Environmental Impact Assessment

Project No. 47279-002
May 2018

PAK: Karachi Bus Rapid Transit Project

Part 1

Prepared by the Transport and Mass Transit Department, Government of Sindh, for the Asian Development Bank.

Package1 Detailed Engineering Design, Procurement and Construction Management (EPCM)

(Phase I: Detailed Engineering Design and Procurement)
Karachi Bus Rapid Transit Project - Project Design Advance

Environmental Impact Assessment (Final)

May 2018

Asian Development Bank (ADB)

Transport and Mass Transit Department
Government of Sindh
Environmental Impact Assessment (Final)

MML-MM Pakistan (Pvt.) Ltd.
Dolmen Estate, 1st Floor, 18-C, Union Commercial Area,
Shaheed-e-Millat Road Karachi-75350 Pakistan
Tel: +92 21 34320527-28, 34320637
Fax: +92 21 34524819

ADB
Transport and Mass Transit Department
Government of Sindh

Package 1 Detailed Engineering Design, Procurement and Construction Management (EPCM)

(Phase I: Detailed Engineering Design and Procurement)
Karachi Bus Rapid Transit Project - Project Design Advance

May 2018

Asian Development Bank (ADB)

Transport and Mass Transit Department
Government of Sindh
Environmental Impact Assessment (Final)

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
A	March, 2018	Timothy Whitington Aqeel Ahmed Magsi	M A Shishmahal Colin Ridding	Ejaz Alam Farooq Chowdhuray	Environmental Impact Assessment (Draft)
B	April, 2018	Timothy Whitington Aqeel Ahmed Magsi	M A Shishmahal Colin Ridding	Ejaz Alam Farooq Chowdhuray	Environmental Impact Assessment (Final)
C	May, 2018	Timothy Whitington Aqeel Ahmed Magsi	M A Shishmahal Colin Ridding	Ejaz Alam Farooq Chowdhuray	Environmental Impact Assessment (Final)

Document reference: 382188 I 05 I A

Information class: Standard

Contents

Appendices

List of Tables

List of Figures

Abbreviations and Acronyms

ADB	:	Asian Development Bank
BRT	:	Bus Rapid Transit
CBD	:	Central Business District
SSEMP	:	Construction Environmental Management Plan
CNG	:	Compressed Natural Gas
CSC	:	Construction Supervision Consultant
EA	:	Executing Agency
ECS	:	Environmental Construction Specification
EIA	:	Environmental Impact Assessment
EMP	:	Environmental Management Plan
EPCM	:	Engineering, Procurement and Construction Management
FTA	:	US Federal Transport Administration
GHG	:	Greenhouse Gases
GOS	:	Government of Sindh
IEE	:	Initial Environment Examination
ITS	:	Intelligent Transport Systems
JICA	:	Japan International Cooperation Agency
KBRT	:	Karachi Bus Rapid Transit Project
KTIP	:	Karachi Transportation Improvement Plan
KWSB	:	Karachi Water and Sewerage Board
MML	:	Mott MacDonald Ltd
MMP	:	MM Pakistan (Pvt.) Ltd.
MSDS	:	Material Safety Data Sheet
NEQS	:	National Environmental Quality Standards
NIPA	:	National Institute of Public Administration
NMT	:	Non-Motorized Transport
ODBM	:	Operational Design and Business Model
PC	:	Public Consultation
PDA	:	Project Design Advance
PDD	:	Planning and Development Department
PIU	:	Project Implementation Unit
PMCCB	:	Project Management, Coordination, and Capacity Building
PPTA	:	Project Preparation Technical Assistance
PTA	:	Public Transport Authority
REA	:	Rapid environmental assessment
SEPA	:	Sindh Environmental Protection Agency
SEQS	:	Sindh Environmental Quality Standards
SMTA	:	Sindh Mass Transit Authority
SSEMP:		Site Specific Environmental Management Plan
TMTD	:	Transport and Mass Transit Department

Units

dB	:	decibels
dBA	:	A-weighted sound level (screens out low and high frequency noise)
L_{max}	:	maximum noise level
L_{dn}	:	day-night sound level (Cumulative 24-Hour Exposure from All Events)
$L_{eq}^{(10)}$	:	equivalent sound level (10 min during peak hour)
$L_{eq}(h)$	:	Hourly Equivalent Sound Level
SEL Event)	:	Sound Exposure Level (The Cumulative Exposure from a Single Noise
VdB	:	Vibration Decibels
CO	:	Carbon Monoxide
NO_X	:	Nitrogen Oxides
PM	:	particulate matter
PM_{10},	:	PM with diameter of 10 microns or smaller
$PM_{2.5}$,	:	PM 2.5 microns or smaller
SO_2	:	Sulphur Dioxide
Km/hr	:	Kilometers per Hour
CM	:	Centimeter

E Executive Summary

E-1 Background

E-1.1 The Environmental Impact Assessment Report

1. The Environmental Impact Assessment (EIA) Report describes environmental and social considerations of the Karachi Bus Rapid Transit Project (KBRT Project), which is an integral part of an overall scheme for improved transport for Karachi. The purpose of the EIA is to establish a framework and related actions for evaluating and mitigating environmental and social impacts stemming from implementation of the Project.

E-1.2 The Project

2. The Project was first identified under the Karachi Transportation Improvement Plan (KTIP) a Japan International Cooperation Agency (JICA) funded planning study covering the whole of the metropolitan area. The Red Line, one of 6 identified in the KTIP, was developed in its preparatory stage in 2014-15 under Asian Development Bank (ADB) funding, as one of two preferred Bus Rapid Transit (BRT) routes for initial development. A preparatory level Initial Environmental Examination (IEE) was prepared at that time, which has been used as a scoping document and basis for the present effort. No environmental review has been conducted by the Government of Sindh prior to the detailed design stage. Organizational arrangements are being put into place through formation of the Sindh Mass Transit Authority (SMTA) for implementation of this and other mass transit projects in Karachi, one of which, the Green Line, is under construction, with an expected completion date for Phase I of April 2018. A Project Design Advance (PDA), or forward loan agreement, was signed in 2017 between the Government of Pakistan (GOP) and ADB to provide advance financing for engineering, procurement, and construction management; an operational design and business model; project management, coordination and capacity building; and staff consultants to provide technical support for the Project Implementation Unit (PIU).

E-1.3 The Consultants

3. Mott-MacDonald Ltd. (MML) together with MM Pakistan (MMP) jointly has been appointed as the Phase I engineering, procurement, and construction management (EPCM) consultant, under which the EIA is prepared. Information derived from other on-going consulting efforts under the PDA is gratefully acknowledged and appreciated.

E-1.4 Objectives of the Project

4. The Project aims to alleviate in part the lack of transport options available in a rapidly growing metropolis, and was identified as such in the Master Plan prepared under the Karachi Transportation Improvement Project (NKYO 2012). In that study, the Project was seen as one component of an urban transport development strategy that combines bus rapid transit with rail service, refurbishment of the Karachi Circular Railway, reclaiming the full capacity of the City's roadways, and selected highway projects, along with safety and pedestrian improvements. A feasibility study was conducted for BRT inclusive of the Red Line at that time.

E-1.5 The Environmental Objectives

5. The Project's environmental objectives are both local and global. They include reduction in congestion along roadways and lessened noise and air pollution exposure for roadway users and people living and working along roadways. BRT is a modernized and low-cost approach to mass transit that is especially suitable to conditions in Karachi. At national and global levels, the Project is expected to reduce consumption of fossil fuels and provide a reduction in the Nation's Greenhouse Gas (GHG) inventory in comparison with a future case without the Project.

E-1.6 Project Location

6. The Project is located along an east-west trending alignment, overall length of 23+ km, running contiguous with New MA Jinnah Rd., University Rd., University Rd.2 (Malir Cantonment Link Rd.) and MA Jinnah Ave, in the north-eastern sector of Karachi. It crosses the administrative districts of Central and East Karachi and Malir Cantonment, specifically: East District: Jamshed and Gulshan Towns, and District Central: Liaquatabad and Gulberg Towns. Toward the east the alignment turns south following the eastern boundary of the Jinnah International Airport. The two depot sites are located along its eastern and southern segment at Gulistan-e-Jauhar Block 6 and a plot near the intersection of MA Jinnah Ave and Shara-e-Faisal Rd. The Location Map for the Project is shown in Figure E--1.

E-2 Legal Framework for Environmental Management

E-2.1 Laws Concerning Environmental Impact Assessment In Pakistan

7. Key legislation related to environmental protection in Pakistan has been devolved to the state level, including The National (and Sindh) Environmental Protection Act (1997, 2014) and Sindh Environment Protection Regulation (2014). Together these laws authorize the Director General (DG) of the Sindh Environment Protection Agency (SEPA) to undertake activities to conserve and enhance the quality of the environment. Main highlights relevant to the Karachi Bus Rapid Transit Project are:

    i. Regulation of development activities from an environmental perspective
    ii. Categorization of development activities on the basis of anticipated environmental impact
    iii. Requirement for undertaking an EIA in keeping with the category of the proposed activity
    iv. Procedure for obtaining and renewing an environmental clearance over the project cycle
    v. Promulgation of standards for air, water and noise quality, as well as effluent standards
    vi. Procedure for claiming damage by persons affected by polluting activities or actions that adversely affect the conduct of ordinary civic life

8. Other laws and ordinances concerning environmental quality standards, labor rights and protections, resettlement, land acquisition and compensation are relevant to the Project.

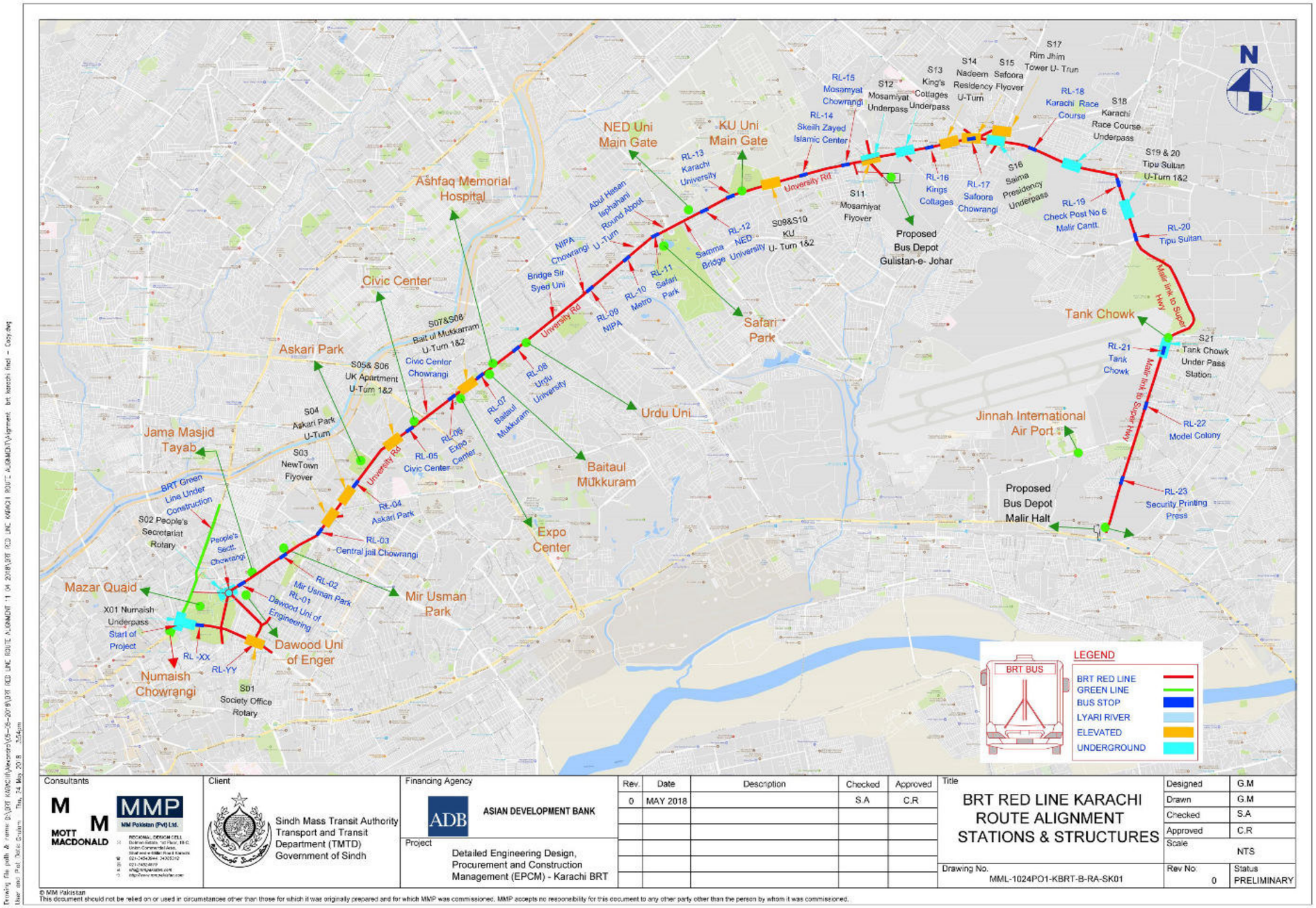

Figure E--0-1: Location Map

E-2.2 ADB's Safeguard Policy Statement

9. The ADB's Safeguard Policy Statement 2009 (SPS 2009) defines the overarching framework for three key safeguard areas: (i) environmental safeguards, (ii) involuntary resettlement safeguards, and (iii) Indigenous Peoples safeguards. ADB's environmental policies cover screening and categorization, environmental assessment, consideration of alternatives, impact mitigation, public consultation, disclosure, and environmental management planning, with topical policies for biodiversity, pollution prevention, occupational health and safety, community safety and physical cultural resources. A proposed project is classified as category A, for which an environmental impact assessment is required, if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. The project is classified as Category A for environment, in line with requirements of the SEPA because, while the impacts will be reversible, they are found to be diverse in nature, thus requiring preparation of an EIA study. The content and main elements for EIA Reports are provided in Appendix A of the SPS, which are consistent with the World Bank Operational Policy - OP 4.01, Annex B and other international safeguard requirements.

E-2.3 Administrative Framework

10. The Government of Sindh (GOS) is the provincial government of the Sindh Province and is based in Karachi. The Government of Sindh has a Transport and Mass Transit Department (TMTD) which operates the Sindh Mass Transit Authority (SMTA) and its Project Implementation Unit (PIU). SMTA operations are supported through the project management, coordination, and capacity building (PMCCB) component of the project design advance (PDA). Financing under the PDA also provides advisors for both environmental and social aspects within the PIU.

E-3 Project Details

11. The Project Description is based on information provided by the EPCM design team and the Operational Design and Business Model (ODBM) team. Both efforts are continually being updated, and numerous changes and additions can be expected during the process of finalization and approval of the EIA. The EIA is not intended to precisely account for these changes. Rather it highlights aspects of design that may adversely affect the environment; are designed to minimize or eliminate impacts; and which introduce energy-saving and clean technology innovations.

12. The KBRT Project is squarely situated within the transport planning context that has been a priority in Karachi for about 20 years. The 2005 Karachi Megacities Development Project financed by the ADB recommended a balanced mix of transport options including bus rapid transit. JICA's master plan in 2012 recommended the Red Line, and ADB's project preparation technical assistance (PPTA) for the Red Line, which was completed in 2016, carried out feasibility for the Red Line BRT.

E-3.1 Project Funding

13. ADB's preliminary estimates put the project cost at United States Dollar (USD) 220 million, of which approximately 75 % will be financed through the loan, with the Government contribution at ~25% (USD 55 million). Additional financing in the form of grants for preparatory studies and training have been provided by ADB.

E-3.2 Salient Features of the Project

14. The salient features of the Project are as follows:

i. Alignment between MA Jinnah Rd, the Mazar-e-Quaid Mausoleum, occupying the median of new MA Jinnah Rd. and continuing to its junction with University Road at Jail Chowrangi, and then on to Safoora Chowrangi, then along the Malir Cantonment Link Rd. to Police Check Post No. 6, and then south along MA Jinnah Ave. to its terminus at Liaquat Ave near Airport Rd, consisting of at-grade, super-elevated and below-grade segments.

ii. Depot sites: two locations, each approximately 3.2 ha in size.

iii. Stations: 24 stations along the alignment, each approximately 80 m in length; outside width of stations will vary to remain within the available public right-of-way. In general stations are 10 m in width.

iv. Façade-to-façade improvements along the alignment, including enhanced drainage

v. Temporary facilities needed for construction, including casting yards, materials and equipment storage, labor camps and cordoned space.

vi. Equipment purchases specified by the ODBM consultant using unified procurement and operations contracts.

E-3.3 Summary of the Project Description

15. The Project Description found in the main text reviews the project background, rationale and objectives, summarizes the BRT corridor and component locations and provides an overview of proposed BRT operations. The vehicle scrapping plan for buses taken out of service is described, and recommendations for vehicle configuration and the power-train specification are provided. The service plan is reviewed, along with bus frequencies and AM peak service plan, fare system and ITS provider and interaction with off-network transport services. Vehicle operations and bus servicing proposals are described, along with the infrastructure development approach, including a description of the segregated busway, bus stops (stations), accommodations to improve station accessibility, the depot locations, and operational management. Finally, the project cost, construction sequence and implementation schedule are reviewed.

E-4 Analysis of Alternatives

16. After detailed deliberations and environmental consultations a number of alternatives were developed and the present alignment has been chosen. The selected alternative links to the Green Line for entry into the greater BRT system. On the eastern extreme, the alignment provides occasional access to the airport, and a possible extension south to Shara-e-Faisal.

17. Equipment alternatives were selected by the ODBM consultant in light of constraints on the types of fuel available in Pakistan and air quality, comfort, health and safety, and energy conservation. A Compressed Natural Gas (CNG) powered hybrid bus is the fuel-propulsion system most favored at present.

E-5 Description of the Environment (Baseline Data)

18. This section covers a large scope of topics under the four major headings of environment. Physical resources include geology, soils and groundwater, surface hydrology and water quality, meteorology and air quality, and noise. Biological resources cover protected areas, land cover, trees and valued flora, mammal and bird life. Socioeconomic resources describe administrative divisions and population, land use along the alignment, community infrastructure, housing, water and sanitation services, transport assets, religion, crime and criminal activities, gender-based violence, in and out migration, and employment. Finally, a list is included of educational and religious institutions, historical and cultural sites, and aesthetic and recreational resources.

E-6 Affected Environment and Environmental Consequences

19. The scope of work specifies a high level of accountability for environmental design of equipment and facilities, construction management, and health and safety. Environmental features are incorporated into the project design. Development of Environmental Construction Specifications (ECS) that will become part of the tender documents requires that all aspects related to sequencing be considered. Some construction environmental impacts are mitigated through a process of pre-planning, traffic management planning and utility relocation being examples.

E-6.1 Mitigation Measures

20. Construction mitigation measures are required by good practice and should be undertaken by the construction contractor in a proactive fashion to get the most benefit in meeting the needs of local communities, which will be most affected by the construction work. Proposed mitigation measures are appropriate for actual field conditions. GOS environmental quality standards for air, noise and water play an important role in determining the extent of mitigation measures that need to be applied by the Contractor.

21. Environmental impacts can be minimized in the planning and design of the Project, and mitigation measures can be applied during construction and operations phases. The EIA identifies numerous types of potential impact that require investigation. Noise and air quality impacts can occur both during construction and operations, whereas impacts due to vibration are limited to its construction phase. Drainage and water quality impacts can occur both during construction and operations; for the latter, potential impacts occur due to heavy rainfall and the need to keep the alignment, stations and depot areas free and clear of flooding. These issues are being accounted for in the project design.

22. Many environmental, health and safety issues are addressed through project engineering, design and planning, including landscape design around stations, traffic management, utility relocation, safety and health, and emergency response. These are included by reference and summaries are provided in Chapter 6 of the EIA. Additional recommendations are made in regard to these issues. Chapter 6 also describes analyses and provides mitigation measures for potential impacts associated with spoil disposal, solid waste and hazardous materials; removal of trees in the right-of-way; and siting/construction impacts related to temporary construction yards. No significant potential impact on birds, mammals and groundwater was identified.

E-6.2 Air Quality

23. Adverse impacts on air quality are due to high ambient dust levels, measured as suspended particulate matter (SPM), PM_{10} and $PM_{2.5}$; and gaseous pollutants typical of internal combustion engines: sulfur dioxide (SO2), carbon monoxide (CO), and oxides of nitrogen (NOx). Existing ambient air quality as measured at four locations in February 2018 was acceptable compared with the Sindh Environmental Quality Standards (SEQS) limits; however, these isolated measurements may not reflect the typical case.

Air Quality during Construction

24. Open excavation, material transport, movement of vehicles and incident wind tend to release and entrain dust at ground level, causing inconvenience and health effects (eye damage, respiratory problems) for workers and people in the area. Construction equipment and transport vehicles generate continuous streams of gaseous and particulate pollutants. Proposed mitigation measures focus on maintaining and cleaning roadway surfaces, covering loads in transport, suppressing dust and removing materials and spoil piles from the work area, and assuring vehicles are maintained and comply with vehicle emissions standards. Contractors will be required to monitor air quality, and implement mitigation measures to keep ambient levels (mainly particulates) within the SEQS limits. Complaints from the community will also be a cause for intensifying use of mitigation measures to control dust.

Air Quality during Operations

25. Air emissions during operations are due to bus vehicle exhaust. Buses may use either a diesel or CNG-hybrid propulsion system. The diesel-fueled option must meet a minimum EURO III emission standard, but must be capable of operating with EURO II fuel, e.g. sulphur content and ash are higher than with a Euro-III fuel. Much of the fleet being replaced operates on CNG, but may be fueled with petrol if CNG supplies are low. Some studies indicate that CNG buses have lower NOx emissions and higher CO emissions than diesel and hybrid buses across all duty cycles, whereas hybrid buses generally have slightly lower NOx emissions than diesel buses. It is not clear how much of a modal shift involves vehicles that currently run on CNG, and whether CNG-hybrid combination will be selected for the new fleet of buses. An assessment was performed based on comparison of daily ridership for various modes of transport with and without the project, combined with available emission factors for primary pollutants, and using a variable percentage (from 20% to 40%) as the modal share of trips captured by the BRT. The analysis indicates that introduction of new buses built to a higher standard of pollution control results in reduced quantities of primary pollutants in the vicinity of University Rd. In other studies, statistical results based on extensive monitoring in an urban environment show that BRT constitutes an effective means for reducing emissions of CO, NOX, PM2.5 and PM10.

E-6.3 Noise Impacts

26. Noise impacts occur during construction and operations. Both construction and operations impacts are analyzed through methods developed by the Federal Transportation Administration (United States Government) that evaluates noise power levels at the point of reception in relation to existing (background) noise levels. These methods are essentially screening models, but are considered adequate for the purpose, considering that insufficient data are available to execute more complex modelling approaches.

Noise Generated by Construction

27. For construction, the procedure targets noise power levels from equipment used in specific construction activities. These are converted to equivalent noise levels at the road right-of-way, which represents a typical location for close-by receptors, then combined into an equivalent combined noise level (A rated decibels). Results are tabulated and compared with existing background noise levels that were measured at that location (average of one hr Leq for day and night-time, respectively). Construction related noise levels are described in relation to ambient noise standards, as well as increases over background.

28. Noise levels are assessed in comparison with a project standard of 85 dB in areas considered office, commercial and industrial enterprises; and 75/60 dB (day/night levels) in residential and hotel zones. Silence zone (hospitals, schools) are restricted to day/night levels of 60/50 dB. If ambient noise (based on monitoring data) exceeds 65 dB, the standard is considered equal to ambient plus 10 dB.

29. Analysis of data shows that excess construction noise above the standard may occur at nearly all locations along the alignment, with the highest exceedances at the entrances to two parks and at the Rehmania Mosque, near development of the Shumail Station. A general set of mitigation measures is set out that can be invoked in the event that measured noise levels exceed the standard, or complaints arise. Mitigation measures can be targeted under any particular circumstance through the ECS for that contract. Noise monitoring is required of the contractor during conduct of the work. Special cases for noise impact during construction can be singled out and measures put into place to mitigate impact.

Noise Generated by Operations

30. A similar approach is used for operations, wherein a nominal sound power level of 85 dB for a bus (the project equipment standard is 83 dB measured at 15 m from the equipment) is combined across all buses operating on a frequency determined by the headway (3 min during peak operations). The contribution of noise from buses is compared to the existing noise levels and the ambient standard, as well as criteria for noise evaluation from other countries. The contribution of noise emissions from diesel buses running at 20 per hour are negligible in comparison with existing background noise levels, and are not expected to cause a significant increase in ambient noise.

