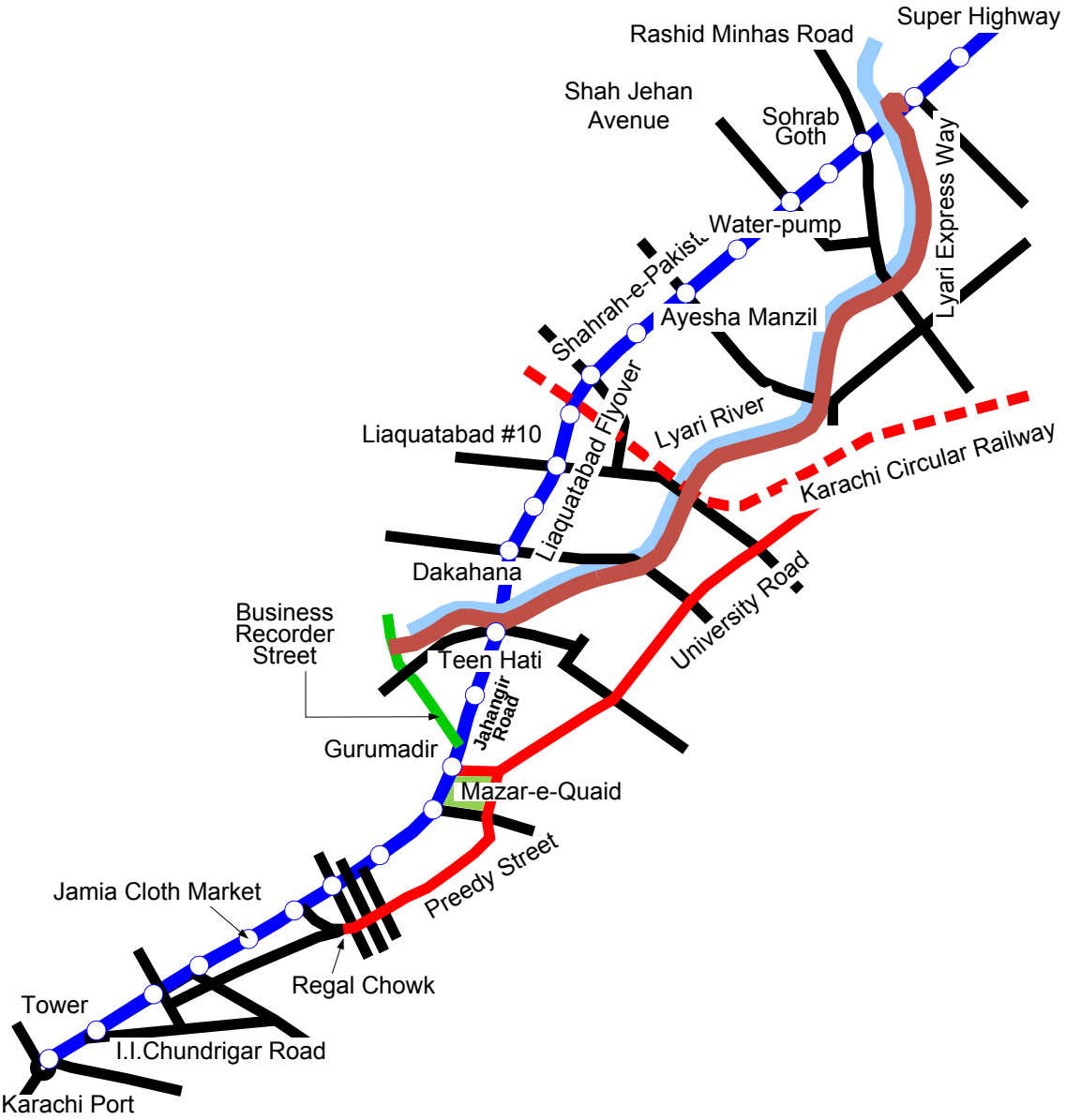
BRT buses of Green Line and Red Line run just through the dedicated lanes except for intersections. And station place is designed at a center of the road for the right door buses, as described in this report Vol. 2.

On the other hand, JICA Study Team proposes that tentative BRT system of Blue Line during short-term run in mixed traffic lanes and station place is set on curb-side for left-door buses. The major reasons for this selection are as follows;

- In case of the center station for the right door buses, pedestrian bridges would be necessary for access between both sidewalk and BRT station. However, pedestrian bridges would become obstructive to the space for LRT structure in the future.
- In additional construction of high height platform would be required at each center station and removal of platform become also necessary before construction of LRT facility.
- Jahangir Road and one-way sections in M.A.Jinnah Road are too narrow to construct the center station of BRT. But construction of the curb-side stations would be possible.
- At the crossing section with KCR, Tentative BRT Blue Line should be designed as elevated structure because KCR is designed at grade. Then tentative BRT lane should be set up in the space of the Liaquatabad Flyover. Although there is no space of the center station, there still would be enough space of curb-side station by constructing elevated platforms at both side of the flyover.
- In case of constructing mixed traffic lane and curb-side stations for tentative BRT, it is possible to make not only initial investment much smaller, but also use of existing buses effective.

3.1.2 BRT route of Blue Line

Tentative BRT route and proposed station locations are shown in Figure A1-3-1 Station distance is set on every around 500 m.



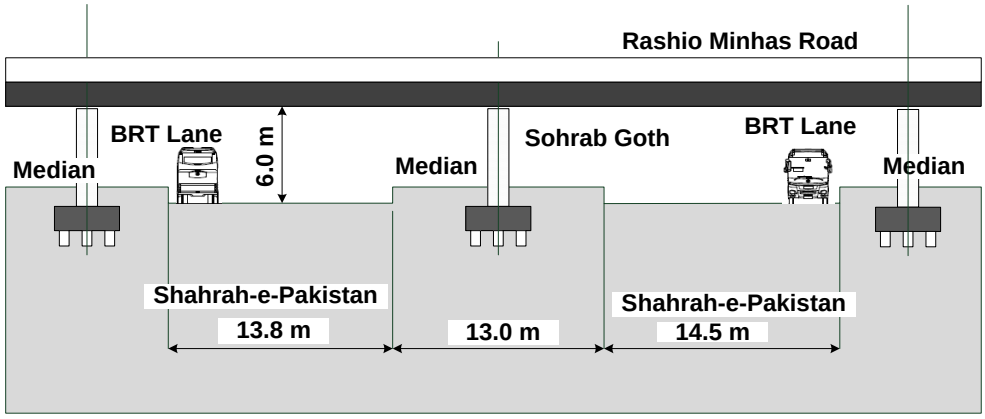
Source: Illustrated by JICA Study Team

Figure A1-3-1 BRT Route and Station Location

3.1.3 Study of Introducing Space for Tentative BRT

(1) Sohrab Goth

BRT lane is designed at both sides in mixed traffic lanes as shown in Figure A1-3-2

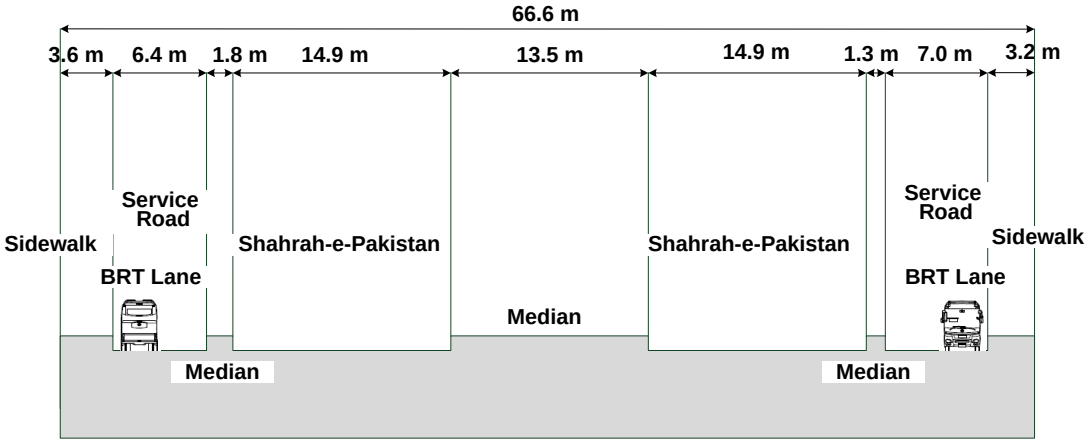


Source: Illustrated by JICA Study Team

Figure A1-3-2 Cross Section of BRT Blue Line at Sohrab Goth

(2) Shahrah-e-Pakistan Road

BRT lanes are designed to be set at both sides in mixed traffic lanes as shown in Figure A1-3-3

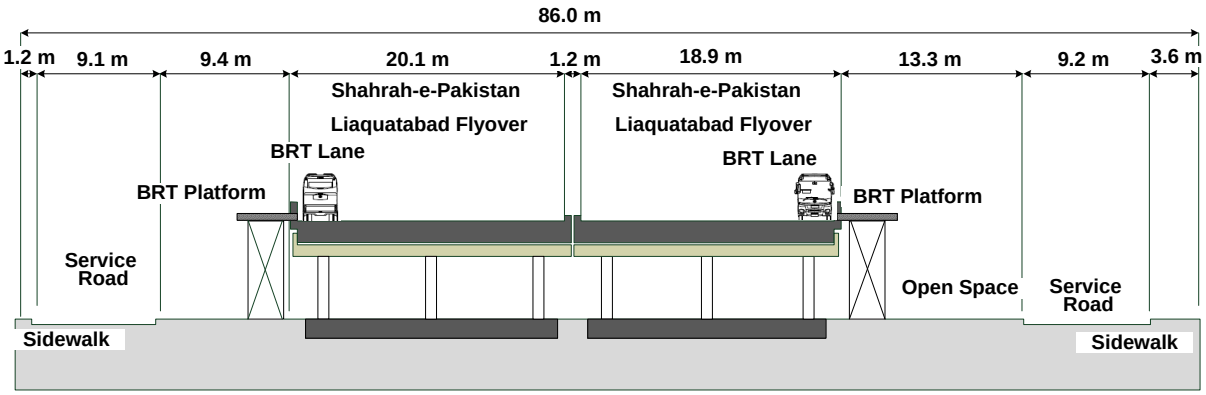


Source: Illustrated by JICA Study Team

Figure A1-3-3 Cross Section of BRT Blue Line along Shahrah-e-Pakistan Road

(3) Cross section with KCR

BRT lane and stations are designed at both sides in mixed traffic lanes as shown in Figure A1-3-4. Both BRT stations and platforms are designed as elevated structure at both side of flyover.

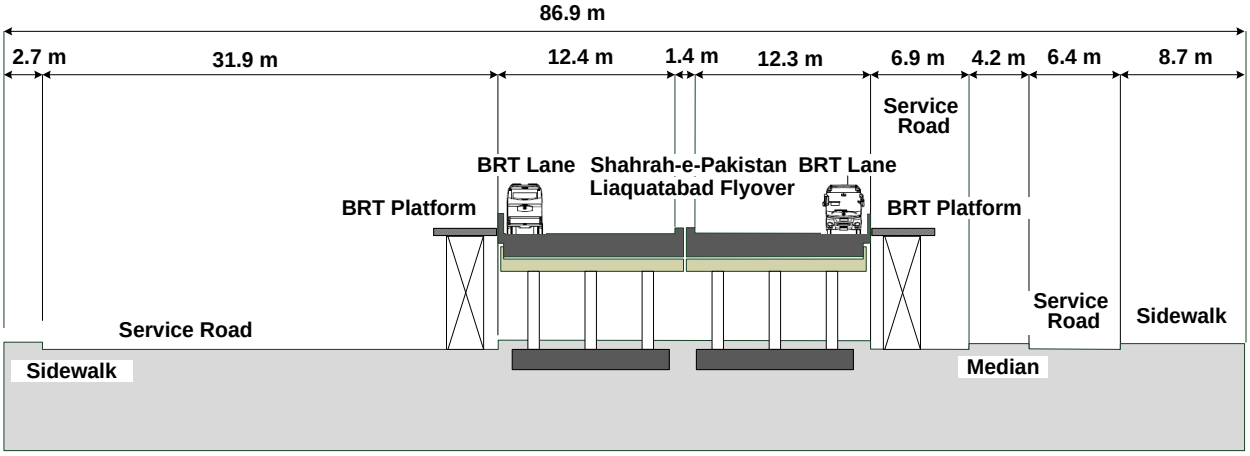


Source: Illustrated by JICA Study Team

Figure A1-3-4 Cross Section of BRT Blue Line with KCR

(4) Section along Liaquatabad Flyover

BRT lane and stations are designed at both sides in mixed traffic lanes as shown in Figure A1-3-5. Both BRT station and platforms are designed as elevated structure at both side of flyover.

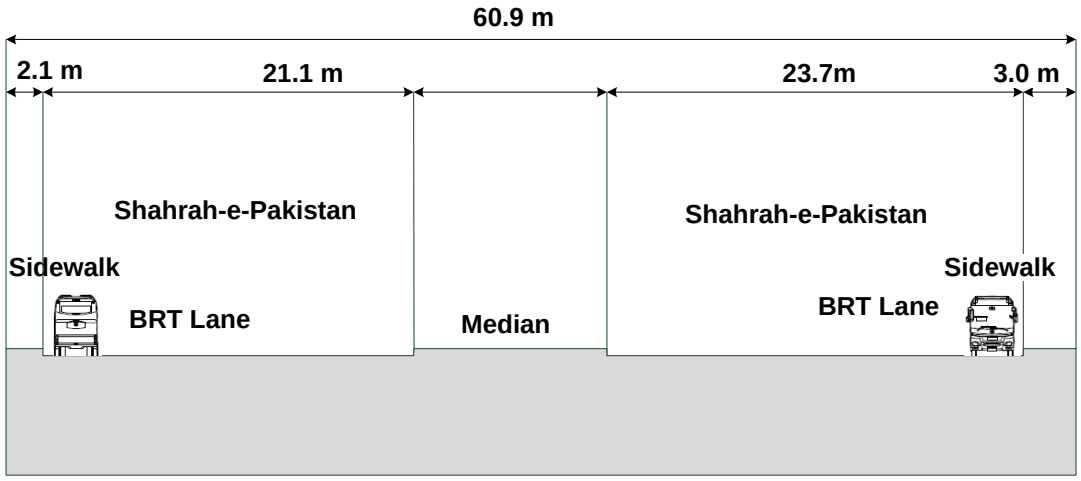


Source: Illustrated by JICA Study Team

Figure A1-3-5 Cross Section of BRT Blue Line along Liaquatabad Flyover

(5) Shahrah-e-Pakistan

BRT lane is designed at both sides in mixed traffic lanes as shown in Figure A1-3-6

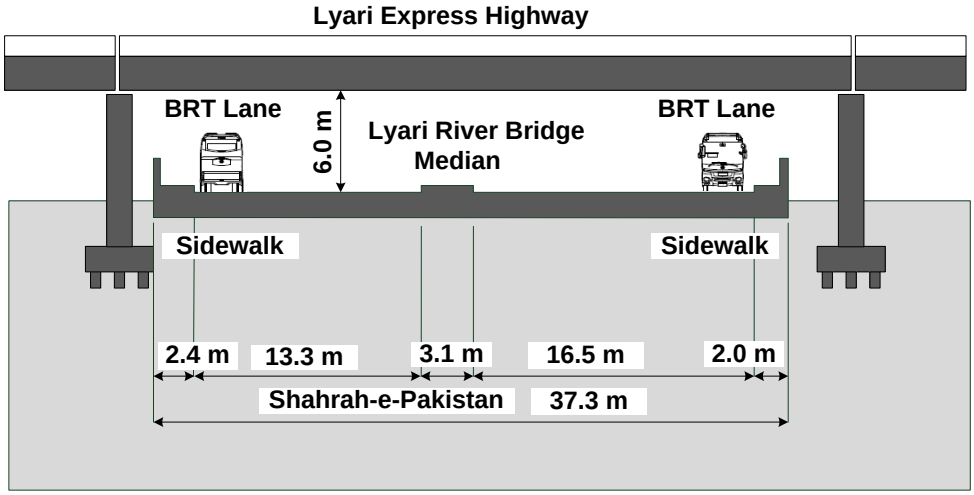


Source: Illustrated by JICA Study Team

Figure A1-3-6 Cross Section of BRT Blue Line along Shahrah-e-Pakistan

(6) Lyari River Bridge

BRT lane is designed at both sides in mixed traffic lanes as shown in Figure A1-3-7

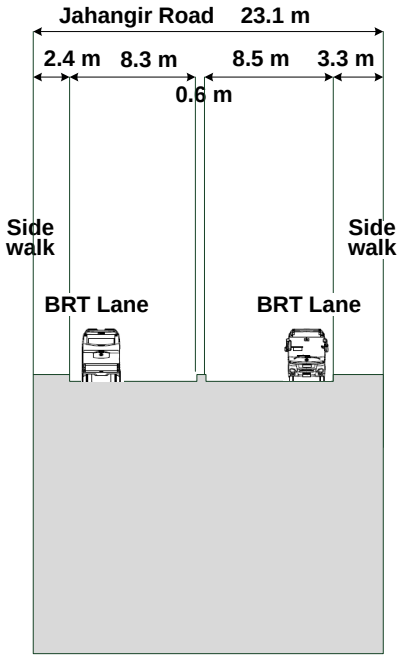


Source: Illustrated by JICA Study Team

Figure A1-3-7 Cross Section of BRT Blue Line on Lyari River Bridge

(7) Cross Section of Jahangir Road

BRT lane is designed at both sides in mixed traffic lanes as shown in Figure A1-3-8

