Chapter 11

REVIEW OF NATURAL CONDITIONS

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11.1 Assessment of Natural Disaster Risks

In the Philippines, the natural disasters of flood, etc. have occurred almost every year and have cause serious damages to people as well as to infrastructure of the country and also Metro Manila. Especially torrential rains and typhoons resulting in flood have frequently occurred. Measures for inundation to the underground structure is an essential element when considering the design and construction of subway.

Philippines is one of the countries where earthquake and volcanic activities are active in the world. Damages caused by the earthquakes have been serious concerns in the past. Although underground structures are relatively strong to earthquake, measures to prevent damages from earthquakes as well as inundation are essential elements in the subway project.

In this Study, the previous data and the current situation of the flood and earthquake in the Philippines have been investigated and the result of the investigation is described in this chapter. Japan's experiences in measures against earthquake and inundation in subway is also introduced and proposals for necessary actions to realize the construction of subway with the highest priority on safety are made.

11.1.1 Flooding

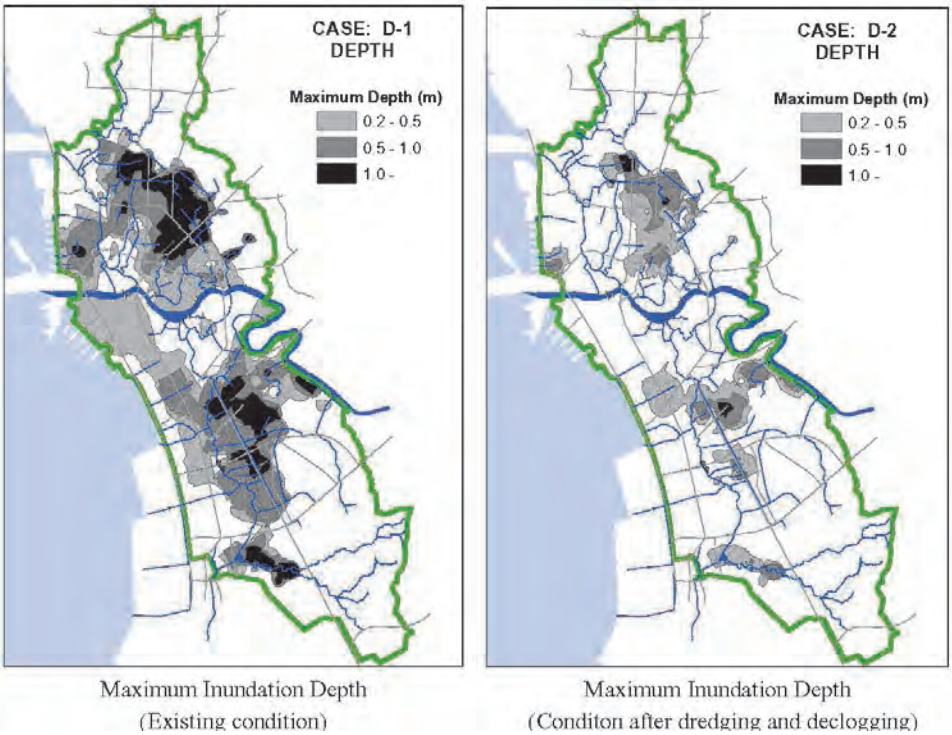
Until now, some studies have been carried out regarding flood control in Manila. Among them, JICA has carried out a study in 2005, namely "The study on drainage improvement in the core area of Metropolitan Manila", which aimed to build a model of the flood and to simulate the flood based on past flood experiences. In addition, JICA has carried out a study in 2014 namely "Data Collection Survey on Flood Management Plan in Metro Manila" to analyze flood model based on the climate change impacts, and to reproduce the past flooding.

11.1.1.1 Relationship between Target Project Area of the Study and Study Results about Flooding

The relationship between the target project area of the Study and the simulation results of the past studies are described below.

(1) Study on Drainage Improvement in the Core Area of Metropolitan Manila

This study was to build a flood model and to simulate 5 cases of flood. The relationship between the target project area of the Study and the flood simulation results on each case are shown in Figures 11.1.1.1-1 - 11.1.1.1-3.

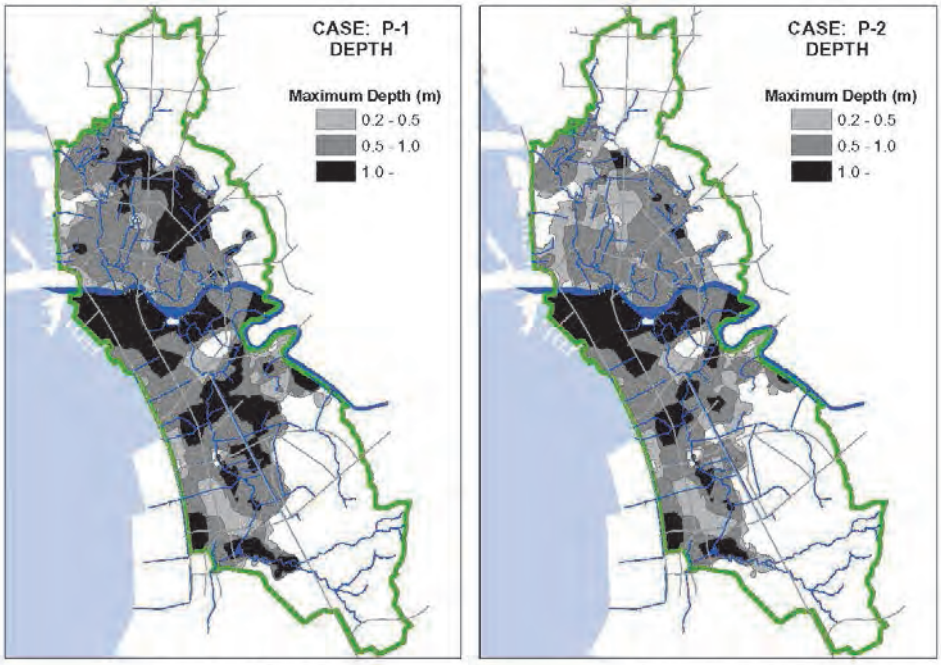


Maximum Inundation Depth (Existing condition)

Maximum Inundation Depth (Conditon after dredging and declogging)

Source: *Study on Drainage Improvement in the Core Area of Metropolitan Manila (JICA, 2005)*

Figure 11.1.1.1-1 Relationship between Target Project Area and Flood Simulation Results (cases 1 and 2) in 2005 JICA STUDY