E-6.4 Vibration Impact

Vibration during Construction

31. Construction activity can result in varying degrees of ground vibration, and buildings in the vicinity of construction may be affected, with resulting damage in the most severe cases. Fragile buildings such as some historical structures are more susceptible to damage from ground vibration. However, there is no historical building close to the alignment to sustain damage from construction vibrations. Vibration levels generated by construction equipment have been evaluated in relation to building type to determine the maximum distance at which short-term vibration impacts could occur. A building would need to be located within 14 – 25 ft of an operating vibratory roller (generating maximum vibration potential) to fall within the range for damage exposure. Close monitoring, and potential mitigation of impact, would be required if

construction equipment were to operate within these safe distances. The contractor is obligated to maintain vibration levels at the faces of buildings within the proposed project criteria of 3 mm/sec PPV.

Vibration Impact during Operations

32. Significant vibration impact from rubber tire-fitted vehicles is rare. This is because rubber tire-fitted vehicles are not massive and are typically well-isolated by the vehicle suspension design and rubber tires, which act as barriers to vibration transmission between the carriage and the ground. Potential vibration impact from rubber tire-fitted vehicles such as those used in BRT projects can be dismissed under general conditions. Vibrations are most commonly caused by discontinuities in the roadway. The best remedy involves repair of roadway surfaces.

E-6.5 Traffic Congestion

33. Traffic Congestion in construction zones is addressed through traffic management planning done by the EPCM Consultant. This will be supplemented by a Traffic Management Plan (TMP) prepared by the Contractor. Because traffic management involves the cooperation of a number of agencies, the process of agreement will be incremental, continuing throughout the period of construction. Traffic management recommendations are summarized in the main text of the EIA. The EIA includes additional measures related to general traffic conditions along thoroughfares, and to the movement of over-weight/over-length (OW/OL) loads. The EIA provides initial guidance on preparation of the TMP by the Contractor.

E-6.6 Community/Occupational Health and Safety

Construction Impacts on Community-use Values

34. Community space can be affected adversely by poor performance during construction. Community health and safety in the context of the KBRT project refers to protection of the community environment near work areas by assuring access to residences and places of work and business, pedestrian and vehicular movements, air quality, reduced congestion and overall safety. Mitigation measures are put forth for control of dust, noise and traffic to minimize these hazards and inconveniences.

Occupational Health and Safety

35. The contractor is expected to give consideration to Occupational Health and Safety (OH&S), so that construction work is conducted in a manner that eliminates risk to persons and property. The Contractor will treat safety as a high priority in his activities while executing the work, and is required to prepare an OH&S Plan that conforms to requirements set out in the Sindh Occupational Safety and Health Bill (2017); that aims to eliminate or minimize unwanted hazards and risks to personnel and the public during construction; and that achieves ‘Best Practice’ within the project context, establishing a work environment that conforms to international standards with respect to health, safety and emergency response. Guidelines related to labor provisions and worker camps also are set out in the main body of the EIA.

36. Employee health and safety during operations is addressed through the Safety Management System (SMS), which is being developed by the ODBM Consultant as part of the overall Quality Management System (QMS) for SMTA.

E-6.7 Water Quality and Drainage

Drainage During Construction

37. Impacts during construction may occur due to water availability and its use on the project, and from uncontrolled drainage from work sites during rainfalls or dewatering of excavations. Guidelines are set out for construction sites and yards for maintaining drainage.

38. The Contractor is required to prepare drainage plans for all areas occupied during construction and is responsible for monitoring water quality. Specific controls are described in the EIA. Drainage from construction sites needs to be controlled to prevent water crossing roadways or interfering with pedestrian movement. The Contractor is required to keep the site clean and free of mud/silt, so that runoff from rainfall can enter the local drain system without negative effect.

Drainage During Operations

39. Drainage design is an important aspect of ongoing work being incorporated into design of the carriageway, drainage of and around stations, and drainage/dewatering controls for underpasses. Drainage design is underway to assure sufficient drainage of roadways, stations and depot areas during operations.

E-6.8 Solid and Hazardous Waste

40. The EIA describes the sources of solid and hazardous waste that might be generated by construction and operations. Trash and construction waste is not a significant amount but can cause an impact on the appearance and functioning of the work site and surrounding public space. Hazardous materials and waste will be managed according to the approved practices of the Government. About 250,000 cubic meters of spoil material will be generated during construction, mainly by excavation of underpasses. Contractors will be required to identify locations for disposal according to strict guidelines. The material is acceptable for fill so long as it does not contain hazardous waste. In respect to operations, solid waste handling and public toilets at stations will be the responsibility of the system operator.

E-6.9 Impact on Habitats

41. The Project is not expected to have a significant impact on habitats along the alignment, whether arboreal or terrestrial. A discussion of these issues is found in the EIA.

E-6.10 Impact on Trees in the Centerline of Roadways

42. Trees found in the centerlines of roadways used for the alignment will need to be removed to make way for construction. These are unavoidable losses that are made up by planting of trees at other, nearby locations according to the replacement requirement of the Government. Some trees to the right and left sides of the alignment may need to be trimmed to provide clearance for construction equipment and development of peripheral aspects of the design. Some bird habitat will be temporarily sacrificed, but is made up for by trees away from the right of way, and rapid re-growth. Species of trees to be replanted in the redevelopment are listed in the EIA.

E-6.11 Utility Relocation

43. Deep excavation, installation of pier foundations and other sub-grade work can damage existing utilities. A utility survey and relocation plan for utilities is being undertaken as an essential part of project implementation. The Contractor will be required to prepare a relocation plan for utilities that addresses any remaining risks. Additional construction and operations issues related to public infrastructure are described in the EIA.

E-6.12 Emergency Response Planning

44. Emergency response planning will be done by the Contractor following guidance provided in the EIA. The Contractor is required to set up procedures for responding to any type of emergency that poses risk for the public or BRT employees. An indicative Emergency Response Procedure to guide the construction contractor in preparation of its plan is provided in the EIA

E-6.13 Reduction in Greenhouse Gas Emissions

45. Offset calculations are based on predicted numbers of vehicles displaced from the roadway as a result of the BRT at target dates into the future, compared to a case without the project. Equivalent GHG emissions from the modal shift are estimated using the average annual daily traffic to approximate the numbers of vehicles present with and without the project, assuming a percentage of ridership (between 20 and 40%) goes over to the BRT. Only CO2 is considered in the line-up of GHGs, and overall it is estimated that 47 – 94 Tons Per Day (TPD) of CO2 is removed from the atmosphere by the project.

E-6.14 Social Impacts

46. Various types of social impact are possible, such as vendors near construction sites that must vacate, shops that must be barricaded due to construction, noise impacts that affect customer arrivals, and other potential impacts affecting income and livelihood. The Resettlement Plan (RP) will catalogue these impacts. Since the RP is not yet complete, information contained in the EIA is of a general nature at this stage.

E-6.15 Female Vulnerability

47. Public transport which is designed to consider the different needs and concerns of women and men is important for equitable social and economic development, for example, by enabling greater access to education and health services, markets, employment and leisure opportunities to both. In Karachi, sexual harassment is a high risk for women, especially young women and girls, who use public transport. The Red Line BRT Gender Action Plan incorporates features designed to reduce and mitigate the risk of sexual harassment and to encourage use of the BRT by women and minority groups to increase its market. Interventions are described aimed at both the design of the facilities as well as operations. These interventions are carried over into the EIA and can be found in the main text.

E-6.16 Depots

48. Two depots are planned, one near Malir Halt and one at Mausamiat. Both sites are currently used, and will be vacated, by the Rangers. Due diligence will be conducted at the sites to determine whether the project could cause environmental risks or impacts. Sites will be

developed according to a specific design providing segregated drainage for 'clean' and 'contaminated' storm water, oil-water separators and wastewater treatment, bunkered fuel and waste oil storage, and other facilities to minimize its impact on the environment. Operational recommendations include enactment of plans for hazardous materials management, conscientious attention to operation of the wastewater treatment unit and oil separator, and consistent application of safety and health programs for employees at the facility.

49. Construction and operations impacts have been assessed, with the most significant being related to noise. A training center is located adjacent to the entrance of the Malir depot that could be subjected to unacceptable noise levels at some of its building facilities.

50. Depots will be operated by independent contractors engaged under integrated contracts for operations and fleet procurement, and will be responsible for operating—and potentially constructing—depot facilities. The contract specifications should include environmental protection requirements relative to all phases of activity: design, construction and operations, which the successful bidder will be required to carry out as part of its development plan. Further technical assistance will be necessary to assure these facilities are designed, built and operated in an environmentally sustainable fashion.

E-7 Coordination and Consultation

E-7.1 Stakeholder Analysis

51. Stakeholder refers to individuals and institutions with an interest or 'stake' in the project. These 'juridical' entities may be able to assist in implementing the project, and are thus enjoined. The entity may have its own constituency as a user of the system, or find itself affected during the process of building the system. Entities may be representatives of the public-at-large, which may benefit, or be adversely affected, by the project, and thus are custodians of the public trust.

52. ADB finances the project at 75%, and is a major stakeholder. Government national and city-wide stakeholders that benefit from the Project include TMTD and Sindh Mass Transit Authority, owner of the Project, and Karachi Municipal Corporation, and other state and national government agencies. Local stakeholders are citizen groups in Karachi, groups of individuals living, operating businesses and working in proximity to the alignment, and existing transport operators. Those adversely affected by environmental impact include those directly exposed to construction impacts, those entitled to compensation for structures and land (currently thought to be none), those along haul routes of construction materials, and those benefitting from the Project during its operation, which includes virtually all groups which are engaged in educational, economic and cultural pursuits in the area. Local governments benefit through the increase in economic activity due to the Project.

E-7.2 Public Consultations

53. Sequential, parallel and comprehensive stakeholder involvement has and will continue to take place through public consultation, focus group discussion, targeted meetings, and other forms of interaction. The Project Management, Coordination and Capacity Building (PMCCB) component of the Project Design Advance (PDA) contains two relevant foci: The Project Communication Plan (PCP); and the Community Awareness and Participation Program (CAPP). PCP contains numerous important aspects that are typically found in a "public relations" portfolio; while CAPP

involves engagement and consultation with key stakeholders from national and local government, advocacy groups and community organizations (mosques, schools, universities and trade associations).

54. Within the EPCM component of the PDA, stakeholder consultation is done as part of the EIA effort, and is carried out under the RP formulation and the Gender Action Plan (GAP) and as such various Focus Group Discussions (FGDs) and socio economic surveys have been conducted and are covered in RP. The EPCM EIA effort has also held one stakeholder consultation involving some 56 persons leading to extensive discussion on environmental issues related to the project. The EIA reports in detail on this public consultation.

55. The formal public hearing for the EIA provides the next forum for Public Consultation on the project. Following that, informal and frequent opportunities for public involvement during the course of construction is expected.

56. A project grievance redress mechanism (GRM) was proposed during the PPTA stage that has been adopted provisionally for the project. By the time of contract award, the GRM established for the resettlement plan (RP) will need to be reconciled with the current proposal, and the two made compatible, so that it works most efficiently for both resettlement and environmentally related grievances.

57. Both ADB and SEPA policies include disclosure requirements for which the current EIA preparation effort is on track for meeting, both in terms of content of information disclosed and timing in relation to board review (for the ADB) and EIA approval (for SEPA).

E-8 Environmental Management Plan

58. The Environmental Management Plan describes institutional proposals, mitigation measures aimed at specific types of impact, and systems for monitoring and reporting on contractor performance in implementation. An institutional framework for environmental management is proposed that addresses the needs of the PIU during the construction phase, and the SMTA during operations. The presentation of mitigation measures aims at confirming use of best practicable technology in planning and design, setting out measures for mitigating construction impacts that conform to good international practice, and more general recommendations related to operations.

E-8.1 Management Framework

59. The PIU is supported on safeguard issues from the Construction Supervision Consultant (CSC) hired through the ADB Project Design Advance (PDA) loan. Strategic and policy aspects of SMTA operations are being developed through the PMCCB component of the PDA loan, and are still formative. The PMCCB consultant is responsible for providing institutional advice for environmental and social functions at SMTA, and hence these aspects are not included in recommendations in this EMP. The Phase II CSC is hired separately to support PIU.

60. Project Management will be performed by the CSC headed by a full-time Project Manager/ Resident Engineer to take responsibility for and manage activities of the CSC. The CSC will be responsible for assisting the PIU in implementing the Project. The PIU will receive support from the CSC to implement the environmental and resettlement plans. Safeguard specialists for

environment and resettlement will be part of the CSC to oversee implementation of the environmental and resettlement plans prior to the bidding stage to ensure the bidding documents include all environmental management requirements.

61. The civil works contractor will be responsible for fulfilling contract conditions related to environmental mitigation and monitoring. The contractor is responsible for implementing all environmental, health and safety actions described in the Environmental Management Plan (EMP) and relevant clauses in the bidding documents and contract during the pre-construction and construction period.

E-8.2 Construction Mitigation Measures

62. The construction mitigation measures specified in the EMP cover a broad range of issues, which are reflected in the Environmental Construction Specification (ECS). If there are multiple contract packages, each ECS will be tailored to fit the needs of a specific package. The contractor will prepare the Construction Site Specific Environmental Management Plan (SSEMP) based on the site-specific construction methodologies it proposes to use for implementing mitigation measures. The SSEMP will provide detailed measures on how it will mitigate impacts covered in the EMP including but not limited to air pollution and noise, traffic, health and safety risk, drainage and sediment, spoil and solid wastes, hazardous materials and other impacts identified in the EIA. Monitoring will be conducted for compliance with the original requirements of the EMP contained in the EIA.

E-8.3 Monitoring System

63. Inspection will be done through the use of checklists that cover mitigation measures set out in the ECS and SSEMP, and any special mitigation measures identified through impact analysis and described in the EMP. In-house air, noise and water quality monitoring will be conducted periodically by the Contractor, and ambient air and noise monitoring will be performed at least quarterly by an Independent Monitoring Group, accompanied by data compilation and reporting.

64. Quarterly monitoring reports will summarize the status of performance among all current work packages. Reports will also summarize the status of complaints (registered/resolved) under the GRM, as well as results of air, water and noise monitoring conducted in house by the contractor and by the Independent Monitoring Group (IMG).

E-9 Conclusions

i. Karachi BRT Red Line Project is compliant with GOS and ADB policies concerning environment, social impact, resettlement and compensation, and local administration.

ii. Sector guidelines related to the environment, public transit design and construction, systems and traffic safety, and public health are complied with through completion of project preparatory and detailed studies.

iii. The EIA Report and EMP provide a means for environmental management through the implementation phase.

iv. The BRT Red Line provides one of several means for alleviating Karachi's transport problems. Use of the public domain for the carriageway allows the project to be built with no

land acquisition. The project provides improved access along University Rd and the central part of the City from Malir Cantonment.

v. By means of connecting public transit services, the alignment serves the core of the City, and provides direct access to the Central Business District (CBD).

vi. The selection of the Red Line alignment for early completion among the proposed BRT lines for Karachi was conditioned on development of BRT lines to serve other core areas of the City, with an integrated system of rapid bus transit as a final outcome.

vii. GHG emissions are likely to be reduced by removing vehicles from the roadway, however data are insufficient at present to substantiate the supposition. In general, BRT has been shown to lead to reduced emissions of primary pollutants as well as GHG.

viii. The Red Line Project has no long term adverse environmental impacts; once constructed and in operation the Red Line will enhance its local environment and improve mobility for local communities. Other aspects of the Facility once in operation do not pose environmental impact if correctly operated and maintained.

ix. The project design incorporates measures for reducing the impact or footprint of the Project. Modern equipment and facilities are designed into the system for environmental protection, rider comfort and safety, and energy efficiency.

x. Social impacts on local transport providers due to the competitive nature of the Red Line is unlikely. Once operational, it becomes a member of the set of transport alternatives for Karachi that is always functioning at capacity.

xi. The mitigation measures proposed for application to construction and supply contracts minimize adverse effects that occur during construction. Air, noise and water pollution levels will be monitored periodically.

xii. Even given the highest degree of performance of mitigation measures, construction of the KBRT will alter local environmental conditions in negative ways over the duration, through increased levels of ambient dust and noise, congestion from reconstruction of the center portion of the roadway and the continuous movement of trucks removing spoil and placing road bed materials.

xiii. Social impacts are minimized by relocating street-side vendors to predefined locations so their occupations can be continued.

xiv. The Project seeks to minimize impact on permanent storefronts during construction by maintaining access and pedestrian movement, since most activity takes place in the roadway.

xv. Adverse effects will be minimized during operations by incorporating environmental requirements into tender documents for recruitment of bus service and Intelligent Transport System (ITS) /facility operations contracts.

E-10 Recommendations

i. Maintaining clean work space;

ii. Pedestrian and vehicle access around and through work areas;

iii. Enclosed or piped drainage from work sites;

iv. Roadways used for haul roads and lanes adjacent to work spaces free of dust and in good repair;

v. Visible signage and traffic directional controls; worker visibility and mandatory use of traffic vests and Personal Protective Equipment (PPE) equipment;

vi. Maintenance of drainage, lighting and dust control at temporary yards and spaces needed in the construction;

vii. Features included in the EMP serve to minimize impacts to an acceptable level;

viii. There is no use of irreplaceable resources in relation to the Red Line Project;

ix. A systematic approach for surveillance and monitoring is mandatory by means of a management framework, and monitoring and reporting protocol;

x. Follow-up public consultation is recommended to provide future input to the identification of environmental impact during the construction phase as well as a grievance redress mechanism for project affected persons;

xi. The EMP be incorporated into individual contract bidding documents in the form of Environmental Construction Specifications (ECS), which form the basis for the contractor's environmental performance;

xii. Periodic monitoring will be undertaken by the PIU supported by the CSC, and quarterly reports provided to the financing agency (ADB).

1. Introduction

1.1 Purpose of the Report

65. This Environmental Impact Assessment (EIA) report describes environmental and social considerations of the Karachi Bus Rapid Transit Project (KBRT Project). The Project concept originated in 2005 as a recommendation found in the Karachi Mega-Cities Development Project[1] financed by the Asian Development Bank (ADB), and was then brought forward as one of five proposed BRT lines in the context of the Karachi Transportation Improvement Plan (KTIP) financed by the Japanese International Cooperation Agency (JICA) and undertaken by a consortium of firms from 2010—2012 (NKYO 2012). Feasibility studies were prepared for the Red and Green Lines as part of that project. Detailed design is complete for the Green Line and construction has commenced under financing by the Federal Government. In 2014, project preparation technical assistance (PPTA) was provided by ADB[2] to help improve the urban transport system of Karachi, and to provide technical and financial support to implement a bus rapid transit (BRT) corridor, including feasibility study for the Red Line, and to strengthen institutions and organizations managing the urban transport sector. A Project Design Advance (PDA) was agreed between ADB and the Government of Sindh in September 2016.

66. An association of firms made up of Mott MacDonald Ltd (Arnhem, the Netherlands) with MM Pakistan was recruited to provide consultancy services for detailed design under the EPCM component, which is a time-bound and objective-oriented undertaking for the first phase of the Red Line bus rapid transit facility. The consultancy services for the KBRT Project are expected to run for 1.5 years; a Construction Supervision Consultant (CSC) will be retained after award of the construction contract for supervision of construction. MML assists the PIU in project development, including technical support for preparing the EIA. Still, the EIA is a document of the PIU, which is familiar with its preparation, contents and recommendations.

67. The purpose of the EIA is to establish a framework and related actions for evaluating and mitigating environmental and social impacts stemming from implementation of the Project. Mitigation involves avoiding and minimizing adverse impacts on the environment and affected people, when possible; and compensating affected people when avoidance is not possible. The EIA also serves the purpose of disclosure by documenting public consultation on the Project's environmental and social impacts, and by summarizing the rationale for appropriate levels of mitigation. Other requirements of ADB's disclosure policy aim to be met through the EIA process documented herein[3]. As part of the Government's disclosure process, the EIA is made available at its website for review and comment prior to public consultation.

1.2 Project Environmental and Social Objectives

68. The Project aims to alleviate in part the lack of transport options available in a rapidly growing metropolis, and was identified as such in the original Karachi Transportation Improvement Project report (2012): "the recent economic growth in Karachi is significant with rapid population increase

[1] This project called for development of a Transportation Masterplan for the City, for development of high capacity city bus routes and a Bus Rapid Transport system, including specific assistance to the Director of Mass Transit in assessing the feasibility, operational approach and optimal route pattern for a network of routes for a high capacity city bus network. Certain routes were identified, including the alignment for the Red Line (NKYO 2012).

[2] ADB approved a project concept paper and project preparatory technical assistance on 6 December 2013. The first phase of project preparation (selection and conceptual design of the BRT corridor) was completed in April 2015. (ADB 2016)

[3] Among these is the timely preparation of the EIA to facilitate posting of the EIA on the ADB website for 120 days prior to Board consideration.

and active land development in suburban areas, and the city has expanded vertically and horizontally very rapidly. Those changes have caused motor-vehicle traffic increase and resulted in heavy traffic congestion due to lack of mass transit system."

69. In that study, the Project was seen as one aspect of an urban transport development strategy that combines mass rapid transit, but with heavy reliance on bus rapid transit (BRT), due to its lower costs and ease of implementation facilitated by use of existing rights-of-way. While some rail-based systems also were emphasized (mainly refurbishment of the Karachi Circular Railway), the strategy aimed to bring about most of its improvement through provision of BRT along five major routes in the City. These components once realized collectively add to the nation's store of physical infrastructure and human resources.

70. The BRT now is in the process of being realized through a combination of institutional means and capital investment. Through government initiative, coordinating bodies have been formed to integrate transport projects, and new organizations created to execute and operate them. The financial means for capital intensive projects are made possible through direct government financing and international lending. The projects themselves are equitable in that they benefit virtually all socioeconomic groups, as identified by age, sex, income and occupation. In contrast, there are few if any groups that stand to be marginalized as a result of the project components of Karachi's urban transport strategy.

71. The Project's environmental objectives are both local and global. They include reduction in congestion along roadways and lessened air pollution exposure for roadway users and people living and working along roadways. At national and global levels, the Project is expected to reduce consumption of fossil fuels leading to a reduction in the nation's greenhouse gas (GHG) inventory in comparison with a future case without the Project. This issue is taken up in the EIA. The ADB sets out the environmental and social objective of the Project to "develop a sustainable urban transport system in Karachi, Islamic Republic of Pakistan, through the delivery of an integrated bus rapid transit (BRT) corridor." BRT in general has the potential to make a significant contribution to accessible, equitable and environmentally sound public transport. BRT has evolved over 40 years to make generational changes in approach that increase usability, profitability and sustainability. Both successes and failures in BRT systems and approach are proven, meaning that the reasons for success and for failure are understood, and what is needed in terms of transport planning and design for a successful system is increasingly well known. The KBRT Project and the Red Line are aimed to emulate the elements of a successful system to the extent practicable in the current context[4]. Hence a high level of achievement of environmental and social norms is expected from the Red Line and from the overall KBRT Project of which it is a part.

72. These are perhaps best typified by the BRT Gold Standard, aspects of which are incorporated into the present project and replicated on future lines. Perhaps most critical for profitability and ridership is the direct service system concept, which provides off-corridor services, minimizes transfers and travel times, avoids construction of terminals and interchanges (hence reducing capital cost), provides vehicles that are able to operate both on and off the busway corridor (thus allowing busways only to be built where actually needed) and maximizes the number of time- and cost-saving express and semi-express services.

73. Up-to-date system design aims to integrate the bus lanes into the environment in terms of traffic flow and drainage. Various means can be used to accomplish these goals that are incorporated

[4] Practicability is important due to physical constraints, such as right-of-way congestion and availability of high quality fuels.

into the present design to the extent practicable. And access and equity are important aspects of modern public transport systems. The system aims to provide safe crossing for access to stations, non-motorized transport (NMT) infrastructure (foot and cycling paths), 'facade-to-façade' development, and to improve accessibility for the physically disabled and elderly, and for children and women, for whom special provisions are made, in keeping with Pakistani mores.

74. In terms of the present initiative, system integration is an explicit goal targeted through all available means by the Government of Sindh and ADB, characterized by particular targets to include interoperability of the various BRT lines, a common industry transition plan, fare policy and system architecture in both physical and IT aspects.

75. The environmental impact of the Project, once it is in operation, is expected to be positive, as is documented in the present report. Air pollution and noise along the BRT corridor will be less in comparison to the case without the Project, due in part to a reduction in traffic congestion. Greenhouse gas emissions will also be less than would be the case of business as usual, without the Project. These environmental issues are analyzed in the present report. The socioeconomic environment is enhanced by addition of a significant element of 'transport capital' as part of the overall household capital of the average citizen. Not only is transport enhanced, but the environment of the street and byways will be improved, along with NMT access and services.