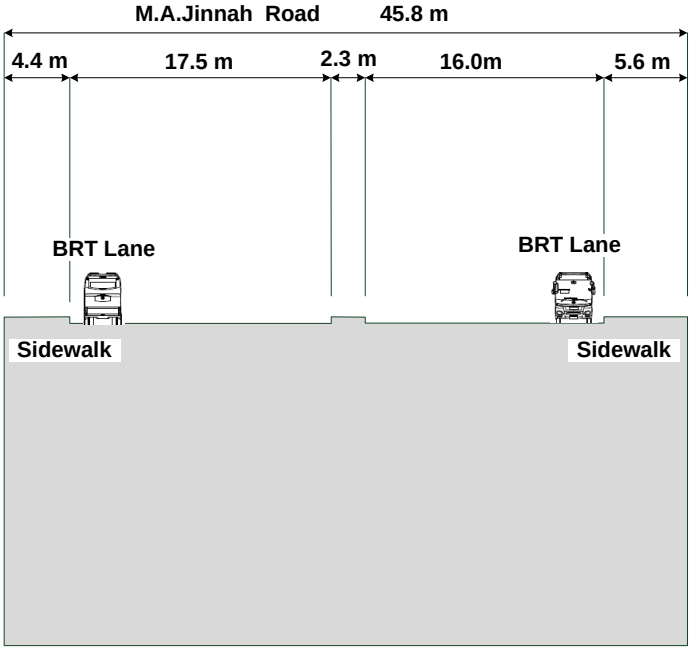


Source: Illustrated by JICA Study Team

Figure A1-3-8 Cross Section of BRT Blue Line along Jahangir Road

(8) Cross section of M.A.Jinnah Road

BRT lane is designed at both sides in mixed traffic lanes as shown in Figure A1-3-9

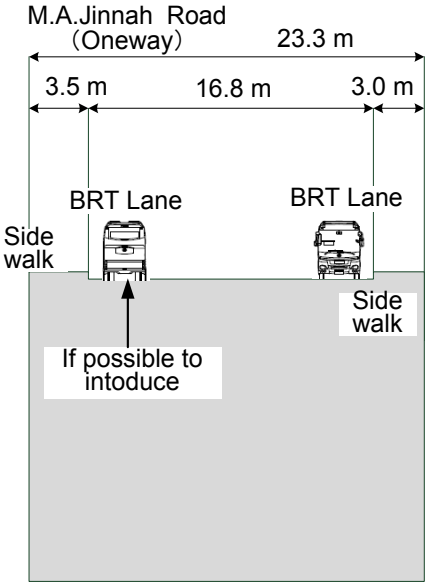


Source: Illustrated by JICA Study Team

Figure A1-3-9 Cross Section of BRT Blue Line along M.A.Jinnah Road

(9) Cross Section of M.A.Jinnah Road (One-way section)

BRT lane and stations are designed mainly at east side in mixed traffic lanes and west side BRT would possibly be introduced as shown in Figure A1-3-10.



Source: Illustrated by JICA Study Team

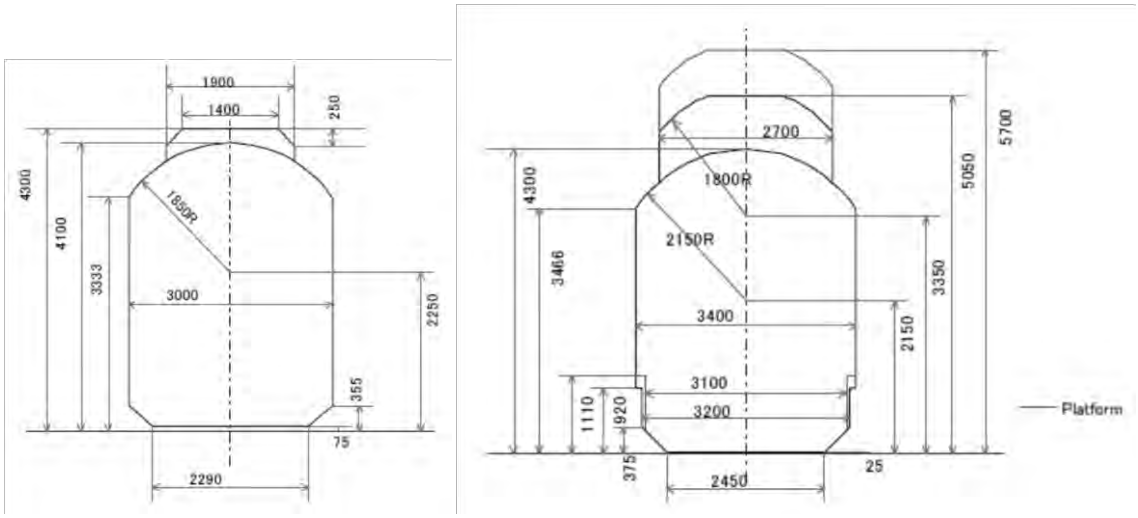
Figure A1-3-10 Cross Section of BRT Blue Line along M.A.Jinnah Road (One-way section)

3.2 Introducing Space for LRT Blue Line

3.2.1 Structure of Railway

(1) Rolling Stock

A car used for the Light Rail Transit (LRT) shall be the typical size of EMU (Electric Multiple Unit), of which length is around 20 meters, and the width is 3 meters. JICA Study Team proposes basic rolling stock gauge and structure gauge of the LRT car as shown in Figure A1-3-11.



Source: Illustrated by JICA Study Team

Figure A1-3-11 Rolling Stock Gauge and Construction Gauge

(2) Design Criteria

Design criteria concerning decision against the introducing space for LRT is shown in Table A1-3-1

Table A1-3-1 Alignment Design Criteria

No.	Items	Technical Features
1	Track Gauge	1,435 mm
2	Design Maximum Speed	90 – 110 km/h
3	Minimum Curve Radius	Main Line: R=160m Platform: R=400m Siding / Depot: R=100m
4	Maximum Gradient	Outside platform: 35 ‰ Platform : 2 ‰ Depot: Level

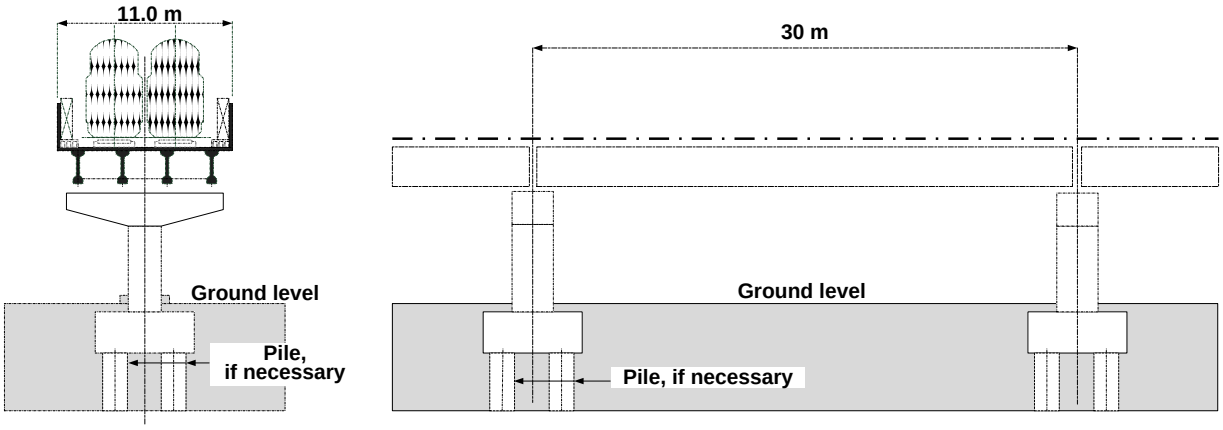
Source: JICA Study Team

JICA Study Team assumed Six-cars train formation in this study. One set of six cars train requires 130m length of platform for both elevated and underground station.

(3) Elevated Structure

1) Elevated structure section between stations

Elevated LRT structure section between stations is designed as shown in Figure A1-3-12. Minimum width for introducing space of LRT lane would be 11.0m.

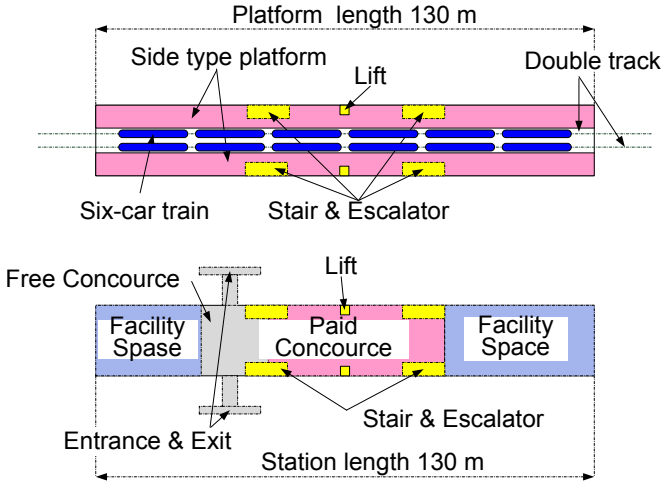


Source: Illustrated by JICA Study Team

Figure A1-3-12 Elevated Structure of LRT

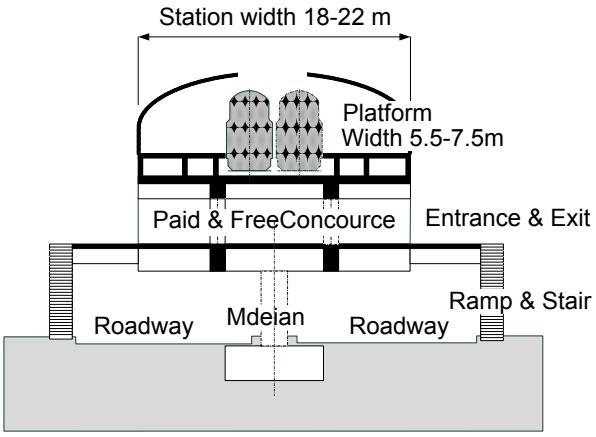
2) Elevated Station Section

Necessary facilities for LRT elevated station such as platform, lifts, and station facility space would be designed as shown in Figure A1-3-13. Cross section of elevated station is shown in Figure A1-3-14, A1-3-15. Minimum width of elevated station would be 18-22 m and length of elevated station would be 130m.



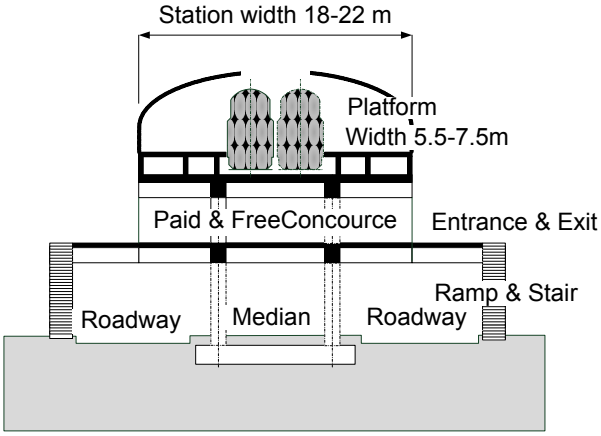
Source: Illustrated by JICA Study Team

Figure A1-3-13 Elevated Station Plan



Source: Illustrated by JICA Study Team

Figure A1-3-14 Elevated Station Supported by the Centre Pier



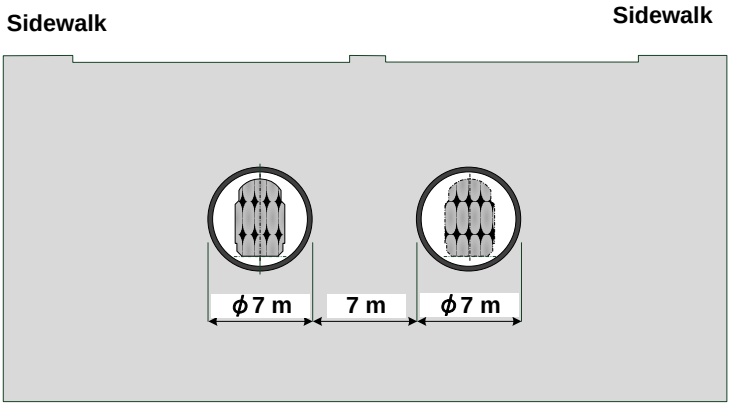
Source: Illustrated by JICA Study Team

Figure A1-3-15 Elevated Station Supported by the Rigid-frame

(4) Underground Structure

1) Tunnel between underground stations

Figure A1-3-16 shows cross section of the tunnel between underground stations.

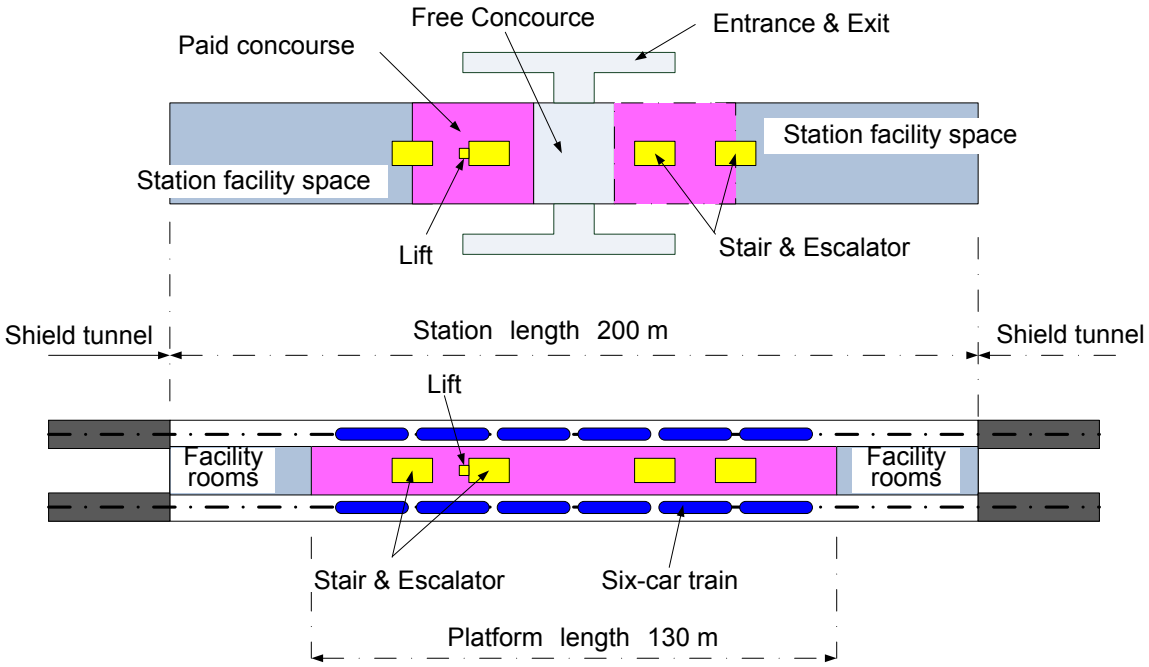


Source: Illustrated by JICA Study Team

Figure A1-3-16 Cross Section of Shield Tunnel

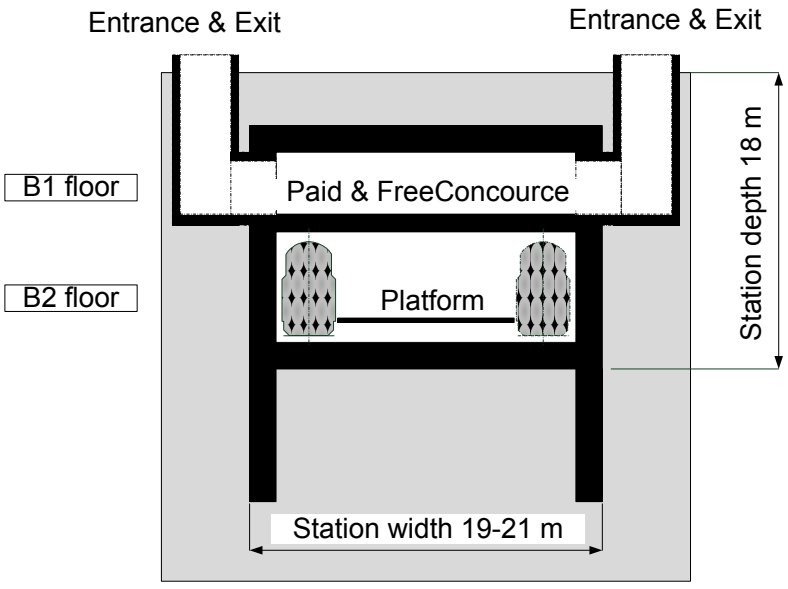
2) Standard Underground Station

LRT facilities for underground station such as platform, lifts and other station facility would generally be designed as shown in Figure A1-3-17. Cross section of an underground station is shown in Figure A1-3-18. Minimum width of the underground station section would become 19-21m, and length would become 200m.



