CHAPTER 6

ROUTE PLAN AND RAILWAY SYSTEM

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6.1 Planning Concept of AER

Planning concepts of Airport Express Railway (hereinafter referred to as AER) are shown in Table 6.1-1.

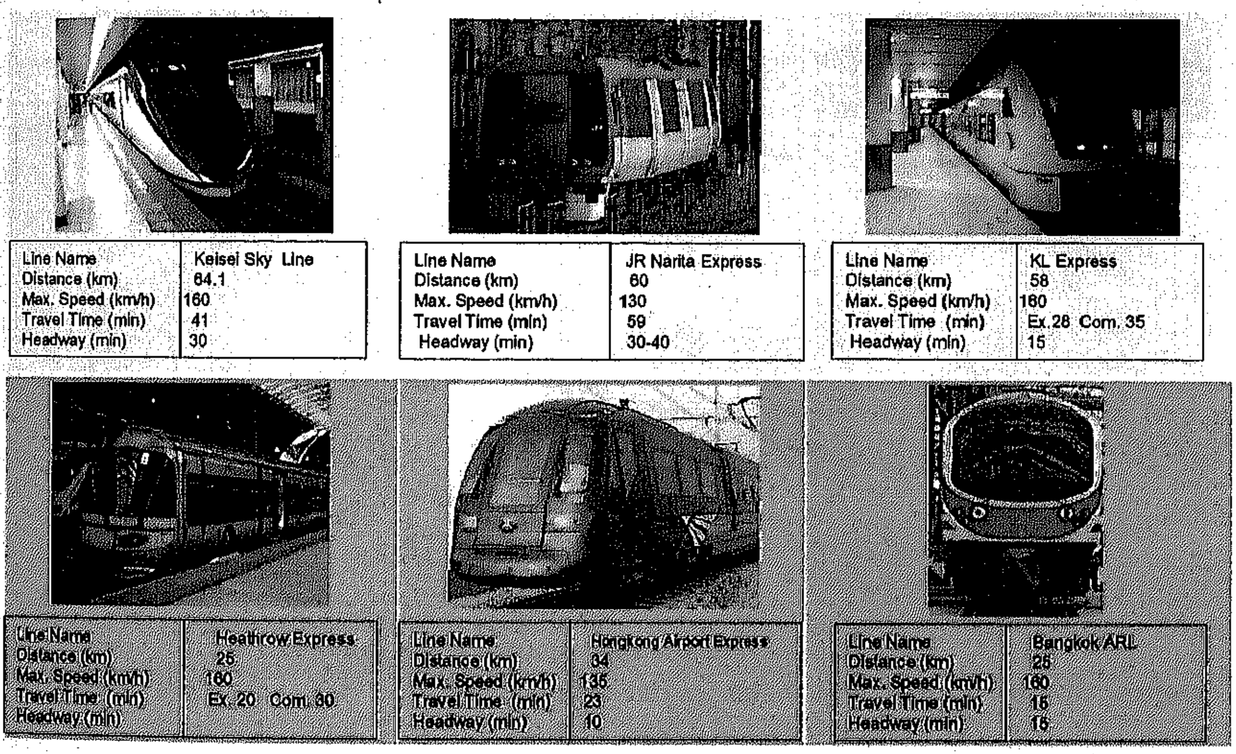
More detailed concept with counterpart will be discussed between the JICA Study Team (hereinafter referred to as JST) and counterpart after the first JCC (Joint Coordination Committee) Meeting which was held on 10th December 2012.

Table 6.1-1 Planning Concepts of AER

Items	Description
Maximum Speed	V= more than 160km/h
Gauge	1,435 mm (Standard gauge)
Traction Energy Supply	Overhead Catenary
Operation Type	Mixed Operation with Commuter Train

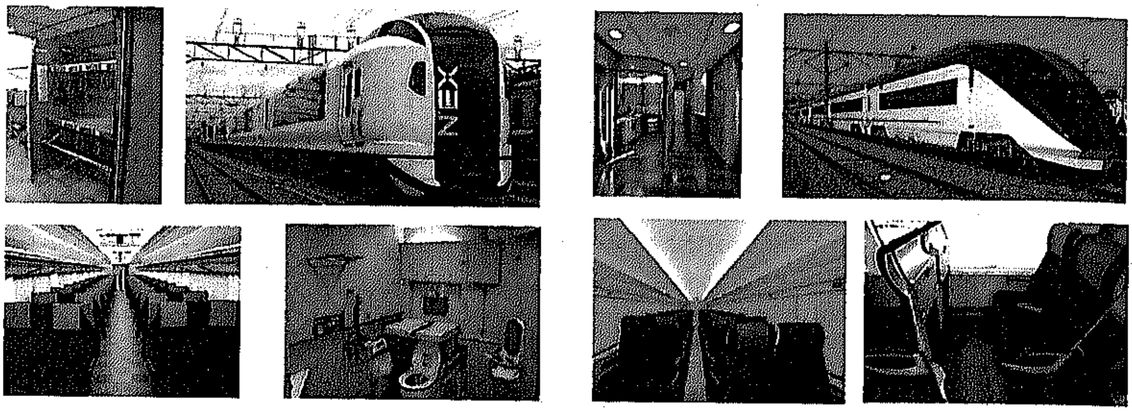
Source: JICA Study Team

Examples of Express Train and Commuter Trains are shown below.



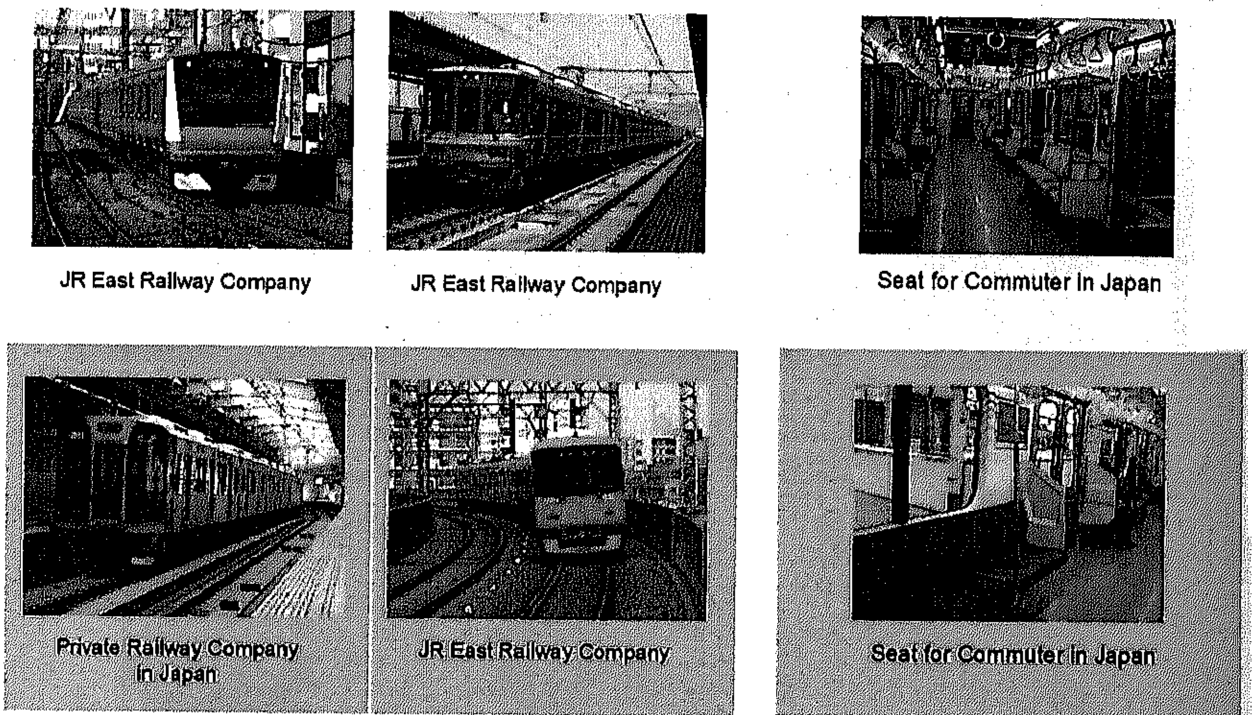
Source: JICA Study Team

Figure 6.1-1 Examples of Airport Access Railways



(1) JR EAST Narita Express (2) Keisei "Sky Liner"

Figure 6.1-2 Examples of Airport Express Trains in Japan



Source: JICA Study Team

Figure 6.1-3 Examples of Commuter Trains in Japan

6.2 A Proposed Route Plan and Station Locations

6.2.1 Initial Screening of Route Plans

Route plans were proposed/evaluated after a study of Existing plans/studies for access railways to CIA which are described in Section 3.1.

These route plans were discussed in the first Technical Working Group (hereinafter referred to as TWG) Meeting which was held on 25th October 2012 by the JST.

Preconditions for Route Planning were set up to propose the route options. One was "connect between CIA and NAIA directly", the other one was "Plan the route using existing ROW and public land ".

1) Proposed Routes

The proposed 11 routes, shown below, were formulated by combination of alternative routes, which were the 4 routes located outside Manila, and 5 routes located inside of Manila. Each alternative route was evaluated for both outside and inside of Manila, then the proposed 11 combined routes were evaluated.

Table 6.2-1 Alternative 11 Routes for Initial Screening

		Inside of Manila			
		Option I	Option II	Option III	Option IV
Outside of Manila	Option (1)	●		●	●
	Option (2)	●		●	●
	Option (3)	●		●	●
	Option (4)		●		
	Option (5)		●		

Source: JICA Study Team

(1) Outside of Manila

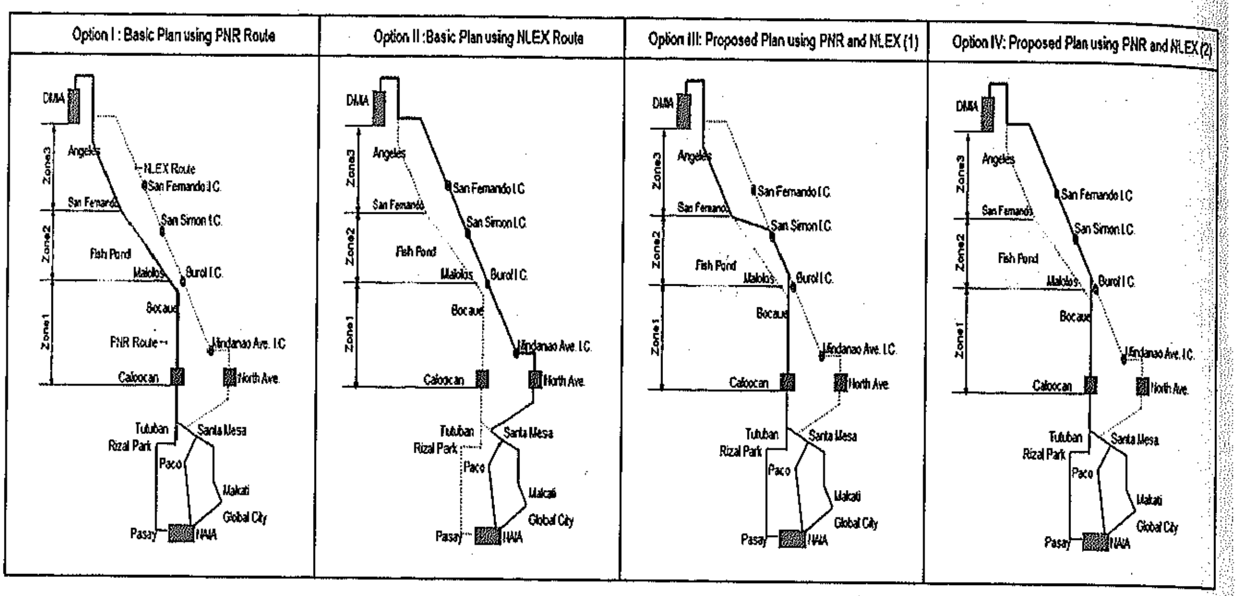
The JST investigated the routes from Manila to CIA along NLEX and MacArthur Highway to confirm existing ROW conditions, Natural Conditions, Obstructing structures (e.g. High Voltage Towers, Flyovers etc), and then proposed 4 route plans for AER which are shown in Table 6.2-2.

Outlines of these routes are shown in Figure 6.2-1.

Table 6.2-2 Proposed Route Plans for AER outside Manila

Option		Outline
Option I	Option I : Basic Plan using PNR Route	This route utilizes the existing PNR route (Same as North Rail Project) from Caloocan to CIA.
Option II	Basic Plan using NLEX Route	This route utilizes the NLEX route and runs on Mindanao Ave from North Ave. (Trinoma) to CIA.
Option III	Proposed Plan using PNR and NLEX (1)	This route utilizes PNR route from Caloocan to Burol I.C and the NLEX route between Burol I.C and San Simon I.C., and PNR route from San Fernando to CIA, although the fishpond area along the old PNR route is avoided.
Option IV	Proposed Plan using PNR and NLEX (2)	This alternative route utilizes PNR route from Caloocan to Burol I.C. and the NLEX route from Burol I.C to CIA

Source: JICA Study Team



Source: JICA Study Team

Figure 6.2-1 Outline of Proposed 4 Route Plans for AER Outside of Manila

Routes of outside of Manila were divided into the following 3 zones, because of the greatly-differing natural conditions, existing ROW conditions and other aspect of each route.

Table 6.2-3 Zoning of Outside of Manila

	Option I	Option II	Option III	Option IV
Zone 1	Caloocan-Malolos	North Ave. - Burol	Caloocan - Burol	Caloocan - Burol
Zone 2	Malolos - San Fernando	Burol - San Simon	Burol - San Simon	Burol - San Simon
Zone 3	San Fernando - Clark Airport	San Simon - Clark Airport	San Simon - Clark Airport	San Simon - Clark Airport

Source: JICA Study Team

(2) Inside of Manila

The JST investigated the inside of Manila PNR route, Quezon Ave. Makati Ave and Global City etc to confirm existing ROW conditions, Natural Conditions, Existing Railways (PNR, LRT1, LRT2 and MRT3),Obstructing structures (e.g. High Voltage Towers, Skyways and another Flyovers etc), and then proposed 5 route plans for AER which are shown in Table 6.2-4.

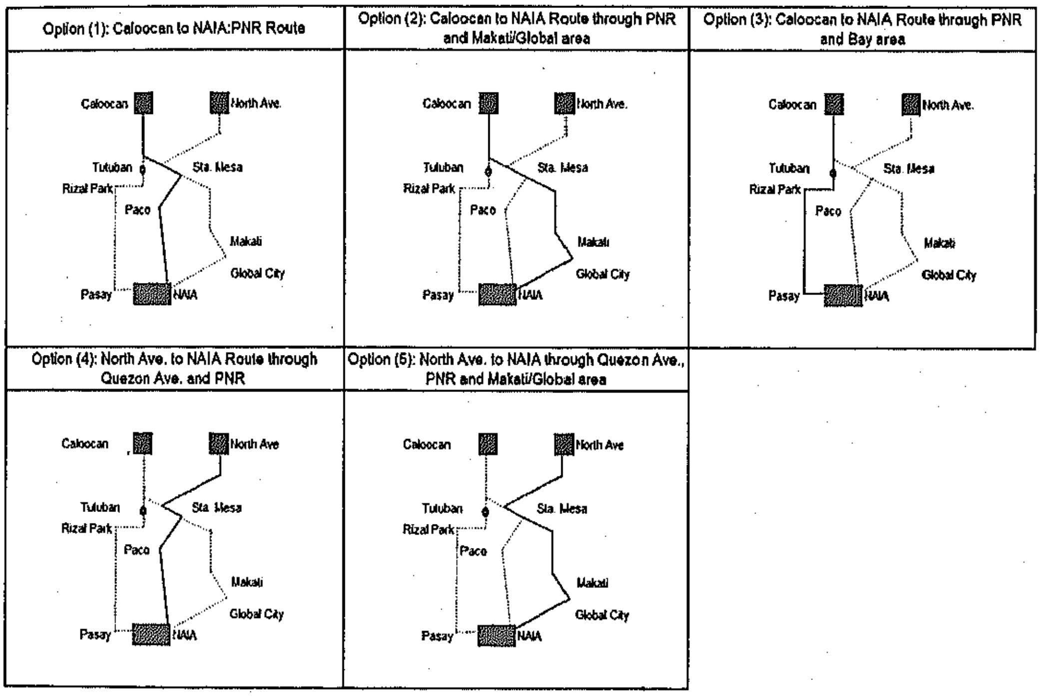
The outlines of these routes are shown in Figure 6.2-2.

Table 6.2-4 Proposed Route Plan for AER Inside Manila

Option		Outline
Option (1)	Caloocan Sta. to NAIA T3 Sta. Route through PNR Route	This route utilizes the existing PNR route from Caloocan Sta. to NAIA Terminal 3.
Option (2)	Caloocan Sta. to NAIA T3 Sta. Route through PNR and Makati/Global area	This route utilizes the existing PNR route from Caloocan Sta. to Santa Mesa Sta. From Santa Mesa Sta. to Makati/Global area, the route goes underground all the way to NAIA Terminal 3.

Option		Outline
Option (3)	Caloocan to NAIA Route through PNR and Bay area	This route utilizes the existing PNR route from Caloocan Sta. to Tutuban Sta, the route from Tutuban Sta. to Pasay runs through Rizal Park, the route goes underground all the way to NAIA Terminal 2 and 3.
Option (4)	North Ave. to NAIA Route through Quezon Ave. and PNR	This route utilizes the Road along Quezon Avenue and the existing PNR route. The viaduct/underground goes through urbanized zones all the way from North Avenue to NAIA Terminal 3.
Option (5)	North Ave. to NAIA through Quezon Ave., PNR and Makati/Global area	This route utilizes the Road along Quezon Avenue and the existing PNR route from España Sta. to Santa Mesa Sta. From Santa Mesa Sta. to Makati/Global area, the route goes underground all the way to NAIA Terminal 3.

Source: JICA Study Team



Source: JICA Study Team

Figure 6.2-2 Outline of Proposed 5 Route Plans for AER inside of Manila

2) Station Locations

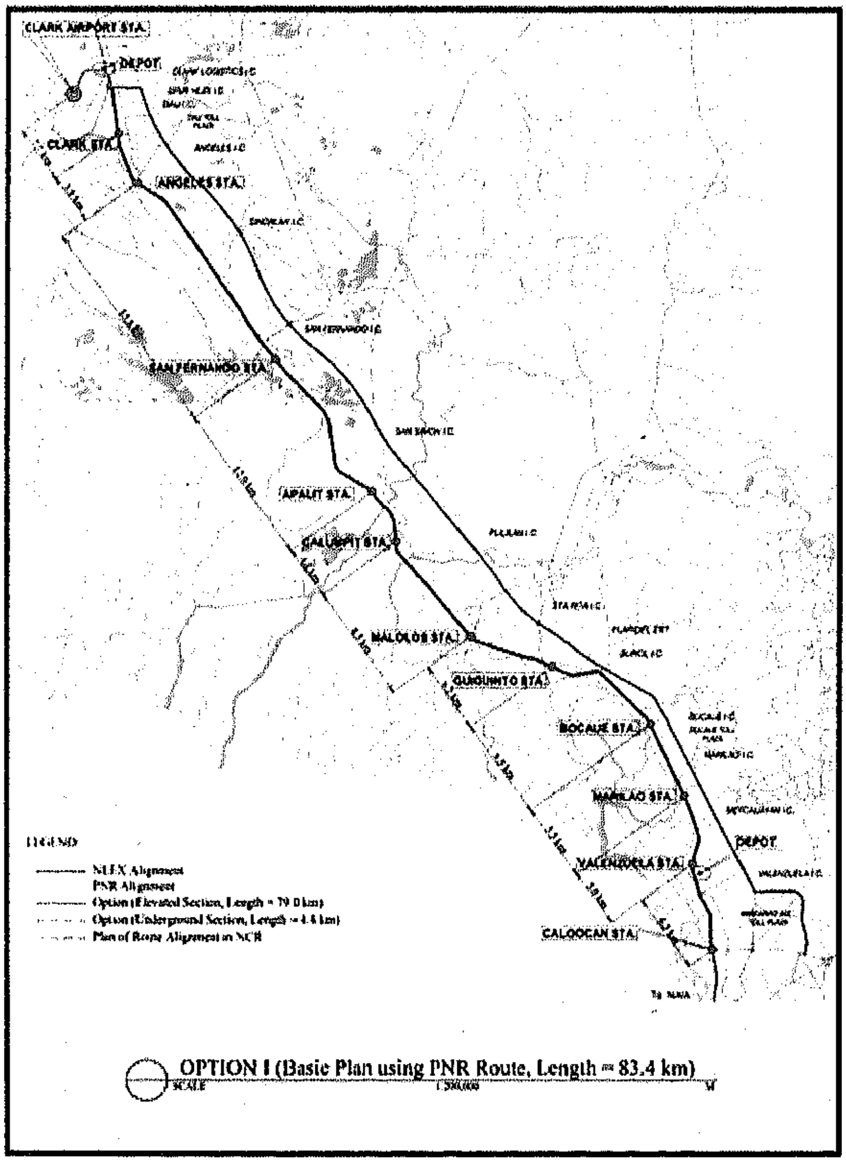
Station locations were selected after taking into account the railway network inside of Manila, planned stations of the Northrail project and the interchange locations of NLEX outside of Manila.

However, there is a flyover near the PNR Pampanga Station inside of Manila, therefore, it is very difficult to plan the AER station locations.

The alignment Plan, station name and distance from station to station for each option are shown below.

(1) Outside of Manila

Option I

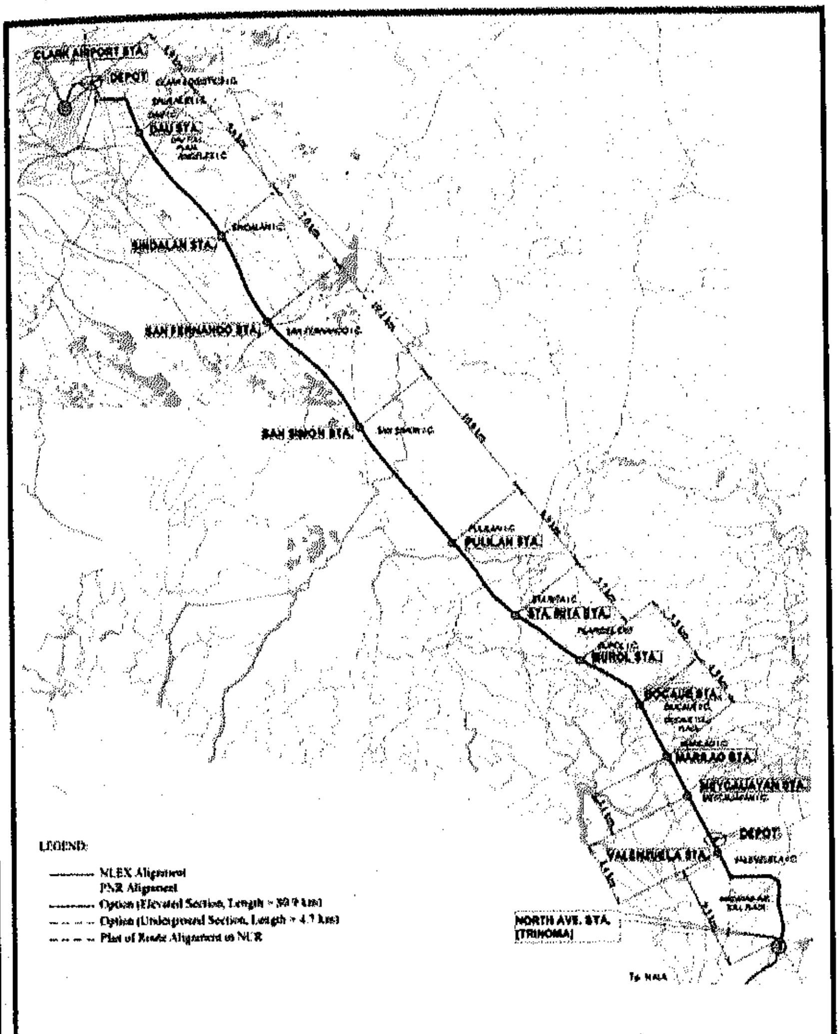


STATION	Distance
CIA	
	7.7km
CLARK	
	3.8km
ANGELES	
	15.8km
SAN FERNANDO	
	12.0km
APALIT	
	4.1km
CALUMPIT	
	8.5km
MALOLOS	
	6.2km
GUIGUINTO	
	8.5km
BOCAUE	
	5.5km
MARILAO/ MEYCAUAYAN	
	5.0km
VALENZUELA	
	6.3km
CALOOCAN	
Total Length	83.4km

Source: JICA Study Team

Figure 6.2-3 Route Plan and Stations of Option I

Option II



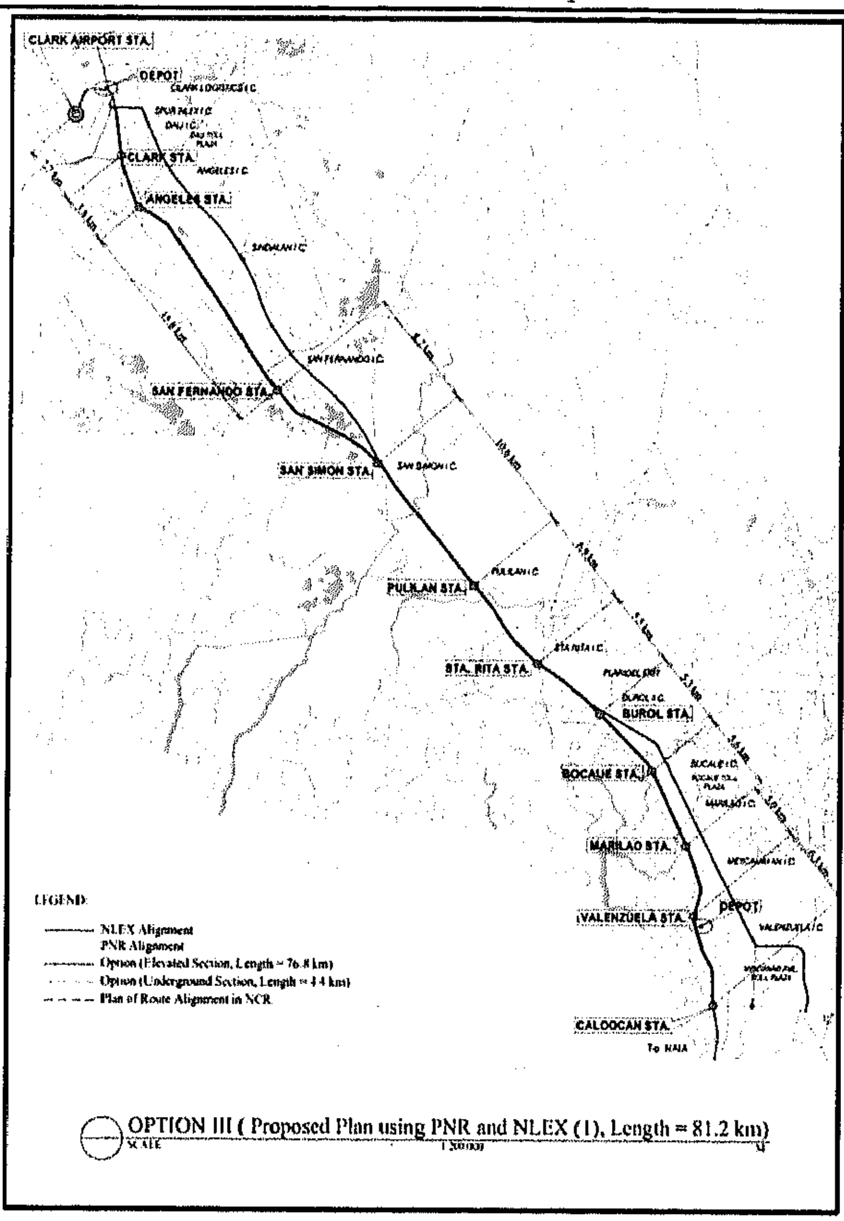
OPTION II (Basic Plan using NLEX Route, Length = 85.6 km)

STATION	Distance
CIA	
	8.9km
DAU	
	9.6km
SINDALAN	
	7.0km
SAN FERNANDO	
	10.1km
SAN SIMON	
	10.6km
PULILAN	
	6.9km
STA.RITA	
	5.7km
BUROL	
	5.5km
BOCAUE	
	4.3km
MARILAO	
	3.1km
MEYCAUAYAN	
	4.4km
VALENZUELA	
	9.5km
NORTH Ave.	
Total Length	85.6km

Source: JICA Study Team

Figure 6.2-4 Route Plan and Stations of Option II

Option III

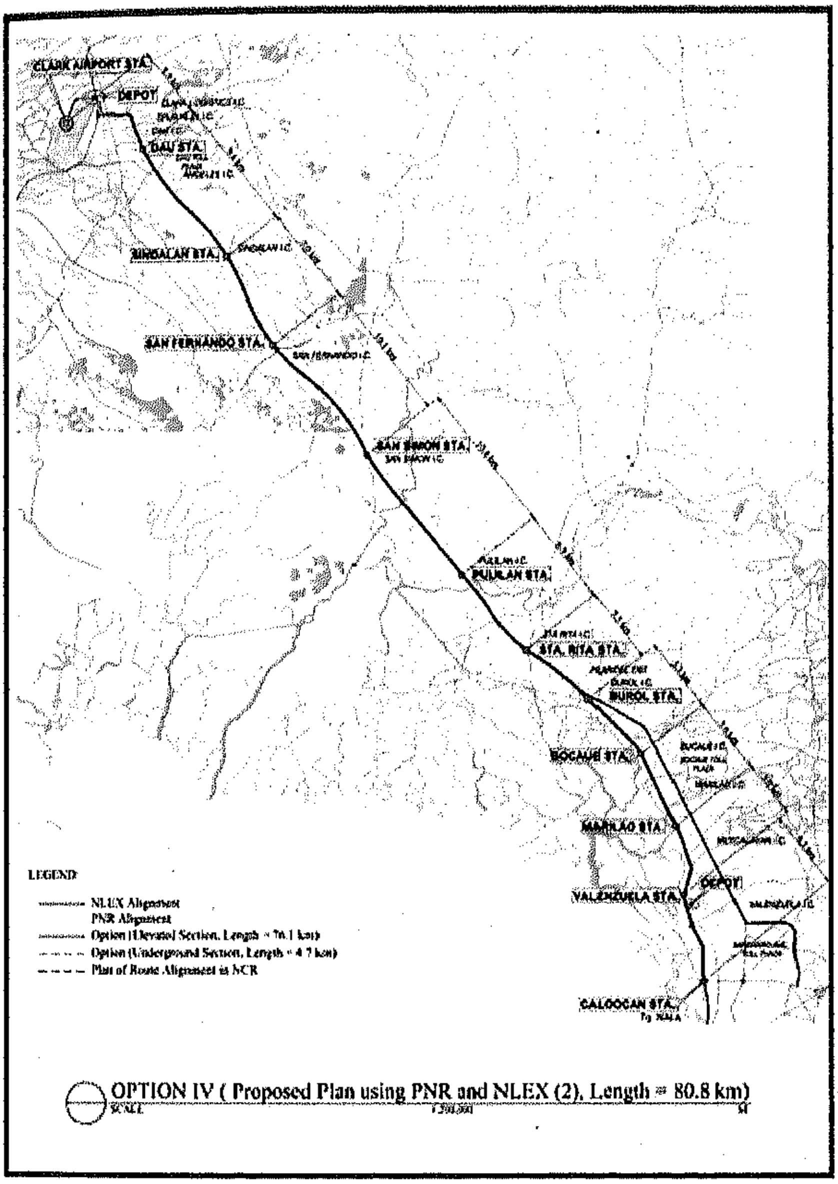


STATION	Distance
CIA	
	7.7km
CLARK	
	3.8km
ANGELES	
	15.8km
SAN FERNANDO	
	8.7km
SAN SIMON	
	10.6km
PULILAN	
	6.9km
STA. RITA	
	5.5km
BUROL	
	5.3km
BOCAUE	
	5.6km
MARILAO/ MEYCAUAYAN	
	5.0km
VALENZUELA	
	6.3km
CALOOCAN	
Total Length	81.2km

Source: JICA Study Team

Figure 6.2-5 Route Plan and Stations of Option III

Option IV



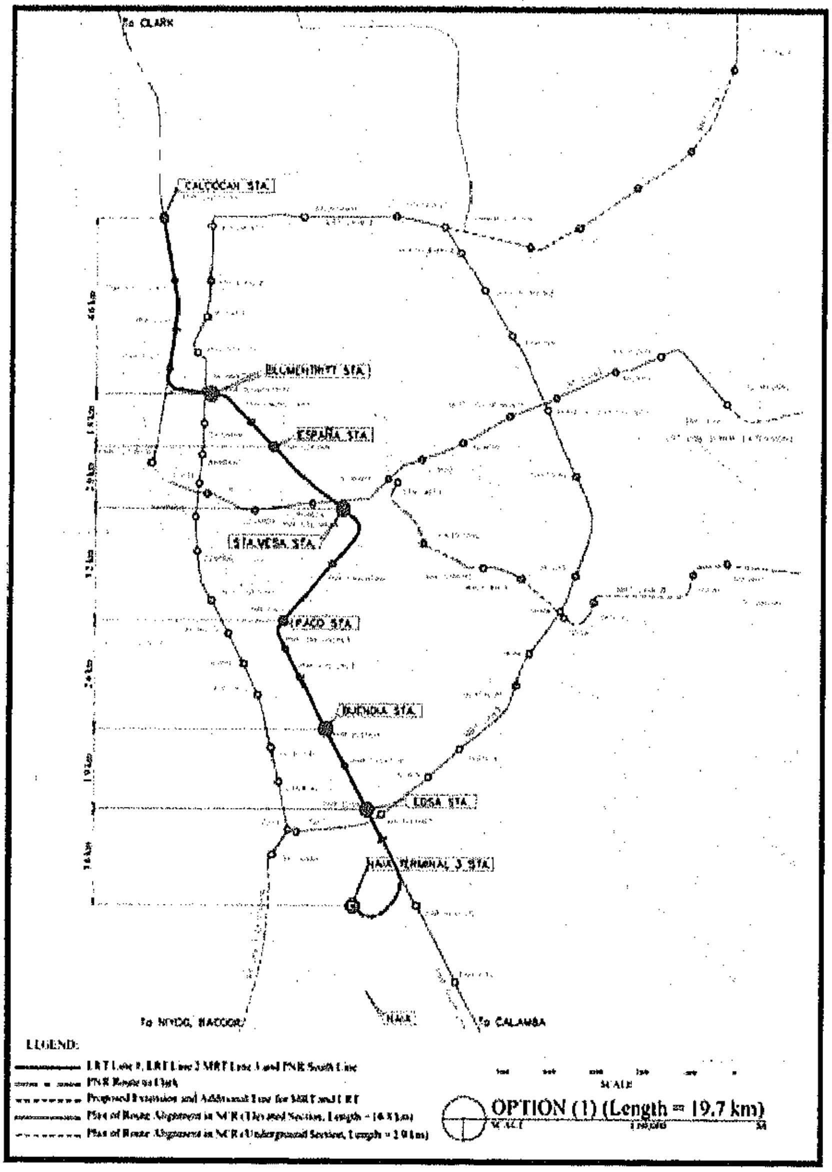
STATION	Distance
CIA	
	8.9km
DAU	
	9.6km
SINDALAN	
	7.0km
SAN FERNANDO	
	10.1km
SAN SIMON	
	10.6km
PULILAN	
	6.9km
STA. RITA	
	5.5km
BUROL	
	5.3km
BOCAUE	
	5.6km
MARILAO/ MEYCAUAYAN	
	5.0km
VALENZUELA	
	6.3km
CALOOCAN.	
Total Length	80.8km

Source: JICA Study Team

Figure 6.2-6 Route Plan and Stations of Option IV

(2) Inside of Manila

Option (1)