1.3 Zone of Influence

76. The Project is located along an alignment generally oriented northeast-southwest, which turns south in its eastern-most portion, as shown in Figure 1-1. The overall length of the alignment is 23+ km, running mostly along University Road in the administrative districts of Central and East Karachi and Malir Cantonment, specifically: East District: Jamshed Town and Gulshan Towns, and District Central: Liaquatabad and Gulberg Towns. Some aspects of the alignment have recently been finalized, including routing at both ends and a portion between Safoora Chowrangi and Malir Link Rd. and Jinnah Avenue, as shown in the Figure 1-1

77. The west end of the alignment is considered the starting point, though Stations are numbered from east to west. Because alternatives are not yet set (see Chapter 4), stationing is tentative. There are two depot sites located at strategic points along the alignment, e.g.one at its easternmost extent at the conjunction with Sharah-e-Faisal Ave, and the other near the proposed Shumail Complex Bus Station (shown also on the figure). Environmental impacts are restricted to a corridor of approximately 50 m on each side of the alignment along the Project's length and in the vicinity of the proposed depot. This zone of influence is defined in terms of environmental factors such as traffic congestion, noise and air pollution during construction as well as some aspects of operations. Cumulative and indirect impacts and benefits resulting from operation of the Project will affect land use, economic development and physical aspects of the urban environment across a broader area. Changes in traffic flow can be expected both during construction and operations, intensifying along the main roadways near the alignment.

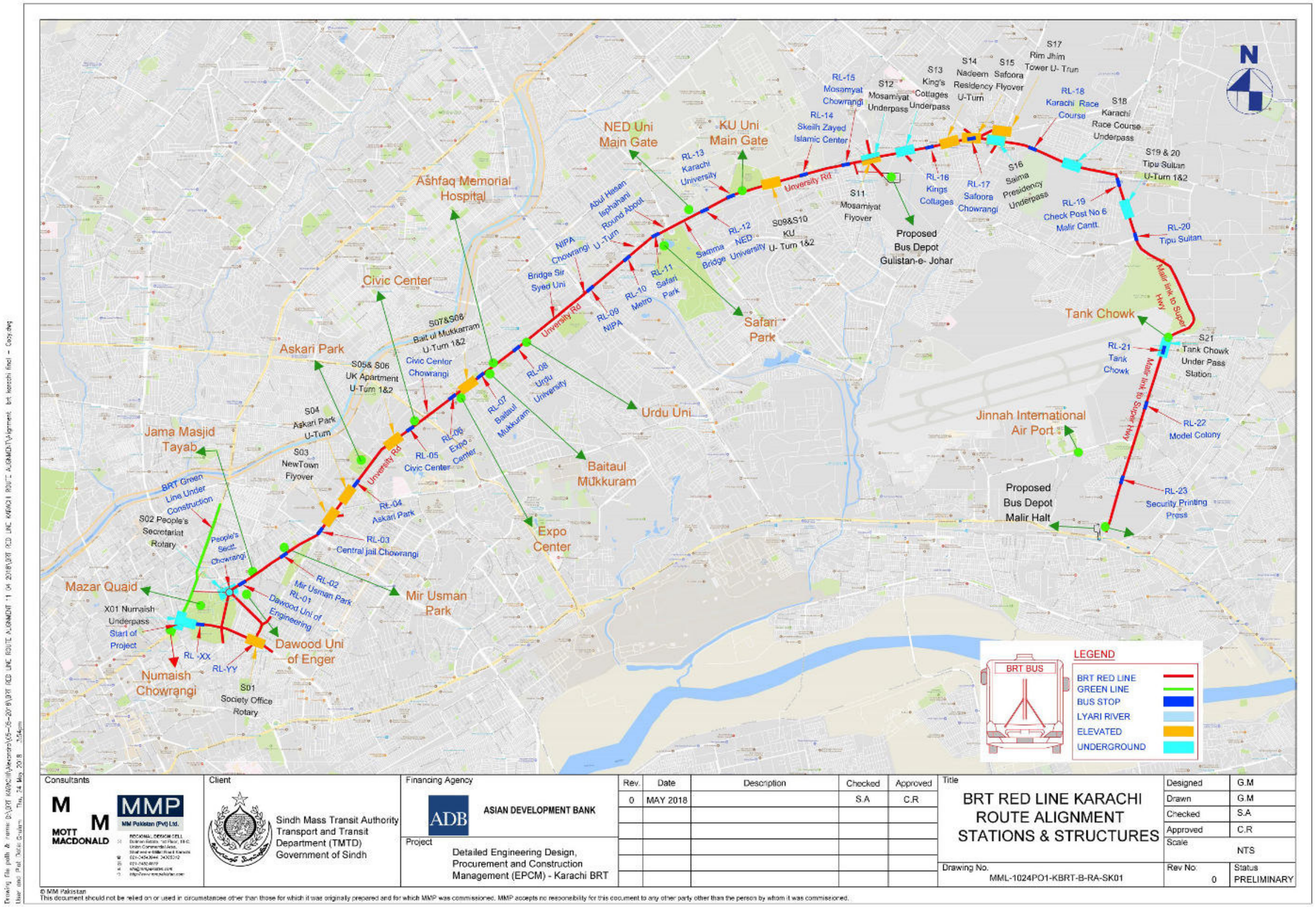

Figure 1-1: KBRT Alignment showing Options as of April 2018

1.4 Financing and Implementation of the Project

78. The project is estimated to cost $220 million. A project design advance (PDA) was provided and the ensuing project loan are listed in the ADB's country operations business plan, 2016–2018 for Pakistan, with an indicative financing of $10 million for the PDA and $100 million for the project loan. The PDA provides advance financing for four consulting services packages: 1) engineering, procurement and construction management (EPCM)[5]. 2) operational design and business model (ODBM), which addresses specification of technical standards and functional requirements including the conceptual design for the Red Line, business and operations plans, branding, and a bus industry restructuring program; 3) project management, coordination, and capacity building (PMCCB), responsible for scheduling and cost control, capacity building, communications, community awareness and participation, and legal and commercial aspects; and 4) individual recruitment of staff consultants to assist the Government of Sindh (GOS) Transport and Mass Transit Department (TMTD) through its Project Implementation Unit (PIU) in managing the Project. The overall contract value (excluding taxes) for these consulting services is estimated at $9 million, whereas the total cost of project preparatory activities under the PDA is estimated at $11.98 million. The government has requested a loan of $9.7 million to help finance the PDA project. Once implemented, the work prepared under the PDA agreement paves the way for ADB Board approval of the loan, expected in Sept 2018, and commencement of construction once the loan becomes effective in November 2018.

79. The borrower is Government of Pakistan, which has entered into a subsidiary loan agreement for the PDA with the Provincial Government of Sindh. The executing agency is the Planning and Development Department (PDD), and the implementing agency is the Government of Sindh's Transport and Mass Transit Department (TMTD)[6], eventually to be replaced by the Sindh Mass Transit Authority (SMTA).

80. A project organization chart (Figure 1-2) shows the relationship of government and ADB and technical support, including technical assistance outside the EPCM contract for legal, planning, fare rates and other matters. Institutional development for TMTD and other preparatory matters as described above are also administered by TMTD under separate contracts.

1.5 Organization of the Report

81. Chapter 2 of the report, Policy, Legal and Administrative Framework sets out the relevant laws, regulations and permits for the State Government of Sindh (GOS) and more specifically for the Sindh Environmental Protection Agency (SEPA). It provides key elements of underlying policy for both SEPA and ADB, as well as an overview of standards, regulations by other branches of government, and international commitments.

[5] Preparation of the EIA and other safeguard documents is done under this contract package.

[6] TMTD oversees the Project Implementation Unit (PIU) for the Project.

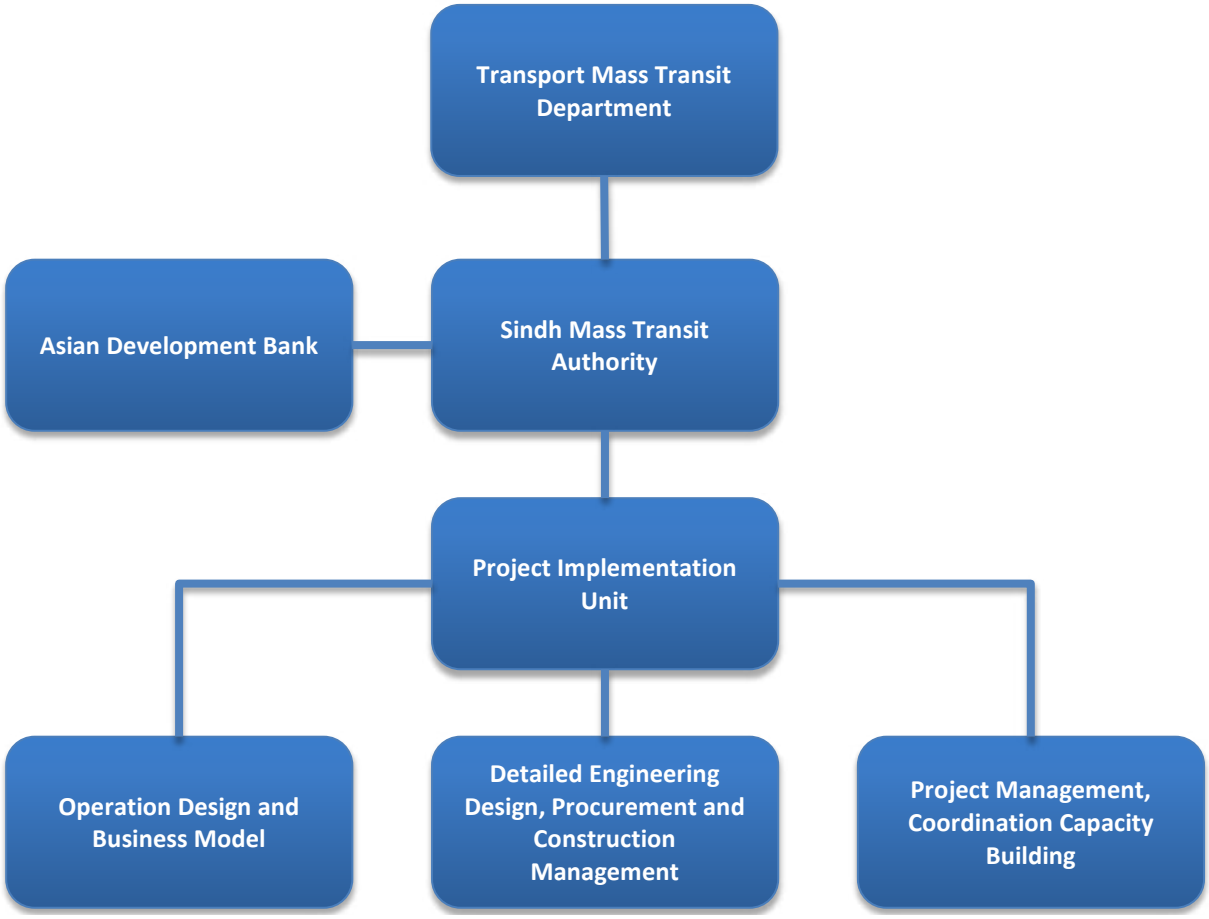

Figure 1-2: Project Organization

82. Chapter 3 describes the project in sufficient detail to highlight environmental aspects, while describing technical features. The Project contains an aggregate of state-of-the-art design know-how that is reflected in the description summary. Methods of construction and scheduling are addressed; construction environmental management will depend on readiness of contractors to implement the Environmental Management Plan (EMP).

83. Chapter 4 describes current alternatives discussed during the detailed design period, while reviewing the history of alignment selection. Other 'selection' issues are described that have environmental implications.

84. Chapter 5 provides a general overview of perspectives on the baseline environment that support impact analysis. The level of detail for information is determined by what is available from secondary sources and primary data obtained by sampling and analysis, and is oriented to the problem of impact.

85. Chapter 6 contains evaluations for a variety of potential impacts across more than 10 major headings. A brief methodology and applicable criteria are presented. Additional project information and background data are presented to support analyses. Mitigation measures are presented, and unmitigated effects are noted and explained. The approach is in general prescriptive, favoring practical means for mitigation rather than quantification of impact, which often is not possible. The chapter summarizes the status for assessing the Project's greenhouse gas (GHG) emission reduction potential, and has a brief section on cumulative impacts.

86. Chapter 7 describes the environmental management plan (EMP) for the Project: the organizational framework for environmental management; factors related to implementing mitigation measures, such as responsibility, conditionality, stage in project development, and source of mitigation in project documentation; a monitoring plan for implementation during the construction stage; capacity building; and cost aspects. Various appendices are related to the EMP and are referenced therein.

87. Chapter 8 covers public consultation, disclosure and the grievance mechanism. The history of public consultation for the Project is reviewed, and descriptions of public consultation held during detailed design are provided, along with a summary of comments. Future public consultation is suggested. The disclosure and grievance redress mechanisms are described.

88. Chapter 9 concludes the EIA by summarizing recommendations and providing a statement of compliance from the owner's point of view regarding certain critical aspects of international concern (use of irreplaceable resources, endangered species and other concerns explicitly described in the ADB Safeguard Policy Statement).

1.6 Data Sources

89. Data are taken from various sources, including EPCM consultant in-house planning and engineering outputs that are continuously updated during detailed design, documents produced under prior projects, web sources that generally tap the open-source international development literature, and secondary data from Government sources and from authenticated data sources, including the outputs of models. The latter includes FAO's local climate estimator and noise prediction methods from the US Federal Transport Administration (FTA). The approach for data collection is to source information where it is needed to present a clear picture of baseline conditions, project interventions and impacts. Government sources are numerous, and data were formally solicited from departmental offices. Secondary data and graphics taken from other reports are accompanied by a reference. Some information comes from the IEE prepared during the PPTA. Reports and other bound materials cited in the text (including e-copies) are listed in Appendix A along with web references where available. Preparers of the EIA gratefully acknowledge the support of the EPCM, ODPM and PMCCB teams in providing valuable information for the EIA.

1.7 Status of EIA and Further Additions

90. An IEE was performed for the Project during the project preparation stage (2014), but was not submitted to SEPA for preliminary review. The EIA is being prepared during the early part of the detailed design phase, before the concept design is available in full, based in part on the scoping that took place during the PPTA. The work takes place over a five-month time frame (11/17—03/18) during which design work is ongoing, and major engineering works are still being finalized. Many aspects of the design are not yet available, and data are provisional, meant to serve the purpose of impact analysis only. The EIA has been prepared before bidding commences for any of the main construction packages. The EIA has been submitted to ADB for comment and will be shared with SEPA once ADB provides a go ahead. Tenets of ADB's disclosure policy, scrutiny and public hearing clauses of the SEPA EIA rules will be strictly adhered too. Updates on detailed design aspects and quantities will be incorporated once available. A revision of the EIA will incorporate responses to comments from the public, SEPA, other Government Agencies, Committee of Experts and the ADB; a final, approved version is targeted for September 2018.

2. Policy, Legal and Administrative Framework

2.1 Requirement for EIA

91. The EIA is prepared under the authority of the Government of Sindh Environmental Protection Act and Regulation (see below) and ADB's Safeguard Policy Statement (2009). It is mandatory to inform the public through a notice where the environmental reports may be accessed along with date, time and location of public hearing for comments on the project

2.1.1 National and Provincial Legislation

92. The Pakistan Environmental Protection Act (PEPA 1997) and the Pakistan Review of Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) Regulations (2000) provide the policy basis for environmental assessment at the national level. The latter were developed further through a technical assistance under the National Impact Assessment Programme (15th November 2009 – 15th May 2014), which gave rise to draft guidelines[7] that were subsequently promulgated following minor modification by the Sindh State Government: the Sindh Environmental Protection Act 2014 and the Sindh Environmental Protection Agency (Review of Initial Environmental Examination and Environmental Impact Assessment) Regulations (NO. EPA/TECH/ 739/2014). The Regulations specify (Article 4) that "a proponent of a project falling in any category listed in Schedule-II shall file an EIA with the Agency, and the provisions of section 17 [of the Sindh Environmental Protection Act 2014] shall apply to such projects." Schedule II includes "Federal or Provincial highways or major roads (including rehabilitation or rebuilding or reconstruction of existing roads)", hence the need for EIA for the KBRT Project.

93. Major national environmental legislation which have direct relevance to the Project are the Pakistan Environmental Protection Act (1997; PEPA) and the Pakistan Review of Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) Regulations (2000).

94. PEPA is the basic legislative tool empowering the Government of Pakistan to frame regulations for the protection of the environment and the promotion of sustainable development. It applies to a wide range of issues and extends to air, water, soil, noise pollution and to the handling of hazardous wastes.

2.1.2 Guidelines for Sensitive and Critical Areas (1997)

95. The Guidelines for Sensitive and Critical Areas, 1997, identify officially notified protected areas in Pakistan, including critical ecosystems, archaeological sites, etc. Environmentally sensitive areas include, among others, archaeological sites, biosphere reserves and natural parks, and wildlife sanctuaries and preserves

2.2 Asian Development Bank

96. According to the ADB's Safeguard Policy Statement (2009), ADB uses a classification system to reflect the significance of a project's potential environmental impacts. A project's category is determined by the category of its most environmentally sensitive component, including direct,

[7] Initial Environmental Examination and Environmental Impact Assessment Rules 2014 (Draft), prepared with assistance from IUCN and other partners under funding from the Embassy of the Kingdom of Netherlands.

indirect, cumulative, and induced impacts in the project's area of influence. Each proposed project is scrutinized as to its type, location, scale, and sensitivity and the magnitude of its potential environmental impacts. Projects are assigned to one of four categories. A proposed project is classified as category A for which an environmental impact assessment is required if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. A project is classified as category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An initial environmental examination is required. A project is classified as category C if it is likely to have minimal or no adverse environmental impacts. A project is categorized as FI if it involves investment of ADB funds to or through a FI (Financial Intermediary).

97. The KBRT Red Line Project was classified as Category B under the PPTA[8], which was later confirmed by ADB in the Project Design Advance document (ADB 2014). During preparation of the detailed design the project category was reconsidered and the categorization for the project established as Category A for environment, in line with requirements of the Sindh Environmental Protection Agency (SEPA).

98. Re-categorization under ADB rules took place because, while the impacts will be reversible, they are found to be diverse in nature, thus requiring preparation of an EIA study.

99. A preparatory stage EIA was not prepared during the PPTA; instead the PPTA consultant performed an initial environment examination (IEE), which serves as the scoping document for the present EIA. The EIA may be considered an update of the IEE, performed at a more stringent level of assessment. It is intended to serve the purpose of both ADB and SEPA. The basic environmental assessment requirements for Category A projects are provided in Table 2-1 below. Requirements for early-stage public consultation (PC) are met through PC conducted during the PPTA. Further public consultation including stakeholder meetings and a public hearing are being conducted as part of the approval process for the current EIA. The report meets all applicable local requirements in keeping with the Government of Sindh EIA approval process.

Table 2-1: ADB Environmental Assessment Requirements for Category 'A' projects

Aspect	Environmental Assessment & Management Requirements
Project processing	
Reporting	▪ Prepare full-scale environmental impact assessment (EIA)
Public consultations	▪ Conduct consultations at the early stage of EIA field work and when the draft EIA report is available during project preparation, and before project appraisal by ADB.
Disclosure of environmental assessment report	▪ Disclose draft environmental impact assessment reports at least 120 days before Board consideration.
Project implementation	
Reporting	▪ Submit semiannual reports during project construction, and annual reports during project operation to ADB for disclosure.

[8] See Sec. 4 of the Karachi BRT Project PPTA Final Report: "Categorization – we have deemed the project Category B, based on local knowledge of Karachi, typical impacts for BRT projects and the likely scale of impact."

2.3 Policy Framework

100. The previously cited SEPA Regulations (2014) are consistent with this approach and set out a framework for conducting the EIA and for government/public review, including preparation, payment of fees, filing with accompanying documents, preliminary scrutiny not to exceed 15 days. Public hearing vide a notice in prominent newspaper in English, Urdu and Sindhi with a minimum notice period of fifteen days after publication, informing date, place and time of the public hearing. A four-month period follows providing time for agency review and public comment, and review before a Committee of Experts, and in due time a decision of the Agency communicated to the proponent, accompanied by conditions. The approval allows for commencement of construction and is valid for a period of three years from the date of issue. The procedure is illustrated in Figure 2-1.

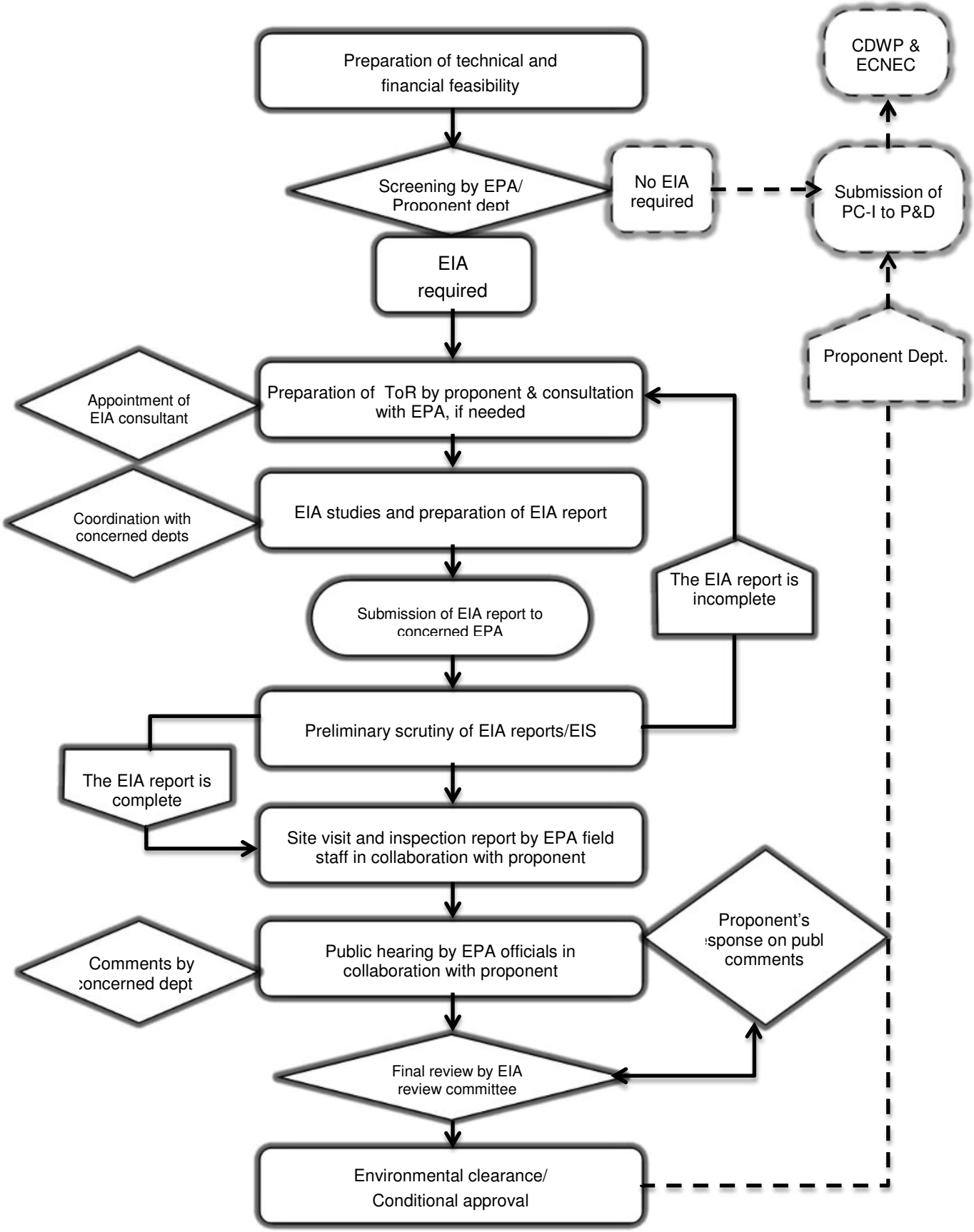

Figure 2-1: EIA Review and Approval Process of Pakistan EPAs

101. The Regulations also specify that reports related to monitoring be submitted to the agency upon completion of the construction and annually thereafter to summarize operational performance of the project.

102. ADB sets out the contents of EIA and critical issues that are important in a regional and holistic context and for affected groups, which are dominant in three key safeguard areas: (i) environmental safeguards, (ii) involuntary resettlement safeguards, and (iii) indigenous peoples safeguards. These are listed in Table 2-2. The present document focuses on environmental safeguards and complies with the requirements of ADB with respect to EIA.