Source: Illustrated by JICA Study Team

Figure A1-3-17 Underground Station Plan

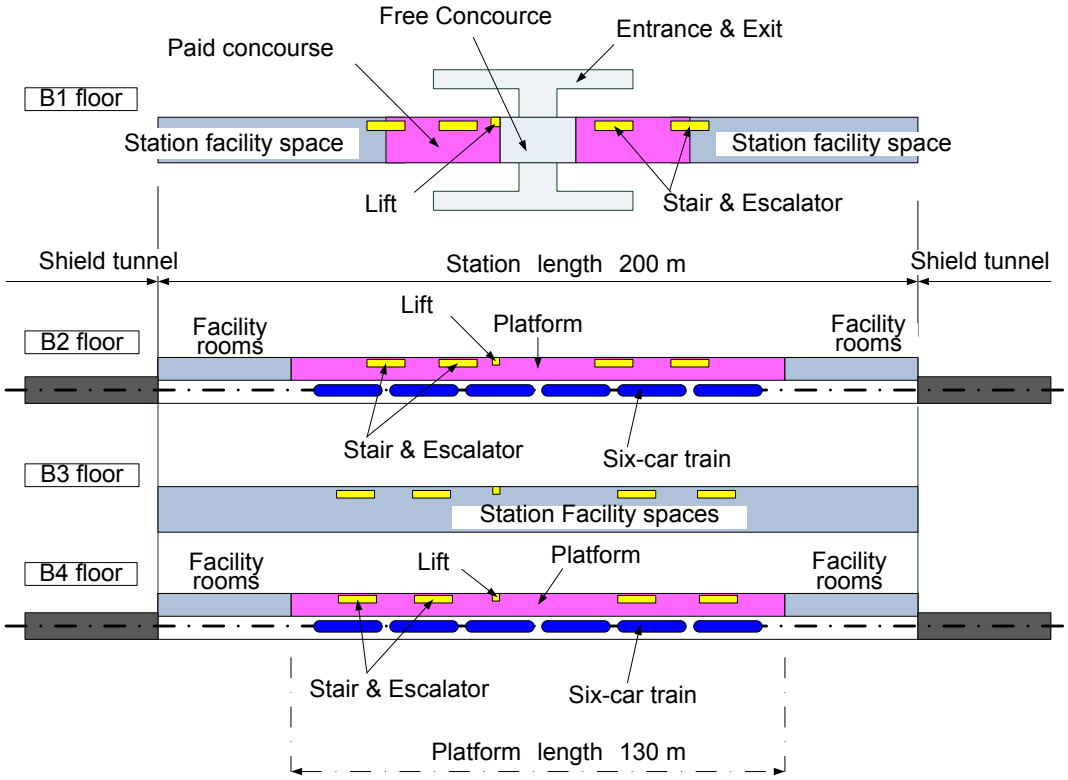


Source: Illustrated by JICA Study Team

Figure A1-3-18 Cross section of Underground Station

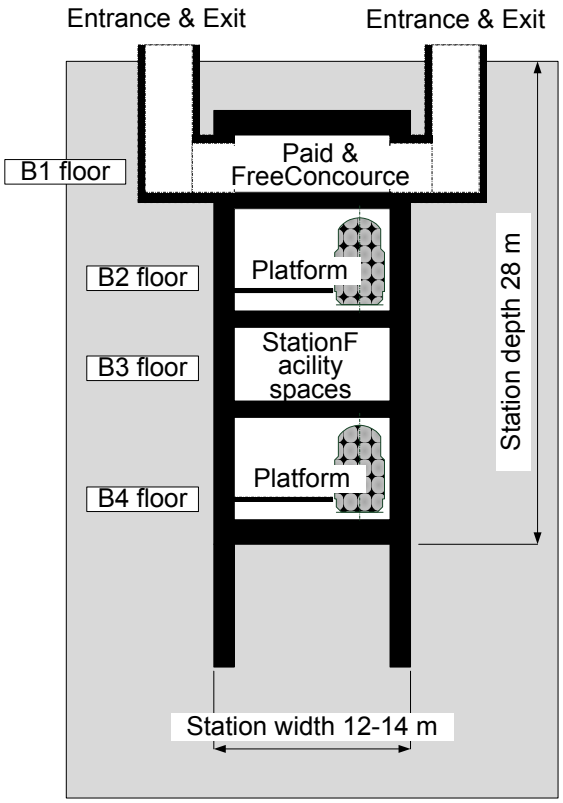
3) Underground Station in case of narrow road

In case of planning underground station under narrow road, two-stories platform type is recommended as shown in Figure A1-3-19. That cross section is shown in Figure A1-3-20. Minimum width of the station would become 12-14m, and length would become 200m.



Source: Illustrated by JICA Study Team

Figure A1-3-19 Two-stories Platform Type of Underground Station

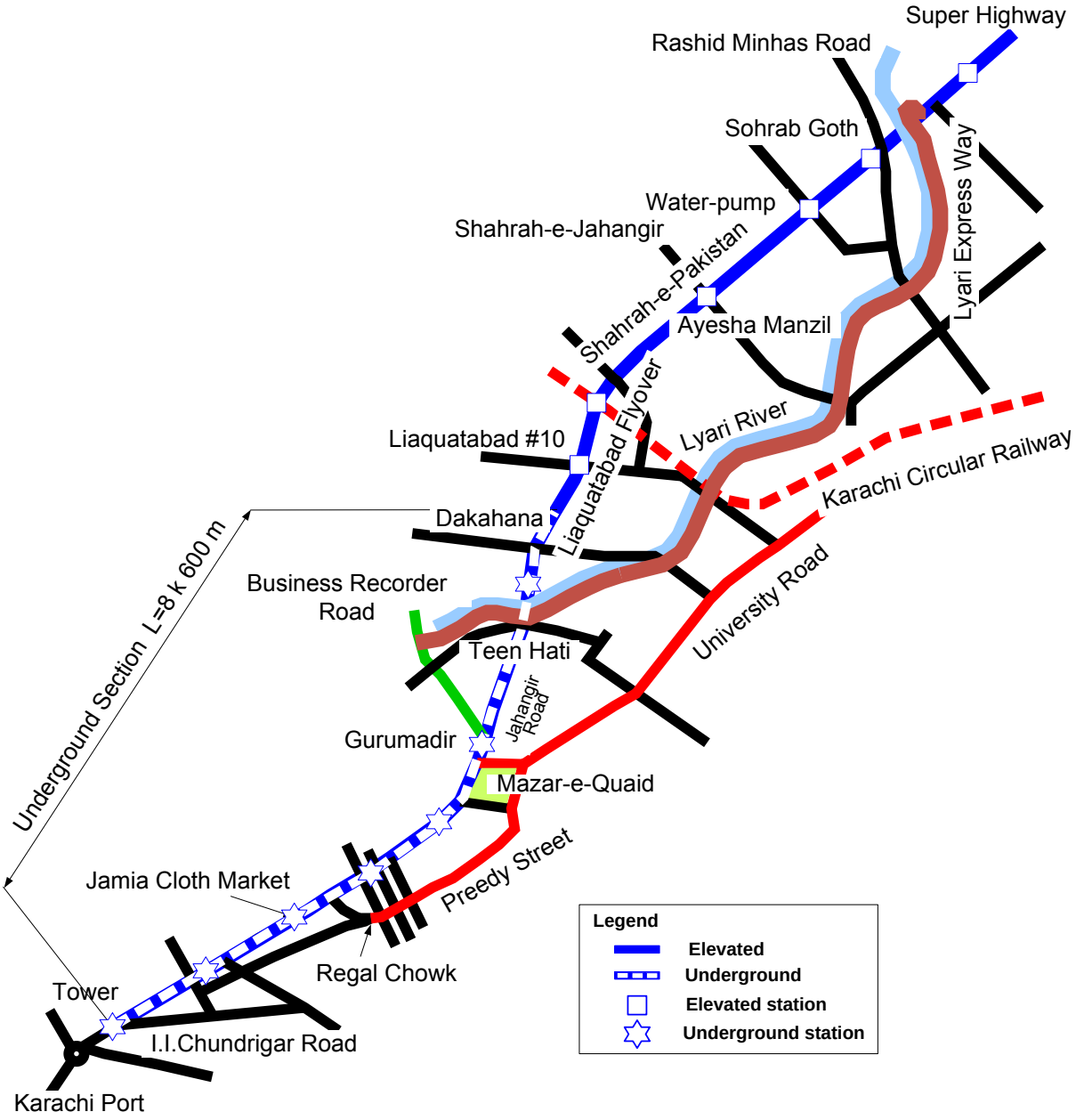


Source: Illustrated by JICA Study Team

Figure A1-3-20 Cross section of Two-stories Platform Type of Underground Station

3.2.2 LRT Blue Line Route

LRT route and proposed station locations are shown in Figure A1-3-21. Distance between stations is designed every about 1000 m.



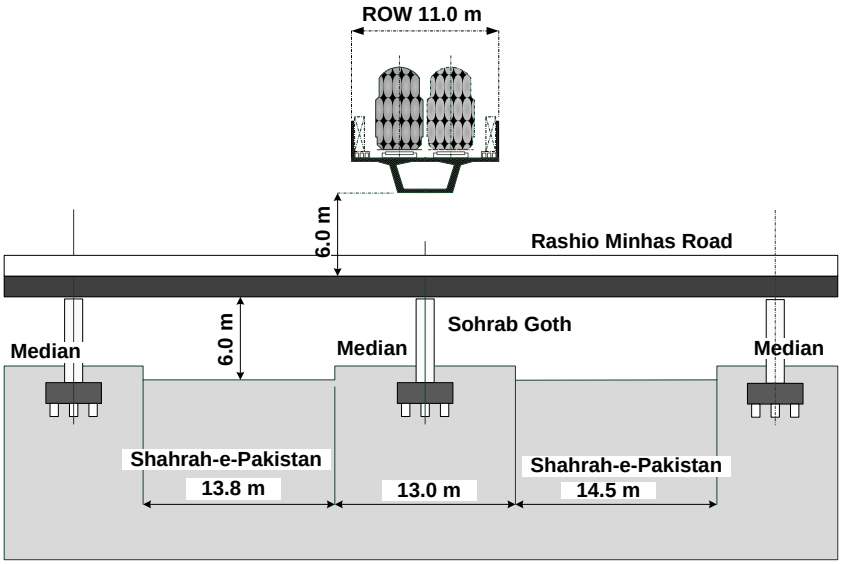
Source: Illustrated by JICA Study Team

Figure A1-3-21 LRT Route and Proposed Station Location

3.2.3 Introducing Space for LRT

(1) Sohrab Goth

Elevated LRT structure is designed over Sohrab Goth Flyover and height of platform near Sohrab Goth Intersection would be as high as 16.5m from the ground as shown in Figure A1-3-22. Station location would be designed at one side of Flyover.

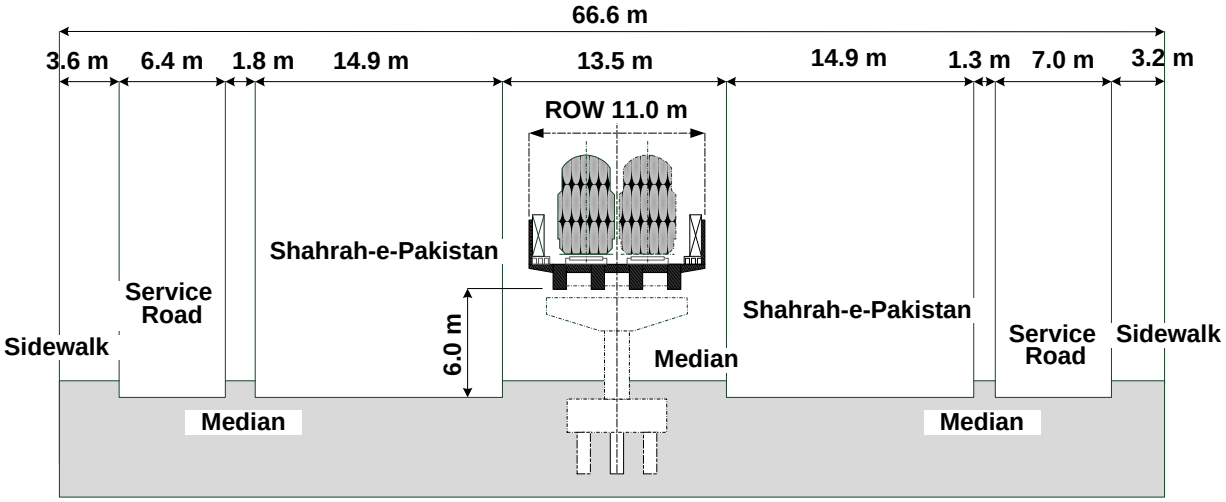


Source: Illustrated by JICA Study Team

Figure A1-3-22 Cross Section of LRT Blue Line at Sohrab Goth

(2) Shahrah-e-Pakistan (from Sohrab Goth to Karimabad colony old)

This section of Shahrah-e-Pakistan Road is very wide with service roads on both side and median strip. Median trip is enough wide to introduce LRT structure as shown in Figure A1-3-23.

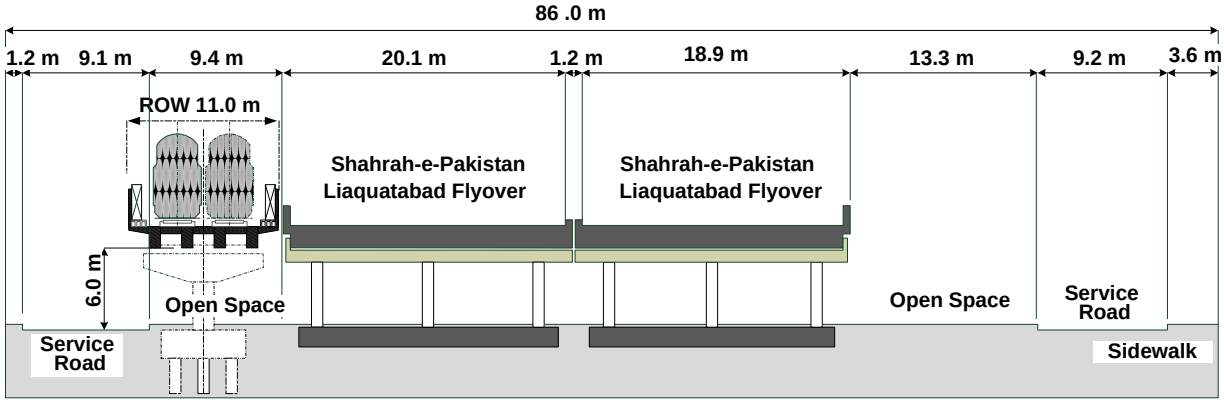


Source: Illustrated by JICA Study Team

Figure A1-3-23 Cross Section of LRT Blue Line of Shahrah-e-Pakistan

(3) Cross section with KCR

Open space is enough wide for elevated structure in KCR cross section as shown in Figure A1-3-24. However, Electric Pylon of KESC would become an obstacle against LRT route. This electric pylon should be relocated before construction of LRT.

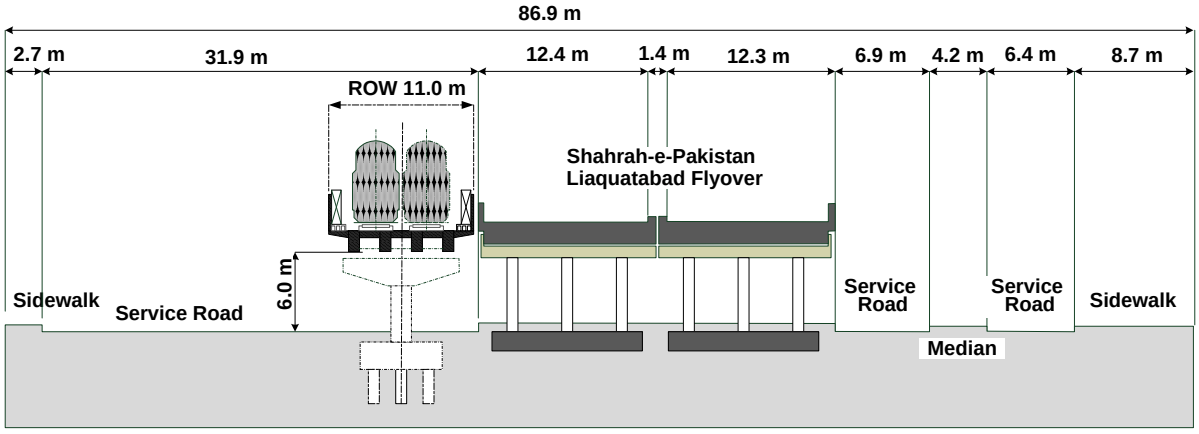


Source: Illustrated by JICA Study Team

Figure A1-3-24 Cross Section of LRT Blue Line with KCR

(4) Section along Liaquatabad Flyover

Service road and median strip is enough wide to introduce LRT structure as shown in Figure A1-3-25.

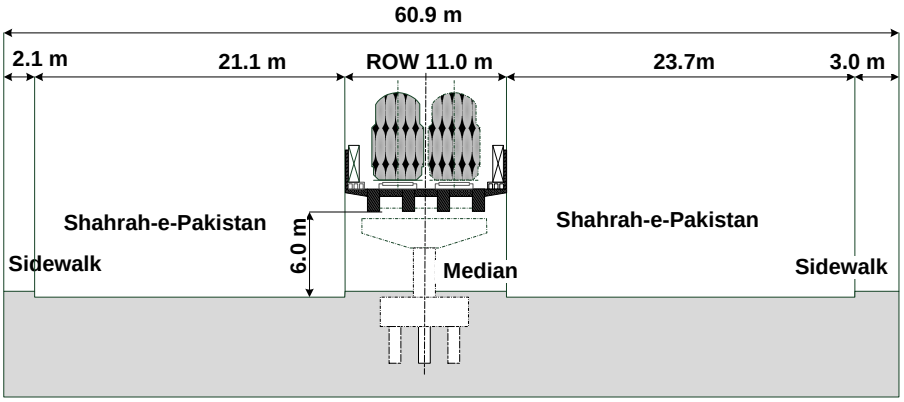


Source: Illustrated by JICA Study Team

Figure A1-3-25 Cross Section of LRT Blue Line along Liaqutabad Flyover

(5) Shahrah-e-Pakistan (from Liaquatabad#10 to Lyari River)

Width of median strip is sufficiently enough for elevated LRT structure as shown in Figure A1-3-26.