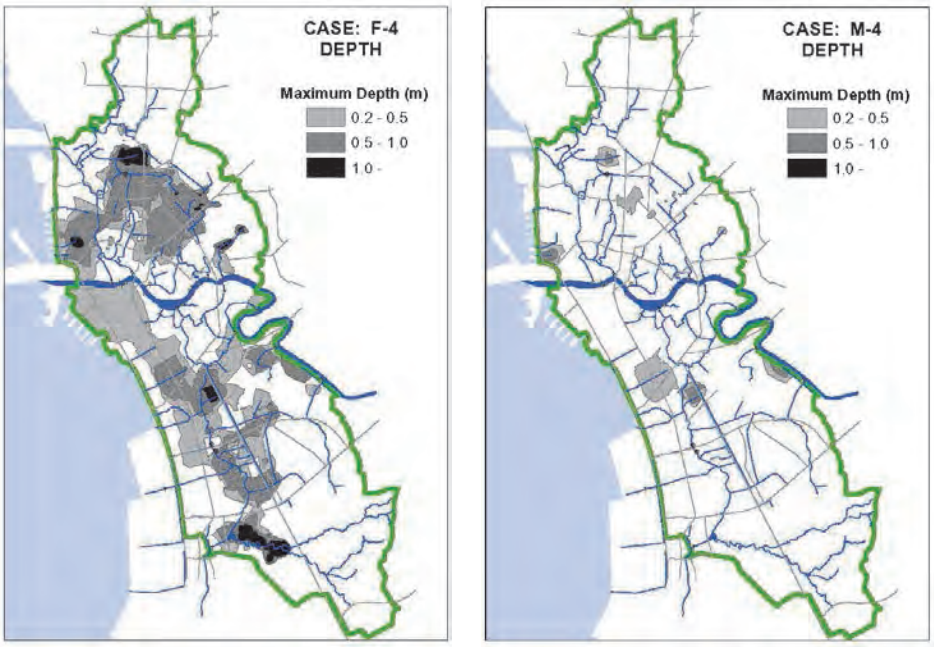


Maximum Inundation Depth (Without pump and gate operation for existing condition)

Maximum Inundation Depth (Without pump and gate operation for condition after dredging and declogging)

Source: *Study on Drainage Improvement in the Core Area of Metropolitan Manila (JICA, 2005)*

Figure 11.1.1.1-2 Relationship between Target Project Area and Flood Simulation Results (cases 3 and 4) in 2005 JICA STUDY



Maximum Inundation Depth
(Condtion after Phase 1)

Maximum Inundation Depth
(Condition after completion of proposed works)

Source: *Study on Drainage Improvement in the Core Area of Metropolitan Manila (JICA, 2005)*

Figure 11.1.1.1-.3 Relationship between Target Project Area and Flood Simulation Results (cases 5 and 6) in 2005 JICA STUDY

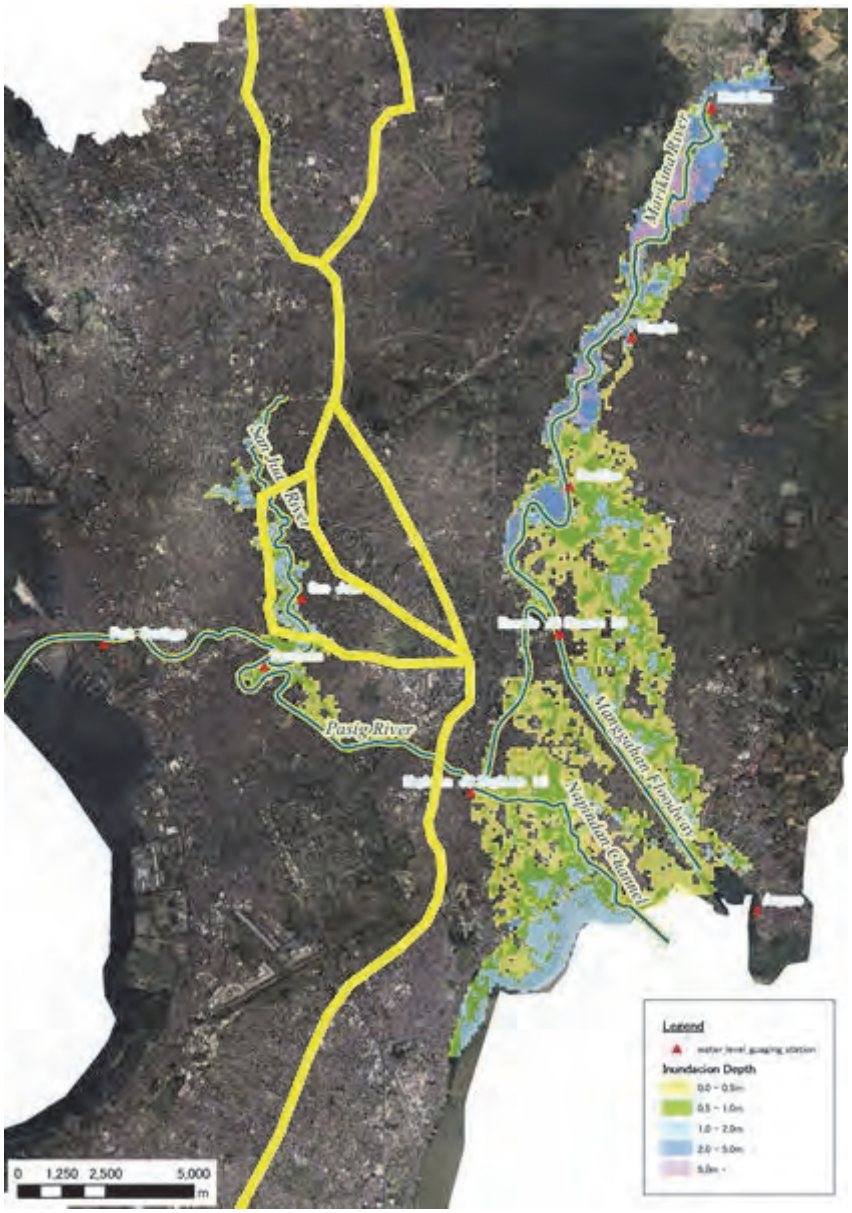
(2) Data Collection Survey on Flood Management Plan in Metro Manila

This study was to build a flood model and to reproduce the past flood experiences by the simulation. In this study, the sever flood in 2009 caused by Typhoon Ondoy was first reproduced and factors affecting the water flow during flooding was calculated. Then, based on those factors, flooding in 2004 and 2012 were also reproduced. Flooding in 2009 observed the highest water flow. The peak water flow was relatively small in the flooding in 2004, whereas the peak water flow was relatively large with frequent peaks observed.