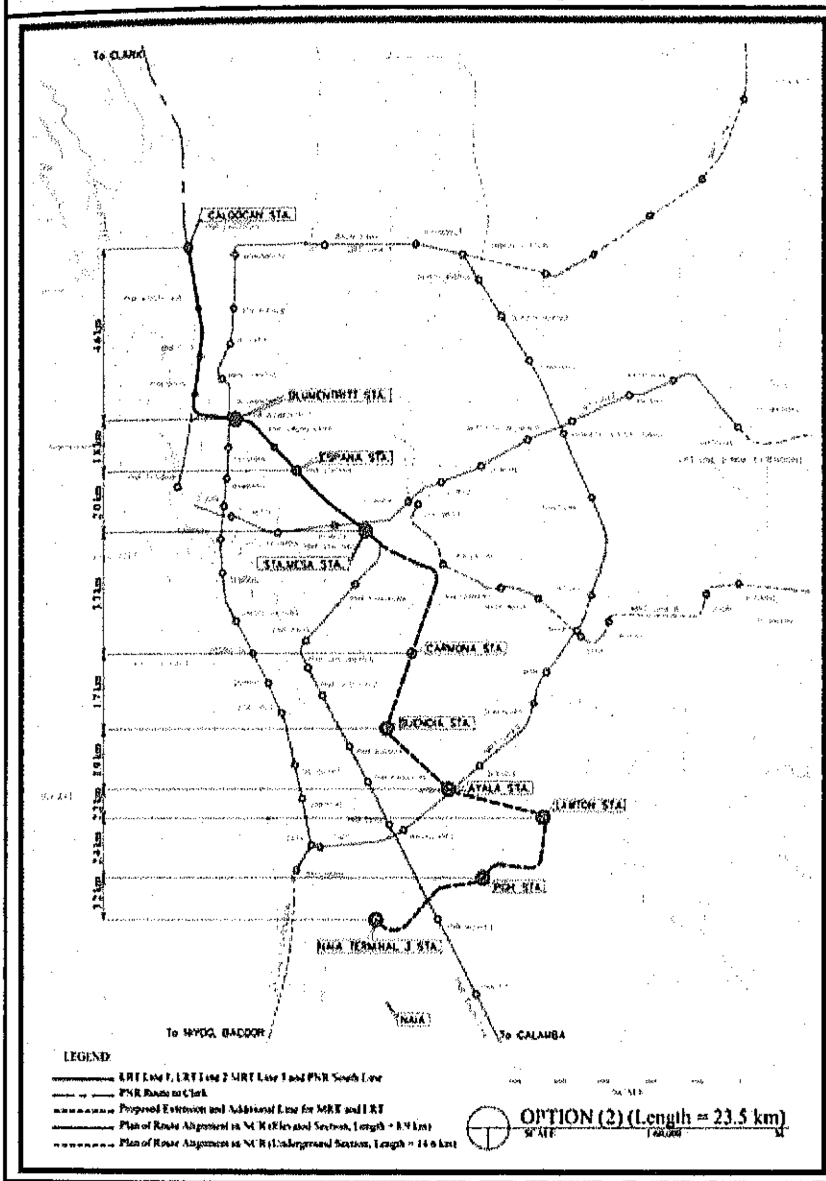


STATION	Distance
CALOOCAN	
	4.6km
BLUEMENTRITT	
	1.8km
ESPAÑA	
	2.0km
STA. MESA	
	3.2km
PACO	
	2.6km
BUENDIA	
	1.9km
EDSA	
	3.6km
NAIA Ter.3	
Total Length	19.7km

Source: JICA Study Team

Figure 6.2-7 Route Plan and Stations of Option (1)

Option (2)

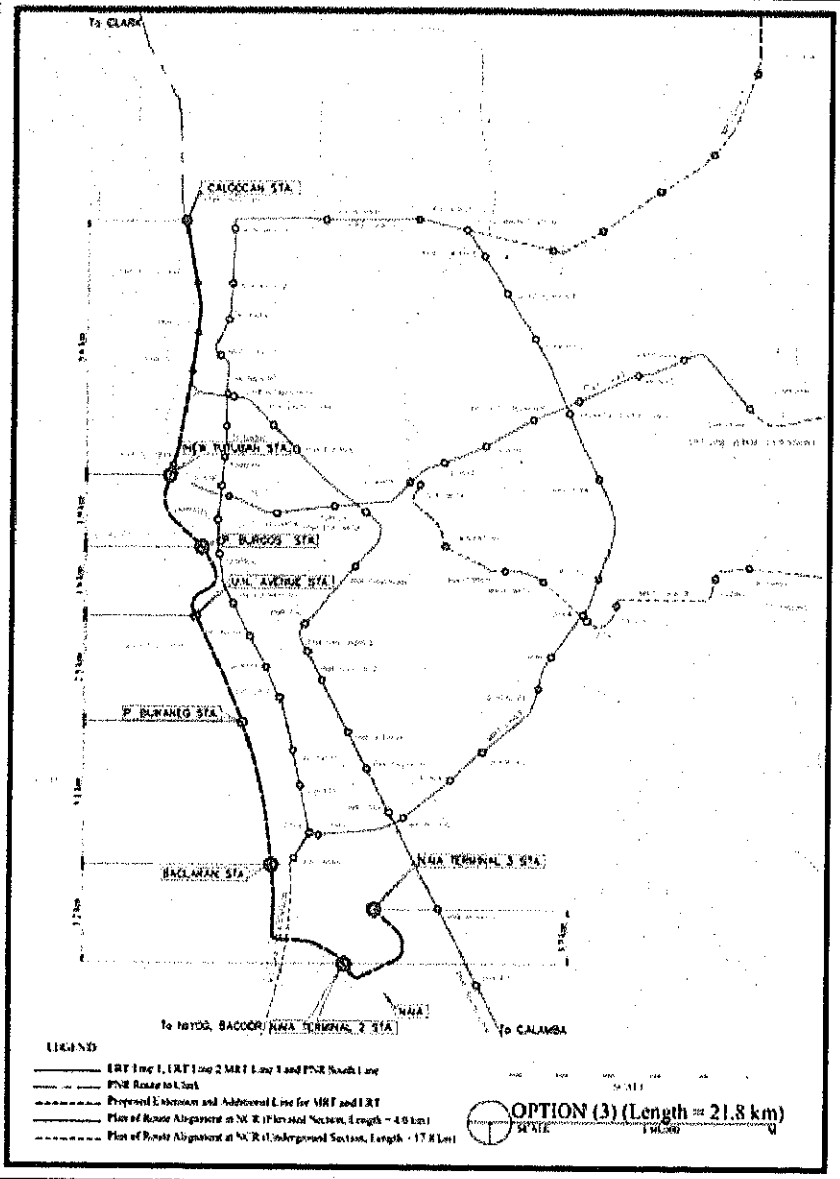


STATION	Distance
CALOOCAN	
	4.6km
BLUEMENTRITT	
	1.8km
ESPAÑA	
	2.0km
STA.MESA	
	3.7km
CARMONA	
	1.7km
BUENDIA	
	1.9km
AYALA	
	2.2km
LAWTON	
	2.4km
PGH	
	3.2km
NAIA Ter.3	
Total Length	23.5km

Source: JICA Study Team

Figure 6.2-8 Route Plan and Stations of Option (2)

Option (3)

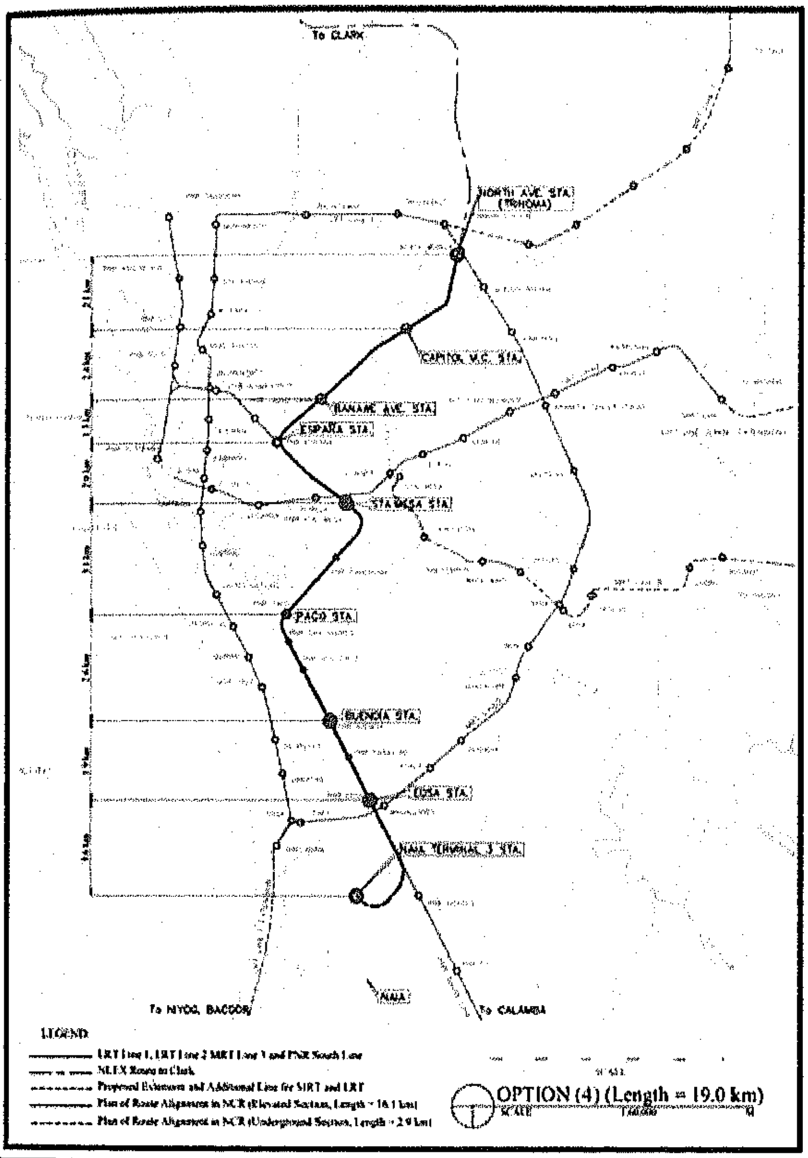


STATION	Distance
CALOOCAN	
	5.6km
NEW TUTUBAN	
	1.9km
P.BURGOS	
	1.8km
U.N. AVENUE	
	2.5km
P.BUKANEG	
	3.1km
BACLARAN	
	3.2km
NAIA Ter.2	
	3.7km
NAIA Ter.3	
Total Length	21.8km

Source: JICA Study Team

Figure 6.2-9 Route Plan and Stations of Option (3)

Option (4)

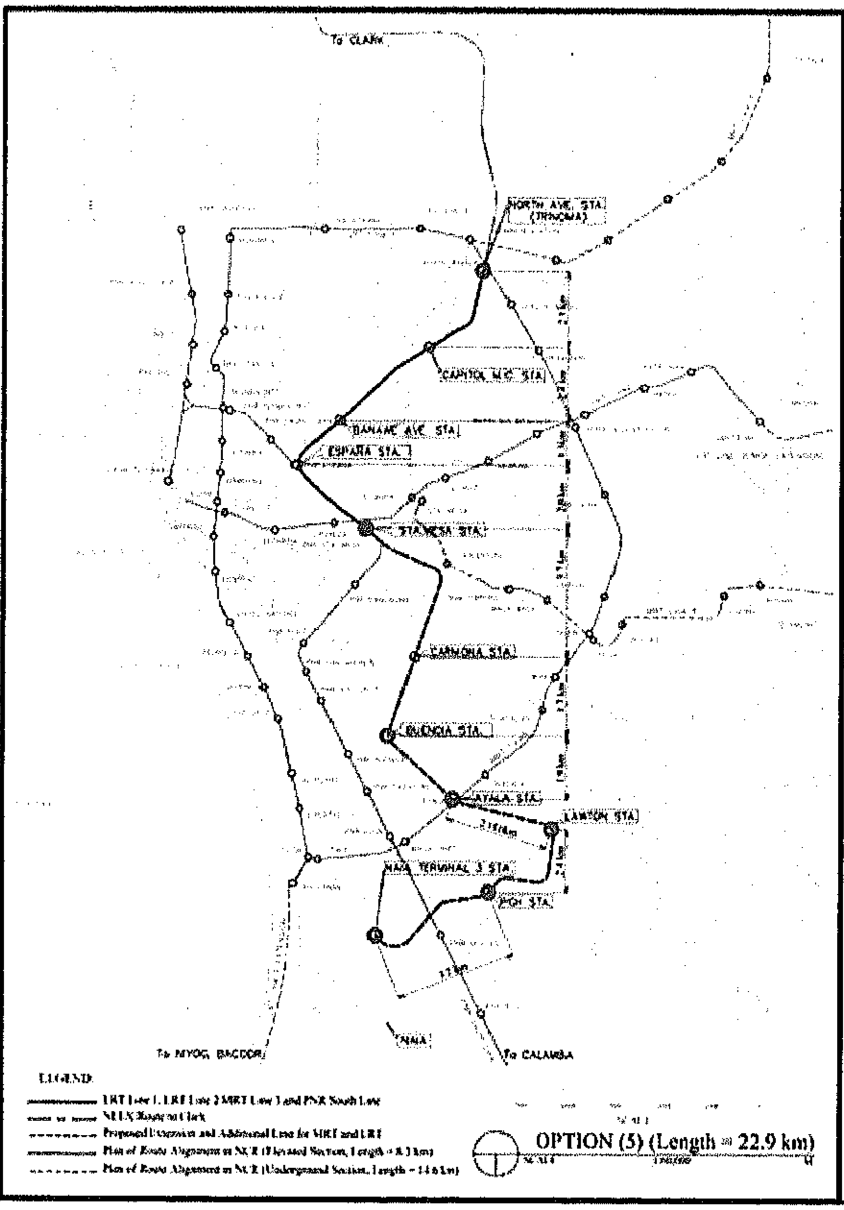


STATION	Distance
NORTH Ave	
	2.1km
CAPITOL	
	2.4km
BANAVE Ave.	
	1.3km
ESPAÑA	
	2.0km
STA.MESA	
	3.1km
PACO	
	2.6km
BUENDIA	
	1.9km
EDSA	
	3.6km
NAIA Ter.3	
Total Length	19.0km

Source: JICA Study Team

Figure 6.2-10 Route Plan and Stations of Option (4)

Option (5)



STATION	Distance
NORTH Ave	
	2.1km
CAPITOL	
	2.4km
BANAVE Ave.	
	1.3km
ESPAÑA	
	2.0km
STA.MESA	
	3.7km
CARMONA	
	1.7km
BUENDIA	
	1.9km
AYALA	
	2.2km
LAWTON	
	2.4km
PGH	
	3.2km
NAIA Ter.3	
Total Length	22.9km

Source: JICA Study Team

Figure 6.2-11 Route Plan and Stations of Option (5)

3) Site Conditions along the Route

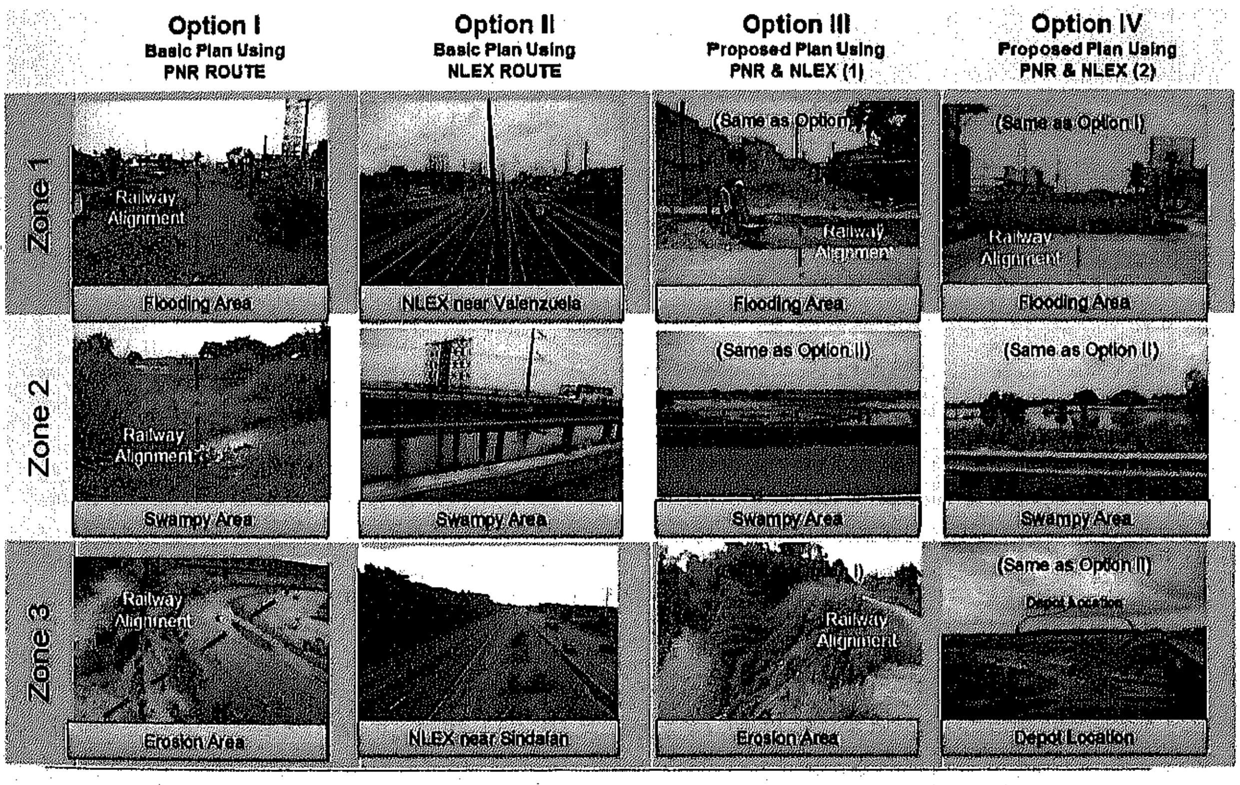
Site conditions along the alternative routes are shown below.

(1) Outside of Manila	(2) Inside of Manila
① Natural Conditions	① Natural Conditions
② Existing ROW Conditions	② Existing ROW Conditions
③ Structure Type	③ Future Road (Highway) Plan
④ Environmental Conditions	④ Structure Type
⑤ Passenger Demand	⑤ Environmental Conditions
	⑥ Passenger Demand

(1) Outside of Manila

① Natural Condition

Typical photographs of natural conditions and existing conditions for each route/zone are shown below. Detailed natural conditions are described in Appendix D.

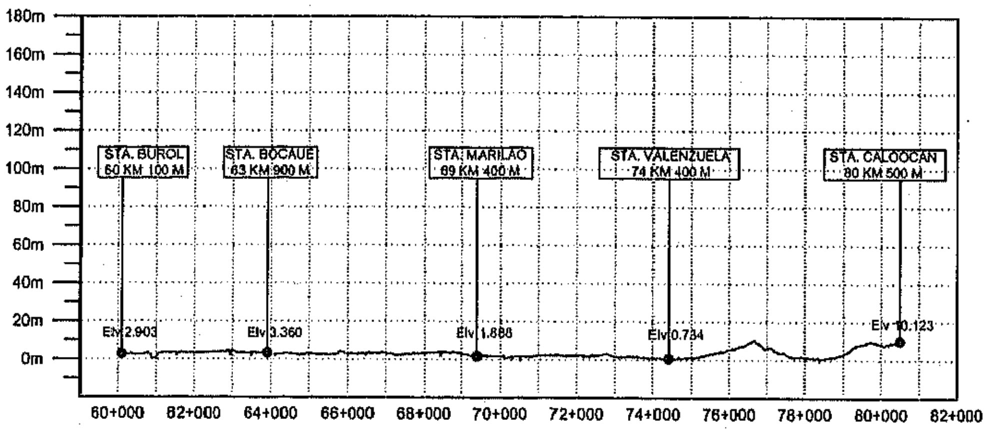


Source: JICA Study Team

Figure 6.2-12 Typical Photographs of Each Route

<u>**Profile of Zone 1 between Malolos and Caloocan**</u>

This section is possibly a flood prone area at the low level ground with elevations varying from 0 to 5 m.

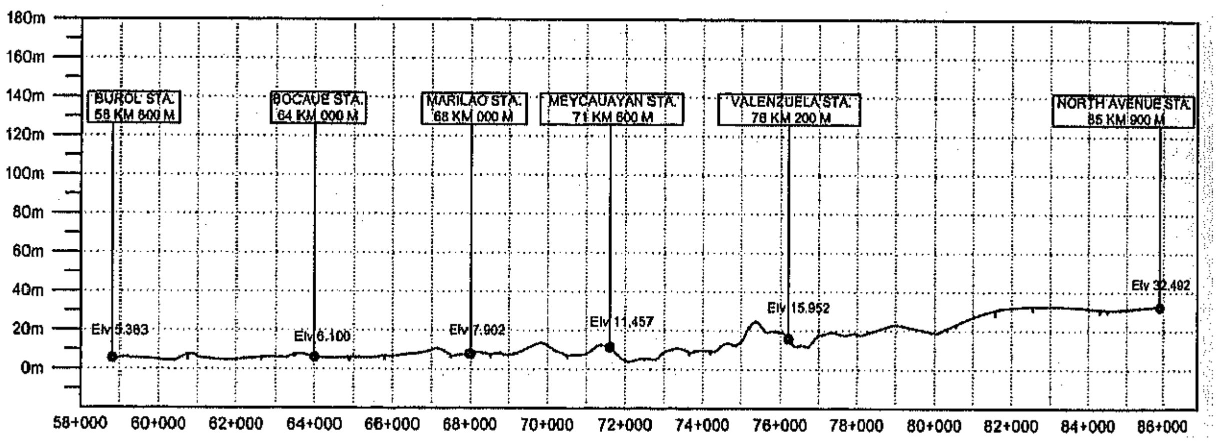


Source: NLRC

Figure 6.2-13 Profile of Zone 1 between Malolos and Caloocan

Profile of Zone 1 between Burol and North Avenue

Expressway structures between Mindanao Ave. and NLEX consist of cuts and embankments with elevations 22m to 20m. Gradient from Valenzuela to Burol is downhill with elevations varying from 22m to 5m.



Source: NLRC

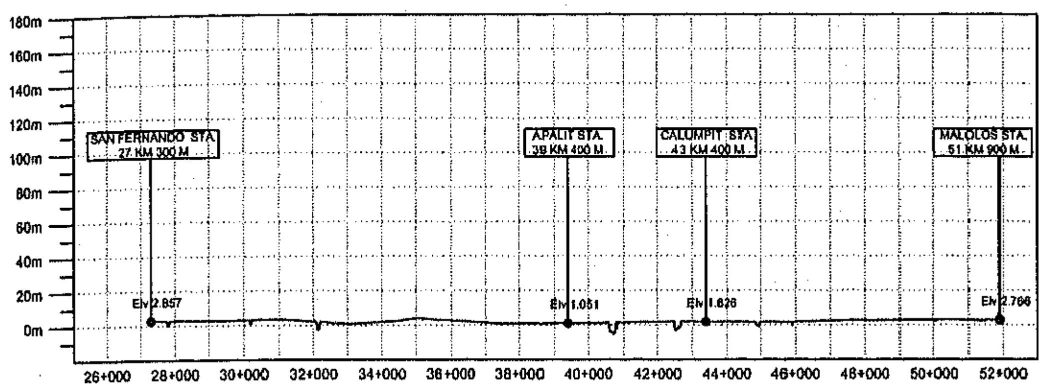
Figure 6.2-14 Profile of Zone 1 between Burol and North Avenue

Profile of Zone 1 near Burol

There are scatted houses and PNR right of way width is 12m between Balagtas and Burol at the connection between PNR and NLEX. There is a high voltage line along NLEX connecting between the PNR route and NLEX route. It is necessary to relocate it.

Profile of Zone 2 between San Fernando and Malolos

This section is possibly a flood prone area at the low level ground and there are many swampy areas with elevations varying from 0 to 3 m.



Source: NLRC

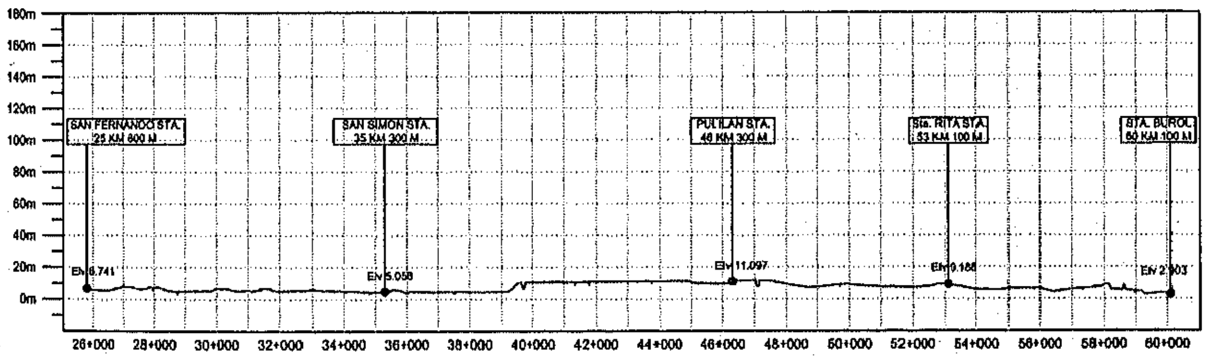
Figure 6.2-15 Profile of Zone 2 between San Fernando and Malolos

There are swampy areas and fish ponds between Apalit and Santo Tomas. It is necessary to investigate ground condition before construction. There are flood prone areas on the road the same level as the swampy area during heavy rain.

Source (Photo): JICA Study Team

Profile of Zone 2 between San Fernando and Burol

Elevation between Burol and San Simon is 5m except in the Candaba Viaduct area. Elevation of Candaba Viaduct area is 10 m. There are swampy areas along Candaba Viaduct for a 5.5km length between Pulian Interchange and San Simon Interchange.



Source: NLRC

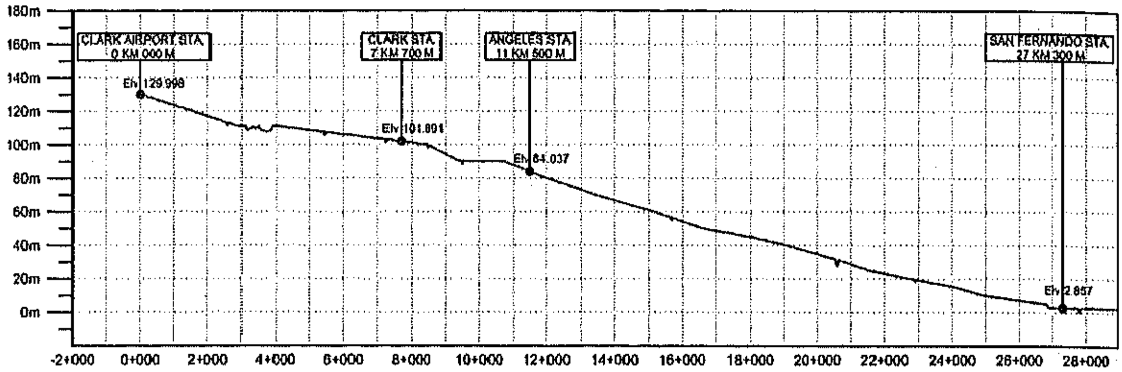
Figure 6.2-16 Profile of Zone 2 between San Fernando and Burol

There might be bad ground conditions. There are swampy areas with 4km length between San Simon Interchange and San Fernando Interchange. It is necessary to investigate the ground condition before construction.

Source (Photo): JICA Study Team

Profile of Zone 3 between Clark and San Fernando (PNR Route)

This section is uphill with elevation varying from 5m to 130m.



Source: NLRC

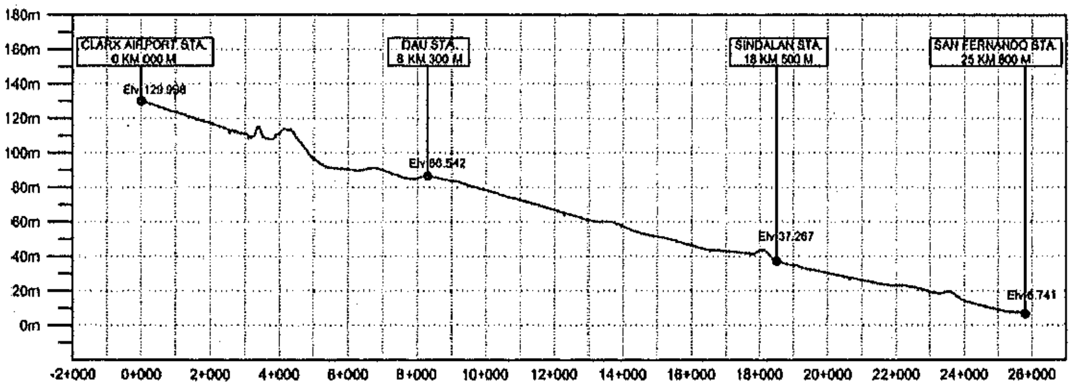
Figure 6.2-17 Profile of Zone 3 between Clark and San Fernando (PNR Route)

There is erosion of the land for a 1.9 km length in the right of way due to river flow. It is necessary to install shore protection before viaduct construction. There is Abacan.River between Angeles station and Clark station. It is necessary to build a long span bridge more than 400m length.

Source (Photo): JICA Study Team

Profile of Zone 3 between Clark and San Fernando (NLEX Route)

Gradient from San Simon to Surp NLEX Interchange is uphill with elevation varying from 5m to 130m.

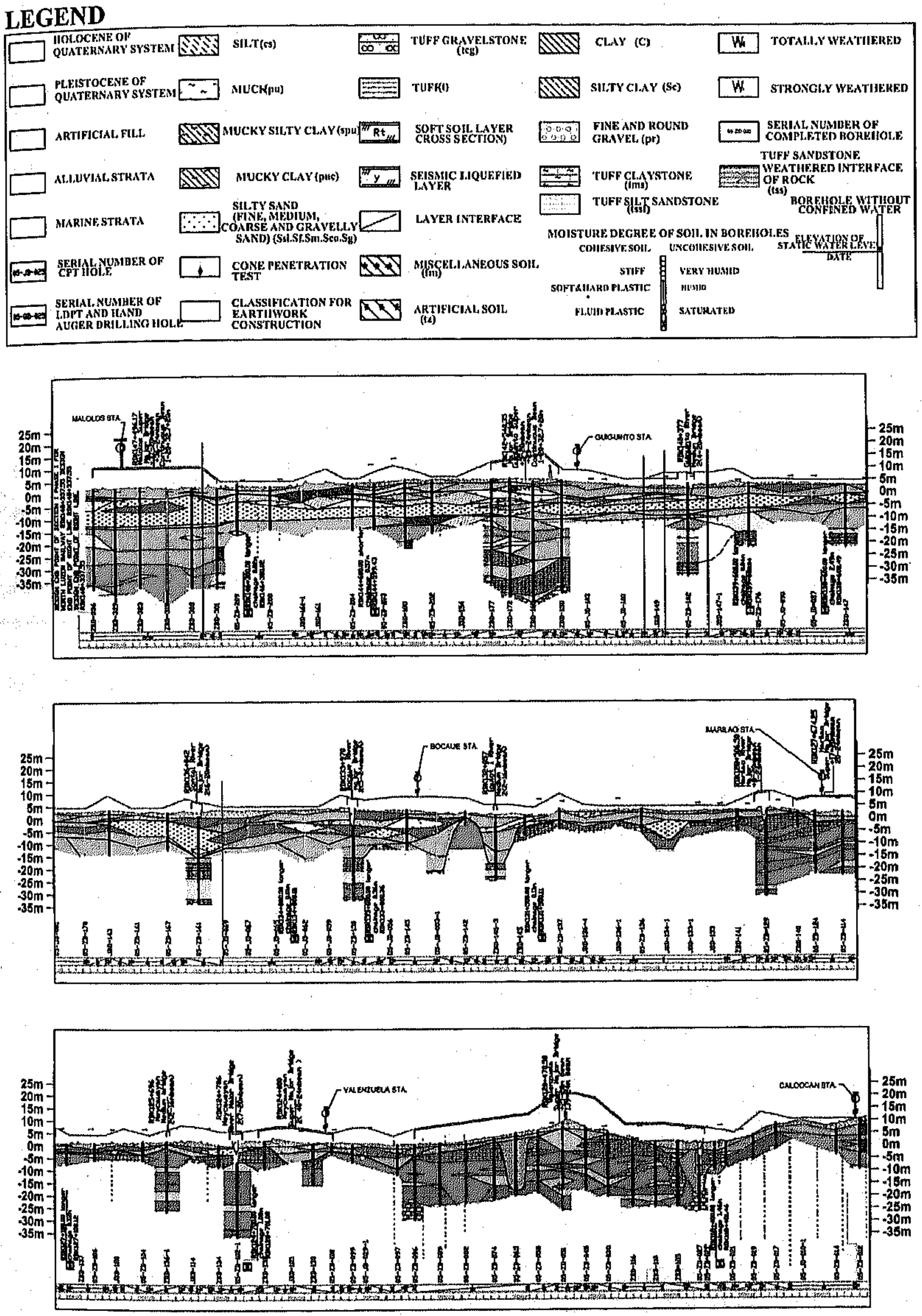


Source: NLRC

Figure 6.2-18 Profile of Zone 3 between Clark and San Fernando (NLEX Route)

Soil Profile Outside Manila

According to the investigation and boring data, the layers at the work site consist of Artificial Fills of Holocene (Q4ml), Alluvium of Holocene (Q4al) and under that are volcanic deposits of upper and mid Pleistocene(Q4Vl) and so on between Caloocan and Malolos. Artificial Fills of Holocene (Q4ml) include Miscellaneous Soil and Artificial Soil. Alluvium of Holocene (Q4al) includes Silt Clay. Volcanic deposits of upper and mid Pleistocene (Q4Vl) include Tuff Clay stone.



Source: NLRC

Figure 6.2-19 Soil Profile of PNR Route

Summary of natural conditions outside of Manila for each option are shown in Table 6.2-5.

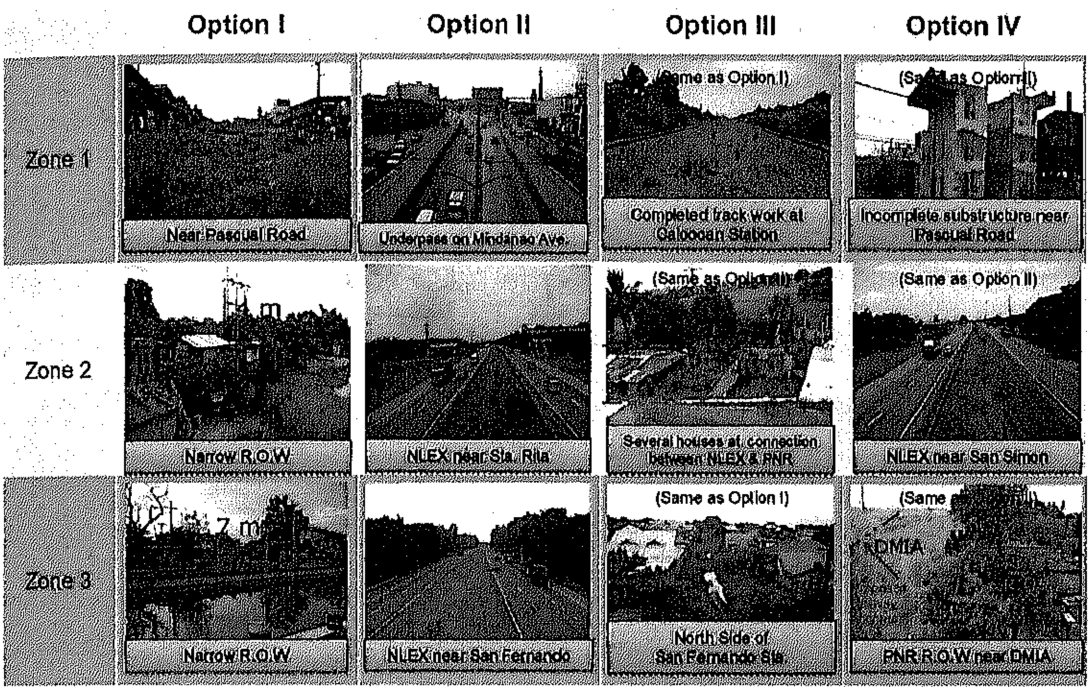
Table 6.2-5 Typical Natural Conditions Outside of Manila

Option I	<Zone1> Possible flood prone area in the low level ground. <Zone2> ・There are swampy areas and fish ponds between Apalit and Santo Tomas ・There are flood prone areas on the road, which are at the same level as the swampy area during heavy rain. <Zone3> ・ There are areas where erosion of the land takes place over a 2.3km length in the right of way due to river flow. ・ There is Abacan River between Angeles Sta. and Clark Sta.
Option II	<Zone1> Expressway structures between Mindanao Ave. and NLEX consist of cutting and embankment <Zone2> ・There are swampy areas along Candaba Viaduct for a 5.5km length between Pulian Interchange and San Simon Interchange. ・There are swampy areas for a 4km length between San Simon Interchange and San Fernando Interchange. <Zone3> Gradient from San Simon to Surp NLEX Interchange is uphill with elevation varying from 5m to 90m.
Option III	<Zone1> Same as Option I ・ There are scatted houses in the PNR ROW, which only 12m width between Balagtas and Burol at the connection between PNR and NLEX. <Zone2> ・Same as Option II ・There are two-way 2 lane roads of narrow width between San Simon and San Fernando. <Zone3> Same as Option I
Option IV	<Zone1> ・Same as Option I ・There are scatted houses within the ROW and PNR ROW width is 12m between Balagtas and Burol at the connection between PNR and NLEX. <Zone2> ・ Same as Option II <Zone3> ・ Same as Option II

Source: JICA Study Team

② Existing ROW Conditions

Typical photographs of typical section of existing ROW conditions of each route and zone are shown in Figure 6.2-20. Detailed ROW conditions are described in Chpter10.



