JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NATIONAL ECONOMIC DEVELOPMENT AUTHORITY (NEDA)

ROADMAP FOR TRANSPORT INFRASTRUCTURE DEVELOPMENT FOR METRO MANILA AND ITS SURROUNDING AREAS (REGION III & REGION IV-A)

FINAL REPORT

SUPPLEMENTAL REPORT NO. 2

MEGA MANILA SUBWAY PROJECT

March 2014

ALMEC CORPORATION

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

BGC	Bonifacio Global City
BRT	Bus Rapid Transit
CALABARZON	Cavite, Laguna, Batangas, Rizal and Quezon
CAVITEX	Manila-Cavite Expressway
CBD	Central Business District
DOTC	Department of Transportation and Communications
DPWH	Department of Public Works and Highways
EDSA	Epifanio de los Santos Avenue
EIRR	Economic Internal Rates of Return
ENPV	Economic net present values
EO	Executive Order
GCR	Greater Capital Region
GMM	Greater Metro Manila
GRDP	Gross Regional Domestic Product
HSH	High standard highways
IEC	Information, Education and Communication
IRR	Implementing Rules and Regulations
JICA	Japan International Cooperation Agency
kph	Kilometer Per Hour
LAR	Land Acquisition and Resettlement
LRT	Light Rail Transit
MM	Metro Manila
MMDA	Metro Manila Development Authority
MMS	Mega Manila Subway
MMUTIS	Metro Manila Urban Transportation Integration Study
MRT	Metro Rail Transit
MUCEP	Manila Urban Transportation Integrated Study (MMUTIS) Update and Capacity Enhancement Project
NAIA	Ninoy Aquino International Airport
NCR	National Capital Region
NEDA	National Economic and Development Authority
ODA	Official Development Assistance
O&M	Operating and Maintenance
PCU	Passenger Car Unit
PHP	Philippine peso
PM	Particulate Matter
PNR	Philippine National Railways
PPP	Public-Private-Partnership
RA	Republic Act
RoW	Right-of-way
SLEX	South Luzon Expressway
TA	Technical Assistance
TC	Tricycle
TOD	transit oriented development

TTC	Travel time cost
UP	University of the Philippines
USD	US dollar
VOC	Vehicle operating cost

1. INTRODUCTION

1) Background

1.1 The Roadmap for Transport Infrastructure Development for Metro Manila and Its Surrounding Areas (Region III and Region IV-A) was conducted by the National Economic and Development Authority (NEDA), with technical assistance from Japan International Cooperation Agency (JICA). It aimed at not only drafting an integrated priority program coinciding with the Philippine Medium-term Development Plans (2011 – 2016) for the Greater Capital Region (GCR) but also considered projects beyond the 2016 horizon till 2030. This is in view of the driving vision to liberate GCR from the crippling effects of transport-related issues on economic growth.

1.2 A Dream Plan 2030 was formulated addressing gaps across subsectors in an integrated approach. The plan consists of five main components, namely: at-grade urban roads, expressways, urban/suburban rails, road-based public transport, and traffic management. Among others, transport networks were fashioned based on the growing demand, to deliver the desired urban growth and a favorable living environment. A railway network is one such plan including in Dream Plan (see Figure 3.4).

1.3 Two heavy mass transit lines were envisioned to form the public transport backbone connecting the flourishing urban areas of Region III, National Capital Region (NCR) and Region IV-A. These are the Mega Manila North-South Commuter Line and the Mega Manila Subway Line. The former has founded its maturity from past efforts and it is poised for implementation within the short-term period. The latter, on the other hand, has its beginnings in consideration during the roadmap initiative. Therefore, JICA has commissioned this supplemental study to preliminarily present the subway project.

2) Objectives

1.4 The objectives of this Supplemental Study are as follows:

(i) To identify and study candidate alignments for the Mega Manila Subway;

(ii) To recommend the most appropriate one based on technical, economic, financial, social and environmental evaluation ; and

(iii) To preliminarily formulate a concept plan for a subway at a selected location.

2. PROJECT CONCEPT

2.1 Overall Urban Rail Network

2.1 The Project has been identified and conceptualized in the context of an urban rail network for Metro Manila and nearby provinces. These are discussed in the following sub-sections.

1) Existing Railway Lines

2.2 There are three mass transit urban railway lines and a commuter mainline railway (PNR) in MM, as illustrated in Figure 2.1. Following are the key features of these lines:

(i) PNR – a narrow gauge 29 km line from Tutuban to Alabang with 16 stations;

(ii) LRT Line-1 – 18 km with 20 stations, standard gauge grade-separated mass transit system from Baclaran in the south to Roosevelt in the northern section of EDSA;

(iii) LRT Line-2 – 16.7 km with 11 stations, standard gauge mass transit system from Recto in Manila city to Santolan in the east; and

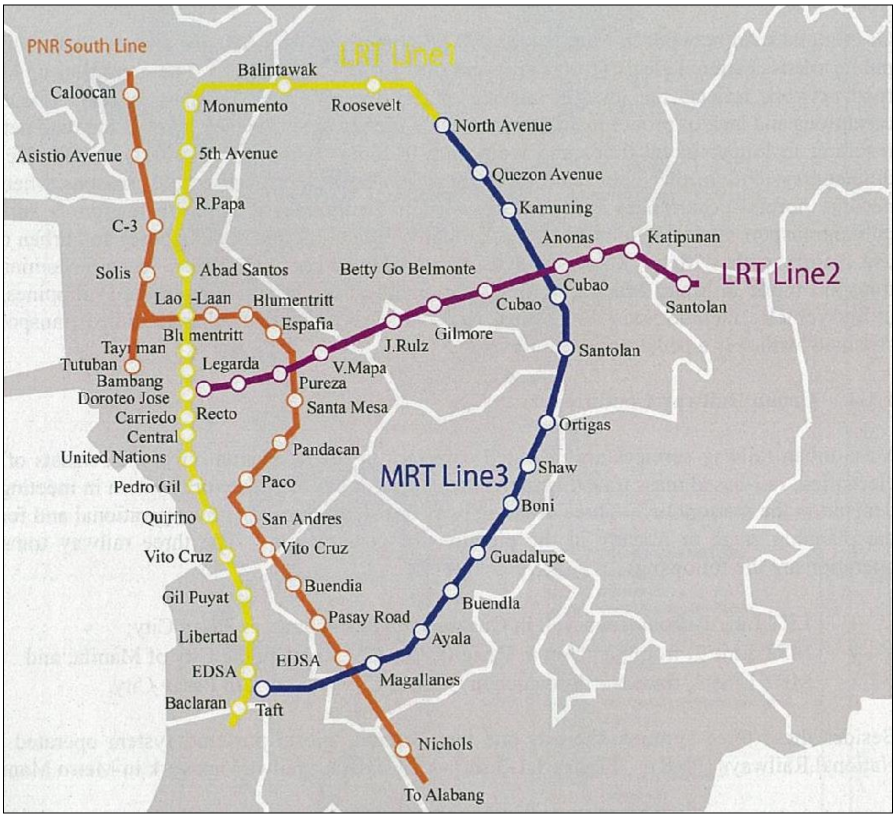
(iv) MRT Line-3 – 16.5 km with 13 stations, standard gauge mass transit system along EDSA (C-4) from Taft to North Avenue.

2.3 The three mass transit lines and the PNR commuter carried about 1.35 million passengers on an average week-day in 2012 (of this, the PNR carried a small proportion of about 46,000 passengers). The daily demand and line capacity characteristics of each line are summarized in Table 2.1. The three mass transit lines combined to carry about 10% of the public transport passenger-km of travel within Metro Manila, compared to 48% by jeepney and 42% by buses on about 850 km of roads. This is a fairly good performance compared to road traffic, with just 51.3 km of mass transit railways with 44 stations (excluding PNR), for a city of over 12 million inhabitants.

(a) Philippine National Railways (PNR)

2.4 Currently, PNR runs a half-hourly service between Tutuban and Alabang. It carries around 40,000 to 50,000 passengers daily. The service is slow and rather erratic as the trains stop-start many times. Trains are full to crush-load from Tutuban to Alabang. Passengers at intervening stations sometimes cannot even get on the train and have to wait 30+ minutes for the next service. The service could hardly be called a ‘commuter’ service with half-hour headways and unpredictable travel times.

2.5 Individual station loadings indicate that 17% of all demand is to/from Alabang. Tutuban and the other four stations (i.e., Blumentritt, Espana, Sta. Mesa and Bicutan) account for majority of the remaining demand. The whole PNR service needs a major overhaul to be called an efficient commuter service between Tutuban and Alabang. The PNR line from Alabang to Calamba is called 'operational,' but services are limited to a few trains per day, and no details were available on patronage on this service.



Source: High Standard Highway Network Development in the Republic of the Philippines, JICA-DPWH, 2010 (as taken from LRTA website).

Figure 2.1 Existing Railway Lines

Table 2.1 Characteristics of Travel Demand by Railways in MM

Description		PNR[2]	LRT Line-1	LRT Line-2	MRT Line-3	Total Railways
Line Length (km)		28.0	18.1	12.6	16.5	75.2
Stations		16	20	11	13	60
2011 Annual Pax (million)		15.4	156.9	63.8	158.8	394.9
2011 Average Weekday Daily Pax		46,000	476,000	193,000	481,000	1,196,000
2012 Average Weekday Pax[1]		50,000	519,000	212,000	572,000	1,348,000
AM-Peak Hour Boarding Pax/hr		2,000[2]	43,200	18,000	48,100	111,300
Peak Line Volume (Max: Pax/hr/direction=pphpd)		1,000[2]	20,100	11,500	20,300	20,300
Current Operational Headway (mins)		30	3	5	3	-
Current Rolling Stock Crush Capacity (Pax/Train)		~500[2]	1,350	1,600	1,180	-
Current Line Capacity (Pax/hr/direction=pphpd)		1,000[2]	27,100	19,500	23,600	-
Current Load Factor (Line Volume/Capacity)		~100%	74%	59%	86%	-
Maximum Future Capacity[3]: Assuming Extended Trains to Full Platform Length & Modern Connected Car Rolling Stock	Train Length (m)	200	110	110	130	-
	Pax/Train	1,800	1,630	1,630	1,930	-
	Headway	3	2.5	2.5	2.5	-
	Pax/hr/dir=pphpd	36,000	40,000	40,000	46,000	-
Available Capacity @ Current Load and Max-Cap:		97%	50%	71%	56%	-

[1] Lines 1&2 data is for March 2012, Line-3 data is for September 2012, and PNR data is for February 2012.

[2] PNR data is for Tutuban to Alabang and peak period data is estimated by the JICA Study Team.

[3] Future capacities are estimated based on possible capacity expansion programs.

Source: PNR/ LRTA/ MRT Data & JICA Study Team Analyses

(b) Metro Manila Urban Mass Transit Lines

2.6 **Line- 1** is the oldest of the three mass transit lines, having been built in the mid-1980's. The patronage on the line grew with time, and reached a peak after about a decade to 450,000 passengers per day by 1994. From then on, the patronage started to decline due to several operational issues mostly related to rolling stock. This lack of capacity led to a decline in patronage to as low as 300,000 passengers per day by 2004/2005. A capacity expansion program was initiated, and the introduction of new/ improved rolling stock led to an increase to the current near maximum patronage of around half a million passengers per day. The maximum demand is during the morning peak hour in the southbound direction, during which the maximum line volume is over 20,000 passengers per hour per direction (PPHPD). The busiest stations are EDSA in the south and Monumento in the north where daily boarding and alighting passengers are over 100,000 per day. The line carries 33% of the rail passenger-km in Metro Manila through the most dense corridor of the metropolis.

2.7 Currently, the line is operating at 74% load factor because of rolling stock issues. There are speed restrictions on several sections of the line. The line headways are also affected due to non-availability of rolling stock resulting in unnecessary congestion at stations and in trains – making the system less attractive to passengers. As a result, Line-1 is going through its second capacity expansion program to enhance its capacity and image.

2.8 Most stations have side platforms with a single entry/exit staircase with no escalators. Serious capacity expansion involving the improvement in travel speed, shorter headways by reducing dwell time at stations, and state-of-the art modern signalling and other improvements (such as platform screen-doors), could lead to almost doubling its current line capacity to 40,000 PPHPD. Such operational improvements would put more pressure on station infrastructure and facilities which would also need to be enhanced in line with other infrastructure and operational improvements.

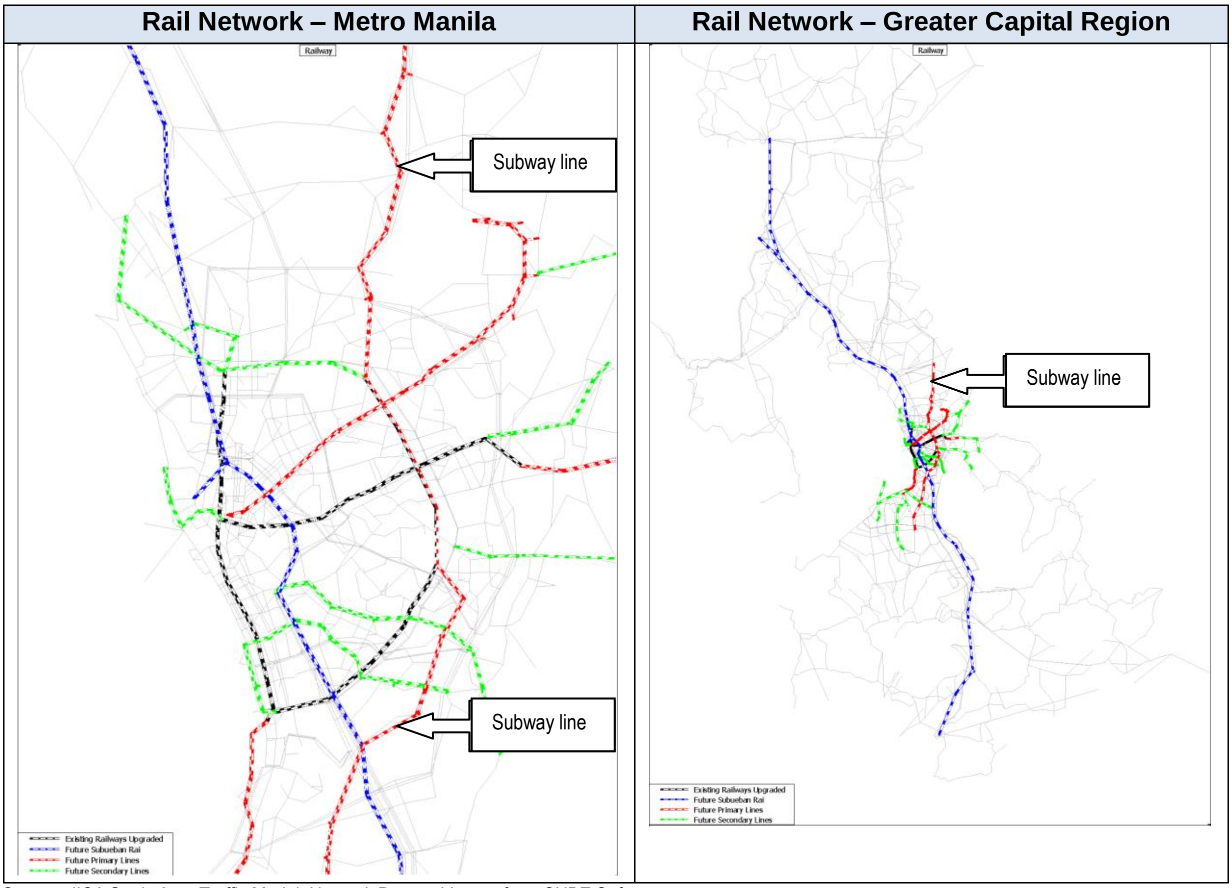
2.9 **MRT Line-3** is a circumferential line that carries most rail passengers in MM, some days well in excess of half a million passengers. The travel demand on the line accounts for over 50% of the total daily rail passenger-km travelled, along one of the busiest transport corridors of MM. It is estimated that Line-3 is operating at near capacity of 85% load factor. The estimation of the load factor, as detailed in the above table, is calculated using train crush capacity at 8 passengers/m2 which, in reality, is difficult to achieve. Such crush capacity train loading leads to other issues like increased dwell time resulting in delays, in turn reducing system capacity, not to mention passenger inconvenience. Currently, it is a well-known fact that patronage on Line-3 is capacity constrained. The travel demand in the corridor far exceeds both the road and rail available capacities. No doubt, enhanced travel time on Line-3 and better passenger handling arrangements and improved station access facilities could bring more patronage, but that would require a serious overhaul of the entire system. Higher capacity rolling stock, better station arrangements and improved accessibility could lead to about 40% increase in peak hour capacity to 46,000 PPHPD, from the current near capacity volume of 24,000 PPHPD.

2.10 **LRT Line-2** is a radial line from Santolan in the east to Recto in the heart of Manila City. The Line is a modern mass transit system which opened for revenue service in 2003. The patronage on the line increased rapidly in the early years since its opening and has now reached over 212,000 passengers per day. Peak line volume analysis revealed that loading on Line-2 is extremely directional compared to Lines 1 and 3, and was estimated to be 11,500 PPHPD. The service operated at 5 minutes headway, with a load factor of about 60%. The traffic on the line accounts for 16% of the total rail passenger-km of MM, with an average trip length of about 7 km. The two terminal stations are busiest, followed by the Cubao station where passengers transfer to Line-3.

2.11 The station facilities are better than the other two lines. At Santolan, the majority of the patronage is of passengers transferring to LRT from jeepneys. The line has major potential and available capacity to increase patronage, but this would require improving multi-modal transfer facilities at Recto, Santolan and Cubao.

2) Proposed Urban Rail Network

2.12 Apart from the currently operating railway lines, the Roadmap for Infrastructure Development for Metro Manila and Its Surrounding Areas (Region III and Region IV-A) proposed two major north-south rail systems following its adopted north/south (N/S) corridor development strategy. The western N/S corridor is based on the philosophy to make best and most effective use of the existing PNR right-of-way (RoW) and provide a high capacity modern suburban railway. On the east side of the N/S corridor, it is proposed to provide a high capacity mass transit system from Cavite to Bulacan through the densest part of MM and along the busiest transport corridor of the metropolis. The proposed railway network for a "do-maximum" scenario is illustrated in Figure 2.2 and its key features are summarized in Table 2.2.



Source: JICA Study Area Traffic Model, Network Demand Image from CUBE Software

Figure 2.2 2030 Rail Network Current and Proposed New Lines ("Do Maximum" Scenario)

2.13 The north/south corridor lines are supported by primary network lines of LRT/MRT lines within MM, supplemented by five secondary lines acting as feeder lines. It is also proposed that the existing three lines should go through major overhaul and capacity expansion programs to utilize the full extent of the infrastructure. The current rail network (excluding PNR which carries minimal passengers) would increase by almost tenfold from the current 47 km to 494 km with 285 stations by 2030.

2.14 It should be noted that the future line lengths are approximate and station numbers are also estimated based on possible location accessibility and station spacing. Exact line lengths and number of stations may be revised/ determined/ confirmed at the feasibility study stage of each line.