The relationship between the target project area of the Study and the reproduced flooding by simulation are shown in Figures 11.1.1.1-4 – 11.1.1.1-6.

Source: *Data Collection Survey on Flood Management Plan in Metro Manila (JICA, 2014) with modification made by JICA Study Team*

Figure 11.1.1.1-4 Relationship between Target Project Area and Reproduced Flooding in 2004 by Simulation (JICA STUDY, 2014)



Source: *Data Collection Survey on Flood Management Plan in Metro Manila (JICA, 2014) with modification made by JICA Study Team*

Figure 11.1.1.1-5 Relationship between Target Project Area and Reproduced Flooding in 2009 by Simulation (JICA STUDY, 2014)

Source: *Data Collection Survey on Flood Management Plan in Metro Manila (JICA, 2014) with modification made by JICA Study Team*

Figure 11.1.1.1-6 Relationship between Target Project Area and Reproduced Flooding in 2012 by Simulation (JICA STUDY, 2014)

11.1.1.2 Conclusion

From the above results, it is observed that most of the target project area is not included in the flooded area in the simulations made by the JICA Study on Flood Management Plan in 2014. However, some part of Option 3 route in the Central Zone runs through areas close to the flooded areas in case of flooding in 2009, and there may be a case that severer flooding would occur in areas where there was no severe flooding in the past. Therefore, although it is considered that the potential risk of inundation to be caused by flooding will be unlikely within most of the target project area of the MMSP, proper measures against inundation to railway facilities shall be taken in the design for station entrances and any opening connected to railway facilities, e.g. ventilation shafts, at all underground stations in principle.

11.1.2 Earthquake

JICA has carried out a study in 2004, namely "Earthquake Impact Reduction Study for Metropolitan Manila, Republic of the Philippines", in which a master plan to mitigate earthquake damage in Metro Manila was established, based on the field survey including geology, ground motion analysis and hazard assessments.

On the other hand, own research has been conducted by a governmental agency in the Philippines, namely Philippines Institute of Volcanology and Seismology (PHIVOLCS), which has been carrying out hazard assessment as its own investigation.

11.1.2.1 Relationship between Target Project Area of the Study and Hazard Assessment regarding Earthquake

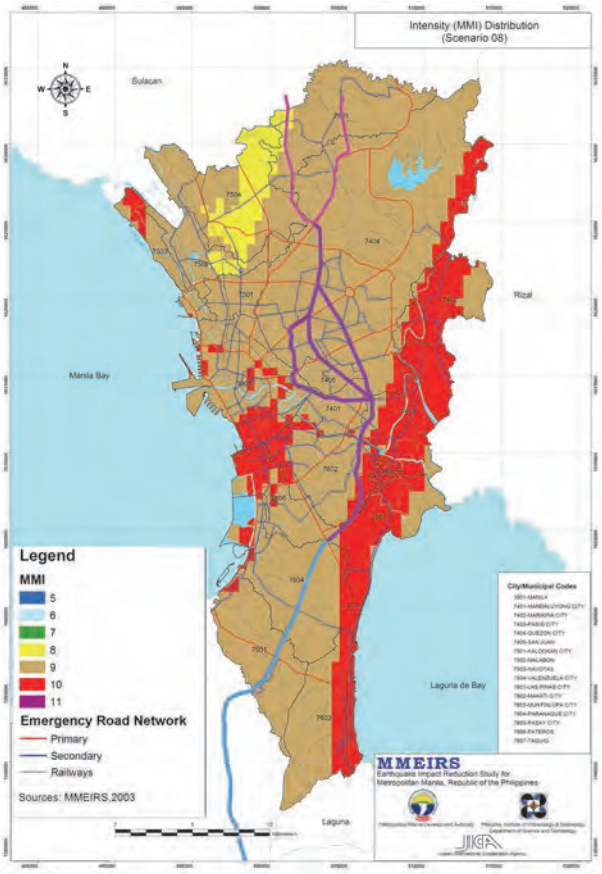
The relationship between the target project area of the Study and the hazard assessment regarding the earthquake is described below.

(1) Hazard Earthquake Impact Reduction Study for Metropolitan Manila, Republic of the Philippines

In this study, 18 types of the occurrences of the earthquake was assumed. Ground motion distribution, liquefaction potential distribution etc. of each earthquake have been studied. As a result, the relationship between the target project area of the Study and the results of the three models made in this study which can be assumed to cause large damage are shown below.