Table 2-2: ADB Policy Principles

	Policy principle	Summary
1	Screening and categorization	Screening process initiated early to determine the appropriate extent and type of environmental assessment.
2	Environmental assessment	Conduct an environmental assessment to identify potential impacts and risks in the context of the project's area of influence.
3	Alternatives	Examine alternatives to the project's location, design, technology, and components and their potential environmental and social impacts, including no project alternative.
4	Impact mitigation	Avoid, and where avoidance is not possible, minimize, mitigate, and/or offset adverse impacts and enhance positive impacts. Prepare an environmental management plan (EMP).
5	Public consultations	Carry out meaningful consultation with affected people and facilitate their informed participation. Involve stakeholders early in the project preparation process and ensure that their views and concerns are made known to and understood by decision makers and taken into account. Continue consultations with stakeholders throughout project implementation. Establish a grievance redress mechanism.
6	Disclosure of environmental assessment	Disclose a draft environmental assessment in a timely manner, in an accessible place and in a form and language(s) understandable to stakeholders. Disclose the final environmental assessment to stakeholders.
7	Environmental management plan	Implement the EMP and monitor its effectiveness. Document monitoring results, and disclose monitoring reports.
8	Biodiversity	Do not implement project activities in areas of critical habitats.
9	Pollution prevention	Apply pollution prevention and control technologies and practices consistent with international good practices. Adopt cleaner production processes and good energy efficiency practices. Avoid pollution, or, when avoidance is not possible, minimize or control the intensity or load of pollutant emissions and discharges. Avoid the use of hazardous materials subject to international bans or phase outs.
10	Occupational health and safety Community safety.	Provide workers with safe and healthy working conditions and prevent accidents, injuries, and disease. Establish preventive and emergency preparedness and response measures to avoid, and where avoidance is not possible, to minimize, adverse impacts and risks to the health and safety of local communities
11	Physical cultural resources	Conserve physical cultural resources and avoid destroying or damaging them. Provide for the use of "chance find" procedures.

103. ADB's safeguard requirements related to the environment are set out in Appendix A of the ADB's Safeguard Policy Statement (2009). This appendix outlines the requirements that borrowers/clients are required to meet when delivering environmental safeguards for projects supported by the ADB. It discusses the objectives and scope of application, and underscores the requirements for undertaking the environmental assessment process. These requirements include assessing impacts, planning and managing impact mitigations, preparing environmental assessment reports, disclosing information and undertaking consultation, establishing a grievance mechanism, and monitoring and reporting. The document also includes particular environmental safeguard requirements pertaining to biodiversity conservation and sustainable management of natural resources, pollution prevention and abatement, occupational and community health and safety, and conservation of physical cultural resources. The applicability of particular requirements is established through the environmental assessment process and

compliance with the requirements is achieved through implementation of environmental management plans agreed to by ADB and the borrower/client. (ADB 2009)

104. The objectives of these policy requirements, as stated by the ADB, are to "ensure the environmental soundness and sustainability of projects, and to support the integration of environmental considerations into the project decision-making process." The requirements apply to all ADB-financed and/or ADB-administered sovereign and non-sovereign projects.

105. The requirements include that for the conduct of EIA, specifically, "the borrower/client will identify potential direct, indirect, cumulative and induced environmental impacts on and risks to physical, biological, socioeconomic, and physical cultural resources and determine their significance and scope, in consultation with stakeholders, including affected people and concerned NGOs."

106. Particular aspects of EIA preparation, as set out in the SPS, require that the "borrower/client . . . examine alternatives to the project's location, design, technology, and components that would avoid, and, if avoidance is not possible, minimize adverse environmental impacts and risks. The rationale for selecting the particular project location, design, technology, and components will be properly documented, including, cost-benefit analysis, taking environmental costs and benefits of the various alternatives considered into account. The "no project" alternative will be also considered." Finally, "the project's potential environmental impacts and risks will be reviewed against the requirements presented in [the SPS] and applicable laws and regulations of the jurisdictions in which the project operates that pertain to environmental matters, including host country obligations under international law."

107. It should also be noted that the SPS requires that "when the project involves existing activities or facilities, relevant external experts will perform environmental audits to determine the existence of any areas where the project may cause or is causing environmental risks or impacts."

2.4 GOS and ADB Resettlement Policy

108. National Resettlement Policy (2002) and Interim Resettlement Framework Guidelines (2010) were developed to ensure equitable and uniform treatment of resettlement issues across Pakistan. These apply to all development projects causing adverse social impacts, land acquisition, loss of assets, income and businesses. The 2010 Guidelines set out the institutional, legal, and implementation framework to guide the resettlement and rehabilitation of project affected people (PAPs) that are adversely affected.

109. Government of Sindh resettlement and compensation policy guiding the allocation of entitlements provides for full replacement cost as compensation, i.e. the Project will replace in kind or cash what is lost in terms of land, structures, livelihood, community facilities and services, with special provisions for the improvement of livelihoods of vulnerable displaced persons and sharing of project benefits.

110. Pakistan's policy is consistent with the ADB's Safeguard Policy Statement as it applies in the context of the KBRT. Furthermore, there is no involuntary land acquisition required for implementation of the Project, though land may be purchased for siting of the depot, staging areas and parking facilities. Additional information on the articulation of GOP and ADB resettlement policy for KBRT can be found in the Resettlement Plan for the Project. Brief comparison of ADB SPS 2009 with LAA 1894 is mentioned in table below

Table 2-3: Comparison of ADB SPS 2009 with LAA 1894

Pakistan's LAA 1894	ADB Safeguard Policy Statement (2009)
LAA 1894: Only titled landowners or customary rights holders are recognized for compensation.	Lack of title should not be a bar to compensation. Requires equal treatment of those without clear land titles (e.g., squatters or other informal settlers) in terms of their entitlements for resettlement assistance and compensation for the loss of non-land assets.
Only titled landowners or customary rights holders are recognized for compensation.	Lack of title should not be a bar to compensation. Requires equal treatment of those without clear land titles (e.g., squatters or other informal settlers) in terms of their entitlements for resettlement assistance and compensation for the loss of non-land assets.
Only registered landowners, sharecroppers and leaseholders are eligible for compensation of crop losses.	Crop compensation is to be provided irrespective of the land registration status of the affected farmers/share croppers. Crops for two seasons Rabi (winter) and Kharif (summer) for full one year are to be compensated based on existing market rates and average farm produce per unit area.
Tree losses are compensated based on outdated officially fixed rates by the relevant forest and agriculture departments.	Tree losses are to be compensated according to market rates based on productive age or wood volume, depending on tree type. All the removed trees will remain the property of the owner for them to salvage
Land valuation is based on the median registered land transfer rate over the 3 years prior to Section 4 of the LAA.15% compulsory acquisition charges are paid over and above the assessed compensation. However, recent practice is that prices based on the average over the last one year prior to acquisition commencing is applied.	Land valuation is to be based on current replacement (market) value with an additional payment of 15%. The valuation for the acquired housing land and other assets is the full replacement costs keeping in view the fair market values, transaction costs and other applicable payments that may be required
The valuation of structures is based on official rates, with depreciation deducted from gross value of the structure and also 15% of the value of salvaged materials,	The valuation of built-up structures is based on current market value but with consideration of the cost of new construction of the structure, with no deduction for depreciation. The DPs can salvage any of their material free of cost and irrespective of compensation payments having been paid.
The decisions regarding land acquisition and the amounts of compensation to be paid are published in the official Gazette and notified in accessible places so that the people affected are well informed.	Information related to the quantification and valuation of land,structures, other immovable assets, entitlements and amounts of compensationand financial assistance are to be disclosed to the displaced persons prior to project appraisal period. This is to ensure that stakeholders are treated in a fair, transparent and efficient manner.
No provision for income and livelihood restoration rehabilitation measures. There are also no special allowances for vulnerable displaced persons including vulnerable groups such as women headed households. There are no requirements to assess opportunities for benefit sharing.	The ADB policy requires rehabilitation for lost income and any expenses by the DP during the relocation process. There are also provisions to be made for transitional period costs, and livelihood restoration. Particular attention must be paid to the poor and vulnerable groups, including women. A guiding principle is that DPs should at least be able to reach a defined minimum livelihood standard. In rural areas, DPs should be provided with legal access to replacement land and resources to the defined minimum livelihood level. In urban areas, provision should be made for appropriate income sources and the legal and affordable access to adequate housing.
Prepare and disclose land acquisition and resettlement plans (LARPs) - there is no law or policy that requires preparation of LARPs.	LARPs are prepared in English and disclosed to the displaced peoples in local language.
Grievance redress is established through the formal land acquisition process at a point in time or through appeals to the court	Provide a continuous mechanisms/ set-up that are accessible locally and available throughout project implementation
Only compensation is paid but not resettlement allowances, there is no mechanism to ensure payment is made before displacement.	All compensation and allowances to be paid prior to physical or economic dislocation.
No requirements to prepare and disclose monitoring reports.	Prepare and disclose monitoring reports.

2.5 Measures to Address the Gaps

111. The measures to address the gaps between the LAA 1894 and ADB's SPS 2009 are as follows:

i. the need to screen the project early on in the planning stage

ii. carry out meaningful consultations

iii. at the minimum restore livelihood levels to what they were before the project, improve the livelihoods of affected vulnerable groups

iv. prompt compensation at full replacement cost is to be paid

v. provide affected people with adequate assistance

vi. ensure that affected people who have no statutory rights to the land that they are working and eligible for resettlement assistance and compensation for the loss of non-land assets; and

vii. Disclose all reports.

2.6 National and Sindh Environmental Quality Standards

112. National environmental standards were first established in 1993 (SRO 742/I/93) governing effluents from new and existing industrial units and municipal sources, and industrial gases, which were amended in 1995 and 2000. NEQS for ambient air, drinking water and noise were issued in 2010 under three SROs (1062(I)/2010, 1063(I)/2010 and 1064(I)/2010). In summary, the Sindh Environmental Quality Standards (SEQS), 2014, specify the following standards:

- Maximum allowable concentration of pollutants (32 parameters) in municipal and liquid industrial effluents discharged to inland waters, sewage treatment facilities, and the sea (three separate sets of numbers);
- Maximum allowable concentration of pollutants (16 parameters) in gaseous emissions from industrial sources;
- Maximum allowable concentration of pollutants (two parameters) in gaseous emissions from vehicle exhaust and noise emission from vehicles;
- Maximum allowable noise levels from vehicles.

113. Similar standards have been promulgated by Sindh Province in 2014 following the devolution of authority to state governments as the Sindh Environmental Industrial Wastewater, Effluent, Domestic Sewage, Industrial Air Emission and Ambient Airs, Noise for Vehicles, Air Emissions for Vehicles and Drinking Water Quality Standards, 2015 (EPA/TECH/739/2014). These standards, referred to as the Sindh Environmental Quality Standards (SEQS), apply to both discharge and ambient pollutant concentrations: gaseous emissions and liquid effluents discharged by batching plants and construction machinery, and ambient air quality and ambient noise. The standards for motor vehicle exhaust and noise apply during the construction as well as operation phase of the project will need to be accounted for regarding construction equipment/vehicles and buses purchased for the KBRT Project. There may be other applications of the SEQS in regard to KBRT. Specific standards relevant to the KBRT are discussed within the context of environmental analysis in the EIA report.

2.7 National and Sindh Government Labor Laws and Regulations

114. Sindh Factories Act 2014, deals with provision for general health and safety of the work force in their work area. Conditions are specified for clean work place, toilets, waste handling, provision of drinking water quality, worker health and hygiene etc.

115. Also of note is the recent passage of the Sindh Occupational Safety and Health Bill (2017) that regulates many of the same issues. These laws and regulations apply in any project situation where labor rights and protections are enforced. These laws are applicable to construction contractors and will be included in the bidding documents of the contractors. Some of the key laws and regulations are mentioned in Table 2-4

Table 2-4: National and Sindh Government Labor Laws and Regulations

National and provisional legislation	Brief description
Sindh Factories Act 2015	The Sindh Factories Act 2015 deals with regulations related to project area, workers and workplace Environment Health and Safety (EH & S) requirements. The Factories Act also provides regulations for handling and disposal of toxic and hazardous materials. As construction activity is classified as 'industry', these regulations will be applicable to the project & construction contractors' scope of work also.
The Protection against Harassment of women at the work place Act 2010	It shall be the responsibility of the employer to ensure implementation of this Act, including but not limited to incorporate the Code of Conduct for protection against harassment at the workplace as a part of their management policy and to form Inquiry Committee referred to in section 3 and designate a competent authority referred to in section 4 of this act.
Employment of Child Act 991	Article 11(3) of the Constitution of Pakistan prohibits employment of children below the age of 14 years in any factory, mines or any other hazardous employment. In accordance with this Article, the Employment of Child Act (ECA) 1991 disallows the child labour in the country. The ECA defines a child to mean a person who has not completed his/her fourteenth year of age. The ECA states that no child shall be employed or permitted to work in any of the occupation set forth in the ECA (such as transport sector, railways, construction, and ports) or in any workshop wherein any of the processes defined in the Act is carried out. The contractor will be bound by this Act to disallow any child labour at the project sites or camp sites.
Bonded labor system (Abolition) Act 1992	On the commencement of this act, the bonded labor system shall stand abolished and every bonded labourer shall stand freed and discharged from any obligations to render any bonded labor.
Sindh Cultural Heritage Act 1994	This provincial Act empowers the Government of Sindh to preserve and protect any premises or objects of archaeological, architectural, historical, cultural, or national interest in Sindh by declaring them protected.
Antiquity act 1975	The Antiquities Act relates to the protection, preservation and conservation of archaeological/historical sites and monuments.
The Sindh Minimum Wages Act, 2015	To provide for the regulation of minimum rates of wages and various allowances for different categories of workers employed in certain industrial and commercial undertakings and establishments.
Workmen's compensation 1923	The liability of an employer is confined to payment of compensation to a "workman" and then only in respect of an injury caused by "accident arising out of and in the

	course of his employment". The liability of employer is limited by ceiling fixed in Schedule to the Act.
Land Acquisition Act, 1894	This Legislation relates to land acquisition and compensation. The LAA 1894 is, however, is limited to a cash compensation policy for the acquisition of land and built-up property and damage to other owned assets, such as crops, trees and infrastructure. The LAA does not consider the rehabilitation and resettlement of disrupted populations and the restoration of their livelihoods.
Telegraph Act 1885:	The Telegraph act (TA) provides that land for tower construction or under a transmission, line is not to be acquired or compensated as long as the land's permanent productive potential is not affected. Under the TA therefore only temporary impacts on crops are compensated.
The Pollution Charge for Industries (calculation and Collection) Rules 2001	Related to methods for evaluation and collection of fee for not meeting environmental standards
The Sindh Forest Act 2012	The law requires review and revision to meet the challenges of management and empower the forest managers to carryout management interventions with full legal support. The new legal instrument should amply address the provision and requirements of UNFCCC, CBD and Convention on Combating Desertification. Legal aspects of carbon sequestration and carbon credit marketing should also be kept in view.

2.8 International treaties and conventions

116. Pakistan is party to a number of international treaties governing protection of wetlands, restricting trade in endangered species, protecting the ozone layer, protection of migratory bird species, maintenance of biological diversity, elimination of persistent organic pollutants, transboundary movement of hazardous wastes, international labor standards, and protocols and conventions related to climate change (UNFCC, Kyoto). The international treaties and conventions to which Pakistan is a party are listed in Table 2-5. With the exception of international labor standards and climate protocols, none is likely to have a direct repercussion on the conduct of the KBRT Project.

Table 2-5: International Treaties and Conventions

Name	Signing	Ratification	Main Theme
Ramsar Convention on Wetlands	1971	1976	Conservation and use of Wetlands through local and national action.
Convention on Migratory Species	1971	1987	Conservation of migratory species
Convention on International Trade in Endangered Species	1973	1976	Protection of endangered species of wild animals and plants
Convention on the Law of the Seas	1982	1997	Peaceful uses of the Seas and Oceans
Vienna Convention for the Protection of the Ozone Layer	1989	1992	Protection of ozone layer
Montreal Protocol on Substances that Deplete the Ozone Layer	1989	1992	Reducing emissions of substances that deplete the ozone layer.
Convention on Biological Diversity	1992	1994	Conservation of biological diversity
Basel Convention on the Control of Trans-Boundary Movement of Hazardous Waste	1992	1994	Controlling the transboundary movement of hazardous waste
United Nations Framework Convention on Climate Change	1992	1994	Stabilizatioin of greenhouse gas concentrations
United Nations Convention to Combat Desertification in those Countries	1994	1997	Combat desertification and mitigate the effects of drought

Name	Signing	Ratification	Main Theme
Experiencing Serious Drought and/or Desertification, Particularly in Africa			
Kyoto Protocol to the United Nations Framework Convention on Climate Change	1997	2005	Mitigation of climate change and carbon sequestration
Stockholm Convention on Persistent Organic Pollutants	2001	2008	Protection from persistent organic pollutants
Paris Agreement	2016	2016	Voluntary accords to mitigate climate change

2.9 Administrative Framework for Implementing the KBRT Project

117. The GOS is the provincial government of the Sindh Province and is based in Karachi. The Government of Sindh has a Transport and Mass Transit Department (TMTD) which operates the Sindh Mass Transit Authority (SMTA) and its Project Implementation Unit (PIU), which is responsible for implementation, through construction and into operations, of the BRT Red Line. SMTA supports integration of operations for the BRT Green, Yellow and Blue Lines through the project management, coordination, and capacity building (PMCCB) component of the project design advance (PDA). Financing under the PDA also provides advisors for both environmental and social aspects within the PIU.

118. The Sindh Mass Transport Authority (SMTA) has only recently received its mandate from the Sindh Government. It includes representing the GOS in all matters pertaining to Mass Transit, and integrating the functions of different bodies that have been responsible for different BRT lines into a common network.

119. The Sindh Environmental Protection Agency (SEPA) is designated as an autonomous agency under the Sindh Environmental Protection Act 2014, and is part of the Forest, Environment and Wildlife Department of the Government of Sindh for administrative purposes. SEPA is a regulatory agency with a number of key functions including enforcement of the Sindh Act 2014; implementation of environmental policies, environmental quality standards, and the environmental impact review procedure for the GOS; and other tasks related to environmental management of the government. The SEPA will review the present EIA and take public comment, then through a process of final review among a committee of experts provide its consent with conditions for the Project. Administrative framework is shown Figure 2-2

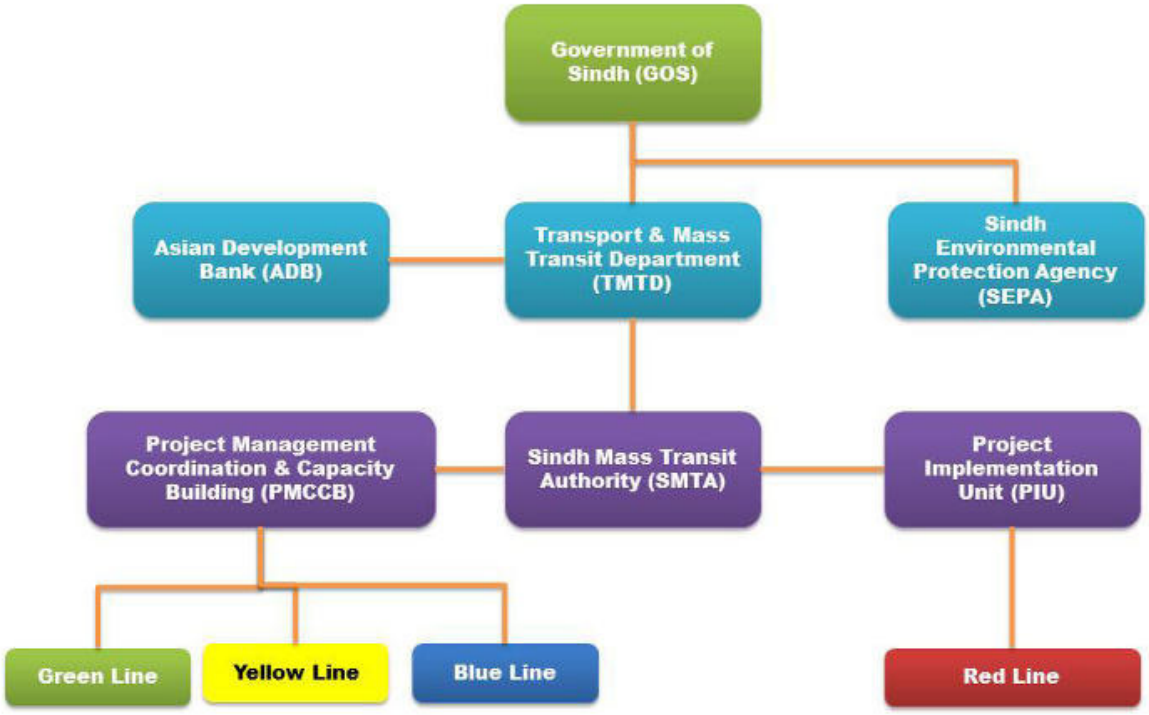

Figure 2-2: Administrative Framework

2.10 Summary of Approach for Environmental Management on KBRT

120. There are three phases: preconstruction, construction and operations. It is assumed the PIU, originally under the SMTC but now administered by the SMTA, is the implementing agency up through construction; whereas SMTA will administer operations of the system. Environmental protection measures during construction are required to be implemented by the Construction Contractor under the authority of the Government of Sindh's Transport and Mass Transit Department, which is the implementing agency for the Project.

121. The IEE prepared during the PPTA (ITP 2016c) set out an approach that is elaborated in the present document. This EIA proposes an Environmental Construction Specification (ECS), referencing the EMP (Chapter 7 of the EIA), which obligates the Contractor to prepare a Site-Specific Environmental Management Plan (SSEMP), incorporating those mitigation measures set out in the EMP that are relevant to construction of the project. The SSEMP will be submitted early in the pre-construction stage for review and approval to the Construction Supervision Consultant (CSC). See further discussion of the ECS and SSEMP in Chapter 7 of the present document. Contents of a typical SSEMP are provided in appendix M

3. Project Description

3.1 Project Background

123. Traffic planning has its origins in Karachi from late 1980s. The Karachi Mass Transit Study conducted by Maunsell-Parsons Brinckerhoff recommended an 87-km network of transit ways located in major traffic corridors for exclusive use of mass transit vehicles. These transit ways were to be designed as busways to be converted later to Light Rail Transit. Over time this proposal was translated into a mass transit master plan comprising of 6 priority corridors, which is now gaining some traction in implementation.

124. ADB lent its support through an endorsement under the Karachi Mega Cities Development Project (ADB 2005) in which "Development of High Capacity City Bus Routes and a Bus Rapid Transport System" was explicitly targeted as one of perhaps 20 "Potential Megacity Priority Projects for Funding through Loans/PPP", and feasibility study for projects related to "Mass Transit/Public Transport Advisory Assistance" was identified. Under this program it was confirmed that "Advisory Services to the Mass Transit Cell on Optimal System of Mass Public Transport" would be provided because "the condition of public transport systems in Karachi is deplorable and is continuing to deteriorate as new investment in public transport fails to keep pace with increasing demand." It is noted at that time that "the Federal Government has committed to support the introduction of clean and environmentally friendly public transport buses," initially as a purchase of CNG buses, "gradually replacing the dilapidated private bus fleet." Further, the proposal called for a review of the 1991 mass transit network proposal, development of a strategy and action plan to fund and implement priority elements, a feasibility study to determine optimum arrangements, and development of a strategy for implementation of both mass transit and bus rapid transit components.

125. The key features of Karachi's current transport master plan were put into place by the Karachi Transportation Improvement Project (KTIP), a JICA-financed initiative taking place from April 2010 – June 2011 (Master Plan Stage) and June 2011 – April 2012 (Feasibility Study Stage) (NKYO 2012). According to the KTIP final report, ADB in its mega-project study was the first to identify the Red Line alignment as a potential BRT location, following essentially the same route as is proposed under the present project. (KTIP Final Report, Chapter 6, p. 6-4) Bus rapid transit (BRT) was expected to play a major role in the system of mass transit proposed for Karachi due to its cost effectiveness and ease of implementation when compared to rail systems (though two commuter rail lines were also proposed). The JICA team conducted extensive household surveys to ascertain the characteristics of demand and locations of usage for mass transit. Six BRT routes were identified during the master planning, and two (Green and Red Lines) were selected for feasibility study. The six proposed lines are shown in Figure 3-1.