Source: JICA Study Team

Figure 6.2-20 Typical Existing ROW Conditions Photographs of Each Route

Summary of existing ROW conditions for each option are shown in Table 6.2-6.

Table 6.2-6 Typical Existing ROW Conditions Outside of Manila

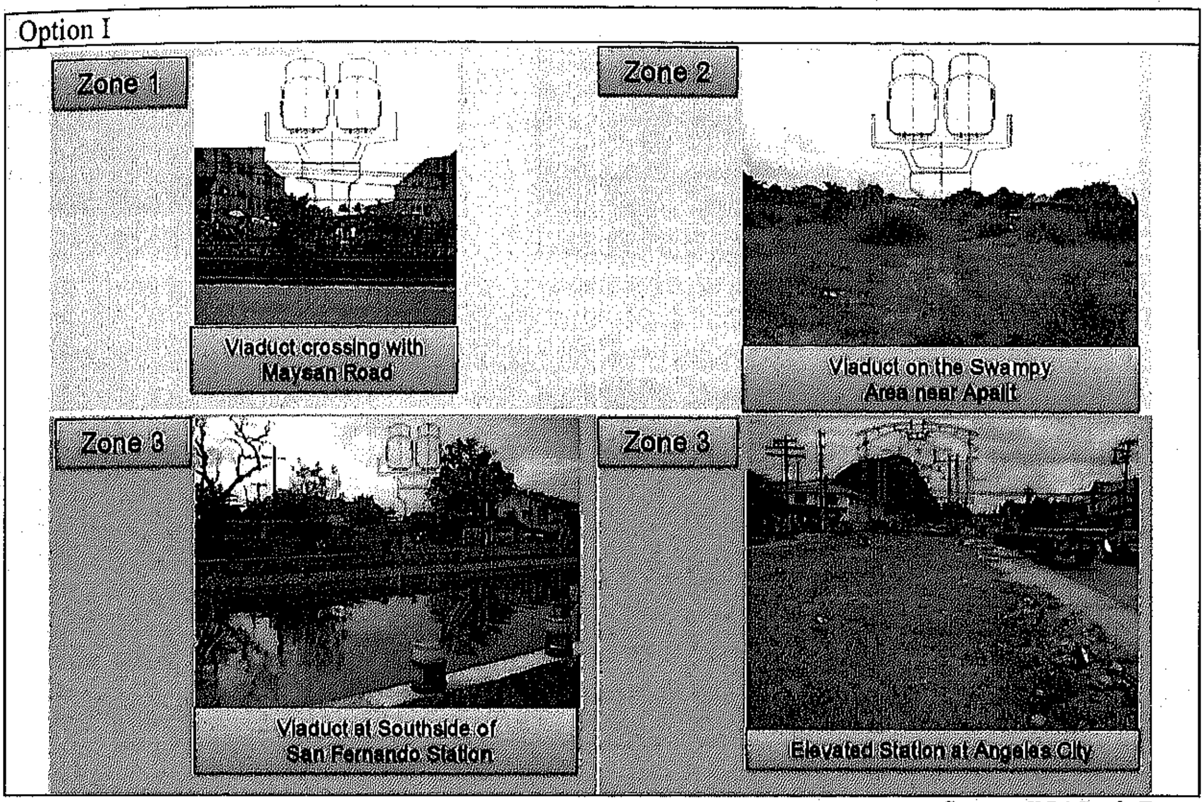
Option I	<Zone 1> • Most of the ROW are along residential areas but there are no informal settlers inside of the ROW. • The ROW is located close to the main road between Caloocan and Marilao. • Many parts of the ROW go though flood hazard areas. • The ROW width is 11 m between Caloocan and Malolos in some areas. <Zone 2> • The ROW goes though a fish pond and swampy areas. The vicinity is almost inundated by the swamp. There is a high risk of inundation. • There are still many informal settler families waiting for relocation. • Piers of Guiguinto Viaduct which were constructed by a Chinese Contractor, has been suspended. • There are many houses scattered in the ROW on either side of Calumpit Station over a 9 km length. <Zone 3> • The ROW has been scoured over a distance of 2.3 kilometers along Cultcut Creek. • The banks of Abacan River have been scoured between Angeles Station and Clark Station. • There are narrow ROW sections, e.g., riverbanks near San Fernando and Calumpit. • The ROW has been occupied by informal settlers along Clark Air Port at Mabalacat over a 6.5km length. • There is narrow right of way with 7m width on the south side of San Fernando Station.

Option II	<Zone 1> • Mindanao Ave. is 4 lanes each way. • NLEX is 4 lanes each way with a central reserve of 1m wide. • NLEX width is 32 m as an expressway with 4 lanes each direction and a ROW of 60m width between Mindanao Ave. IC and Burol IC. <Zone 2> • Candaba Viaduct of 5.5km in length runs through the swamp area between Pulian I.C. and San Simon I.C. • NLEX has 2 lanes each way and spacial central reserves in this zone. • NLEX width is 32 m as an expressway with 3 lanes each direction and an open space at the center of expressway and right of way of 60m width between Burol IC and San Fernando IC. <Zone 3> • NLEX between San Simon I.C. and San Fernando I.C. lies on the embankment in swampy areas. • The ROW has been occupied by informal settlers along the Clark Air Port on the north side of the SCTEX Mabiga Exit • • NLEX width is 32 m as an expressway with 2 lanes each direction and more open space at the center of the expressway and a right of way of 60m width between San Fernando IC and Spur NLEX IC.
Option III	<Zone 1> • Same as Option I <Zone 2> • Same as Option II • Connection between PNR and NLEX • There is an old PNR branch track from Balagtas Station to Gapan City. ROW is 12m in width. • Several houses are scattered on both sides. <Zone 3> • Same as Option I • Mac Arthur Highway between San Fernando and San Simon is a narrow road with 2 lanes each way and runs through small communities. • The vicinity is almost inundated by the swamp. There is a high risk of inundation.
Option IV	<Zone 1> • Same as Option I <Zone 2> • Same as Option II • Same as Option III <Zone 3> • Same as Option I

Source: JICA Study Team

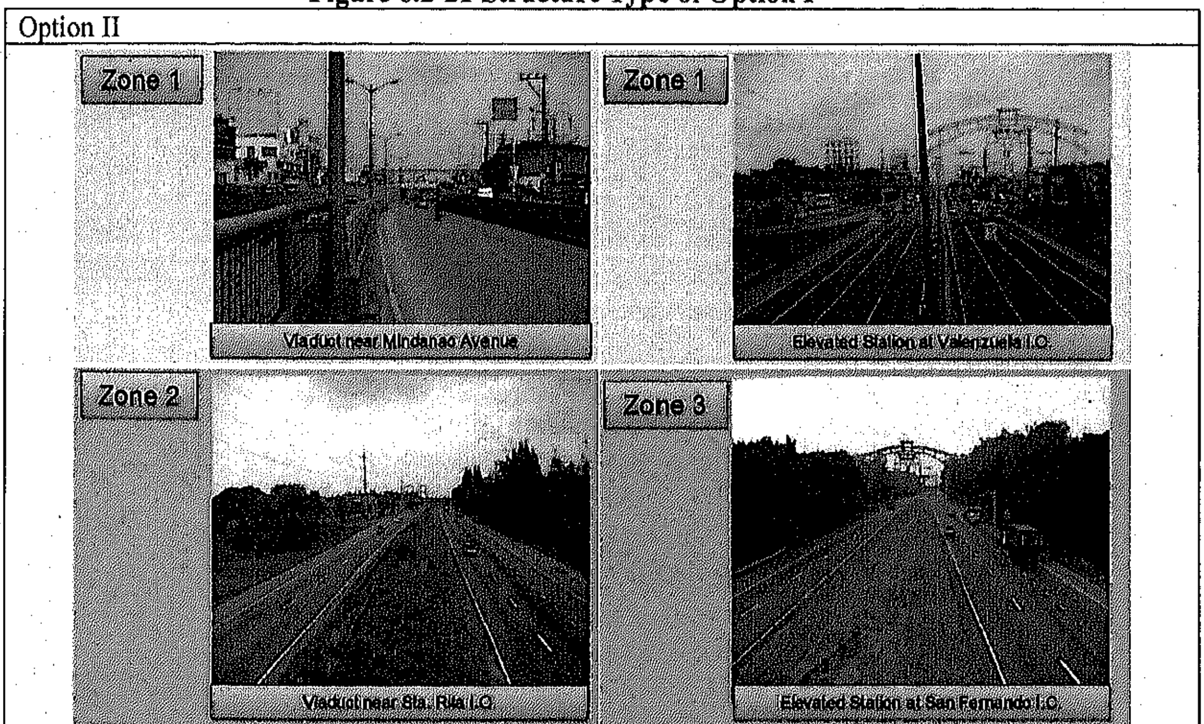
③ Structure Type

Outline of structure types for each route/zone are shown below.



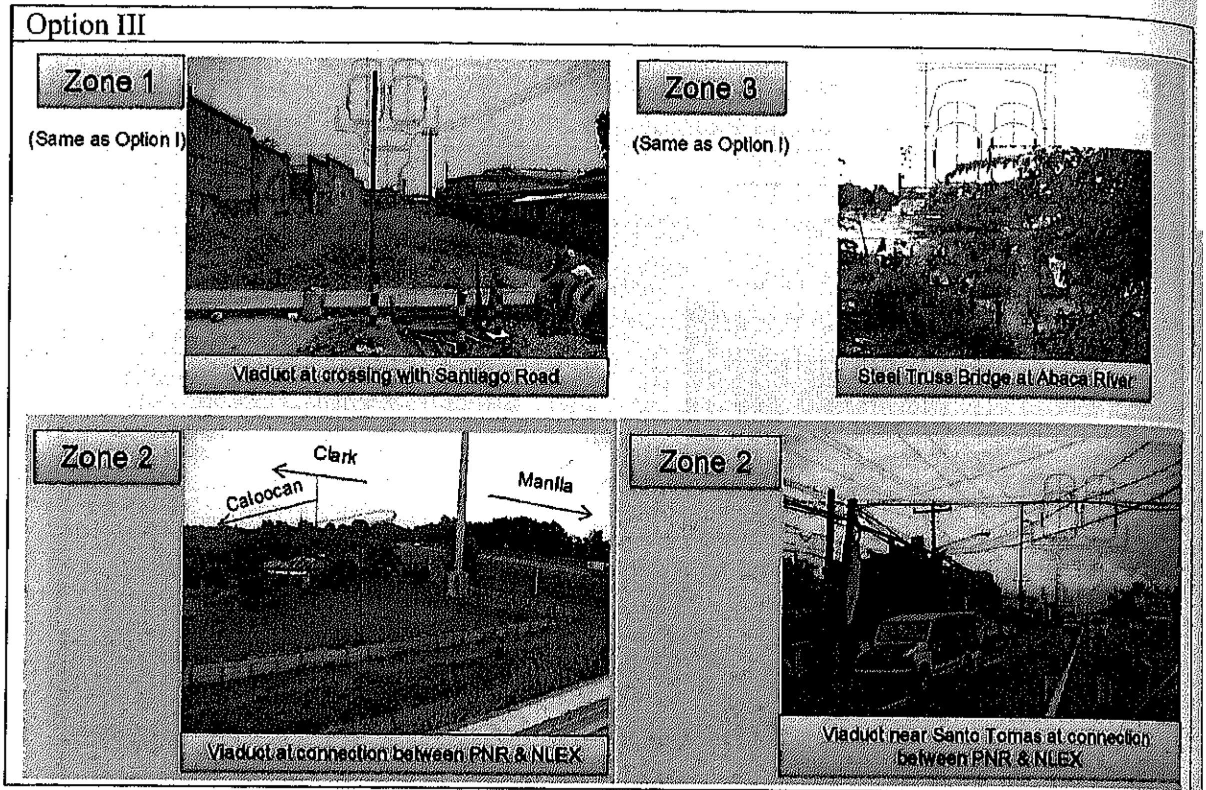
Source: JICA Study Team

Figure 6.2-21 Structure Type of Option I



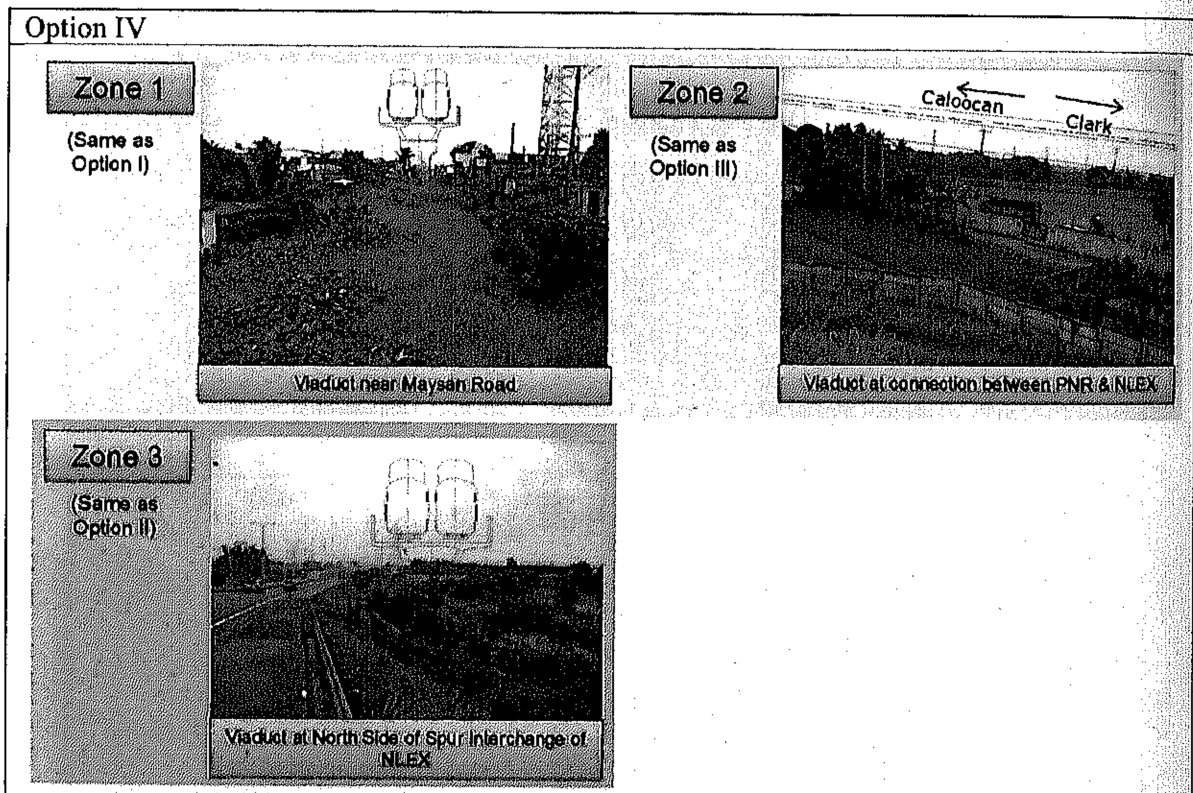
Source: JICA Study Team

Figure 6.2-22 Structure Type of Option II



Source: JICA Study Team

Figure 6.2-23 Structure Type of Option III



Source: JICA Study Team

Figure 6.2-24 Structure Type of Option IV

④ Environmental Conditions

A summary of environmental conditions for each option in the initial screening based on the site investigation is shown below.

Table 6.2-7 Comparison of Environmental Conditions (Outside Manila)

Phase	Zone	Option I	Option II	Option III	Option IV
Construction Phase	Zone 1	• Dust Pollution • Noise & Vibration • Traffic Congestion	• Dust Pollution* • Noise & Vibration* • Traffic congestion*	Same as Option I	Same as Option I
	Zone 2	• Dust Pollution • Noise & Vibration • Turbid water diffusion in swamp and fish ponds	• Dust Pollution* • Noise & Vibration* • Turbid water diffusion in swamp and fish ponds*	Same as Option II	Same as Option II
	Zone 3	• Dust Pollution • Noise & Vibration • Traffic congestion • Historical heritage sites	• Dust Pollution* • Noise & Vibration* • Traffic congestion*	Same as Option I	Same as Option II*
Operation Phase	Zone 1	• Noise & Vibration	• Noise & Vibration*	Same as Option I	Same as Option I
	Zone 2	• Noise & Vibration	• Noise & Vibration*	Same as Option II	Same as Option II
	Zone 3	• Noise & Vibration	• Noise & Vibration*	Same as Option I	Same as Option II*

Note: Less impact than Option I*

Source: JICA Study Team

⑤ Passenger Demand

A comparison table of passenger demand for each option in the initial screening based on existing traffic and travel pattern data and other related information is summarized below in Table 6.2-8.

a) Passenger Demand Current (2009) Travel Demand by Mode: Car, Jeepney & Bus (Source: HSH Study)

Table 6.2-8 Passenger Demand Current (2009) Travel Demand (Outside Manila)

Option I	<All Zones> • Car demand is unlikely to shift to rail, and would be mainly dependent on the connectivity with the MM section of the alignment and station locations • Jeepney demand is substantial – in all areas it is almost equal to the combined Car & Bus Demand – but it is more localized, short distance trips – trip length limited to adjacent developments or at most to next town • Bus passenger demand is about 1/3 of total demand in most areas, a very healthy proportion of Public transport. <Zone 1> • Travel demand to/from Bulacan is about 4 times higher than to/ from Pampanga. <Zone 2 & 3 > • Demand from Pampanga is mostly from the San Fernando area, and to a limited extent from Angles and other areas. • This alignment would serve San Fernando and has a high potential to capture this demand.

Option II	<All Zones> • Current demand is divided between MacArthur Highway and NELEX by the distance to be traveled. • Local short distance demand along MacArthur Highway, - mostly in Jeepneys • Long Distance Car & Bus demand along NLEX. • Longer distance (inter-urban) demand along NLEX • High Value of time demand – such as business travel along NLEX. • Attractive to even longer distance demand from northern, eastern and western regions. • Demand would have to compete with NLEX – this presents a negative outlook for door-to-door demand. • Local demand less than Option-I, but more suited to inter-urban demand of medium to long distance. • Local demand to/from MM less than Option-I.
Option III	<All Zones> • Same as Option I • Limited impact of moving the alignment to NLEX for the short distance between San Simon & Burol i.e. Zone-2.
Option IV	<Zone 1> • Same as Option I. <Zones 2 & 3 > • Same as Option II. • Pampanga (longer distance) NLEX demand would prefer to be on AER.

Source: JICA Study Team

b) Potential Passenger Demand

Table 6.2-9 Potential Passenger Demand (Outside Manila)

Option I	<Zone 1> • Potential demand from Bulacan would be contingent upon the areas served in MM due to shorter tip length. • Would be constrained by main line station accessibility in Bulacan built up areas. <Zone 2 & 3 > • Potential from Pampanga could be substantial and would be maximized by station locations which should serve both current (like San Fernando area) and future developments.
Option II	<Zone 1> • Potential local demand from Bulacan would be similar to Option-I. • Longer distance demand would be much more attractive. <Zones 2 & 3> • Potential from Pampanga and outer regions could be maximized by providing a greater number of well planned multi-modal interchanges than Option-I.
Option III	<All Zone> • Same as Option I • Limited impact of moving the alignment to NLEX for the short distance between San Simon & Burol i.e. Zone-2.
Option IV	<Zone 1> • Same as Option I <Zones 2 & 3 > • Same as Option II • Pampanga (longer distance) NLEX demand would prefer to be on AER.

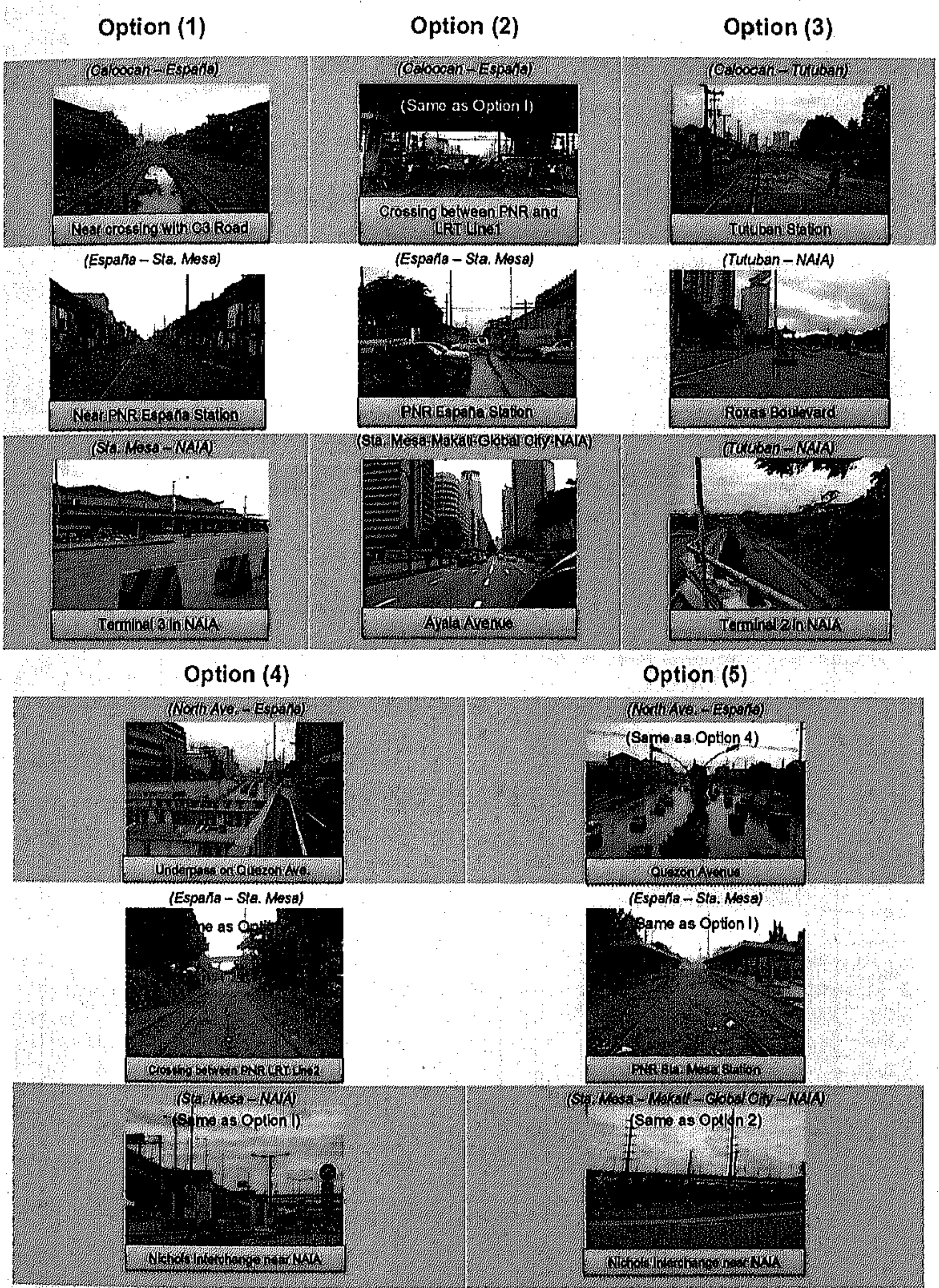
Source: JICA Study Team

(2) Inside of Manila

① Natural Conditions

Typical photographs of natural conditions for each option are shown below.

Detailed natural conditions are described in Appendix D.



Source: JICA Study Team

Figure 6.2-25 Typical Photographs of Each Route

Profile in Manila City

- **Route between Caloocan, España, Sta. Mesa and NAIA**

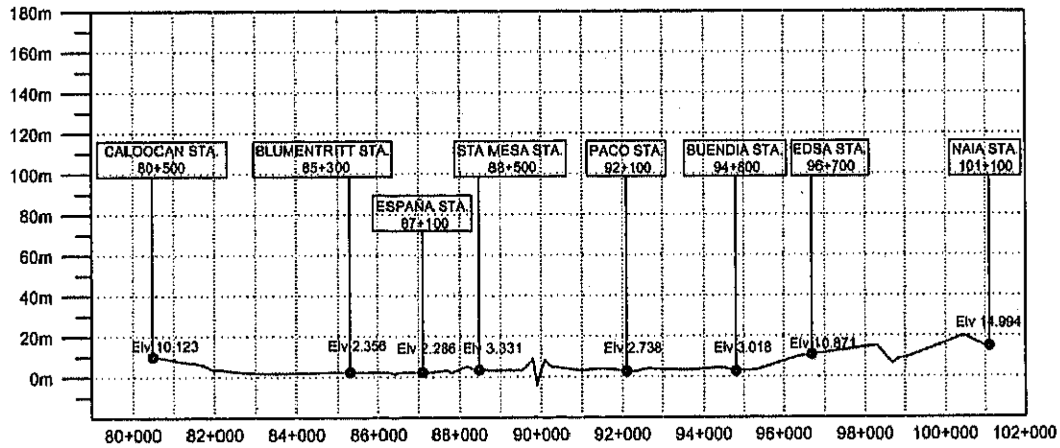
Curve Radius is Min. 300 m, gradient is less than 1% in this section.

- **Route between North Ave. and España on the Quezon Ave.**

The route is downhill with elevations varying from 35 m to 5 m.

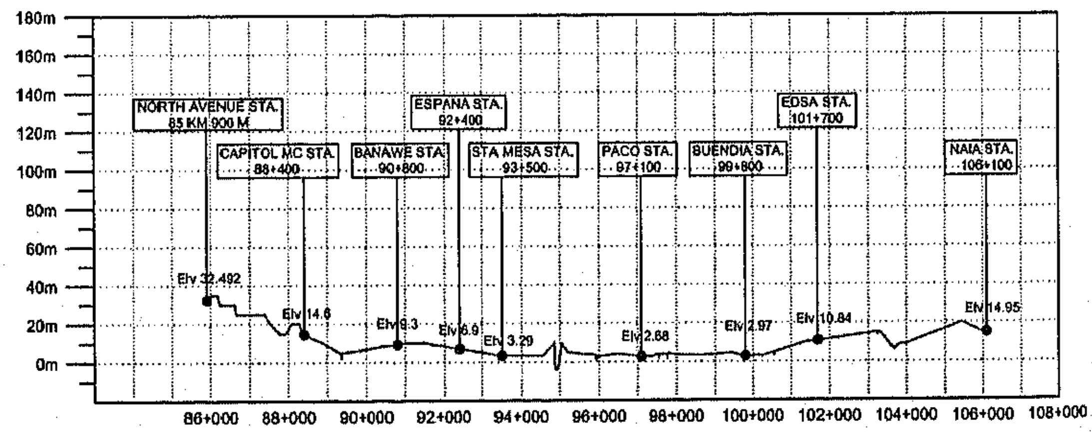
- **Route between Sta. Mesa and NAIA through Makati and Global City**

The route is uphill with elevations varying from 5 m to 30m near Global City and downhill with elevations varying from 30 m to 10 m near NAIA.



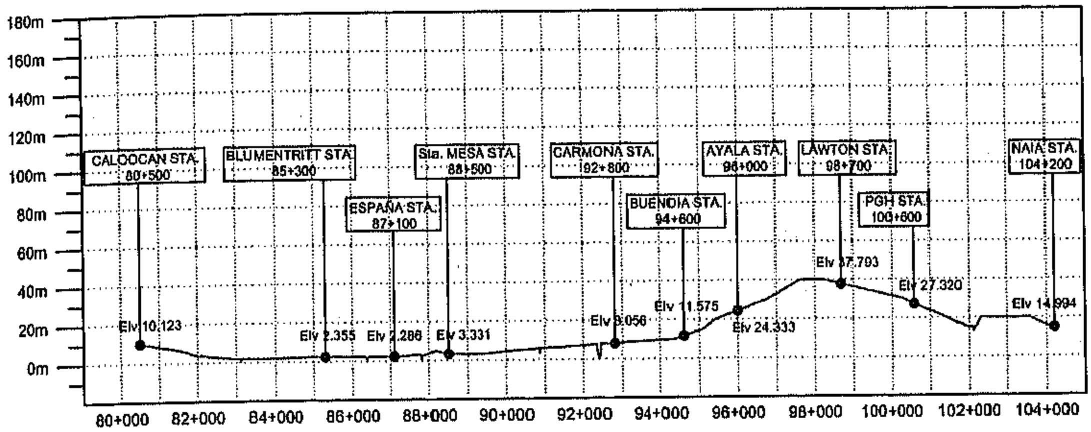
Source: NLRC

Figure 6.2-26 Profile between Caloocan and NAIA through PNR



Source: NLRC

Figure 6.2-27 Profile between North Ave. and NAIA through Quezon Ave. and PNR



Source: NLRC

Figure 6.2-28 Profile between Caloocan and NAIA through PNR and Makati/ Global Area

<u>Soil Profile in Manila City</u>

- **<u>Route between Caloocan and España</u>**

There seem to be no problems with ground condition on the PNR route because it consists of Alluvium, sand stone, tuff and so on.

- **<u>Route between Espana and Sta. Mesa</u>**

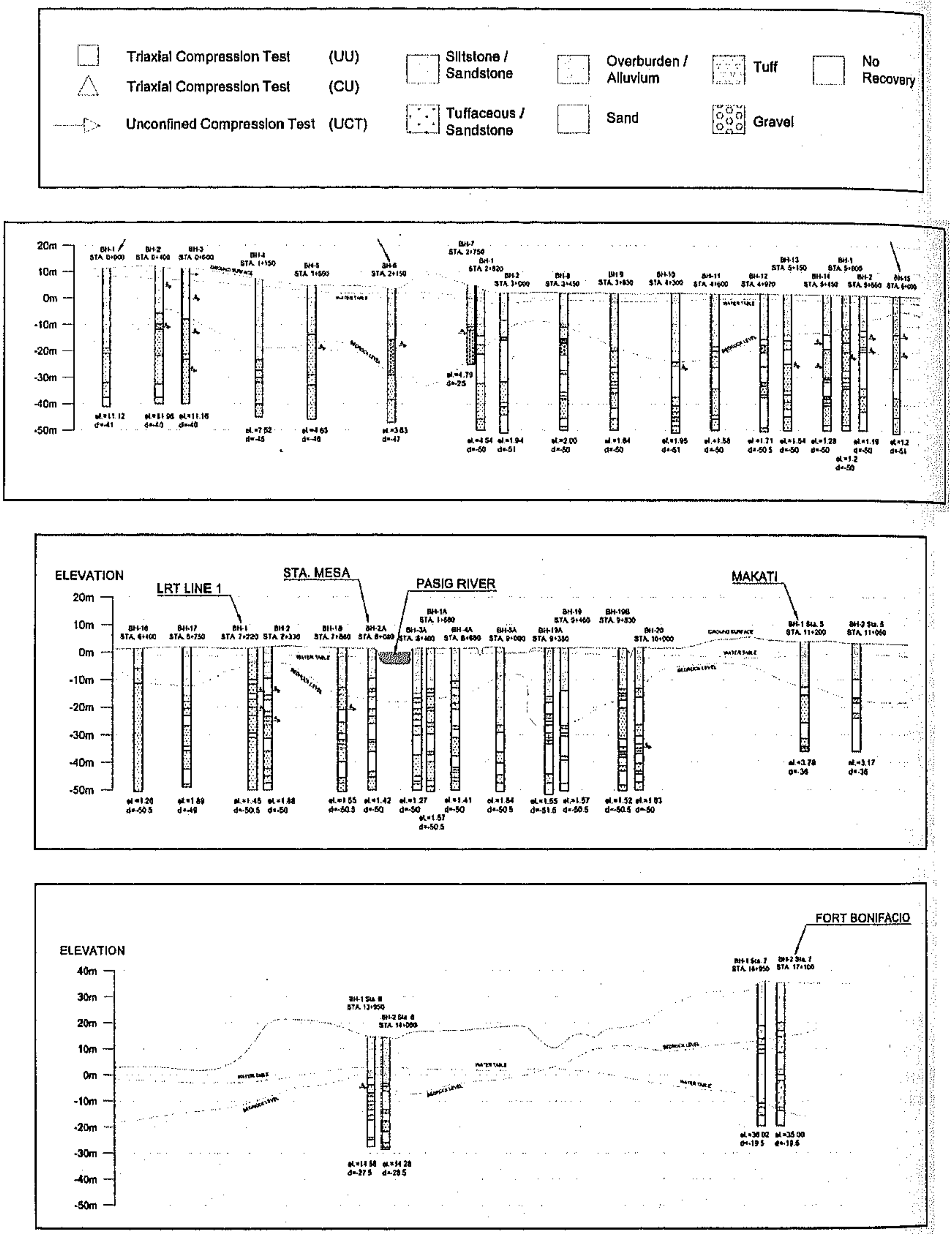
There seem to be no problems with ground condition on the PNR route except in the Pasig river area because it consists of Alluvium, sand stone, tuff and so on.

- **<u>Route between Sta. Mesa and NAIA</u>**

There seem to be no problems with ground condition on the PNR route except in the Pasig river area because it consists of Alluvium, sand stone, tuff and so on.

- **<u>Route between Tutuban and NAIA though Roxas Boulevard</u>**

In the Manila Bay Area, Soil conditions comprise sediments overlying the Guadalupe Tuff formation (GTF). The sediments comprise shallow deposits of loose to very dense silt sand overlying deep deposits, bearing layers are encountered at depths ranging from 33m near Divisoria Station to 25m along Recto Avenue at the location of the existing line 2 structures.



Source: NLRC

Figure 6.2-29 Soil Profile in Manila City

A summary of natural conditions inside of Manila for each option is shown in Table 6.2-10.