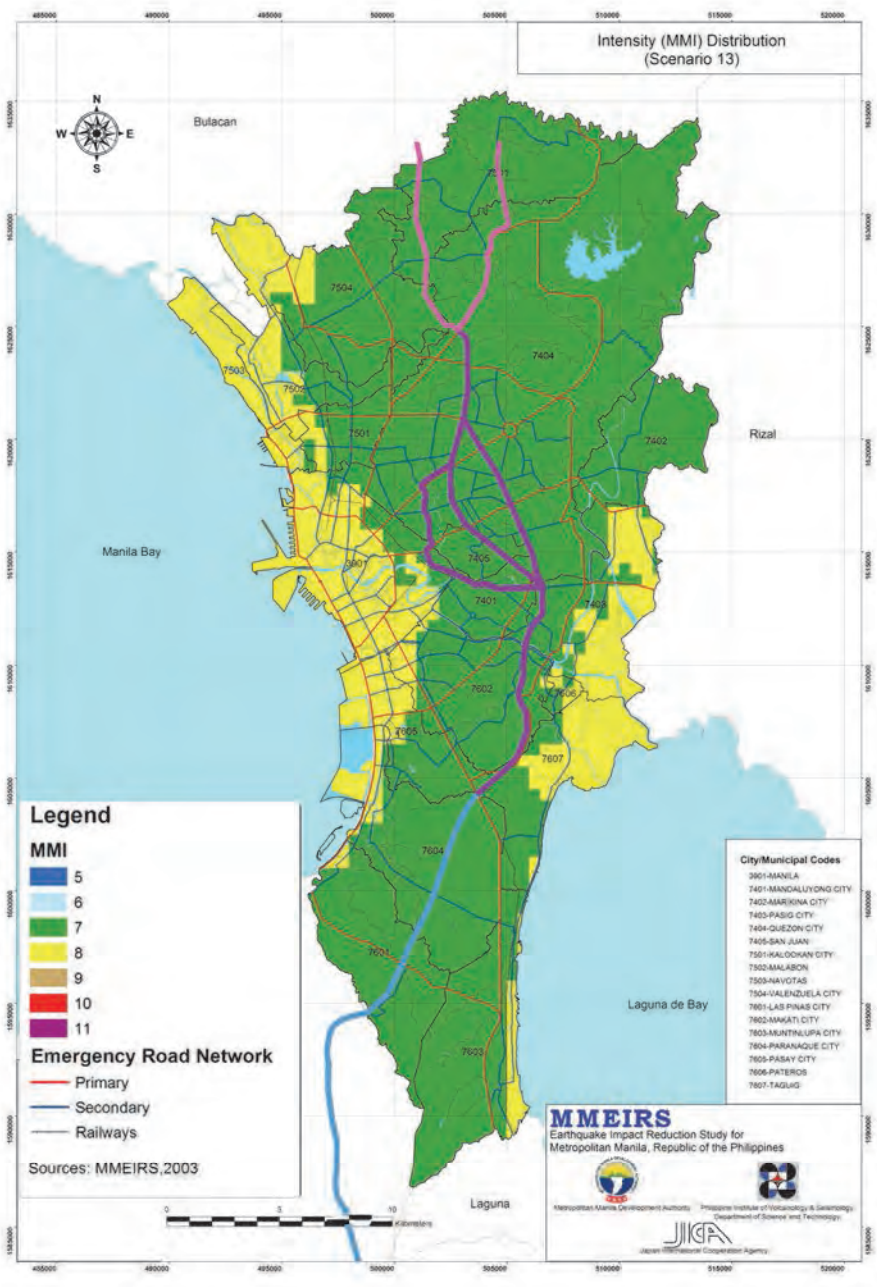
(a) Shaking

The relation between the target project area of the Study and the expected intensity distribution of the three types of earthquakes are shown in Figures 11.1.2.1-1 – 11.1.2.1-3. When designing the structures, particularly elevated structures and at-grade structures, it is necessary to adopt seismic design.



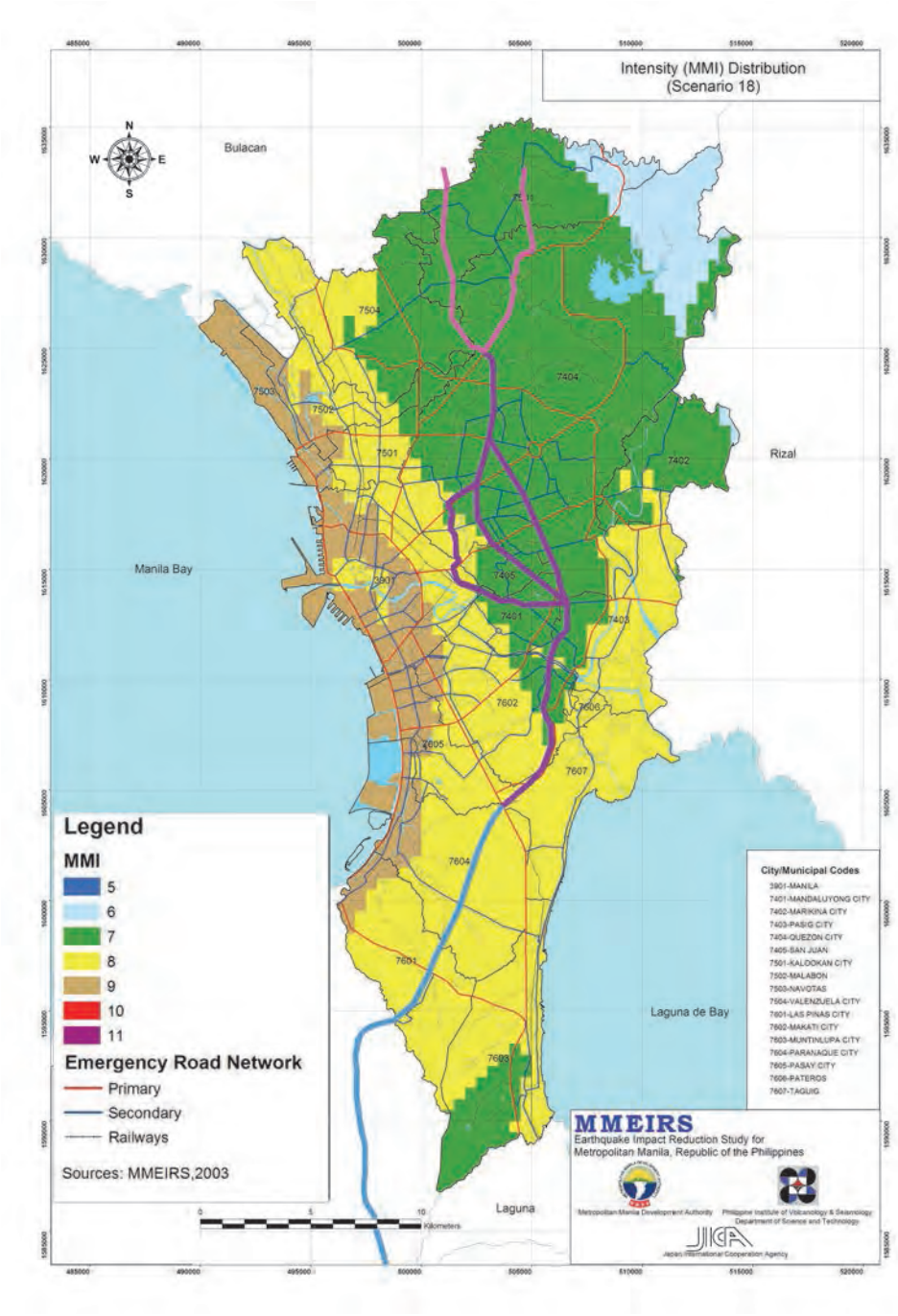
Source: *Earthquake Impact Reduction Study for Metropolitan Manila, Republic of the Philippines (JICA, 2004) with modification made by JICA Study Team*

Figure 11.1.2.1-1 Relationship between Target Project Area and Intensity Distribution (scenario 08)



Source: *Earthquake Impact Reduction Study for Metropolitan Manila, Republic of the Philippines (JICA, 2004) with modification made by JICA Study Team*

Figure 11.1.2.1-2 Relationship between Target Project Area and Intensity Distribution (scenario 13)