Table 2.2 2030 Do-maximum Proposed Railway Network – Key Characteristics

Code	Project	Section /Description	Line Characteristics	
			Length (km)	Stations (Approx.)
LRT 1	LRT 1 Existing Capex	Baclaran - Monumento	18.1	20
LRT 1-1	LRT 1 South Ext. Phase1	Baclaran - Niog	11.8	8
LRT 1-2	LRT 1 South Ext. Phase 2	Niog-Dasmarinas	18.4	13
LRT 1-3	LRT 1 North Ext.	Monumento-Malabon	2.7	2
LRT 1	**Sub-total**		**51.0**	**43**
LRT 2	LRT 2 Existing Capex	Recto-Santolan	12.6	11
LRT 2-1	LRT 2 East Ext. Phase 1	Santolan-Masinag	4.2	2
LRT 2-2	LRT 2 East Ext. Phase 2 (a)	Masinag-Antipolo (Underground)	3.0	1
LRT 2-2	LRT 2 East Ext. Phase 2 (b)	Masinag-Antipolo	6.0	5
LRT 2-3	LRT 2 West Ext.	Recto-Manila North Harbor	4.7	3
LRT 2	**Sub-total**		**30.5**	**22**
MRT 3	MRT 3 Existing Capex	Taft-North Avenue	16.5	13
MRT 3-1	MRT 3 Ext. South	Taft-Mall of Asia (Underground)	2.2	2
MRT 3-2	MRT 3 Ext. West	Monumento-Malabon/Navotas	7.2	5
MRT 3	**Sub-total**		**25.9**	**20**
MRT 7-1	MRT 7 (Underground)	Recto-Blumentritt	2.1	3
MRT 7-2	MRT 7 (Elevated)	Blumentritt-Commonwealth Ave.-Banaba	24.0	18
MRT 7	**Sub-total**		**68.6**	**48**
MRT NS-1	Subway Line	MM-BGC-Makati	43.5	30
MRT NS-2	Subway Line	North & South Sections	74.6	23
MRT NS	**Sub-total**		**68.6**	**48**
Sub-total of Upgrade/Capex		**Existing Lines (excluding PNR)**	**47.2**	**44**
Sub-total LRT/MRT		**Extensions + New**	**154.9**	**110**
Monorail-1	Ortigas	Ortigas-Angono	13.7	14
Monorail-2	Paco	Paco-Pateros	11.3	12
Monorail-4	Marikina Line	Marikina-Area	16.8	15
Monorail-5	Alabang	Alabang-Zapote	9.3	8
Monorail-6	Cavite	Zapote-Cavite-Gen.Trias	20.6	18
Sub-total Secondary Lines		**Monorail Lines**	**71.7**	**67**
PNRC-1	NS Commuter Rail	Malolos-Calamba	91.3	32
PNRC-2	NS Commuter South Ext.	Calamba-Batangas	47.7	12
PNRC-3	NS Commuter North Ext.	Malolos-Angeles-Tarlac	81.1	20
Sub-total Main Railways		**Commuter & Suburban**	**220.1**	**64**
GRAND TOTAL		**ALL RAILWAYS**	**493.9**	**285**

Source: JICA Study Team

2.2 Expected Role of the Project

2.15 The EDSA Subway Project would cover the MRT-N/S Line cited in the previous section. It will start at San Jose Del Monte in Bulacan Province in the north, then traverse the high volume corridors of Metro Manila and end at Dasmarinas in Cavite Province in the south. With its North-South alignment, it will effectively connect Region III (Central Luzon), the National Capital Region (Metro Manila) and Region IV-A (CALABARZON).

2.16 The Project supports the vision for an integrated and complementary development of the three regions as one multi-nodal development corridor, based on each region's competitive advantage, with an efficient transport backbone as the integrating element. It will be part of a transport network that has been developed and guided by an appropriate spatial development strategy that would lead to equitable development, reduced disaster risks and pollution, and improved work-life balance. It is envisioned to address the following:

(i) **Provide a strong north-south transport backbone that will augment the constrained capacities of the current railway lines and ease traffic congestion in Metro Manila.**

2.17 The impact of the current traffic congestion in Metro Manila is substantial. According to the Department of Transportation and Communications (DOTC), traffic congestion caused an economic loss of PHP137.7 billion in 2012.[1] The negative externality or simply cost of traffic congestion include lost opportunities of business, inefficiency in the economy, pollution, waste of energy and resources, impact on health, decline of quality of life, increased risk of accidents, etc. It was estimated that economic losses from traffic congestion in the last decade are indeed four times larger than investments needed for the public transport projects in Metro Manila.[2]

2.18 Traffic congestion in Metro Manila needs an integrated approach based on urban mass transit, since improvement of the road network alone cannot solve the issue. While several railway lines are already being planned, it is foreseen that there will still be an urgent need to provide a high capacity rail system to fully address the ever increasing demand for transport which is the result of continuing urbanization and rapid population growth.

(ii) Connect Metro Manila with the growth poles in the north and south suburban areas

2.19 The rapid growth of population in the Metro Manila area is manifested in the extent and influence of its urban development which can be both seen and felt well beyond the boundaries of the metropolis. Encouraged by cheaper land and services but still within relatively easy access to Metro Manila, predominantly private sector-led investments can be found beyond the northern, eastern, and southern administrative boundaries of the metropolis. The physical pressures exerted by fast-

[1] The Philippine Star, "Traffic congestion cost PhP137 billion last year," September 27, 2012.

[2] Regidor, Jose Regin F., 2012. Revisiting the Costs of Traffic Congestion in Metro Manila and Their Implications. Proceedings of the 2012 UP College of Engineering Professorial Chair Colloquium. Available from http://doctrine.files.wordpress.com/2012/09/prof-chair-2012-jrfr-02july2012.pdf. Accessed on June 23, 2013.

paced urbanization have extended the urban built-up area. In the north, focus is given to San Jose Del Monte, Bulacan which has been identified as one the fastest growing cities in the Greater Capital Region. The planned MRT7 will connect this city to the highly urbanized areas in Quezon City and Manila in an East-West alignment, while the EDSA subway will be its connection to the Central Business Districts in Pasig, Mandaluyong, Makati and Taguig and then to Cavite in the south through Dasmarinas which is currently the largest city in the province in terms of population and land area.

(iii) Provide a reliable and efficient mass transport system that will promote synergistic growth of the whole Greater Capital Region (GCR) comprised of Central Luzon, Metro Manila, and CALABARZON.

2.20 These three are the most populous regions in the Philippines, collectively accounting for almost 60% of the country's population. The fastest growing areas are those located on the periphery of Metro Manila. A key element of this growth is the entry of migrants as they are among the top five destinations of most migrants. This is attributed to the opportunities for gainful employment and access to better amenities. The mobility of people across the GCR shows both inward and outward movements – residents of Metro Manila have moved to the adjacent regions, while those of Central Luzon and CALABARZON still see Metro Manila as the land of opportunity.

2.21 With the concentration of labor-intensive establishments in Metro Manila and its adjacent municipalities of Bulacan, Rizal, Laguna, and Cavite, the three regions account for more than 30% of the total employed population of the country, and about 50% of the total non-agricultural employed persons. However, the three regions have a majority of all recorded unemployed, a symptom of the social and economic problems of rapidly urbanizing areas.

2.22 Metro Manila serves Central Luzon and CALABARZON as (a) the major market for their agricultural products; (b) the destination of students seeking education and to people seeking medical services and facilities; (c) a major shopping center for finished products; and (d) the gateway for people, goods, and services to and from the rest of the country and abroad. In return, Metro Manila looks to the adjacent regions as (a) its major source of food supply; (b) a key source of manpower; and (c) a nearby area for recreation and leisure activities. The municipalities on the immediate fringes have served as source of land for residential and industrial development and for main infrastructure such as water supply.

(iv) Alternative Project Concept

2.23 In the Philippines, a railway system is either installed at-grade along open areas or elevated along existing roads and waterways. On the other hand, due to rapid urbanization of some areas in Metro Manila, the cities and even the first class municipalities are left with very small areas for expansion of their infrastructure system. This dilemma resulted in overcrowding of streets, heavily congested roads, and insufficient capacity of the transport system. Planners and project implementers are now left with no choice but to maximize utilization of available right-of-way, which oftentimes results in complicated structures and high implementation costs. Deviation from this scheme will otherwise result in expensive right of way acquisition and payment of compensation to project-affected properties and persons, disruption of economic activities, and costly mitigating measures for adverse social and environmental impacts.

2.24 While the said systems are still applicable in most of the existing roads' right-of-way, some of these locations are no longer available due to committed projects, which were planned some years back and just awaiting implementation. Other roads have complicated arrangements already due to the installation of different transport systems and project components in the same location.

2.25 The country's continuously growing urban population, high cost of fuel, and the concern for traffic congestion and the need to meet environmental regulations to minimize if not totally eliminate pollution (emissions control) have put pressure to the existing public transport system. More so that public transportation systems such as the LRT/MRT is becoming more and more popular and attractive to ordinary citizens, employees and even to those who are holding managerial positions in their respective offices because of faster travel and cheaper fare. The said transport system is still the most reliable and dependable mode since one can predict travel time to destination.

2.26 With the advent of new technologies and state-of-the art construction equipment, any project could now be handled with ease and precision. This study introduces the application of the Subway System Concept in one of the country's transportation systems. This system is now being widely used in other countries with large metropolitan and highly populated areas where space for construction of the structure for a mass transport project is very limited and the remaining option is to go underground wherever feasible.

2.27 A subway structure is almost similar to an underpass structure except that construction can go deeper in the former, avoiding some obstacles such as manholes and utility lines which are normally encountered in shallow excavation and underpass construction but could not be cut off or interrupted even for a short period as it will mean economic losses to business establishments and factories as well as discomfort to the public. A subway system is more expensive than any other ordinary alternative. However, the trade-offs in ease of construction, minimum disturbance and disruption to traffic flow, and continuous operation of business outweigh this cost factor.

3. Preliminary Demand Forecast

3.1 Methodology

3.1 The following sections describe the approach taken and the methodology followed in the estimation of ridership for different alignment options for the Project. The transport demand model developed for the Formulation of a Transportation Roadmap Study, which was based on state-of-the-art "CUBE" transport planning software, was utilized.

1) General Approach

3.2 The traffic demand analysis methodology has been kept simple and relied mostly on the available data and information from recent studies. The process adopted for the traffic demand analysis and the forecast methodology is depicted in Figure 3.1.The key steps in the development of the transport model are as follows:

(i) Convert MMUTIS and HSH study area O/D trip matrices to the project traffic model zone system;

(ii) Create 2012 O/D trip matrices for common base year of the project 2012. This aspect is detailed in the model validation section and shows that the traffic model replicates the current situation well by mode of travel;

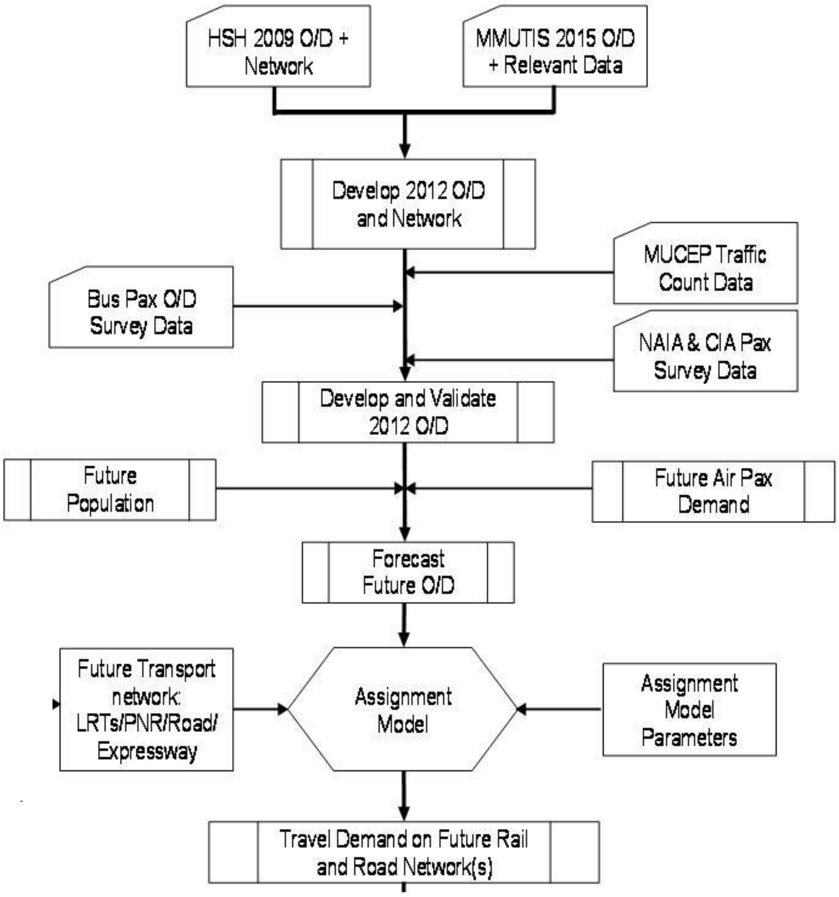
(iii) Combine 2012 MMUTIS and HSH O/D trip matrices by selecting the whole of MMUTIS area trips for the Mega Manila area, and HSH O/D trips for the remainder of the GCR regions;

(iv) Develop the study area highway and railway network from HSH study and update where necessary;

(v) Validate the 2012 O/D trip matrices by assigning to the 2012 network and comparing the assigned traffic volume against the MUCEP traffic count data collected in 2012; and

(vi) Prepare future year O/D trip tables and assign to the 2012 network and to the committed/ proposed highway and rail networks.

3.3 The demand model was used in assessing the ridership of the project under different alignment options. The outputs were then used in the ensuing economic, financial and environmental evaluation.



Source: JICA Study Team

Figure 3.1 Traffic Demand Analysis – Methodology

2) Traffic Zone System

3.4 The new zone system developed for the study is compatible with other studies, mainly MMUTIS, HSH and recently completed study of Airport Express Rail study, summarised in Table 3.1.

Table 3.1 Study Traffic Zone System and its Compatibility with Other Projects

Area Description	Number of Traffic Zones in the Study Area		
	Roadmap[1]	MMUTIS[2]	HSH[3]
Metro Manila (NCR 17 Cities)	94	94	94
Bulacan province	26	23	26
Laguna province	14	11	19
Rizal province	15	19	17
Cavite province	23	30	25
Rest of Region III	37	1	74
Rest of Region IV-A	18	1	28
Special Zones (Ports & Airports)	8	2	1
Other Areas in Luzon (Externals)	10	-	36
Total Zones	**245**	**181**	**320**

1. Roadmap for Transport Infrastructure Development for MM and its Surrounding Areas (Regions III & IV-A).
2. Metro Manila Urban Transport Integration Study 1999, Forecast Model Zone System.
3. The Study of High Standard Highway Network Development, 2009.

Source: Compiled by JICA Study Team

3.5 The traffic zone system was devised such that when converting O/D trip tables to the project area, minimum detail is lost in aggregation of zones within the Greater Metro Manila (GMM) area consisting of NCR, Bulacan, Laguna, Rizal and Cavite provinces. In the outer areas within the Greater Capital Region (consisting of NCR, Region III and Region IV-A), some zones were aggregated to lose the detail not necessary for this project.

3) Development of the Base Year (2012) Travel Demand O/D Tables

3.6 The traffic model was developed for the following four types of O/D trip matrices:

(i) Car person trips O/D (including taxi trips);

(ii) Jeepney passenger trips O/D (including FX and HOV);

(iii) Bus passenger trips O/D (including all buses); and

(iv) All goods vehicles (including delivery vans, pick-up vehicles and trucks).

3.7 All O/D trips matrices represented average number of daily (on an average weekday) trips. The O/D tables by mode from MMUTIS and HSH study 2012 were combined to arrive at an initial 2012 O/D as shown in Table 3.2.

Table 3.2 Formation of Initial 2012 O/D Tables – Sources of O/D Trips

Area	Greater MM Area (Zones 1-172)	Remaining Areas (Zones 173-245, excluding Special Zones)
Greater MM Area (Zones 1-172)	O/D Source MMUTIS O/D table	HSH Study O/D table
Remaining Areas (Zones 173-245, excluding special zones)	HSH Study O/D table	HSH Study O/D table

Note: Special Zone trips were estimated exogenously from various O/D surveys and added to the O/D table
Source: JICA Study Team

4) Base Year 2012 Traffic Model Networks

3.8 The traffic model base year network was developed from both MMUTIS and HSH study area networks on the same basis as the O/D table described above. The key characteristics of the two networks are summarized in Table 3.3. The level of detail of the network model was based on the area, i.e., in the MM inner area the network includes all expressways, primary roads (R1-R10 and C1-C5) and most secondary roads. In some cases in small zones, local roads were also included. Outside MM and within the Greater Capital Region, all expressways and primary/ national roads are included in the network while only the secondary roads of strategic importance (those linking key conurbations to primary/ national roads) are included.

3.9 The rail network included the three mass transit lines and the PNR Tutuban-Alabang operation, all within Metro Manila.

Table 3.3 Key Characteristics of the Study Area Traffic Model Network

Description	MM Area (km)	Rest of GCR (km)	Total (km)
Expressways	54	244	298
Primary Roads	272	2,517	2,789
Secondary / Local Roads	470	1,968	2,438
Sub-Total Primary & Secondary Roads	*742*	*4,485*	*5,227*
Total Roads	**796**	**4,729**	**5,525**
Railway Network Metro Manila			
Line/ System	Length (km)		Stations
LRT Line-1	18.1		20
LRT Line-2	12.6		11
MRT Line-3	16.5		13
PNR Tutuban-Alabang	28.0		16
Total Rail Network	**75.2**		**60**

Source: JICA Study Team

3.10 The combined road/ rail network was used in the model to assign the O/D table. The assignment process used is based on the well-known 'equilibrium' method, where the traffic from each O/D pair is assigned iteratively to the network until no cheaper/ quicker route could be found. The shortest path building was based on the generalized cost of travel for private mode and public transport fares while wait & walk times were represented for the public modes according to the service on each line. The equilibrium method re-calculates the new travel time based on the road capacity and assigned traffic volume after each assignment iteration. As the travel speed slows down with the addition of more traffic, each succeeding iteration of the assignment adds more traffic to the network. The speed/ flow, i.e., volume delay function, was calibrated according to the network and is based on the USA BPR adopted formula.

3.11 The general form of the function is described below and is graphically depicted in Figure 3.2. The road capacities and maximum link speed were adopted from the MMUTIS demand model but, where necessary, the road capacity and maximum speed coded in the network were updated according to the current (2012) conditions. The 'base' road capacities and maximum speeds adopted for the study are summarized in Table 3.4. Other assignment model parameters are listed in Table 3.5 and the related railway assignment parameters are given in Table 3.6.

$$Tx = T0\left\{1 + \alpha\left(\frac{V}{C}\right)^{\beta}\right\}$$

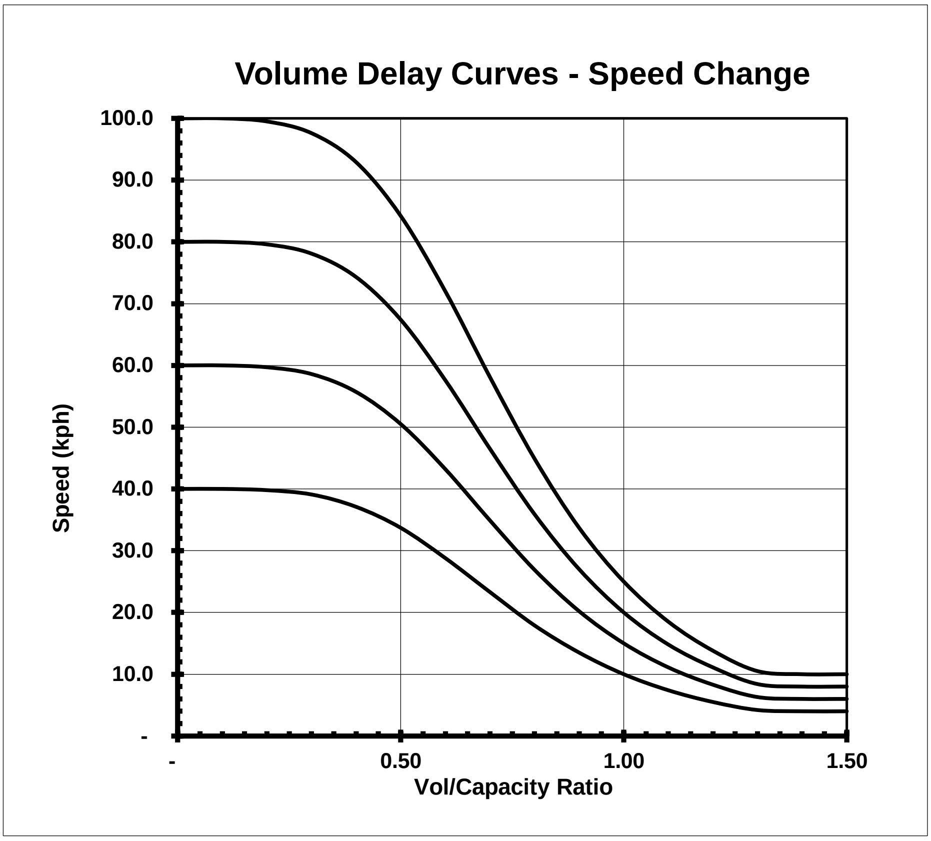
Where: Tx= Travel Time at a Volume/Capacity Ratio x;