Table 6.2-10 Typical Natural Conditions Inside of Manila

Option (1)	<Caloocan – España> • There seems to be no problem with ground conditions on the PNR route because it consists of Alluvium, sand stone, tuff and so on. • Radius of Curve Min. 300 m • Gradient less than 1% <España – Sta. Mesa> • There seems to be no problem with ground conditions on the PNR route except in the Pasig river area because all other areas consist of Alluvium, sand stone, tuff and so on. • Radius of Curve Min. 300 m • Gradient less than 1% <Sta. Mesa – NAIA> • There seems to be no problem with ground conditions on the PNR route except in the Pasig river area because all other areas consist of Alluvium, sand stone, tuff and so on. • Radius of Curve Min. 300 m • Gradient less than 1%
Option (2)	<Caloocan – España> Same as Option (1) <España – Sta. Mesa> • There seems to be no problem with ground conditions on the PNR route except in the Pasig river area because all other areas consist of Alluvium, sand stone, tuff and so on. <Sta. Mesa-Makati-Global City-NAIA> • There seems to be no problem with ground conditions on the PNR route except in the Pasig river area because all other areas consist of Alluvium, sand stone, tuff and so on
Option (3)	<Caloocan – Tutuban> • There seems to be no problem with ground conditions on the PNR route because it consists of Alluvium, sand stone, tuff and so on. • In the Manila Bay Area, Soil conditions comprise sediments overlying the Guadalupe Tuff formation (GTF). The sediments comprise shallow deposits of loose to very dense silty sand <Tutuban – NAIA> • In the Manila Bay Area, Soil conditions comprise sediments overlying the Guadalupe Tuff formation (GTF). • The sediments comprise shallow deposits of loose to very dense silty sand overlying deep deposits. Bearing layers are encountered at depths ranging from 33m deep near Divisoria Station to 25m along Recto Avenue at the location of the existing line 2 structure.
Option (4)	<North Ave. – España> • There seems to be no problem with ground conditions regarding the PNR route because it consists of Alluvium, sand stone, tuff and so on. <España – Sta. Mesa> • Same as Option (1) <Sta. Mesa – NAIA> • Same as Option (1)
Option (5)	<North Ave. – España> • Same as Option (4) <España – Sta. Mesa> • Same as Option (1) <Sta. Mesa-Makati-Global City-NAIA> • Same as Option (2)

Source: JICA Study Team

② Existing ROW Conditions

A summary of existing ROW conditions for each option is shown in Table 6.2-11.

Table 6.2-11 Typical Existing ROW Conditions Inside of Manila

Option (1)	<Caloocan –Sta. Mesa> ・ PNR ROW ・ Informal settlers are observed along the old PNR route just south of Caloocan Work Shop and on the north side of the Depot site. <Sta. Mesa – NAIA> ・ PNR ROW ・ There is a crossing near Santa Mesa between LRT line2 and the PNR route. <Vicinity of NAIA> ・ In the vicinity of NAIA, there is a parking lot of the New Port City and Villamor Golf course. ・ There is a 3 story interchange near NAIA. It is necessary to examine the railway alignment as an underground structure.
Option (2)	<Caloocan –Sta. Mesa> ・ Same as Option (1) <Sta. Mesa – NAIA> ・ PNR ROW ・ The old PNR line, which goes southeast from Sta. Mesa Station, is occupied by informal setters. It is necessary to confirm the width and length of the ROW. ・ Underground route from south Sta. Mesa to NAIA. <Vicinity of NAIA> ・ Same as Option (1)
Option (3)	<Caloocan – Tutuban> ・ Same as Option (2) ・ A new station shall be recommended at Tutuban. <Tutuban – NAIA> ・ Underground route from north Tutuban to NAIA. ・ There is a narrow and winding road between Tutuban station and Padre Burgos. ・ There are 2 flyovers with grade separation along Roxas Boulevard. <Vicinity of NAIA> ・ Underground
Option (4)	<North Ave.– España> ・ There is no existing road/railway ROW between Trinoma Terminal and Quezon Avenue. ・ There are no tall buildings between North Ave. and Quezon Ave except MRT line3. ・ There is a two way road with 4 lanes each way on Quezon Ave. An underpass has been constructed at the crossing between C-3 Road and Quezon Ave. <España-Sta. Mesa –NAIA> ・ PNR ROW <Vicinity of NAIA> ・ Same as Option (1)
Option (5)	<North. Ave.– España> ・ Same as Option (4) <Sta. Mesa –NAIA> ・ Same as Option (2) <Vicinity of NAIA> ・ Same as Option (1)

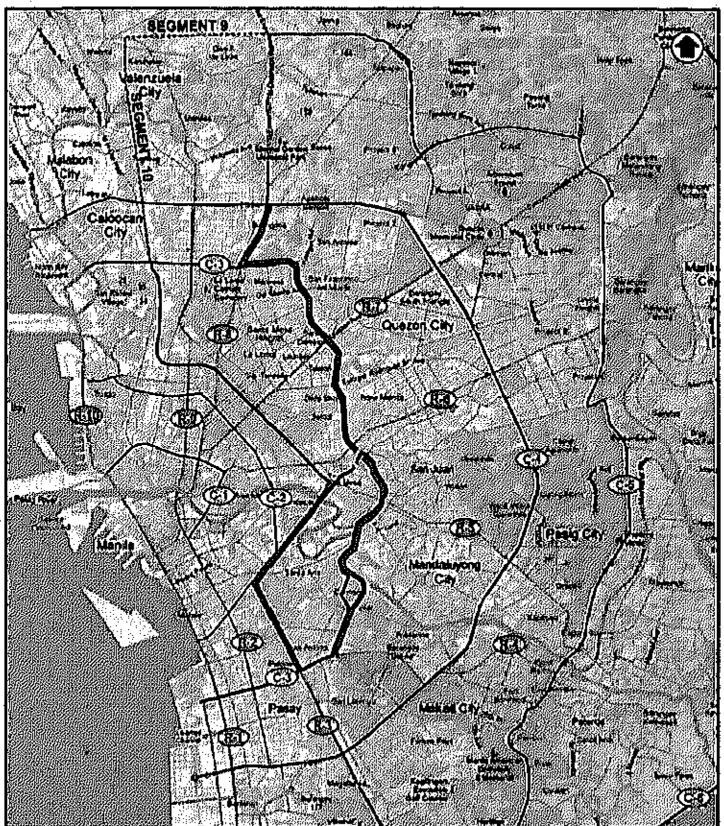
Source: JICA Study Team

③ Future Road (Highway) Plan

The future road plan for each option is shown in Table 6.2-12.

Table 6.2-12 Future Road Plans

Option (1)	NLEx-SLEx Connector are planed along this route. C3 Expressway is planed crossing over this route. NAIA Expressway is planned at NAIA Terminal 3.
Option (2)	NLEx-SLEx Connector is planed along this route. C3 Expressway, C3 Missing Link are planed crossing over this route. NAIA Expressway is planned at NAIA Terminal 3.
Option (3)	NLEx-SLEx Connector is planed along this route between Caloocan and near Tutuban Sta. NAIA Expressway is planned at NAIA Terminal 3 and Seaside Drive/NAIA Road.
Option (4)	NLEx-SLEx Connector is planed along this route. C3 Expressway and C3 Missing Link plan are planed crossing over this route. NAIA Expressway is planned at NAIA Terminal 3.
Option (5)	NLEx-SLEx Connector is planed along this route. C3 Expressway and C3 Missing Link are planed crossing over this route. NAIA Expressway is planned at NAIA Terminal 3.



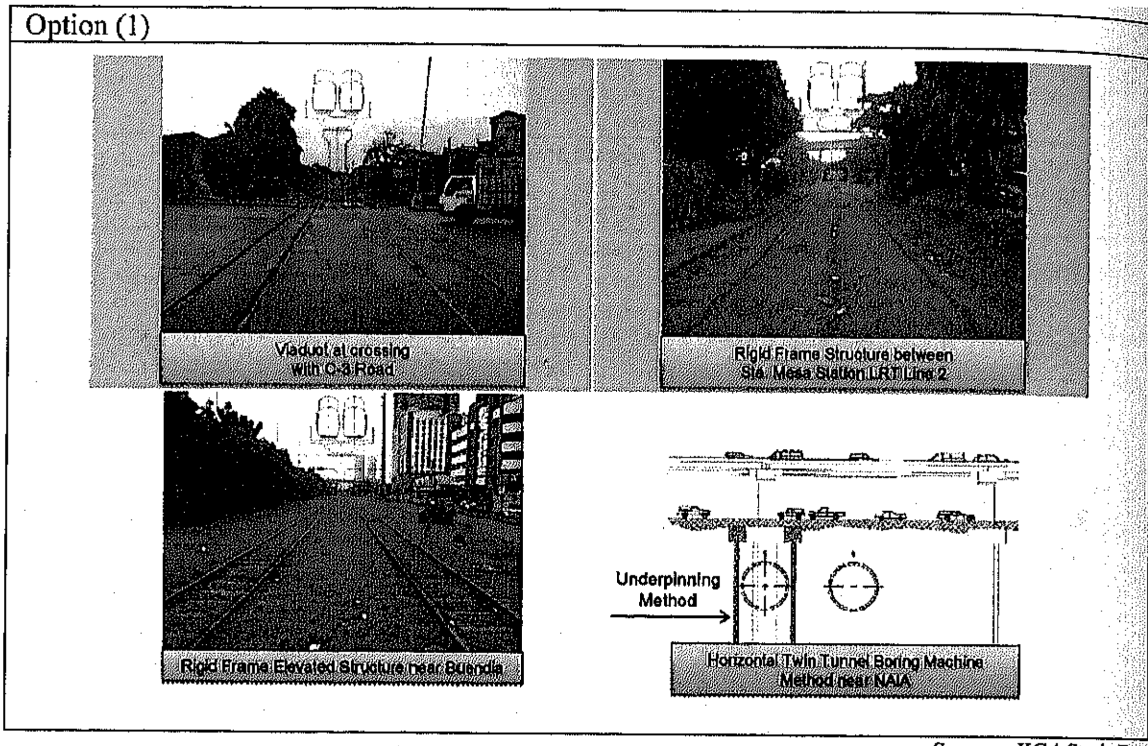
PROJECT	PROPONENT	LENGTH (km)	LEGEND	REMARKS
1. C-3 Missing Link	DPWH	6.1		6 Lanes - ODA
2. Skybridge	MMDA	8.5		6 Lanes - MYOA
3. Skyway Stage 3	CITRA	14.5		6 Lanes - PPP
4. NLEx-SLEx Connector	MNTC	13.3		4 Lanes - BOT
5. C-3 Expressway	AYALA	16.2		6 Lanes - BOT / PPP

Source: C3 Missing Link by JICA Study Team. Others are from study reports of proponents indicated.

SOURCE: C3 Missing Link by JICA Study Team

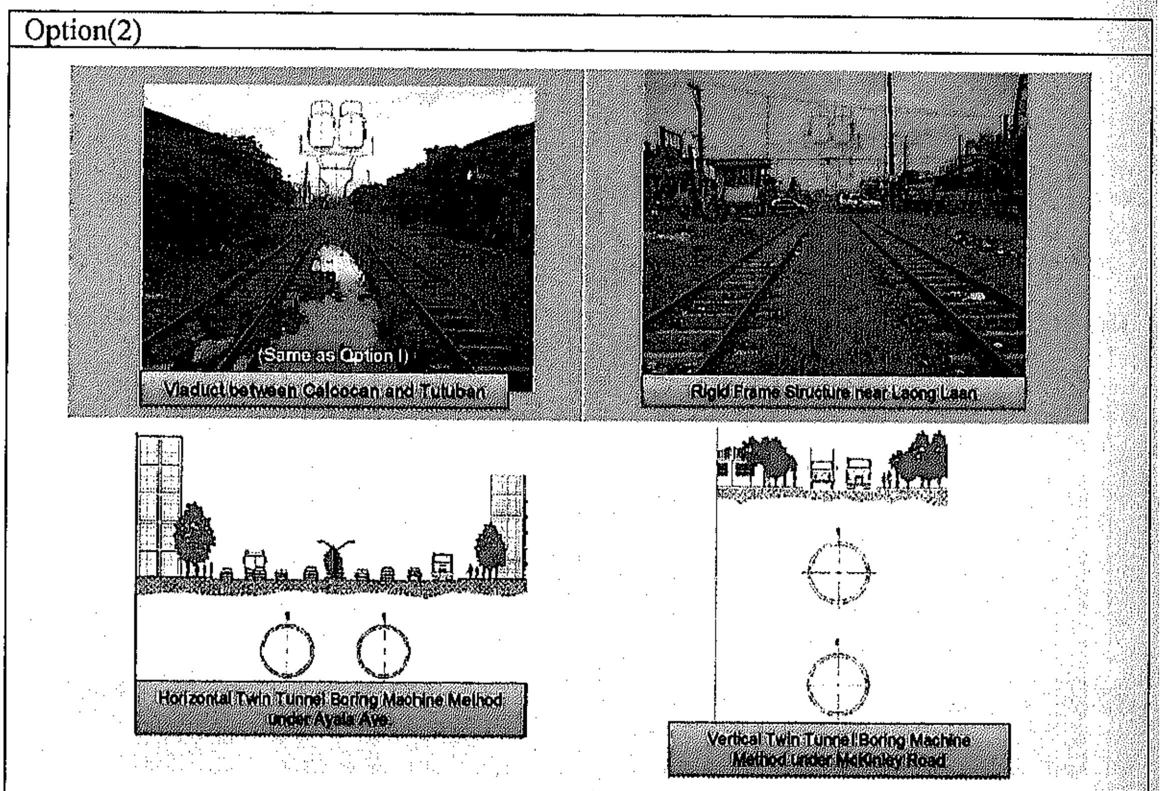
④ Structure Type

Outline of structure types for each option are shown below.



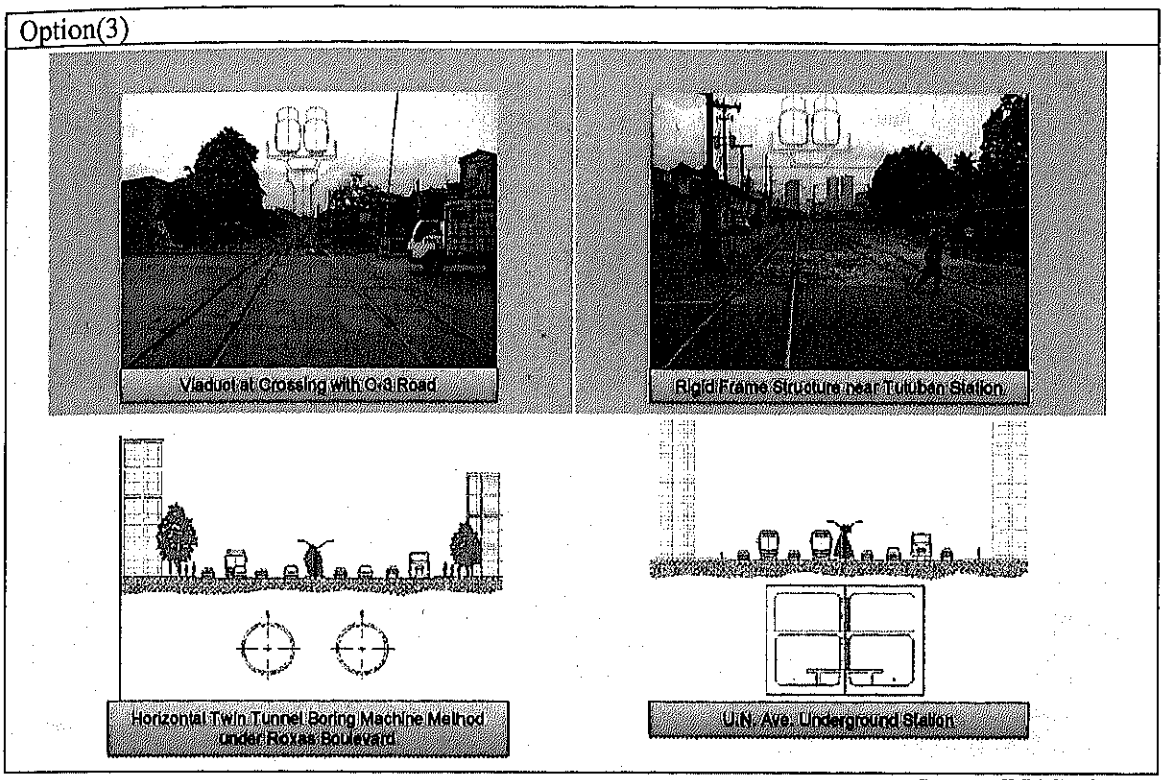
Source: JICA Study Team

Figure 6.2-30 Structure Type of Option (1)



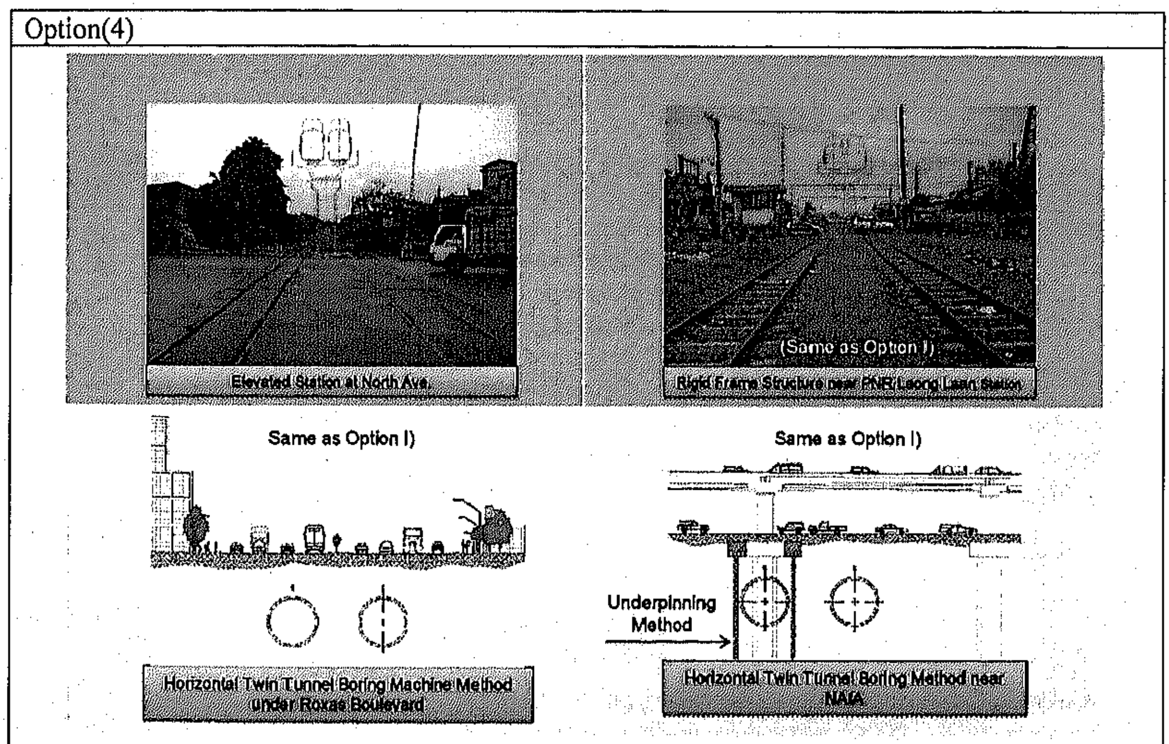
Source: JICA Study Team

Figure 6.2-31 Structure Type of Option (2)



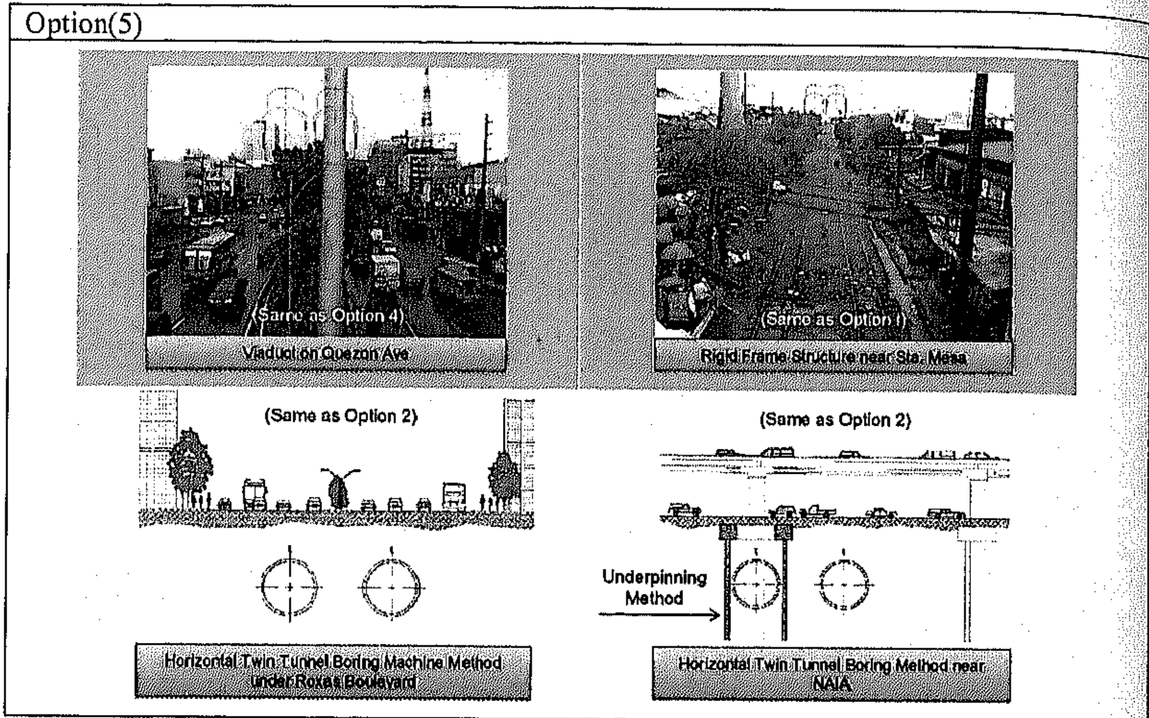
Source: JICA Study Team

Figure 6.2-32 Structure Type of Option (3)



Source: JICA Study Team

Figure 6.2-33 Structure Type of Option (4)



Source: JICA Study Team

Figure 6.2-34 Structure Type of Option (5)

⑤ Environmental Conditions

A comparison table of environmental conditions for each option in the initial screening based on the site investigation is shown below.

Table 6.2-13 Comparison of Environmental Conditions Inside of Manila

Phase	Option (1)	Option (2)	Option (3)	Option (4)	Option (5)
Construction Phase	Viaduct Zone ・Dust Pollution ・Noise and Vibration ・Traffic Congestion ・Turbid water diffusion into Pasig River	Viaduct Zone ・Dust Pollution ・Noise and Vibration ・Traffic Congestion Underground Tunnel ・ ・Groundwater	・Same as Option (2)	・Same as Option (1)	・Same as Option (2)
Operation Phase	Viaduct Zone ・Noise and Vibration ・Shadows Underground Tunnel ・Change in groundwater vein	・Same as Option (1)	・Same as Option (1)	・Same as Option (1)	・ Same as Option (1)

Source: JICA Study Team

⑥ Passenger Demand

A comparison table of passenger demand for each option in the initial screening based on existing data and information is shown below.

a) Passenger Demand Current (2009) Travel Demand by Mode: Car, Jeepney and Bus

(Source: HSH Study)

Table 6.2-14 Passenger Demand Current (2009) Travel Demand

Option (1)	• In the south of Caloocan, heavy demand can be expected as an urban rail transit system. • People along PNR would struggle to afford fare payment, hence, very low demand is expected to be generated between Caloocan & Tutuban. • Currently, the SLEX Corridor has the largest demand in MM. • Transfer passengers from existing LRT 1, 2 and 3 may be expected.
Option (2)	• In the northern part, same as Option (1). • South of Sta. Mesa, this option will have a higher demand than Option (1) with passengers to/ from the two CBDs. • Transfer passengers from existing LRT 1, 2 and 3 may be expected, but demand from Caloocan area would be limited.
Option (3)	• Some of the demand along Roxas Blvd., which is almost saturated, would shift to AER. • As an urban rail transit system, this route will compete with LRT Line-1 for patronage limiting its potential.
Option (4)	• Some portion of trips along Quezon Ave. will convert to this AER alignment. • Currently, the SLEX Corridor has the largest demand in MM • Significant diverted demand from EDSA would be expected. • Transfer passengers from existing LRT 1, 2 and 3 would be expected.
Option (5)	• Some portion of trips along Quezon Ave. will convert to this AER. • South of Sta. Mesa, this option will have a larger demand than Option (1) with passengers to/ from CBDs. • Significant diverted demand from EDSA would be expected. • Transfer passengers from existing LRT 1, 2 and 3 would be expected.

Source: JICA Study Team

b) Potential Passenger Demand

Table 6.2-15 Potential Passenger Demand

Option (1)	• When the demand for Line-1 reaches the capacity of Line 1, some of the demand may divert to this AER alignment.
Option (2)	• A new section of C3 will run parallel to the route, which will positively affect AER's demand. • The southern section will have a large demand from EDSA, by connecting EDSA, Fort Bonifacio and a New CBD.
Option (3)	• The southern part of MM and Cavite have had high growth rates in the past three decades. Hence there is a good potential to capture north-south long distance demand.
Option (4)	• The MMTC project will attract more passengers. • When the demand for Line 1 reaches the capacity of Line 1, some of the demand would divert to AER.
Option (5)	• The MMTC project will attract more passengers. • The new section of C3 will run parallel to this alignment, which will enhance the AER demand. • The southern section will have much higher demand from EDSA, by connecting EDSA, F. Bonifacio and a New CBD.

Source: JICA Study Team

4) Evaluation Items

The summary of the weight of the items for evaluation of the proposed routes is as shown in Table 6.2-16. The evaluation items and weight was determined through discussion with DOTC. The score of each evaluation item for candidate routes were examined by JST experts, then the overall evaluation was finalized through discussion and confirmation with DOTC.

Table 6.2-16 Evaluation Item and Weight

Evaluation Items	Outside Manila	Inside Manila	Weight	
①Relation with existing Railway Network		✔	1	Connectivity with existing railway network is considered in the route selection.
②Land Acquisition and Resettlement	✔	✔	1	It will be settled by the Philippine side with adequate compensation.
③Future Land Development Potential	✔	✔	3	Important due to being concerned with the project sustainability
④Population along the Corridor	✔	✔		
⑤Construction Workability	✔	✔	2	Technically feasible
⑥Approximate Project Implementation Cost and Approximate Operation and Maintenance Cost	✔	✔	5	The most important due to being concerned with the project feasibility
⑦Approximate Project Implementation Schedule	✔	✔	1	Effect on the project feasibility is small

Source: JICA Study Team

5) Comparison for Initial Screening of Route Plans

(1) Outside of Manila

① Land Acquisition and Resettlement

A comparison and the evaluation score of land acquisition and resettlement for each option in the initial screening based on site investigations is shown in Table 6.2-17.

Table 6.2-17 Comparison of Land Acquisition

	Option I	Option II	Option III	Option IV
Land Acquisition	-	<Zone 1> Underpass section on Mindanao Ave.	-	-
Land Acquisition	<Zone 2> Additional land acquisition	-	<Zone 2> • Connection route between PNR & NLEX • Narrow ROW around San Fernando Station	<Zone 2> Connection route between PNR & NLEX
Land Acquisition	<Zone 3> Alternative ROW	<Zone 3> Same as Option I	<Zone 3> Same as Option I	<Zone 3> Same as Option I
Resettlement	<Zone 1> Completion of Resettlement	-	-	-
Resettlement	<Zone 2> Large scale resettlement	-	<Zone 2> Large, medium & small scale resettlement	<Zone 2> Small scale resettlement
Resettlement	<Zone 3> Five thousand Informal settlers beside Clark Airport.	<Zone 3> Same as Option I	<Zone 3> Same as Option I	<Zone 3> Same as Option II
Score	3.0	4.0	2.5	3.5

Source: JICA Study Team

② Future Land Development Potential

A comparison and the evaluation score of future land development potential for each option in the initial screening is shown in Table 6.2-18.

Table 6.2-18 Comparison of Future Land Development Potential

	Future Land Development Potential	Score
Option I	<Zone-3> • San Fernando area development plan is limited to defining land-use changes and shows potential land use, but was not conceived with AER passing through the town – and therefore it has limited relevance to AER. <Zone 2> • Malolos City has developed with the alignment going through the city, possible station location adjacent to the development, but accessibility required for a sub-urban train station would be constrained due to lack of space. • Development potential within the walk-in or 1km radius VERY limited due to issue of land consolidation due to small land holdings and multiple ownerships. <All Zones> • All future 'planned' growth would have to be outside the existing built-up areas. • Any induced growth due to AER would be heavily constrained because of alignment/ station accessibility issues.	2.5
Option II	<All Zones> • In the Plaridel development plan the agricultural area was estimated to be 62% of the existing land use. However, urban sprawl from Metro Manila has rapidly changed agriculture land to urban developments. • Numerous housing and industrial development plans exist for development along the NLEX corridor – as many advertisements appear along NLEX. However the pace and timing of the plans remains undefined. • Development potential almost unlimited as the areas are green-field sites. Despite the route being 6km shorter than Option-I it has one more station • All future 'planned' growth could be accommodated in a planned fashion. • The AER alignment would give additional mobility & accessibility options to proposed developments. • AER would attract high density population nearer stations without any constraints. <Zone 1> • Alignment in this section runs quite close to Option-I alignment, and the potential would be constrained as adjacent areas are already developed (though more recently than Option-I) but has more potential due to greater possibilities of further densification of relatively larger land parcels compared to Option-I.	4.0
Option III	<Zone 1> Same as Option I <Zone 2> Same as Option II • No additional specific development in the section between San Simon & Burol I/C • However development opportunities are limited as the area is mostly marsh land and used for fish farming, any residential or industrial use would be expensive. <Zone 3> Same as Option I	2.5
Option IV	<Zone 1> Same as Option I <Zones 2 & 3 > Same as Option II	3.0

Source: JICA Study Team

③ Population along the Corridor

A comparison and the evaluation score of population along the corridor for each option in the initial screening is shown in Table 6.2-19.

Table 6.2-19 Comparison of Population along the Corridor

	Population along the Corridor	Score
Option I	<All Zones> • Almost the complete route is through built up unplanned ribbon development • density varies – nearer the towns it is quite dense, for a radius of up to 1-km around 'old' PNR stations – all the population is within the walk in or short-ride catchment of the old stations • Population growth in the last decade has been limited. Higher growth rates are only in towns nearer MM in Zone-1. • Densities at study area traffic model zone level are still low, and it is similar along the entire corridor with even distribution except in the Fish-farm areas in Zone 2.	4.0
Option II	<All Zones> • Almost the complete route is through segregated land – without direct access • Catchment population is similar to Option-I, but would not reach existing population centers like San Fernando, Calumpit, or Malolos (Zones 2 & 3). • Population of Pampanga City, San Simon, Plaridel... would be served much better by this alignment than by the other options. Also an additional station would increase the catchment area population by a considerable amount more than the other options. • South of Balagtas the area is densely populated the same as Option-I, and is similar to the MM urbanized areas. However, there are more high-rise buildings showing more affluence of the residents of the area than in Option-I. • On balance total population served may be marginally less than Option-I.	3.0
Option III	<Zone 1 & 3> Same as Option I <Zone 2> Same as Option II	3.5
Option IV	<Zone 1> Same as Option I <Zones 2 & 3 > Same as Option II	3.5

Source: JICA Study Team

④ Construction Workability

A comparison and the evaluation score of construction workability for each option in the initial screening based on the site investigation is shown in Table 6.2-20.

Table 6.2-20 Comparison of Construction Workability

	Option I	Option II	Option III	Option IV
Construction Workability	<Zone 1> • Flooding Area • No Access to the site in some areas <Zone 2> • Swampy Area • No Access to the site in some areas <Zone 3> • Erosion Area • No Access to the site in some areas	<Zone 1> • Heavy traffic congestion • Limited lanes for NLEX <Zone 2> • Swampy area • Temporary limited lanes for NLEX <Zone 3> • Temporary limited lanes for NLEX	<Zone 1> Same as Option I <Zone 2> Same as Option II <Zone 3> Same as Option I	<Zone 1> Same as Option I <Zone 2> Same as Option II <Zone 3> Same as Option II
Score	3.5	3.0	3.0	4.0

Source: JICA Study Team

⑤ Approximate Project Implementation Cost and Approximate Operation and Maintenance Cost

The ratio and the evaluation score of approximate project implementation cost and operation and maintenance cost for each option are shown below.

Table 6.2-21 Approximate Project Implementation Operation & Maintenance Cost

		Option I	Option II	Option III	Option IV
Elevated Structures	Viaduct Length (km)	79.0	80.9	76.8	76.1
	Number of Stations	10	11	10	10
Underground Structures	Tunnel Length (km)	4.4	4.7	4.4	4.7
	Number of Stations	1	1	1	1
Total	Length (km)	83. 4	85. 6	81. 2	80. 8
	Number of Stations	11	12	11	11
Project Implementation Cost Rate		1.00	1.17	0.99	0.98
	Score	4.9	4.2	4.9	5.0
Operation and Maintenance Cost Rate		1.00	1.02	0.98	0.97
	Score	4.9	4.8	4.9	5.0

Source: JICA Study Team

⑥ Approximate Project Implementation Schedule

All Options have the same schedule from feasibility study stage through Tender stage to preliminary design by the consultant. The Feasibility Study is planned to take 1 year including investigation of detailed topographical and geological information for the route alignment. It is required to examine the existing substructures made by the Chinese contractor due to using the PNR route between Caloocan and Clark. Therefore, examination of the substructure regarding design and quality based on the terms of reference of the feasibility study are included. Preliminary Design is planned to take 6 months including additional investigation, basic design and tender documents with the FIDIC yellow book. Selection of consultants and the Tender stage for contractor is planned to take 5 months based on Philippine regulations.

In the construction and procurement stage, it is planed that Option (I) will take 5.5 years, Option (II) 5.0 years, Option (III) 5.0 years and Option (IV) 4.5 years based on track length and project scope. However, it is required to acquire additional land before the beginning of construction as a precondition of the project implementation schedule.

Approximate Project Schedule is estimated for all options to be between 7 and 8 years. The evaluation score of approximate project implementation schedule is shown in Table 6.2-22.

Table 6.2-22 Approximate Project Implementation Schedule

Unit Year

	Option I	Option II	Option III	Option IV
Feasibility Study	1.0	1.0	1.0	1.0
Consultants Selection	0.5	0.5	0.5	0.5
Preliminary Design	0.5	0.5	0.5	0.5
Tender	0.5	0.5	0.5	0.5
Construction and Procurement	5.5	5.0	5.0	4.5
TOTAL	8.0	7.5	7.5	7.0
Score	4.4	4.7	4.7	5.0

Source: JICA Study Team

(2) Inside of Manila

① Relation with existing Railway Network

A comparison and the evaluation score of the relation with the existing railway network for each option is shown in Table 6.2-23.

Table 6.2-23 Comparison of Relation with Existing Railway Network

	Relation with Existing Railway Network	Score
Option (1)	• Utilizes existing PNR ROW, future operation of PNR South Line to be considered. Interconnection at Station for Blumentritt Line 1 (less than 50 m.), Pureza Line 2 (530 m.), and Magallanes Line 3 (300 m.). • Possible interconnection to future Global Cities Mass Transit (GCMT) Project (Monorail) at Nichols.	3.5
Option (2)	• Utilizes existing PNR ROW, future operation of PNR South Line to be considered. Interconnection at Station for Blumentritt Line 1 (less than 50 m.) and Pureza Line 2 (530 m.). Interconnection to MRT-3 Ayala Station. Sharing same alignment with GCMT Project (Monorail) from Ayala up to NAIA terminal following McKinley and Lawton avenues.	4.0
Option (3)	• Utilizes existing PNR ROW near Tutuban station and depot areas, future operation of PNR South Line to be considered. No interconnection with exiting rail network.	2.5
Option (4)	• Good Interconnection at future Common Station of Lines 1 and 3 in the Trinoma area (736 m.) or existing North Avenue MRT-3 Station (480 m.), and future terminal of Line 7 (490 m.). • Utilizes existing PNR ROW, future operation of PNR South Line to be considered. Additional Interconnection at Station for Pureza Line 2 (530 m.) and Magallanes Line 3 (300 m.). Possible interconnection to future Global Cities Mass Transit (GCMT) Project (Monorail) at Nichols.	3.5
Option (5)	• Good Interconnection at future Common Station of Line 1 and 3 at Trinoma area (736 m.) or existing North Avenue MRT-3 Station (480 m.), and future terminal of Line 7 (478 m.). • Utilizes existing PNR ROW, future operation of PNR South Line to be considered. Additional Interconnection at Pureza Line 2 Station (530 m.) Interconnection to MRT-3 Ayala Station. Sharing same alignment with GCMT Project (Monorail) from Ayala up to NAIA terminal following McKinley and Lawton avenues.	4.0

Source: JICA Study Team

② Land Acquisition and Resettlement

A comparison and the evaluation score of land acquisition and resettlement for each option in the initial screening based on the site investigation is shown in Table 6.2-24.