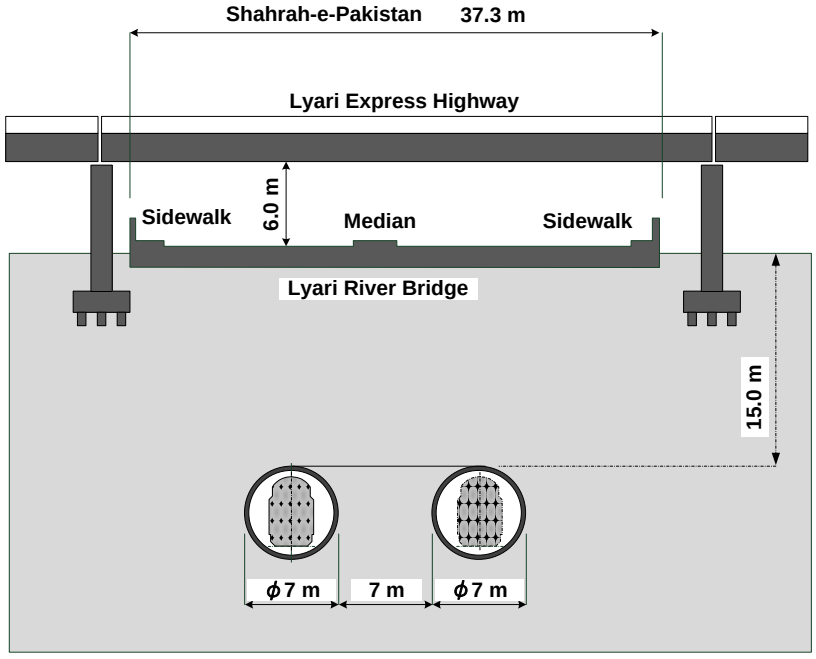


Source: Illustrated by JICA Study Team

Figure A1-3-26 Cross Section of LRT Blue Line along Shahrah-e-Pakistan

(6) Cross Section at Lyari River

There is no space for elevated or underground station at Teen Hati due to narrow Jahangir Road. Transition section from elevated to underground would be located at the section between Dakahana Intersection and Lyari River as described in.3.2.4 in Appendix-2. As a result, underground structure would be adopted under Lyari River as shown in Figure A1-3-27.

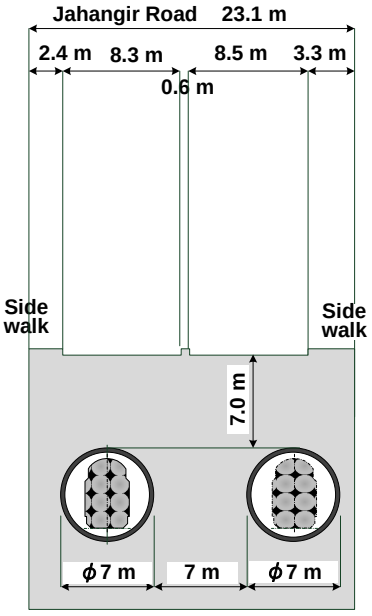


Source: Illustrated by JICA Study Team

Figure A1-3-27 Cross Section of LRT Blue Line at Lyari River

(7) Jahangir Road

Road width is narrow for Right of Way width, 130 ft (39.6 m). Cross section of underground tunnel is shown in Figure A1-3-28.

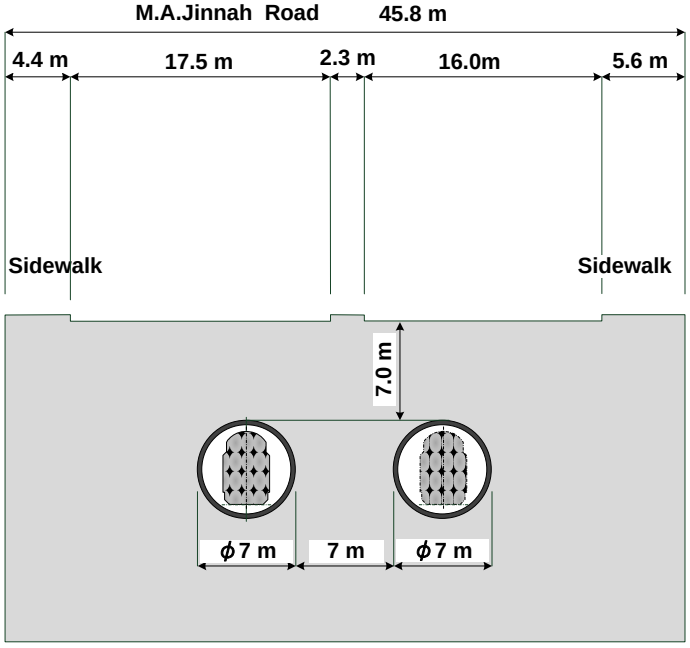


Source: Illustrated by JICA Study Team

Figure A1-3-28 Cross Section of LRT Blue Line under Jahangir Road

(8) M.A.Jinnah Road

Cross section under M.A.Jinnah road is shown in Figure A1-3-29.

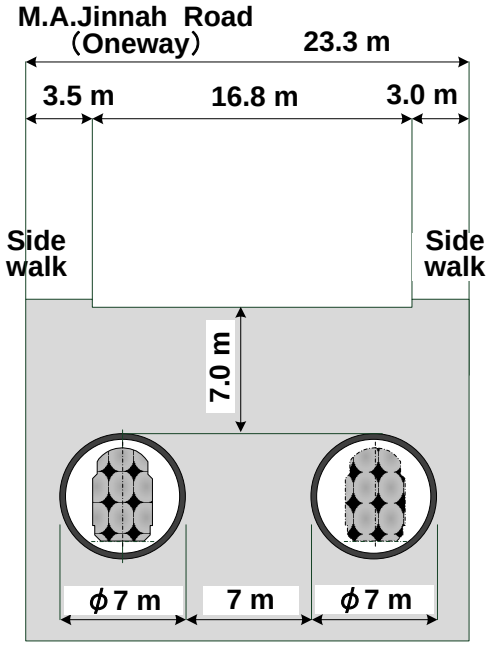


Source: Illustrated by JICA Study Team

Figure A1-3-29 Cross Section of LRT Blue Line under M.A.Jinnah Road

(9) One way section in M.A.Jinnah Road

Cross section in one way section in M.A. Jinnah Road is shown in Figure A1-3-30.



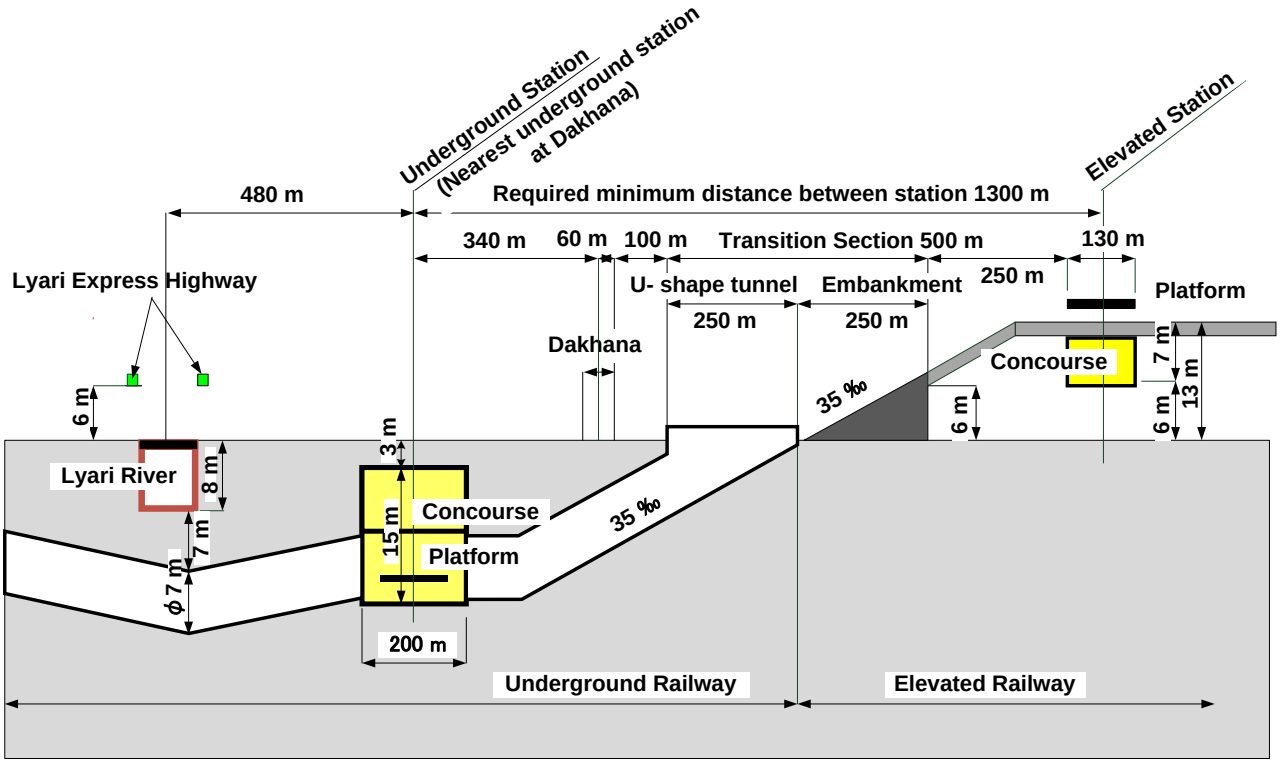
Source: Illustrated by JICA Study Team

Figure A1-3-30 Cross Section of LRT Blue Line under one way section

3.2.4 Transition Section between Elevated and Underground

Source: JICA Study Team

Figure A1-3-31 Transition Section of LRT Blue Line



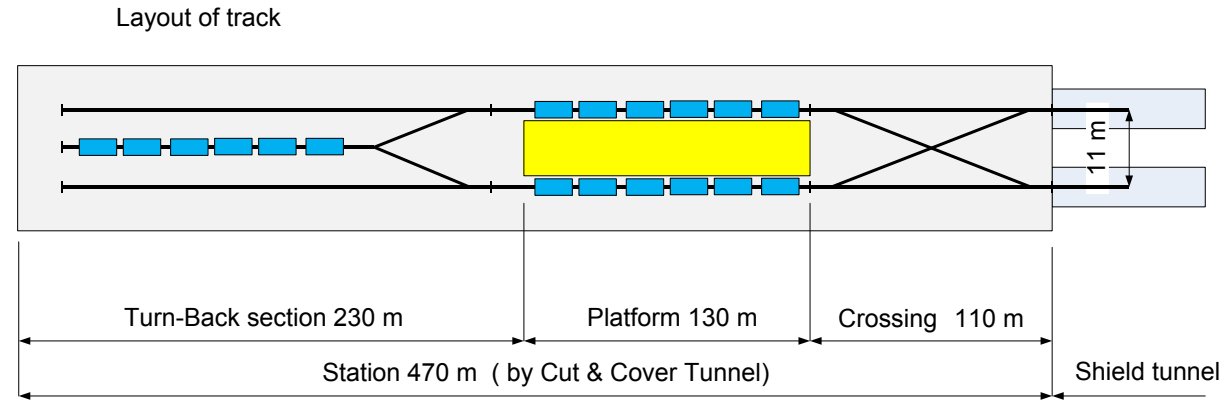
Source: Illustrated by JICA Study Team

Figure A1-3-32 Longitudinal Transition Section of LRT Blue Line

3.2.5 Terminal of LRT (Tower Station)

Source: JICA Study Team

Figure A1-3-33 Terminal Station Plan (Tower Station)



Source: Illustrated by JICA Study Team

Figure A1-3-34 Layout plan of Track Alignment at Terminal Station (Tower station)

APPENDIX-2 STAKE HOLDER MEETING

1 Hand out (Scoping stage)

Contact:
Environmental Management Consultants (EMC),
503, Anum Estates, opp Duty Free Shop,
Shahrae Faisal, Karachi.
Tel: 021 34311466, Fax: 021 34311467,
Email: mail@emc.com.pk

3. Identification and Assessment of environmental & social impacts caused by the project.
4. Propose necessary mitigation measures as Environmental Management Plan based on the predicted impacts.
5. Prepare preliminary Environmental Monitoring Plan for the project.
6. Conduct Stakeholder Meeting for EIA;
7. Integrate all findings and prepare EIA report.

Environmental Management Consultants (EMC) team will collect **Relevant Baseline Data** pertaining to **Natural Environment**: Protected Area, Topography, Geology, Hydrology, Climate, Flora and Fauna, Landscape, Hazard, Global Warming. Environmental quality and monitoring, **Social Conditions:** Social structure, Economic activity, Social infrastructure and public facilities, Land acquisition/ Involuntary resettlement, Heritage, Sanitation, **Legal:** Environmental standards and regulations, Procedure of EIA.

Field surveys will be conducted for primary data collection with regard to the Ambient Air Quality, Noise and Vibration Level Measurement, Traffic Count Survey, Soil Quality Measurement, Roadside Trees Measurement and Land use and Illegal resident confirmation.

Objectives of Stakeholder Meeting at the Scoping Stage

The objective of stake holder meeting is to incorporate the opinion and suggestion of the public and all other stakeholders into the EIA study for the KTIP.

- Provide information on environmental and social benefit of the project.
- To offer opportunities to vice the concerns of the stakeholders regarding the project during the during the planning stage and obtain opinions during stakeholder meeting and feed back to the planning process of the project
- Dissemination of information on the project in respect to the alignment, schedules and plan;

As per the requirements of PEPA 1997 and JICA guidelines, **Stakeholder Meeting** has been planned to be conducted at two stages: 1) one for each corridor during the preparation of EIA Study and 2) after submission of draft final EIA report to EPA.

Thank you!

EIA Study Team

KARACHI TRANSPORTATION IMPROVEMENT PROJECT

The Environmental Impact Assessment Study

Introduction

The City District Government of Karachi (CDGK) approved Karachi Strategic Development Plan-2020 (KSDP 2020) in 2007 which offered improvement of public mass transit system to provide the convenience and inexpensive mode of transportation for the people of Karachi. Subsequently the Government of Pakistan requested Japan International Cooperation Agency (JICA) to formulate an urban transportation improvement project for Karachi.

Accordingly under the agreed arrangement, the JICA Study Team of 24 consultants/experts in different fields kicked off the study in April 2010 and implemented the task of the development of Karachi Urban Transport Master Plan 2030 vision in June 2011, as its first phase in close association with KMTC.

Based on that study, JICA and KMTC agreed that a Bus Rapid Transit (BRT) study would be conducted for two (Green and Red Line) proposed BRT routes in the Feasibility Study Stage.

The Environmental Impact Assessment (EIA) is one of the on-going studies executing by Environmental Management Consultants that will achieve the key objectives of the KTIP leading to prioritization and implementation of mass transit system for Karachi.

Proposed Transport System - Beijing, China

What is Bus Rapid Transit (BRT) System?

Bus Rapid Transit (BRT) is an advanced urban bus system with railway like features by lower cost. The concept of BRT is based on railway system, i.e. running along exclusive way, high speed, accurate travel time, and high capacity.

- Faster / reliable travel time: Free from traffic jam
- Higher capacity: High frequency by multi slot bus stop and large bus fleet.
- Higher comfort must be competitive to private car/ motorcycle.

Objective of the Project

The objective of the BRT Project is to construct the mass transit corridor, thereby shifting cars users to public transport and consequently reducing the traffic congestion and Chaos.

Bus Rapid Transit System - Bogota, Colombia

Project Location

Green and Red BRT routes are designed in the center of the wide existing major road in Karachi. Green line originating from Surjani Town passing through Road 5000 (Sakhi Hassan round about), Sher Shah Suri Road (Board Office round about), Nazimabad Chowrangi, Gulbahar / Golimar, Business Record Road (Lasbela), Gurumandir to M.A.Jinnah Road up to Radio Pakistan/ Jamia Cloth Market and terminate at Regal Chowk Saddar. Red line originating from Model Colony (Tank Chowk) and passing through Check Post No.6 of Malir Cantt, Safoora Mazar-e-Quaid / People's Party Secretariat to Preedy Street extension, Empress Market and end at Regal Chowk.

Proposed BRT Corridors (Green & Red Line)

Purpose of EIA

Section 12 of Pakistan Environmental Protection Act 1997 and Pakistan Environmental Protection Agency (PEPA) Review of IEE/EIA Regulations 2000 require that all development initiatives in Pakistan have to be preceded by an Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA), depending upon the size and severity of impacts anticipated during construction, commissioning and operation of the project.

The purpose of EIA is to give environment its due place in the decision-making process by clearly evaluating the environmental consequences of the proposed activities before action is taken. Early identification and characterization of critical environmental impacts allows the public and the government to form a view about the environmental acceptability of the proposed developmental project and what conditions should apply to mitigate, reduce or compensate those risks and impacts.

Objectives of EIA Study for KTIP

The EIA study for KTIP will cover all the aspects related to the natural environment, social conditions along with legal and institutional framework in the proposed project area.
The main objectives of the EIA study are:

1. Collection of the relevant baseline data for the environmental information fronting the Study Areas which are directly affected by the Project;
2. Implement field survey and collect primary data as necessary;

2 Hand out (Draft EIA stage)

- Dissemination of information on the project in respect to the alignment, schedules and plan;

Expected Outcomes from the Stakeholder Consultation Meeting

Stakeholders are requested for their valuable input and comments on the Red and Green Line that have been identified in the project's EIA:

- Reduction in traffic congestion;
- Reduction in traffic accidents;
- Benefits for disabled people who may be end-consumers of the proposed BRT
- Following socio-economic benefits for the large number of people who would be using the proposed BRT service, either for transport from one place to another or as a 'feeder service' for the Karachi Circular Railways:
  - Reliability of BRT
  - Punctuality of BRT
  - Reduction in travelling time for end-users
  - Affordable and Transparent fare system
  - BRT will provide sufficient passenger capacity at comfortable loading standards.