T0= Travel Time at Maximum Speed;

V=Traffic Volume in PCU;

C=Road Capacity in PCU; and

α *and* β *are Calibrated Parameters with values:* α = 3.0, β = 4.0



Source: MMUTIS Study and Updated by JICA Study Team

Figure 3.2 Volume Delay Curves

Table 3.4 Road Network Capacities and Maximum Speed

Area	Road Category	Carriageway Type	Capacity 1-way pcu/hour/lane	Maximum Speed
Inside EDSA	Local road	Single	220	30
	Secondary	Single	440	40
	Primary	Single	660	45
Outside EDSA Inside MM (including EDSA)	Secondary	Single	770	50
	Primary	Single	825	60
	Secondary	Divided	1,400	70
	Primary	Divided	1,650	80
Outside MM	Local road	Single	800	30
	Secondary	Single	1,100	55
	Primary	Single	1,540	60
Urban / Inter City	Access / egress	Single	1,500	80
	Expressway	Single	1,700	80
	Expressway	Divided	2,000	100

Source: MMUTIS Study and updated by JICA Study Team where appropriate

Table 3.5 Assignment Model Parameters – 2012 Road Transport 2012

Parameter Description	Car	Jeepney	Bus	Truck
Average 24-hour Occupancy (Person)	1.70	10.02	35.28	n/a
PCU Factor	1.00	1.50	2.00	2.00
Value of Time (PhP/min)	1.86	1.30	1.30	n/a
Vehicle Operating Cost (PhP/km)	7.30	n/a	n/a	n/a
Toll Rate Within MM (PhP/km)	10.30	10.30	20.60	30.90
Toll Rate Outside MM (PhP/km)	3.40	3.40	6.80	10.20
Perceived Toll Factor	1.00	0	0	0.50
Public Transport Fare (PhP/km)	n/a	2.00	1.72	n/a

Source: JICA Study Team

Table 3.6 Assignment Model Parameters 2012 – Railways

Parameter Description	LRT-1	LRT-2	MRT-3	PNR
Average Peak Hour Headway (mins)	3.0	5..0	2.5	30.0
Average Speed (km/h)	26.0	29.6	29.5	26.1
Boarding Fare (PhP/boarding)	12.0	12.0	10.0	10.0
Additional Fare (Boarding + PhP/km)	0.45	0.18	0.28	0.30
Perceived Wait Time (Factor)	1.3	1.3	1.3	1.3
Access Walk Speed (km/h)	4.0	4.0	4.0	4.0

Source: JICA Study Team

5) Validation of the Base Year (2012) O/D Tables

3.12 The traffic model validation process involved comparison of modelled traffic volume against the traffic counts by vehicle type. For this purpose, 2012 MUCEP traffic count data was used. The MUCEP data was available at the following three levels:

(i) Outer Cordon – Outer boundary of Mega Manila Area (i.e., outer boundary of Bulacan, Cavite, Laguna and Rizal Provinces), almost the same area inside the outer cordon as the MMUTIS Study area;

(ii) Inner Cordon – Metro Manila boundary; and

(iii) Three Screenlines within MM – (a) Pasig River; (b) San Juan River; and (c) PNR.

3.13 A total of 16 roads crossed the outer cordon, 20 roads crossed the inner cordon, and 46 roads crossed the three screenlines. The comparison was at aggregate level across a combination of roads along a particular corridor like north, south and east. Table 3.7 compares the modelled traffic volumes and the observed counts for the two cordons and three screenlines within MM. It can be seen that a good comparison was achieved after a few iterations of adjustments to the O/D trip matrices by each mode at daily level. The overall assessment is that total screenlines and cordon volumes are within 10% of the counts.

3.14 Validation of person trips on railways was carried by comparing the modelled patronage with the total daily boarding on each line, and the results are summarized in Table 3.8. It can be seen that the total modelled rail patronage is within 10% of the average daily volume of all lines. The Line-1 modelled daily demand is 17% higher than the observed volume. This was further analyzed and was deemed to be acceptable as the modelling process is set-up to forecast overall demand rather than each station by station volume, which requires a greater level of detail of rail line access (road and walk) network and finer/ smaller traffic zone system than adopted for this strategic network assessment model. In the case of PNR patronage, the actual boarding numbers are small and are not of much concern as the service provided is erratic and observed volumes are also subject to large daily fluctuations.

3.15 The model validation process yielded the 2012 O/D trip matrices by four modes of travel. Table 3.9 summarizes the total Inter-Zonal trips in each trip O/D table by region.

Table 3.7 Road Network Capacities and Maximum Speed

Description - MM Screenlines	Cars			Truck PCU			Total PCU		
	Count	Model	M/C	Count	Model	M/C	Count	Model	M/C
Pasig River – Screenline	480,000	508,600	1.06	142,600	150,900	1.06	622,600	659,500	1.06
San Juan River – Screenline	372,800	379,100	1.02	154,500	144,400	0.93	527,300	523,500	0.99
PNR - Screenline	349,700	388,100	1.11	88,600	85,700	0.97	438,300	473,800	1.08
Total All MM Screenlines	**1,202,500**	**1,275,800**	**1.06**	**385,700**	**381,000**	**0.99**	**1,588,200**	**1,656,800**	**1.04**

Description - MM Screenlines	Jeepney Pax			BUS Pax			Total Pax		
	Count	Model	M/C	Count	Model	M/C	Count	Model	M/C
Pasig River – Screenline	620,217	561,700	0.91	647,104	675,400	1.04	1,267,321	1,237,100	0.98
San Juan River – Screenline	870,800	863,400	0.99	733,100	649,900	0.89	1,603,900	1,513,300	0.94
PNR - Screenline	452,900	410,300	0.91	418,000	510,700	1.22	870,900	921,000	1.06
Total All MM Screenlines	**1,943,917**	**1,835,400**	**0.94**	**1,798,204**	**1,836,000**	**1.02**	**3,742,121**	**3,671,400**	**0.98**

Description - MM Cordon	Cars			Truck PCU			Total PCU		
	Count	Model	M/C	Count	Model	M/C	Count	Model	M/C
Inner Cordon - North (GR01-05, EW01)	61,100	87,100	1.4	63,300	64,800	1.0	124,400	151,900	1.22
Inner Cordon - East (GR06-14)	126,900	105,100	0.8	59,400	56,700	1.0	186,300	161,800	0.87
Inner Cordon - South (GR15-18, EW02,03)	142,300	166,200	1.2	68,800	57,500	0.8	211,100	223,700	1.06
Inner (MM) Cordon Total	**330,300**	**358,400**	**1.1**	**191,500**	**179,000**	**0.9**	**521,800**	**537,400**	**1.03**

Description - MM Cordon	Jeepney Pax			BUS Pax			Total Pax		
	Count	Model	M/C	Count	Model	M/C	Count	Model	M/C
Inner Cordon - North (GR01-05, EW01)	166,900	276,500	1.7	337,840	428,100	1.3	504,740	704,600	1.40
Inner Cordon - East (GR06-14)	671,000	536,800	0.8	43,400	88,300	2.0	714,400	625,100	0.88
Inner Cordon - South (GR15-18, EW02,03)	328,000	326,300	1.0	543,700	535,400	1.0	871,700	861,700	0.99
Inner (MM) Cordon Total	**1,165,900**	**1,139,600**	**1.0**	**924,940**	**1,051,800**	**1.1**	**2,090,840**	**2,191,400**	**1.05**

Description - GMM Cordon	Cars			Truck PCU			Total PCU		
	Count	Model	M/C	Count	Model	M/C	Count	Model	M/C
Outer Cordon - North (OC1, 6-8&20)	37,800	37,400	0.99	46,400	46,200	1.00	84,200	83,600	0.99
Outer Cordon - East (OC09)	1,100	1,000	0.91	1,500	8,300	5.53	2,600	9,300	3.58
Outer Cordon - South (OC1, 6-8&20)	53,400	56,127	1.05	36,400	36,800	1.01	89,800	92,927	1.03
Total Outer (GMM) Cordon	**92,300**	**94,527**	**1.02**	**84,300**	**91,300**	**1.08**	**176,600**	**185,827**	**1.05**

Description - GMM Cordon	Jeepney Pax			BUS Pax			Total Pax		
	Count	Model	M/C	Count	Model	M/C	Count	Model	M/C
Outer Cordon - North (OC1, 6-8&20)	42,100	47,800	1.14	153,300	141,100	0.92	195,400	188,900	0.97
Outer Cordon - East (OC09)	1,900	6,300	3.32	1,400	800	0.57	3,300	7,100	2.15
Outer Cordon - South (OC1, 6-8&20)	153,100	142,900	0.93	212,100	226,700	1.07	365,200	369,600	1.01
Total Outer (GMM) Cordon	**197,100**	**197,000**	**1.00**	**366,800**	**368,600**	**1.00**	**563,900**	**565,600**	**1.00**

Source: JICA Study Team

Table 3.8 Comparison of Observed and Modelled Patronage on MM Railways

Description - Railway Line	Daily Railway Pax		
	Count	Model	M/C
Line-1 Baclaran to Roosevelt	518,600	605,100	1.17
Line-2 Recto to Santolan	212,000	206,500	0.97
Line-3 Taft to North Avenue	570,000	577,900	1.01
PNR Tutuban to Alabang	46,700	61,200	1.31
Total MM Railways	**1,347,300**	**1,450,700**	**1.08**

Source: JICA Study Team

Table 3.9 Summary of 2012 Inter-Zonal Trips by Study Area Regions

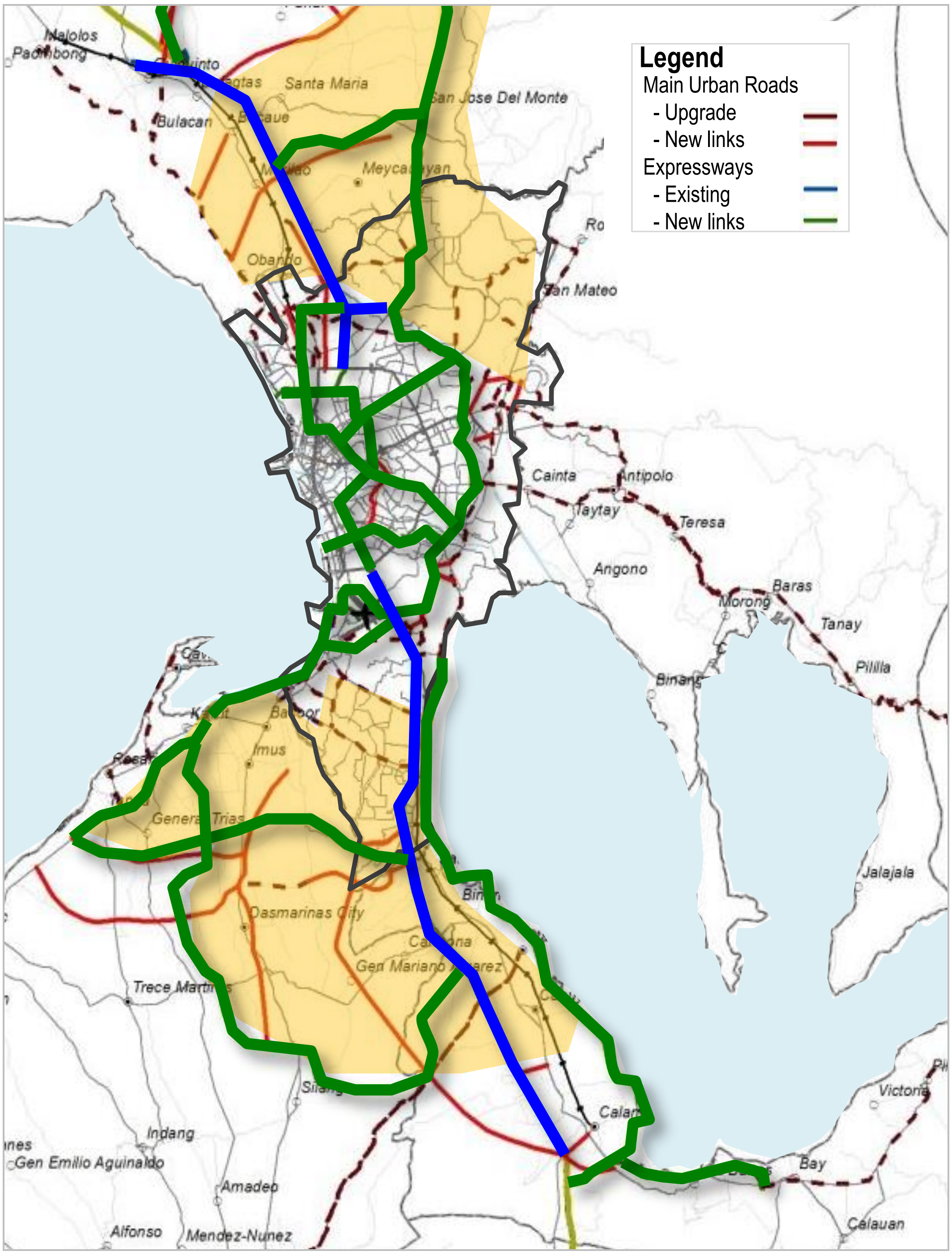
TRSD - 2012 Validated Person Trips by Car					Pax ('000)
No.	City/Province/ Region	1	2	3	Total
1	Metro Manila	4,077.9	73.1	20.3	4,171.4
2	Bulacan+Laguna+Rizal+Cavite	73.1	1,711.6	18.6	1,803.2
3	Rest of GCR	20.3	18.6	156.3	195.2
	Total	4,171.4	1,803.2	195.2	6,169.8
TRSD - 2012 Validated Person Trips by Jeepney					Pax ('000)
No.	City/Province/ Region	1	2	3	Total
1	Metro Manila	5,307.3	318.9	15.0	5,641.3
2	Bulacan+Laguna+Rizal+Cavite	318.9	1,408.4	38.5	1,765.8
3	Rest of GCR	15.0	38.5	160.1	213.5
	Total	5,641.3	1,765.8	213.5	7,620.5
TRSD - 2012 Validated Person Trips by Bus					Pax ('000)
No.	City/Province/ Region	1	2	3	Total
1	Metro Manila	2,692.3	247.0	90.1	3,029.4
2	Bulacan+Laguna+Rizal+Cavite	247.0	2,164.2	14.4	2,425.6
3	Rest of GCR	90.1	14.4	121.1	225.6
	Total	3,029.4	2,425.6	225.6	5,680.5
TRSD - 2012 Validated Goods Vehicle Trips					Vehs('000)
No.	City/Province/ Region	1	2	3	Total
1	Metro Manila	266.6	16.8	15.5	298.9
2	Bulacan+Laguna+Rizal+Cavite	16.8	76.0	10.7	103.6
3	Rest of GCR	15.5	10.7	11.0	37.1
	Total	298.9	103.6	37.1	439.6

Source: JICA Study Team

3.2 Estimated Ridership

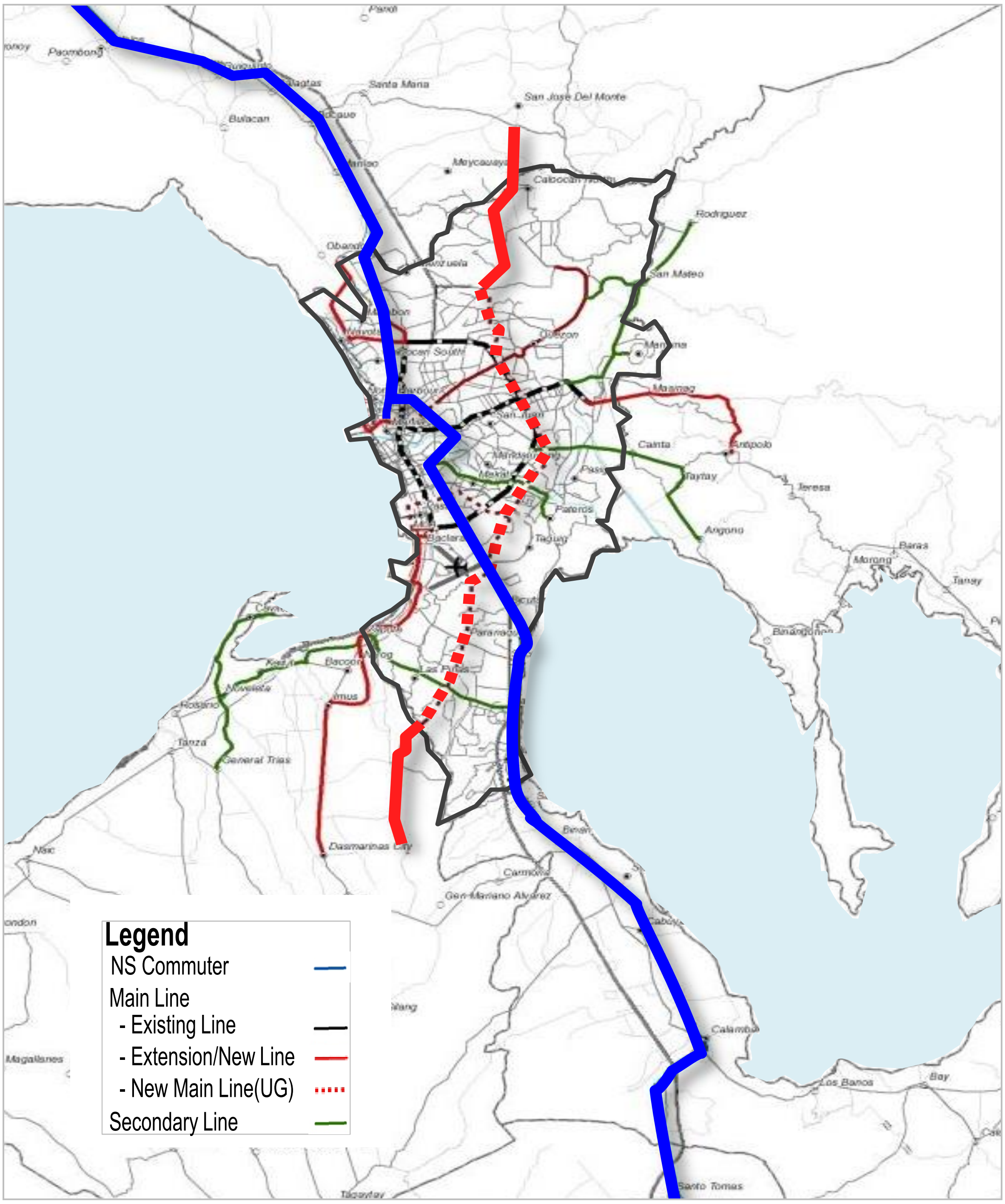
3.16 The validated model was then run for the year 2030 using forecast 2030 O/D matrices and future transport networks, shown in Figures 3.3 and 3.4. These were also presented in Table 2.2 of Chapter 2 of this Report, while more details can be referred from the Roadmap for Infrastructure Development for Metro Manila and Its Surrounding Areas (Region III and Region IV-A).

3.17 A model run without the Project was made, the results of which comprised the "Without Project" case that will be used in the comparison of system costs for the economic evaluation task. The resulting system costs for this scenario are discussed in Chapter 6 of this Report, Project Evaluation.