Table 6.2-24 Comparison of Land Acquisition and Resettlement

	Land Acquisition and Resettlement	Score
Option (1)	• Encroaching structures and informal settlers shall be confirmed along the entire route based on the existing PNR ROW. • Medium scale relocation of informal settlers will be unavoidable along the old PNR route just south of Caloocan Work Shop and on the north side of the Depot site.	3.5
Option (2)	• Encroaching structures and informal settlers shall be confirmed along the viaduct zone based on the existing PNR ROW. • Large scale resettlement of informal settlers will be unavoidable along the old PNR line southeast of Sta. Mesa.	2.5

	Land Acquisition and Resettlement	Score
Option (3)	• Encroaching structures and informal settlers shall be confirmed along the viaduct zone based on the existing PNR ROW. • Medium scale relocation of informal settlers will be unavoidable along the old PNR route just south of Caloocan Work Shop and on the north side of the Depot site.	3.0
Option (4)	• Land acquisition and large scale resettlement will be needed in the following portions: - Between Trinoma Terminal and Quezon Avenue - Between España Boulevard and PNR España Station • Encroaching structures and informal settlers in the ROW shall be confirmed along the existing PNR route.	3.0
Option (5)	• Land acquisition and large scale resettlement will be needed at the following portions: - Between Trinoma Terminal and Quezon Avenue - Between España Boulevard and PNR España Station • Large scale resettlement of informal settlers will be unavoidable along the old PNR line southeast of Sta. Mesa.	2.5

Source: JICA Study Team

③ Future Land Development Potential

A comparison and the evaluation score of future land development potential for each option in the initial screening is shown in Table 6.2-25.

Table 6.2-25 Comparison of Future Land Development Potential

	Future Land Development Potential	Score
Option (1)	• Redevelopment in and around PNR Tutuban Terminal • Urban Redevelopment Project in/ around Paco Station Area • The route area is already saturated with population and demographic growth has leveled off or is even decreasing along the entire section from North of Caloocan to Tutuban. • AER may be a trigger of urban regeneration along the old PNR area, which is completely run down, and the possibility of regeneration of the area is remote as most of the development emphasis is in and around the EDSA area and new CBDs.	2.5
Option (2)	• Urban development with high-rise buildings at the race course near Pasig River. • Large-scale urban development is planned around the southern terminal area between Tamarind Road and Lawton Avenue. Because of this, population density will increase.	4.0
Option (3)	• Further urban development may be expected in the reclamation area in Pasay. • Old town along the coast may be redeveloped incrementally over time which may generate demand for AER.	3.0
Option (4)	• Between EDSA and North Ave. urban development and a Transport Complex called MMTC is on-going. • Urban Redevelopment Project in/ around Paco station Area • Unlike Option (1), the area along the northern section has a lower population density than Option (1) however, fare affordability may be higher, and hence there could be more potential demand for AER.	3.0
Option (5)	• Between EDSA and North Ave. urban development and a Transport Complex called MMTC is on-going. • Urban development with high-rise buildings at the race course near Pasig River. • Large-scale urban development is planned around the southern terminal area between Tamarind Road and Lawton Avenue.	4.0

Source: JICA Study Team

④ Population along the Corridor

A comparison and the evaluation score of population along the corridor for each option in the initial screening is shown in Table 6.2-26.

Table 6.2-26 Comparison of Population along the Corridor

	Population along the Corridor	Score
Option (1)	• The route goes through most densely populated areas in MM but population growth has been stagnant.	3.5
Option (2)	• After deviating Option (1), the route passes through densely populated Mandaluyoung and penetrates the tow largest CBDs of Makati and Fort Bonifacio.	4.0
Option (3)	• South of Tutuban terminal, the route goes to Roxas Blvd passing Ermita and Pasay, with large populations and one of the busiest commercial areas.	3.0
Option (4)	• Entering inside EDSA through MMTC, one of the busiest transport corridors, the option takes the route along Quezon Ave. and merges to Option (1). Quezon is inhabited by comparatively rich people at moderate density, hence there is lower potential demand for AER.	3.5
Option (5)	• Same as Option (4) but merges to Option (2) in the south, which will bring about more demand than the other options. • In the sections south of Sta. Mesa, the route passes through densely populated Mandaluyoung and penetrates the two largest CBDs of Makati and Fort Bonifacio.	4.5

Source: JICA Study Team

⑤ Construction Workability

A comparison and the evaluation score of construction workability for each option in the initial screening based on the site investigation is shown in Table 6.2-27.

Table 6.2-27 Comparison of Construction Workability

	Construction Workability	Score
Option (1)	<Caloocan – España> • Construction of Elevated Structure during Train Operation <España – Sta. Mesa> • Construction of Elevated Structure during Train Operation <Sta. Mesa – NAIA> • Construction near existing structure • Underpinning Method	3.0
Option (2)	<Caloocan – España> • Same as Option (1) <España – Sta. Mesa> • Same as Option (1) <Sta. Mesa – Makati – Global City – NAIA> • Twin Tunnels must be constructed one above the other due to narrow ROW • Underpinning Method	3.0
Option (3)	<Caloocan – Tutuban> • Construction of Elevated Structure during Train Operation <Tutuban – NAIA> • Construction near existing structure • Narrow R.O.W • Underpinning Method	3.5

	Construction Workability	Score
Option (4)	<North Ave. – España> • Construction of Viaduct near underpass of C-3 Road <España – Sta. Mesa> • Same as Option (1) <Sta. Mesa – NAIA> • Same as Option (1)	3.0
Option (5)	< North Ave. – España> • Same as Option (4) <España – Sta. Mesa> • Same as Option (1) <Sta. Mesa – Makati – Global City – NAIA> • Same as Option (2)	3.0

Source: JICA Study Team

⑥ Approximate Project Implementation Cost and Approximate Operation and Maintenance Cost

The ratio and the evaluation score of approximate project implementation cost and operation and maintenance cost for each option are shown in Table 6.2-28.

Table 6.2-28 Approximate Project Implementation Operation & Maintenance Cost

		Option (1)	Option (2)	Option (3)	Option(4)	Option (5)
Elevated Structures	Viaduct Length (km)	16.8	8.9	4.0	16.1	8.3
	Number of Stations	7	4	1	8	5
Underground Structures	Tunnel Length (km)	2.9	14.6	17.8	2.9	14.6
	Number of Stations	1	6	7	1	6
Total	Length (km)	19.7	23.5	21.8	19.0	22.9
	Number of Stations	8	10	8	9	11
Project Implementation Cost Rate		1.00	1.39	1.28	0.94	1.38
	Score	4.7	3.4	3.7	5.0	3.4
Operation and Maintenance Cost Rate		1.00	1.16	1.08	0.98	1.17
	Score	4.9	4.2	4.5	5.0	4.2

Source: JICA Study Team

⑦ Approximate Project Implementation Schedule

All Options have the same schedule from feasibility study stage through Tender stage to preliminary design by the consultant. The Feasibility Study is planned to take 1 year including investigation of detailed topographical and geological information for the route alignment. Preliminary Design is planned to take 6 months including additional investigation, basic design and tender documents with the FIDIC yellow book. Selection of consultants and the Tender stage for a contractor was planned to take 5 months based on Philippine regulations.

In the construction and procurement stage, it is planned that Option (1) will take 5 years, Option (2) 5.5 years, Option (3) 5.5 years, Option (4) 4.5 years and Option (5) 5.5 years based on track length and project scope. However, it is required to acquire additional land before the beginning of construction as a precondition of the project implementation schedule.

Approximate Project Schedule is estimated for all options to be between 7 and 8 years for all Options. The evaluation score of approximate project implementation schedule is shown in Table 6.2-29.

Table 6.2-29 Evaluation of Approximate Project Implementation Schedule

Unit Year

	Option (1)	Option (2)	Option (3)	Option (4)	Option (5)
Feasibility Study	1.0	1.0	1.0	1.0	1.0
Consultants Selection	0.5	0.5	0.5	0.5	0.5
Preliminary Design	0.5	0.5	0.5	0.5	0.5
Tender	0.5	0.5	0.5	0.5	0.5
Construction and Procurement	5.0	5.5	5.5	4.5	5.5
TOTAL	7.5	8.0	8.0	7.0	8.0
Score	4.7	4.4	4.4	5.0	4.4

Source: JICA Study Team

6) Evaluation Results

Evaluation results for each option outside and inside of Manila are shown below

Table 6.2-30 Evaluation of Outside of Manila

Evaluation Item	OPTION				weight
	I	II	III	IV	
· Land Acquisition and Resettlement	3.0	4.0	2.5	3.5	1
· Future Land Development Potential	2.5	4.0	2.5	3.0	3
· Population along the Corridor	4.0	3.0	3.5	3.5	3
· Construction Workability	3.5	3.0	3.0	4.0	2
· Approximate Project Implementation Cost	4.9	4.2	4.9	5.0	5
· Approximate Operation and Maintenance Cost	4.9	4.8	4.9	5.0	5
· Approximate Project Implementation Schedule	4.4	4.7	4.7	5.0	1
TOTAL SCORE	82.9	80.7	80.2	86.0	
SCORE RATIO	0.96	0.94	0.93	1.00	

Source: JICA Study Team

Table 6.2-31 Evaluation of Inside of Manila

Evaluation Item	OPTION					Weight
	(1)	(2)	(3)	(4)	(5)	
· Relation with existing Railway Network	3.5	4.0	2.5	3.5	4.0	1
· Land Acquisition and Resettlement	3.5	2.5	3.0	3.0	2.5	1
· Future Land Development Potential	2.5	4.0	3.0	3.0	4.0	3
· Population along the Corridor	3.5	4.0	3.0	3.5	4.5	3
· Construction Workability	3.0	3.0	3.5	3.0	3.0	2
· Approximate Project Implementation Cost	4.7	3.4	3.7	5.0	3.4	5
· Approximate Operation and Maintenance Cost	4.9	4.2	4.5	5.0	4.2	5
· Approximate Project Implementation Schedule	4.7	4.4	4.4	5.0	4.4	1
TOTAL SCORE	83.7	78.9	75.9	87.0	80.4	
SCORE RATIO	0.96	0.91	0.87	1.00	0.92	

Source: JICA Study Team

As shown in Table 6.2-32, there are 11 alternative routes between CIA and NAIA, which are combinations of 4 route plans outside Manila and 5 route plans inside Manila. A result of comprehensive evaluation for initial screening of these route plans was discussed in the first TWG, and 4 combined routes were selected as the recommended route plans for the secondary screening.

Table 6.2-32 Comprehensive Evaluation for Initial Screening

		Outside of Manila			
		Option I	Option II	Option III	Option IV
Inside of Manila	Option (1)	0.96 0.96 / **1.92**		0.93 0.96 / 1.89	1.00 0.96 / **1.96**
	Option (2)	0.96 0.91 / 1.87		0.93 0.91 / 1.84	1.00 0.91 / **1.91**
	Option (3)	0.96 0.87 / 1.83		0.93 0.87 / 1.80	1.00 0.87 / 1.87
	Option (4)		0.94 1.00 / **1.94**		
	Option (5)		0.94 0.92 / 1.86		

Source: JICA Study Team

6.2.2 Secondary Screening of Route Plans

The four pre-selected route plans for AER, which were selected in the first TWG were examined more deeply considering demand forecast, problems with land acquisition and resettlement, construction workability, implementation cost and others.

These pre-selected route plans were evaluated in the second TWG Meeting which was held on 28th November 2012 and in the first JCC (Joint Coordination Committee) Meeting which was held on 10th December 2012.

1) Secondary Evaluation Routes

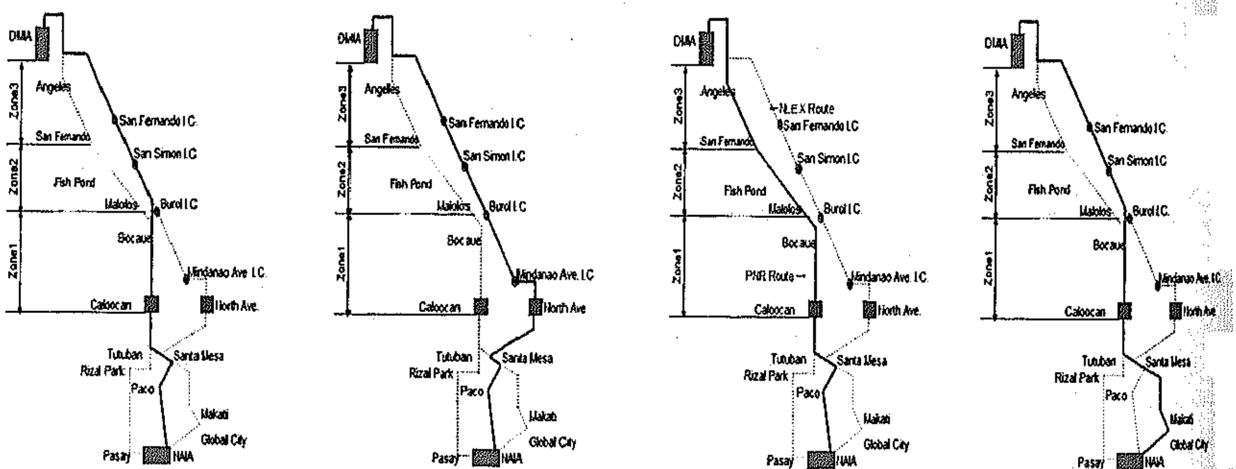
An outline of Pre-Selected Route Plans is shown in Table 6.2-33 and Figure 6.2-35.

Table 6.2-33 Outline of Pre-Selected Route Plans

Option		Outline
Option A	NLEX and PNR Route Burol to NAIA Route through PNR	**Outside of Manila:** This route utilizes the PNR route from Caloocan to Burol I.C. and the NLEX route from Burol I.C to CIA. **Inside of Manila:** This route utilizes the existing PNR route from Caloocan to NAIA Terminal 3. The viaduct/underground goes through urbanized zones all the way to NAIA Terminal 3.
Option B	NLEX Route North Avenue to NAIA Route through Quezon Avenue and PNR	**Outside of Manila:** This route utilizes the NLEX route and Mindanao Ave from North Ave. (Trinoma) to CIA. **Inside of Manila:** This route utilizes the Road along Quezon Avenue and the existing PNR route. The viaduct/underground goes through urbanized zones all the way from North Avenue to NAIA Terminal 3.
Option C	PNR Route	**Outside of Manila:** This route utilizes the PNR route (Same as North Rail Project) from Caloocan to CIA. **Inside of Manila:** This route utilizes the existing PNR route from Caloocan to NAIA Terminal 3. The viaduct/underground goes through urbanized zones all the way to NAIA Terminal 3.
Option D	NLEX and PNR Route Burol to NAIA Route through PNR and Makati/Global Area	**Outside of Manila:** This route utilizes the PNR route from Caloocan to Burol I.C. and the NLEX route from Burol I.C to CIA. **Inside of Manila:** This route utilizes the existing PNR route from Caloocan to Santa Mesa. From Santa Mesa to Makati/Global area, the route goes underground all the way to NAIA Terminal 3.

Source: JICA Study Team

Option A (Option IV+(1)) | Option B (Option II+(4)) | Option C (Option I+(1)) | Option D (Option IV+(2))



Source: JICA Study Team

Figure 6.2-35 Outline of Pre-Selected Route Plans

2) Station Location and Express Train Stop Stations

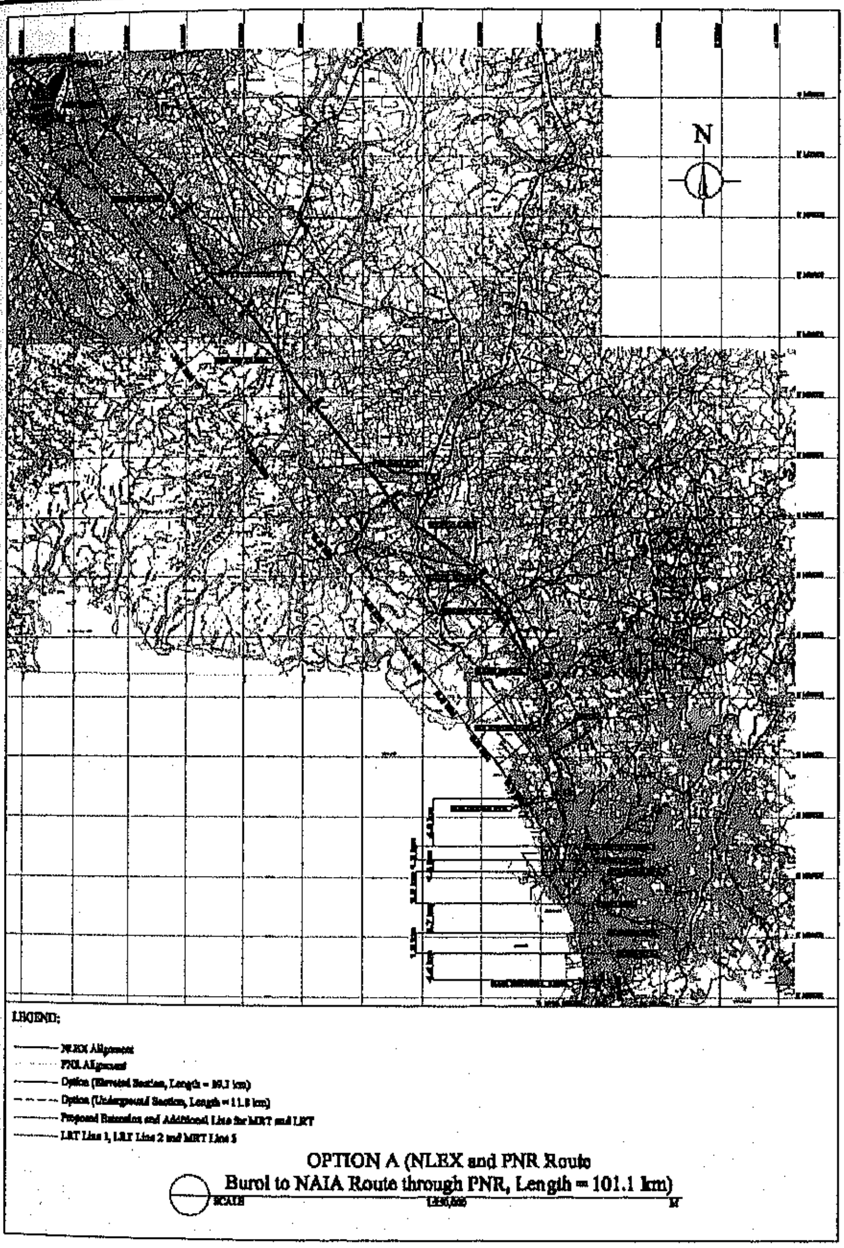
Station locations were selected to take into account the railway network inside of Manila, planned stations of the Northrail project and interchange locations of NLEX outside of Manila.

Express train stopping stations were planned by taking into account quick travel time between CIA and NCR area with highest patronage for the Airports (CIA/NAIA). Station name and distances between stations for each option are shown below.

(1) Option A

Stop stations for Express trains are CIA, BLUMENTRITT(for Interchange station of LRT1),EDSA(Interchange with MRT3) and NAIA Terminal3.

Option A



STATION	Distance
CIA	8.3km
DAU	10.2km
SINDALAN	7.3km
SAN FERNANDO	9.5km
SAN SIMON	11.0km
PULILAN	6.8km
STA. RITA	7.0km
BUROL	3.8km
BOCAUE	5.5km
MARILAO/ MEYCAUAYAN	5.0km
VALENZUELA	6.1km
CALOOCAN	4.8km
BLUMENTRITT	1.8km
ESPAÑA	1.4km
STA.MESA	3.7km
PACO	2.6km
BUENDIA	1.9km
EDSA	4.4km
NAIA Ter.3	
Total Length	101.1km

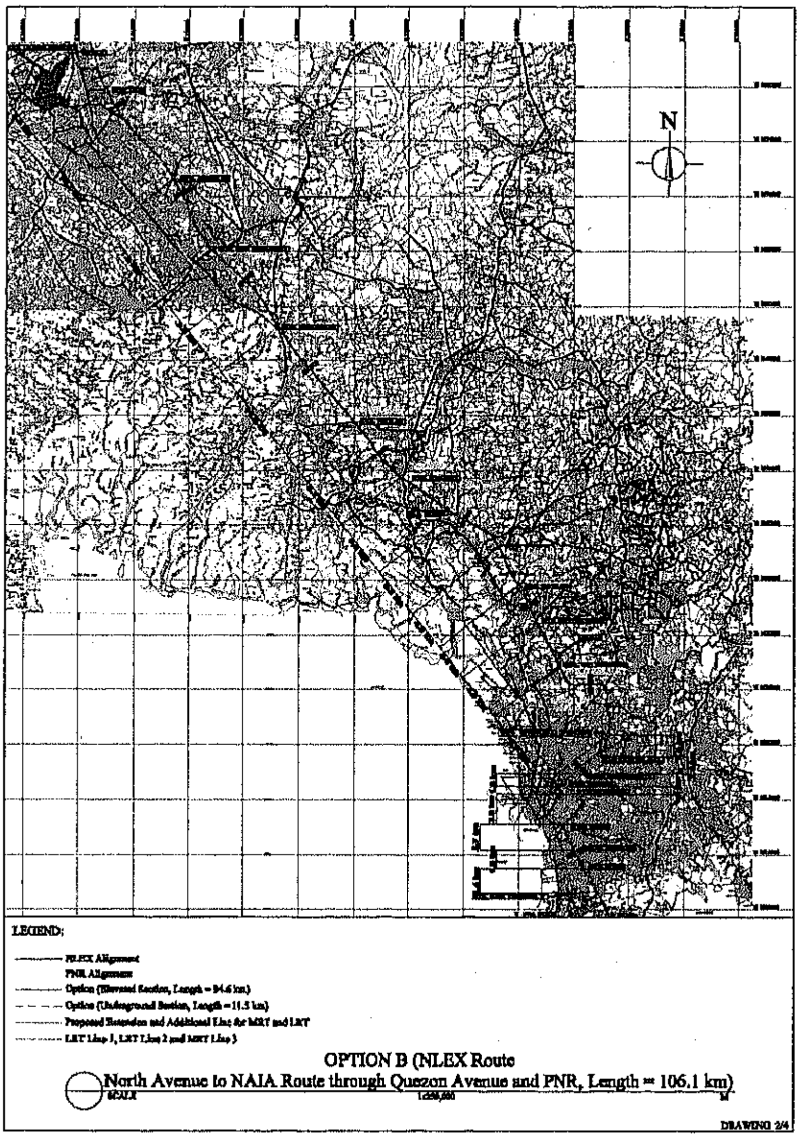
Source: JICA Study Team

Figure 6.2-36 Route Plan and Stations of Option A

(2) Option B

Stop stations for Express trains are CIA, NORTH Ave. (Interchange with MRT3), EDSA (Interchange with MRT3) and NAIA Terminal 3.

Option B



STATION	Distance
CIA	
	8.3km
DAU	
	10.2km
SINDALAN	
	7.3km
SAN FERNANDO	
	9.5km
SAN SIMON	
	11.0km
PULILAN	
	6.7km
STA. RITA	
	5.8km
BUROL	
	5.2km
BOCAUE	
	4.0km
MARILAO	
	3.6km
MEYCAUAYAN	
	4.6km
VALENZUELA	
	9.7km
NORTH Ave.	
	2.5km
CAPITOL	
	2.4km
BANAWE Ave.	
	1.6km
ESPAÑA	
	1.1km
STA.MESA	
	3.6km
PACO	
	2.7km
BUENDIA	
	1.9km
EDSA	
	4.4km
NAIA Ter.3	
Total Length	106.1km

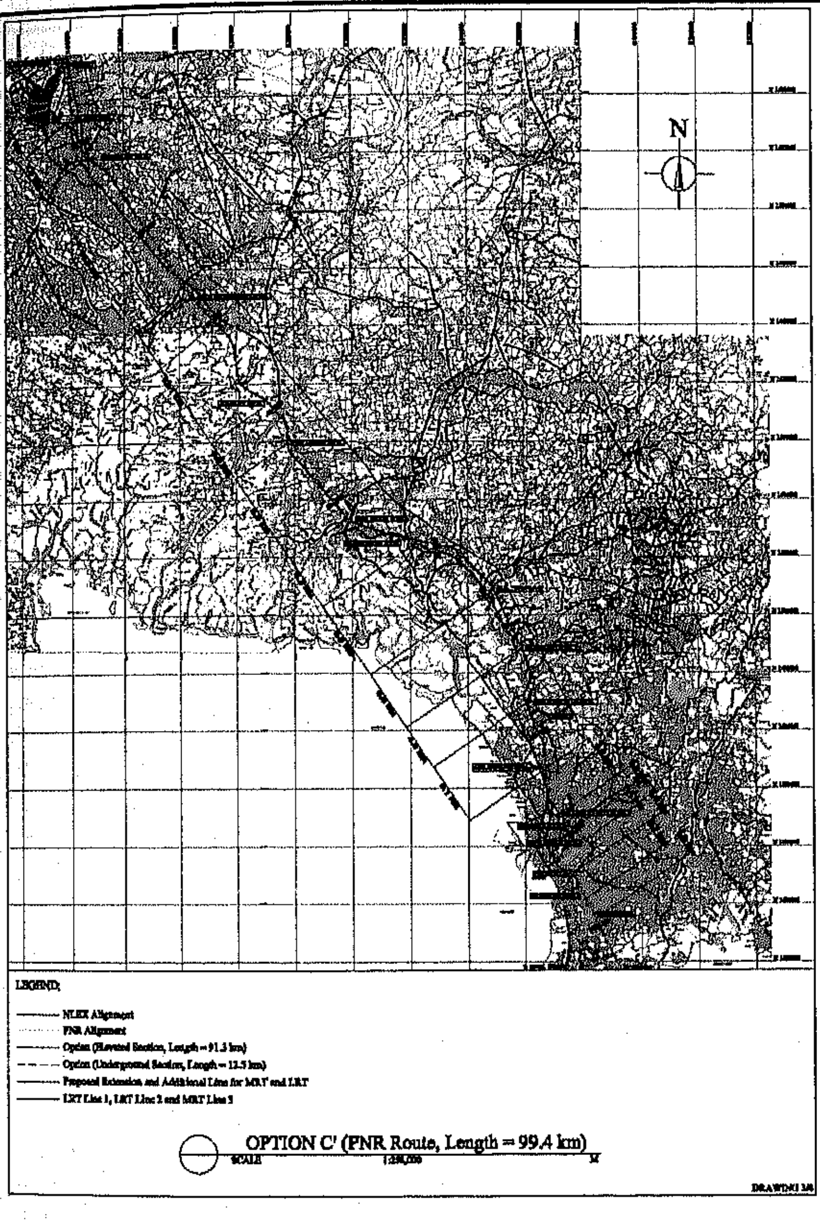
Source: JICA Study Team

Figure 6.2-37 Route Plan and Stations of Option B

(3) Option C

Stop stations for Express trains are CIA, BLUMENTRITT (for Interchange station of LRT1), EDSA (Interchange with MRT3) and NAIA Terminal 3.

Option C



STATION	Distance
CIA	
	7.7km
CLARK	
	3.8km
ANGELES	
	15.8km
SAN FERNANDO	
	12.1km
APALIT	
	4.0km
CALUMPIT	
	8.5km
MALOLOS	
	6.2km
GUIGUINTO	
	8.5km
BOCAUE	
	5.6km
MARILAO/ MEYCAUAYAN	
	4.9km
VALENZUELA	
	6.1km
CALOOCAN	
	4.8km
BLUMENTRITT	
	1.8km
ESPAÑA	
	1.4km
STA.MESA	
	3.7km
PACO	
	2.6km
BUENDIA	
	1.9km
EDSA	
	4.4km
NAIA Ter.3	
Total Length	103.8km

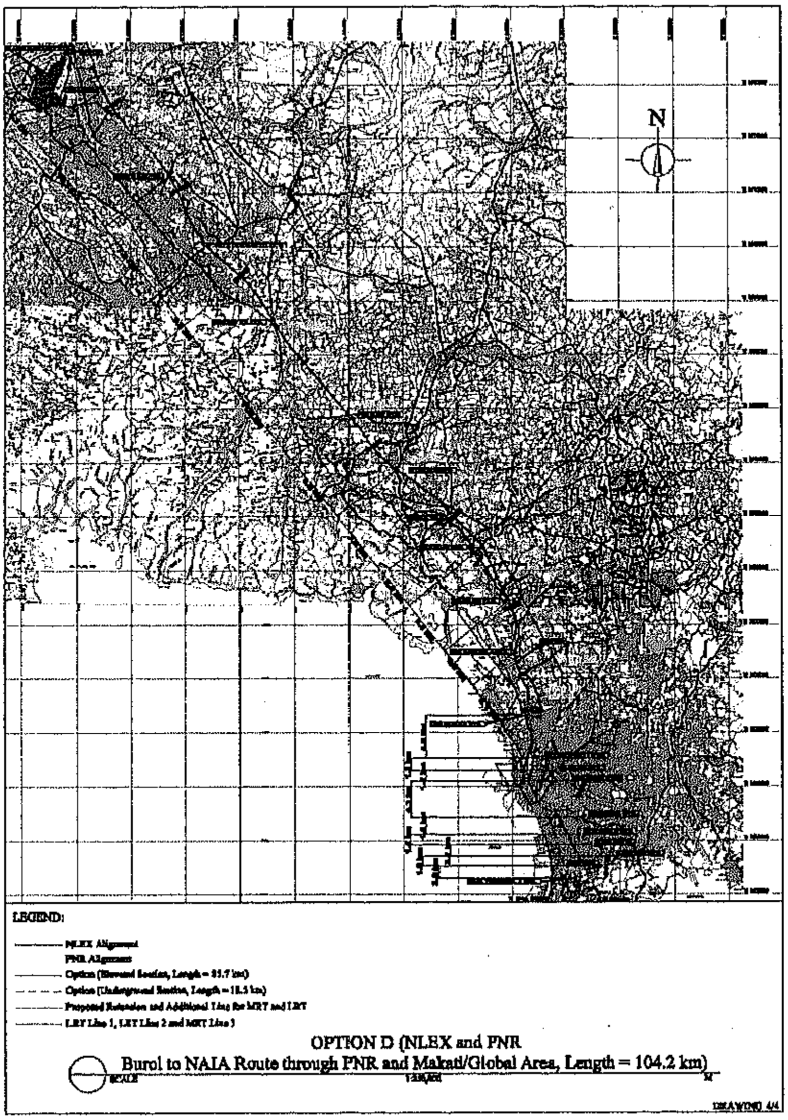
Source: JICA Study Team

Figure 6.2-38 Route Plan and Stations of Option C

(4) Option D

Stop stations for Express trains are CIA, BULUMENTRITT (for Interchange station of LRT1), AYALA (Interchange with MRT3) and NAIA Terminal 3.

Option D



STATION	Distance
CIA	
	8.3km
DAU	
	10.2km
SINDALAN	
	7.3km
SAN FERNANDO	
	9.5km
SAN SIMON	
	11.0km
PULILAN	
	6.8km
STA. RITA	
	7.0km
BUROL	
	3.8km
BOCAUE	
	5.5km
MARILAO/ MEYCAUAYAN	
	5.0km
VALENZUELA	
	6.1km
CALOOCAN	
	4.8km
BLUMENTRITT	
	1.8km
ESPAÑA	
	1.4km
STA. MESA	
	4.3km
CARMONA	
	1.8km
BUENDIA	
	1.4km
AYALA	
	2.7km
LAWTON	
	1.9km
PGH	
	3.6km
NAIA Ter.3	
Total Length	104.2km

Source: JICA Study Team

Figure 6.2-39 Route Plan and Stations of Option D

3) Examination and Evaluation Items for Secondary Screening of Route Plans

The 4 proposed routes were examined and evaluated based on the following criteria after the first TWG meeting

① Land Acquisition and Resettlement
② Construction Workability
③ Environmental Conditions
④ Passenger Demand
⑤ Approximate Project Implementation Cost
⑥ Approximate Operation and Maintenance Cost

Each proposed route was evaluated in the second screening for each criteria in the following three ranks in terms of project feasibility, and the final determination was made with judgment of both JST and Philippine personnel. In addition, any "RED" rated option for any criteria is also rated as "RED" in the comprehensive evaluation.

GREEN: Good in the relative valuation (up to 2nd rank), or no significant issues

YELLOW: No serious obstacles

RED: Contains critical obstacles or concerns

4) Comparison for Secondary Screening of Route Plans

① Land Acquisition and Resettlement

Options A and D were recommended in the second TWG by JST, DOTC requested considering further examinations on land acquisition and resettlement issues.

The data regarding land acquisition and resettlement for each option, which was submitted by Northrail, is shown in Table 6.2-34 and was considered for evaluation of the route selection.

A comparison and evaluation of land acquisition and resettlement required for each option in the secondary screening is shown in Table 6.2-35.