Expected Outcome of the EIA

Following expected outcomes have been identified in the project's EIA.

- On the macro-environment the impact would be reduction in the air emissions due to expected switch over to a more environment friendly mode of transport which would curtail unnecessary delays in traffic that results in excessive vehicular emissions in the events of road jams particularly during peak hours.
- The project BRT does not directly involve any discharge of effluents into the surrounding environment, except for the certain locations identified in the project where physical activities involving excessive or commercial use of water is involved, which may therefore require proper treatment prior to disposal. The main sources of wastewater regarding the BRT operation include each station and depot.
- Noise will have no significant impact at sensitive receptors, BRT buses will generate less noise.
- The majority of the road works proposed are designed to be within the existing median of major roads on paved surfaces and therefore soil erosion and sedimentation will not takes place hence no geological disturbances.
- The trees are present in the median of both BRT corridors, on the median lane minimal trees will be removed on the points where the bus station and depot will be constructed. Trees will be retained and maintained wherever possible on the rest of the corridors
- Median will not be disturbed and will only be disturbed at station location
- Track will be beside the towards median so existing road median site will be utilized hence resettlement of any kind is foreseen .
- No business will be affected with the implementation of this project.
- BRT is provided with dedicated lane; hence it will not create any hindrance in the traffic flow. Moreover, additional space will not be required for the BRT buses.

Thank you!

EIA Study Team

Contact:
Environmental Management Consultants (EMC),
503, Anum Estates, opp Duty Free Shop,
Shahrae Faisal, Karachi.
Tel: 021 34311466, Fax: 021 34311467,
Email: mail@emc.com.pk

KARACHI TRANSPORTATION IMPROVEMENT PROJECT STUDY

Under JICA & KMTC, KMC
(Feasibility Study of Two BRT Lines)

KMC
KARACHI METROPOLITAN CORPORATION
KARACHI MASS TRANSIT CELL

JICA

Consulting Partners

Environmental Management Consultants

KARACHI TRANSPORTATION IMPROVEMENT PROJECT

The Environmental Impact Assessment Study
(Stakeholder Consultation Meeting)

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Proposed Transport System - Beijing, China

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3 Presentation (Scoping stage)

Green line (Taimuria Library on 31st January, 2012) and Red Line (NED University on 8th February, 2012)

1) Introduction

KMC

KARACHI TRANSPORTATION IMPROVEMENT PROJECT

January 31, 2012

by

Mr. Rasheed Mughal
Director General
Karachi Mass Transit Cell
KMC, Karachi.

KMC

Presentation Format

- Karachi Mass Transit Cell, KMC
- Overview of Karachi Transport System
- Karachi Transportation Improvement Project (KTIP) by JICA - Progress
- Next Step

KMC

KARACHI MASS TRANSIT CELL, KMC

Functions of KMTC:

- **Arrange for provision of adequate Transport facilities for all segments of the population.**
- **Identify, plan and implement various transport routes structures / alignments for Mass Transit modes.**
- **Coordinate, management, control and develop public transport, procure plans, machinery, instruments, equipment and materials required for its use.**

KMC

KARACHI MASS TRANSIT CELL, KMC

- **Seek and obtain advice and assistance from Government or any agency for the preparation & execution of any plan, program or project related to Mass Transit.**
- **Case studies, surveys, experiments and technical researches to be made in facilitating the Mass Transit System in the city**
- **Create general awareness among masses of public through seminar, workshop, media conference and other publicity sources.**

KMC

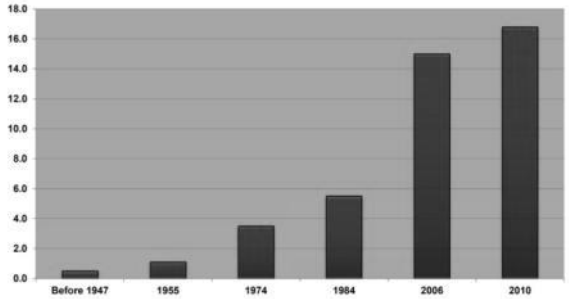
NEED OF MODERN BUS & RAIL BASED COMMUTER SYSYTEM

- Increase in city population is more than annual growth rate
  - 22 million person trips generated in the city every day
  - 60% person trips catered by buses, coaches, etc.
  - Only 6% share of public vehicles on the road
- Optimization of road capacity
- Enormous problems for commuters due to non-existent of effective mass transit framework

5

KMC

Population of Karachi *(in million)*



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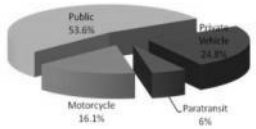
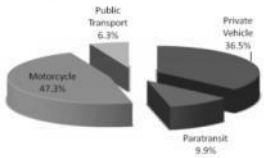
KMC

Modal Distribution on by Persons



Modal Distribution of Vehicles



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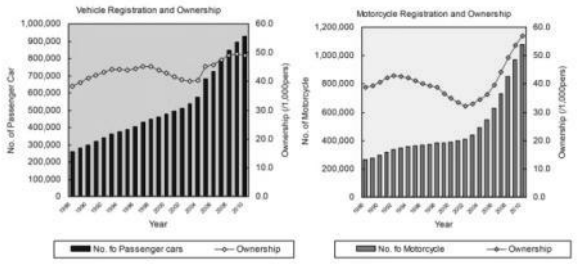
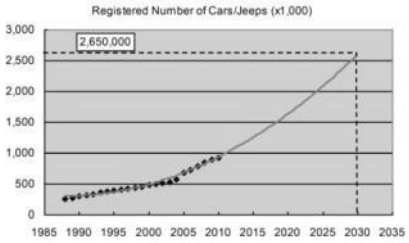
KMC

Car Ownership of Karakhi in last 20 Years



KMC

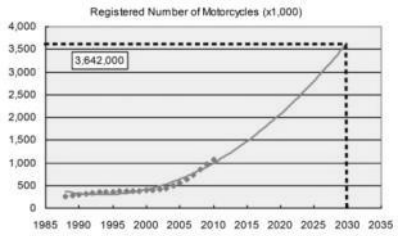
Estimation of Registered Number of Private Cars



	2010	2030
Registered Number	929,000	2,650,000
Population	18,930,000	31,580,000
Ownership (veh./1,000population)	49.1	83.9

KMC

Estimation of Registered Number of Motorcycles



	2010	2030
Registered Number	1,078,000	3,642,000
Population	18,930,000	31,580,000
Ownership (veh./1,000population)	57.0	115.3

KMC

Scenes of Traffic Jam in Karachi

11

KMC

12

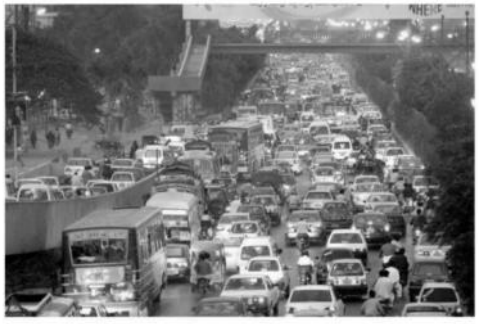
KMC

13

KMC

14

KMC



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KMC

16

KMC

17

KMC

PRESENT SCENARIO

- Over crowding
- Passengers travel on roof of buses/coaches
- Serious traffic jams
- Increasing bottle-necks on the main roads
- Increase in travel cost
- Increase in road accidents
- Reduction in travel speed
- Reduced ROW on the roads
- Deteriorating health due to more toxic emission from vehicles
- Less/marginalized output in offices due to mental stress

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SOLUTION

- Need vehicles of large passenger carrying capacity moving on higher speed
- Mass Transit (BRT) an ideal choice with higher carrying capacity

Importance of Mass Transit

- Mass Transit System will be environment friendly with less air & noise pollution & socially acceptable
- Mass Transit to provide safe, efficient, reliable, dignified, speedy modern urban rail or Bus based commuter system

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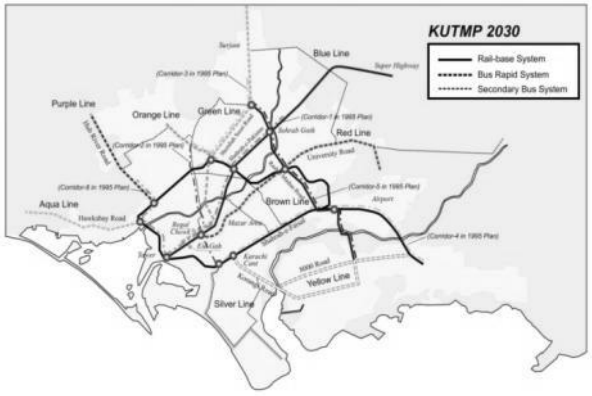
Bus Rapid Transit

KTIP Study

It was initiated by signing the agreement on 7th October, 2009 between JICA, GOP, GOS and CDGK for the study project under Grant-in-Aid

Main Objectives:

- **Development of Karachi Urban Transport Master Plan (KUTMP) for year 2030.**
- **Demand based validation and screening of projects already identified by KSDP 2020 in transport sector.**
- **Identification of additional projects in the light of KUTMP 2030.**
- **Demand based Prioritization of Projects identified in TOR Outline / Scope of work.**
- **Feasibility Study of a high priority project on mass rapid transit system based on outcomes of the study.**



Thanks for your attention

2) Scoping

ENVIRONMENTAL IMPACT ASSESSMENT

Karachi Transportation Improvement Project (KTIP)

Bus Rapid Transit (BRT) Corridors

KMC JICA

AGENDA

- WHAT IS BRT?
- OUTLINE OF THE PROJECT
- EIA METHODOLOGY
- STUDY SCHEDULE

What is Bus Rapid Transit (BRT) ?

Bus Rapid Transit (BRT)

BRT is a High Quality Bus System as Compared to Traditional Bus Services, by Providing a Solution for the Urban Transport Problem of Karachi in the following manner:

- Cost Effective
- High Capacity
- Comfortable Services
- Accurate Traveling Time
- High Speed
- Reliability
- Running along Exclusive Way

Why BRT ?

Actually, BRT improves road capacity

- One car lane in one direction moves about 1200 passengers per hour
- One BRT lane in one direction can carry:
  - 3min headways: 3000 passengers
  - 2 min headways: 4500 passengers
  - 1 min headways 9000 passengers
  - With passing lanes: 20,000+ passengers

ONE BRT bus =125 cars

A global view of transit improvement

Bus Transit Projects Completed

Europe
Bradford
Eindhoven
Essen
Ipswich
Leeds
Lyon
Montpellier
Nancy
Rennes
Rouen
Rurcom
Strasbourg

Latin America
Belo Horizonte
Bogotá
Campinas
Curitiba
Goiania
León
Porto Alegre
Quito
Recife
Sao Paulo

Africa
Abidjan
Saint-Denis

Asia
Ankara
Istanbul
Jakarta
Kunming
Nagoya
Seoul
Taipei

North America
Alameda
Chicago
Honolulu
Los Angeles
Miami
Ottawa
Orlando
Philadelphia
Pittsburgh
Seattle
Vancouver

Oceania
Adelaide
Brisbane
Sydney

Projects at the planning or construction stages

Latin America
Barranquilla
Cali
Cartagena
Ciudad Juarez
Cuenca
Guatemala City
Guayaquil
Lima
Medellin
Mexico DF
Panama City
Pereira
Puebla
San Juan
San Salvador
Santo Domingo

North America
Albany
Boston
Charlotte
Chicago
Cleveland
Eugene
Hartford
Las Vegas
Louisville
San Francisco
Toronto

Africa
Accra
Cape Town
Dakar
Dar es Salaam

Asia
Bangalore
Bangkok
Beijing
Delhi
Dhaka
Hanoi
Ho Chi Minh
Pakistan
Shanghai

Oceania
Auckland
Perth
Canberra

Europe
Annecy
Brest
Caen
Maubeuge
Nice
La Rochelle
Toulon

Video

Proposed BRT Features

- Reduced Travel Time
- Punctual & Efficient Service
- Safe & Comfortable Journey
- Commercial Speeds of BRT Depend on the Number of Stations because Buses Need to Spend a Time at Each Station for Boarding and Alighting.
- Capacity = 3,000 – 13,000 per hour per direction

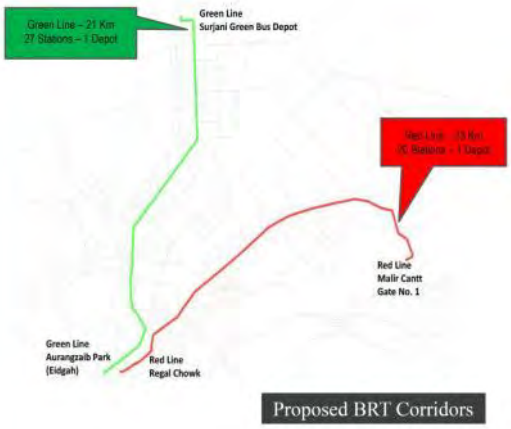
Bogata, Liberia (Africa)

Dehli, India

BRT For Karachi

- ***Buses Run BRT Lanes Only***
  In Case of BRT, Buses are only operated on the Dedicated Lanes controlled by a single operator along the Lanes.
- ***Quality Buses with Higher Frequency***
  Since the BRT Buses need not run in General Traffic Roads, these buses will have higher Frequency and Speed.

Outline of the Project



Proposed BRT Corridors

Location

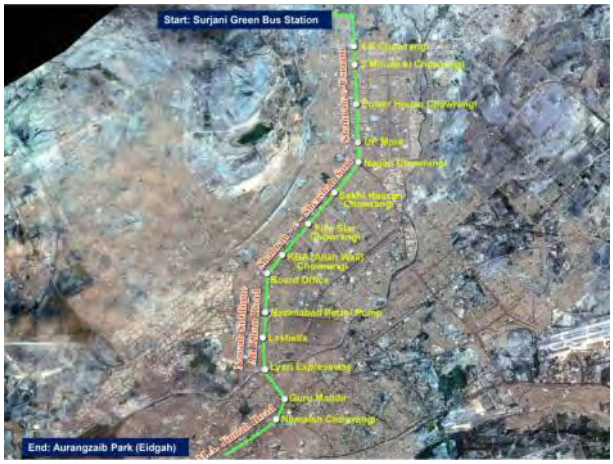
1. Red Line

Originating From Model Colony (Tank Chowk) and Passing through Check Post No.6 of Malir Cantt, Safoora Mazar-e-Quaid / People's Party Secretariat to Preedy Street Extension, Empress Market, Regal Chowk.

Location

2. Green Line

Origination From Surjani Town and Termination at Regal Chowk Saddar Passing through Road 5000 (Sakhi Hassan Round About), Sher Shah Suri Road (Board Office Round About), Nazimabad Chowrangi, Gulbahar / Golimar, Business Record Road (Lasbela), Gurumandir to M.A.Jinnah Road upto Radio Pakistan/ Jamia Cloth Market.



Criteria Of BRT Station Location

1. Approximately 500m Distance

2. Major Street Intersections

Major street intersections should be considered for station location in order to link other mode of public transportation.

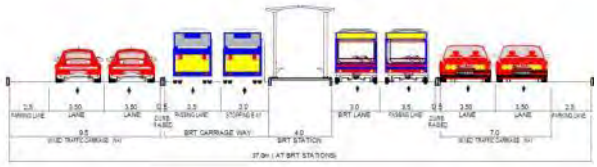
3. Public Facilities

Any public facilities, such as civic center, shopping center and college, should be considered for station location for convenience.

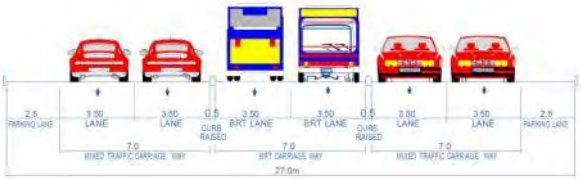
4. Traffic Control

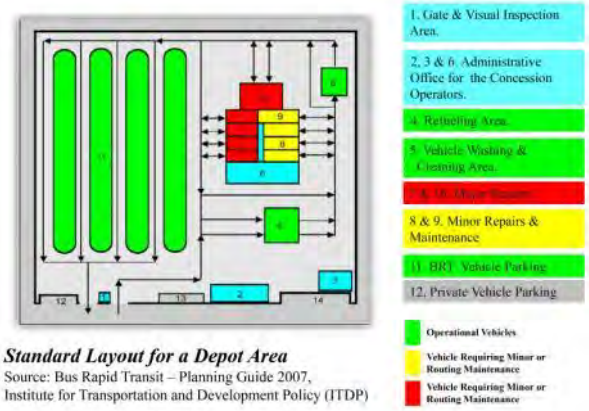
Due to traffic control at major street section, some stations may be set split in north bound and south bound

Cross Section at Station



Cross Section at Road





Standard Layout for a Depot Area
Source: Bus Rapid Transit – Planning Guide 2007, Institute for Transportation and Development Policy (ITDP)

Proposed Depot

S.No	Location	Area
1	Gulistan-e-Johar Depot, ST-1, Block-6, Sch-36, Gulistan-e-Johar near Mahakma Massamyat	8.36 Acres
2	Plot No. St-5/1, Sector 7A, Surjani Town	4.00 Acres

Source: Illustrated by JICA Study Team based on the Confirmatory Green Routes Study for Karachi
Presented Situation of Depot area on Confirmatory Green Routes Study for Karachi

EIA Methodology

Need For EIA Study

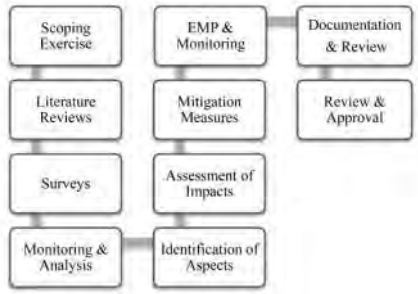
Compliance with section 12 of Pakistan Environmental Protection Act 1997.