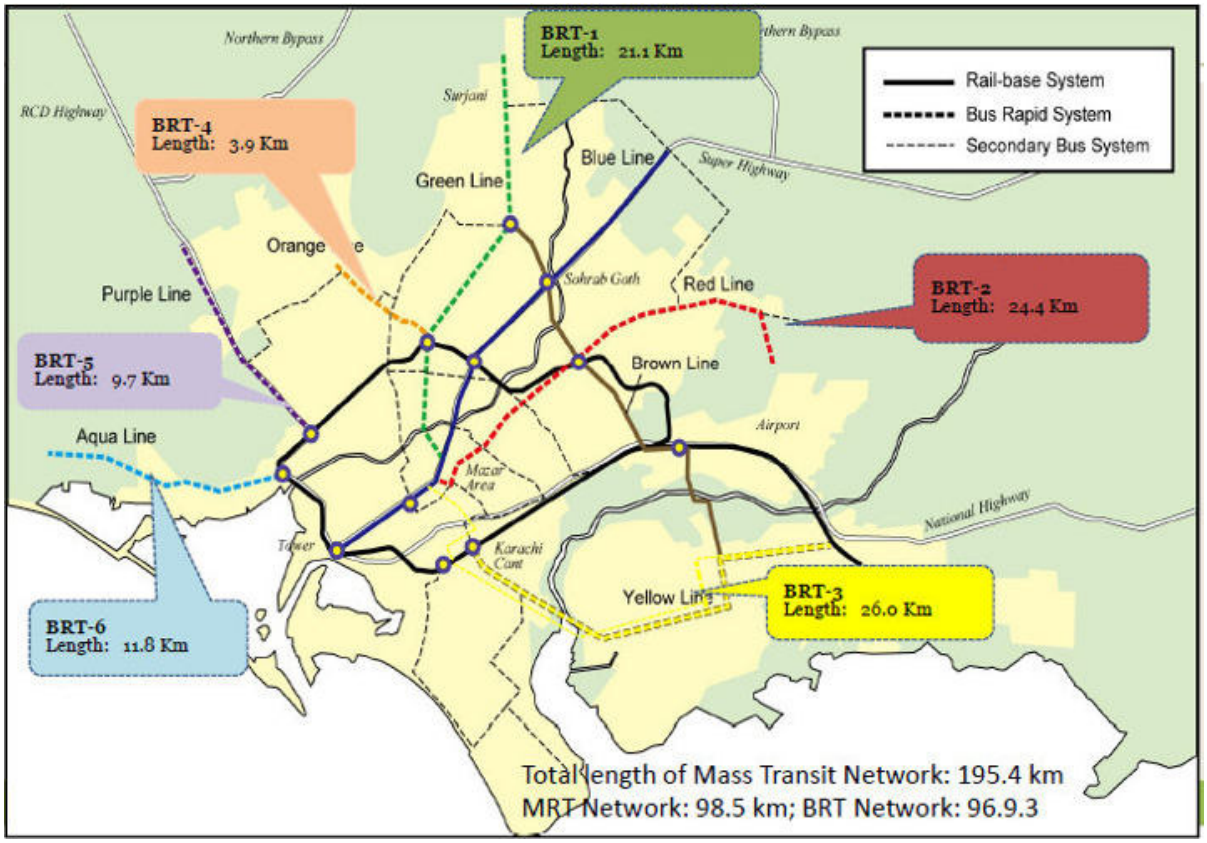

Figure 3-1: BRT lines proposed under KTIP

3.2 Project Rationale and Objectives

127. The project will contribute to developing a sustainable urban transport system in Karachi through the delivery of a bus rapid transit (BRT) corridor, focusing on accessibility and people's mobility. It will aim at organizing urban growth and public space along the selected corridor through integration of land-use and transport planning (transit-oriented development), making the city more pleasant to live in and providing a holistic solution for integrated urban mobility.

128. The project is consistent with the Government of Pakistan's Vision 2030 and Framework for Economic Growth (2011), and supports priorities set out in the Tenth 5-Year People's Plan 2010-15 for Karachi and in the Karachi Strategic Development Plan 2020. It is aligned with ADB's Sustainable Transport Initiative and country partnership strategy. It will contribute to make Karachi more liveable and safer through green urban infrastructure and will boost private sector investment. The project design will incorporate lessons learned from past assistance, notably the need for strong political support and consensus, and for good governance.

3.3 The BRT Corridor and Component Locations

129. The BRT corridor will have an approximately 23-km long corridor extending from Malir City in the northeast to Mazar-e Quaid Mausoleum and Jinnah Avenue in the southwest, where it will intersect with the BRT Green Line now under construction. The route passes through 13 major intersections and will provide stops at 24 bus stop locations along the route.

130. Details of each component as described in the ODBM concept plan (EE 2018)[9] are the following: (i) a segregated busway between Malir City/Malir Cantonment and MA Jinnah Road (approximately 23 km depending on the selection of the final alignment), (ii) 24 stations / bus stops along the BRT busway route, (iii) depots at two locations for the garaging of buses designated to operate as BRT services, (iv) an Intelligent Traffic System (ITS) to facilitate run times within the corridor and give citywide benefits of improved traffic flow, (v) traffic management measures to improve traffic flow outside of the corridor that are seen to complement the BRT and maximize its benefit, (vi) parking management measures that will similarly complement BRT and improve traffic flow, (vii) grade separation at intersections to insure a high level of service for BRT passengers, (viii) an open service plan that links BRT services between the Red and other BRT lines and among various off-network direct routes, and (ix) urban planning improvements consisting of enhanced integration of transport and land use, façade-to-façade development along the route, and non-motorized transport facilities.

3.4 Proposed BRT Operations

131. Operational aspects are decided by the Operations Design and Business Model (ODBM) consultant, whose work is ongoing up until March 2019; some aspects are described in the following sections.

132. As set out by the ODBM consultant (EE 2017a), operations will be initiated by the Public Transport Authority (PTA) by launch of contract tenders for BRT vehicle procurement and operations; a Fare System and ITS provider; a Commercial Activities provider; and a fund manager for the system. A further tender may be needed for traffic management services.

133. Fleet procurement is also described in the ODBM October 2017 interim report (EE 2017a—Appendix F) and most of the information contained herein regarding vehicles is taken from that document.

3.4.1 Vehicle Scrapping Plan

134. According to the ODBM Consultant (EE 2017a—Appendix F), Karachi's public transport sector has a very old fleet in which most vehicles will need to be scrapped upon the startup of a new BRT. The Scrapping Plan includes financial compensation to vehicle owners based on the type and age of buses to be scrapped. The Government will pay compensation on the basis of 100% of the current market value of the vehicle, with some opportunity built into the plan for current vehicle owners to join the Operator Company as shareholders. Ensuring the vehicles are scrapped is a key element of the plan, as improper return of vehicles to the system in competition with the BRT will reduce demand for the new system.

[9] Much of the information contained in this chapter is linked to the ODBM Consultant output. Alignment, equipment selection, location of over- and underpasses and other aspects of the proposal are contained in the ODBM concept plan and other outputs of the ODBM Consultant that are available only in part.

3.4.2 Recommendations for Vehicle Configuration

135. The proposal is for a body design that evokes a modern, tram-like appearance with sleek and aerodynamic curve lines, as shown in Figure 3-2. and Figure 3-3 for 12 m and 18 m bus, respectively. The Bus configuration will fit either a standard 12 m or articulated 18 m bus as shown in Table 3-1 and Table 3-2:

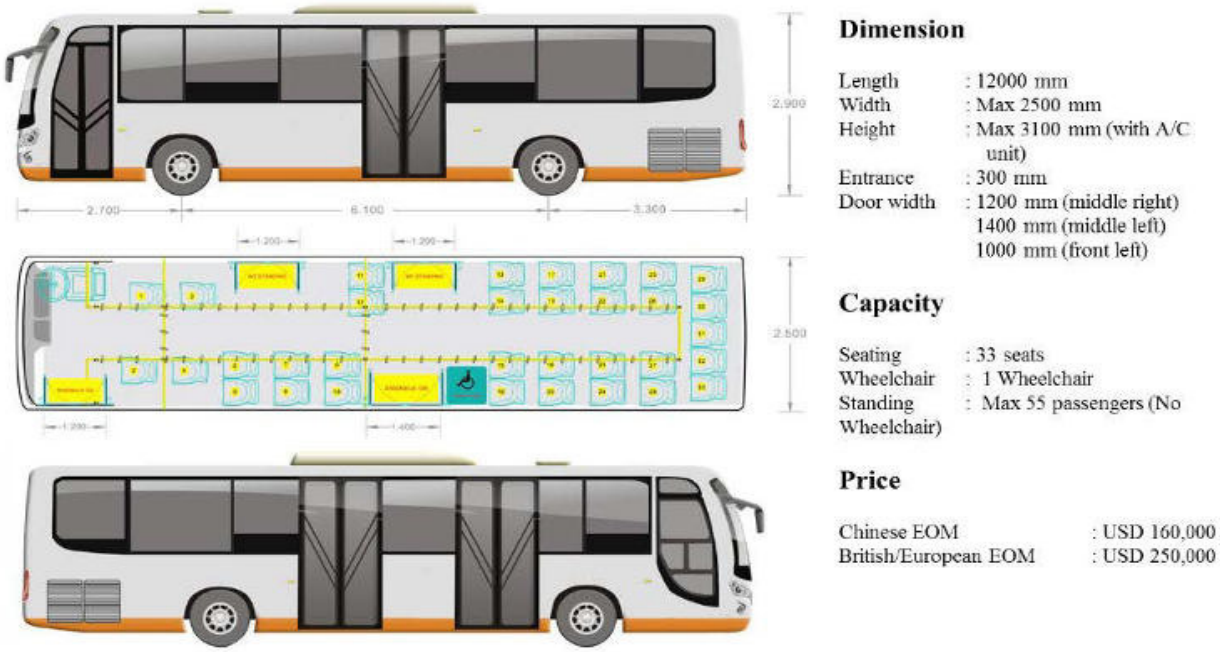

Figure 3-2: Vehicle Specification (12 m length)

3.4.3 Figure & specifications of 18m bus

Figure 3-3: 18 meter bus

Table 3-1: 12 m standard bus configuration

	Type	Standard
1	Dimensions	12-meter
2	Vehicle Capacity	84 passengers
3	Floor Height:	350-380 mm
4	No of Doors (R)	2

	Type	Standard
5	No of Doors (L)	2
6	Max. Speed	80 km/hr
7	Air Conditioner	Yes
8	Fuel Type	Diesel

Table 3-2: 18 m articulated bus configuration

	Item	BRT bus Specification
1	Dimensions	18-meter
2	Vehicle Capacity	170 passengers
3	No of Doors (R)	3
4	No of Doors (L)	3
5	Model	HFF6180G02D
6	Curb weight/GVW	curb weight:18500kg,GVW:31000kg
7	Max speed	80km/h
8	Minimum Gravibility	80km/h
9	Height of floor	1220mm
10	Length	18000mm
11	Width	2500mm
12	Height	≤3800mm(with AC)
13	front overhang	2570mm
14	rear overhang	3400mm
15	ground clearance	≤300mm
16	passenger compartment height	≥2100mm(articulated area:1900mm)
17	departure angel	≥8°
18	height of the door frame	≥1800mm
19	outer turning radius	≤12000mm
20	engine	WEICHAI WP12NG380E40 , 380HP
21	CNG system	TYPE4,total capacity:1450L,190Lx8,rail,leakage sensor and auto fire distinguisher,warning buzzer in driver aera
22	transmission	ZF 6AP1700B
23	retarder	with transmission
24	rear axle	Dongfeng 13 tons axle
25	middle axle	Dongfeng
26	front axle	Dongfeng
27	turning system	Right hand drive,ZF8098
28	brake system	dual circuit air brake
29	front brake	disc
30	middle brake	disc
31	rear brake	drum
32	front suspension	air suspension
33	middle suspension	air suspension
34	rear suspension	air suspension
35	Tire	295/80R22,5(GITI)
36	battery	200AH

	Item	BRT bus Specification
37	alternator	150AX2
38	door	3pcs every side,the width of door frame:1600mm,1200mm,1600mm;installed with door glass by ANKAI
39	articulated plate	Ikarus
40	speed limiter	when the high temperature of engine,the speed of bus will be reduced
41	clock	yes,offered and installed
42	emergency valve	yes,offered and installed
43	CCTV camera	yes,offered and installed
44	on board camera	yes,offered and installed
45	front display panel	yes,offered and installed 300x1500mm
46	side display panel	yes,offered and installed
47	interior display panel and communication system	yes,offered and installed 700x200mm , 2 pcs
48	station broadcaster	yes,offered and installed
49	radio	yes,offered and installed
50	GPS	yes,offered and installed
51	Dashboard	Odometer Digital up to 0.1 Km's reading · Tachometer · Speedometer (kph reading) · Air pressure · Engine Hour Meter. · Fuel level meter digital reading CNG · Warning light · Battery charging · Oil pressure · Main beam · Handbrake indicators · Low air pressure · Low coolant level · High coolant temperatur · Warning buzzers · Reverse horn switch· Ignition switch = start & stop engine. · Ignition switch = start & stop CNG CNG · Ignition switch = start & stop electrical · Switch on auxiliary circuits · Hazard warning switch = direction indicator flash simultaneously LED · Side & headlights switch · Multi-function steering column switches for wipers, washers, horn, indictors dan main beam · Buzzer for speed limiter and engine temperature
52	tool kit	1 set (hydraulic jack capacity 10 ton , wheels' bolt wrenches ,spanners 1 set, open end wrenches 1 set; screw driver + and - ; brake-pipe/hose wrenches ; oil filter wrench ; hammer; voltage indicator lamp, etc.) and include tool box
53	emergency steps	yes,offered and installed,can be opened from passenger room

	Item	BRT bus Specification
54	service hole under the driver window	yes
55	service holes on every axle	Yes

136. Various specifications related to finish, durability, coatings, seals doors and other visual aspects are set out by the ODBM consultant. Features related to safety and convenience include:

- Provision of an audible announcement that informs passengers when the doors are either about to open or close. Door movements will also be shown by luminous indicators. Vehicle door opening and closing will be wirelessly communicated to the sliding doors at the station interface.
- Doors that do not open until the vehicle comes to a stop. Doors will have an interlock control with brake and accelerator to prevent movement of vehicle with doors in open position. The doors will function with ignition off.
- Visual alignment indicators to properly align the vehicle both along the length of the stations as well as the distance away from the station platform.
- An electronic “boarding bridge” at the median doorways and a manual boarding bridge at the curb-side doorways.
- Windows provided along the sides of the vehicle will be provided with a positive lock type emergency latch on each emergency window frame. Both sides of the vehicle will have a window decal describing emergency window operation procedures.
- While the vehicles will be fitted with air conditioning, there will be the option of manually-opened vents to be used in case of air conditioning failure.
- No part of the vehicle will be damaged as a result of a ten (10) km/hr impact at the front or rear of the vehicle.
- ITS control compartment doors controlled by some form of key access (“T” key style is acceptable), and an access door for emergency workers to gain entry to the “Battery Disconnect” labelled as such.
- Features that is standard on any public service vehicle (mirrors, doors, roof escape hatch.)

3.4.4 Recommendations for Power-train Specification

137. According to the ODBM consultant, rear engine / rear propulsion system vehicles are preferred. Engines / propulsion systems have to be separated from the passenger compartment by means of a sound, vapor and fire proof wall. The propulsion system will have a design life of at least 1 200 000 kilometers, subject to proper maintenance practices.

138. The vehicle speed will be set to limit maximum vehicle speed to 100 km/hr. The expected maximum operational speed of these vehicles is 80 km/hr.

139. For vehicle operations, the stations are located on the right-hand side of the vehicle. For this reason, it is preferred that the exhaust is emitted from a location on the lower rear left-hand side of the vehicle. The exhaust and tail pipes will be as designed to provide sufficient clearance from the running gear under all operating conditions.

140. The engine will use liquid cooling. The radiator will be of durable corrosion-resistant construction with bolted-on removable tanks.

3.4.4.1 Power-Plant Rating

141. The vehicle may either be based on a diesel or an all-electric/hybrid propulsion system. Final recommendations are still underway by the ODBM Consultant. Fuel efficiency and emissions of criteria pollutants and greenhouse gases weigh in the selection of engine/fuel and propulsion system technology (see Sec. 4.5). These specifications are taken from the ODBM Interim Report no. 1.

142. The propulsion system will provide the greater of 11 kW per ton gross vehicle mass or that required to achieve and maintain 70 km/hr on a 4% up grade and 40 km/hr on an upgrade of 8% with a full vehicle load. The vehicle speed will be set to limit maximum vehicle speed to 100 km/hr. The expected maximum operational speed of these vehicles is 80 km/hr.

3.4.4.2 Fuel Type and Emissions Standard

143. For the diesel-fueled option, the vehicle must meet a minimum EURO III emission standard, and must be capable of operating with EURO II fuel. Currently, only diesel fuel meeting a EURO II emission standard is available in Pakistan, EURO II fuel will thus be utilized in the vehicles. It is recognized that EURO II compatible engines are generally being phased out of production. In addition, the BRT system would benefit from the potential future option of a cleaner emission standard. Thus, the vehicle is to be designed with a propulsion system capable of meeting a EURO III emission standard (while recognizing EURO II fuel will be employed in the system).

3.4.4.3 Hybrid options

144. For the electric/hybrid option, the vehicle will be equipped with a regenerative braking system to capture the kinetic energy from vehicle deceleration. The energy from the regenerative braking system will be stored in the vehicle's battery bank. The battery portion of the plug-in diesel-electric hybrid system will hold a charge capacity capable of delivering a minimum service range of 50 kilometers without re-charging. The battery size is estimated at 60 kWh to deliver the target electric-only range. The battery packs for the vehicle must either have sufficient longevity for the life of the vehicle (12 years / 1.2 million kilometers).

3.4.4.4 Transmission

145. Vehicles will be equipped with electronically controlled automatic gearboxes that are matched to the engine and other drive train components to ensure the required performance characteristics. The system gearbox will provide smooth power transfer throughout the power range and will not transfer any power when the gear selector is in neutral.

3.4.4.5 Exhaust Emission and Noise Specification

146. Vehicles will conform to the national air-pollution control standards and all other local air-pollution requirements as established for the year of vehicle manufacture. Vehicles will meet a minimum emission standard of EURO II.

147. In no mode of operation will the vehicle generate external noise levels greater than 83 dB, measured 15 meters from the centreline of the lane in which the vehicle is travelling. The vehicle-generated exterior noise at station idle will not exceed 65 dB.

148. The interior noise at any location greater than 300 mm from an interior window or wall and 1 200 mm from the floor will not exceed 80 dB during any vehicle operating condition.

3.5 Service Plan

3.5.1 Bus Frequencies and AM Peak Service Plan

149. The ODBM Consultant is preparing the operations plan that will identify bus operating frequencies and peak service accommodation.

3.5.2 Fare System and ITS provider

150. The ODBM Consultant proposes to integrate equipment supply and operation and maintenance components for both Fare System and Intelligent Transport Systems (ITS), as well as to integrate traffic management services within the scope of work to be carried out by the Fare System and ITS provider. This level of integration aims to reduce cost and increase efficiency through lowering staff costs, possible bundling of services into an integrated software package, and possible integration of equipment such as BRT vehicle consoles and station computers. As such the supplier would be responsible for

- Provision of fare system activities including equipment supply and operation & maintenance of hardware and software components of the system
- Issuance of smartcards, provision of top-up services and cash handling
- Provision of intelligent transport system activities including equipment supply and operation & maintenance of hardware and software components of the system
- Provision of station management services, which include provision of power, water and network connectivity as well as security, cleaning and maintenance of the stations and landscaping
- Management of kiosks and other commercial space on the stations
- Management of advertising on the stations and the smartcards

3.5.3 Interaction with Off-network Transport Services

151. Off-network, or direct service interface is being developed by the ODBM Consultant. Routes selected for BRT (including the Red Line) will be transformed into ‘direct-service’ BRT routes, which will be upgraded with a new fleet suitable for BRT to serve a segment of the BRT corridor and continue the journey beyond the BRT corridor to reach off-corridor destinations. Increased capacity and ease of use is provided without significant added investment, as compared to trunk line services wherein terminals are constructed.

152. Direct service operation provides flexibility in both bus frequency and number of bus routes along any segment of the corridor. For example, mid segments of the BRT on the University road could have a bus frequency of 150 buses per hour per direction, whereas the northern segment of the corridor would have less frequency to conform to actual demand, expected to be

about 46 buses per hour in one direction. While running off-corridor, a BRT bus will operate similarly to the current situation, traveling in mixed traffic and picking up passenger from curb side bus stops. Once the route joins the BRT corridor, the bus will use the right-side door to allow passengers boarding and alighting at BRT stations.

153. The concept is illustrated in Figure 3-4 wherein off-corridor routes access the main corridor and provide service to stops. Direct service brings up special considerations related to fare collection that are addressed through appropriate means.

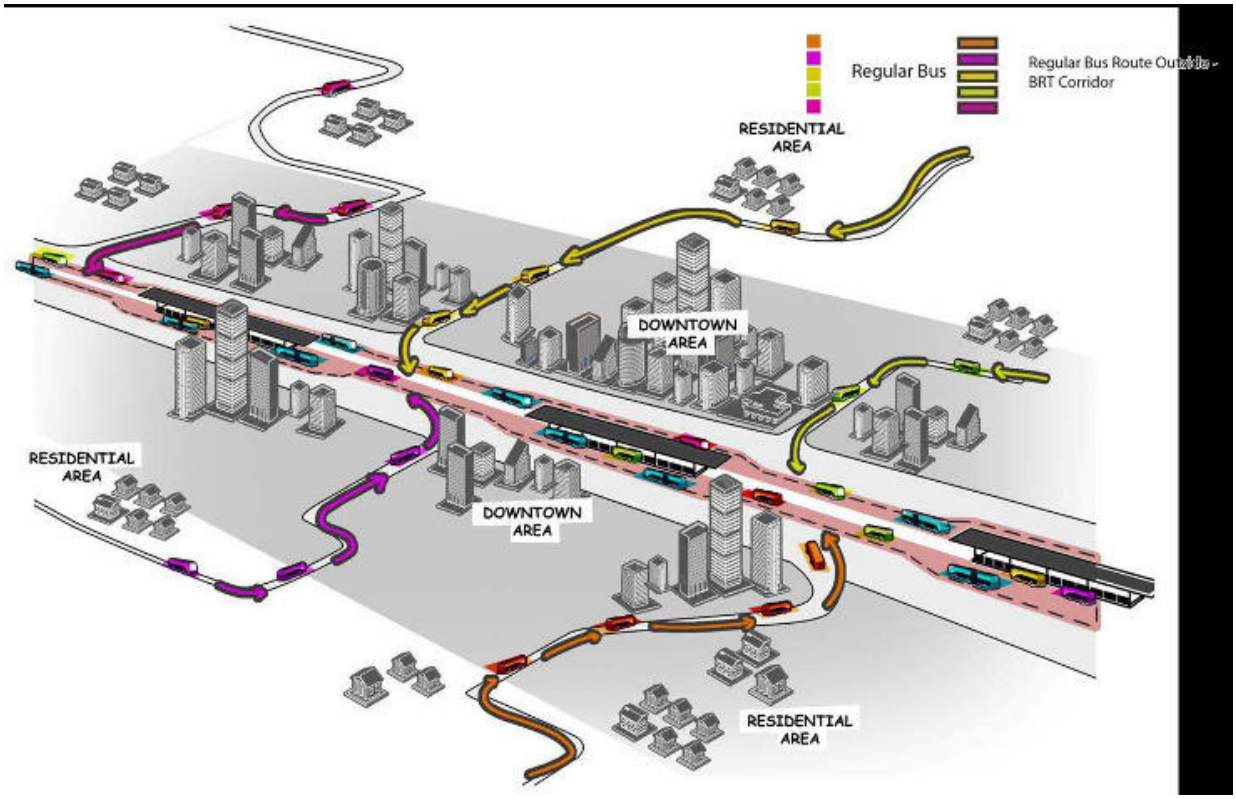

Figure 3-4: Direct Service Concept and Off-Corridor Service

3.5.4 Vehicle Operations and Bus Servicing

154. The proposed business model recommends carrying out the BRT via subcontracting business services to private entities. Under this model, it is recommended to follow an integrated contract for operations and fleet procurement in order to allocate risks and insure a strong sense of ownership of the BRT vehicles by the BRT Operators. Two tenders for vehicle operators are recommended, in which responsibilities are approximately similar and comparison of performance can be made. Assigned responsibilities include for BRT Vehicle Operators: (EE 2017a App D)

- Procurement of BRT vehicles adhering to specified technical specifications, along with vehicle homologation and licensing, vehicle warranty, spare parts, and tools and diagnostic equipment
- Operation of a proportion of fleet adhering to schedules set by public transit authority
- Dispatching BRT vehicles
- Employment of drivers, conductors, and other employees

- Provision of maintenance services
- Provision of BRT system operation training to BRT vehicle drivers
- Provision of advertising activities on the interior and exterior of the BRT vehicles

3.6 BRT Road Infrastructure

3.6.1 Infrastructure Development Approach

155. The direct service concept was described in the previous section. Direct service interfaces with the segregated busway described in the next section. Key to that interface are access and egress through curb design and other means to facilitate merging off-network buses with dedicated bus lanes.

3.6.2 Segregated Busway

156. The main corridor begins at its intersection with the Green Line at MA Jinnah Rd. at the Mazar-e-Quaid Mausoleum, occupying the median of new MA Jinnah Rd. and continuing to its junction with University Road at Jail Chowrangi, and then on to Safoora Chowrangi. From Safoora Chowrangi the line continues along the Malir Cantonment Link Rd. to Police Check Post No. 6, and then runs south along MA Jinnah Ave. to its terminus at Liaquat Ave near Airport Rd. Alternative alignments are still under consideration for the tie-in with the Green Line at MA Jinnah Rd. the terminus along Jinnah Ave. and a possible service line to the Airport, and routing from Safoora Chowrangi to MA Jinnah Ave. Alternatives for the alignment are described in Sec. 4.3.2. Figure 3-5 shows the alignment along with locations of the currently proposed 24 bus stops along the route. Stations to be constructed at these stops are described in a later section.