Source: JICA Study Team

Figure 3.3 Expressway and Road Network 2030



Source: JICA Study Team

Figure 3.4 Railway Network 2030

1) Base Case Alignment (A1)

3.18 The base case alignment (A1) conceptually defined in the Roadmap Study, starts 3.0 km west of the San Jose Town Proper or the middle of San Jose Del Monte City and Sta. Maria Municipality. The line moves southward, cutting through open lands wherever possible and residential areas along barangays and subdivisions in San Jose, Novaliches, Caloocan and Paranaque while maximizing utilization of existing minor and major roads' right-of-way until it terminates east of Dasmariñas near the San Lazaro Leisure Park and

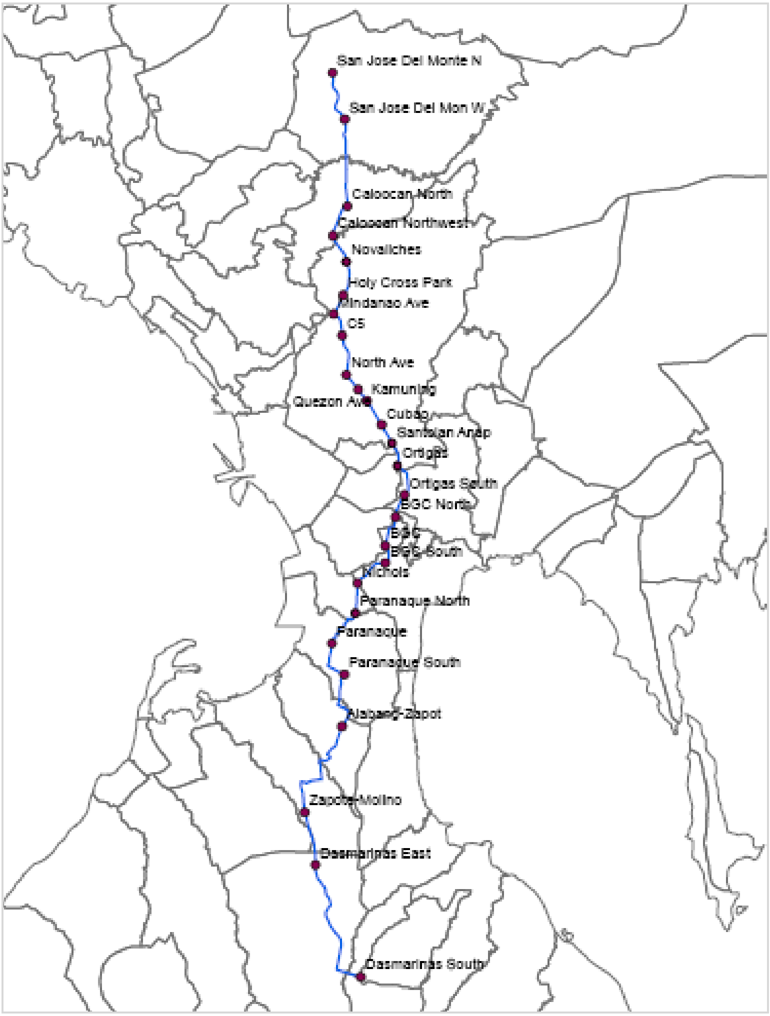
Casino.

3.19 The alignment, shown in Figure 3.5, traverses a slightly rolling terrain in San Jose and Novaliches, relatively flat terrain to slightly rolling terrain in Caloocan, Quezon City, Ortigas Center, Bonifacio Global City, Paranaque and from slightly hilly in San Pedro to mountainous terrain in Dasmariñas, Cavite.

3.20 The results for the daily passenger boarding and alighting by station for year 2030 are given in Table 3.10 and plotted in Figure 3.6.

3.21 The average trip length of passengers is about 9.25 km, with total daily boarding of about 1.739 million passengers. It is noteworthy that the number of boarding and alighting passengers at the two Dasmariñas stations, estimated at more than 200,000 passengers each, are more than double that of the next high volume stations which are at just over 100,00 passengers, namely, Mindanao Avenue and Quezon Avenue (boarding) and Caloocan North West and Quezon Avenue (alighting).

3.22 Maximum line load for the northbound direction is 243,000 passengers, occurring at Novaliches Station. On the other hand, the maximum line load for the southbound direction is 240,000 passengers at Caloocan North West station.



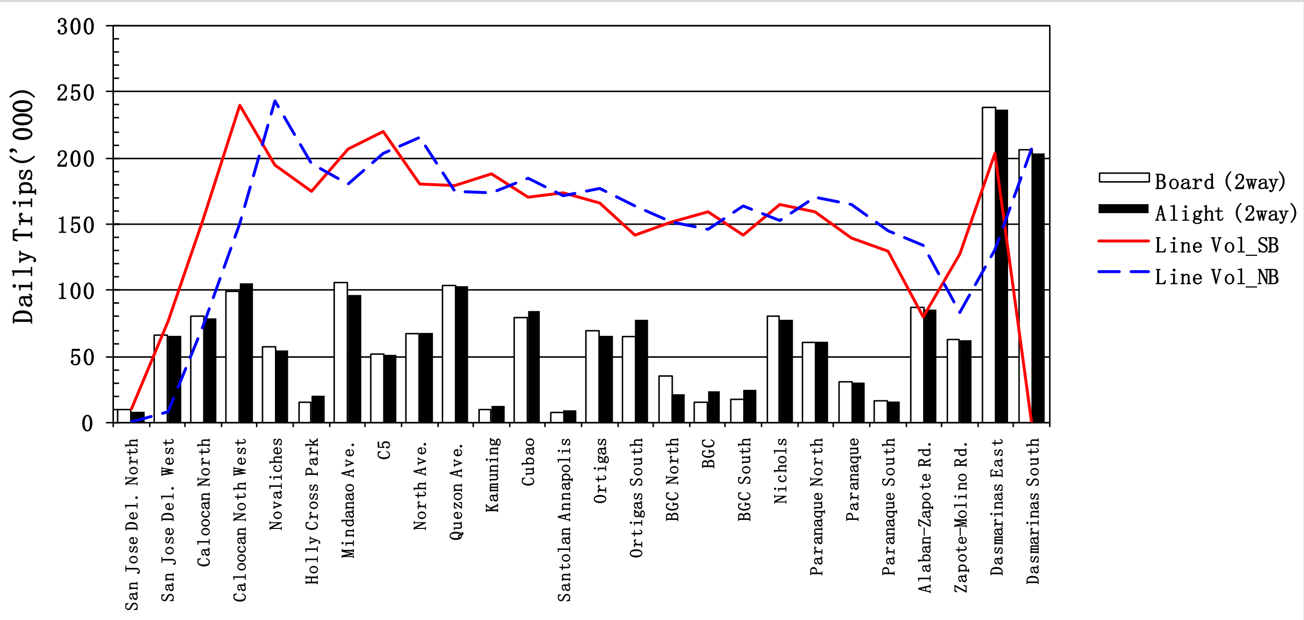
Source: JICA Study Team

Figure 3.5 Basecase Alignment

Table 3.10 2030 Daily Two-way Station Boarding and Alighting Passengers

No	Stations	No. of Pax/day		No. of Pax/day/direction		Distance (km)
		Board (2way)	Alight (2way)	Line Vol_SB	Line Vol_NB	
1	San Jose del Monte (North)	10,000	8,000	10,000	-	3.82
2	San Jose del Monte (West)	66,000	65,000	76,000	8,000	4.36
3	Caloocan North	80,000	79,000	154,000	73,000	2.13
4	Caloocan Noth (West)	99,000	105,000	240,000	150,000	1.50
5	Novaliches	57,000	54,000	195,000	243,000	2.12
6	Holly Cross Park	15,000	20,000	175,000	195,000	1.50
7	Mindanao Ave.	106,000	96,000	207,000	180,000	1.10
8	C5	52,000	51,000	220,000	203,000	2.83
9	North Ave.	67,000	67,000	180,000	215,000	1.33
10	Quezon Ave.	104,000	103,000	179,000	175,000	1.30
11	Kamuning	10,000	12,000	188,000	173,000	1.32
12	Cubao	79,000	84,000	170,000	184,000	1.11
13	Santolan Annapolis	8,000	9,000	174,000	171,000	1.74
14	Ortigas	70,000	65,000	166,000	177,000	1.52
15	Ortigas South	65,000	77,000	142,000	164,000	1.57
16	BGC North	35,000	21,000	151,000	151,000	1.83
17	BGC	15,000	23,000	159,000	146,000	0.93
18	BGC South	18,000	24,000	142,000	163,000	2.08
19	Nichols	81,000	77,000	165,000	152,000	2.94
20	Paranaque North	61,000	61,000	159,000	170,000	1.13
21	Paranaque	31,000	30,000	139,000	165,000	1.77
22	Paranaque South	16,000	16,000	129,000	145,000	3.21
23	Alaban-Zapote Rd.	87,000	85,000	80,000	134,000	4.91
24	Zapote-Molino Rd.	63,000	62,000	127,000	83,000	3.67
25	Dasmarinas East	238,000	237,000	204,000	130,000	6.03
26	Dasmarinas South	206,000	204,000	-	206,000	-
Total		**1,736,000**	**1,736,000**	**240,000 (max)**	**243,000 (max)**	

Source: JICA Study Team



Source: JICA Study Team

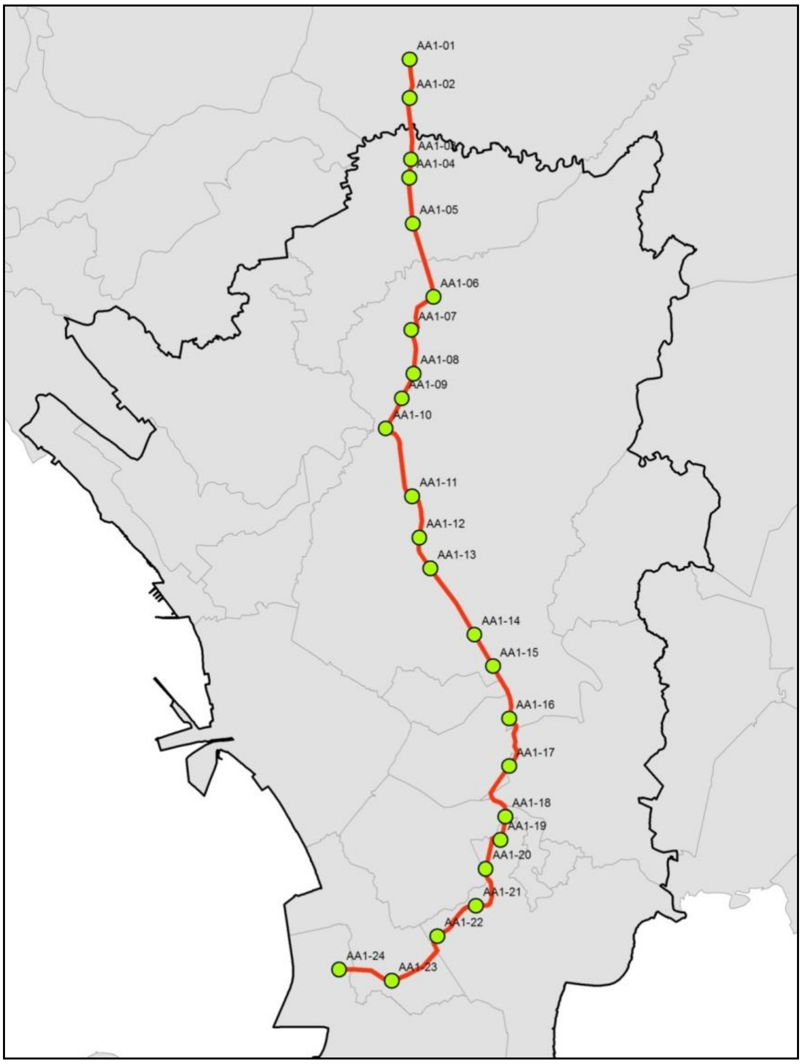
Figure 3.6 2030 Daily Passenger Ridership

2) Alternative Alignment (A2)

3.23 This alternative will run from San Jose Del Monte City Proper passing through the residential and open areas and existing roads towards south until it terminates at the intersection of Roxas Boulevard and Manila Cavite Coastal Road. After running under the Barangay Road in San Jose City Proper, A2 finds its way under open lands and a stretch of residential area until it intersects Sta. Maria-Tungkong Mangga Road, after which it needs to traverse under another stretch of residential area to reach Old Zabarte Road, which begins at the intersection of the existing Langit Road.

3.24 For the purpose of the demand analysis, 24 stations and a total length of 43.4 km in the network model was initially adopted. The alignment is shown in Figure 3.7 while the results of the model run are shown in Table 3.11 and plotted in Figure 3.8.

3.25 Total daily boarding passengers are about 941,000. It is noted that one station, Mindanao Avenue, accounts for almost 13% of total boarding, while the others are only at the range of 7% and below. The maximum line load for the southbound is 223,000 occurring at Congressional Avenue, while for the northbound it is at 220,000 at North Avenue. The average trip distance per passenger is at 13.78 km.



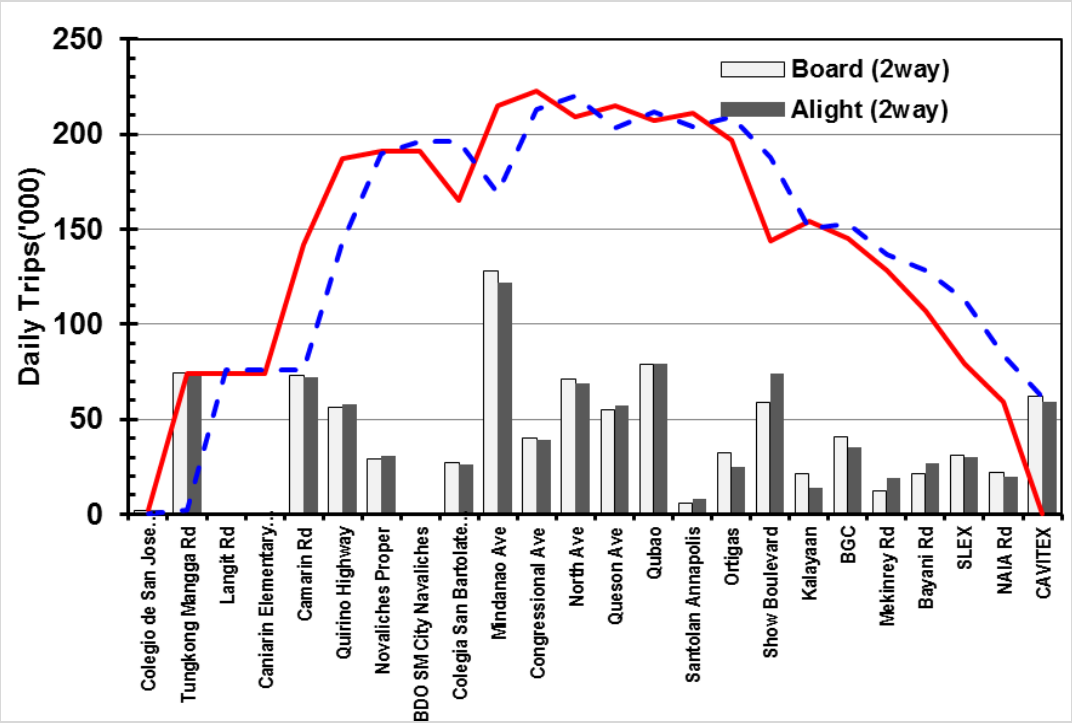
Source: JICA Study Team

Figure 3.7 Alignment Option A2

Table 3.11 2030 Daily Two-way Station Boarding and Alighting Passengers, Alignment A2

No	Line-1 Stations	No. of Pax/day		No. of Pax/day/direction		Distance
		Board (2way)	Alight (2way)	Line Vol_SB	Line Vol_NB	(km)
1	Colegio de San Jose del Monte	2,000	2,000	2,000	-	1.5
2	Tungkong Mangga Rd	74,000	75,000	74,000	2,000	2.4
3	Langit Rd	-	-	74,000	76,000	0.7
4	Caniarin Elementary School	-	-	74,000	76,000	1.8
5	Camarin Rd	73,000	72,000	142,000	76,000	2.9
6	Quirino Highway	56,000	58,000	187,000	143,000	1.8
7	Novaliches Proper	29,000	31,000	191,000	190,000	1.7
8	BDO SM City Novaliches	-	-	191,000	196,000	1.1
9	Colegio San Bartolate de Novaliches	27,000	26,000	165,000	196,000	1.3
10	Mindanao Ave	128,000	122,000	215,000	169,000	3.0
11	Congressional Ave	40,000	39,000	223,000	213,000	1.7
12	North Ave	71,000	69,000	209,000	220,000	1.3
13	Quezon Ave	55,000	57,000	215,000	203,000	3.0
14	Cubao	79,000	79,000	207,000	212,000	1.4
15	Santolan Annapolis	6,000	8,000	211,000	204,000	2.2
16	Ortigas	32,000	25,000	197,000	209,000	2.1
17	Shaw Boulevard	59,000	74,000	144,000	188,000	2.4
18	Kalayaan	21,000	14,000	154,000	150,000	0.9
19	BGC	41,000	35,000	145,000	153,000	1.5
20	Mckinley Rd	12,000	19,000	128,000	137,000	1.9
21	Bayani Rd	21,000	27,000	107,000	128,000	2.0
22	SLEX	31,000	30,000	79,000	113,000	2.8
23	NAIA Rd	22,000	20,000	59,000	84,000	2.1
24	CAVITEX	62,000	59,000	-	62,000	-
	Total	**941,000**	**941,000**	**223,000 (max)**	**220,000 (max)**	

Source: JICA Study Team

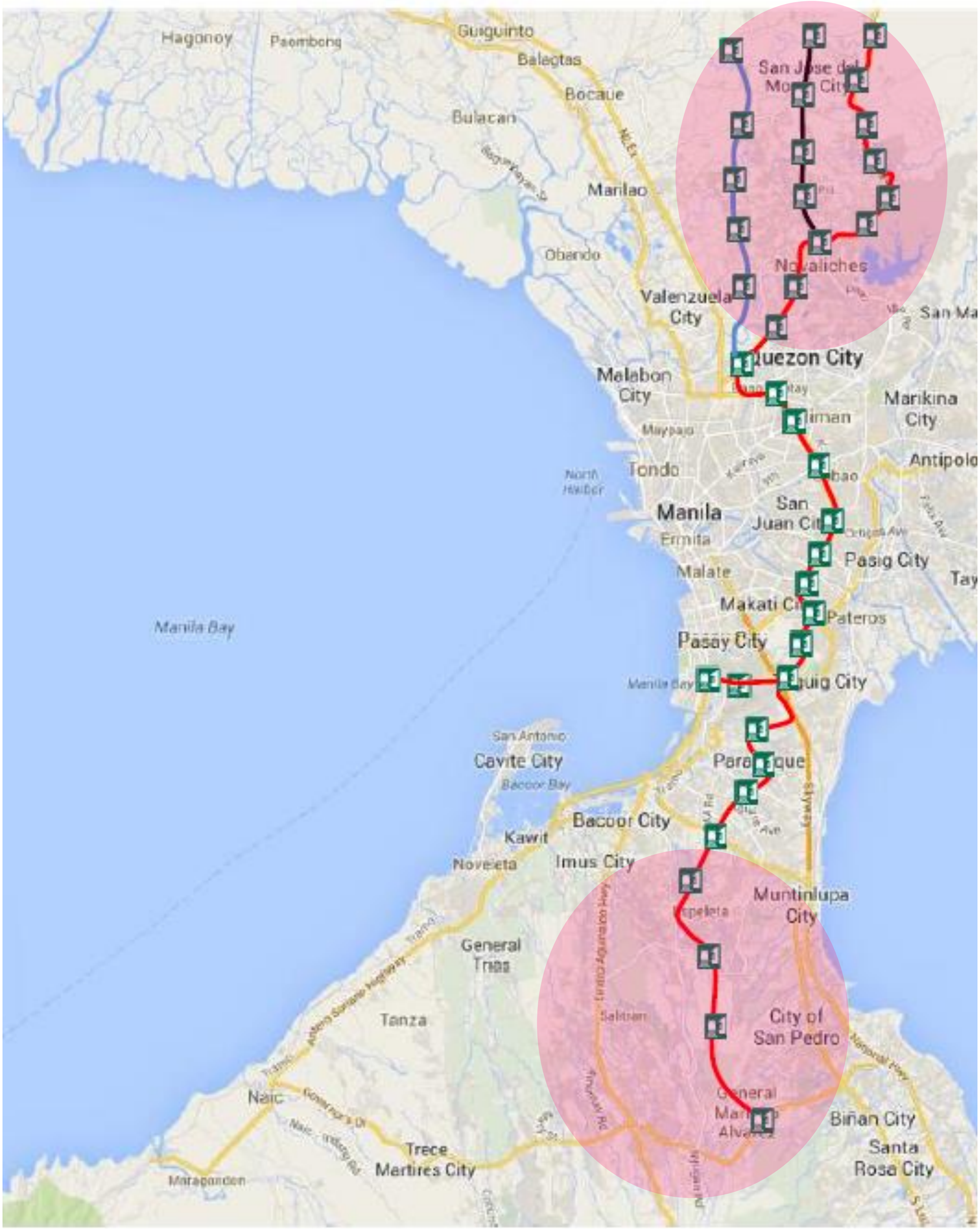


Source: JICA Study Team

Figure 3.8 2030 Daily Passenger Ridership, Alignment A2

3) Other Options

3.26 As one of the key objective of the line is to attract demand as widely as possible in suburban areas both in the north and south, it is necessary to study more options on the alignment considering land use and urban development opportunities in those areas (see Figure 3.9)



Source: JICA Study Team

Figure 3.9 Areas of Alaternative Alighment for the Subway must be Examined in Integration with Planned Suburban Development

4. PRELIMINARY SYSTEM DESIGN

4.1 Routes and Alignments

1) Introduction

4.1 The proposed Subway Project was conceptualized to provide alternative transport infrastructure to the different railway modes such as the Rapid Railway, Light Rail Transit, and Monorail Transit Systems, all of which when planned on existing rail right-of-way, road right-of-way, and even on open lands create inherent technical, social and environmental issues. The concept involves installing the proposed facility underground at a depth where no obstacles will be encountered such as deep building foundation systems, underground utilities, underpass structures, waterways and others. The scheme is to go as deep as possible to avoid these structures and other technical issues while keeping in mind the commercial aspect of the proposed project. Likewise, the usual issue of dealing with illegal settlers and right-of-way acquisition and traffic congestion during construction, while unavoidable, will be minimized.