Table 6.2-34 Data regarding Land Acquisition and Resettlement for each Option

LAND ACQUISITION AND RESETTLEMENT

LOCATION		OPTION A				OPTION B			
		LAND ACQUISITION (sq.m.)	COST (PhP)	RESETTLEMENT OF INFORMAL SETTLERS	COST (PhP)	LAND ACQUISITION (sq.m.)	COST (PhP)	RESETTLEMENT OF INFORMAL SETTLERS	COST (PhP)
OUTSIDE OF METRO MANILA	ZONE 3			900	193,500,000.00			900	193,500,000.00
	REMARKS	No available Railroad ROW. Needs to acquire /lease land from MNTC (NLEX).	No available data.	Informal settlers are present along Mabalacat area (beside Clark Airport).	Rate of PhP215,000.00 per family is based on NHA 2006 estimate.	No available Railroad ROW. Needs to acquire /lease land from MNTC (NLEX).	No available data.	Informal settlers are present along Mabalacat area (beside Clark Airport).	Rate of PhP215,000.00 per family is based on NHA 2006 estimate.
	ZONE 2								
	REMARKS	Ditto	Ditto	No available data.	No available data.	Ditto	Ditto	No available data.	No available data.
	ZONE 1	17,565.00	35,146,000.00	0	0.00				
	REMARKS	Railroad ROW is available; however, land acquisition is required on some areas to meet the proposed 15.0m design width.	Based on BIR Zonal Valuation (2009).	Area is clear from informal settlers. A total of 18,418 families were relocated since 2005.	-	Ditto	Ditto	Ditto	Ditto
	TOTAL	-			193,500,000.00	-			193,500,000.00

LOCATION		OPTION C				OPTION D			
		LAND ACQUISITION (sq.m.)	COST (PhP)	RESETTLEMENT OF INFORMAL SETTLERS	COST (PhP)	LAND ACQUISITION (sq.m.)	COST (PhP)	RESETTLEMENT OF INFORMAL SETTLERS	COST (PhP)
OUTSIDE OF METRO MANILA	ZONE 3	24,199.21	122,834,550.00	1,650	354,750,000.00			900	193,500,000.00
	REMARKS	Railroad ROW is available; however, land acquisition is required on some areas to meet the proposed 15.0m design width.	Based on BIR Zonal Valuation (2009).	A total of 11,250 families were already relocated; however, there are still some informal settlers present at Mabalacat, San Fernando, and Angeles Areas.	Rate of PhP215,000.00 per family is based on NHA 2006 estimate.	No available Railroad ROW. Needs to acquire /lease land from MNTC (NLEX).	No available data	Informal settlers are present along Mabalacat area (beside Clark Airport).	Rate of PhP215,000.00 per family is based on NHA 2006 estimate.
	ZONE 2	2,748.16	13,470,000.00	35	7,525,000.00				
	REMARKS	Ditto	Ditto	A total of 2,584 families were already relocated; however, there are still some informal settlers present at Calumpit area.	Ditto	Ditto	Ditto	No available data.	No available data.
	ZONE 1	12,117.00	48,904,000.00	0	0.00	17,565.00	35,146,000.00	0	0.00
	REMARKS	Ditto	Ditto	Area is clear from informal settlers. A total of 18,418 families were relocated since 2005.	-	Railroad ROW is available; however, land acquisition is required on some areas to meet the proposed 15.0m design width.	Based on BIR Zonal Valuation (2009).	Area is clear from informal settlers. A total of 18,418 families were relocated since 2005.	-
	TOTAL	39,064.37	185,208,550.00	1,685	362,275,000.00				193,500,000.00

SOURCE:NORTHRAIL

Source: JICA Study Team

Table 6.2-35 Comparison of Land Acquisition Requirements

		Option A	Option B	Option C	Option D
Land Acquisition	Outside of Manila	<Zone3> • Alternative ROW along SCTEX and in BCDA property <Zone2> • Connection route between PNR & NLEX	<Zone3> • Same as option A <Zone1> • Underpass section on Mindanao Ave.	<Zone3> • Alternative ROW in BCDA property <Zone2> • Additional Land Acquisition	• Same as Option A
	Inside of Manila	• All station areas	• Between Trinoma Terminal to Quezon Avenue • Underpass Section on Quezon Avenue • Between España Boulevard and PNR España Station. • All Station Areas	• Same as Option A	• Same as Option A • Using private land between Ayala & Global City in some areas

Resettlement	Outside of Manila	<Zone3> • Large scale relocation • Informal settlers beside Clark Airport <Zone2> • Medium scale relocation <Zone1> • Completion of Resettlement	<Zone3> • Same as option A <Zone1> • Large scale relocation	<Zone3> • Extra-large scale relocation • Informal settlers beside Clark Airport <Zone2> • Large scale relocation of informal settlers remains <Zone1> • Same as Option A	• Same as Option A
	Inside of Manila	• Small scale relocation of informal settlers within the PNR ROW (Caloocan Sta, Solis Sta., Sta. Mesa Sta.)	• Large scale relocation within the new ROW above	• Same as Option A	• Large scale relocation is unavoidable along the old PNR line southeast of Sta. Mesa (U-shape zone)
Score					

Source: JICA Study Team

② Construction Workability

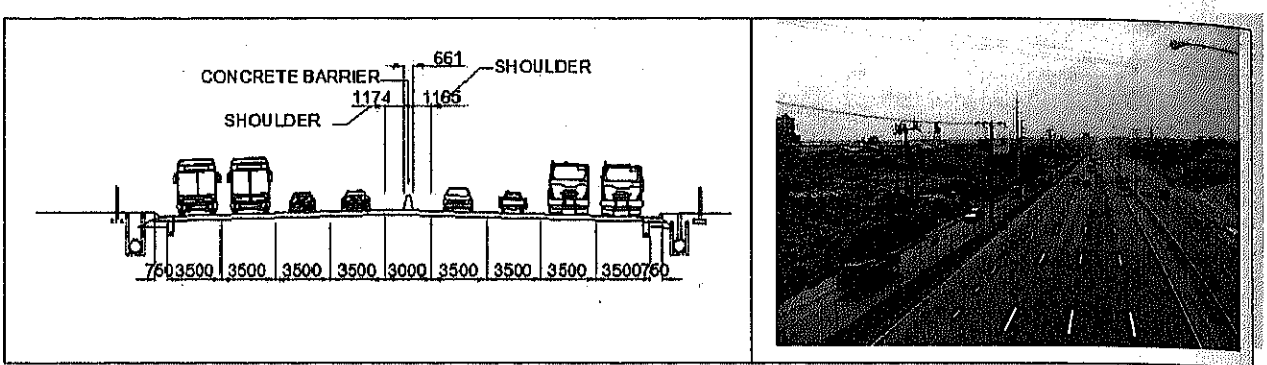
A comparison and evaluation of construction workability for each option in the secondary screening is shown in Table 6.2-36.

Table 6.2-36 Comparison of Construction Workability

	Option A	Option B	Option C	Option D
Outside of Manila	<Zone3> • Temporally limited lane for NLEX <Zone2> • Swampy area • Temporally limited lane for NLEX <Zone1> • Flooding Area • No access to the site in some areas	<Zone3> • Same as option A <Zone2> • Same as option A <Zone1> • Heavy traffic congestion • Limited lane for NLEX*[1)]	<Zone3> • Erosion Area • No access to the site in some areas <Zone2> • Swampy area • No access to the site in some areas <Zone1> • Same as Option A	<Zone3> • Same as Option A <Zone2> • Same as Option A <Zone1> • Same as Option A
Inside of Manila	<North Area> • Construction of elevated structure during train operation <South Area> • Construction near existing structure • Underpinning Method • High Voltage Line and Flyover along PNR route	<North Area> • Construction of Viaduct near underpass of C3 road <South Area> • Same as Option A	<North Area> • Same as Option A <South Area> • Same as Option A	<North Area> • Same as Option A <South Area> • Twin tunnels must be constructed one above the other due to narrow ROW • Underpinning Method
Score				

Source: JICA Study Team

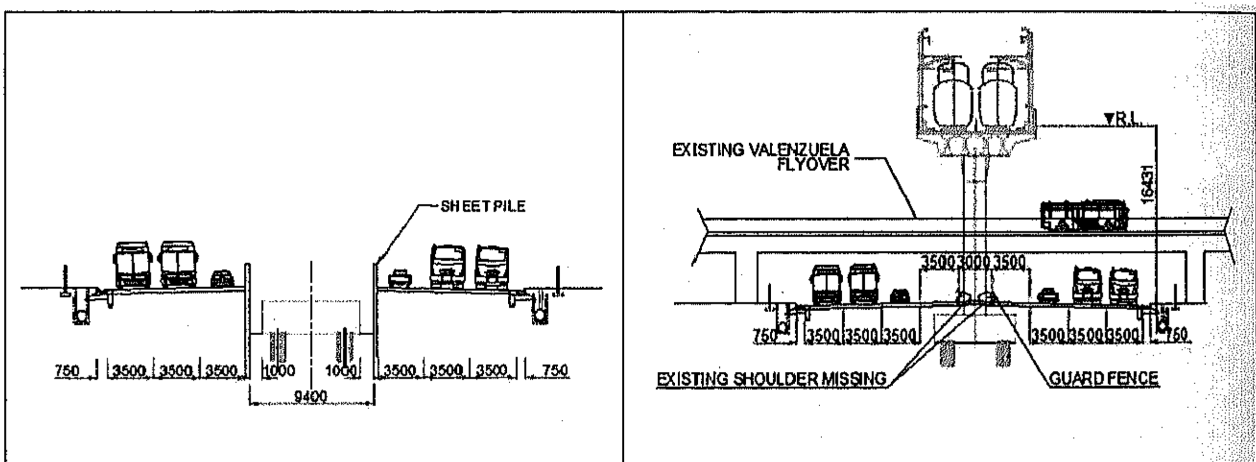
Option B was evaluated as "RED" due to poor construction workability. As shown in Figure 6.2-40, there is a dual carriageway with 4 lanes in each direction and less than 3 meter wide median between Burol I.C and Mindanao Avenue I.C, of NLEX. An elevated Structure would be recommended in this section.



Source: JICA Study Team

Figure 6.2-40 Existing Cross Section of NLEX

However, it would be necessary to occupy 2 lanes during construction. Furthermore, the carriageway width is not enough to maintain 4 operational lanes on both sides for traffic after construction of the AER elevated structure. This would lead to severe road congestion due to the high traffic volume in to NCR from the North Luzon areas..



During Construction of AER | After Construction of AER

Source: JICA Study Team

Figure 6.2-41 Expected Temporary/ Permanent Structures on NLEX

③ Environmental Conditions

A comparison and evaluation of environmental condition for each option in the secondary screening is shown in Table 6.2-37.

Table 6.2-37 Comparison of Environmental Conditions

		Option A	Option B	Option C	Option D
Construction Phase	Outside of Manila	<Zone3> • Air Pollution* • Noise and Vibration* • Traffic Congestion*	<Zone3> • Same as Option A	<Zone3> • Air Pollution • Noise and Vibration • Traffic Congestion	<Zone3> • Same as Option A
		<Zone2> • Air Pollution* • Noise and Vibration* • Turbid water diffusion in swamp & fish pond*	<Zone2> • Same as Option A	<Zone2> • Air Pollution • Noise and Vibration • Turbid water diffusion in swamp & fish pond	<Zone2> • Same as Option A
		<Zone1> • Air Pollution • Noise and Vibration • Traffic Congestion	<Zone1> • Air Pollution* • Noise and Vibration* • Traffic Congestion*	<Zone1> • Air Pollution • Noise and Vibration • Traffic Congestion • Historical heritage site	<Zone1> • Same as Option A
	Inside of Manila	<Viaduct Zone> • Air Pollution • Noise and Vibration • Traffic Congestion • Turbid water diffusion in Pasig River <Underground Tunnel> • Ground water • Subsistence, Waste soil	• Same as Option A	• Same as Option A	<Viaduct Zone> • Air Pollution • Noise and Vibration • Traffic Congestion • Turbid water diffusion in Pasig River <Underground Tunnel> • Same as Option A, but longer tunnel zone than Option A
Operation Phase	Outside of Manila	<Zone3> • Noise & Vibration*	<Zone3> • Same as Option A	<Zone3> • Noise & Vibration	<Zone3> • Same as Option A
		<Zone2> • Noise & Vibration*	<Zone2> • Same as Option A	<Zone2> • Noise & Vibration	<Zone2> • Same as Option A
		<Zone1> • Noise & Vibration	<Zone1> • Noise & Vibration*	<Zone1> • Same as Option A	<Zone1> • Same as Option A
	Inside of Manila	<Viaduct Zone> • Noise & Vibration • Shadows <Underground Tunnel> • Vibration • Change in groundwater vein, subsidence	• Same as Option A	• Same as Option A	<Viaduct Zone> • Same as Option A <Underground Tunnel> • Same as Option A, but longer tunnel zone than Option A
Score					

Note:* Less impact than Option C

Source: JICA Study Team

④ Passenger Demand

Detailed analysis of Passenger Demand is described in Chapter 5. Daily Passengers and evaluation score for each option in the secondary screening are summarized in Table 6.2-38.

Table 6.2-38 Comparison of Passenger Demand

	Option A	Option B	Option C	Option D
2020	257,100	173,100	291,200	325,500
2030	395,600	278,100	436,500	456,400
2040	548,800	457,500	597,900	615,500
Score				

Source: JICA Study Team

⑤ Approximate Project Implementation Cost

Approximate project implementation cost for each option in the secondary screening is shown in Table 6.2-39.

Table 6.2-39 Approximate Project Implementation Cost

Unit: Mil USD

			Option A	Option B	Option C	Option D
Civil	Elevated Structures	Quantity	89.6km 15 stations	94.6km 17 stations	91.3km 15 stations	85.7km 14stations
		Cost	2,750	3,059	2,320	2,579
	Underground Structures	Quantity	11.5km 4 stations	11.5km 4 stations	12.5km 4 stations	18.5km 7 stations
		Cost	713	737	791	1,043
	Depot & Workshop	Quantity	38.5ha	37.8ha	39.2ha	38.8ha
		Cost	257	253	261	259
	Sub Total	Quantity	101.1km 19 stations	106.1km 21 stations	103.8km 19 stations	104.2km 21 stations
		Cost	3,720	4,049	3,372	3,881
E&M System			1,761	1,845	1,788	1,832
Rolling Stock			632	524	712	652
Grand Total			6,113	6,418	5,872	6,365
		Score				
O&M Cost per Year			167	174	171	174
		Score				

Note; Costs exclude Utility Relocation, Land Acquisition, Consultant Service, Price Escalation, Contingency and TAX

Source: JICA Study Team

5) Evaluation Result

The evaluation result is shown in Table 6.2-40. Options A and C Route plans were recommended by the JST.

Table 6.2-40 Evaluation Result for Pre-selected Routes

Evaluation Item	Option A	Option B	Option C	Option D
Land Acquisition and Resettlement				
Construction Workability				
Environmental Conditions				
Passenger Demand				
Project Imprementation Cost				
O&M Cost				

Legend

: Good/ no significant issues

: No serious obstacles

: With critical obstacles or concerns

Source: JICA Study Team

Table 6.2-41 Comparative Analysis of Alternative Options

Items \ Alternatives	Option A NLEX (Burol to CIA) and PNR Route (Burol to NAIA)	Option B NLEX and North Ave to Quezon Ave and PNR Route	Option C PNR Route	Option D NLEX (Burol to CIA) and PNR/Makati/Global Route	Zero Option
Structures/stations	Elevated 89.6 km/ 15 stations Underground 11.5 km/4 stations	Elevated 94.6 km/ 17 stations Underground 11.5 km/4 stations	Elevated 91.3 km/ 15 stations Underground 11.5 km/4 stations	Elevated 85.7 km/ 14 stations Underground 18.5 km/7 stations	None
Future Land Development Potential	•Numerous housing and industrial development plans along the NLEX corridor. •Redevelopment/rejuvenation along old urbanized PNR areas in Metro Manila	•Numerous housing and industrial development plans along the NLEX corridor. •Conflict with the on-going development of urban & transport complex at Trinorma	•Future development should be planned outside the existing built-up areas in the provinces. •Redevelopment/rejuvenation along old urbanized PNR areas in Metro Manila	•Numerous housing and industrial development plans along the NLEX corridor. •Large-scale development is planned around southern terminal area	•There will be no railway for the development of the growth corridor.
Population along the corridor	•Less populated areas without direct access except Bulacan.	•Less populated areas without direct access in the provinces.	•Densely populated in the station towns in the provinces.	•Less populated areas without direct access except Bulacan.	•Population growth has been limited.
Passenger Demand (thousand @2040)	Daily total 548.8 (Commuter477.3+Express71.5) 90 pax/Mil USD	Daily total 457.5 (Commuter383.8+Express73.7) 71 pax/Mil USD	Daily total 597.9 (Commuter526.1+Express71.8) 102 pax/Mil USD	Daily total 615.5 (Commuter548.0+Express 67.5) 97 pax/Mil USD	No passengers
Construction workability	•Temporally limited lane for NLEX. Soft ground swamps. •Construction of elevated structure during PNR operation	•Limited lane and heavy traffic for NLEX. Soft ground swamps •Construction of elevated structure during PNR operation	•Erosion along rivers/creeks. Soft ground swamps. •Construction of elevated structure during PNR operation	•Temporally limited lane for NLEX. Soft ground swamps • Vertical twin tunnel is needed due to narrow ROW at Grobal City.	No construction
Project Implementation schedule	Outside of Manila 7.0 Years Inside of Manila 7.5 Years	Outside of Manila 7.5years Inside of Manila 7.0years	Outside of Manila 8.0years Inside of Manila 7.5years	Outside of Manila 7.0years Inside of Manila 8.0years	None
Project cost (Mil USD)	6,113	6,418	5,872	6,365	None
Operation cost (Mil USD/Year)	167	174	171	174	None
Resettlement (only for Track ROW)	2,550 families to be relocated (Outside city 1,000/Inside city 1,550)	3,000 families to be relocated (Outside city 950/Inside city 2,050)	3,250 families to be relocated (Outside city 1,700/Inside city 1,550)	1,250 families to be relocated (Outside city 1,000/Inside city 250)	No relocation
Environmental Condition	Noise and vibration: less than C Swampy area	Noise and vibration: less than C	Noise and vibration: large impact Swamp and fish ponds	Noise and vibration: less than C Groundwater interference: large	No impacts on natural environment
Overall evaluation and selected route (Table 6.2-40)	○Recommendable option •The project cost is less than Options B and D. •The number of affected families is smaller than Options B and C. •Contribute to the housing and industrial development plans along the NLEX corridor.	x Not recommendable option •The center 2 lanes of NLEX need to be closed due to installation of viaducts. This will cause traffic jams. •The project cost is the highest, thus the number of passengers per cost is the smallest among the alternative options.	○Recommendable option •The project cost is the lowest, thus the number of passengers per cost is the largest among the alternative options. •The number of affected families is the largest, but thousands of families had been already relocated by Northrail.	Δ Moderate option •Underground part is the longest so construction period is the longest inside of Metro Manila. •The risk of groundwater interference is higher than in the other options.	•Development of the transportation network in Clark-Manila growth corridor will not be accomplished.

Source: JICA Study Team

6.2.3 A Proposed Route Plan and Station Locations

A proposed route and station locations have been decided in the first JCC (Joint Coordination Committee) Meeting which was held on 10th December 2012.

Finally, Option C was selected by JCC but DOTC suggested that it is not necessary to connect to NAIA Airport.

Therefore, JST examined the Travel Demand Forecast, Travel Time and Economic Financials after the 1st JCC meeting to comply with following conditions.

1) Selected route plan is Option C

2) Selected Route is between EDSA and CIA (hereinafter referred as to the Selected Route)

3) The project will be implemented in 2 phases.

   First phase is between EDSA and Malolos, and opening year is 2020.

   Second phase is between Malolos and CIA, and opening year is 2025.

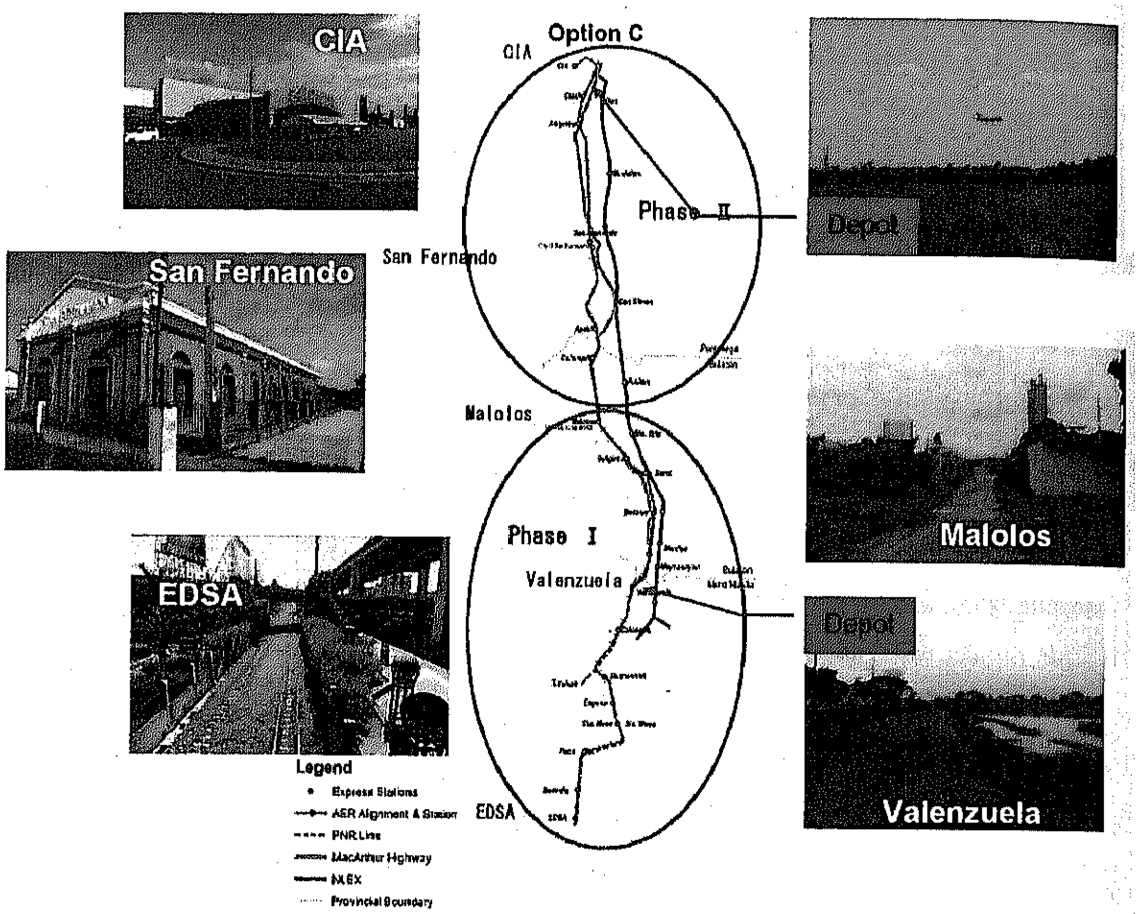
4) The project will not affect existing PNR operation. However, the JICA study team will recommend removal of the PNR line to avoid duplication of the commuter service.

5) Standard gauge (1,435mm) is adopted. However, the JICA study team will recommend narrow gage considering development of the rail network using the existing PNR line.

6) Train Operation of AER and PNR is not integrated. This means that there is no direct connection.

7) The possibility of expanding south bound is considered for future AER operation.

8) Train number, operation plan and economic and financial analysis shall be examined for the Years 2020, 2025, 2030 and 2040.



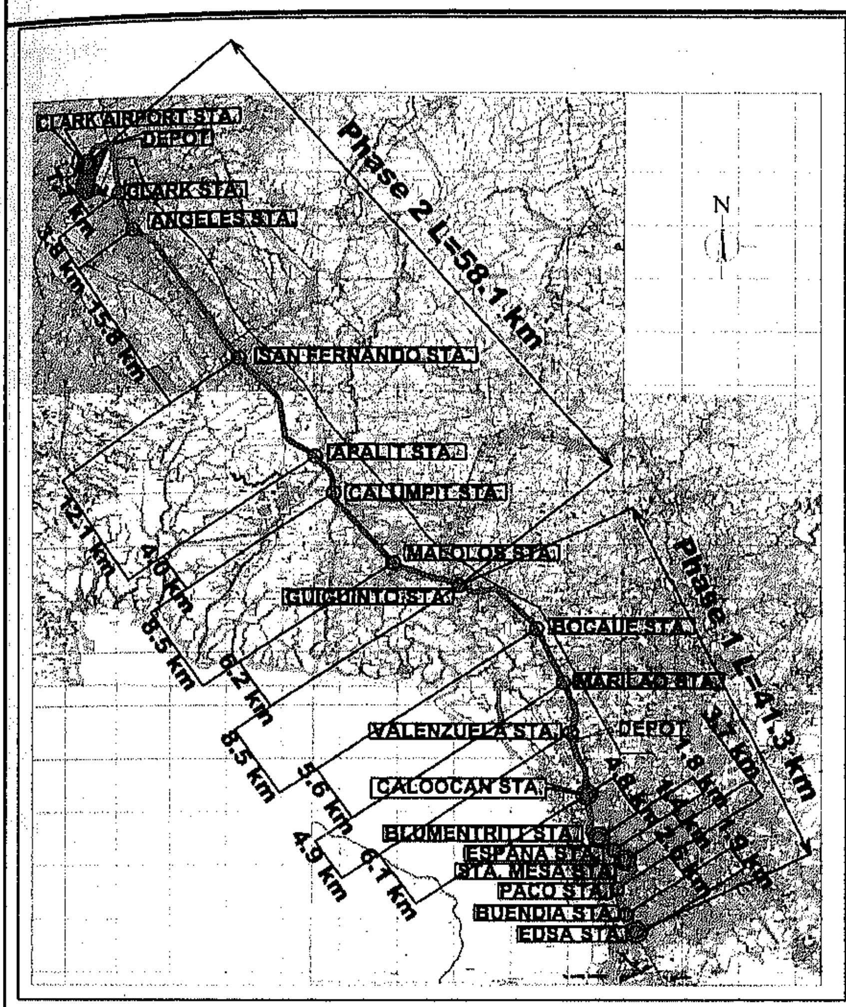
Source: JICA Study Team

Figure 6.2-42 Construction Phasing Plan

Route plan of selected route is shown below.

Stop stations for Express trains are CIA, BLUMENTRITT (for Interchange station of LRT1), EDSA (Interchange with MRT3).

Selected Route



STATION	Distance
CIA	7.7km
CLARK	3.8km
ANGELES	15.8km
SAN FERNANDO	12.1km
APALIT	4.0km
CALUMPIT	8.5km
MALOLOS	6.2km
GUIGUINTO	8.5km
BOCAUE	5.6km
MARILAO/ MEYCAUAYAN	4.9km
VALENZUELA	6.1km
CALOOCAN	4.8km
BLUMENTRITT	1.8km
ESPAÑA	1.4km
STA.MESA	3.7km
PACO	2.6km
BUENDIA	1.9km
EDSA	
Total Length	99.4km

Source: JICA Study Team

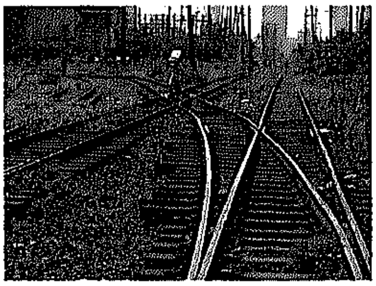
Figure 6.2-43 Route Plan and Stations of Selected Route

6.2.4 AER Operation and PNR Operation

If the PNR operation between Tutuban Sta. and EDSA Sta. could be closed before AER construction, supposed impact to the PNR and AER are described in this section.

1) Basic Planning Concept

- Competitive Section Area:
  PNR 2km (near Interchange point)～14km 200m (EDSA Station)
  Total length is Approximately 12.2km.
- Elevated structures are adopted for eliminating rail crossings for reduction of accidents and road congestion.
- Station of origin of PNR will be changed from Tutuban Sta. to EDSA Sta.



(a) Interchange Point

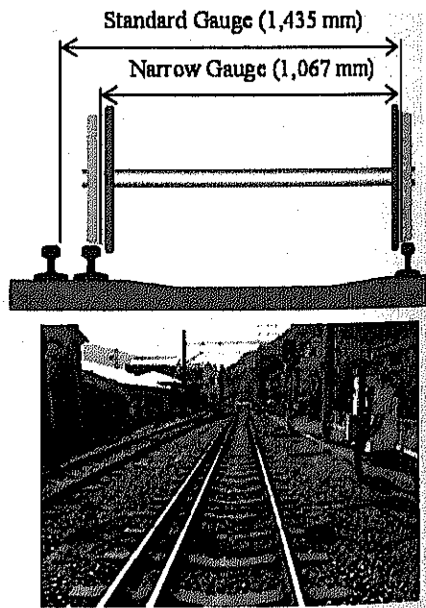
(b) PNR EDSA Station

Source: JICA Study Team

Figure 6.2-44 Photograph T-Junction and EDSA Sta.

2) Impact to the PNR

- It is necessary to construct a new Depot instead of Tutuban and Caloocan Depot before AER construction. The candidate for the new depot is in the vicinity of Calamba according to DOTC information.
- Tutuban Sta. will be closed.
- If PNR utilizes AER for the Caloocan Depot, the density of train operation will be increased and integration of the signaling systems is necessary. This condition is a negative impact to AER.
- If the track gauge of AER is Standard gauge (1,435mm), PNR (is narrow gauge 1,067mm) can go to Caloocan Depot on dual gauge (see Figure). Adoption of narrow gauge system for AER is recommendable in this case.

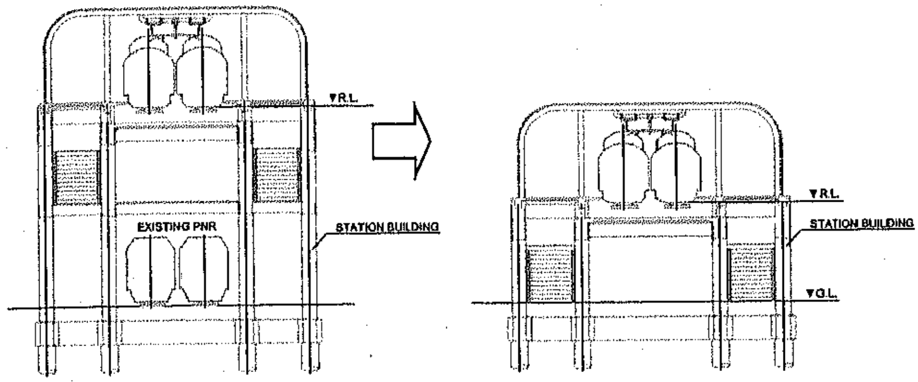


Source (Photo): Hakone Tozan Railway website

Figure 6.2-45 An Example of Dual Gauge

3) Impact to the AER

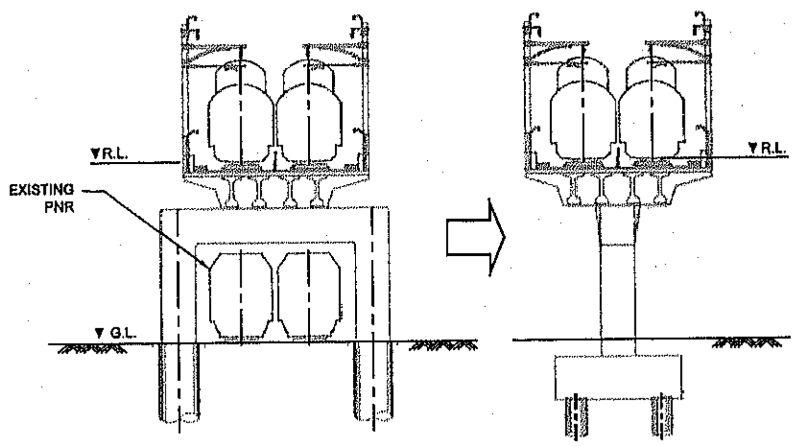
(1) The concourse level of the station can be at ground level, this means that the convenience of passengers can be increased and construction cost can be decreased.



Source: JICA Study Team

Figure 6.2-46 Station Building of AER

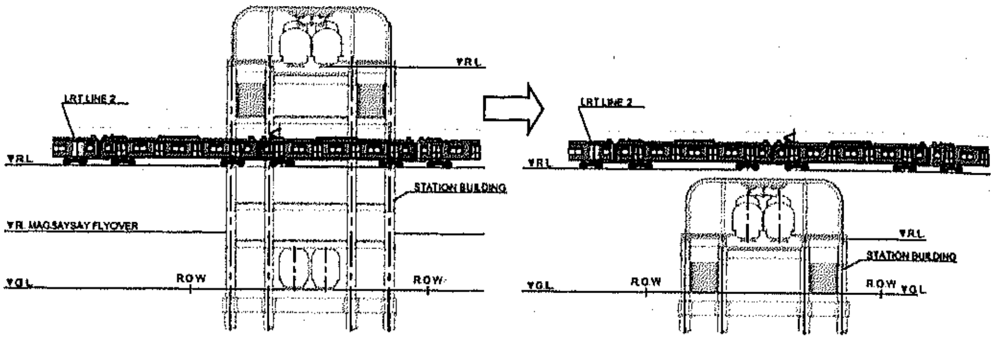
(2) Structure type of typical pier can be changed from portal type to T type pier, this means construction cost can be decreased.



Source: JICA Study Team

Figure 6.2-47 Typical Pier Section of AER

(3) AER will be planed under LRT2 line near Sta. Mesa Station.
In this case, the existing Magsaysay Bridge shall be demolished before AER construction
It is necessary to confirm the details of LRT2 and Magsaysay Bridge and examine a detour route to be used during demolishing of this bridge.



Source: JICA Study Team

Figure 6.2-48 Sta. Mesa Station of AER

Source Study on PPP Project Development of the Nlex-SkywaySlex Connector Road in Metro Manila

Figure 6.2-49 Photograph of Magsaysay Bridge and LRT2

Clearance between the rail top of PNR and bottom of Magsaysay Bridge is approximately 4.5m now. Necessity of minimum clearance for AER is 5.5m or more.
Another alternative case;

a. Lowering AER vertical alignment about 100cm from existing PNR rail level.
b. Rising road level of Magsaysay Bridge to provide clearance.
c. Planning Underground method of AER

Rail crossings cannot be closed in above cases a & b

4) Vertical Alignment of AER

There are 38 railway crossings between Caloocan and EDSA. Planning of vertical alignment shall take into consideration of eliminating rail crossings first.

Vertical alignment of some areas can be at grade for no rail crossing section, this means construction cost can be decreased.

5) Important Issues for Future Study

Railway network planning for AER and PNR including operation, alignment, rail gauge, location of depot, multiple operation etc. shall be discussed and decided between DOTC and PNR before the next Feasibility Study, because these matters are preconditions for the next Feasibility Study.

6.3 Train Operation Plan

The assumed train operation plans for each of the four pre-condition routes are compared for determining the best route that links between CIA and NAIA.

6.3.1 Operation Philosophy

The underlying operation philosophy is to make the AER system more attractive, comfortable and economical, the main features are given below:

- Transport services are Airport access Express and Commuter.
- Selecting the optimum frequency of Train Service to meet sectional capacity requirements during peak hours on most of the sections.
- An express train is composed of 8 cars and a Commuter train is composed of 10 cars.
- Maximum Running speed of Express trains is more than 160km/h.
- The service runs for 18 hours a day (6 AM to Midnight)

Table 6.3-1 shows a summary of the assumed train operation plan for each of the four pre-condition routes.

Table 6.3-1 Summary of the assumed Train Operation Plans

Pre-selected		Option A	Option B	Option C	Option D
Features of Operation Conditions					
Gauge (mm)		1,435			
Traction Energy supply		Overhead wire			
Route length (km)		101.1	106.1	103.8	104.2
Radius of limiting curve on main line (m)		300	300	300	300
Steepest gradient (‰)		30	30	30	30
Stations					
Number of stations		19	21	19	21
Interval Distance	longest (km)	10.2	10.2	15.8	10.2
	Shortest (km)	1.4	1.1	1.4	1.4
	Average (km)	5.6	5.3	5.8	5.2
Demand Forecast (PPHPD)					
2020	Express	800	300	800	800
	Commuter	7,100	6,100	8,600	7,000
2030	Express	1,600	600	1,500	1,500
	Commuter	11,100	9,800	12,900	11,200
2040	Express	2,900	2,900	2,900	2,700
	Commuter	14,900	14,000	16,000	15,000
Train plan					
Train composition	Express	8 Cars			
	Commuter	10 Cars			
Passenger capacity/ train	Express	400			
	Commuter	1,800			

Pre-selected			Option A	Option B	Option C	Option D
Operation plan						
Max running Speed (km/h)	Express	CIA-CALOOCAN/Valenzuela	160			
		CALOOCAN/Valenzuela-NAIA	80			
	Commuter	CIA-CALOOCAN/Valenzuela	120			
		CALOOCAN/Valenzuela-NAIA	80			
Travel Time (Min)		Express	76	87	79	80
		Commuter	110	120	113	116
Stop Time (Sec)		Express	60			
		Commuter	30			
MIN Turn-back time (Min)		Express	8			
		Commuter	6			
Train Operation						
Service hours			6:00-24:00 (18 Hours)			
Headway at Peak hours (Min)	2020	Express	30	60	30	30
		Commuter	15	15	12	15
	2030	Express	15	30	15	10
		Commuter	10	10	9	10
	2040	Express	8	8	8	9
		Commuter	7	8	7	7
Rolling Stock						
Train composition		Express	8 Cars			
		Commuter	10 Cars			
Required Train Sets	2020	Express	6	4	6	6
		Commuter	16	17	20	17
	2030	Express	16	12	11	14
		Commuter	26	24	27	24
	2040	Express	22	26	22	20
		Commuter	35	34	36	37

Source: JICA Study Team

6.3.2 Stations

Station plans for the 4 routes are shown below and details are given for each in Table 6.3-2.