157. The Red Line will be a segregated busway running adjacent to and on either side of the roadway median. In general, the busway runs at-grade, though in a few locations it will enter underpasses. The median will be removed over the main length of the busway; the removal of existing trees will be made up with planting elsewhere. The buses will utilize existing flyovers at main cross-thoroughfares, and grade separations using flyovers or underpasses will be installed at other intersections, providing unimpeded passage for buses moving in the carriageway. The over- and underpasses have been identified in the concept design, and are undergoing further elaboration in detailed design. The description herein is based on preliminary documentation that may undergo revision before commencement of construction.

158. The alignment begins with its tie-in with the Green Line at MA Jinnah Rd., for which various alternatives are under consideration as described in Sec. 4.3.2.4. The concept design (EE 2018) illustrates passage of the alignment through an underpass at People's Secretariat Chowrangi (Figure 3-6) that will involve open excavation across a distance of some 300 m, producing some 15,000 cubic meters. After emerging from the underpass, the alignment enters the 200-m long Dawood University Station (BS-120)[10], with access by overhead pedestrian bridge at both ends, near the intersection with Jamshed Rd. Following that, the alignment enters into a near straight run without stations or grade separations for 700 m before reaching the Usman Park Station (BS-119) (Figure 3-7), then passing through the Jail Chowrangi intersection using the existing flyover, and Jail Chowrangi Station (BS-118) (Figure 3-6). No major structures (such as flyovers) will need to be built to pass through this intersection; however, a pedestrian bridge is

[10] Station names and numbering are tentative and subject to change.

needed to span the traffic lanes entering University Rd. from the north and heading east, to facilitate access to the BRT station.

159. Jail Chowrangi Station is shown clearly on Figure 3-9, along with the T-intersection at National Stadium Rd., which enters obliquely from the south. The intersection, while at-grade, will require construction of a flyover for local traffic in the south lanes moving west along University Rd. BRT Buses will utilize the existing roundabout to negotiate the intersection, whereas local traffic will not enter the roundabout.

160. Figure 3-10 Illustrates the station at Askari Park, Faisan-e-Madina (BS-116), with its single centrally located pedestrian bridge accessing the station, and main off-network feeder route entry point from the north along the improved junction of Daruloom Ghosia Rd. Except for the widening of the carriageway to accommodate entry traffic, there is no other unusual aspect of the alignment through this transition.

161. Figure 3-11 shows the underpass to be constructed at Gulshan-e-Iqbal to provide U-turn capacity and entry into the roadway for local traffic. The location is an important existing U-turn along University Rd. The underpass will accommodate the dedicated carriageway with a 15-m wide passage some 5.5 m deep at its maximum, an approach ramp of some 100 m in each direction and full-depth section of around 60 m. The nominal amount of spoil generated in the excavation of the underpass is 10,000 cubic meters. A bridge will need to be constructed spanning the cut. Also shown is the Civic Center Station (BS-115) with centerline overhead access pedestrian bridge.

162. Figure 3-12 shows the major intersection at Civic Center Plaza where Habib Ibrahim Rahimtoola Rd. crosses in the Hasan Square Roundabout and Flyover. A direct service entry point for the BRT comes in from the north, where a traffic signal is proposed. The Expo Center Station (BS-114) is also shown.

163. Figure 3-13 illustrates an essentially straight section punctuated by elevated, 2-directional U-turns before entering the station area at Baitul Mukarram Station (BS-113). Traffic controls in the station area allow for direct service (off-network) buses to enter the carriageway and access the station.

164. Figure 3-14 shows an essentially straight section of improved carriageway, but with the station at Federal Urdu University (BS-112). There is no grade separation or U-turn provided in this stretch of around 700 m. Likewise, the transition shown in Figure 3-15 is without any distinguishing feature.

165. Figure 3-16 illustrates the important intersection at Rashid Minhas Rd., which is a grade-separated interchange referred to as NIPA (National Institute of Public Administration) Chowrangi; and also shows the NIPA Station with its centrally positioned pedestrian access bridge. The carriageway will pass under the existing flyover and there is no major structure or excavation required to facilitate passage at this intersection.

166. Figure 3-17 shows a major entry point to the main roadway from the north slated for improvement, as well as the BS-110 (Metro) Station and the existing circular U-turn, which facilitates traffic and reduces the amount of infrastructure required to be built in this area.

167. Figure 3-18 shows the Safari Park Station (BS-109), the existing flyover at that location, and important entry points to the main thoroughfare from the north and the south. No major infrastructure is required through this transition as there is an existing flyover (Safari Park Flyover) at the Samama Intersection.

168. Two stations are shown in Figure 3-19, BS-108 NED University and BS-107 Karachi University Stations. Both are served by centrally located overhead pedestrian access that are connected by an overhead walkway. No traffic flow or interchange needs to be facilitated through this section.

169. No station is located in the transition shown on Figure 3-20; however, traffic flow is facilitated through a U-turn made possible by construction of bi directional U turn flyovers

170. Figure 3-21 shows little other than the station at Sheikh Zayed Islamic University (BS-105). Figure 3-22 shows entry and access points for direct service buses and crossing of mixed traffic from both north and south directions. A dedicated throughway to the south provides access to the bus depot to be located in this area. This sheet also shows Mosamyat Station, BS-104

171. Figure 3-23 shows a below grade transition providing at grade mixed traffic controls via a traffic signal and return lanes, as well as the Shumail Complex Station (BS-103). Significant amounts of earth will be excavated for this below grade transition, on the order of 20,000 CM.

172. Figure 3-24 shows little other than the juncture with Safoora Chowrangi. This intersection (Figure 3-25), will consists of at grade approaches from three directions and an elevated pass trough of mixed traffic

173. Additional concept plan sheets are available that illustrate the alignment up to its terminus just beyond the turn-off to Airport Rd, a distance of about 7 km. The alignment runs at grade for the remainder of its length, and there are no particular difficulties or environmental issues associated with this segment. There are six additional stations in this segment.

174. The median is occupied by stations at most locations as shown in Figure 3-26 for the proposed station at Civic Center Plaza.

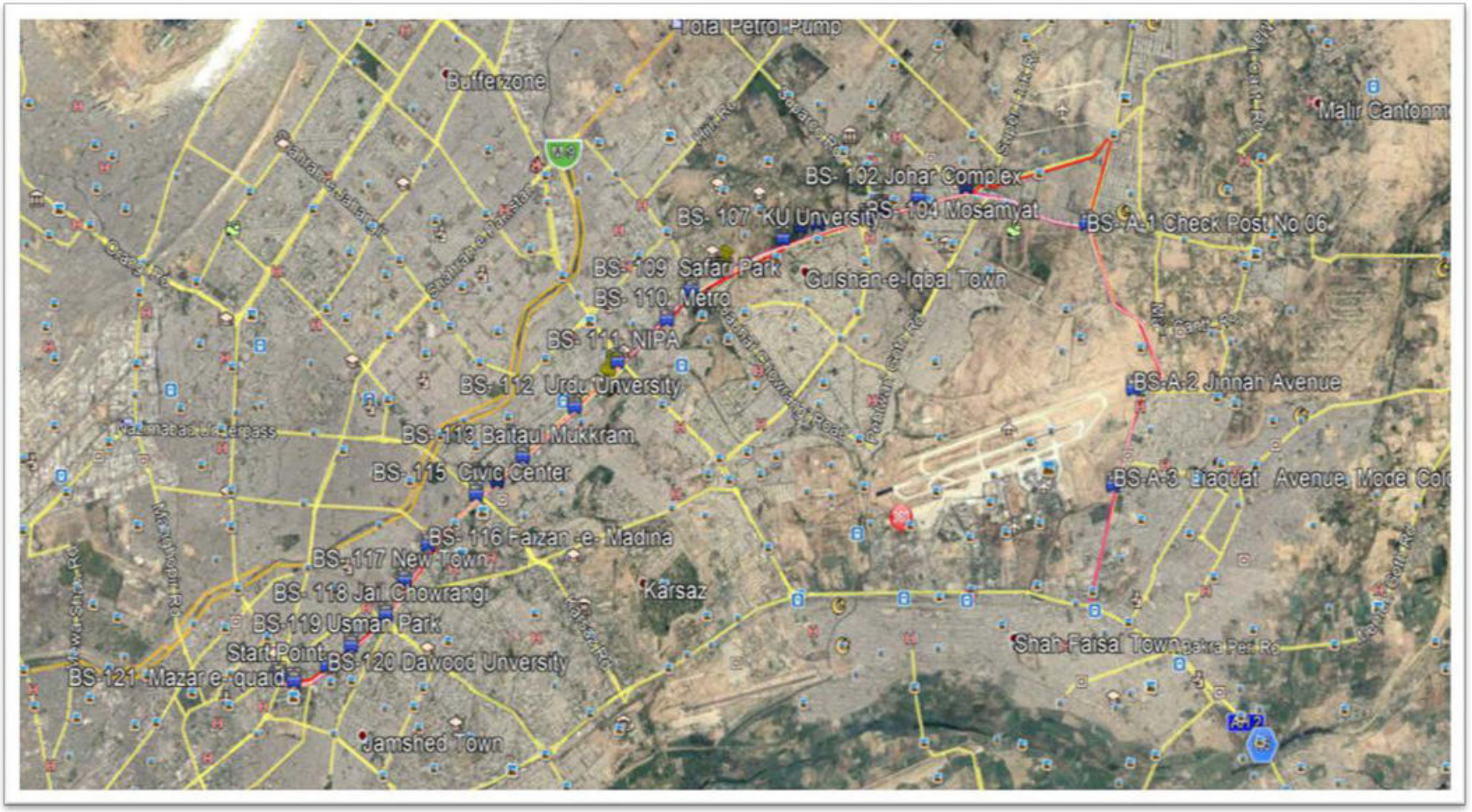

Figure 3-5: Alignment and Station Layout

Note: This figure is intended as indicative only; positioning, name and number of stations shown on this figure may not be consistent with information in the Concept Plan.

Figure 3-6: Sheet 1 Concept Design of Alignment

Note: the bar scale on this and following drawings is off by a factor of 50 (4,000 should be 80)