4.2 The proposed Subway Project intends to connect the commercial business districts of the different cities and municipalities from San Jose del Monte in the north to Dasmariñas, Cavite in the south, through a railway system that will be installed inside a tunnel structure. Subway stations will be provided at strategic locations to access these business districts from various locations.

2) Technical Findings on General Geologic Characteristics of the Project Area

4.3 The project site is underlain by the Diliman Tuff represented as sandstone-siltstone which had to be cored. The upper two meters have been weathered to sandy silt or silty fine sand with gravel with high SPT N-values ranging from 77 to 89. The tuff may be considered as either soft rock or hard soil and should be excavated as such. It may be excavated by backhoe. It can also be bored for piling and/or tunneling. Groundwater levels were observed between 1.0 to 8.5 m.

4.4 There is no active or potentially active fault cutting through the project site. There is no risk of actual ground rupture or displacement – either by catastrophic faulting or by fault creep. Nevertheless, the proposed subway will experience seismic loading in case of a major earthquake along the West Valley Fault or the Philippine (Infanta) Fault.

4.5 Although the West Valley Fault is not associated with any earthquake activity, geologic evidence shows that the fault is definitely active. The Infanta segment of the Philippine Fault is also associated with a seismic gap.

4.6 The application of a probabilistic approach to both faults is, therefore, not feasible since the approach does not take into consideration the concepts of seismic gaps, aseismic faults or creeping faults. The absence of seismic activity along the Valley Fault System actually corresponds to a higher probability of a major event occurring. Risk is actually higher because stress is accumulating and is not being released.

4.7 Without taking into consideration foundation conditions, a magnitude 8.0 design earthquake along the Infanta segment of the Philippine Fault can result in a peak ground acceleration of 0.34g at the site. This value is reduced to 0.20g for rock and 0.30g for hard soil.

4.8 On the other hand, a magnitude 7.4 earthquake along the West Valley Fault can produce a peak ground acceleration of 0.12g without taking into consideration foundation conditions. This value is reduced to 0.07g for rock and 0.10g for hard soil. There is no or very little risk of settlement, and liquefaction. Expansive bentonitic clay has not been observed from the information.

3) Proposed Design Criteria for the Subway Alignment

4.9 Similar to any railway design, the geometric features of subway alignment will be governed by design standards relating to design speed from which the different design components and elements are established such as radius, super-elevation, horizontal and vertical curve lengths, and vertical gradient. The following design criteria were referred to in the establishment of the subway alignment:

Table 4.1 Main Design Criteria

Item	Criteria
(i) Design unbalanced speed	80 KpH
(ii) Superelevation	100 mm
(iii) Absolute minimum horizontal curve radius	300 m
(iv) Desired minimum horizontal curve radius	600 m
(v) Maximum gradient of main line track	± 3.5%
(vi) Minimum gradient of mainline track (for drainage purposes)	± 0.3%
(vii) Gradient through Stations	± 0.3%
(viii) Tunnel Diameter, Inside	5.2 m
(ix) Tunnel Diameter, Outside	5.65 m

Source: JICA Study Team

4) Alignment Selection and Evaluation Parameters

4.10 The alignment identification and selection criteria and guidelines for the proposed subway project were established from those standards being adopted internationally and taking into account other local parameters being applied to similar and related projects under planning and to those that were already implemented. The proposed subway concept, being a first in the country, will be developed based on approved and acceptable international guidelines and standards.

4.11 The alignment examination and screening criteria consists of several factors, as follows:

(i) Technical Evaluation Factor

- Accessibility to urban centers is evaluated in terms of the presence of highly developed and densely populated areas where significant passenger traffic volume could be generated and diverted to the proposed transportation facility.
- Harmony with existing transport network is evaluated in terms of the existence of other transport modes where trip transfers and change in preference of transport system could be expected.
- Construction difficulty is evaluated in terms of the presence of other major buildings that could be affected by the proposed project and the number of curves or changes in direction along each alternative alignment.

- Passenger attractiveness will be measured in terms of the number of major stations that could be possibly installed along each alternative alignment to provide access to major and important institutions and service facilities such as schools and universities, hospitals and medical care centers, and government centers.

(ii) Environmental Evaluation

- Social Aspect is evaluated in terms of the number of residential and commercial structures that will be affected directly or indirectly by the alternative alignments.
- Environmental Aspect is evaluated with the number of water bodies that would be crossed and subsequently affected by the Project.

5) Alignment Identification

4.12 The alignment tested in the demand analysis was further refined taking into consideration the above technical aspects. The alignment has a total of 74.55km connecting Sta. Maria – San Jose Road to Gov. Halili Road in san Jose Del Monte and Governor's Drive in Dasmarinas, Cavite (see Table 4.2).

Table 4.2 Base Case Alignment by Road Section

Road Section	Length, Km
a. Sta. Maria – San Jose Road to Gov. Halili Road (Residential Area)	3.30
b. Gov. Halili Road to Marilao San Jose Del Monte Road (Residential Area)	1.50
c. Marilao San Jose Del Monte Road to Bagumbong Road (Residential Area)	5.80
d. Bagumbong Road to Gen. Luis Road (Residential Area)	3.85
e. Gen. Luis Road – NLE (Residential Area)	3.10
f. NLE – EDSA/North Avenue (Residential Area, 1.30 km)	5.05
g. EDSA (North Avenue to Ortigas Avenue)	7.70
h. EDSA/Ortigas Avenue – Meralco Ave.	2.80
i. Meralco Ave – Shaw Blvd	1.50
j. Shaw Blvd. – Kalayaan Ave. (0.70 Km Residential/Industrial)	2.00
k. Kalayaan Ave. – McKinley Parkway	2.00
l. McKinley Parkway – Nichols Interchange	3.75
m. Nichols Interchange – Merville	1.80
n. Merville – DaangBatang	3.15
o. DaangBatang – Sucat Road (Residential Area)	4.70
p. Sucat Road – AlabangZapote Road (Residential, 1.55 Km)	4.25
q. AlabangZapote Road – Alvarez Extn.	4.75
r. Alvarez Extn. – DaangHari Road	4.00
s. DaangHari Road – Victoria Ave (Residential Area)	2.30
t. Victoria Ave. – GMA/Congressional Road	5.10
u. GMA/Congressional Road – Governor's Drive	1.30
v. Governor's Drive – San Lazaro Leisure Park	0.85
Total Length	74.55

Source: JICA Study Team

4.13 The condition of the project location varies along the route. From San Jose Del Monte to Caloocan, the terrain varies from rolling to relatively flat while from Caloocan to Quezon City, the terrain is generally flat with some sections becoming slightly rolling.

Likewise from Quezon City to Mandaluyong, the terrain changes slightly from flat to gently rolling. While the elevation slightly rises from Mandaluyong to Makati, the terrain is relatively flat until Paranaque but becomes rolling from the boundary of Paranaque to the boundary of Dasmariñas. The terrain east of Dasmariñas is slightly rugged.

4.14 The land use of the section from San Jose Del Monte to Caloocan varies from residential to commercial but predominantly residential. In Quezon City, Mandaluyong and Makati, the land use is basically mixed residential, institutional and commercial. In Paranaque, the land use of the section is basically residential with few areas devoted to business and commercial uses. In Cavite, the land use traversed by the project route is predominantly residential with considerably large open areas still undeveloped.

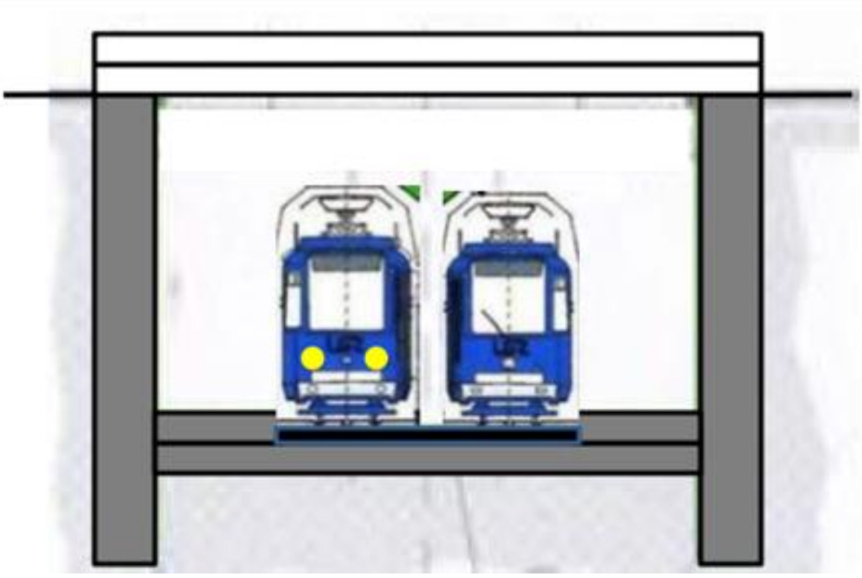
4.15 The different types of alignment systems being considered for the Project consist of the following: (a) At-grade; (b) Elevated; and (c) Subway.

4.16 **At-Grade:** For alignment cutting through private properties, especially the sections located in the outskirts of Metro Manila where the land value is not that expensive, the system could be at-grade. In view of the absence of policy or legislation governing the use and ownership of land under and above the surface for infrastructure projects, it is inevitable to consider that the vertical projection of land area still belongs to the landowner or property owner such that it cannot be traversed easily without proper permission and compensation. The at-grade system along this section would be an economic trade-off for the acquisition of the property for the Project since the acquisition removes the legal and technical restrictions for the installation of the different project components at that area.

4.17 **Elevated:** Elevated alignment could not be dispensed with in areas where grade separation is necessary to preclude the disruption of traffic flow along the otherwise heavily congested road sections and dislocation and cutting off of other routes. Elevated systems are adapted in existing road and railway alignments, waterways, and undulating gradients where the functionality of the proposed infrastructure will not be attained if an at-grade system will be used.

4.18 **Subway:** The subway system is the most expensive of all the alternatives especially if the structure will be installed deeper than the ordinary underpass. Underground construction is cost efficient and cost effective only if the method could be done at a cost comparable or even lesser than that of an elevated system. On the other hand, shallow underground construction is adaptable only in areas where there is a minimal number of underground utilities installed along the route. Further, if there are other structures along the existing roads or government properties and/or right-of-ways, such as buildings, towers, road and pedestrian overpasses and underpasses with foundation installed deep into the subsurface, an alternate method or system has to be considered other than the at-grade, elevated and even shallow underpass systems. Subway construction has two methods, namely cut and cover and tunneling.

4.19 **Cut and Cover Construction Method:** In "cut and cover" construction, the pavement structure is demolished and removed, an area for the subway and stations is dug, and after the installation of the required structure the pavement structure is restored (see Figure 4.1). The method using standard excavation equipment is very much cheaper than deep excavation by special boring machine. The cut and cover method provides easier access by foot to station platforms and feasible up to a depth of 6 meters or around two storeys.



Source: JICA Study Team

Figure 4.1 Cut and Cover Method

4.20 Nevertheless, this method poses too much obstruction and disruption to traffic flow resulting in long lines of traffic, waste of fuel and manhour losses due to long hours of being idle and waiting for the traffic to move. The economic activities along the proposed section is likewise affected until such time that the project components are completed.

4.21 **Tunneling Method:** Tunneling uses a large machine, usually built for the specific project, to excavate a tunnel and remove excavated material, as well as place the initial tunnel lining, in a continuous highly automated process. This subway construction method is the most expensive but the disruption to surface activities is minimized except at locations of insertion points. Aside from the financial aspect, accessibility by foot to the station platform is difficult and time consuming unless an automatic or mechanized access system is provided, which is an added cost factor to the system. Furthermore, the condition of subsoil has to be considered also since soft soil formation would be more difficult and complicated to treat.

4.22 On the other hand, few existing structures and utilities will be affected if there are any along the project route but basically during implementation, subway construction is unnoticeable.

Table 4.3 Preliminary Assessment of Base Case Alighment

	Item	Description
Technical Factors	1) Topography and Terrain Characteristics	• Flat: 60% • Slightly rolling: 30% • Hilly: 10%
	2) Geometric Characteristics	• At-grade: 13.5 km • Viaduct: 6.4 km • Underground: 54.7 km • Horizontal bends: 37 ±
	3) No. of Stations	• 23
Environmental Factors	4) Right-of-Way Conditions	• Up to NAIA - Length: 22.6 km

	Item	Description
		- No. of structures: 810± • Up to Dasmarinas - Length: 53.15 km (residential area/ factories) - No. of structures: 2,050 ± (residential area)
	5) Right-of-Way Requirement	• ROW requirement (approximate kms) - Agricultural land: none - Rediential/commercial area: 53.15 - Open area: 7.85

Source: JICA Study Team

4.2 Related Subsystems and Facilities

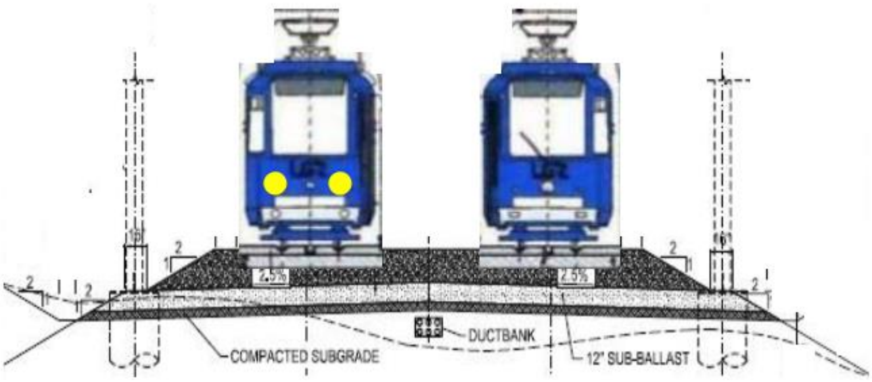
4.23 The different components of the subway system are presented in the following section.

1) Track and Structures

4.24 Double tracks should be provided to meet minimum requirements especially for overhead/elevated construction as well as for the subway system due to the difficulty of installing or constructing the additional track structure later.

4.25 For stage construction in anticipation of low traffic volume turnout, the structure that will support the tracks should have provision for the easy installation of the additional track. Right-of-way should be also secured to arrest any speculation that will bring the cost of lands to an unaffordable level in the future.

4.26 At-grade system is proposed along residential and open land areas that will be acquired for the right-of-way of the rail system (see Figure 4.2).

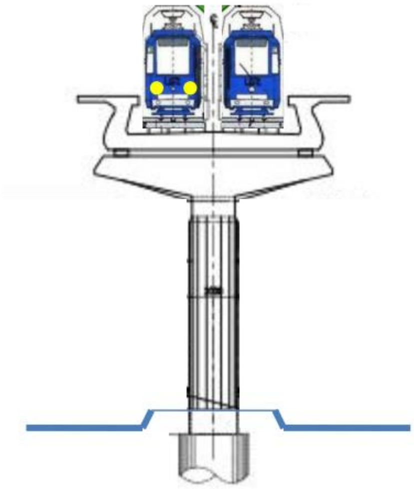


Source: JICA Study Team

Figure 4.2 At-Grade Track System

4.27 Elevated structures (see Figure 4.3) will be installed along existing roadways and other government-owned spaces, which are still available for such installation but may contain some restrictions due either to the presence of other transport infrastructure systems or the lands are committed already for other and future infrastructure utilization. The elevated structure could fit in local roads with limited right-of-way as long as there is sufficient width for the installation of the substructure.

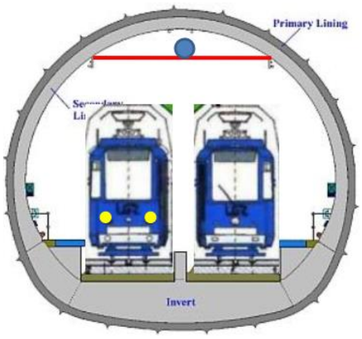
4.28 A subway structure is proposed along major roads' right-of-way but with complicated cross-sectional features to include the presence of flyover structures, pedestrian overpass structures and utilities. The subway will be installed to occupy a clearance of at least 12 meters horizontal space way below the road surface. Investigations conducted along the major roadways indicate that some components of the utility systems, such as manholes and lift stations, were installed and constructed at around 10 meters depth from the road surface.



Source: JICA Study Team

Figure 4.3 Elevated Track System

4.29 The subway structure should be able to accommodate a double track rail system with sufficient space for ventilation, duct work and maintenance purposes. Different types or shapes of subway structure could be explored and studied to determine the most techno-economic solution that could be adaptable along the proposed route. Basically, circular, oval or egg shape could be used as may be adaptable to site condition(see Figure 4.4).



Source: JICA Study Team

Figure 4.4 Subway Track and Structure System

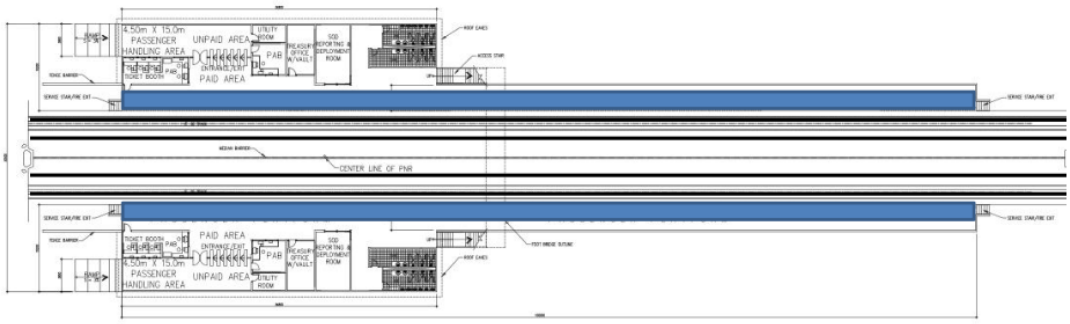
4.30 Transition from at-grade and elevated to tunnel or subway is executed through the provision of ramps at the approaches to the underground structure. The ramps are designed to contain sufficient and appropriate transition length and gradient corresponding to the design speed of the railway system.

2) Subway Stations

4.31 Along the route, stations will be provided for loading and unloading requirements of rail passengers. The stations will be adequately spaced to accommodate as many passengers as possible that could be attracted to this modern transport system.

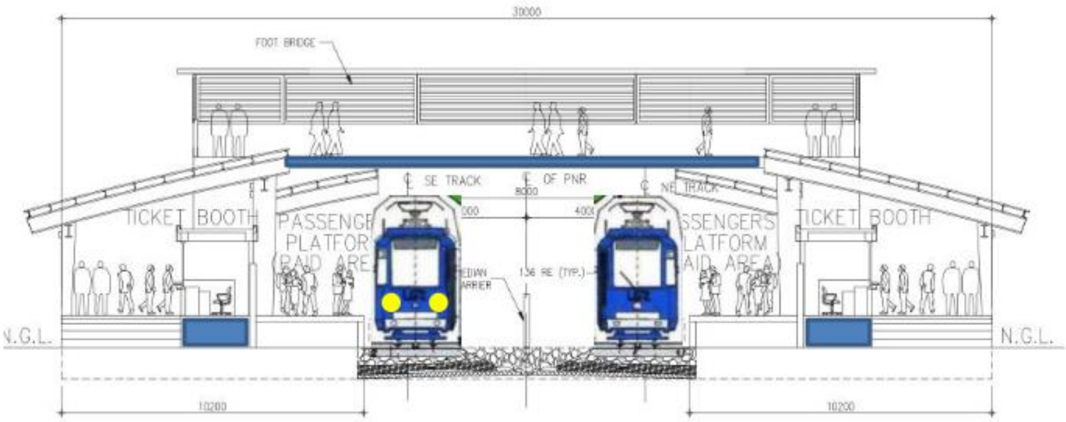
4.32 The stations will correspond to the different types of rail structure system installation. Basic concept layouts of the different types of stations are presented hereafter.