Table 6.3-2 Summary of Station Plans

Pre-selected Option		Option A	Option B	Option C	Option D
Number of Stations		19	21	19	21
Route length (km)		101.1	106.1	103.8	104.2
Max Interval Distance (km)		10.2	10.2	15.8	10.2
Min Interval Distance (km)		1.4	1.1	1.4	1.4
Ave. Interval Distance (km)		5.6	5.3	5.8	5.2
Ave. Interval Distance (km)	Suburb of MANILA CIA-CALOOCAN/Valenzuela	7.3	6.9	7.6	7.6
	Within MANILA CALOOCAN/Valenzuela-NAIA	3.4	2.5	3.4	3

Source: JICA Study Team

Table 6.3-3 Station Plans of Pre-Selected Routes

Option A

Station	Interval Distance	Stopping Train Type	Remarks
CIA		Express/Commuter	Underground
DAU	8.3	Commuter	Elevated
SINDALAN	10.2	Commuter	Elevated
SAN FERNANDO	7.3	Commuter	Elevated
SAN SIMON	9.5	Commuter	Elevated
PULILAN	11	Commuter	Elevated
STA.RITA	6.8	Commuter	Elevated
BUROL	7	Commuter	Elevated
BOCAUE	3.8	Commuter	Elevated
MARILAO	5.5	Commuter	Elevated
VALENZUERA	5	Commuter	Elevated
CALOOCAN	6.1	Commuter	Elevated
BLUMENTRITT	4.8	Express/Commuter	Elevated
ESPANA	1.8	Commuter	Elevated
STA.MESA	1.4	Commuter	Elevated
PACO	3.7	Commuter	Elevated
BUENDIA	2.6	Commuter	Underground
EDSA	1.9	Express/Commuter	Underground
NAIA Ter.3	4.4	Express/Commuter	Underground

Total Length	101.1

Max Interval Distance	10.2
Min Interval Distance	1.4
Ave Interval Distance	5.6

Option B

Station	Interval Distance	Stopping Train Type	Remarks
CIA		Express/Commuter	Underground
DAU	8.3	Commuter	Elevated
SINDALAN	10.2	Commuter	Elevated
SAN FERNANDO	7.3	Commuter	Elevated
SAN SIMON	9.6	Commuter	Elevated
PULILAN	11	Commuter	Elevated
STA.RITA	6.7	Commuter	Elevated
BUROL	5.8	Commuter	Elevated
BOCAUE	5.2	Commuter	Elevated
MARILAO	4	Commuter	Elevated
MEYCAUAYAN	3.6	Commuter	Elevated
VALENZUELA	4.6	Commuter	Elevated
NORTH Ave	9.7	Express/Commuter	Elevated
CAPITOL	2.5	Commuter	Elevated
BANAVE Ave	2.4	Commuter	Elevated
ESPANA	1.6	Commuter	Elevated
STA.MESA	1.1	Commuter	Elevated
PACO	3.6	Commuter	Elevated
BUENDIA	2.7	Commuter	Underground
EDSA	1.9	Express/Commuter	Underground
NAIA Ter.3	4.4	Express/Commuter	Underground

Tatal Length	106.1

Max Interval Distance	10.2
Min Interval Distance	1.1
Ave Interval Distance	5.3

Option C

Station	Interval Distance	Stopping Train Type	Remarks
CIA		Express/Commuter	Underground
CLARK	7.7	Commuter	Elevated
ANGELES	3.8	Commuter	Elevated
SAN FERNANDO	15.8	Commuter	Elevated
APALIT	12.1	Commuter	Elevated
CALUMPIT	4	Commuter	Elevated
MALOLOS	8.5	Commuter	Elevated
GUIGUINTO	6.2	Commuter	Elevated
BOCAUE	8.5	Commuter	Elevated
MARILAO	5.6	Commuter	Elevated
VALENZUELA	4.9	Commuter	Elevated
CALOOCAN	6.1	Commuter	Elevated
BLUMENTRITT	4.8	Express/Commuter	Elevated
ESPANA	1.8	Commuter	Elevated
STA.MESA	1.4	Commuter	Elevated
PACO	3.7	Commuter	Elevated
BUENDIA	2.6	Commuter	Underground
EDSA	1.9	Express/Commuter	Underground
NAIA Ter.3	4.4	Express/Commuter	Underground

Tatal Length	103.8

Max Interval Distance	15.8
Min Interval Distance	1.4
Ave Interval Distance	5.8

Option D

Station	Interval Distance	Stopping Train Type	Remarks
CIA		Express/Commuter	Underground
DAU	8.3	Commuter	Elevated
SINDALAN	10.2	Commuter	Elevated
SAN FERNANDO	7.3	Commuter	Elevated
SAN SIMON	9.5	Commuter	Elevated
PULILAN	11	Commuter	Elevated
STA.RITA	6.8	Commuter	Elevated
BUROL	7	Commuter	Elevated
BOCAUE	3.8	Commuter	Elevated
MARILAO	5.5	Commuter	Elevated
VALENZUERA	5	Commuter	Elevated
CALOOCAN	6.1	Commuter	Elevated
BLUEMENRITT	4.8	Express/Commuter	Elevated
ESPANA	1.8	Commuter	Elevated
STA.MESA	1.4	Commuter	Elevated
CARMONA	4.3	Commuter	Underground
BUENDIA	1.8	Commuter	Underground
AYALA	1.4	Express/Commuter	Underground
LAWTON	2.7	Commuter	Underground
PGH	1.9	Commuter	Underground
NAIA Ter.3	3.6	Express/Commuter	Underground

Tatal Length	104.2

Max Interval Distance	10.2
Min Interval Distance	1.4
Ave Interval Distance	5.2

Source: JICA Study Team

6.3.3 Train Operation

1) Salient Features

- Service runs for 18 hours a day (6 AM to Midnight)
- Station dwell time of 30 seconds for commuter, 1 minute for express.
- Minimum turn-back time of 6 minutes for commuter, 8 minutes for express at terminal Stations.
- Maximum speed of express train is more than 160kph.
- An express train is composed 8 cars, and the Commuter train is 10 cars.

2) Traffic Demand

Station to station loading in peak hours on NAIA- CLARK Airport is tabulated hereunder:

Table 6.3-4 Maximum Traffic Volume (PPHPD)

Year	Alignment Option A		Alignment Option B		Alignment Option C		Alignment Option D	
	Commuter	Express	Commuter	Express	Commuter	Express	Commuter	Express
2020	7,100	800	6,100	300	8,600	800	7,000	800
2030	11,100	1,600	9,800	600	12,900	1,500	11,200	1,500
2040	14,900	2,900	14,000	2,900	16,000	2,900	15,000	2,700

Source: JICA Study Team

3) Train Formation

Salient Feature:

- Express train seats are all reserved before boarding by each passenger.
- Considering Passenger luggage and the long distance traveled, commuter train passenger capacity is flexible with standing riders at 4pax/m^2.

Table 6.3-5 Train Formation

Type	Express	Commuter
Cars of a train set	8 cars	10 cars
Seat Capacity	400	520
Passenger capacity	400	1800 (4 Pax/m^2)

Source: JICA Study Team

4) Approximate Travel Time and Schedule Speed

Approximate travel times are calculated from the estimation of average running speed. Average running speed of the Express is 120km/h from CIA to Caloocan or Valenzuela. Due to the alignment, option C average speed is reduced by 5km/h to 115km/h and it is 40km/h from Caloocan to NAIA. Commuter train average running speed is 80km/h from CIA to Caloocan or Valenzuela. Option C is 75km/h and it is

40km/h from Caloocan to NAIA. Scheduled speed includes stop time at stations. Calculation results reflect the difference in route length and the number of stations in each option route and the fastest is option A.

Table 6.3-6 Approximate Travel Time and Schedule Speed

Train Type	Option A		Option B	
Express	CIA-NAIA Ter.3 (101.1km)		CIA-NAIA Ter.3 (106.1km)	
	Traveling Time	Schedule Speed	Traveling Time	Schedule Speed
	76 min	*79.8 km/h*	*87 min*	*73.1 km/h*
	CIA - BLUMENTRITT (85.3km)		CIA - North.Ave (85.9km)	
	Traveling Time	Schedule Speed	Traveling Time	Schedule Speed
	49 min	104.4 km/h	54 min	95.4 km/h
	BLUMENTRITT - NAIA Ter.3 (15.8km)		North.Ave - NAIA Ter.3 (20.2km)	
	Traveling Time	Schedule Speed	Traveling Time	Schedule Speed
	27 min	35.1 km/h	33 min	36.7 km/h
Commuter	CIA-NAIA Ter.3 (101.1km)		CIA-NAIA Ter.3 (106.1km)	
	Traveling Time	Schedule Speed	Traveling Time	Schedule Speed
	110 min	*55.1 km/h*	*120 min*	*53 km/h*
	CIA - BLUMENTRITT (85.3km)		CIA - North.Ave (85.9km)	
	Traveling Time	Schedule Speed	Traveling Time	Schedule Speed
	81 min	63.1 km/h	83 min	62 km/h
	BLUMENTRITT - NAIA Ter.3 (15.8km)		North.Ave - NAIA Ter.3 (20.2km)	
	Traveling Time	Schedule Speed	Traveling Time	Schedule Speed
	29 min	32.6 km/h	37 min	32.7 km/h

Train Type	Option C		Optin D	
Express	CIA-NAIA Ter.3 (103.8)		CIA-NAIA Ter.3 (104.2km)	
	Traveling Time	Schedule Speed	Traveling Time	Schedule Speed
	79 min	*78.8 km/h*	*80 min*	*78.1 km/h*
	CIA - BLUMENTRITT (88km)		CIA - BLUMENTRITT (85.3km)	
	Traveling Time	Schedule Speed	Traveling Time	Schedule Speed
	52 nin	101.5 km/h	49 min	104.4 km/h
	BLUMENTRITT - NAIA Ter.3 (15.8km)		BLUMENTRITT - NAIA Ter.3 (18.9km)	
	Traveling Time	Schedule Speed	Traveling Time	Schedule Speed
	27 min	35.1 km/h	31 min	36.5 km/h
Commuter	CIA-NAIA Ter.3 (103.8)		CIA-NAIA Ter.3 (104.2km)	
	Traveling Time	Schedule Speed	Traveling Time	Schedule Speed
	113 min	*55.1 km/h*	*116 min*	*53.8 km/h*
	CIA - BLUMENTRITT (88km)		CIA - BLUMENTRITT (85.3km)	
	Traveling Time	Schedule Speed	Traveling Time	Schedule Speed
	84 min	62.8 km/h	81 min	63.1 km/h
	BLUMENTRITT - NAIA Ter.3 (15.8km)		BLUMENTRITT - NAIA Ter.3 (18.9km)	
	Traveling Time	Schedule Speed	Traveling Time	Schedule Speed
	29 min	32.6 km/h	35 min	32.4 km/h

Source: JICA Study Team

5) Train Frequency

Train frequencies that meet the need of the previous described traffic demand in each year are as follows:

Table 6.3-7 Train Frequency in Peak Hours in 2020

Option A						Option B					
Express			Commuter			Express			Commuter		
PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h
800	30	2	7,100	15	4	300	60	1	6,100	15	4

Option C						Option D					
Express			Commuter			Express			Commuter		
PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h
800	30	2	7,000	12	5	800	30	2	7,000	15	4

Source: JICA Study Team

Table 6.3-8 Train Frequency in Peak Hours in 2030

Option A						Option B					
Express			Commuter			Express			Commuter		
PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h
1,600	15	4	11,100	10.0	6	600	30	2	9,800	10	6

Option C						Option D					
Express			Commuter			Express			Commuter		
PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h
1,500	15	4	12,900	9.0	7	1,500	15	4	11,200	10	6

Source: JICA Study Team

Table 6.3-9 Train Frequency in Peak Hours in 2040

Option A						Option B					
Express			Commuter			Express			Commuter		
PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h
2,900	8.0	8	14,900	7.0	9	2,900	8.0	7	14,000	8.0	8

Option C						Option D					
Express			Commuter			Express			Commuter		
PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h	PPHPD	Headway	Trains/h
2,900	8.0	8	16,000	7.0	9	2,700	9.0	7	15,000	7.0	9

Source: JICA Study Team

6.3.4 Train Set Requirements for Each Year

1) Gross Train Set Requirements

The required train sets that meet the need of the train operation for each year are as follows:

Table 6.3-10 Gross Train Set Requirements for Express Trains

	Option A			Option B			Option C			Option D		
Year	2020	2030	2040	2020	2030	2040	2020	2030	2040	2020	2030	2040
Headway at Peak Hour (Min)	30	10	7.5	60	15	7.5	30	15	7.5	30	12	8.5
Turn-back Time (Min)	8	8	8	8	8	8	8	8	8	8	8	8
Required Rakes	*6*	*17*	*22*	*4*	*13*	*26*	*6*	*12*	*23*	*6*	*15*	*21*
Required cars	*48*	*136*	*176*	*32*	*104*	*208*	*48*	*96*	*184*	*48*	*120*	*168*

Source: JICA Study Team

Table 6.3-11 Gross Train Set Requirements for Commuter Trains

	Option A			Option B			Option C			Option D		
Year	2020	2030	2040	2020	2030	2040	2020	2030	2040	2020	2030	2040
Headway at Peak Hour (Min)	15	8.5	6.6	15	10	7.5	12	8.5	6.6	15	10	6.8
Turn-back Time (Min)	6	6	6	6	6	6	6	6	6	6	6	6
Required Rakes	*16*	*27*	*35*	*17*	*25*	*33*	*20*	*27*	*36*	*17*	*24*	*37*
Required cars	*160*	*270*	*350*	*170*	*250*	*330*	*200*	*270*	*360*	*170*	*240*	*370*

Source: JICA Study Team

2) Total Train Set Requirements

Spare train sets should be provided for inspection and temporarily each 1 set, therefore, total train set requirements for each year are as follows:

Table 6.3-12 Total Train Set Requirements for Express Trains

	Option A			Option B			Option C			Option D		
Year	2020	2030	2040	2020	2030	2040	2020	2030	2040	2020	2030	2040
Required Rakes	6	17	22	4	13	26	6	12	23	6	15	21
Spare for Inspection	1	1	1	1	1	1	1	1	1	1	1	1
Spare for temporarily	1	1	1	1	1	1	1	1	1	1	1	1
Total required Rakes	*8*	*19*	*24*	*6*	*15*	*28*	*8*	*14*	*25*	*8*	*17*	*23*
Total required cars	*64*	*152*	*192*	*48*	*120*	*224*	*64*	*112*	*200*	*64*	*136*	*184*

Source: JICA Study Team

Table 6.3-13 Total Train Set Requirements for Commuter Trains

	Option A			Option B			Option C			Option D		
Year	2020	2030	2040	2020	2030	2040	2020	2030	2040	2020	2030	2040
Required Rakes	16	27	35	17	25	33	20	27	36	17	24	37
Spare for Inspection	1	1	1	1	1	1	1	1	1	1	1	1
Spare for temporarily	1	1	1	1	1	1	1	1	1	1	1	1
Total required Rakes	*18*	*29*	*37*	*19*	*27*	*35*	*22*	*29*	*38*	*19*	*26*	*39*
Total required cars	*180*	*290*	*370*	*190*	*270*	*350*	*220*	*290*	*380*	*190*	*260*	*390*

Source: JICA Study Team

6.3.5 Train Operation of the Selected Route for Each Year

The option C was selected from 4 pre- selected routes as a result of the study. Selected section is between EDSA and CIA. The project will be implemented in 2 phases.

First phase is between EDSA and MALOLOS, and opening year is 2020.

Second phase is between MALOLOS and CIA, and opening year is 2025.

The opening year between EDSA and CIA is 2025.

Train operation plan was reexamined for the years 2020, 2025, 2030 and 2040.

1) Traffic Demand

The PPHPD of the selected route is shown below:

Table 6.3-14 Maximum Traffic Volume of the Selected Route (PPHPD)

PHASE 1:EDSA-MALOLOS

Year	2020	
Type	Express	Commuter
PPHPD		6,400

AFTER PHASE 2:EDSA-CIA

Year	2025		2030		2040	
Type	Express	Commuter	Express	Commuter	Express	Commuter
PPHPD	1,150	10,650	1,500	12,800	2,900	16,000

Source: JICA Study Team

2) Train Frequency

Train frequencies that meet the need of the demand at peak hours in each year are as follows:

Table 6.3-15 Train Frequency at Peak Hours for Each Year

PHASE 1: EDSA-MALOLOS

Year	2020	
Type	Express	Commuter
PPHPD		6,400
Trains/1H		4
Headway (min)		15

AFTER PHASE 2:EDSA-CIA

Year	2025		2030		2040	
Type	Express	Commuter	Express	Commuter	Express	Commuter
PPHPD	1,150	10,650	1,500	12,800	2,900	16,000
Trains/1H	3	6	4	7	7	9
Headway (min)	20	10	15	8.5	8.5	7

Source: JICA Study Team

3) Approximate Travel Time and Schedule Speed

Approximate travel times are estimated by simulation of the hypothetical train running. The results and performance of the Rolling stock are as follows:

Table 6.3-16 Approximate Travel Time and Schedule Speed

PHASE1:EDSA-MALOLOS

Type	Travelling Time(min)	Scheduled Speed (km/h)
Commuter	48	59.3

AFTER PHASE 2:EDSA-CIA

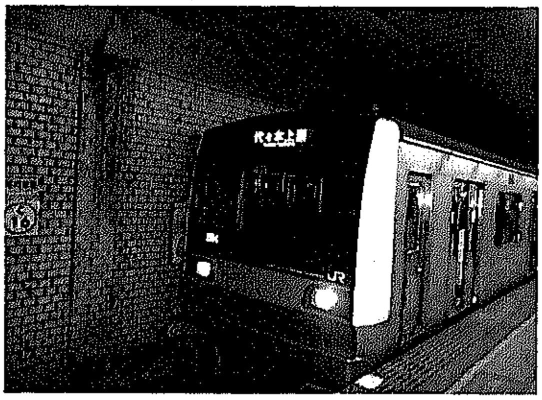
Type	Travelling Time(min)	Scheduled Speed (km/h)
Commuter	86	69.3
Express	56	106.5

Source: JICA Study Team

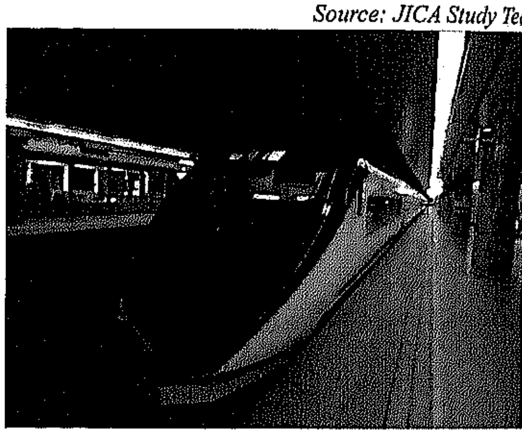
Table 6.3-17 Main Performance of the Hypothetical Rolling Stocks

Type	Maximum Speed(km/h) CIA- CALOOCAN ※CALOOCAN- EDSA :80km/h	Acceleration (km/h/s)	Deceleration (km/h/s)
Commuter	120	3.3	4.7
Express	160	2.0	4.0

Source: JICA Study Team



(1) Example of Commuter Type



(2) Example of Express Type

Source: JICA Study Team

Figure 6.3-1 Examples of the Hypothetical Rolling Stocks

4) Approximate Train Set Requirements for Each Year

The required train sets that meet the need of train operation each year are follows:

Table 6.3-18 Train Set Requirements

PHASE 1:EDSA-MALOLOS

Year	2020	
Train type	Express	Commuter
Train sets		6
Resreve		2
Total		8

AFTER PHASE 2:EDSA-CIA

Year	2025		2030		2040	
Train type	Express	Commuter	Express	Commuter	Express	Commuter
Train sets	6	18	8	21	15	27
Resreve	2	2	2	2	2	3
Total	8	20	10	23	17	30

Source: JICA Study Team

5) Approximate Daily Train Operation Plan for Each Year

(1) Daily Traffic Volume

The daily traffic volumes of the selected route are shown below:

Table 6.3-19 Daily Traffic Volumes of The Selected Route

PHASE 1:EDSA-MALOLOS

Yea	2020	
Train Type	Express	Commuter
Total		237,700
Oneway (Southbound)		118,500

AFTER PHASE 2:EDSA-CIA

Yea	2025		2030		2040	
Train Type	Express	Commuter	Express	Commuter	Express	Commuter
Total	29,950	330,700	38,300	396,400	71,100	518,200
Oneway (Southbound)	14,950	164,950	19,600	197,300	36,200	257,500

Source: JICA Study Team

(2) Approximate Daily Train Operation Plan

The required daily train operation plans that meet the need of traffic volume each year are as follows.

Three time periods are considered as peak hours, semi-peak hours, and off peak hours.

- Peak :7:00AM-9:00AM
  6:00PM-9:00PM
- Semi-peak : 6:00AM-7:00AM
  10:00AM-0:00PM
  4:00PM-6:00PM
  9:00PM-10:00PM
- Off peak :0:00PM-4:00PM
  :10:00PM-0:00AM

Table 6.3-20 Approximate Daily Train Operation Plan

PHASE 1:EDSA-MALOLOS

Year	2020	
Train Type	Express	Commuter
Hour		
6:00~6:59		4
7:00~7:59		4
8:00~8:59		4
9:00~9:59		4
10:00~10:59		4
11:00~11:59		4
12:00~12:59		4
13:00~13:59		4
14:00~14:59		4
15:00~15:59		4
16:00~16:59		4
17:00~17:59		4
18:00~18:59		4
19:00~19:59		4
20:00~20:59		4
21:00~21:59		4
22:00~22:59		4
23:00~23:59		4
South bound		72
Bouth		144

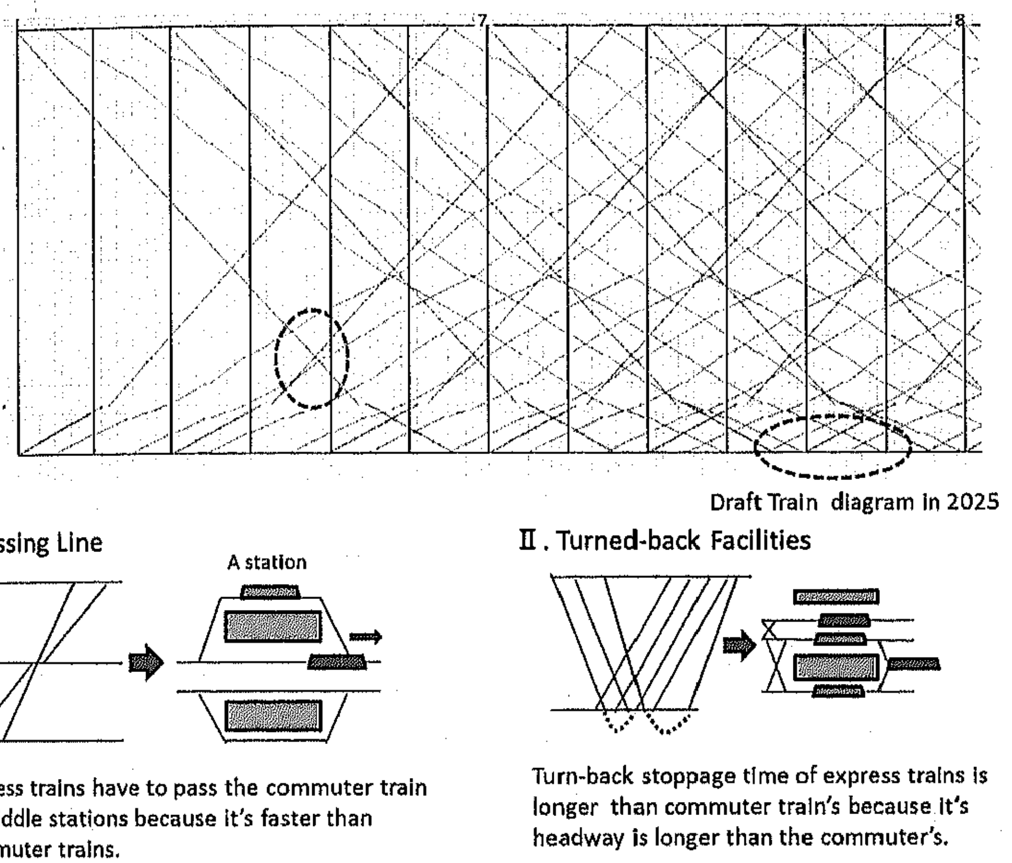
AFTER PHASE 2:EDSA-CIA

Year	2025		2030		2040	
Train Type	Express	Commuter	Express	Commuter	Express	Commuter
Hour						
6:00~6:59	2	5	3	6	5	9
7:00~7:59	3	6	4	7	8	9
8:00~8:59	3	6	4	7	8	9
9:00~9:59	3	6	4	7	8	9
10:00~10:59	2	5	3	6	5	9
11:00~11:59	2	5	3	6	5	9
12:00~12:59	2	5	2	5	3	7
13:00~13:59	2	5	2	5	3	7
14:00~14:59	2	5	2	5	3	7
15:00~15:59	2	5	2	5	3	7
16:00~16:59	2	5	3	6	5	9
17:00~17:59	2	5	3	6	5	9
18:00~18:59	3	6	4	7	8	9
19:00~19:59	3	6	4	7	8	9
20:00~20:59	3	6	4	7	8	9
21:00~21:59	2	5	3	6	5	9
22:00~22:59	2	5	2	5	3	7
23:00~23:59	2	5	2	5	3	7
South bound	42	96	54	108	96	150
Bouth	82	192	108	216	192	300

Source: JICA Study Team

6) Issues concerning the Preparation of the Train Operation Plan

The AER will do mixed train operations both for Commuter trains and limited express trains. It is hard to design a train operation plan, especially for the morning and evening rush hours. It is necessary to consider facilities to pass and turn-back for limited express trains because running speed and headway are different from each other. In the next stage F/S, it will be necessary to examine this deeply.



Source: JICA Study Team

Figure 6.3-2 Example of Required Facilities for Mixed Train Operation

6.4 Rolling Stock

6.4.1 General

The main features which decide a rolling stock plan are gauge, passenger capacity, train formation, body size and materials. There are many factors which should be considered to formulate rolling stock features and specifications. Some of the important items are presented below.

- Characteristics of Railway Line
  - Role of the line: Commuter/ Intercity/ Express/ Airport express/ High speed rail
  - Passenger demand volume
  - Alignment of route: Minimum curve radius/ Maximum gradient
- Sub-Systems Related
  - Track gauge
  - Construction gauge
  - Power supply system: AC/ DC, Voltage level, OHC/ Third rail
  - Signaling & communication systems
- Standards & Regulations

6.4.2 Difference in Requirements for Rolling Stock between Commuter Trains and Airport Express trains

In the study on the Clark-Manila airport line, two types of trains; airport express and commuter type; are planned. The requirements for each type of rolling stock are different.

An airport express should be designed to provide privileged service to passengers using an airport that corresponds to extra fees. On the other hand, it is necessary that a commuter train provide convenient inexpensive transport to mass passengers.

The requirements for each type of rolling stock are given in Table 6.4-1

Table 6.4-1 Requirements for Each Type of Rolling Stock

Type	Commuter	Airport express
Concept	Convenient to mass passengers	Comfortable to privileged passengers
Running performance	Adequate speed & High acceleration ratio	Higher speed over 130km/h
Passenger capacity	High capacity	Adequate capacity for all-seating service
Doorways	Arrangement: 3~5 doorways on each side of a car Type: double sliding doors, 1300mm width or wider	Arrangement: 1~2 doorways on each side of a car Type: Single sliding door, about 900 mm width
Seats	Longitudinal seats alongside a window	2 reclining seat-sets each side of an aisle
Special Facilities		Baggage space & Lavatories are vital

Source: JICA Study Team

6.4.3 Passenger Capacity and Body Length, Width, train Configuration.

Body length, width and train configuration reflect passenger capacity and influence construction gauge. In the study on the Clark-Manila airport line, the passenger capacity, 1800 pax for a commuter train and 400 pax for an airport express, is required by the railway plan based on the demand forecast. Table 6.4-2 shows passenger capacity of some typical body types.

Table 6.4-2 Body Size & Passenger Capacity of Commuter Trains

Body type	Long & Wide (LRT-Line 2 base)	Standard	Narrow	Short & Narrow
Car body size (mm) Length×Width	23300×3200	20000×2950	2000×2800	18000×2800
Cars in a train set	8 cars	10 cars	10 cars	10 cars
Train length (m)	187m	200m	200m	180m
Seat capacity	480	520	520	500
Passenger Capacity AW2:4 pax/m2	1600	1800	1700	1500
AW3:7 pax/m2	3300	2800	2650	2300
Train formation	All Motor cars	6 motor cars & 4 trailers	6 motor cars & 4 trailers	6 motor cars & 4 trailers

Note: Actual figures differ according to seat layout and whether there are wheel chair spaces/ lavatories or not.

Source: JICA Study Team

A part of the lines inside of Metro Manila is planned to be constructed underground and have smaller radius curves than 400m. Wider and longer body size would have disadvantages in construction and operation on tight curves. Besides, Long & Wide car body trains can accommodate so many passengers that the heavier weight of the train requires all motor cars formation, resulting in higher cost for rolling stock and civil construction cost. Therefore, a train set composed of long & wide cars is not suitable for this project. Considering these things, the Standard type (20000mm x 2950mm x 10cars) should be selected.

In this project both airport expresses and commuter trains are operating through the Metro Manila area to the Clark airport on the same line so the body width of both types should be the same. Moreover, considering maintenance facilities, the body length of both types should be same. Based on these conditions and the requirements of Table 6.4-1, average passenger capacity per car will be approx. 50 and 8 car train-sets are suitable to accommodate 400 passengers.

6.4.4 Body Materials

Materials which are generally used for rolling stock are steel, stainless steel or aluminum alloy. Table 6.4-3 shows a comparison of body materials.

Table 6.4-3 Comparison of Body Materials

Materials	Steel	Stainless steel	Aluminum alloy
Density (g/cm3)	around 8	around 8	around 3
Tractive strength	High	High	Low
Surface hardness	Low	High	Low
Welding technology	Easy	Difficult	Most difficult
Reparability in case of accident	Easy	Difficult	Almost irreparable
Corrosion resistance	Low	High	High
Painting	Needed	Not needed	Not needed
Manufacturing complex design	Possible	Impossible, use F.R.P if necessary	Possible
Cost	Low	Expensive	Most expensive

Source: JICA Study Team

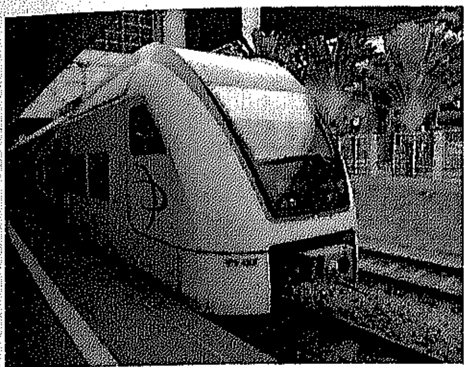
Stainless steel cars do not need to be designed with extra initial strength to allow for the decline in strength due to corrosion, so the weight of a car made of stainless is much lighter than that of steel body. In addition, Japanese technology in this field is very superior. Further, the surface of a stainless steel body is harder, this contributes to damage resistance. As its name indicates, stainless steel doesn't corrode. Stainless steel does not need painting, contributing to maintenance reduction. A disadvantage of stainless steel is the difficulty in manufacturing complex designs. If such a complex design is necessary, fiber reinforced plastics (FRP) should be used.

Though aluminum alloy is lighter than stainless steel, the surface is soft and easy to be damaged. Moreover, the welding technology of aluminum alloy is the most difficult of these three materials.

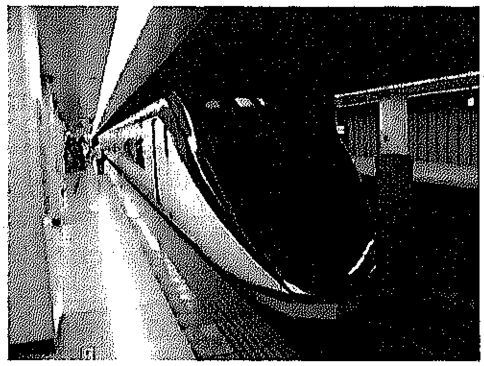
The most recent practice is that most commuter train bodies are made of stainless or aluminum alloy and almost all high speed trains, the maximum speed of which is over 300km/h, use aluminum alloy.

Some examples of airport express in Asia are shown in Figure 6.4-1. All of their materials are aluminum alloy.

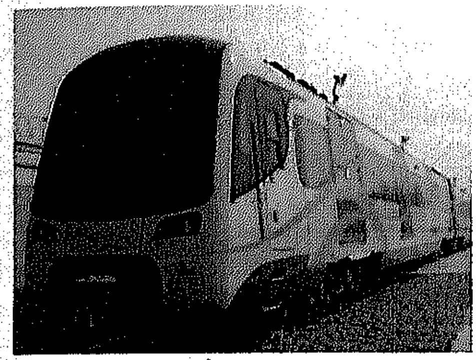
The body material should be selected considering these advantages and disadvantages including cost.



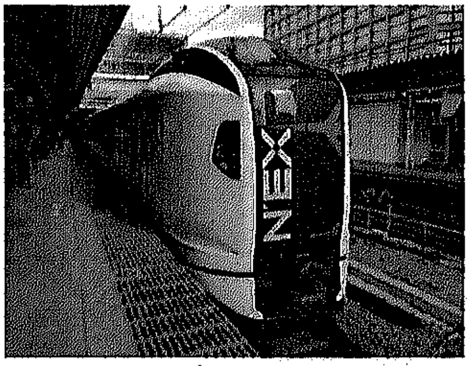
Malaysia : Kua-la Lum-pur
KLIA express : 160km/h



Japan : Narita
Keisei Sky-liner : 160km/h



India : Delhi
Airport express : 120km/h



Japan : Narita
Narita express : 130km/h

Source: JICA Study Team

Figure 6.4-1 Examples of Airport Express in Asia

6.4.5 Main Specifications

Considering the characteristics described above, specifications of rolling stock should be decided. Table 6.4-4 shows one example of main specifications recommended in this project and some major items are explained below.

Table 6.4-4 Main Specifications of Rolling Stock

Item		Commuter	Airport express
Train Formation *Tc: Trailer car with driver's cab *M: Motor car *T: Trailer car		EMU: 10 cars, 6M4T Tc+M+M+T+M+ M+T+M+M+Tc	EMU:8 cars, 6M2T Tc+M+M+M+M+M+M+Tc
Major dimensions	Leading car length	20000 mm	21000 mm
	Intermediate car length	20000 mm	20000 mm
	Body width	2950 mm	2950 mm
Passenger capacity per train	Seat	Approx. 520	Approx. 370
	Aw (4 pax. /m2)	Approx. 1800	No standing passenger
Weight per train (Tare)		Approx. 320t	Approx. 310t

Item		Commuter	Airport express
Body materials		Light weight stainless steel / Aluminum alloy	Aluminum alloy
Saloon design	Doorways	4 doorways each side of a car	2 doorways each side of a car
	Door type	Double sliding doors, 1300mm width	Single sliding doors, 950 mm width
	Seat type	Longitudinal seat	2 reclining seat-sets
Special facilities	Lavatory	2 lavatories per a train set	3 lavatories per a train set
	Baggage space	Not equipped	On a side of each doorways
Maximum operation speed		120 km/h	160km/h
Traffic performance	Acceleration	3.3 km/h/s	2.0 km/h/s
	Deceleration (Service/Emergency)	Service: 4.7 km/h/s Emergency:4.7 km/h/s	Service: 4.5 km/h/s Emergency: 5.2 km/h/s
Propulsion system	Power collector	DC 1500 V/ AC 25kV Single-arm pantograph 3 units per a train-set	DC 1500 V/AC25kV Single-arm pantograph 2 units per a train-set
	Control system	VVVF inverter with IGBT elements	
		6 sets per a train set	6 sets per a train set
	Traction motor	3-phased induction motors	
		120kw X 24 units	180kw X 24 units
Brake control system		All electric command electro-pneumatic brakes	
Bogies		Bolster-less type	
Air conditioning equipment		On roof type	Under floor type
Auxiliary power supply equipment		SIV: 3-phase inverter with IGBT element 2 units per a train set	
Passenger information system		Public address system via loudspeakers Visual information system via LCD screens	

Note: Actual figures differ according to seat layout and whether there are wheel chair spaces/ lavatories or not.

Source: JICA Study Team

1) Car Body Structure and Interior Furnishing

- Airport Express

Airport expresses operate at a speed over 130 km/h so an airtight structure which protects passengers from discomfort in the ears when the train enters into a tunnel at high speed is desirable. Train's weight and running resistance influence energy consumption of train operation. Therefore, light weight body and aerodynamic design of front shape are desirable. That is why aluminum alloy should be selected for the body material.