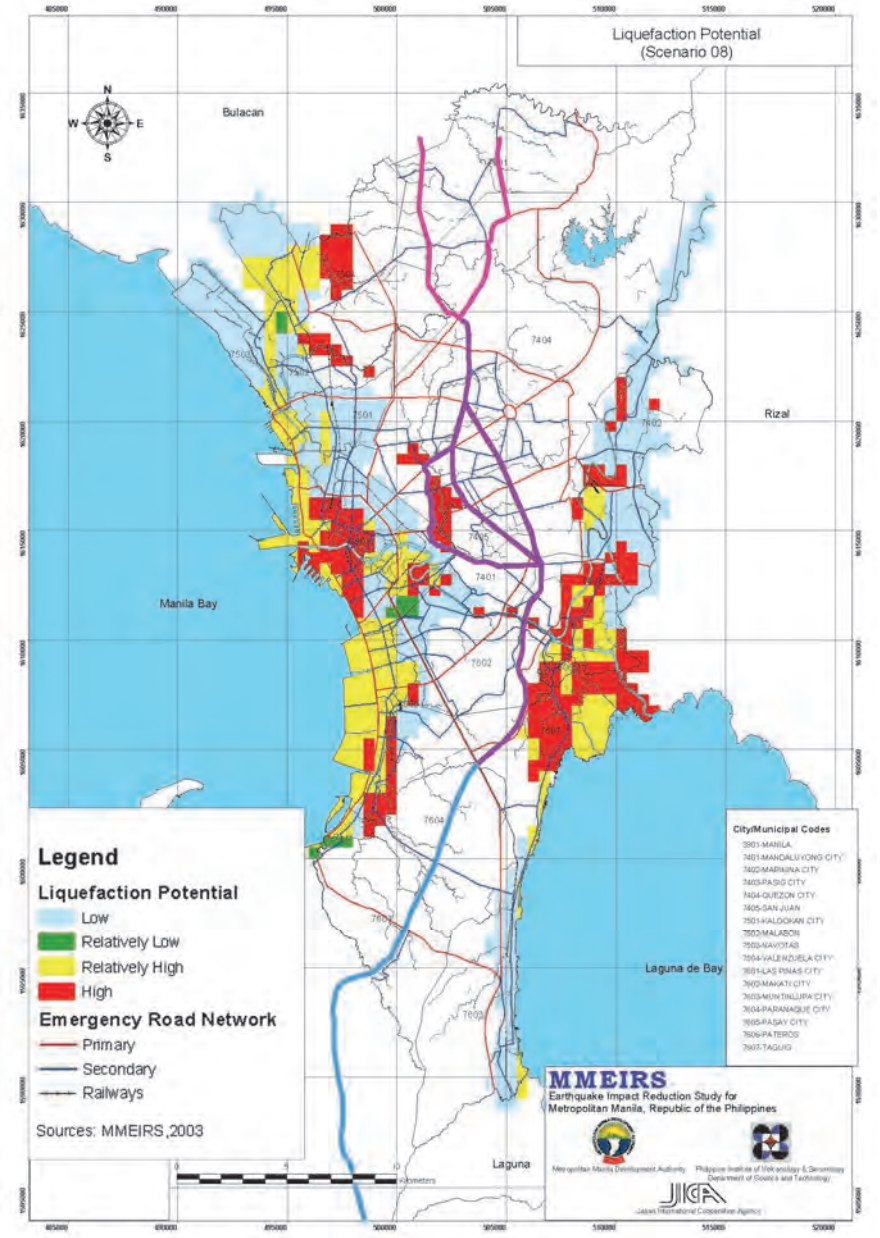


Source: *Earthquake Impact Reduction Study for Metropolitan Manila, Republic of the Philippines (JICA, 2004) with modification made by JICA Study Team*

Figure 11.1.2.1-3 Relationship between Target Project Area and Intensity Distribution (scenario 18)

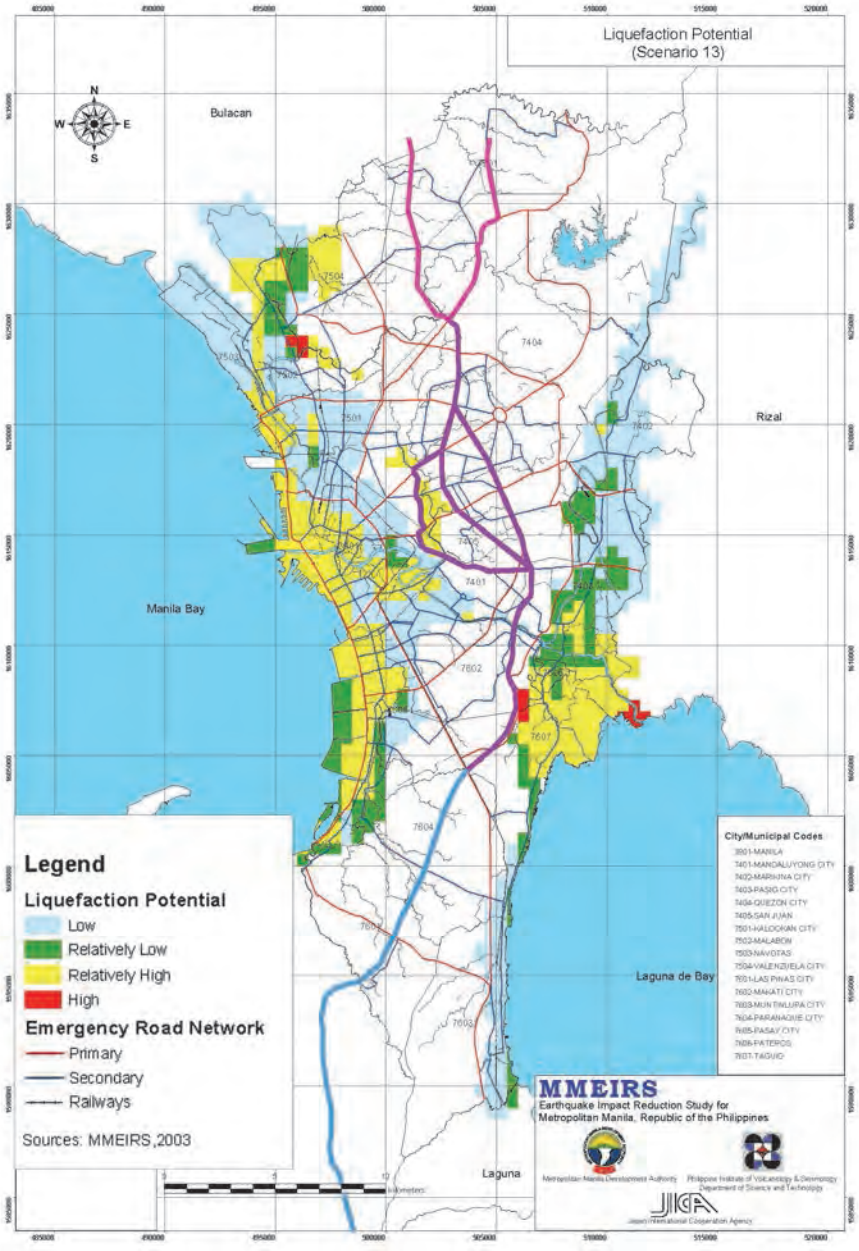
(b) Liquefaction

The relationship between the target project area of the Study and the forecast of liquefaction due to earthquakes are shown in Figures 11.1.2.1-4 – 11.1.2.1-6. Although most of the areas is considered to be free from possibility of liquefaction, some part of Option 3 in Central Zone and south part of Central Zone runs near or on the areas with potential of liquefaction. If a route a part of which is within the potential area of liquefaction is selected, proper measures shall be taken, e.g. constructing underground structures at deep underground to avoid the impact of liquefaction, soil improvement where possible, etc.