Scope of EIA

- To address any major adverse impact on the environment (physical and ecological) during different stages of the project.
- Identified socioeconomic aspects &
- Adequate mitigation measures
- Environmental Management Plan (EMP) for sustainable development & operation of the project.

EIA Methodology

Conducted in accordance with the EIA Regulations and Guidelines of the Government of Pakistan and JICA Guidelines



Scoping- An initial stage in EIA

- The objective is to incorporate the opinion and suggestion of the public and all other stakeholders into the EIA study for the KTIP
- Provide information on environmental and social benefit of the project.
- To offer opportunities to vice the concerns of the stakeholders regarding the project during the during the planning stage and obtain opinions during stakeholder meeting and feed back to the planning process of the project
- Dissemination of information on the project in respect to the alignment, schedules and plan;

Collection Of Relevant Baseline Data

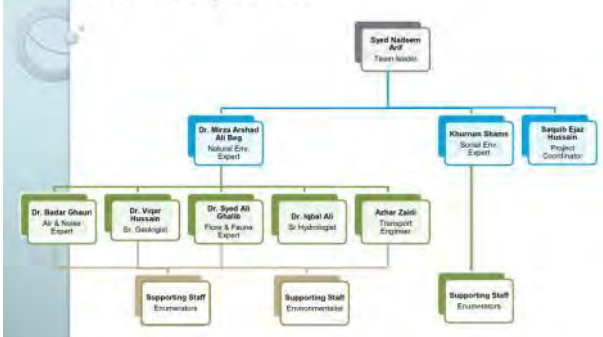
Content	Items
Natural Environment	Protected Area, Topography, Geology, Hydrology, Climate, Flora and Fauna, Landscape, Hazard, Global Warming, Environmental quality and monitoring
Social Conditions	Social structure, Economic activity, Social infrastructure and public facilities, Land acquisition/ Involuntary resettlement, Heritage, Sanitation

Field Survey Plan

EMC will be conducted field surveys for primary data collection from 30th Jan to 29th Feb with regard to:

- Ambient Air Quality
- Noise and Vibration Level Measurement
- Traffic Count Survey
- Soil Quality Measurement
- Roadside Trees Measurement
- Land use and Illegal resident confirmation

EIA Study Team



Study Schedule

Study Schedule

EIA Work Schedule

Thank You For Your Participation

Your feedback please

4 Presentation (Draft EIA stage)

1) Green Line : Largess Restaurant (Green Line Corridor) on 27th April, 2012

Presentation on Findings from Draft Report

Environmental Impact Assessment

Karachi Transportation Improvement Project (KTIP)

Environmental Management Consultants

Contents of EIA

- Introduction
- Legislative & Administrative Framework
- Description of Project
- Screening of Alternatives
- Environmental & Social Baseline
- Stakeholders Consultation
- Environmental Impacts & Mitigation Measures
- Environmental Management & Monitoring Plan

Objective of Today's Meeting

- To share the main findings from the Draft EIA Study of KTIP – Green Line.
- To get the feedback from all relevant stakeholders
- To get the consent from stakeholders on the study
- Once finalized we shall conduct a joint public hearing for this study

EIA Methodology

Background

The JICA Study Team consulted with Karachi Mass Transit Cell (KMTC) about the plan to select BRT for the project of the feasibility study based on the result of the master plan study submitted on 30th June 2011. JICA and KMTC after detailed discussion and consultation with stakeholders agreed that the JICA Study Team would conduct the feasibility study for the Green Line and Red Line that are proposed in the master plan.

EIA Study

The services of EMC have been acquired for the preparation of this environmental assessment of the Project, required to meet the regulatory requirements of the country and JICA. This document has been prepared to meet the following key requirements:

- The Environmental Impact Assessment (EIA) as required by the Pakistan Environmental Protection Act 1997 for submission and approval by Sindh Environmental Protection Agency (SEPA).
- The environmental impact assessment (EIA) complying with the environmental and social guidelines of the JICA and World Bank and satisfying the evaluation criteria of the JICA for consideration of financial assistance for project implementation.

BRT Vision

BRT Vision is:

"To have a state of the art public transport system at reasonable cost to the users and yet profitable to the operators using high capacity buses which meet international service standards, environmentally friendly, operating on exclusive lanes, at scheduled travel time"

BRT Mission

The BRT Mission is:

"To provide quality, accessible and affordable mass transport system for the residents of Karachi which will subsequently:

- Elevate the standard of living;
- Remove the constraints to sustainable economic growth; and
- To pioneer a private and public investment partnership in the transport sector in the City of Karachi".

Concept of BRT

The concept of BRT is based on railway system, i.e. running along exclusive way, high speed, accurate travel time, and high capacity. BRT has been recognized as a cost-efficient mass transit system which can solve urban transport problem in not only developing country but also developed country. Bus Rapid Transit (BRT) is a high quality road service that provides high speed, reliable, and comfortable services compared to traditional bus services.

Objectives of BRT Project in Karachi:

- To provide an alternative mass transit system.
- To contribute to solving the problems due over congestion of roads, ever-increasing volume of traffic, improve air quality and meet the mobility needs, particularly of the less privileged and poor masses of the Karachi Megapolis.

The Project

The proposed Bus Rapid Transit (BRT) project will be implemented on two priority corridors named as "Green Line Corridor" and "Red Line Corridor". The 21 km long proposed Green Line corridor originates from Surjani Town and Terminates at Regal Chowk Saddar.

This route passes through major roads of Karachi having significant demand of passengers including Sakhi Hassan Round About, Sher Shah Suri Road (Board Office Round About), Nazimabad Chowrangi, Gulbahar/Golimar, Business Record Road (Lasbela), Gurumandir to M.A. Jinnah Road up to Radio Pakistan/Jama Cloth Market. There are 27 stations and one depot proposed on this corridor.

BRT Routes

Study Area

The 'Study Area' refers to the Right of Way (RoW) of proposed corridors where activities related to the construction and operation of the BRT proposed to take place or in which the environmental impact of these activities are likely to occur. 'Study Area' will refer to the area restricted to width of existing road(s) along proposed corridors which include a median, a carriageway and foot path.

Since the project is being implemented within exiting RoW which is the property of Karachi Metropolitan Corporation, no land acquisition would be involved. The structures would be elevated where road congestion exists in order to avoid land acquisition and involuntary physical or economic resettlement.

Green Line

Features of BRT System (BRT)

Segregated Lanes

Buses will run on BRT lanes only. In case of closed BRT, buses are only operated on non-overtaking lanes that are dedicated and controlled by a single operator along the lanes.

Capacity

The maximum Capacity of a standard BRT is 3,000 – 13,000 /hour /direction.

Features of BRT System (BRT)

Speed & Frequency

Since the BRT buses need not run in general traffic roads, advanced vehicle technologies can be used to increase the capacity and speed. In addition, pre-board fare collection reduces dwell time at bus stations.

The average commercial speed of a standard BRT is approximately 20km/h. The commercial speed of BRT depends on the number of stations since the buses need time at each station for boarding and alighting.

Location of Stations

Designing & Spacing Criteria

The criteria for spacing and designing the bus stations is based on optimizing the distance that minimizes the total passenger hours that includes the total travel time which is the sum of walking time, waiting time for a bus, and on-board time. In general, the optimum distance between stations is approximately 500m considering the standard BRT systems the world over

Assuming the proper walking time along the major road is less than 5 minutes and the walking speed is 4km/h, the maximum distance between stations is estimated at 667m.

Location of Station

Criteria for Siting Stations

The two options for siting BRT stations are 1) At the center for right door buses, and 2) Curb-side stations for left-door buses. The preferred alternative is to have the center station for the right door buses. The major reasons for the selection are:

- Approach to stations is needed for pedestrian bridge instead of pedestrian crossing because of heavy traffic of the corridor. Separation of stairs for both side stations will increase the cost.
- Passing lanes are needed at major stations. Center side station is better than curb side station in view of design.
- Center side station needs to be provided in order to manage paid and unpaid passengers.

General Setting of Station

Cross Sections at Stations

The station is wide enough for both sides boarding and alighting with 4m width. Parking lanes are provided for both sides of carriageways. The road with one-lane for mixed traffic is not recommended as a BRT corridor. Therefore, at least two lanes for one direction are necessary. The road width excluding pedestrian walks is 37m. Only North Nazimabad has enough space to satisfy this width.

Cross Section (1)

Cross Section at Station (37m wide road)

Cross Section (2)

Cross Section at Station (33m wide road)

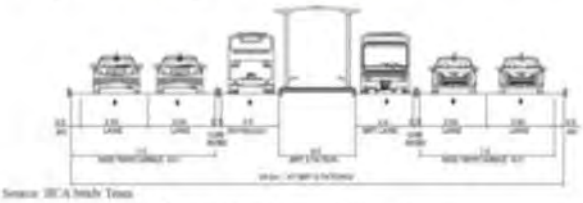
Cross Section (3)

If platforms are provided at different locations by direction, the necessary width can be reduced to 28m. However, the length of a station becomes longer.

Cross Section at Station (28m wide road)

Cross Section (4)

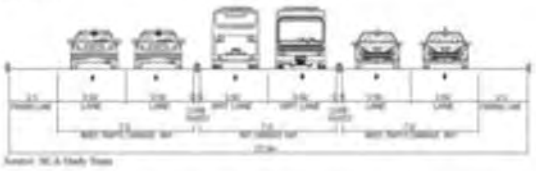
In case that BRT passing lanes are not provided, the width of cross section at BRT station is 26m. However, such siting requirement will be necessary only at and along M.A. Jinnah Road.



Cross Section at Station (Without Passing Lane)

Cross Section (5)

The cross section between stations where parking demand along the road exists. The necessary width is 27m. If parking lanes are not provided, the width can be reduced to 23m.



Cross Section between Stations (With Parking Lanes)

Specification of BRT Bus

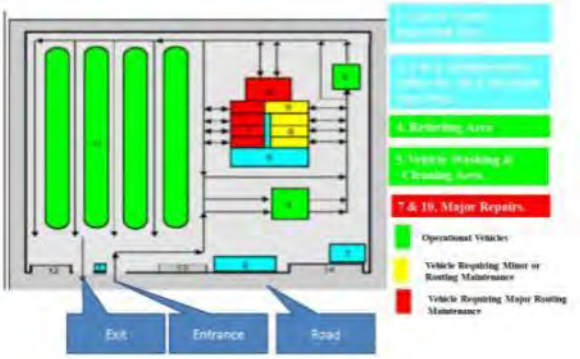
Selected type of the vehicle for Karachi BRT is the standard bus of 12m length, platform-level boarding type of high-floor bus with two doorways on the right hand side. Propulsion system is CNG drive.

BRT Bus Depot

Criteria for Set-up of Bus Depot

Bus depots have to, in order to meet the functional criteria, cater to the needs of parking, re-fuelling; vehicle washing and cleaning; maintenance and repairs; office space and employee facilities. The bus depots will be set-up according to the "Government Order on Road Design Standards in Japan" on 142 m^2 per vehicle. The total area of parking space will be over 7,000 m^2 for 50 vehicles.

Layout of the BRT Bus Depot



Selection of Bus Depot for Green Line

In case of Green Line, two areas in North Karachi are being considered: 1) Two Minutes Chowrangi, and 2) The depot area of CNG Bus Project. Both the areas will have to rent a space for the depot and pool, whereby the function of depot will be divided; the CNG bus depot will be used as the main depot area while the other one will be the pool area. The area of the depot can be extended if required to meet different functions and number of vehicles.

Location of Bus Depot

Arrangement for Existing Traffic

(1) U-Turn Traffic in North Nazimabad

U-turn along Shahrae-Shershah Suri Road (North Nazimabad) between KDA Chowrangi and Five Star Chowrangi needs to be retained with modification at the median by reducing the width to 6.0 meter in the u-turn area to accommodate an inside lane for BRT and storage lane for the u-turn.

Arrangement for Existing Traffic

(2) Intersections

Traffic diversion as in vogue will be modified so that the BRT at Gurumandir can pass through the left side portion of the intersection (northwest) by the two way traffic. It will also be necessary to avoid the traffic jam or congestion along this area by modifying the existing island so as to channelize the flow of traffic crossing into the BRT lane.

Arrangement for Existing Traffic

(3) Roundabouts

Existing Roundabouts along Green Line

#	Location	Improvement Policy
1	Gurumandir	Signalized Intersection
2	KDA Chowrangi	Signalized + BRT lanes through the roundabout
3	Sakhi Hassan Chowrangi	Signalized + BRT lanes through the roundabout
4	Powerhouse Chowrangi	Signalized roundabout
5	Surjani Chowrangi	Signalized Intersection

Source: JICA Study Team

Arrangement for Existing Traffic

(3) Roundabouts

All roundabouts will accommodate the BRT. Modification of the existing roundabouts will be required to provide space for the new BRT lane crossing into the area.

Accordingly roundabouts will be converted to standard 4-leg signalized intersections. In case the signalization is constrained by some such structure as the monuments or fountains. Traffic signals should be installed to the roundabout.

Traffic Management

The proposed BRT routes have bottlenecks such as the section of Nawab Siddiq Ali Khan Road between Nazimabad No.1 Chowrangi and Lasbela Chowk & the section of Business Recorder Road between Lasbela Chowk and Gurumandir. Exclusive BRT lanes are difficult to be sited at these locations. To cope with the situation an appropriately designed traffic management system will be introduced.

Operation Plan

(1) Cross Operation

The Green Line will operate up to Jama Cloth Market on M.A. Jinnah Road on Green Line. This will avoid the transfer between two lines near the center of the city.

(2) Round Trip Operation

The required number of buses is different from section to section. At the initial stages of operation it may not be necessary to provide the target capacity along the sections which are at a distanced from the center. From the results of the demand forecast, it is proposed to provide eight routes for Green Line.

Operation Plan

Proposed Round Trip Route of Green Line

Line	Round Route	Center	U-turn point
Green Line	G11	Cloth Market	Board Office
	G12	Cloth Market	Nagan Chowrangi
	G13	Cloth Market	New Karachi
	G14	Cloth Market	Surjani
	G21	Regal Chowk	Board Office
	G22	Regal Chowk	Nagan Chowrangi
	G23	Regal Chowk	New Karachi
	G24	Regal Chowk	Surjani

Source: JICA Study Team

Operation Plan

Peak Hour Operation

(1) Peak Hours

Approximately two hours in morning i.e. 7:00-9:00 a.m. is peak hour time, while approximately three hours from 18:00-21:00 are the evening peak hours. In total, the peak hour operations will be 5 hours in a day

(2) Off-Peak Hour Operation

The frequency will be reduced according to passenger demand. However, the minimum frequency will be maintained.

Operation Plan

Peak Hour Operation

(3) Schedule of Operation

The target capacity in peak hours is 10,000 passengers per hour per direction. Buses should arrive at station in 20 second interval. From this high frequency, the time table of bus arriving will not be necessary for passengers. BRT will be operated based on time table for efficient operation.

Likewise the boarding and alighting time will be short at stations; this will increase the capacity. The boarding and alighting time at stations will be fixed at 20 seconds to enable the operation of buses at scheduled times. The time of 20 seconds for boarding and alighting at a station is popular time for BRT operations around the world.

Operation Plan

Peak Hour Operation:

(3) Schedule of Operation (Cont...)

Additionally, 10-20 seconds will be allowed for deceleration and acceleration at the stations and rapid deceleration and acceleration will be avoided. The In total, 40 seconds will be necessary for a bus at a station.

(4) Speed

The target speed of 25km/h will be maintained to achieve the objective of providing comfortable and timely operation of BRT.

Operation Plan

Peak Hour Operation:

(5) Frequency

3 buses with carrying capacity of 100 passengers will arrive in a minute (180 buses per hour) during peak hours to achieve the hourly capacity. Since the time of 40 seconds will be necessary for a bus at a station, a stopping slot can deal with 90 buses per hour (3600/40) at 100% of usage of the slot.

Under the random arrival, the saturation rate of 80% is achievable. In this case, the capacity is estimated at 72 buses per hour per direction for a stopping slot (90 * 0.8 = 72). This suggests that 3 stopping slots will be necessary to accommodate 3 buses in a minute at a station.

Operation Plan

Reorganization of Present Bus Network:

Green Line

There are 49 routes which compete with Green Line, in which 18 routes will have to be discontinued because they overlap the Green Line over a large distance. Feeder routes will be provided for the 18 routes outside the Green Line in consultation with the stakeholders especially the bus owners /operators.

Operation Plan

Reorganization of Present Bus Network:

List of Bus Routes Compete with Green Line				
2-K	F-16	G-25	W-1	401-GUL
4	X-3	G-27	U-8	Khan
4-J	F-18	W-23	W-22	Niaz
1-D	W-11	C-17	X-10	National
4-L	C-25	P-3	U	Shiraz
2-D	F-21	W-55	G-11	Shama
4-X	G-17	W-25	G-3	UTS-1
5-C	W-18	W-19	U11	Masood
6	Z-A	W-21	Umer-Coach	
8	G-13	W-30	201-CITY	

Source: JICA Study Team based Public Transport Survey in 2010

Operation Plan

Traffic Signal

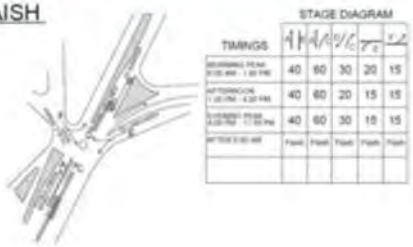
Traffic management at all intersections is overburdened with failures due to both technical and non technical reasons. The following system of signalization is proposed at the critical BRT intersections.