(i) At-Grade Stations



Source: JICA Study Team

Figure 4.5 Platform (At-grade)

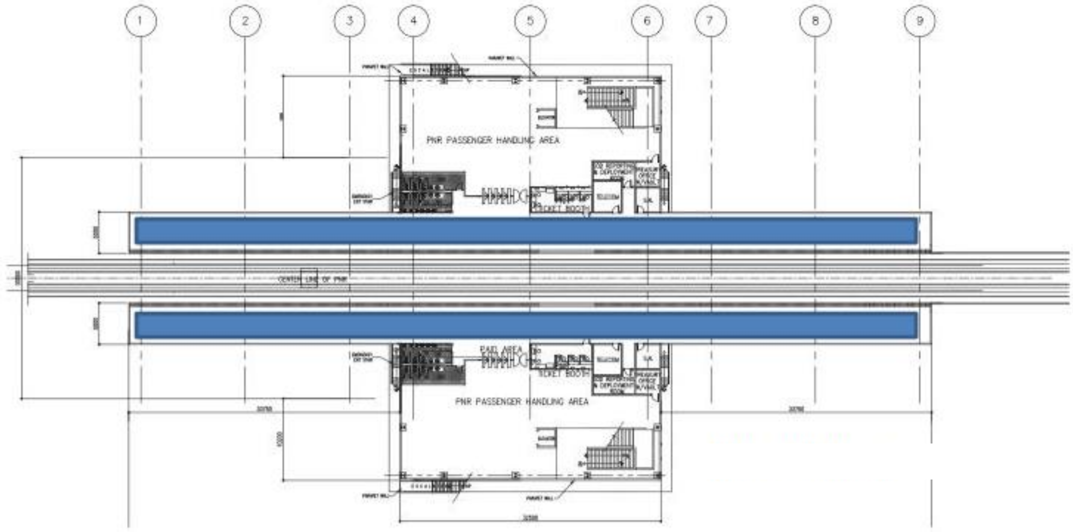


Source: JICA Study Team

Figure 4.6 Transverse Section of Station (At-grade)

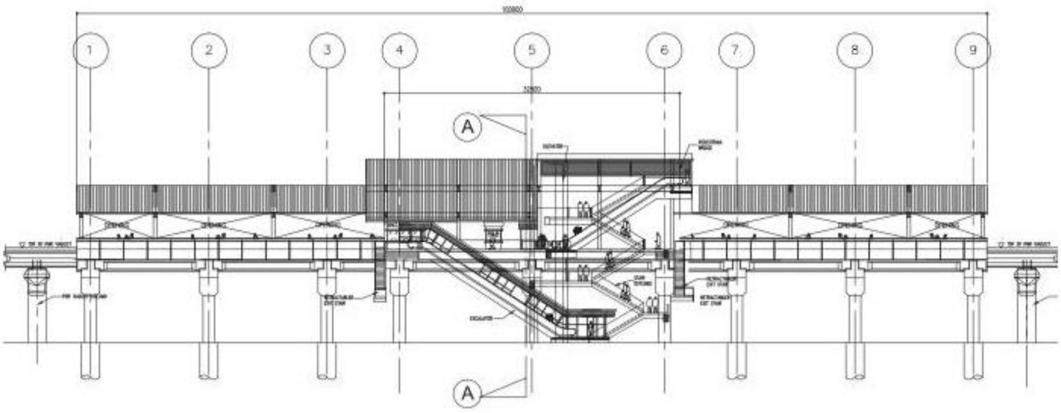
(ii) Elevated Station

4.33 The height of the structure for the elevated station is dependent on the configuration and condition of the site. A structure with second level could be installed for areas without any other obstruction such as flyover or pedestrian overpass. A third level structure might be needed for locations with existing development.



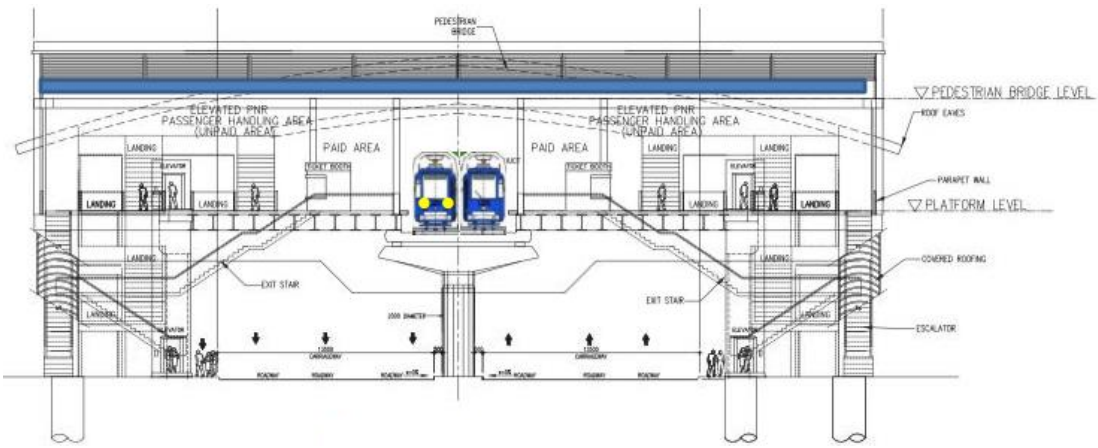
Source: JICA Study Team

Figure 4.7 Platform (Elevated)



Source: JICA Study Team

Figure 4.8 Longitudinal Section of Station (Elevated)

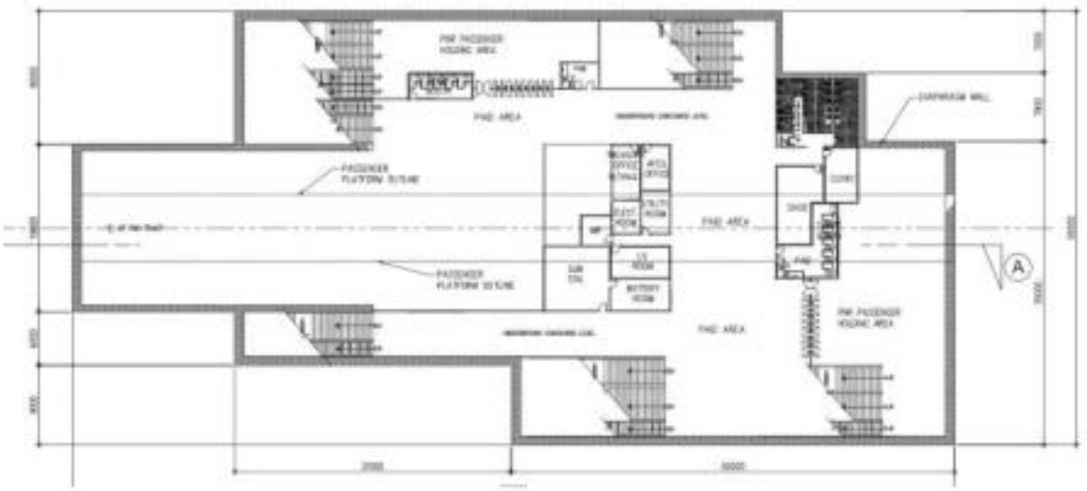


Source: JICA Study Team

Figure 4.9 Transverse Section of Station (Elevated)

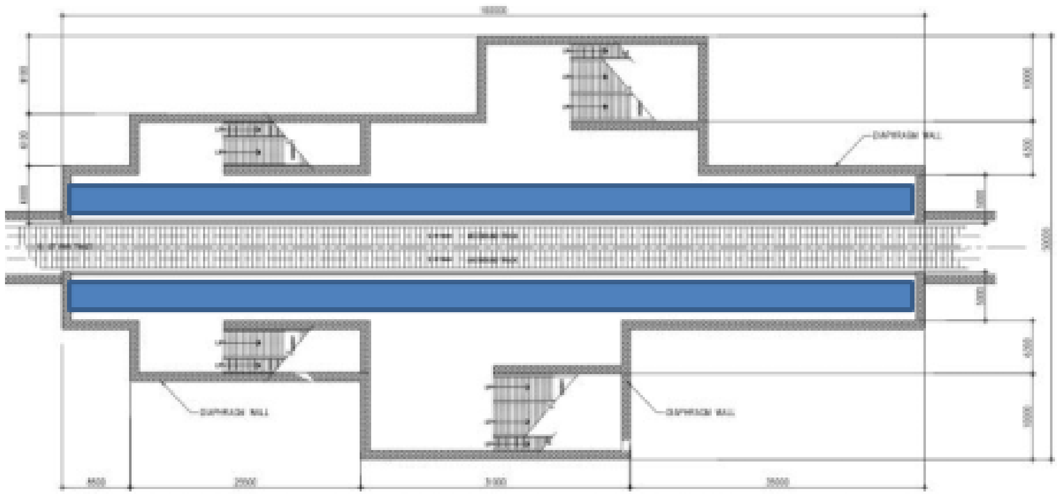
(iii) Subway Stations

4.34 The following figures present the initial concept of a proposed subway station. Configuration will vary depending on the location.



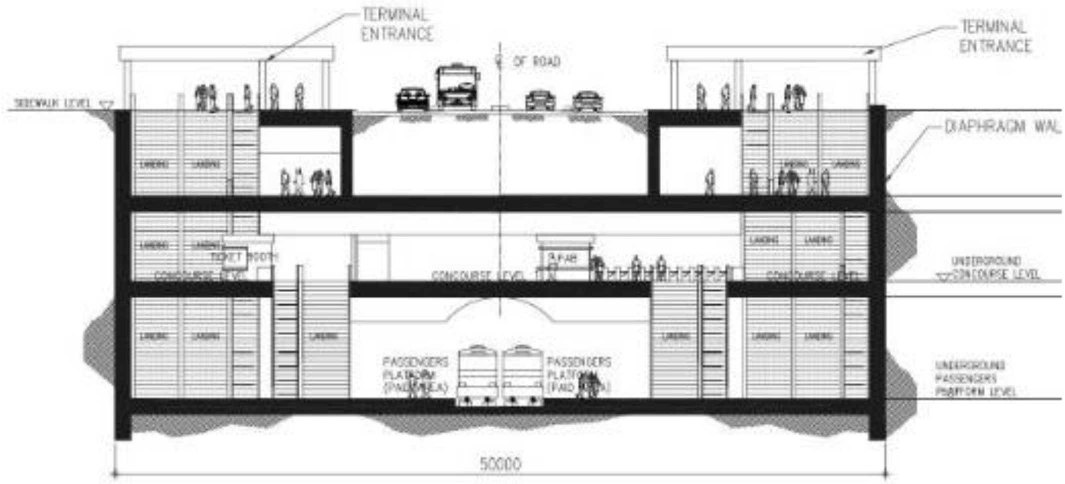
Source: JICA Study Team

Figure 4.10 Concept for Concourse of Station (Subway)



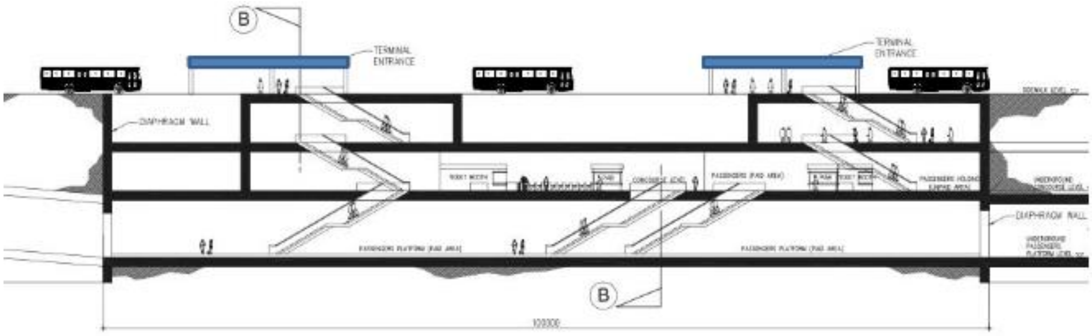
Source: JICA Study Team

Figure 4.11 Platform of Station (Subway)



Source: JICA Study Team

Figure 4.12 Transverse Section of Station (Subway)



Source: JICA Study Team

Figure 4.13 Longitudinal Section of Station (Subway)

3) Other Facilities

(i) Communications and Central Control

4.35 The proposed communication system would be the Supervisory and Control and Data Acquisition System (SCADA), which is widely used in similar transport systems in the world. Radio equipment will be integrated in the communication system to provide two-way communications between the field and communication center.

4.36 Emergency and public pay telephone stations will also be installed in major stations. A public address system will be provided for announcements purposes. Automatic vehicle locator will be utilized and other supporting communication equipment such as CCTV to ensure real time information gathering and dissemination.

(ii) Electrical Systems

4.37 Electrical supply will be provided to different fixtures and equipment such as lighting, fare collection equipment, communications and CCTV, emergency lighting and transit signal equipment.

4.38 All electrical systems shall conform with applicable standards and codes.

(iii) Signal System

4.39 The latest signaling system will be applied at various critical locations and at areas where occurrence of accident is possible, to enhance safety in the movement of trains and to improve the overall efficiency of the system operations.

4.40 These functions include protection and control of track switches, rail operation and highway grade crossing if there is any.

(iv) Raceways and Duct Banks

4.41 Raceways and duct banks will be provided to protect all power wiring and system cables and the system-wide electrical system will include conduits, duct banks, cable trays and cable trough installations and related manhole, handhole and pullbox equipment.

(v) Fare Collection Equipment

4.42 The fare collection system will consist of Ticket Vending Machines (TVMs), a Central Data Collection and Information System (CDCIS), Stand Alone Validators (SAVs), and other equipment to support the efficient and continuous operation of the collection system.

(vi) HVAC and Ventilation System

4.43 Proper ventilation system shall be provided along underground facilities in accordance with applicable codes and standards.

4) Rolling Stock Requirements

4.44 Requirements for rolling stock were estimated based on the daily and peak hour ridership volumes. The basic assumptions adopted are as follows:

a)	Average commercial speed	-	50 kph
b)	Number of days in a year	-	360
c)	Railcar capacity (crash capacity)	-	412 (seating and standing passengers, based on LRT2 railcar configuration)
d)	Number of cars/train set	-	6
e)	Train capacity, q	-	2,472 per train set
f)	Cost per railcar, C_{rs}	-	USD2.50 million
g)	Operating hours/day, h	-	16 (out of 24)
h)	Load factor @ max section	-	90% (applies at peak hour)
i)	Target average line load factor (TALF)	-	60%
j)	Peak-2-day traffic factor	-	8.67 (based on LRT1 actual relationship)
k)	Fleet availability	-	80%
l)	Peak-2-day train trips	-	15.25

4.45 Applying the above assumptions for all alignment options, the required fleet size of the rolling stock and corresponding costs were estimated as shown in Table 4.4.

Table 4.4 Fleet Size Requirements

Item	
Max Sectional Flow	240,000
Line Length (km)	75.5
Ave. Trip Length (km)	9.3
No. of Stations	26
Peak-hr Flow @ Max Section	28,000
Frequency (required)	12
Peak Hour Headway (min)	5
Round Trip Time (min)	140
Pax-Km/Day (000)	16,058
Train-Trips per Day	190
Train-Km per Day	14,375
Ave. Line Load Factor/Day	60%
Required No. of Railcars (based on TALF)	126

Source: Estimates of JICA Study Team

5. PROJECT EVALUATION

5.1 Economic Analysis

1) Approach/ Methodology

5.1 The Study Team conducted incremental discounted cash flow analysis to assess the economic viability of the proposed EDSA Subway System (North-South Commuter Line). The economic internal rates of return (EIRRs) and economic net present values (ENPVs) were calculated to determine the viability of the proposed alignment. The analysis focused on the assessment of the "with-project" and "without project" scenarios to measure the incremental impact of the project. The duration of the project was assumed to be 40 years, including a construction period of 10 years and an operating period of 30 years.

5.2 A sensitivity analysis was carried out to assess the responsiveness of the viability indicators to changes in critical variables such as economic costs and economic benefits.

2) Project Cost

5.3 The economic costs were determined by deducting all taxes and price contingencies included in the financial cost and by applying the shadow wage rate to the unskilled labor component of investment cost. Economic costs were estimated to be equivalent to about 85% of financial cost. The conversion factor applied to the operating and maintenance (O&M) costs was also 85% (see Table 5.1 and Table 5.2).

Table 5.1 Estimated Project Cost

Items	USD mil. (2013 constant price)
Civil Works	4,421.6
Track Works	285.2
Stations and Depot	711.9
Rolling Stocks	207.2
E&M System and Others	758.6
Physical Contingency	319.5
Total Construction Cost	**6,703.9**
Engineering and Management Cost	734.9
Miscellaneous Cost	1,075.6
Total Project Cost	**8,514.3**

Source: Study Team's estimates

Table 5.2 Estimated Operating and Maintenance Cost

Items	USD mil.
Labor	62.9
Materials	40.8
Power	41.7
Maintenance	44.2
Overhead	106.3
Total O&M Cost	**295.8**

Source: JICA Study Team

3) Benefits

5.4 The main economic benefits of EDSA Subway Line are the savings owing to the reduction in vehicle operating cost (VOC) and travel time cost (TTC). The construction of the new commuter line is expected to reduce traffic volume, which in turn will result in shorter travel times and faster vehicle operating velocity. The shorter travel time translates into lower traveling time costs, while the faster vehicle velocity implies lower operating costs. The values of these economic benefits will be based on the willingness to pay for time cost and VOC per trip. Additional economic benefits that may be included in the analysis are accident cost savings, reduction in carbon dioxide emissions, and avoided road maintenance cost.

5.5 In the process of calculating the core benefits of the project, the unit VOCs and TTCs were estimated. The unit VOCs were based on the average operating costs of a representative set of vehicles (see Table 5.3). The cost items that were considered in the computation were: (1) fuel cost, (2) lubricant cost, (3) tire cost, (4) repair cost, (5) depreciation cost, (6) capital opportunity cost, (7) overhead cost, and (8) crew cost. The results of the computation were consolidated and expressed as a function of travel speed.

Table 5.3 Unit VOC in the Philippines, 2013

(In pesos per kilometer)

	Speed (Km/hour)	Motor cycle	Car	HOV/Van	Jeepney	Standard Bus	Small Truck	Big Truck
Financial Cost	5	11,868	37,303	59,561	50,300	100,491	162,488	197,130
	10	6,918	22,622	33,840	30,010	58,068	88,321	110,870
	20	4,353	14,851	20,616	19,095	36,479	50,749	67,278
	30	3,476	12,129	15,284	15,651	29,529	37,314	48,920
	40	3,001	10,721	12,527	13,658	25,930	31,121	40,103
	50	2,785	9,944	11,247	13,647	25,399	27,899	36,175
	60	2,764	10,011	10,616	14,674	26,609	26,349	34,154
	70	2,824	10,337	10,436	16,275	28,685	25,536	33,826
	80	2,946	10,838	10,629	18,134	31,186	26,123	35,285
	90	3,144	11,583	11,238	19,719	33,441	27,391	37,844
Economic Cost	5	10,353	27,333	50,773	44,244	85,799	151,082	178,178
	10	6,038	16,746	28,298	25,742	49,323	81,375	99,240
	20	3,803	11,145	17,081	16,308	30,827	46,187	59,533
	30	3,038	9,188	12,595	13,361	24,941	33,756	43,107
	40	2,625	8,182	10,318	11,663	21,888	28,035	35,274
	50	2,437	7,658	9,223	11,658	21,473	24,994	31,702
	60	2,421	7,744	8,669	12,580	22,519	23,447	29,762
	70	2,473	8,024	8,474	13,973	24,316	22,571	29,308
	80	2,581	8,454	8,544	15,527	26,491	22,937	30,423
	90	2,756	9,083	8,987	16,854	28,449	23,928	32,533

Source: JICA Study Team

5.6 The estimates of unit TTCs were based on the mode of transportation across household income groups. The monthly TTC per mode of transportation was the weighted average of household income with percentage of vehicle ownership as weights (see Table 5.4). However, these values represented the value of time while working and not the travel time cost. The average value of travel time per mode of transportation was the product of value of time per hour and the share of business trip and "to work" trip. Unit TTCs were assumed to grow in line with per capita GRDP of the Mega Manila area.