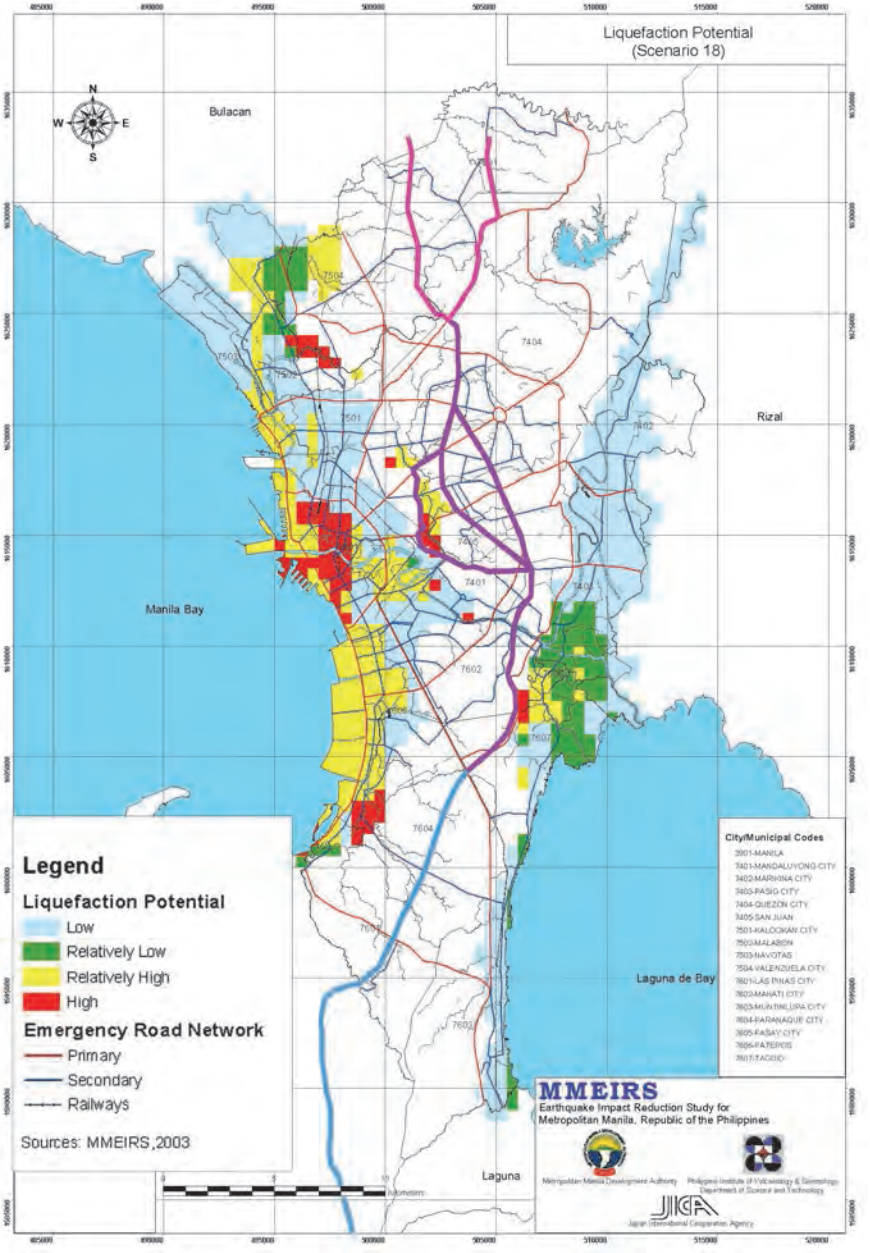
Source: *Earthquake Impact Reduction Study for Metropolitan Manila, Republic of the Philippines (JICA, 2004) with modification made by JICA Study Team*

Figure 11.1.2.1-4 Relationship between Target Project Area and Liquefaction (scenario 08)



Source: *Earthquake Impact Reduction Study for Metropolitan Manila, Republic of the Philippines (JICA, 2004) with modification made by JICA Study Team*

Figure 11.1.2.1-5 Relationship between Target Project Area and Liquefaction (scenario 13)