Figure 3-7: Sheet 2 Concept Design of Alignment

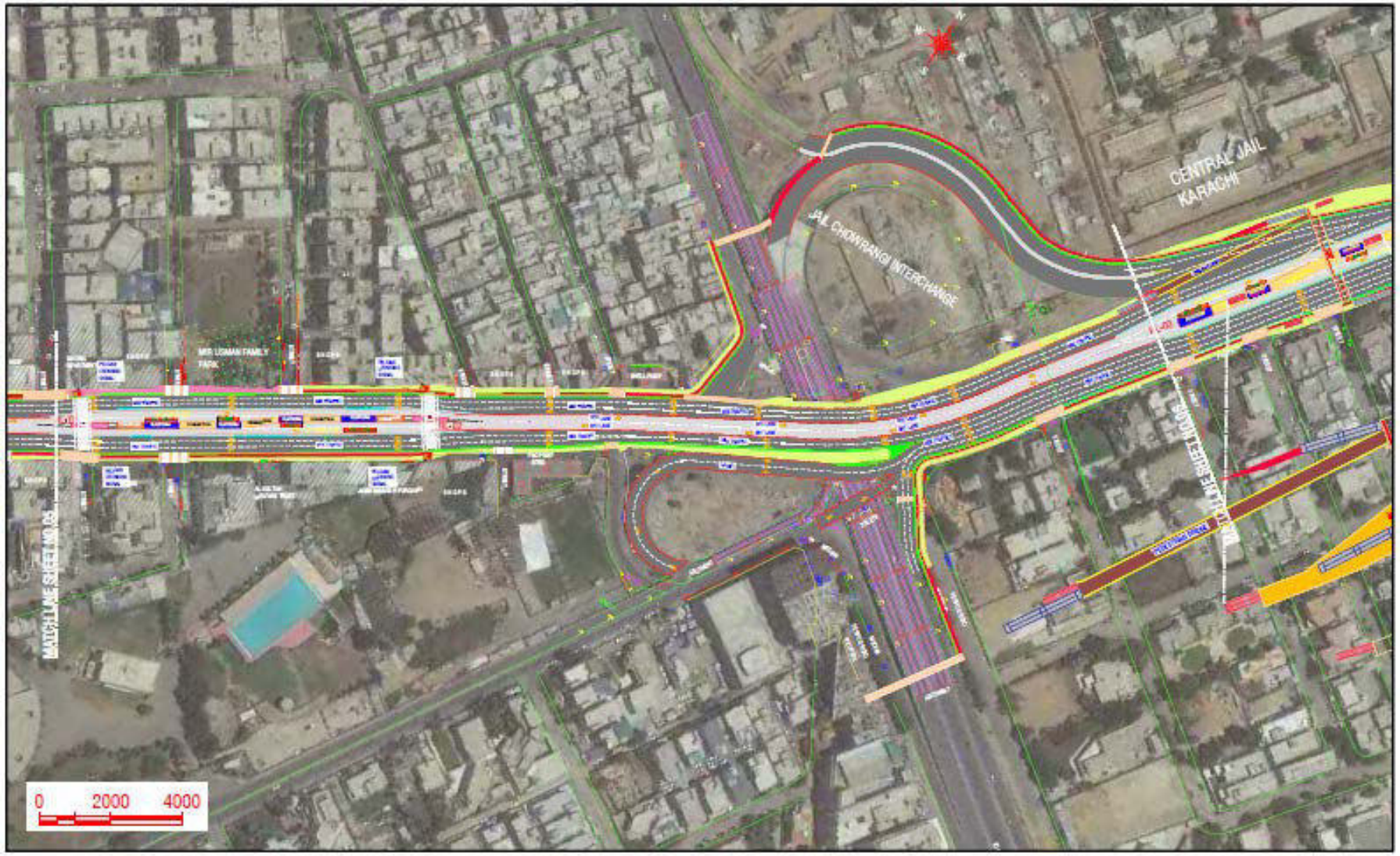

Figure 3-8: Sheet 3 Concept Design of Alignment

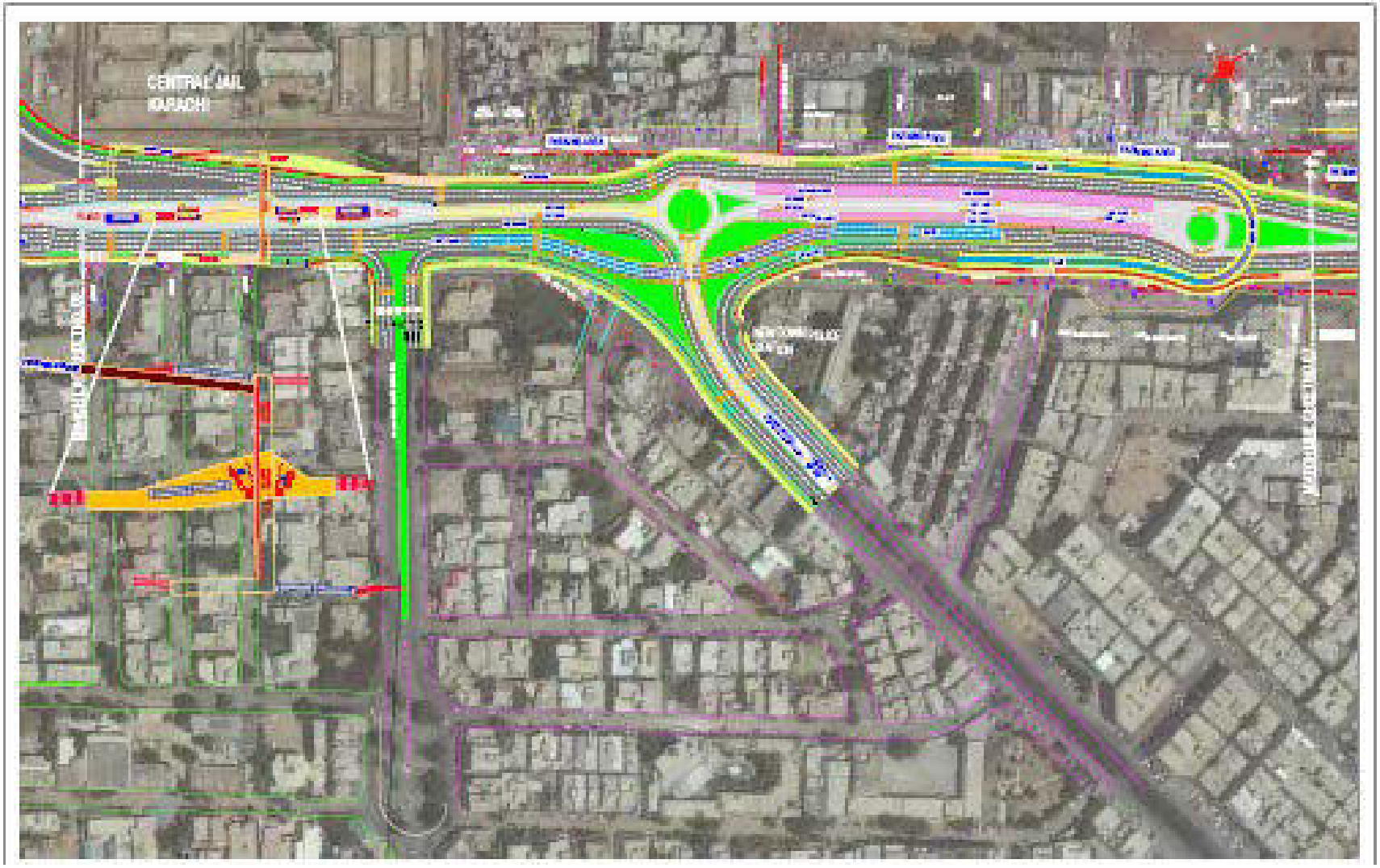

Figure 3-9: Sheet 4 Concept Design of Alignment

Figure 3-10: Sheet 5 Concept Design of Alignment

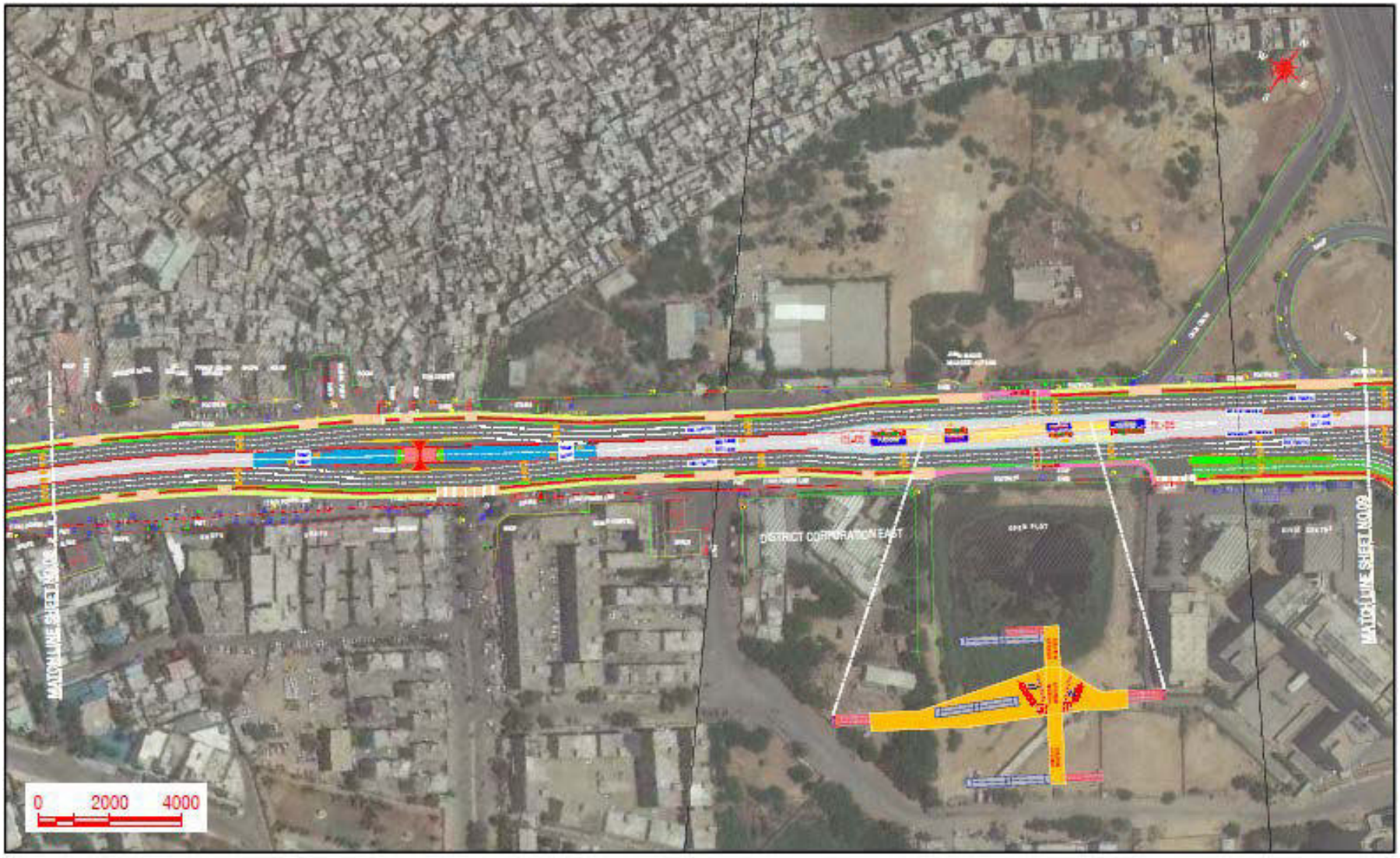

Figure 3-11: Sheet 6 Concept Design of Alignment

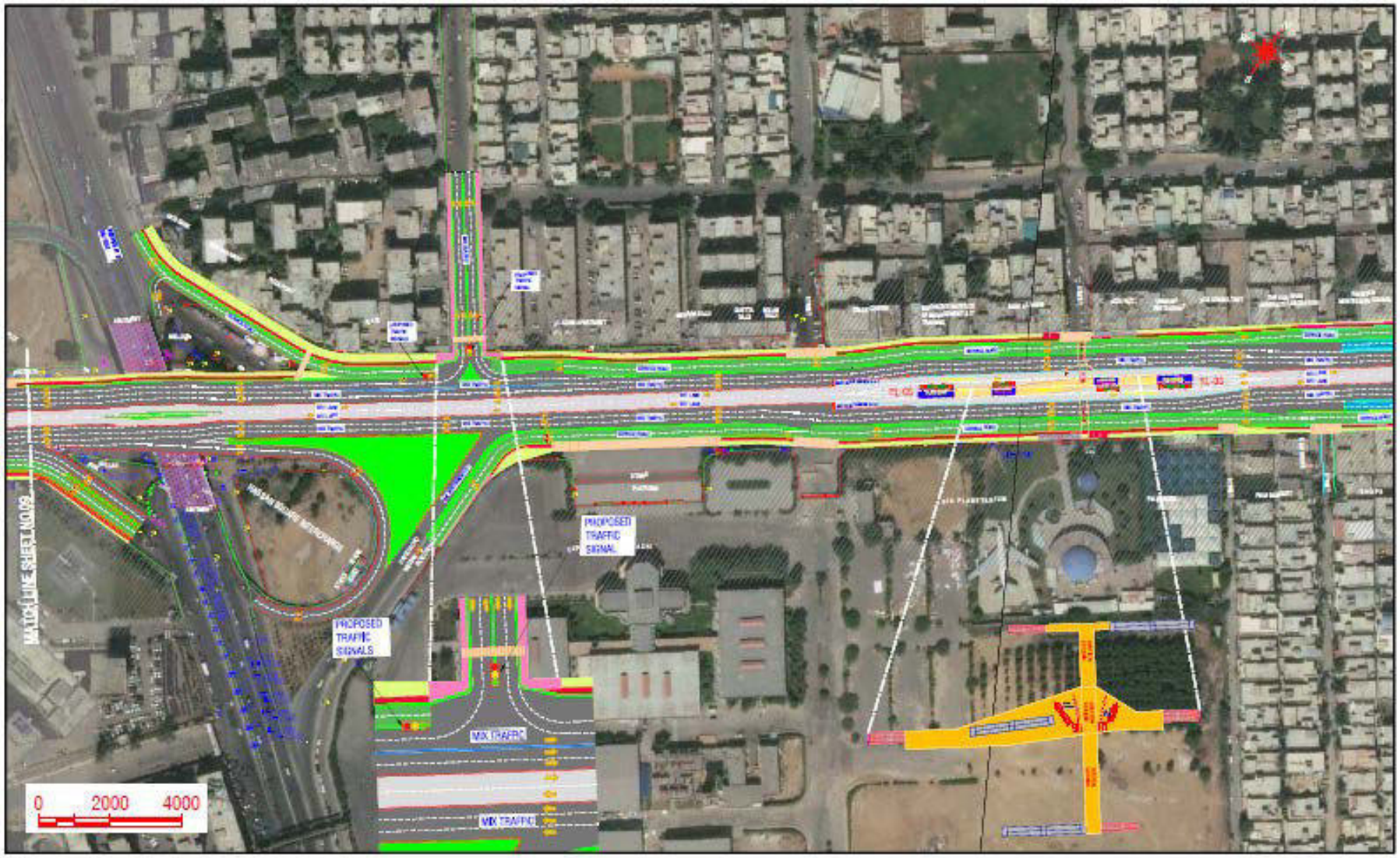

Figure 3-12: Sheet 7 Concept Design of Alignment

Figure 3-13: Sheet 8 Concept Design of Alignment

Figure 3-14: Sheet 9 Concept Design of Alignment

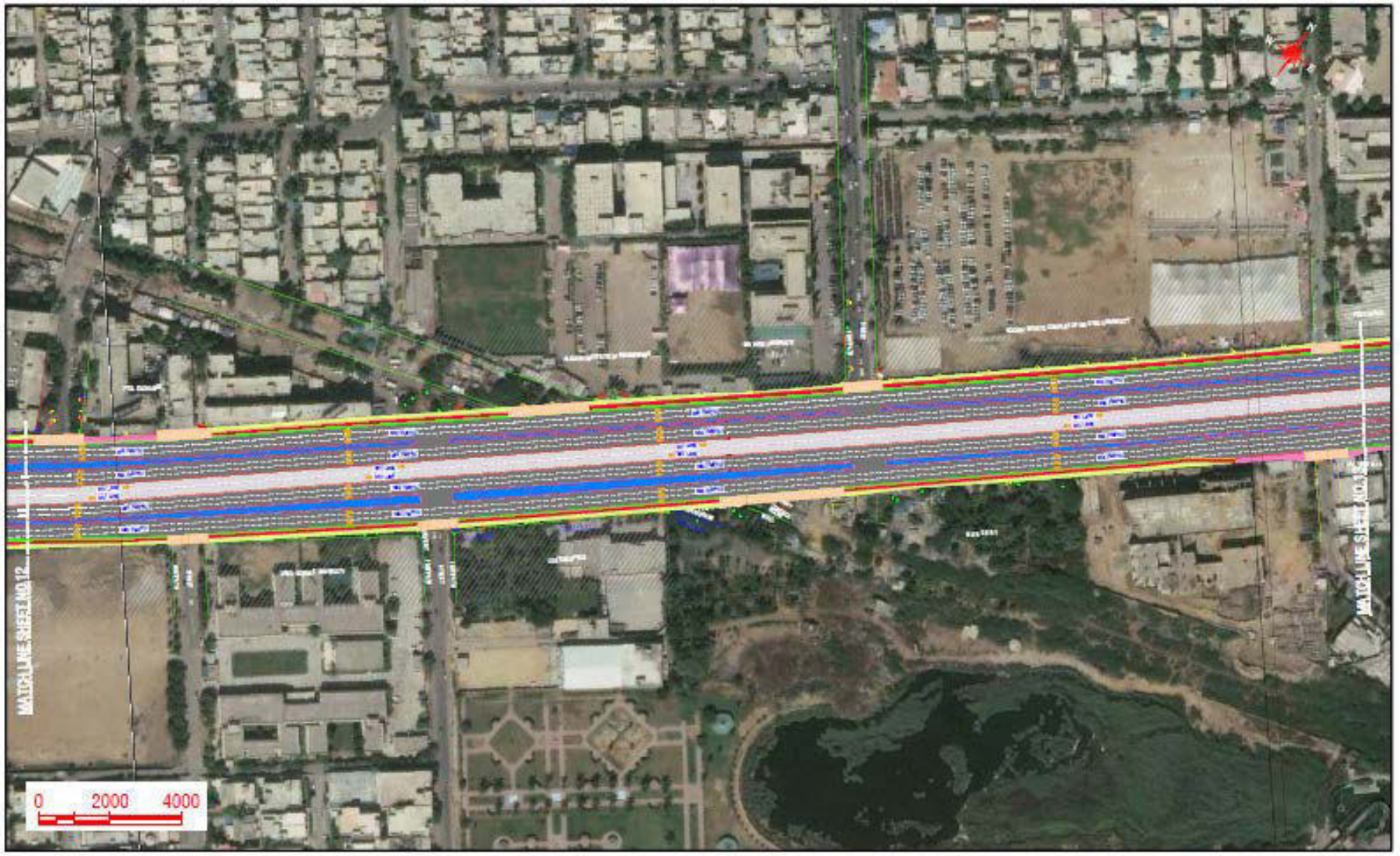

Figure 3-15: Sheet 10 Concept Design of Alignment

Figure 3-16: Sheet 11 Concept Design of Alignment

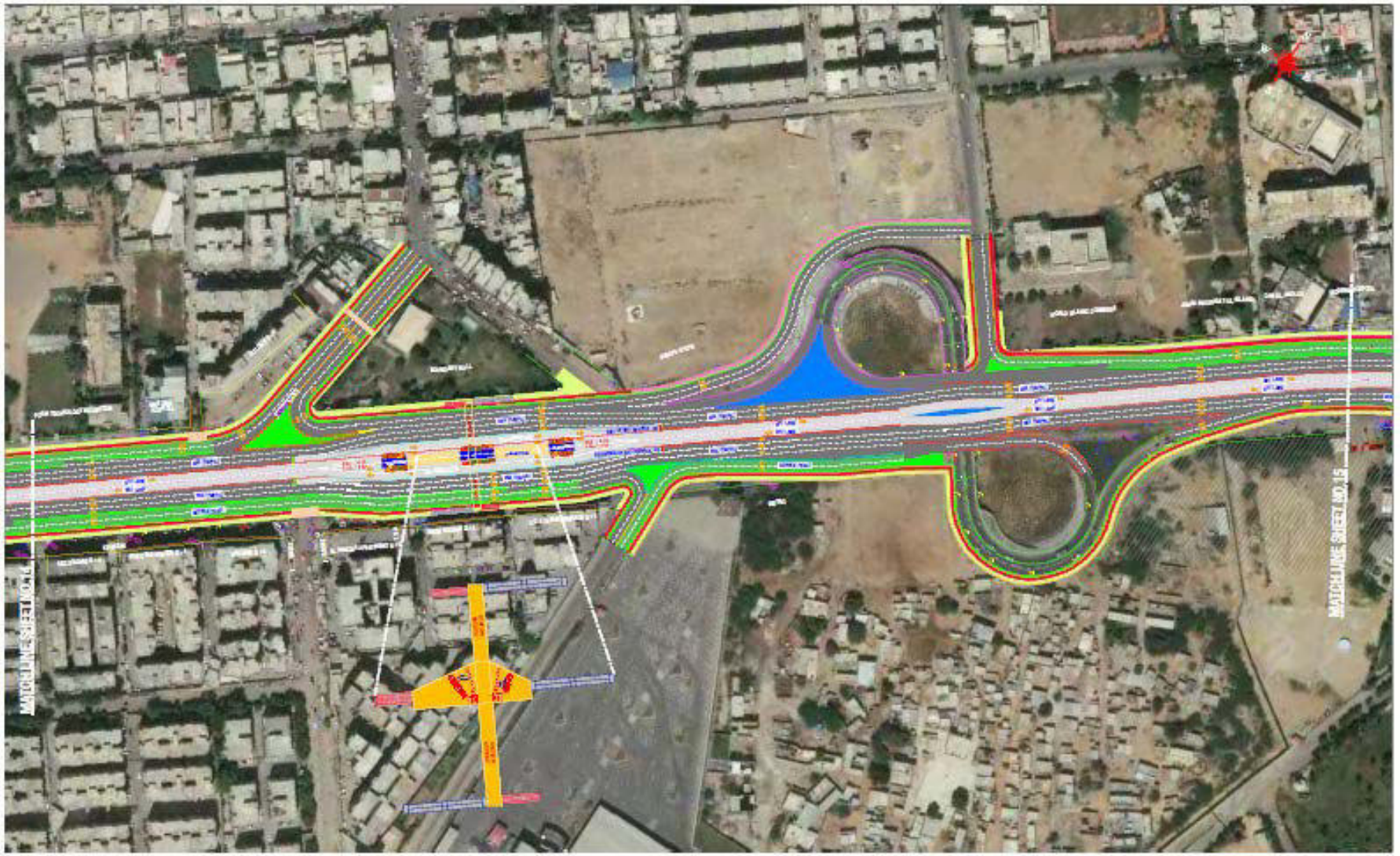

Figure 3-17: Sheet 12 Concept Design of Alignment

Figure 3-18: Sheet 13 Concept Design of Alignment

Figure 3-19: Sheet 14 Concept Design of Alignment

Figure 3-20: Sheet 15 Concept Design of Alignment

Figure 3-21: Sheet 16 Concept Design of Alignment

Figure 3-22: Sheet 17 Concept Design of Alignment

Figure 3-23: Sheet 18 Concept Design of Alignment

Figure 3-24: Sheet 19 Concept Design of Alignment

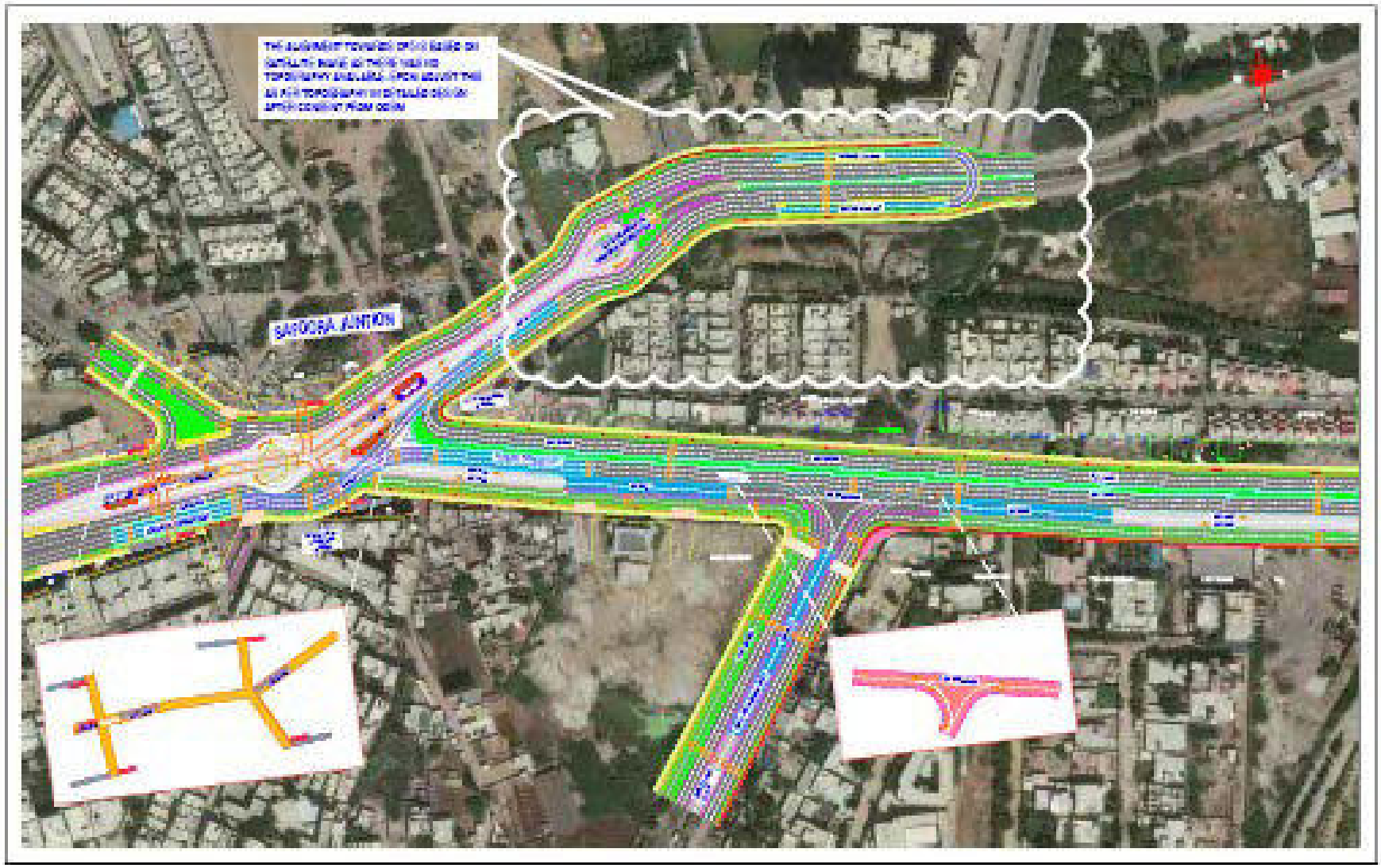

Figure 3-25: Sheet 1 of Set 2 Concept Design of Alignment

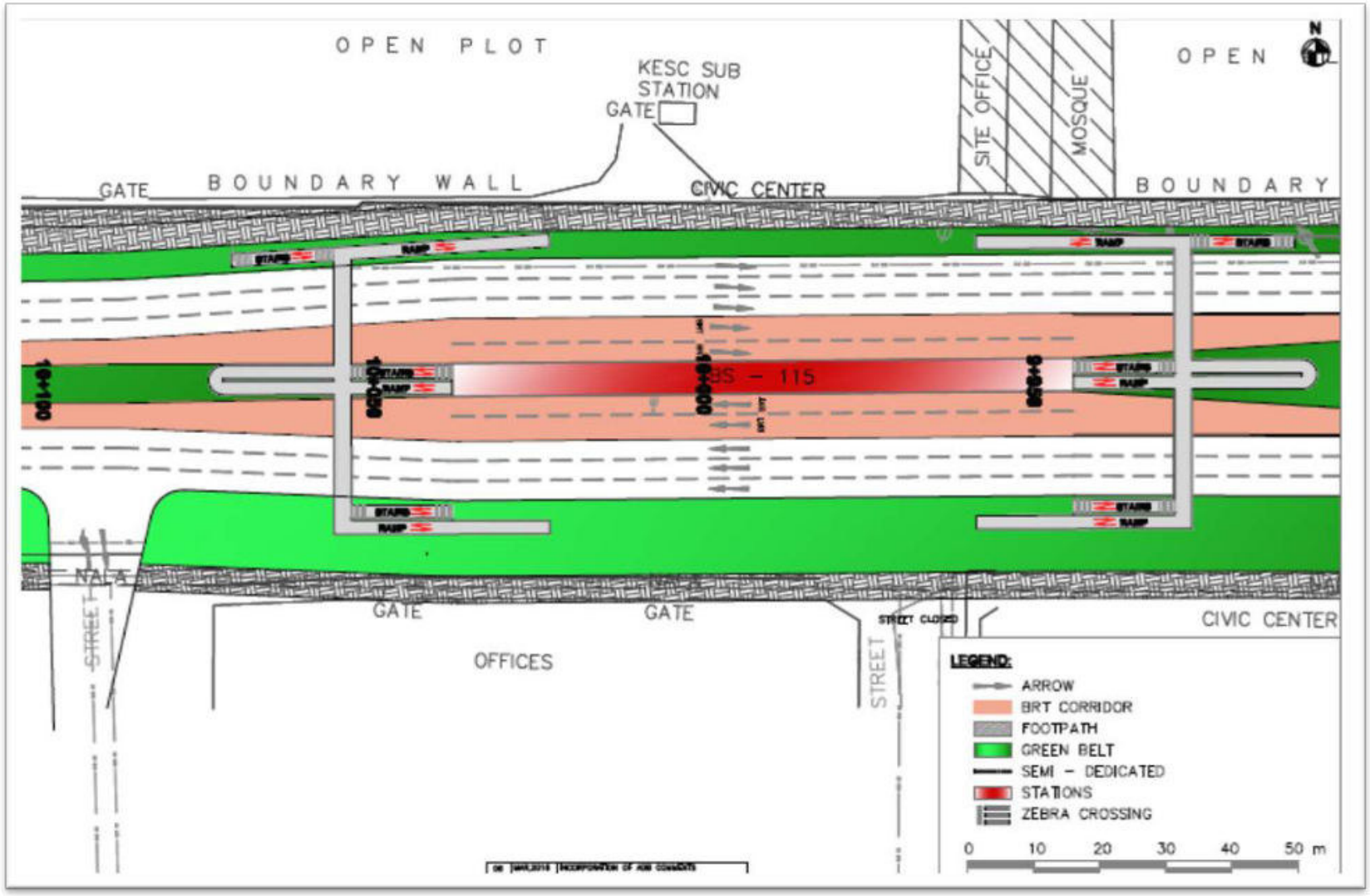

Figure 3-26: Example Arrangement of Lanes and Station Access (Civic Center Station)

3.6.3 Drainage Accommodation

175. The drainage design is in the process of being prepared by the EPCM consultant; a hydrological assessment of the BRT corridor and environs has been undertaken. Consultation with the local community has identified five locations where run-off accumulates with ponding on the existing carriageway during rainfall events along the proposed red line route. These areas are Dawood University of Engineering Chowrangi, Civic Centre Chowrangi/National Stadium, Bait UL Mukarram/C.O.D Hills, Nipa Chowrangi/Aladin Park Rashid Minhas Road and Saadi Town/Safoora Chowangi.

176. The detailed design will undertake a root cause analysis to evaluate the reason behind these ponding with the aim of providing adequate mitigation measures to alleviate the existing situation. The drainage design will review practicalities in implementing a sustainable urban drainage system to reduce pressures on existing outfalls, by delaying time of entry to the existing drainage system, and upgrade of collection system and outfalls.

177. The drainage system of carriageways, underpasses, stations, depot areas and adjacent developed areas will be designed to cater for peak rainfall derived through a standard TOC-intensity-duration relationship for Karachi. The parameters derived shall be increased by a minimum of 20% to take into consideration any risk of further change in climate conditions in accordance with best international practice.

3.6.4 Bus Stations

178. There are 24 stations currently being planned along the alignment. Various types of station modular design for BRT Karachi stations have been proposed (ITDP 2015); however detailed designs are not clearly delineated as yet. Stations with 1 and 2 sub-stops can accommodate one 18-meter bus, or two 12-meter buses per sub-stop, with sub-stop length of 30 meters per sub-stop. Another type of station with two sub-stops can accommodate two 18-meter buses, or three 12-meter buses and at least one off-network direct service bus per sub-stop, within a sub-stop length of 40 meter.

179. The stations are being designed with access on both sides, to allow easy and quicker access to the station. For station with 1 sub-stop, access on another side is provided for exit only. Overtaking lane of 15 meter is needed to allow the maneuver of an 18-meter bus. The recommended width for station is 6 meters, although on some stations, 5-meter width is also acceptable. Final design for stations is pending, and information herein is indicative.

180. Table 3-3 lists the 24 stops, though information on the type of station to be installed at the location is not yet available. Further, names, number and location of stations beyond Safoora Intersection have not been finalized. Figure 3-27 provides a perspective view of the proposed BRT station. Figure 3-28 illustrates aspects of entry and egress to stations described in the next section.

Table 3-3: Red Line BRT Bus Station Inventory

S. No.	KBRT Stations Name	S.No.	KBRT Stations Name
1	Mazar e Quaid	13	Safari Park
2	Dawood University of Engineering	14	NED
3	Usman Park	15	KU
4	Central Jail	16	KU Botanical Garden
5	New Town PIB Colony	17	Sheikh Zayed Islamic Center
6	Faizan e Madina	18	Mosamyat
7	Civic Center	19	Shumail Complex
8	Expo Center	20	Johar Complex
9	Baitaul Mukarrum Masjid	21	Safoora Chowk
10	Urdu University	22	Malir Check post 6
11	NIPA	23	Jinnah Avenue
12	Metro	24	Liaquat Avenue Model Colony

Figure 3-27: Architectural Rendering of Proposed Typical Red Line Station

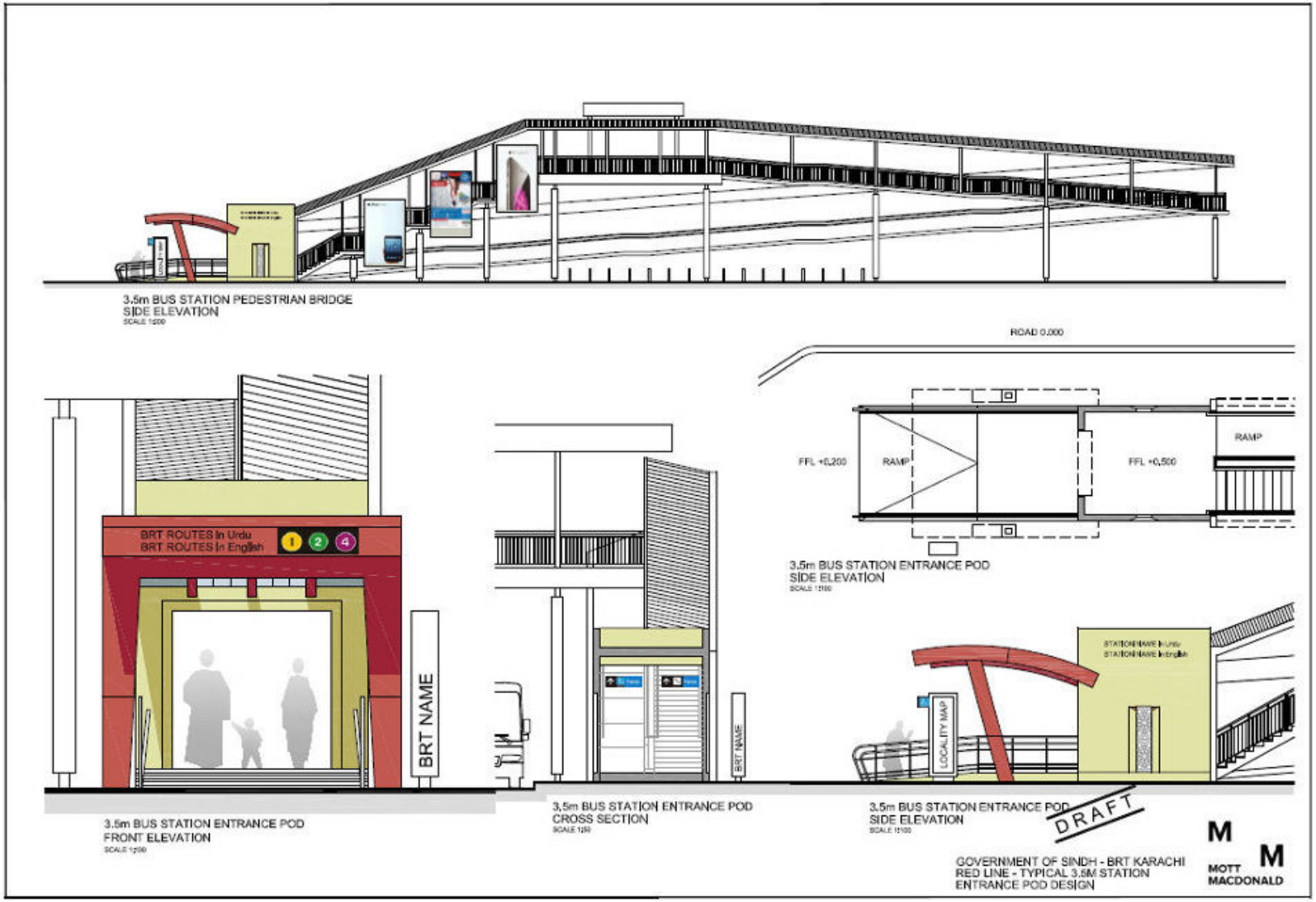

Figure 3-28: Station Access: General and for Disabled Persons

3.6.5 Station Accessibility for Persons with Limited Mobility

181. Various features allow for access by persons with limited mobility. Station overhead access is by both stairway and ramp. Architectural considerations are being taken into account with use of either escalators or lifts to improve access for disabled persons.

3.6.6 BRT Depots

182. There are two locations proposed for depots, identified as (a) Gulistan-e-Jauhar Block 6 and (b) the Malir site, both along the eastern segment of the alignment (see Figure 3-29). Depot plan and layout, or site usage, is not yet available, since the sites have only recently been identified. Section 4.3.1 describes the selection of the sites in relation to other alternatives, and **Section 6.15.3 describes** environmental aspects of depot development.

Figure 3-29: Locations for Depot Sites

3.7 Operational Management

183. As set out by the ODBM consultant (EE 2017a), the Public Transport Authority will launch four tenders under the proposed structure for implementing operational management, including a two-lot tender for BRT vehicle operators; a tender for Fare System and ITS provider; a tender for Commercial Activities provider; and a tender for recruitment of the fund manager for the system. A further tender may be needed for traffic management services.