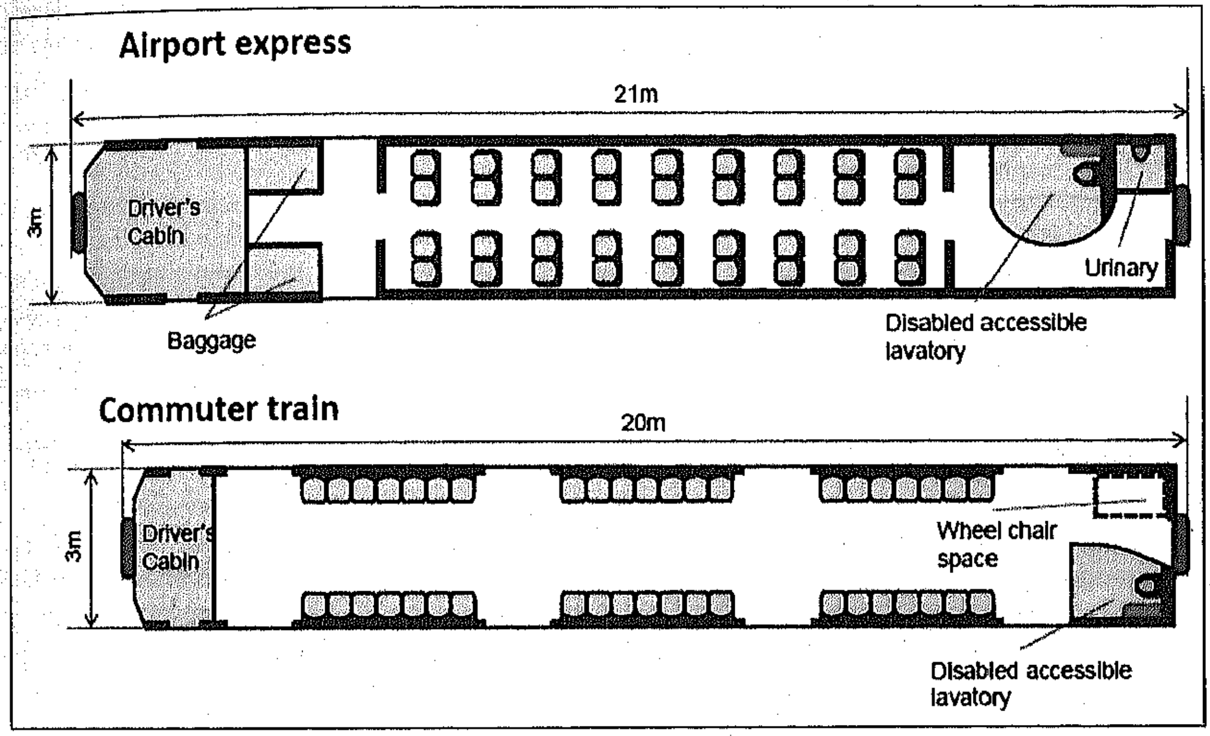
Regarding interior design of the car, 2 reclining seat-sets are located each side of an aisle and standing passengers should not be acceptable. A train set is composed of 8 cars so as to accommodate more or less 400 pax and train-formation is 6 motor cars and 2 trailers with driver's cab. Baggage spaces are equipped on both ends of each car alongside the doorways (except one car which has a wheelchair-accessible lavatory). Each train set has a large wheelchair-accessible lavatory, two standard lavatories and three urinals.

- Commuter

Commuter trains don't operate at a high speed but stop more times than the airport express. Higher acceleration and deceleration performance is required, so a light weight body is important. Light-weight stainless body as well as aluminum alloy is acceptable to the requirement. Body size, 20000mm×2950mm×10cars, should be selected according to '6.4.3 Passenger Capacity and Body Length, Width, train Configuration.'. Train-formation is 6 motor cars and 4 trailer cars, 2 of which are with driver cabs.

Regarding interior design of the car, 4 doorways are located on each side of a car and the door type is double sliding doors so as to allow passengers to get on/off smoothly. Each train set has a large wheelchair-accessible lavatory and a standard lavatory on both leading cars.

Typical layouts of each type are shown in Figure 6.4-2.



Source: JICA Study Team

Figure 6.4-2 Typical layouts of Airport Express and Commuter Trains

2) Bogies

There are two bogie types in recent heavy rail systems. The first type has a bolster, the center beam that supports the body weight and can rotate around a center pin of the bogie frame. This enables a car to rotate through the way the bolster rotates around the center pin. The latter which doesn't have a bolster, is called the bolsterless type.

A bolsterless bogie supports the body weight with air suspension directly mounted on the bogie frame and this enables it to absorb the car body rotation as deflection and twist of the air suspension. A bolsterless type should be proposed as long as minimum curve radius is above 200m because it is a simple structure, light weight and low maintenance.

3) Traction System

The traction system is composed of power collectors, power control systems and traction motors. Two motor cars of a train-set should compose a functional unit and complement each other. Technology of the traction system is ever-improving. The system which is most suited among the state of the art technologies should be adopted.

- Power Collector
  DC 1500V or AC 25kV Overhead catenary system is selected for the Power supply system, thus a power collector would be a single-arm pantograph and they should be mounted on the roofs of each unit.

- Power Control System
  Currently, the VVVF- PWM inverter system employing IGBT elements is the main stream of Power control systems. This type should be adopted. One inverter, which controls four traction motors, is mounted on each motor car, ensuring redundancy for operation.
  *VVVF: Variable Voltage Variable Frequency
  *PWM : Pulse Width Modulation
  *IGBT : Insulated Gate Bipolar Transistor

- Traction Motors
  Induction motors are predominant for the traction motor of rolling stock. It is lighter, stronger, higher efficiency and lower maintenance than a direct current motor because they don't have a commuter. Induction motors should be adopted and especially an enclosed type is preferable because sweeping in the motor is unnecessary.

4) Braking System

The braking system should be an electric command electro-pneumatic braking system. The propulsion equipment provides regenerative braking and a pneumatic friction brake system adds brake power to a regenerative brake at high speeds and final stopping and provides fail-safe emergency braking. It performs electro-pneumatic calculations to ensure the proper functioning of the air supplement control for the trailers and increases the efficiency of the regenerative braking system.

5) Air-Conditioning System

Air conditioning is one of the most important facilities which contribute to passenger comfort. It consists of 4 functions, cooling, heating, drying and ventilation. The climate around Manila is so hot and high humidity that cooling and drying functions are especially important. The capacities are determined through calculations based on climate conditions and passenger capacity so as to provide comfortable conditions such as not over 28 degrees Celsius and less than 60% relative humidity. In the case of an express type they could be mounted under the frames. However, in the case of a commuter type, they will need to be mounted on the roofs because the capacity is much larger than those of an express type due to its larger passenger capacity. It is desirable that a driving cab module is provided separately.

Temperature and humidity sensors are fitted to each vehicle to facilitate optimum control over the atmospheric conditions. The control system operates automatically in accordance with the conditions detected from the sensors. The air-condition mode can be selected from a monitor screen, and the target temperature can be set as desired by the crew.

6) Passenger Information Systems

The passenger information systems consist of

- Public Address system, providing audible information via mounted loudspeakers.
- Visual information from the LCD screens, which are located in passenger cabins, thus permitting a view for all passengers.

The Public Address system includes a digital voice announcement to provide automatic transmission of information such as the next station name.
The LCD screens display general information and/or advertising media to passengers.

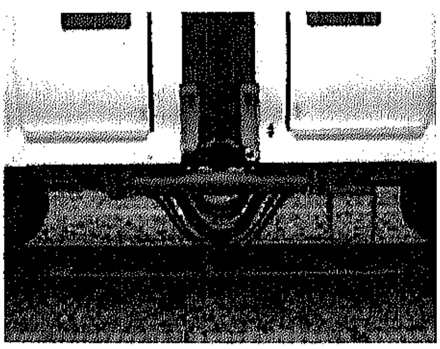
7) Special Equipment for an Express Train

As operation speed increases, more irregular movement of the rolling stock arises and the less comfortable passengers are. So it should be necessary to reduce vibration in case a train operates over 130km/h.

This movement consists of three factors, pitching, yawing and rolling. They are the movements of vertical, longitudinal and lateral respectively.

The damper installed on a bogie and between a bogie and a body reduces vertical movements. The yaw damper, mounted between the lower ends of the car bodies, is a shock absorber used to prevent excessive swaying from side to side. The anti-roll damper is also positioned between two car bodies but in a lateral position. These dampers have to control the relative rolling movement between car bodies.

Examples are shown in Figure 6.4-3.



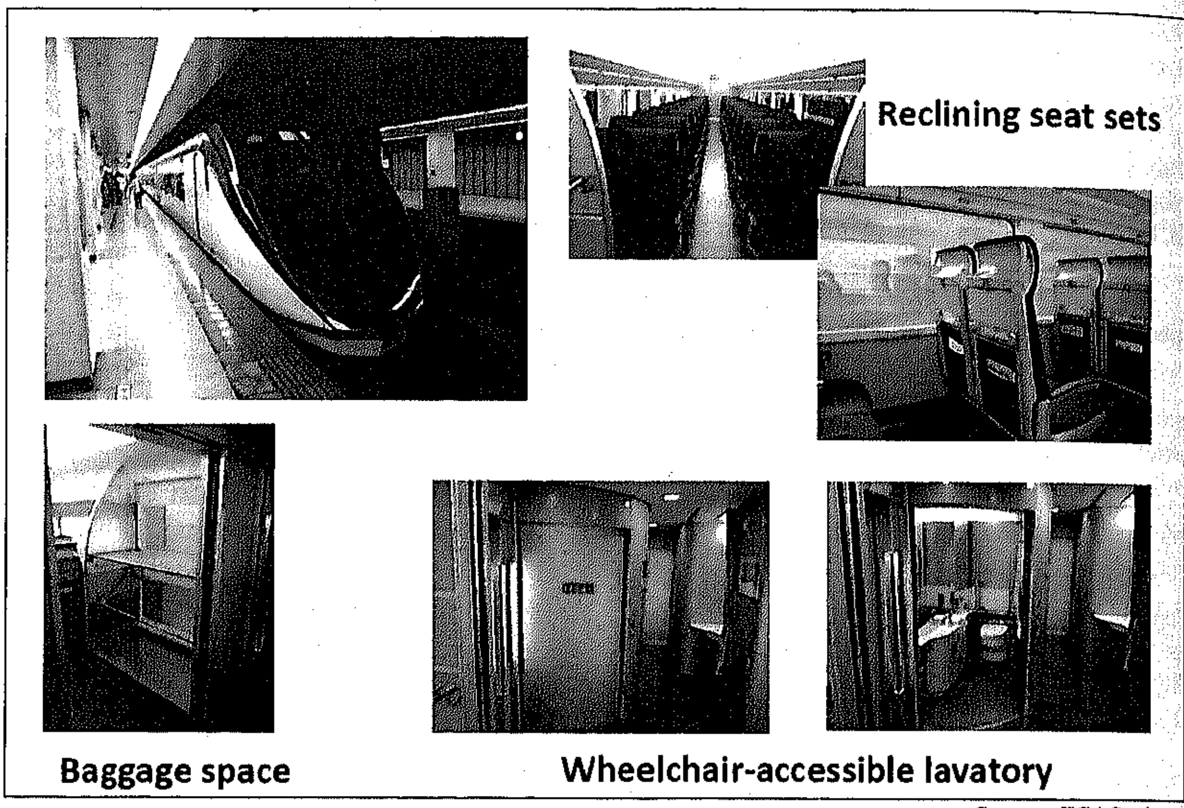
Yaw damper between cars

Anti-roll damper between cars

Source: JICA Study Team

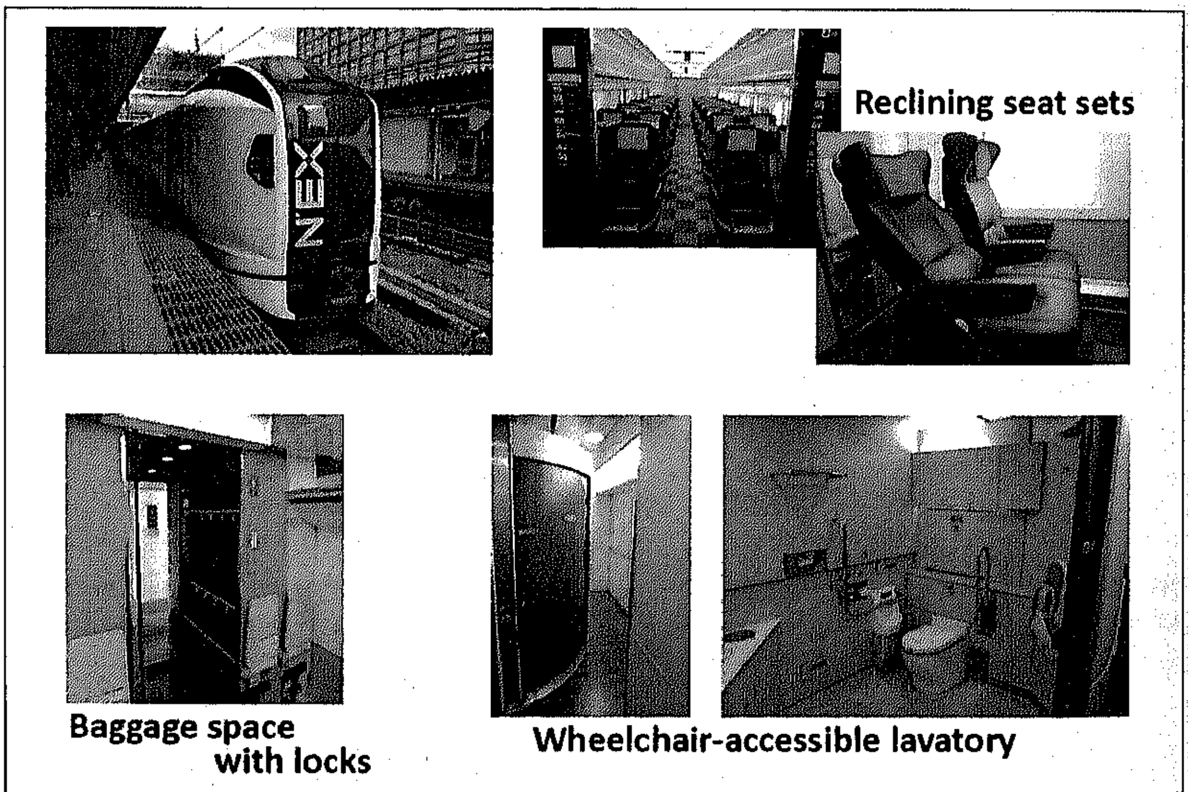
Figure 6.4-3 Equipment Reducing Irregular Movement

For reference, some pictures of airport express and commuter train in Japan are indicated in Figure 6.4-4, Figure 6.4-5and Figure 6.4-6.



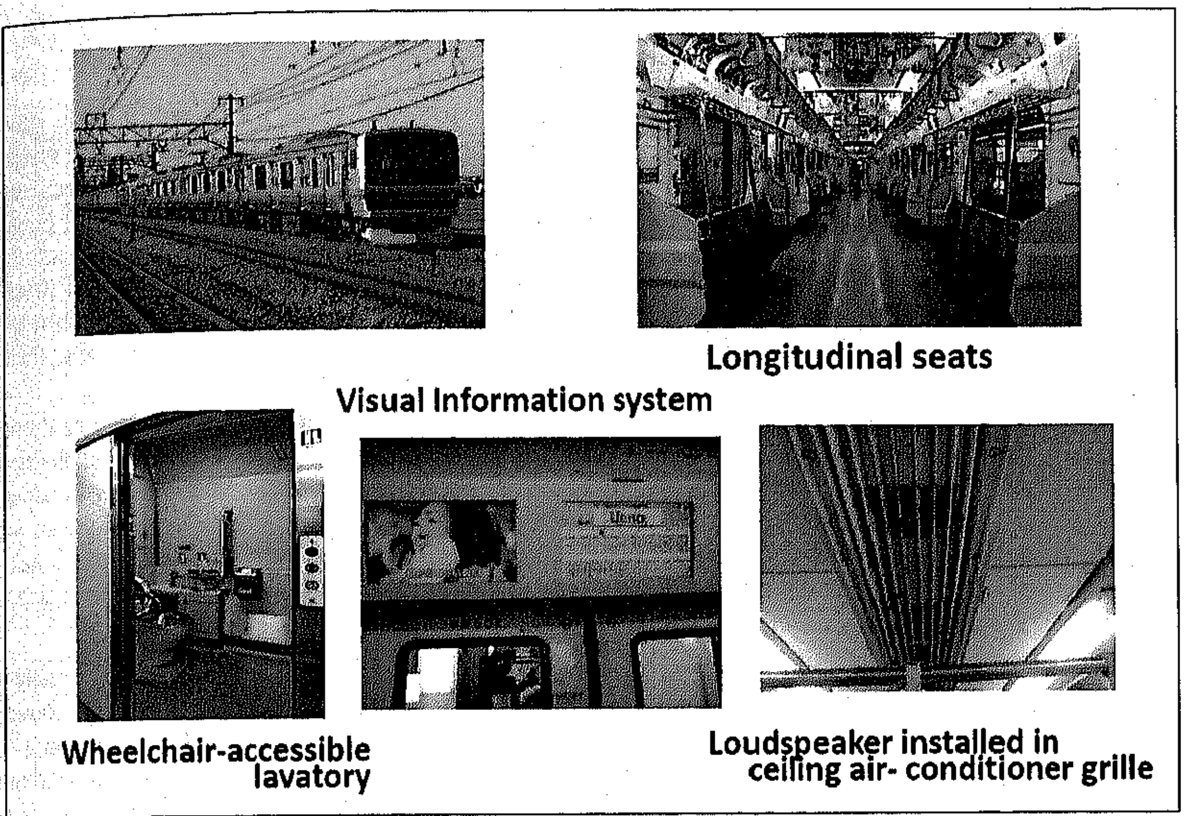
Source: JICA Study Team

Figure 6.4-4 An Example of Airport Express: Keisei Sky-Liner



Source: JICA Study Team

Figure 6.4-5 An Example of Airport Express: Narita Express, JR EAST



Source: JICA Study Team

Figure 6.4-6 An Example of Commuter Train: JR EAST

6.5 AER Fare System

The fare system of a public transport project is one of the important factors which will directly affect demand and revenue and consequently the feasibility of the project. Prior to setting the AER fare system, several analyses were made to obtain basic information for fare setting, such as (1) Fare for cost recovery, (2) AER user's benefit, (3) Fare for revenue maximization and (4) International comparison of public transport fares, as well as review of current public transport fare systems in the Philippines.

6.5.1 Current Fare of Public Transport Services

Current systems of public transport fare as of October 2012 in the MM and adjacent regions are as shown in Table 6.5-1. The fare of public transport in MM is a fixed amount for a certain distance of the first portion of the ride and when exceeding that distance, some rate for each additional kilometer is added. For example, the fare of PUJ (Jeepney) in the MM is 8.00 Pesos for the first 4.0 km and 1.8 Pesos per additional one kilometer. A ten kilometer ride will be charged 8.00 + (10-4) x 1.4 = 16.4 Pesos. Regular buses will charge 10.00 Pesos for the first 5km and 1.85 Pesos for each additional one kilometer, which is higher than PUJ by about 30%.

On the other hand, fare of inter-city buses has no fixed rate for the first portion of the ride, but only a distance proportional rate from the beginning. The rate per kilometer is 1.35 Pesos for regular buses, 1.75 Pesos for super-deluxe buses and 2.20 Pesos for luxury buses, which more or less corresponds to intra-city public transport fares of PUJ, regular buses and air-conditioned buses, respectively. Fares of rail transit in the MM are also combinations of a fixed rate and a distance proportional rate, which are lower than PUJ and buses by 30 to 50%.

Bus fare from the MM to CIA is 235 Pesos of which 135 Pesos is from the MM to the Dao terminal by a regular bus and 100 Pesos from the terminal to CIA for a shuttle service by vans. FILTRANCO, a private bus company operates an express bus service from Pasay city directly to CIS, of which the fare is 450 Pesos (400 Pesos from Ortigas to CIA). This might become a competitor to AER.

Table 6.5-1 Current Public Transport Fare as of October 2012

Kind of Public Transport	Fare(Peso: D:Distance in km)
PUJ, Mega-Manila	8+(D-4)*1.40
PUB Ordinary, MM	10+(D-5.0)*1.85
PUB Air-conditioned, MM	12+(D-5.0)*2.20
PUB Ordinary, Provincial	1.35*D
PUB Super Deluxe, Provincial	1.75*D
PUB Luxury, Provincial	2.20*D
LRT 1, MM	12+(D-6.0)*0.57
LRT 2, MM	12+(D-4.5)*0.44
MRT 3, MM	10+(D-3.0)*0.36

Source: Elaborated by JICA Study Team

6.5.2 Fare Level for Cost Recovery

Some parts of project cost and O&M cost cannot be determined before demand is estimated. Demand is strongly affected by the fare system. Fare to recover the cost can be determined by using cost. Thus, the analysis falls into a "chicken and egg" proposition. However, if cost and demand are estimated under any assumptions, a fare level to recover the cost, that is, a unit transport cost is easily estimated.

Table 6.5-2 shows the estimating process and the result of the unit transport cost. Total project cost inclusive of land cost, contingency and rolling stock cost is estimated at 338.5 billion Pesos (about 707.4

billion JPY). In the project evaluation presented in Chapter 11, the evaluation period is assumed to be 35 years, which is considered as the economic project life. However, land and infrastructure will actually have economic value beyond 35 years and the residual value after 35 years after operation starts is estimated at 98.8 billion pesos. Then, depreciation during the 35 years is 239.7 billion Pesos (338.5 – 98.8), that is, 6.85 billion pesos per annum. Adding to this, 9.17 billion pesos of annual O&M cost in 2030, 16.01billion Pesos is the average annual cost to be covered.

On the other hand, annual transport demand of AER is estimated to reach 4.76 billion passenger-km in 2030. Thus, cost per passenger-km is 3.4 pesos. If the fare of AER is set below this rate, total cost cannot be covered. As the rate does not include capital opportunity cost, revenue cannot recover financial cost such as interest and commitment charge even under this rate, if the fund is raised with loan.

Table 6.5-2 Fare Level for Cost Recovery

Item	Unit	Amount
Total Project Cost	Million Pesos	338,466.9
Residual in 2055	Million Pesos	98,822.1
Net Total Cost	Million Pesos	239,644.8
Annual Capital Cost (/35)	Million Pesos/ Year	6,847.0
O&M Cost in 2030	Million Pesos/ Year	9,166.2
Total Annual Cost	Million Pesos/ Year	16,013.2
Total Demand in 2030	Million passenger-km	4,755.1
Cost per passenger-km	Pesos	3.4

Source: JICA Study Team

6.5.3 AER User's Benefit

As an unwritten rule, fare of a public service cannot exceed the user's benefit. Then, the economic benefit of travel time saving by using AER is estimated. Table 6.5-3 (1) shows the time value, estimated based on the income data collected through interviews with passengers travelling along the NLEX corridor. The time value was assumed to grow at the same rate as GDP per capita growth. The average bus passenger's time value is estimated at 78 pesos per hour at present while car user's time value is 111 pesos, 1.4 times that of bus passengers. These time values will almost double by 2040.

In the same Table (2), time reduction by using AER is shown for each passenger that converted from cars and buses, respectively. Although a car and a bus can travel at the speed of 80 to 90 km/hour in NLEX, the speed will drop to 20 to 30 km/hour on and inside EDSA. The assumed speeds in the table take account of this fact. The travel time from Pasay or Makati to CIA of 100 minutes by car and 120 minutes by bus reflect reality well. According to the operation schedule of AER, the average speed is 110km/hour and travel time will be significantly reduced to 55 minutes.

Value of the saved time in the same Table (3) is obtained by multiplying reduced time in (2) by the time value in (1). The time value is estimated based on income and then it is originally applied to trips for business purpose and commuting purpose. In this analysis, however, the same vale was assumed for trips for other purposes having no relation with productive activity. (Some research reported that trips with non-productive purposes have 50 to 60 % of the time value of productive purpose trips.)

The value shown in the same Table (3) is the value of saved time only. Then, the upper limit of AER fare will be given by the total amount of the saved time value and travel cost spent before changing travel mode. Vehicle operating cost of a car is estimated to be about 600 Pesos per 100 km, excluding toll payments while the fare of express buses is 450 Pesos. Therefore, from the viewpoint of user's benefit, the maximum fare of AER for a one-way trip is estimated at 687 Pesos for car passengers and 509 Pesos for bus passengers as shown in Table (4). As differentiated fares are impossible to apply practically, about 500 Pesos can be regarded as the maximum level in 2020, considering that the majority of AER passengers are converted from express buses.

Table 6.5-3 AER User's Benefit

(1) Value of Time

(Peso/Hour)

Year	Car	Bus
2012	111.8	78.1
2020	141.6	98.9
2030	182.6	127.5
2040	233.2	162.9

(2) Saved Time by using AER

(Minutes/100 km)

Mode	Av. Speed (Km/Hr)	Travel Time (Minute)	Saved Time (Minute)
Car	60	100	45
Bus	50	120	65
AER	110	55	-

(3) Time Saving Benefit

(Peso/100km)

Year	Car	Bus
2012	85	59
2020	107	75
2030	138	97
2040	177	123

(4) Maximum Level of AER Fare

(Peso/100km)

Year	Car	Bus
2012	687	509
2020	709	525
2030	740	547
2040	779	573

Source : JICA STUDY Team

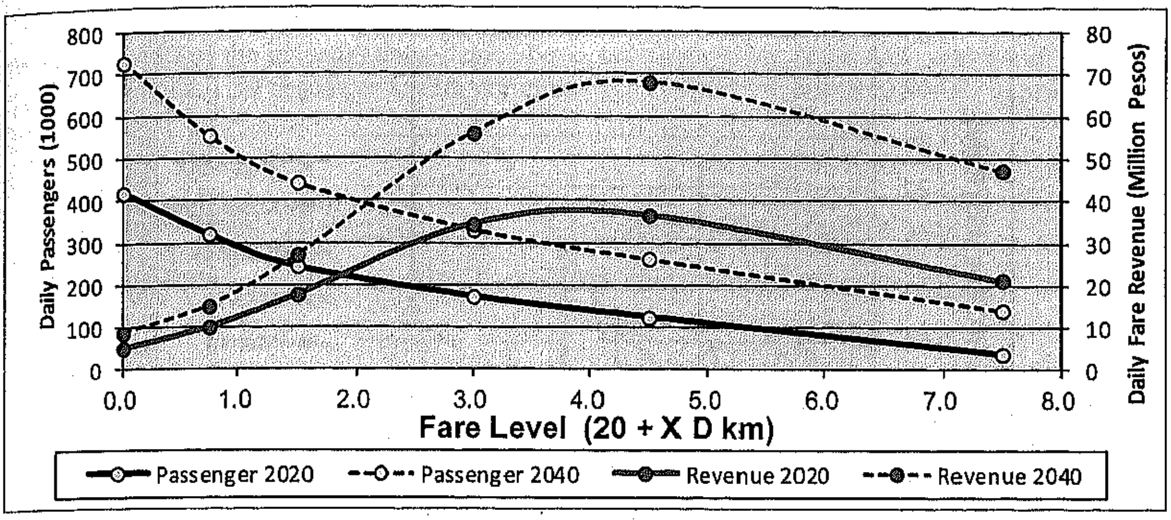
6.5.4 Fare Level for Revenue Maximization

Demand for public services will be highest when the service is free of charge and gradually decrease as the fare rises. On the other hand, fare revenue is zero when free of charge and increases as the fare rises. But if the fare is too high, demand will fall down to zero and the revenue will also go down to zero. Thus, the revenue will draw a convex curve with a peak at a certain fare. This fare level which maximizes the revenue is optimal to investors and operators. It should be noted, however, the fare is not necessarily optimal to passengers.

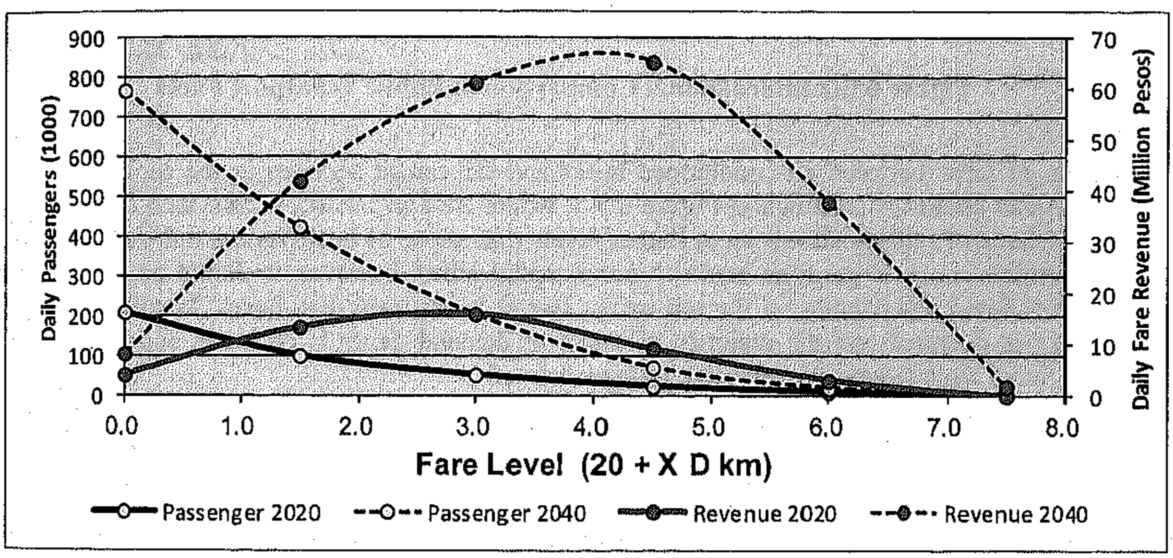
By changing fare level, demand and fare level are estimated as shown in Figure 6.5-1. The minimum fare of 20 pesos per ride is assumed and the X-axis stands for the distance proportional fare rate. Therefore, Fare revenue is not zero even when X is zero.

In the year 2020, the fare level which maximizes revenue is 3.7 Pesos/km for commuter trains and 3.0 Pesos/ km for Express trains with 20 Pesos as the initial fare. In 2040, they will rise to 4.2 Pesos and 4.0 Pesos, respectively, reflecting future rises of household income. Express trains will compete against cheap services of intercity buses and then demand will become zero if the fare exceeds7.0 Pesos/ km.

(1) Commuter Train (Phase 1)



(2) Express Train (Phase 2)

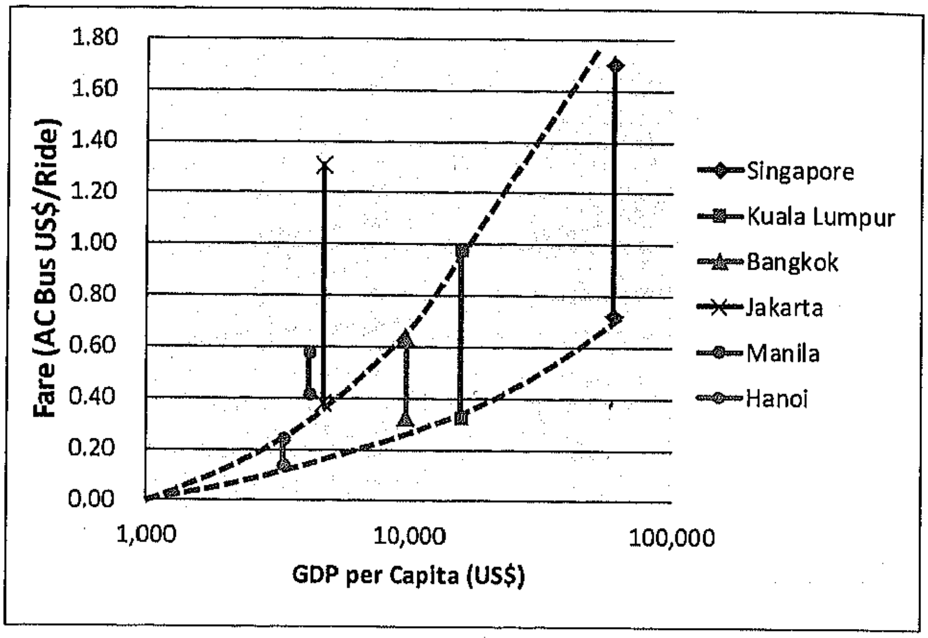


Source : JICA STUDY Team

Figure 6.5-1 Relationship of Fare Level, Demand and Revenue

6.5.5 International Comparison of Public Transport Fare

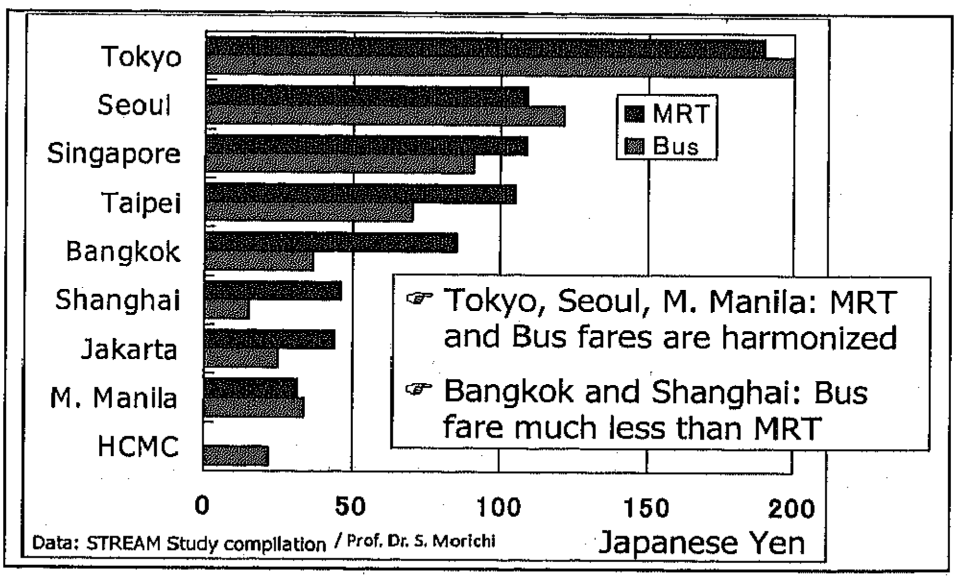
Figure 6.5-2 compares public transport fares with GRDP per capita in selected capital cities in the Southeast Asian Countries. Except for Hanoi and Jakarta, urban railways are under operation and there is a variety of bus services. Consequently, fares of public services per 10 km are shown not as a point but as a range. By connecting the lowest points of each city and in the same way connecting the highest points, a clear tendency can be observed in two exponential-type curves. While the fares of most cities are within the area of the two curves, Jakarta and Manila are exceptionally above the higher tendency curve, which means transport fares are set relatively high comparing to passengers' income level. This may be because transport cost cannot be lower than a certain level, whatever kind of mode is used and however low the passenger's income is. In the case of Hanoi where the bus fare is cheapest and the GDP per capita is lowest, bus services are mostly operated by the public sector and the operating deficit is covered by Governmental subsidies.



Source : JICA STUDY Team

Figure 6.5-2 International Comparison of Public Transport Fares

Comparison of fares between air-conditioned buses and rail-transit services in the capital cities of the Southeast Asian countries is shown in Figure 6.5-3, where BRT in Jakarta is classified as rail transit. In general, the fares of rail transit are set at higher levels than those of buses as the rail transit requires an initial investment much larger than buses. Among capital cities, however, it should be noted that three cities, Tokyo, Seoul and Manila set the rail transit fare at lower level than buses. Manila has only three urban rail lines operated and the majority of transport demand depends on buses and jeepneys, while Tokyo and Seoul already have an extensive railway network.



Source: Seminar Material made by Prof. Dr. Shigeru MORICHI

Figure 6.5-3 Fare Comparison of Bus and Rail Transit in Capital Cities of Southeast Asian Countries

6.5.6 AER Fare Setting

Based on the results of the investigations stated above, the fare system of the AER was set at 20.00 pesos as the initial cost plus 1.50 pesos per km for commuter trains and 3.00 pesos per km for express trains, as shown below.

Commuter Train: 20.00 + 1.50 x D (D represents riding distance in km)

Express Train : 20.00 + 3.00 x D (D represents riding distance in km)

The fare system is presented at 2013 constant price and considered suitable at present if the AER existed. The fare could be raised in real terms, in accordance with future economic growth and improvement of household income. In this study, however, periodic fare revision is not applied because fares of other public transport services will also be raised as the economy grows. In addition, neither fare reduction for students and disables nor season ticket discounts were taken into consideration for simplification at this pre-F/S stage.