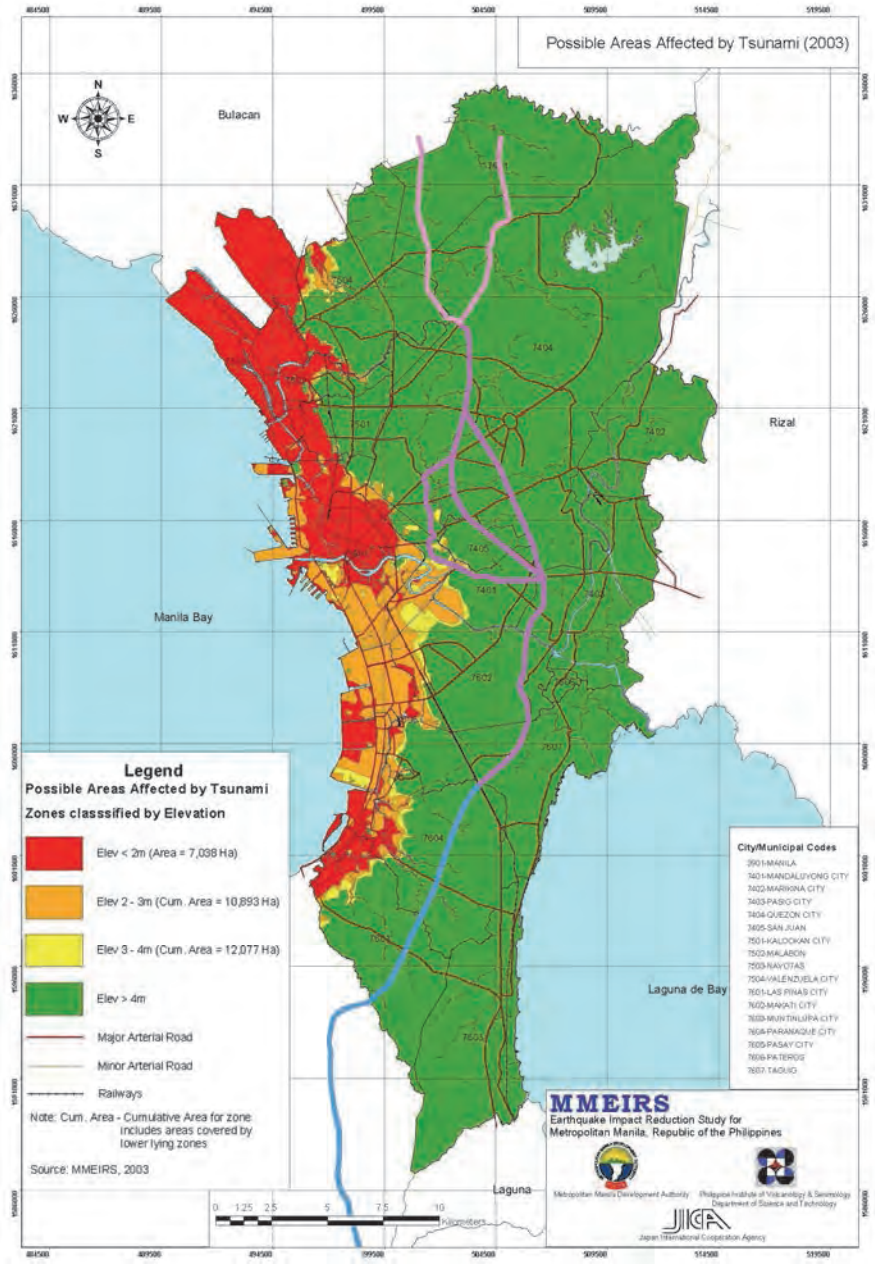


Source: *Earthquake Impact Reduction Study for Metropolitan Manila, Republic of the Philippines (JICA, 2004) with modification made by JICA Study Team*

Figure 11.1.2.1-6 Relationship between Target Project Area and Liquefaction (scenario 18)

(c) Tsunami

The relationship between the target project area of the Study and damage area affected by Tsunami caused due to the earthquake in 2003 is shown in Figure 11.1.2.1-7. It is considered that measures for Tsunami is not necessary or limited to minimum in the target project area.

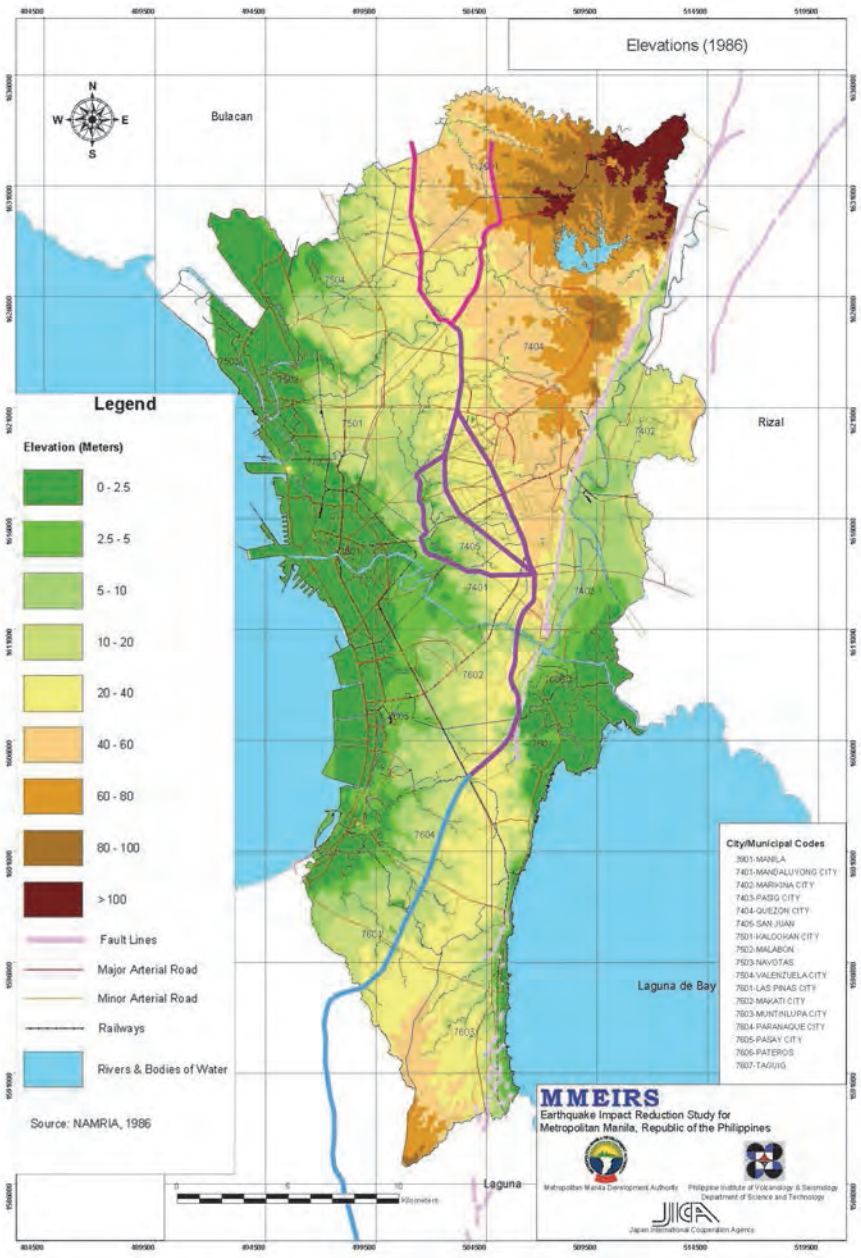


Source: *Earthquake Impact Reduction Study for Metropolitan Manila, Republic of the Philippines (JICA, 2004) with modification made by JICA Study Team*

Figure 11.1.2.1-7 Relationship between Target Project Area and Damage Area affected by Tsunami (2003)

(d) Fault

The target project area of the Study partly crosses faults. The relationship between the target project area of the Study and the faults is shown in Figure 11.1.2.1-8. When designing the structures of Mega Manila Subway, consideration on measures against faults shall be taken.