3.8 Construction Sequence

184. Construction activities will include some or all of the following:

- Construction/relocation of utilities
- Roadway rehabilitation work (including demolition, clearing and earthwork)
- Construction of station platforms and facilities such as ticket machines and information kiosks
- Excavation of underpasses and cross-traffic bridges/flyovers
- Construction of landscape medians and irrigation systems
- Traffic signal and street lighting installation
- Pavement overlays
- Construction of electrical and other utility service lines to stations
- Erection of overhead pedestrian walkways and lifts for access to station areas

185. Additional work taking place along curb lanes may include:

- Sidewalk, curb and gutter reconstruction
- Storm drainage modifications
- Signage and street lighting
- Localized lane striping and pavement marking

186. A Construction Staging Plan will need to be developed in collaboration with the CSC and KMC prior to the start of the work. The Construction Staging Plan will describe how the overall construction will be phased, how work zones will be sequenced and how work locations within the zones will be managed. Proposed construction work hours and zone limits will need to be established subject to final confirmation with the CSC, TMTD and KMC.

187. The construction staging plan is necessary to minimize construction impact on businesses by providing reasonable access to parking and pedestrian access between the parking and the businesses for patrons. Construction staging precedes development of traffic control strategies for minimizing traffic delays and queuing; and provides for development of safe pedestrian access during construction through and around work sites.

3.9 Project Cost

188. The project is estimated to cost $220 million. The project design advance (PDA) and the ensuing project loan are listed in the Asian Development Bank (ADB) country operations business plan, 2016–2018 for Pakistan and are proposed to be financed from the ordinary capital resources of the ADB, with an indicative financing of $10 million for the PDA and $100 million for the project

loan, with the Government financing 19% of the PDA. The borrower is Pakistan, which will enter into a subsidiary loan agreement with the provincial Government of Sindh.

3.10 Implementation Schedule

189. The advance loan (PDA) is expected to be implemented over an 18-month period subject to scheduling and mobilization of components and award of the main construction contracts. The construction period is expected to extend over 18 months. Overall period prior to actual commissioning of the project will depend on award of equipment procurement and operations contracts and delivery of buses. No time line is available thus far in the project documentation that identifies a milestone for comprehensive assembly and deployment of the various project components, but is likely to be some time in 2020-21.

4. Analysis of Alternatives

4.1 The No-Project Alternative

190. The Red Line is a key element in the proposed Karachi BRT system, currently under construction starting with the Green Line. The "no-project" option (or "do-nothing scenario") was analyzed extensively in the early planning phase, where it is most appropriately considered. The Karachi Transportation Improvement Plan (KTIP) contains quantitative evaluation of a do-nothing scenario based on:

- No mass transit system including KCR would be implemented,
- Population growth, economic growth and urban development are consistent with other growth projections in the project, and
- The number of buses would increase according to passenger demand, though it is noted this is unlikely to happen.

191. The result of their analysis, based on best-available data for demand, shows that most roads would need to operate well beyond their volume-to-capacity (V/C) ratio, and hence would not be able to deal with the demand imposed by population and economic growth, the increase in car ownership, and expansion of the urbanized area. A further option, the "road development scenario", was investigated by the KTIP team. Through the addition of 750 km of new roads (for which there is little space), while traffic on some roads would improve somewhat in comparison with the do-nothing case, conditions on the majority of roads would remain essentially the same, e.g. demand would outstrip capacity and roadway congestion and bottlenecks would be a common occurrence throughout the metropolis.

192. One can conclude as well that without the project and others aimed at provision of mass transport, the contribution of greenhouse gases (GHGs) to the global atmosphere from Karachi will only continue to increase adding further to the unsustainability of urban transport as it currently exists. Whereas through introduction of the KBRT, which will serve as a model for future BRT development, Karachi is at least on the path to improved sustainability of its public transport system, inclusive of the reduction in GHGs brought about by these projects.

193. Along with a GHG reduction, one can also count the reduction in conventional primary air pollutants and noise that will come about as a result of the project and similar initiatives, by the removal from the roadways of old and inefficient buses, lorries, and other forms of public transport that have come to dominate the current service market.

194. Both GHG emissions, emissions of primary pollutants and noise are evaluated in the relevant sections of Chapter 6 of the EIA report.

195. Hence the no project alternative was investigated extensively at the most appropriate juncture in the planning of the Karachi BRT, with the conclusion that to not proceed with the project would condemn Karachi to a traffic impasse.

4.2 Mass Rapid Transit Systems Alternatives

- **Monorail:** It is a contemporary means of elevated rail transit.

- **Maglev trains:** These are also elevated rail transit system. Conventional wheels are replaced by magnetic fields with much higher speeds and acceleration.
- **Light Rail Transit:** These trains have articulated rail vehicles powered by electricity from overhead trolley cables at surface level. .
- **Heavy Rail:** These are urban passenger transportation service operating on fully grade-separated right of ways i.e. underground or elevated structures.
- **Commuter Rail:** They are passenger train transit service that operates on the same right of ways used by intercity railway. It carries passengers from corridors of heavy concentrations of suburban and urban locations therefore also known as suburban rail.
- **Bus Rapid Transit:** These are bus based transit system that operates on segregated right of ways to provide higher quality of service with characteristics similar to modern rail based transit system.
- **Costs (Infrastructure & Operation)**
  Bus rapid transit systems are the cheapest when compared to the other alternates. Based on the international experience of different cities, the ranges of infrastructure cost per kilometer of different mass rapid transit system are mentioned below.
- **Infrastructure cost per kilometer (US$ Million/km)**
  Bus Rapid Transit 0.5 - 15
  Light Rail Transit (At grade) 13 - 40
  Metro (elevated) 30 - 100
  Metro (under ground) 45 - 320
  Source (GTZ, 2004). *Range depends on the quality of stations, exclusive ROW etc sought within system

Reference document : Journal of the Eastern Asia Society for Transportation Studies, Vol. 7, 2007. Suggesting urban mass transit technology for Pakistan. " A comparative analysi of rail based repid transit and bus rapid transit

4.3 Location and Alignment Alternatives

4.3.1 Depot

196. TMTD has been engaged in a lengthy search for depot sites for the Red Line; initially two were identified near the northeastern fringe of the City (the airport area) and the start of the alignment, and it was thought that one or the other would suffice, depending on which could be obtained for use. One location is located closer to the alignment and thus has better access. It also has relatively few surrounding residences (though some), and the size of the parcel was sufficient to allow some setback from the property boundary for noise-producing activities. Its location, set back at least 50 m from any nearby residence, is a benefit in terms of air pollution and noise exposure.

197. The other location along Moinabad Rd. has a narrow access with street-side parking. Three- and four-storey residential housing units line the roadway with typically zero setback, and the site is surrounded by residential flats.

198. Both sites were eventually rejected in favor of locations seen to be more readily available for use and both with good access and close proximity to the alignment. In addition, surrounding land use, in the sense of fewer residential neighbours, is more appropriate for the sites selected. These sites are described in Sec 6.15.3.

4.3.2 Alignment

199. There are four locations where alternatives have been considered in the process of finalizing the alignment. One involved the extension of the Red Line into the Central Business District (CBD) and was settled at the time of contract negotiations, while the other three have been addressed in the early stages of design.

4.3.2.1 Extension to Tower Market (Laxmi Das St.) along MA Jinnah Rd.

200. This extension (about 5.2 km) would allow the Red Line to penetrate into the CBD (see Figure 4-1); however, it has been rejected for the time being due to the difficulty in siting and constructing dedicated BRT lanes over the stretch along MA Jinnah Rd beyond the location of the present Red Line terminus. Because of the narrow roadway width, generally about 20 between building faces, this extension will require special design features such as unidirectional routing and conversion of some segments into pedestrian zones coupled with wholesale upgrading, which exceeds what is possible under the EPCM contract. In summary, the Green Line Project is slated to take up this section of BRT.

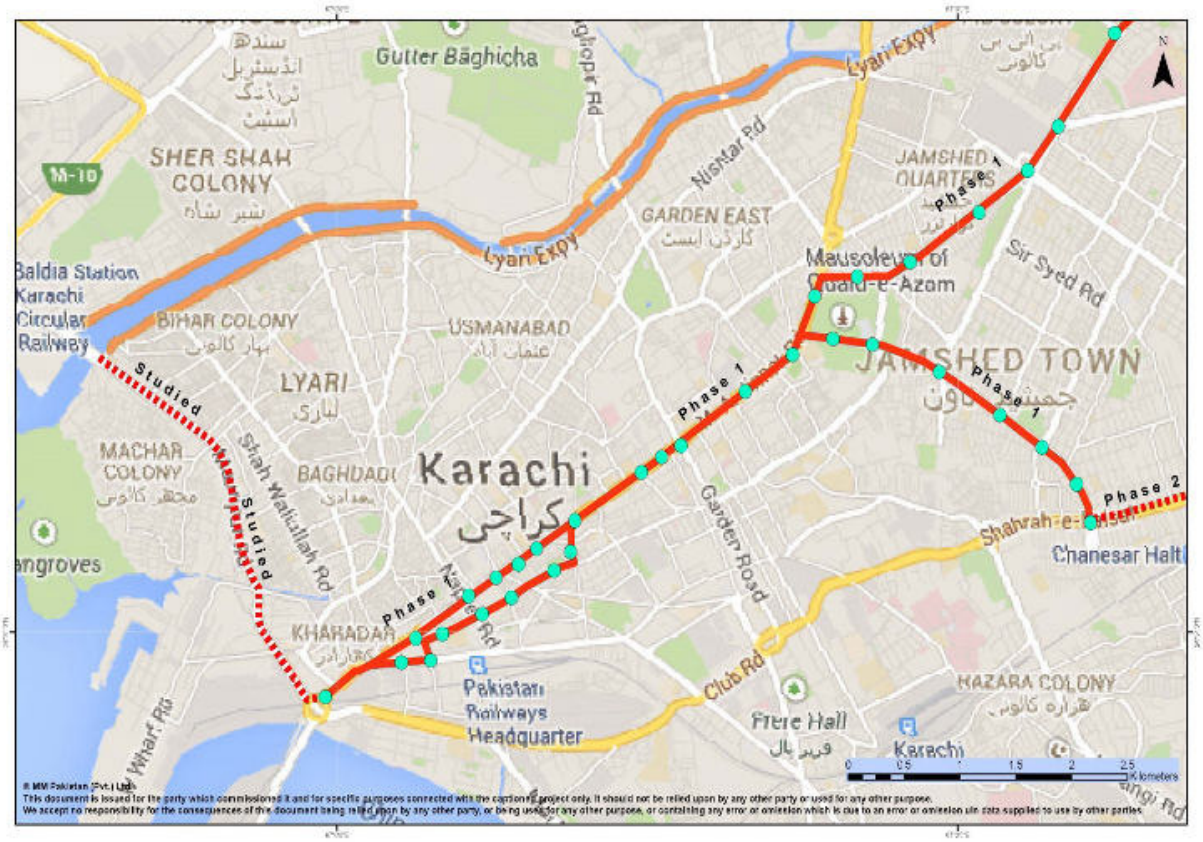

Figure 4-1: Extension along MA Jinnah Rd.

4.3.2.2 Alignment Extensions near Airport

201. The potential to provide service to Moinabad Colony, the airport and to connect to the Karachi Circular Railway (KCR) introduces alternatives at the northeastern extremity of the system, as shown in Figure 4-2. Different options that were considered include providing an extension or low-frequency off-corridor service to the airport, extending the service to the area of the proposed bus depot, and connecting to the KCR. Servicing the additional lengths comes at a

cost, and while demand is thought to be sparse, the decision was made to extend the service up to Faisal Avenue. In addition, it is still possible to provide occasional service to the airport to connect buses coursing along the segment.

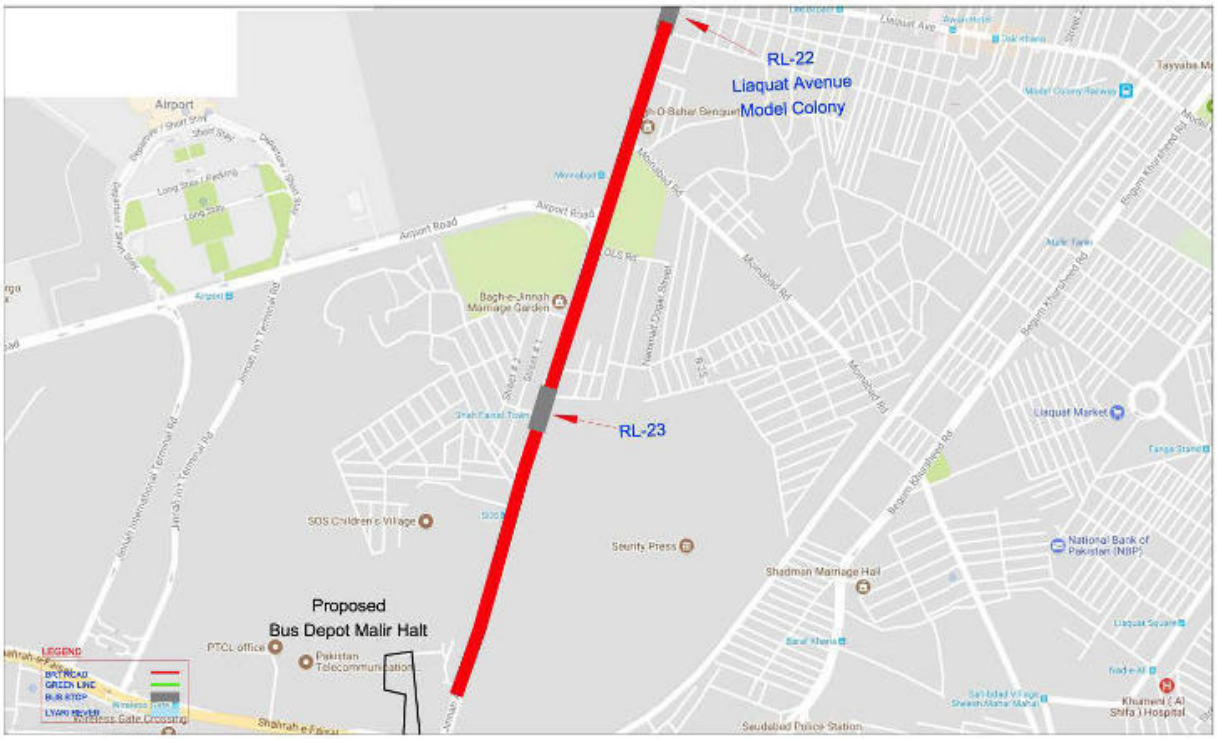

Figure 4-2: Alignment Extensions near Airport

4.3.2.3 Alignment between Safoora Roundabout and Malir Link Rd

202. Alternatives were considered for the alignment between Safoora Roundabout and Malir Link Rd, as shown in Figure 4-3. The original or primary alternative follows a southern alignment along University Rd. 2 (adjacent to the racecourse) that is shorter by some 2.1 km; however, there is less service potential in comparison with the alternative route that follows the alignment of University Rd. to Gate No. 5, then south along the Malir Link Rd. to Gate No. 6 where it joins the original proposed alignment. The alignment along the southern route is aggravated by the poor condition of the roadway and traffic congestion from tank trucks that congregate at a water filling station referred to as the Safoora Hydrant. Various alternatives were considered, including maintaining the original corridor alignment and elevating the lanes in the area of the water hydrant, while serving the new population areas north and east of the alternative route using mixed traffic service and off-corridor stations. Finally, it was decided that this option would not be selected, and service to the northern areas will be provided by means of an off-network, or direct service, bus line.

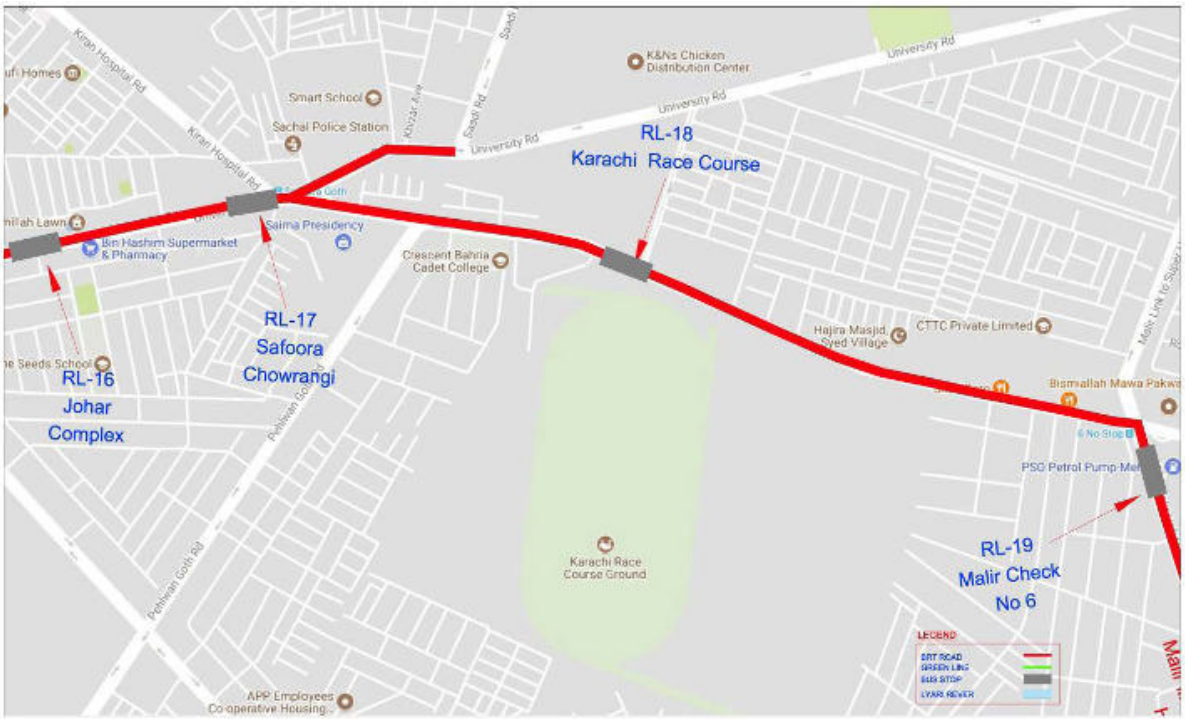

Figure 4-3: Alternative Routes from Safoora to Malir Link Rd.

4.3.2.4 Alignment from People's Roundabout to MA Jinnah Rd.

203. The alignment through this area effects the tie-in with the Green Line System, hence the difficulty in arriving at a suitable solution. Maintaining the original alignment (see Figure 4-4) is not feasible due to the lack of turning distance between an elevated section of the Green Line (to the north) and a depressed or subgrade section that begins shortly after the junction. Following the alignment on the drawing requires elevating that section of the Red Line to effect the tie-in. was selected despite its longer length". Since some of this route also is shared by the Yellow Line, some integration or synergy is accomplished by it. There is no environmental ramification related to the selection among these options, though there are more trees in the median that will need to be removed along the route (Jigar Miradabadi Rd.) than along other routes.

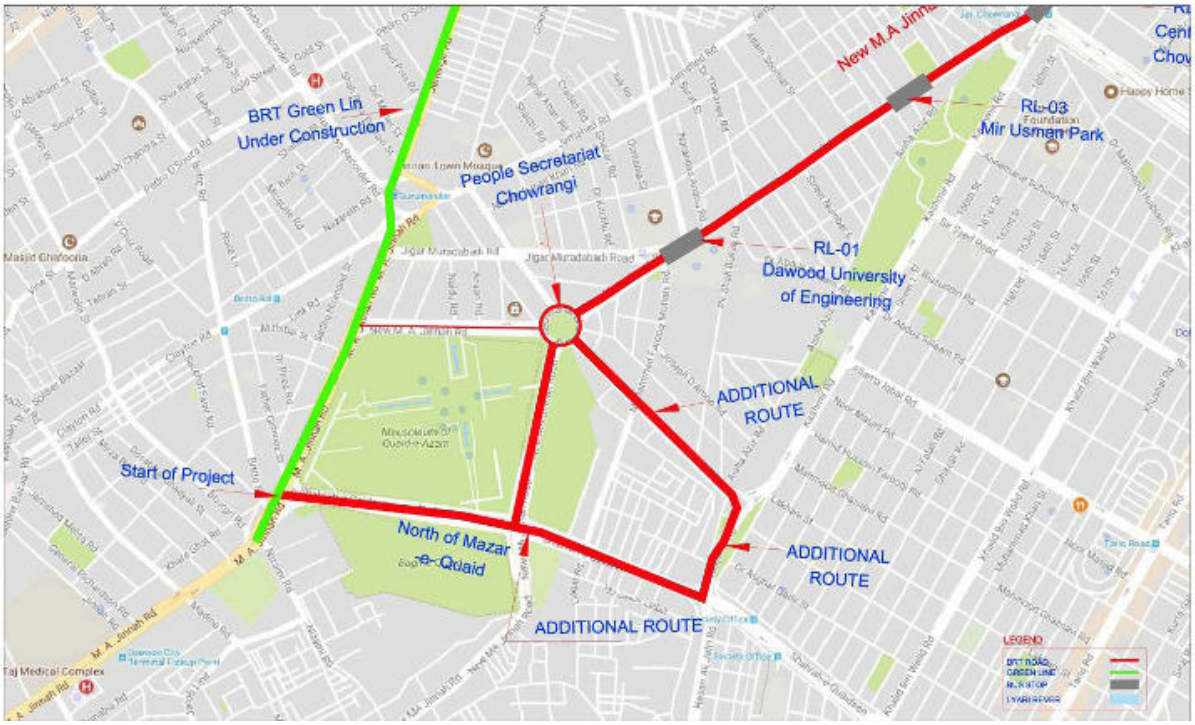

Figure 4-4: Alternative for Tie-in with the Green Line System

4.4 Business Model and Implementation

204. The ODBM consultant is preparing the business model and approach for tendering the operations of the system. Its approach proposes five contracts, administered by the proposed Public Transport Authority (PTA), covering the following major areas:

- Two-lot tender for BRT vehicle operators
- Tender for Fare System and ITS provider
- Tender for Commercial Activities provider
- Tender for Fund Manager

205. Under the operations contracts, the operator will be responsible for: procurement of BRT vehicles adhering to specified technical specifications, along with vehicle homologation and licensing, vehicle warranty, spare parts, and tools and diagnostic equipment; operation of fleet vehicles adhering to schedules set by PTA; dispatch of BRT vehicles; selection of drivers, conductors, and other employees; provision of maintenance services; provision of BRT system operation training to BRT vehicle drivers; and provision of advertising activities on the interior and exterior of the BRT vehicles.

206. The fare system and ITS provider will be responsible for: provision of fare system activities including equipment supply and operation & maintenance of hardware and software components of the system; issuance of smartcards, provision of top-up services and cash handling; provision of intelligent transport system activities including equipment supply and operation & maintenance of hardware and software components of the system; provision of station management services, which include provision of power, water and network connectivity as well as security, cleaning and maintenance of the stations and landscaping; management of kiosks

and other commercial space on the stations; and management of advertising on the stations and the smartcards.

207. Finally, the Fund Manager will see to: auditing of system revenues; provision of escrow account services; and distribution of funds to due entities.

208. While many of these aspects have little direct impact on the environment, the most efficient business model that transfers rights and responsibilities to owner-operators will likely be the most pollution-free and sustainable approach.

4.5 Energy Efficiency, Pollution Prevention and Abatement

209. Many of the buses currently in use in Karachi have spark-ignition engines that operate on natural gas (CNG). New fleet additions for service on the BRT will not be fueled by CNG, rather diesel, diesel-hybrid or electric buses are proposed. A study conducted in 2013 for the Federal Transportation Administration (Lowell 2013) compares benefits of different engine/fuel and propulsion system technologies.

210. The study found that CNG and diesel buses have similar over-all drivetrain efficiency. However, of 14 direct comparisons (diesel and CNG versions on the same bus platform), the diesel bus had higher fuel economy over 10 different tests. Hybrid buses consistently have higher average fuel economy than the diesel and CNG versions of the same bus platform on slow- and medium-speed test cycles, and annual fuel savings from operating new hybrid buses instead of new diesel buses could be as high as 3,100 gallons per bus. (Lowell 2013)

211. Regarding air quality, CNG buses were consistently shown to have lower NOx emissions and higher CO emissions than diesel and hybrid buses across all duty cycles, whereas hybrid buses generally have slightly lower NOx emissions than diesel buses. Modern diesel and hybrid technologies produce PM and hydrocarbon emissions well within the US EPA standard. Diesel and CNG buses emit very similar levels of CO2; while CNG has lower carbon content, the benefit is offset by the higher fuel efficiency of diesel. Hybrid buses generally emit lower CO2 than diesel or CNG buses due to their higher fuel economy. (Lowell 2013) In any case, reliable and uninterrupted supply of CNG will be an issue for CNG buses.

212. The preferred choice of fuel and propulsion is CNG-hybrid, which may be possible if certain constraints can be overcome, including use of CNG for public service vehicles (such as the BRT); and a reliable supply chain based on importation from Qatar. TMTD would also need to petition for permission to establish a CNG fueling station; which is currently prohibited.