GURUMANDIR

Operation Plan

Traffic Signal

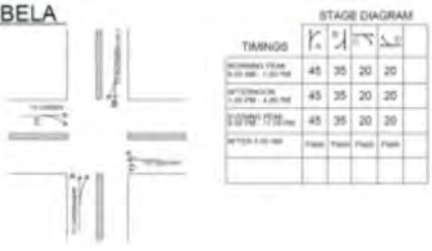
NUMAISH



Operation Plan

Traffic Signal

LASBELA



Operation Plan

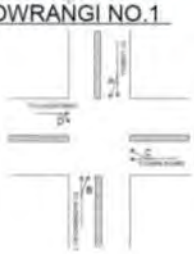
Traffic Signal

FIVE STAR

Operation Plan

Traffic Signal

CHOWRANGI NO.1



STAGE DIAGRAM

TIMINGS	A	B	C	D
	50	40	20	25
	50	40	20	25
	50	40	20	25
	Flash	Flash	Flash	Flash

Operation Plan

Traffic Signal

BOARD OFFICE

STAGE DIAGRAM

TIMINGS	A	B	C	
	35	60	24	
	35	60	24	
	35	60	24	
	35	60	24	
	Flash	Flash	Flash	

Consultation Process

The first meeting was held on the Green Corridor at Taimuria Library at Five Star Chowrangi on 31st January 2012.

Findings from Stakeholder Meetings

The findings from the responses provided by the participants in the two meetings are as follows:

A huge Majority of the participants (98% from Greenline Corridor and 96% from Redline Corridor) expressed dissatisfaction with the present system of transportation in Karachi. The reasons stated for dissatisfaction with the current transportation system are as follows:

- Sub standard quality, lack of discipline and lack of awareness of rules and regulations.
- Increase in No. of vehicles is indiscriminate and traffic jam is too frequent.
- Road related accidents taking toll of life of at least 900-1200 persons per year.
- Time delays are uncontrolled, man hour loss is heavy.

Findings from Stakeholder Meetings

- Air and Noise pollution at all intersections aggravated by operation of generators.
- Fares are high, services are poor and undisciplined.
- Lack of security, reliability and congestion
- Buses have more passengers than capacity.
- Violation of traffic rules
- Transport mafia is very influential.
- No security for females.
- No schedule observed for operation of private buses.
- Illegal parking and encroachment on the roads.

Findings from Stakeholder Meetings

68% of the participants from Green Line Corridor and 71% from Redline Corridor were of the opinion that congestion will decrease while the remaining did not think that there will be any alteration in congestion. Perceptions given by participants who believe that congestion would decrease through introduction of BRT were:

- A single BRT vehicle will carry about 100 passengers and if it is allowed to operate at full capacity it might replace an equivalent of 50 cars or 100 motorcycles or 25 cars and 50 motorcycles. This implies that there will be substantial reduction in the volume of traffic operating on the corridor.

Findings from Stakeholder Meetings

- BRT would operate on dedicated lanes and would be reducing the traffic jam due to operation of school buses and pick-up services at peak hours and hence will reduce the congestion at the concerned points.
- BRT will have a dedicated lane to operate on and hence the air pollution as well as noise will be localized into the microenvironment.
- BRT system would entail substantial reduction in air pollution load and also noise pollution level.
- BRT is supposed to be providing comfortable and disciplined service if owned by the commuters it will be able to provide the comfortable service that the commuters are looking for.

Findings from Stakeholder Meetings

- Public transport may shift towards feeder service and that may reduce congestion and also the air pollution load.

The remaining persons (32% from Green Line Corridor and 29% from Redline Corridor) who did not think of any improvement were of the view that strict implementation of the traffic rules is necessary before it could be thought that there would be any reduction in congestion while other thought that the real reduction in congestion would be possible if the number of vehicles operating on road are reduced simultaneously with the introduction of BRT and all elements for example old buses, hand or animal driven carts and pedestrians are discouraged for impeding the transportation.

Findings from Stakeholder Meetings

Participants also think that the space for siting the BRT lane is too insufficient; the required free lane road is not met anywhere and the proposal to elevate the lane may not be cost effective. Moreover there is heavy encroachment at all intersections and also wherever the car dealers are doing their business.

On Green line Corridor 27% of the participants indicated that they travel by car, 18% by Bus, 5% by motorcycles, 7% use both motorcycle and cars. On Redline Corridor 35% of the participants indicated that they travel by car, 45% by Bus, 10% by motorcycles, 8% use both motorcycle and cars.

Findings from Stakeholder Meetings

The rest 42% (in case of Green Line Only) either did not register any mode of travel perhaps because they were all students who manage to travel by one or the other system which they could not mean or else they were not using the road at all.

85% of the participants from Green Line Corridor were hoping to travel by BRT provided it offers the same facilities of travel as promised. Participants were of the view that they shall prefer BRT if:

- It is affordable and observes the schedule of time for arrival and departure.
- Provided the Japanese standards on operating procedures are followed in letter and spirit.

Findings from Stakeholder Meetings

- It will save fuel usage
- It will take care of gender issues.
- Being on the dedicated lane it will only stop at dedicated stations and hence the present mode of 'stopping at will' will be eliminated. Stoppage at fixed stations will also discourage J-walking on main the corridor.

The remaining 15-18% did not think of using the BRT perhaps because they have to travel only short distances which condition will be fulfilled by using the feeder system. According to them there are constraints to distant traveling. Commuters who have to change buses may not be able to benefit completely from BRT.

Findings from Stakeholder Meetings

A majority of the participants (96% from Green Line Corridor and 82% from Redline Corridor) believe that BRT system will improve social life, environmental condition and economic activities in city because:

- It will improve the quality of life by providing less polluted and stress free environment to the commuters and the residential and commercial enterprises on the corridor.
- It will provide rapid, comfortable and disciplined transportation system which the people on the corridor have been looking for.
- It will hopefully induce reduction in traffic volume since the present bus service would be oriented towards feeder routes.

Findings from Stakeholder Meetings

- BRT will reduce the expenses on fuel and operation of their vehicles.

58% of participants from Green Line Corridor are of the opinion that there are technical hurdles and the technical hurdles that they can think of are the congestion which cannot be removed by placing a dedicated lane at the center. They highlighted the following constraints:

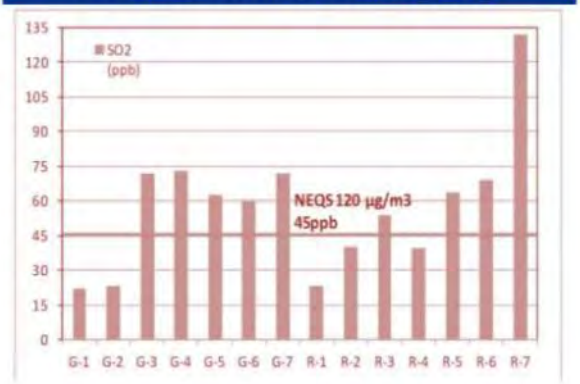
- BRT implementation will require relocation of utilities, removal of trees, removal of existing structures and the like.
- Learning from the lessons of the past doubts can be raised if the project will get off at all. It may not have the blessings of the parliamentarians who are agriculturists and not urbanized.

Findings from Stakeholder Meetings

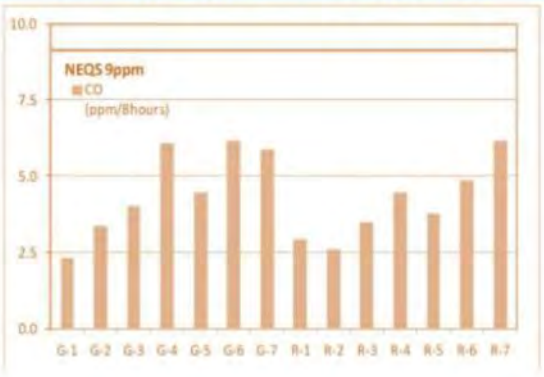
- Non technical issues such as the role of transport mafia and the political blessings offered to the mafia as well as encroachers will be great impediments in locating the system at the middle of the road.
- Underpasses, flyovers to make a signal free corridor are already a constraint on the smooth operation of the system. The BRT will be pose constraints of similar nature.

The remaining (42% and 29%) who thought that it is non-technical reasons have the lessons from the past failures of the 5 mass transit systems that could not get the approval of the decision makers.

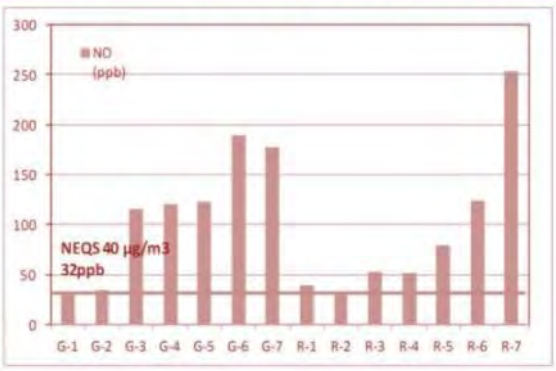
Baseline Data on Air Quality



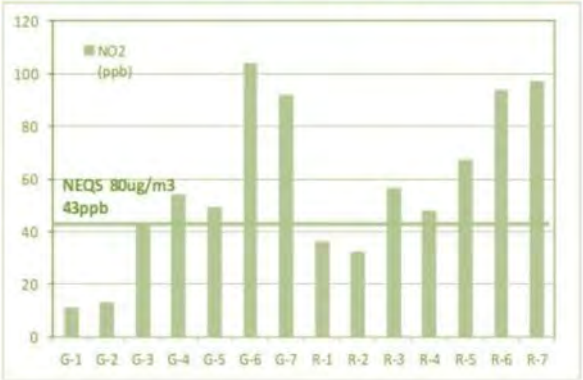
Baseline Data on Air Quality



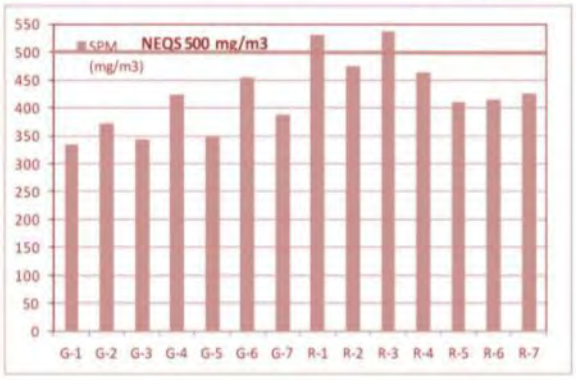
Baseline Data on Air Quality



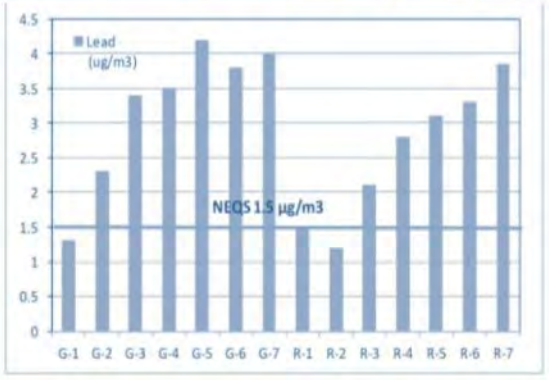
Baseline Data on Air Quality



Baseline Data on Air Quality



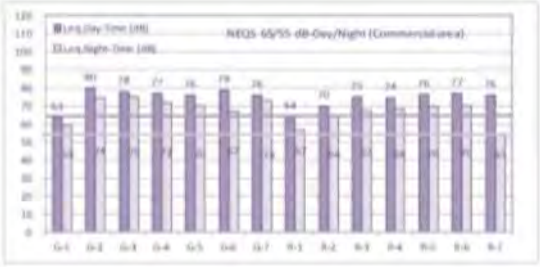
Baseline Data on Air Quality



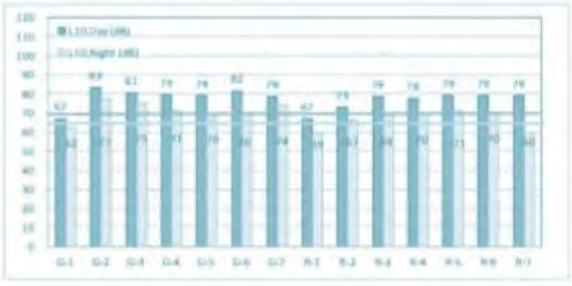
Baseline Data on Air Quality

According to the report of Vehicular Emission Control Programme (VECOP) by The Sindh Environmental Protection Agency, regular monitoring and inspection was started from January 2010 and during the last 18 months, about 11,384 vehicles of all categories have been inspected and tested for their emission levels. Out of them, about 3,503 did not comply with the National Environmental Quality Standards (NEQS) for vehicles and 1,947 were challenged by the traffic police for violation of the standards.

Baseline Data on Noise



Baseline Data on Vibration



Environmental Impacts & Proposed Measures

Removal of Vegetation:

There are at least 4200 trees on the Green Line. This number relates to trees that are on the median and the same will have to be removed to yield to BRT-RoW where road width is narrow along the Green Line corridors as well as the station sites. However, a few trees will be removed from the left and right edge of the road to make room for construction of pedestrian bridges at the stations. Removal of trees may also be necessary at points where bored concrete piles will be introduced for elevated structure

Environmental Impacts & Proposed Measures

Removal Vegetation:

Figure 7.5: Example showing the affected segment of road when BRT is at median and location of stations

Environmental Impacts & Proposed Measures

Mitigation Measures:

- After removing the existing trees and top soil (down to 0.5 m), the topsoil shall be retained for use elsewhere on the corridors. The cut wood shall be removed and not burned on site. All stumps and surplus vegetation shall be disposed of at landfill via routes or other destinations as designated and instructed by Horticulture Department of KMC
- International practice suggests that replacement at a minimum rate of 5:1 for trees would be appropriate given possible difficulties with establishing trees and low survival rate of young trees. This rate is acceptable however; the present scenario is that some fast growing variety of trees has been planted all along the two corridors. They are to be designated as only maturing trees and hence EMC proposed that the loss of maturing trees would be compensated by a rate of 3:1 and for mature trees the compensation rate would be 5:1. Countries, where the population has to rely on forestry resources for livelihood (felling for sell in the market and use as fuel) the replacement rate has recently been raised to 25:1. Therefore it will be important to seek cooperation of the KMC Horticulture department for removal as well as replanting

Environmental Impacts & Proposed Measures

Mitigation Measures:

Figure 7.6: The maturing trees on the median of BRT corridor

Environmental Impacts & Proposed Measures

Mitigation Measures:

The mature trees on the median of BRT corridor

Environmental Impacts & Proposed Measures

Siting of Stations:

Keeping in view the current system of undisciplined operation of vehicles and carefree attitude of pedestrians, the stations will be sited at closer distances. The stations will be provided with amenities including a library, bookstall, telephone and internet service, rest rooms, access and emergency ramps, ticketing system, pedestrian bridge and storm water as well as wastewater drainage system.

Environmental aspects identified for siting the stations include: 1) provision of safe drinking water, 2) drainage system for wastewater as well as storm water, 3) ventilation, 4) safety and security.

Environmental Impacts & Proposed Measures

- Safe Drinking Water: Such gadgetries for provision of safe drinking water as are currently available in the market will be installed at each station.
- Drainage System: Drainage system such as the one shown in the following figure will be installed at each station. The waste water will be treated in a sewage treatment facility to conform to the National Environmental Quality Standards (NEQS) and then discharged into the nearest sewerage line; the storm water will be drained into the Bus Lane Drainage Channel which will carry it to the central storm water drainage system where it will be stored as harvested rainwater and utilized wherever possible for example, in the drip irrigation system.

Environmental Impacts & Proposed Measures

Availability of space for operation of the system:

The Green Line is constrained to operate up to Aurangzeb Park because the section from this section to Merewether Tower is very narrow and does not fulfill the demand of at least 4 lanes for smooth operation of the BRT system. The road width near Tower is approximately 15m for the length of 400m. Moreover there is no provision for a turnaround and hence the BRT will have to terminate at Aurangzeb Park.

Furthermore the Jail Chowrangi to Saddar is a very busy commercial area, which requires parking lanes or emergency shoulder for both sides. Considering the demand of commercial vehicle for loading and unloading, the width of parking lane is required to be 2.5m. This means that even if bus stop is not provided along this section, a minimum road width of 19m plus side-walk is required.

Environmental Impacts & Proposed Measures

Mitigation Measures:

- Construction of BRT on the narrow section from Jama Cloth Market to Merewether Tower will not be socially and economically acceptable proposition because it will require Land Acquisition as well as temporary relocation. The system will have to terminate at Aurangzeb Park for which the turnaround will be suitably established.

Environmental Impacts & Proposed Measures

Structure Stability:

The Red Line and Green Line corridors would be sited in the Seismic Zone 2B corresponding to moderate to major earthquake having magnitude between 5.0 and 6.5 on Richter Scale and Intensity between VII and IX on Modified Mercallis Scale. As such the Ground Force in terms of Assumed Approximate Acceleration equivalent of 0.3 g would be adopted to mitigate the seismic impact due to siting the two lines.

Geotechnical study will be undertaken before start of construction to ascertain that the sub-soil stratum has the desired strength for laying the foundation

Environmental Impacts & Proposed Measures

Vehicle Size & Capacity:

The following aspects need to be considered for selection of vehicle type, its size and capacity:

- The vehicle should be cost effective
- It should be of high quality and high reliability so that the chances of breakdown are minimum
- Its maintenance should be manageable
- Parts supply should easily available.

The bus vehicles run on segregated BRT lanes; at the roundabout and intersections, the bus will merge into the general traffic and/or cross into the general traffic. Moreover, at the terminus of the route, the bus will turn into road space. Under such road conditions, maneuverability of the long articulated bus, which has a large turning circle, will be constrained and there would then be interference with movement of vehicular traffic.