Table 5.4 Present and Future Time Value of Passengers (In pesos per hour)

Mode	Private	Public		
	Car	LRT	Jeepney	FX
2012	111.8	97.4	66.0	71.0
2020	141.6	123.3	83.5	89.9
2030	182.6	159.0	107.7	115.9
2040	233.2	203.1	137.6	148.1

Source: JICA Study Team

5.7 Total economic benefits that will accrue to the project in the landmark year of 2030 are shown in Table 5.5.

Table 5.5 Daily Economic Benefits Generated by the Project, 2030

Indicators		Php mil.
Without project	VOC	4,173
	Time	2,752
	Total	6,924
With project	VOC	3,957
	Time	2,527
	Total	6,484
Benefit	VOC	216
	Time	224
	Total	440

Source: JICA Study Team

4) Results of Analysis

5.8 The results of the economic analysis are shown in Table 5.6. The proposed alignment yielded EIRR greater than 15% social discount rate set by the National Economic and Development Authority (NEDA). This indicates that proposed alignment is economically viable. The result also shows large ENPV (see Table 5.8 for detail).

Table 5.6 Results of the Economic Valuation

Indicators	Results
EIRR (%)	19.0%
ENPV (USD million)	1,578.6
B/C Ratio	1.61

Source: JICA Study Team

5.9 A sensitivity analysis was carried out to determine the sensitivity of EIRR to changes in costs and benefits. The results show that a 20% increase in cost accompanied by a 20% decrease in benefits will still render the project economically viable.

Table 5.7 Sensitivity Analysis of Economic Evaluation

Benefit / Cost		Change in Economic Cost (%)		
		Base Case	+10%	+20%
Change in Economic Benefit (%)	Base Case	19.0%	18.2%	17.4%
	-10%	18.1%	17.3%	16.5%
	-20%	17.1%	16.3%	15.6%

Source: JICA Study Team

Table 5.8 Evaluation of Economic Costs and Benefits (In million US dollars, constant 2013 prices)

Year	Invest-ments	O&M Cost	Benefits	Net Cash Flow	Discounted Cash Flow at 15%		
					Costs	Benefits	Net
1	-1,252	0	0	-1,252	-541	0	-541
2	-1,203	0	0	-2,454	-452	0	-452
3	-1,029	0	0	-3,484	-336	0	-336
4	-923	0	0	-4,407	-262	0	-262
5	-875	0	0	-5,281	-216	0	-216
6	-632	0	0	-5,913	-136	0	-136
7	-632	0	0	-6,545	-118	0	-118
8	-632	0	0	-7,177	-103	0	-103
9	-669	0	0	-7,845	-95	0	-95
10	-669	0	0	-8,514	-82	0	-82
11	0	-296	3,622	-5,188	-32	387	355
12	0	-296	3,812	-1,672	-27	354	327
13	0	-296	4,003	2,036	-24	323	300
14	0	-296	4,203	5,943	-21	295	275
15	0	-296	4,413	10,061	-18	270	252
16	0	-296	4,634	14,399	-16	246	230
17	0	-296	4,866	18,969	-14	225	211
18	0	-296	5,109	23,782	-12	205	193
19	0	-296	5,364	28,851	-10	187	177
20	0	-296	5,633	34,188	-9	171	162
21	0	-296	5,914	39,806	-8	156	148
22	0	-296	6,210	45,720	-7	143	136
23	0	-296	6,521	51,945	-6	130	124
24	0	-296	6,847	58,496	-5	119	114
25	0	-296	7,189	65,389	-4	109	104
26	0	-296	7,548	72,641	-4	99	95
27	0	-296	7,926	80,271	-3	91	87
28	0	-296	8,322	88,298	-3	83	80
29	0	-296	8,738	96,740	-3	75	73
30	0	-296	9,175	105,619	-2	69	67
31	0	-296	9,634	114,957	-2	63	61
32	0	-296	9,634	124,295	-2	55	53
33	0	-296	9,634	133,633	-1	48	46
34	0	-296	9,634	142,971	-1	41	40
35	0	-296	9,634	152,309	-1	36	35
36	0	-296	9,634	161,647	-1	31	30
37	0	-296	9,634	170,985	-1	27	26
38	0	-296	9,634	180,323	-1	24	23
39	0	-296	9,634	189,661	-1	21	20
40	0	-296	9,634	198,999	-1	18	17
41	0	-296	9,634	208,337	0	16	15
42	0	-296	9,634	217,675	0	14	13
43	0	-296	9,634	227,013	0	12	11
44	0	-296	9,634	236,351	0	10	10
45	0	-296	9,634	245,690	0	9	9
Total	-8,514	-10,353	264,557	3,488,272	-2,582	4,161	1,579

Source: JICA Study Team

5.2 Social and Environmental Considerations

1) Social Considerations

5.10 As previously discussed, the subway project will involve installing the proposed facility underground at a depth where no obstacles will be encountered to include deep building foundation system, underground utilities and underpass structures, waterways and others. In regard to the social impacts of the Project, the objective is for the project design, including alignment, to avoid to the maximum extent possible and otherwise minimize adverse impacts (providing just compensation for the same) on existing surface structures, land use and other assets while keeping in mind the commercial aspect of the proposed project.

(a) Land Acquisition and Resettlement (LAR) Impacts

5.11 Based on documented international experience, potential land acquisition and resettlement impacts of subway projects include the following:

(i) Acquisition of land on which surface facilities (such as stations) will be laid, which will affect households and organizations/ institutions owning, residing or operating within the Corridor of Impact (i.e., the area that will be cleared of all structures and obstructions for the Project);

(ii) Impacts on structures on the surface directly over the underground works;

(iii) Displacement of people from non-material assets (e.g., sources of employment, social support, and organizations), which may increase some households' risk of impoverishment; and

(iv) Variations in land price in areas close to surface and subsurface facilities.

5.12 It should be noted that significant lengths of the proposed alignment are under existing road ROW and, thus, avoid affecting high-rise structures. However, the acquisition of land for establishment of the subway ROW cannot be avoided in alignment sections passing under private property or in areas where there are residences, businesses and other structures on the surface. Likewise, there are areas located along intersections that will be affected especially when the alternative alignments change direction as the lines follow the routes of existing roads. Acquisition and enforcement of the ROW must, therefore, be carried out to secure the integrity of the subway tunnels from any future development and also protect the safety and rights of surface property owners/users.

(b) Potential Resettlement Impacts of Alternative Alignments

5.13 This section provides a summary of potential adverse social impacts of the proposed alternative tunnel alignments based on available information on key socioeconomic characteristics and existing surface land use.

5.14 The alignment begins 3.0 km west of San Jose Town Proper and moves southward cutting through open lands wherever possible as well as residential areas in San Jose, Novaliches, Caloocan and Paranaque, while maximizing utilization of existing minor and major roads ROW. The line terminates east of Dasmariñas, running a total of 74.5 km.

5.15 Overall, this will require residential land acquisition for a ROW for 22.6 km (if the line terminates at NAIA), or 53.5 km (if the line terminates at Dasmariñas East). Based on the number of identified surface structures and the average GCR household size, approximately 3,564 persons could be displaced due to land acquisition and resettlement for the proposed alignment should the line terminate at NAIA, or about 9,020 persons displaced if the alignment ends at Dasmariñas East.

5.16 The table below summarizes LAR impacts for the proposed alternative alignments of the Subway Project.

Table 5.9 Summary of LAR Impacts for Alternative Alignments

Alternative Alignment	Land Acquisition for Subway ROW			Land Use	Remarks
	Length, Km	Number of Structures	Number of Affected Persons (APs)		
Up to NAIA	22.60	810 ±	3564±	Residential Area / Factories	Significant land acquisition and resettlement impacts (high number of APs), relatively high LAR costs
Up to Dasmariñas East	53.15	2050 ±	9020±	Residential Area	

Source: JICA Study Team

(c) International Compensation Practices for Underground Works

5.17 Land acquisition practices for underground works differs across countries based on legal rights to surface and subsurface areas and whether or not the surface user or property owner is compensated for (i) simple use of underground space (relevant project phase: design and construction); (ii) effects on structural integrity and safety (relevant project phase: design, construction, operations); or (iii) compensation for change in land use or valuation[3] or limitations on surface developments[4] and/or extra expense for surface land owners/ developers linked with underground works (relevant project phase: construction and operations).

5.18 For reference, a summary of international experience in compensation linked with underground construction projects is found in Table 5.10 below:

Table 5.10 Comparison of International Experience in Compensation for Underground Works

	Right to Use Underground Space	Compensation				Other Support Provided
		Risk of Damage to Surface Structures, Activities	Impacts on Land Use/ Future Development		Relevant Project Phase	
			Shallow Tunnel	Deep Tunnel		
Australia	Land Owner	Yes	Proposed[1]	No	Design Phase, Construction Phase, Operations Phase (complaints filed by	Relocation Support Additional $ 3,000 cash[2]

[3] Valuation of surface property adjacent to the Paramatta Rail Link in Australia showed an assessed reduction in value linked with underground works construction, particularly in the shallower areas of the tunnels, which ranged in depth from 13 to 70 meters underground, as measured from the floor of the tunnel (http://www.parliament.nsw.gov.au/prod/parlment/nswbills.nsf/d6079cf53295ca7dca256e66001e39d2/968f58b4926720feca256d17003ae9af/$FILE/TAA%20(Parra%20Rail%20Link).pdf)

[4] In Seoul, these effects were primarily linked to restrictions in the number of floor buildings and in groundwater usage. Compensation based on "loss ratio of spatial use (Lee, I., 2004. Experiences in Seoul Subway Development).http://www.ita-aites.org/fileadmin/filemounts/general/pdf/ItaAssociation/ProductAndPublication/OpenSession/SlideLEE.pdf

	Right to Use Underground Space	Compensation				Other Support Provided
		Risk of Damage to Surface Structures, Activities	Impacts on Land Use/ Future Development		Relevant Project Phase	
			Shallow Tunnel	Deep Tunnel		
					residents due to devaluation of property)	
Hong Kong	Land Owner	Yes	-	-	Design Phase, Construction Phase, Operations Phase (1 year after completion of construction works)	Compensate for increased construction costs, extra measures to protect underground facilities
India	State	Yes	No	No		- Rehabilitation package[3] - Cash assistance - Cost of restoring affected public property
Japan	Land Owner	Yes	Yes	No		
Malaysia	Land Owner	Yes	-	-	Design Phase[4]	Relocation Support Acquisition if damage/danger to activities is expected
Singapore	State	Yes	No	No		
Korea	Land Owner	Yes	Yes[5]	-		
Thailand	Land Owner	Yes	-	-		Contractors All Risk Policy (CARI)
Turkey[6]		Yes	-	-	Design Phase, Construction Phase, Operations Phase	- Relocation support - Rent for temporary housing, retrofit of original dwelling (where feasible) - Compensation for losses "in case of emergency evacuations" (No information on specific period limit for compensation) - Compensation for down-payments to landlords - "Hardship compensation" - "School bus fees"
USA	Land Owner	Yes		No[7]		Subsurface easement one-time payment for temporary/permanent use/ purchase

Source: JICA Study Team complied with several sources

Notes:

1. Case of Paramatta Rail Link in Austraila, due to unforeseen impacts on property values (from http://www.parliament.nsw.gov.au/prod/parlment/nswbills.nsf/d6079cf53295ca7dca256e66001e39d2/968f58b4926720feca256d17003ae9af/$FILE/TAA%20(Parra%20Rail%20Link.pdf)
2. Construction of tunnel under houses in the Kogarah district as part of M5 East motorway.
3. Underground and elevated sections of Bangalore Metro Rail Transit System Project (from http://www.adb.org/documents/RRPs/IND/ 43912/43912-01-ind-rrp.pdf).
4. Klang Valley Mass Rapid Transit (KVMRT) Sungai-Buloh Kajang Line.
5. Seoul Metropolitan Government Ordinance 2931.
6. Environmental and Social Review Summary: Istanbul Otogar-Ikitelli Rail Transportation System (from http://www.miga.org/documents/esrs_turkey_village_metro_nov16_2010.pdf).
7. Metro Rail Segment 3 Tunnel through Hollywood Hills.

(d) Compensation for Land Acquisition and Resettlement in the Philippines

5.19 In the Philippines, subsurface rights belong to the owner of the surface, and "[the owner] can construct thereon any works or make any plantations and excavations which he may deem proper" (Article 437 of Republic Act (RA) 386, the Civil Code of the Philippines, enacted on June 18, 1949). Additionally, it is held that "no person shall be deprived of his property except by competent authority and for public use and always upon payment of just compensation (Article 435 of the Philippine Civil Code). This is, likewise stressed in the Philippine Constitution (1987) in Articles II and III.

5.20 The Implementing Rules and Regulations (IRR) of RA 8974 (An Act to Facilitate the Acquisition of Right-of-Way (ROW) Site or Location for National Government Infrastructure Projects, enacted on November 7, 2007), specify that the Project Implementing Agency will negotiate with the property owner for the purchase of the property by first offering the current zonal value issued by the Bureau of Internal Revenue (BIR) for the location. Further, that valuation of improvements and/or structures on land to be acquired will be based on the replacement cost, defined as the amount necessary to replace the structure or improvement based on the current market prices for materials, equipment, labor, contractor's profit and overhead, and all other attendant costs associated with the acquisition and installation in place of the affected improvements/installation.

5.21 Other existing Philippine Government legislations and guidelines relevant to land acquisition and resettlement include Executive Order (EO) 1035 (Providing The Procedures and Guidelines for the Expeditious Acquisition by the Government of Private Real Properties or Rights Thereon for Infrastructure and Other Government Development Projects, enacted on June 25, 1985), RA 6657 (An Act Instituting a Comprehensive Agrarian Reform Program to Promote Social Justice and Industrialization, Providing the Mechanism for Its Implementation, and for Other Purposes, enacted on June 10, 1988), RA 7160 (An Act Providing for a Local Government Code of 1991), RA 7279 (An Act To Provide for a Comprehensive and Continuing Urban Development and Housing Program, Establish the Mechanism for Its Implementation, and for Other Purposes, passed on February 3, 1992), and RA 8435 (Agricultural and Fisheries Modernization Act, 1997).

5.22 Development projects that are financed and/or otherwise supported by donor agencies or multilateral development banks are also subject to land acquisition and resettlement policies of the said donor agencies/ development banks.

(e) Steps in LAR Planning Based on International Good Practice

5.23 During detailed design, it is recommended that the following activities be carried out to (i) validate likely types and severity of proposed alignment impacts; (ii) design and implement measures to avoid these impacts; and (iii) minimize, mitigate, and compensate for all unavoidable impacts.

5.24 A clear policy for meaningful consultation, public information campaign, and compensation and rehabilitation based on relevant government laws and regulations and the safeguards requirements of any involved funding agency will have to be developed during detailed design. The steps involved in preparing a land acquisition and resettlement plan based on international good practice should be adopted.

(f) Addressing the Needs of Vulnerable Populations

5.25 Specific groups (e.g., the poor; women-, elderly- and disabled-headed households without other means of support; ethnic minorities; and the landless, among others) are recognized as particularly vulnerable to social and environmental shocks such as natural disasters and displacement from homes and livelihoods, etc., and care must be taken during the design and implementation of the subway project to ensure that they are meaningfully consulted throughout the process and not further disadvantaged. It is recommended that apart from compensation for their affected assets, vulnerable affected households should be entitled to additional rehabilitation assistance (including participation in an income restoration program5) in keeping with the objective of inclusive urban development.

5.26 The poor account for the large number of informal settlers, or those without decent housing who often settle in areas where disaster risk is high, such as along waterways. In these blighted areas, access to public facilities and social services (e.g., open spaces, education and healthcare) are also inadequate. As can be seen in Figure 3.9, the proposed alignments may pass through several urban poor areas and informal settlements. As the proposed alignments are only tentative, it is recommended that during the detailed design phase, every effort should be taken to avoid physical or economic displacement in these areas, where the populations are already highly vulnerable. In cases where resettlement impacts in these areas cannot be avoided, additional rehabilitation measures must be put in place to ensure vulnerable households are not further disadvantaged by the project.

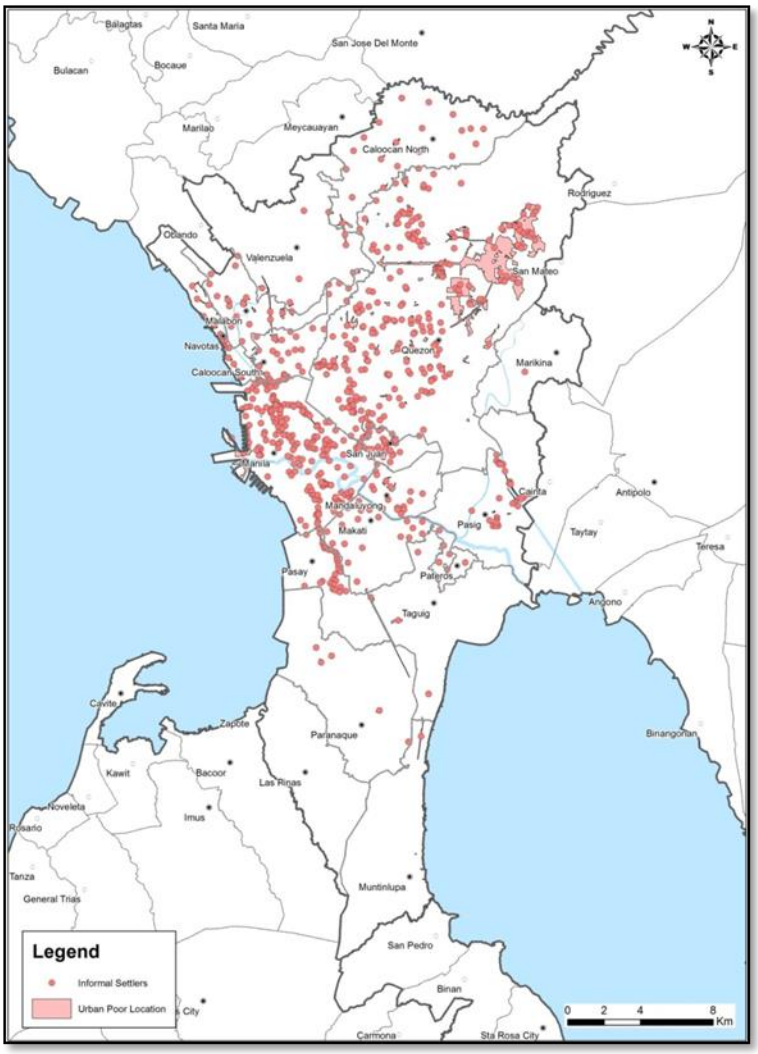
(g) Gender Issues

5.27 In light of the fact that there may be gender-based differences in access to, needs and priorities relating to urban transport, it is important that socioeconomic data gathered during detailed project design is aggregated by gender and that this is factored into project design and impact assessment. It should also be noted that LAR impacts could affect women and men differently. Therefore, the situation of women-headed affected households must be carefully studied as part of LAR planning for the subway project. It must be ensured that women are equal participants in the public consultations and that these are scheduled and located in times and venues that are convenient to women in the project areas.