Environmental Impacts & Proposed Measures

Recommended Measures:

- Articulated bus and bi-articulated bus if selected to operate on the routes will require large corridor capacity and up gradation and improvement of infrastructures such as the BRT lane, station and intersection. In view of these constrains the standard bus (10.5m~12.0m) will be purchased and operated on the two BRT lanes.
- The hundreds of bus vehicles that will be purchased by KMC should be operated on the Red Line and Green Line by employing local drivers; they will be trained on safe driving practices. To arrange for local drivers training for safe driving such vehicles will be needed that do not require special driving techniques. Standard buses are therefore recommended in preference over the articulated buses.
- Selection of drivers will be on the basis of their qualification, fitness, observation of rules and regulations as well as standard operating procedures for operation as well as maintenance.

Environmental Impacts & Proposed Measures

Engine Design and Emission:

1. The Pakistan Environment Protection Agency (PEPA) has set the limit for respirable particulate matter of 2.5 micron size (PM2.5) at 25 $\mu g/m^3$ on annual average basis. However the level observed in the atmosphere of Karachi is 41.49 $\mu g/m^3$ on an annual average from June 2010 to May 2011. This exceeds the yearly average limit set by National Environmental Quality Standards.

   Monitoring of the respirable particulate matter level by EMC finds that the 24 hour average level at Red Line is 23.8 $\mu g/m^3$ and 24.3 $\mu g/m^3$ on the Green Line.

Environmental Impacts & Proposed Measures

Engine Design and Emission:

2. Clean diesel engine and Hybrid system which can adapt to EURO-V use ultra-low Sulphur diesel oil (15ppm). From the view point of the fuel supply situation in Karachi, Clean diesel engine and Hybrid system have remote chances of conforming to the requirements of EURO-V BRT vehicles.
3. In Pakistan, steps are being taken to adopt EURO-II emission standards. The Ministry of Environment has planned for all diesel cars which will be imported or manufactured on and after July 2012 to conform to EURO-II emissions. Also, it has been planned by the Ministry of Petroleum and Natural Resources to supply low Sulphur diesel oil (500 ppm) which can be adapted to EURO-II on and after January 2012. However, up gradation of the oil refinery facilities do not seem to be preparing to achieve the stated target.

Environmental Impacts & Proposed Measures

Engine Design and Emission:

4. Use of the diesel oil containing about 0.2 – 0.6% Sulphur will alter the quality of emissions and this time the emissions will contain SO2 as well as Particulate Matter (Black smoke) and higher amounts of CO (Carbon Monoxide). This will need use of low Sulphur Diesel oil (0.05 % - 0.35%) for efficient operation of EURO II and EURO III engines.
5. According to Pakistan Clean Air programme (PCAP) established by the Ministry of Environment, gradual exclusion of the diesel car from centre of the city is under consideration. In Pakistan, CNG has been introduced as an alternative to reduce the amount of oil import and to control air pollution. CNG engine does not discharge PM and can adapt to EURO-II by installing the oxidation catalyst

Environmental Impacts & Proposed Measures

Engine Design and Emission:

6. Comparison of the fuel cost of CNG bus and diesel bus is shown in the following table. The cost has been calculated using the fuel unit price in Karachi as of April 2012 and the fuel consumption of the CNG bus currently operating by KMC.

Fuel Cost				
Fuel	Unit Price	Fuel Consumption	Fuel Cost	Fuel
CNG	79	2.5km/kg	Rs. 32	CNG
Diesel	104	2.7km/liter	Rs. 39	Diesel
Source: JICA Study Team				

Environmental Impacts & Proposed Measures

Mitigation Measures:

- To reduce the particulate matter (PM) and the nitrogen oxide (NOx) emission the mitigation measures are use of engines that have adopted the latest clean diesel technology and also attaching the exhaust post-processing equipment. Moreover, as the alternative system of the diesel engine, there are the low emission vehicles applying CNG (Compressed Natural Gas) drive and hybrid system
- Maintenance of vehicles to conform to emission standards should be legalized as per the requirement of Vehicular Emission Control Program (VECOP) by Sindh EPA. Accordingly all vehicles should be subjected to regular inspection and certification by a competent authority so that the emissions are controlled at source

Environmental Impacts & Proposed Measures

Boarding and Alighting:

The boarding and alighting if not properly designed can cause difficulty for senior citizens and physical disadvantaged people to get benefit of BRT service. This aspect has been identified by stakeholders in two consultation meetings. The height of the station platform, therefore, has to be level with the floor of the vehicle to facilitate easy boarding and alighting for such passengers

Environmental Impacts & Proposed Measures

Mitigation Measures:

- High level platform with 1,000mm height is recommended. In order to account for the gap between station platform and BRT vehicle, a bridge plate may be provided that would be in automatic synchronization with door opening at each doorway of the vehicle. Although at-level boarding with 1,000mm height is a desirable proposition, yet if it would be preferable to have raised floor of the vehicle. In this case, the vehicle floor height and the gradient of a bridge plate shall not exceed 1,100mm and 10 degrees respectively; this is to secure the inside standing height and wheelchair access.
- In addition, the use of high level platform will prevent the illegal ridership which may enter into the station without passing the ticket gate. This will also provide security to the passengers inside the station in case a collision of cars occurs at the station.

Environmental Impacts & Proposed Measures

Designing of Drainage System:

A drainage system will be designed for the Green Line corridor to cater to the runoff from within the corridor right-of-way only. The drainage system will be directed to outlets at the existing channels and drains along or intersecting the corridors

The 5 years rainfall Average Recurrence Interval (ARI) should be adopted for the computation of the road surface runoff, while Intensity-Duration-Frequency (IDF) Curves for the City of Karachi shall be used for the estimation of rainfall intensity. The Rational Method shall be used to estimate the surface runoff from the Right of Way of BRT corridors.

Environmental Impacts & Proposed Measures

Land Preparation:

The establishment BRT system will require extensive shallow cutting and filling of the ground along most part of the median to make room for the Right of Way. It is envisaged (depending on the mode of construction) that the existing road surfaces will need to be modified (e.g. to remove unstable materials) and fill in the remaining surface for the BRT transit ways. In other places surfacing will proceed straight to BRT standard. At this stage the removal of only the medians that are about 50cm high will require at least 20,000 m3 to be cut.

Environmental Impacts & Proposed Measures

Mitigation Measures:

- A disposal or reuse plan for these materials will need to be identified in the detailed design phase and included in the EMP.
- Cut and fill requirements will have to be balanced to minimize the impacts. Accordingly surplus materials arising from removal of surface material will be used elsewhere on the corridors as fill material.
- The BRT detailed design will carry the estimates on additional materials that will be required.
- Works should be planned and scheduled to facilitate the timely production of rock, gravel and sand materials for construction and to avoid the need for excessive stockpiling and importing from elsewhere in the district.

Environmental Impacts & Proposed Measures

Mitigation Measures:

- Materials Management Plan (MMMP) including mitigation measures will be prepared for: (i) a mass haul chart for the rock based materials, aggregate and bitumen materials needed for the construction works, (ii) extraction of materials including mass haul procedure to specify (iii) the construction methodology, (iv) measures to be employed to mitigate nuisances to local residents, and (v) additional measures such as compensatory planting of trees.
- The MMMP will be updated regularly and reported monthly as a contract requirement for each contractor to monitor the production and use of materials. The construction supervising consultant (CSC) shall be held responsible for updating and reporting the cut and fill estimates in the MMMP.

Environmental Impacts & Proposed Measures

Traffic Diversion/Management during Construction

A practical traffic diversion plan will be prepared to ensure minimum inconvenience to road users during the construction stage. The number of the traffic lanes and capacity of diversion should not be reduced in order to minimize traffic congestion, especially during the peak hours. Similarly the existing profile of road, if possible should not be reduced or raised significantly (>0.3m) unless proper diversion is arranged

A Safety Manager, with working experience in road construction, shall supervise and maintain all traffic diversion and safety matters. The traffic diversion plan shall be maintained and kept in good order at all times (no potholes, good road marking, adequate sign boards, traffic barriers/cones/New Jersey Barriers, blinker light etc.)

Environmental Impacts & Proposed Measures

Traffic Diversion/Management during Construction

A traffic engineer will prepare a traffic diversion plan which can be satisfactorily implemented on site to comply with local statutory requirements and conditions

Environmental Impacts & Proposed Measures

Noise and Vibration

Noise emission sources are expected to be the powered mechanical equipment such as generators, excavators, bulldozers, piling rigs, stabilizers, and drills while stone crushers, graders, vibratory rollers, concrete-mixing plants, and screening plants will generate noise of high level besides vibration. However the noise level and impact of vibration can controlled at source by regulation of contractual obligation.

The cumulative effects from equipment, machinery and the vehicular traffic can be significant but the same will be limited to the microenvironment of the median of the BRT system

Environmental Impacts & Proposed Measures

Mitigation Measures:

- Sufficient buffer distance may not be available along the corridor between the works and the scores of receptors and hence adverse impact of construction activities in terms of noise, vibration, dust and waste disposal is expected to be significant. The contractor will therefore be mandated to segregate the construction area at the median from the edge of the road. The segregation should be easily erected and substantial enough to minimize noise impacts.
- Background noise levels are likely to be high during nighttime (10 pm to 7 am). Therefore the performance criteria shall be as follows. During nighttime (10 pm to 7 am) the impact of noise measured at the residential and hospital (sensitive receptor) shall not exceed 3dBA over the background noise level. The contractor shall also maintain and service all equipment to minimize noise levels.

Environmental Impacts & Proposed Measures

Mitigation Measures:

- Where schools and mosques are nearby, the contractor shall discuss with the CSC and the school principals the agreed time for operating the noisy machines and completely avoid use of machines during school times and near mosques during prayer times.
- Construction activity will be preceded by a round of public consultations at each section of the corridor, where the public would be informed of the construction schedule, alternate traffic routes, if necessary, and the likely impact on the site.

Environmental Impacts & Proposed Measures

Mitigation Measures:

- Options to control noise pollution include increasing the use of heavy thick ply-board or corrugated metal sheet to supplement the mass of the hoarding barriers to achieve a mass of greater than 10kg/m2. The design of the hoardings and the working plan will include safe passage for the pedestrians.
- Large building components could be prefabricated nearer the concrete batching plants or in controlled dedicated areas away from Sensitive Receptors to minimize impacts along the BRT corridor.

Environmental Impacts & Proposed Measures

Mitigation Measures:

To minimize impacts the contractors will be mandated by the KMC to:

- Ensure NEQS compliance to the effect that all equipments and machinery to be used during construction are equipped with the necessary air pollution and noise dampening devices to meet statutory requirements;
- Perform regular maintenance and service all equipment to minimize noise levels;
- Locate and operate equipment to minimize nuisances; and
- Install acoustic insulation or use portable noise barriers or install a hoarding where practicable to limit noise at sensitive receivers. Major construction activities will be limited to daylight hours to minimize construction noise. Mufflers will be used on diesel equipment and power generators.

Environmental Impacts & Proposed Measures

Mitigation Measures:

- Major construction activities will be limited to daylight hours to minimize construction noise. Mufflers will be used on diesel equipment and power generators.
- Appropriate PPE such as ear muffs shall be provided for the workforce and their usage enforced with sound policies and by setting examples.
- Effective staff awareness campaign on the implications of non-compliance with PPE policy shall be enforced. All workers will be required to make proper use of the protection equipment provided by management and also to observe all rules and regulations pertinent to the use of equipment designed to minimize noise exposure.
- Records of noise-exposure measurement of workers shall be maintained.
- Individual worker's exposure to excessive noise shall therefore be controlled by shift arrangement.
- Acoustic enclosures and silencers shall be used for high capacity diesel generators.

Environmental Impacts & Proposed Measures

Air Pollution

Reports available on air quality on the two corridors suggest that the congested areas at traffic intersections and narrow lanes are heavily polluted but at the center of the road.

Bituminous materials may generally be applied using machines supplied from the asphalt plant but if bituminous compounds are to be applied manually and melted in heaters and mixed on site, the fuel used shall be kerosene, diesel or gas. Fire wood shall not be used for heating bitumen; neither will bitumen be used as fuel. Due to the scale of the works fumes from asphalt chemicals are likely to be noticed by local residents as phenolic compounds in the bitumen have a very low odor threshold and extremely low concentrations can cause nuisances. These are unlikely to accumulate to toxic levels but the plant for the supply of molten bitumen shall be sited at reasonable distance from water bodies and sensitive areas including schools, health clinics and praying places

Environmental Impacts & Proposed Measures

Mitigation Measures:

- Water sprinkling is the general method to suppress dust emission. Water is available along the corridors but the same may not be available as and when required. It will therefore be advisable to enter into contract with KW&SB or its contractors to ensure the supply through tankers.
- In case sensitive receptors are within 10 m of the activity area, the contractor will install structures / barriers to segregate the works to protect the sensitive receivers and passing traffic. The segregation will be manageable with 3m high hoarding within which all construction works can take place. The hoarding will be moveable from worksite to worksite along the BRT corridor as the work proceeds and as and when the works are completed.
- Hoardings and tarpaulins will be used to retain dust and cover the exposed earthworks, stockpiles and surfaces.

Environmental Impacts & Proposed Measures

Mitigation Measures:

- If for some engineering reason the construction of a hoarding is not practicable at some locations it can be substituted with a continuous 3m high tarpaulin sheet suspended on wires and designed to retain dust and provide a temporary dust and visual barrier to the activity area. Where dust is the major consideration the barrier can take the form of tarpaulins strung between two poles mounted on a concrete base. These can be moved along the road as the work proceeds.
- The need for large stockpiles will be minimized by careful planning of the supply of materials from controlled sources. Stockpiles will not be located within 50m of sensitive areas such as schools, hospitals or other public amenities and will be covered with tarpaulins when not in use. If large stockpiles (>25m3) of crushed materials are necessary they will be enclosed within side barriers and also covered when not in use.

Environmental Impacts & Proposed Measures

Mitigation Measures:

- Construction materials (sand, gravel, and crushed stone) and spoil materials will be transported by trucks covered with tarpaulins and all vehicles (e.g., trucks, equipment, and other vehicles that support construction activity) will comply with the NEQS for emissions and noise and duly monitored by the contractor as well supervision consultant.
- Sites for mixing asphalt shall be located 100m from sensitive receptors and asphalt plant and concrete batching shall be at least 500m downwind of the nearest sensitive receptors. The surfacing works will be so programmed as to finish the work in time to minimize the nuisances in any given location.
- Bitumen drums will be stored in designated areas, not scattered along the works and any small accidental spills of bitumen or chemicals will be cleaned up immediately. The waste including the top 2 cm of any contaminated soil and disposed of as chemical waste to an approved landfill or approved local authority disposal location.

Environmental Impacts & Proposed Measures

Mitigation Measures:

- Wherever possible, materials should be brought to site on an as needed basis to avoid the need for stockpiling in the restricted work sites that will have to be located in the median of the roads that will form the BRT corridors.
- The interaction of the activities at the construction site with the vehicular traffic at the corridors will have to be controlled by implementing the traffic management rules. This will need transport planning to optimize freight and passenger transport.
- Mobilization of construction trucks and machinery shall be effective after "peak hours". Road dividers or kerbs shall be installed. Road will be properly signed and traffic warders employed to facilitate smooth vehicle traffic, at all times

Environmental Impacts & Proposed Measures

Solid Waste Management

Solid waste will be mainly generated from the construction debris and packaging material besides different activities at the camp site or the working area. The entire solid waste generated at the construction site and camp site is recyclable but for the food waste.

Mitigation Measures:

- The safe disposal of solid waste will be outsourced to a contractor.
- After construction activities, regular maintenance practices including manual road sweeping will be carried out to supplement the flushing of pollutants from the road by natural rainfall events to remove large particle size pollutants.

Environmental Impacts & Proposed Measures

Noise

Noise from local traffic in the towns is generally accepted as a consequence of urban life but concerns have been expressed during the consultation meetings about the congested sections on the Green Line and Red Line corridors.

Depending on the eventual traffic flows most road sections near the BRT are expected to carry less but still substantial volume of traffic. This is based on the assumption that the BRT will be instrumental in removing the major source of annoyance including noise emission from buses operating on the BRT routes and transfer of passengers to the BRT system.

Environmental Impacts & Proposed Measures

Noise

It is expected that the traffic noise level is reduced approximately 0.1% to 2.1 % by modal shift of transportation from passenger cars/ buses to the BRT system.

Environmental Impacts & Proposed Measures

Mitigation Measures:

- Utilization of vegetation belts on the project corridor and the enforcement of relevant standard and regulation on vehicular emission are the appropriate mitigation measures as the most important influence on the spread of the pollution after its release is the strength of the wind.

Environmental Impacts & Proposed Measures

It is expected that the exhaust pollution gas is reduced approximately 26% by modal shift due to the implementation of BRT.

Table : Reduction Ratio in Air Quality

BRT	Forecast of NOx volume along the BRT line :Q (g/day)		Reduction due to the implementation (%)
	With the BRT Project Road Traffic (KCR + Green Line + Red Line)	Without the BRT Project Road Traffic (Only KCR)	
Green Line	4,197	5,793	27.6%
Red LIne	7,644	10,210	25.1%
Total	11,841	16,003	26.0%

Environmental Impacts & Proposed Measures

It is expected that the total emission factor for CO_2 is reduced approximately 12 % in respect of the modal shifting of transportation from passenger cars/ buses to the new transportation system.

BRT	Forecast of CO_2 volume along the BRT line (g/day)		Reduction rate (%)
	With the BRT Project Road Traffic (KCR + Green Line + Red Line)	Without the BRT Project Road Traffic (Only KCR)	
	GHG_w	GHG_{wo}	$(GHG_{wo}-GHG_w)/GHG_{wo}$
Green Line	689,120	802,531	14.1%
Red Line	270,251	292,469	7.6%
Total	959,370	1,095,000	12.4%