5.28 Based on the gender analysis to be conducted during detailed design (data from socioeconomic surveys, desk review of relevant literature and other document, public consultations), it is recommended that a Project Gender Action Plan be developed to identify activities and strategies for addressing identified gender issues and provide details on how women will be involved in project implementation and monitoring. Recommendations may include (i) ensuring that information education and

[5] To be designed as part of the Project's Land Acquisition and Resettlement Plan to address the needs of households losing productive assets, incomes, employment or sources of living, to supplement payment of compensation for acquired assets, in order to achieve, at a minimum, full restoration of living standards and quality of life. The program should be designed with the full participation of affected households at the detailed design stage and form an integral part of the Project's Land Acquisition and Compensation/ Resettlement Plan. Human and financial resources required for the efficient implementation of the IRP must be clearly identified and made available in a timely manner. Additionally, it must be ensured that affected households eligible to participate in the IRP are assisted in meeting their daily needs during the transition period

communication (IEC) materials used during project implementation are gender-sensitive; (ii) minimum targets for women in administrative and technical positions in the Project Management and Implementation team(s); and (iii) monitoring the project impact on women, reporting results through the collection and analysis of sex-disaggregated information and consultations with both male and female stakeholders during project reviews.



Source: Metro Manila Urban Services for the Poor Project (ADB, 2006).The Study on Climate Change Impact Over Asia Mega Cities Phase 2 (JBIC 2008).

Figure 5.1 Location of Urban Poor and Informal Settlements in Metro Manila

2) Environmental Considerations

5.29 The common impacts attributed to subway projects would have to be classified by implementation phases. That is, during the pre-construction phase, the construction phase and the operation phase. By source, expected impacts are generally as follows:

a) Impacts related to waste matter - During the pre-construction phase, this would relate to waste matter generated from activities such as dismantling or demolition works. During the construction phase, this would be waste matter as a result of site clearance, underground railway construction, soil and construction materials conveyance to/from construction sites, waste of workers, exhaust gases from construction vehicles, etc. During project operation phase, waste generation would be from the operation of trains, from stations and depot area.

b) Impacts not related to waste matter – This covers compensation and resettlement at pre-construction phase. For construction phase, this would entail ground subsidence caused by tunneling works, change of ground water level, noise and vibration from construction vehicles, and floods. Similarly, the operation phase would entail ground subsidence at railway tunnel and commercial activities, noise and vibration in the elevated sections of the railway line as well as probable hazards such as fire and explosion inside tunnel and traffic accident.

5.30 Based on experiences of subway projects in other parts of the world, potential impacts can be predicted. As such, mitigation measures will have to be formulated during the drafting of an Environmental Impact Assessment (EIA). Predicted impacts during the pre-construction phase are mainly due to land acquisition which will have influences on the living and business activities of the affected households. This will be addressed in the processes explained in the preceding section on social considerations.

5.31 Potential impacts during the construction phase include the following:

(i) Traffic congestion on selected routes caused by the assembling of construction materials or caused by the movements of construction equipments and vehicles;

(ii) Air pollution caused by dust from construction sites, activities of concrete mixing and conveyance of materials;

(iii) Noise and vibration pollution caused by construction equipment;

(iv) Soil contamination caused by conveyance and disposal of waste soil;

(v) Contamination of water bodies due to run off rain water carrying construction debris; and

(vi) Transmission of contagious diseases from the construction workers to local community members and vice versa.

5.32 Potential impacts during the operation phase include the following:

(i) Increase in vibration along the line caused by the operation of trains;

(ii) Contamination caused by waste water and garbage from stations in case of improper collection and treatment; and

(iii) Soil and water supply contamination at depot site caused by garbage and waste water from depot.

5.33 For the alignments presented, impacts on the ecosystem/biological environment above ground are not expected to be significant since they basically traverse built up areas. However, a detailed inventory of flora and fauna would have to be conducted and measurements of water and air quality as well as noise and vibration should be done during the full feasibility study and detailed design stage.

6. INTEGRATED URBAN DEVELOPMENT CONCEPT

1) Non-transport Role of the Project

6.1 The proposed Mega Manila Subway Line (MMSL) is expected to have a multiplier effects on greater Metro Manila, as it is envisaged to be the main backbone of the public transport network providing travel unhampered by road congestion. At the same time, the project will open up new areas for development especially around stations and terminals.

6.2 The reliable and high-quality transportation services of MMSL are available to rich and poor alike. It is, thus a social equalizer affording the lower income households to reach their work places or school faster or almost at the same time as the wealthier car-owners.

6.3 The detailed feasibility study would quantify the expected savings from avoided fuel cost of the proposed MMSL in the greater Metro Manila. When commuters take the MMSL rather than drive in individual cars or motorcycles, everybody benefit from cleaner air.

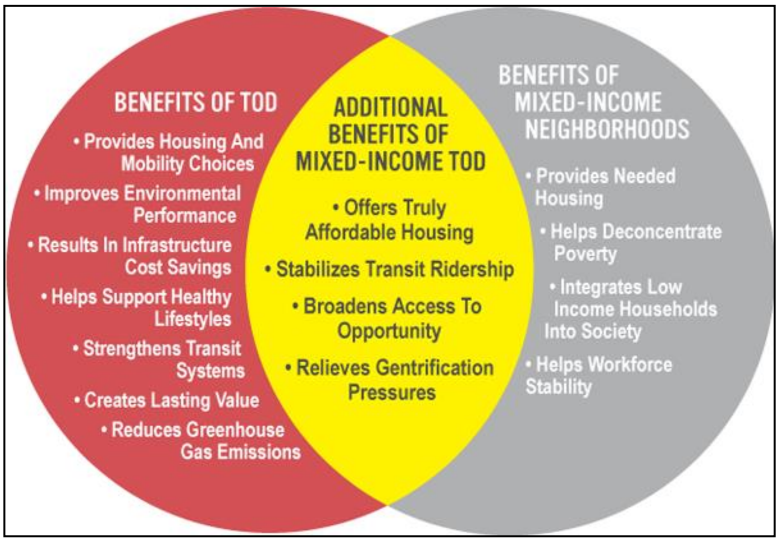
2) Concept of Integrated Development and Opportunities

6.4 In the Philippines, none of the rail entities have engaged in or pursued large-scale property developments in and around stations that could be classified as Transit Oriented Developments (TOD). Neither is there a restriction in the charters of LRTA or PNR to undertake TOD.

6.5 The development of TODs is much to be desired as they lead to higher and stable transit patronage. TODs are crucial to the realization of Metro Manila's vision as a livable city. The benefits from integrated development are shown on Figure 6.1.

6.6 To maximize the benefits that can be derived from MMSL developments, a proven and successful approach is the adoption of an integrated urban development. At stations and terminals and in their adjoining areas, commercial and public facilities are integrally developed with transportation. When this occurs, the MMSL attracts higher patronage while the commercial/urban development benefits from good accessibility. This synergy is often so huge that many private companies in Japan have captured the external benefits for their own financial gains.

6.7 The urbanizing fringes of Metro Manila – particularly in Bulacan and Cavite offer the greatest potential for applying the TOD concept – because they are less hampered by existing land uses and ownership. These Greenfield or new sites can be planned and designed with a clear transit focus. To succeed, these Greenfield sites must be provided with high quality, fixed guideway public transport systems with regular connections to the CBD and other regional centers and other TOD nodes. This concept of urbanism seeks to bring together modern lifestyles, housing, and places of employment, retail activity and leisure time in a compact pedestrian-dominated neighborhood with linkages by transit to other points of interests in the greater Metro Manila region.



Source: www.mitod.org

Figure 6.1 Illustration of TOD Benefits

6.8 The MMSL is the key driver to the realization of TOD – because of its new alignment that deviates from the radial-circumferential pattern of the metropolis, its highest passenger carrying capacity among all public transport modes, and a route through the most-traffic-intensive CBDs. While the MMSL is expected to form the transportation backbone of Mega Manila, buses and jeepneys will remain to be the most important road-based public transportation mode even in the future, providing services in areas not covered by the MMSL and LRTs or providing feeder services to them.

6.9 The differences in land uses among the stations of MMSL Line offer diverse opportunities for urban development. For stations surrounded by built-up areas, future developments would be of the re-development or urban renewal kind. Changes in land uses towards higher intensity would be slower – except when a single-owned large land area is available. Land owned by government belongs to this category. On the other hand, new large-scale urban developments are less constrained on the end points of the MMSL, particularly in and around stations at the San Jose del Monte in Bulacan and in Dasmariñas in Cavite. The stations in the urban periphery also have the potentials to pull more users as a regional center of urban services and transportation hub to other areas. Many users from surrounding areas of greater Metro Manila and neighboring provinces will go to these stations, if and when more varied commercial services get provided. Thus, these stations could grow beyond their simple transportation hub functions and into full-pledged commercial and business centers of suburban areas.

3) Necessary Institutional Arrangement

6.10 There are two roles in the preceding sections that no public sector entities currently perform: (i) the development of TODs as the embodiment of integration of land uses at or around MMSL stations, and (ii) the re-organization of buses and jeepneys on the road network.

6.11 The planning and construction of the MMSL falls squarely with DOTC. Funding from the national government – as well as loans - will have to be included in the Budget, and hence in the investment program of DOTC. The funding could not be earmarked directly to LRTA or PNR, because of the impaired capitalization of these two rail entities.

6.12 Logically, there should be a single rail transit authority for the greater Metro Manila region. The LRTA's charter restricts it to one particular technology – light rail. Hence, the MMSL cannot be lodged with LRTA unless its charter is amended by an act of Congress. The Philippine National Railways (PNR) has no such restriction but its capitalization is too small at Php1.5 billion and its corporate life of PNR will expire in 2025, which is too short for the MMSL operation. An act of Congress is also required to re-capitalize and re-organize the PNR before it can assume the responsibility for MMSL. The biggest stumbling block to the construction of MMSL is the absence of a law covering the use of land below the surface, particularly for underground or subway transport.

6.13 It is possible to enact a new law that will address the weaknesses of LRTA and PNR, as well as assert the State's rights over transport right-of-way below ground. Several bills on railways have been filed in past and current Congress – but none have managed to reach 2nd reading. It is also unclear whether any of these Bills would have remedied the aforementioned institutional deficiencies and gaps had they been enacted.

6.14 Based on past studies and proposals, it would be advisable to have a railways act that, among other things:

- Create a single authority for mass transit planning and development in the greater Metro Manila region, which should include power to re-organize buses by corridors into BRT systems;
- Adopts a policy of privatization (or private sector participation) in the operation and maintenance of mass transit lines, with corresponding creation of a strategic railway office in DOTC as economic regulator;
- Exempt mass transit assets from local government taxation;
- Set limits on private rights over subterranean uses of land for public purposes, like transport of people, and public utility (water, gas, electricity, telecommunications) pipelines;
- Addresses the future of rail entities LRTA, PNR, MRTC, and North Luzon Railway Corporation. While LRTA and PNR are state-owned enterprises (SOEs) with legislative charters, the MRTC and NLRC are Securities Exchange Commission (SEC) registered corporations with no franchise to operate rail transit systems. MRTC owns the assets of MRT-3 but is not owned by the government, although DOTC has repeatedly announced takeover or reverse privatization in the last 2 years. NLRC is a subsidiary of BCDA but is under the management control of DOTC via a Presidential Order.

6.15 It should be noted that the operation and maintenance of MMSL will be more demanding than LRT or conventional surface rail. It would be risky to assign this responsibility to public sector entities, considering their poor track records in running and maintaining rail assets.

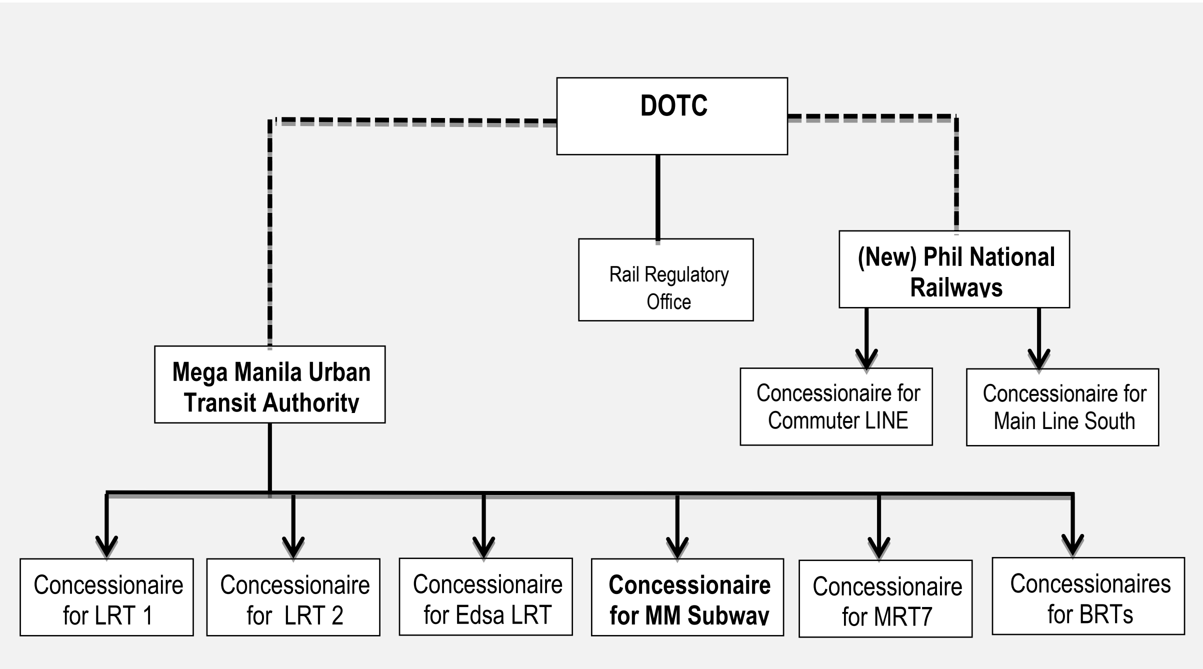
7. PROPOSED IMPLEMENTATION STRATEGY

1) Implementation Strategy

7.1 There are three existing railway SOEs that can be considered in the implementation of the Mega Manila Subway Project (MMS). These are: LRTA, PNR and NLRC. None of them are suitable. The charter of LRTA limits the rail technology to light rail, whereas the railway envisaged for the MMS is heavy rail. There is no such limitation on the PNR charter, except that its corporate life expires in 2025. On the other hand, NLRC has no rail franchise. A new railway company for the MMS cannot be avoided.

7.2 The MMS Company can be organized in the context of a private-sector biased strategy or a public-sector one. The former assumes a PPP framework, where operations and maintenance is delegated to a private concessionaire. The latter assumes a government-run railway system, where private sector participation is minimal and occasional, as exemplified by PNR and LRTA. To achieve a professionally-run system that is insulated from political interference and changing political winds, the first model (i.e., heavy private-sector involvement) is the preferred arrangement.

7.3 A corresponding re-structuring of the existing urban railway sector should be instituted so that all the railway lines (and not just the MMS) will be on similar footing and function as an integrated network. An analogous reform of the road-based public transport system – particularly buses – should also be put in place, so that a wider integration can emerge. This can be realized by creating a Mega Manila Mass Transit Authority (MMTA) that will plan and own all the urban railway assets (LRT-1, LRT-2, MRT-3, MRT-7, MMS, other lines). It shall also be responsible for integrating the more than private 600 bus operators into a coordinated mass transit network. The broader framework is illustrated in Figure 7.1.



Source: JICA Study Team

Figure 7.1 Implementation Framework

7.4 During the construction phase of the MMS Project, particularly Stage 1, a Project Management Office (PMO) can be organized in the DOTC. It shall report to an inter-agency Project Steering Committee (composed of representatives from DOTC, DPWH, MMDA, DOF, and business sector). The PMO shall be supported by an inter-disciplinary team of national and international Consultants with deep experience in building a subway system. Aside from constructing the MMS on-time and on-budget, there are three other important missions for the PMO, viz.,:

- The formation of the Mega Manila Subway Company by a private concessionaire chosen through international competitive bidding;
- The planning and development of the various Stations with the active participation of property owners adjacent to them and concerned local government units; and
- Management of the overlaps between construction and operations.

7.5 Congressional action is needed to resolve the legal vacuum on the subterranean rights-of-way. As long as the surface uses of the land by private owners are not impaired, the State should have the right to build below-ground public utilities like railway and water lines without need of expropriating the land or compensating the owners. Without such a law, the best alignment for a subway system (and benefits to the community) may not be realized.

2) Funding Opportunities

7.6 The proposed EDSA Subway Line may be implemented under a public-private partnership (PPP) arrangement or financed through official development assistance (ODA). If implemented under a PPP scheme, the private proponent will most likely require full cost recovery of investment cost, O&M cost, capital expenditures, and loan amortization. Given the huge capital requirements, the private proponent may be unwilling to shoulder the entire portion market risk of the project unless some forms of guarantees are provided by the national government. Moreover, full cost recovery may result in tariffs higher than the potential commuters' willingness and ability to pay.

7.7 If the project will not generate interest from the private sector, then it can be financed by ODA coming from bilateral or multilateral agencies. The Government of the Philippines may consider availing of an ODA loan from the Japan International Cooperation Agency (JICA). Concessional loans from JICA usually carry a 40-year repayment period (inclusive of a 10-year grace period on the principal repayment) with interest rate as low as 0.2% per annum.

7.8 Another possible funding approach is the separation of the construction of and ownership of the basic railway infrastructure and the procurement of the rolling stock and the E&M system. The former will be the responsibility of the public sector, while the latter will be assigned to the private sector on a concession basis. The same public authority that owns the railway infrastructure will conduct the policymaking and regulatory function. ODA loans can be used by the public sector to finance the construction of civil works, stations, depot, railway track, escalators, and others. The Thai Government adopted this scheme for the Bangkok Blue Line.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1 The preliminary analysis shows that Mega Manila Subway Project is economically viable. There are compelling reasons, other than economics, for a high-capacity subway transit system for a sustainable Mega Manila region. With proper phasing of construction, the economic benefits could be enhanced further.

8.2 The final route still needs to be fleshed out. This can only be done in a subsequent detailed feasibility study phase with the involvement of relevant stakeholders. A principal determinant to the alignment study is the legal issue of subterranean rights. This should be clarified at the start. The different alignments considered here followed closely the existing public roads, on the presumption that the State may have to expropriate lands where the rail line passes through – even if there is no impairment to the use thereof. Such a rigid interpretation, however, runs counter to the accepted right of the State to limit building heights. A better and more efficient alignment would emerge, if height restriction below the surface also applies.

8.3 The obstacles for a proposed transport infrastructure, when at-grade or elevated, can be ascertained visually. A large part of the subway project will be underground. Thus, sub-surface testing and investigations need to be undertaken before a final alignment – vertical and horizontal – can be arrived at. Such a level of effort is beyond the scope of this study.

8.4 The station locations here are indicative only; their actual siting, layout, and scale have to take into account several critical factors; the final route, the expected volume of passengers, passenger mode of access to/from the station, existing and expected land uses within 500 meters radius, and openness of property owners as well as local government units to integrate the station into the overall fabric of their developments. These will come into play during the feasibility study phase.

8.5 In this study, 3 possible termini of the subway were identified. These are San Jose del Monte in Bulacan, Bay Area on Roxas Boulevard (NAIA side) and Dasmarinas in Cavite. They have to be revisited in the next phase of the feasibility study. More than just stations, these termini have other functions, aside from the technical requirements of turn back facilities. Therefore, they will require special planning attention. The location of the Depot will require a larger land area for acquisition and will dictate where one of the line Terminus will be.

8.6 With a line length ranging from 40 to 70 km, project implementation would have to be phased; the first phase would be on the northern segment of the line and there shall the Depot be also. The corner of NAIA Road and Roxas Boulevard is not a suitable terminus for the first phase, because it would be inconvenient for passengers and tight for inter-modal transfers. Extending the line farther means a terminus at the heart of the Bay Area (where the Mall of Asia and the Entertainment City are located), which is already a major traffic magnets on the scale of Bonifacio Global City.

8.7 The method of tunneling also needs to be explored in detail, since it will significantly affect construction cost. The choice is expected to be influenced by the vertical elevation of the subway, geotechnical characteristics of the route, and length of the tunnel. The Guadalupe plateau, where the line would traverse, lends itself to the use of a Tunnel Boring Machine (TBM), which are made-to-order. On the other hand, cut-and-cover would be disruptive to surface activities and would be objectionable in the CBDs.

8.8 The Mega Manila Subway is only one of several mass transit lines. The basic assumption in this study is that all of the other lines are in operation in 2030, or when it starts commercial service. The demand of the subway will be different under this scenario. Thus, the subsequent study needs to consider the mostly occurrence of the various components of the Dream Plan 2030.