Source: *Earthquake Impact Reduction Study for Metropolitan Manila, Republic of the Philippines (JICA, 2004) with modification made by JICA Study Team*

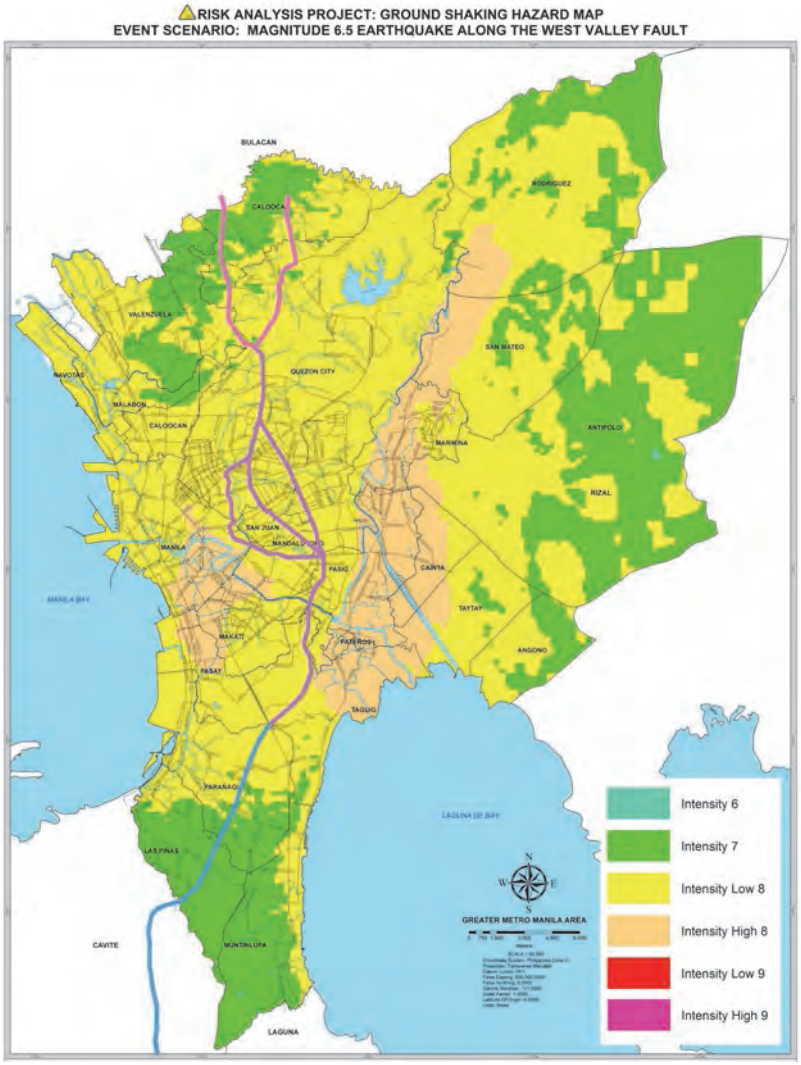
Figure 11.1.2.1-8 Relationship between Target Project Area and Faults

(2) Hazard Assessment by Institute of Volcanology and Seismology (PHIVOLCS)

PHIVOLCS has carried out a hazard assessment in its own investigation. The relationship between the target project area of the Study and the results of PHIVOLCS are shown below.

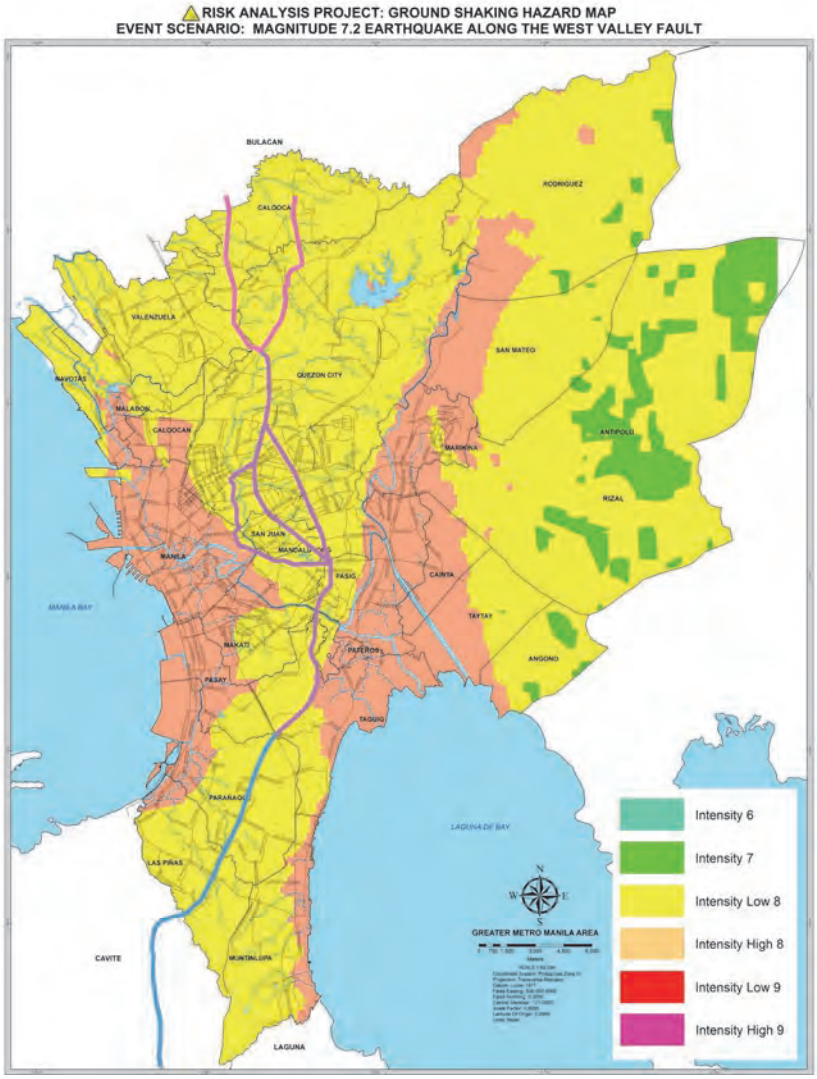
(a) Shaking

The relation between the target project area of the Study and the expected intensity distribution of earthquake are shown in Figure 10.1.16～10.1.17. When designing the structures for Mega Manila Subway, it is necessary to adopt seismic design.



Source: *Hazard Assessment by Institute of Volcanology and Seismology (PHIVOLCS) with modification made by JICA Study Team*

Figure 11.1.2.1-9 Relationship between Target Project Area and Intensity Distribution (M6.5)

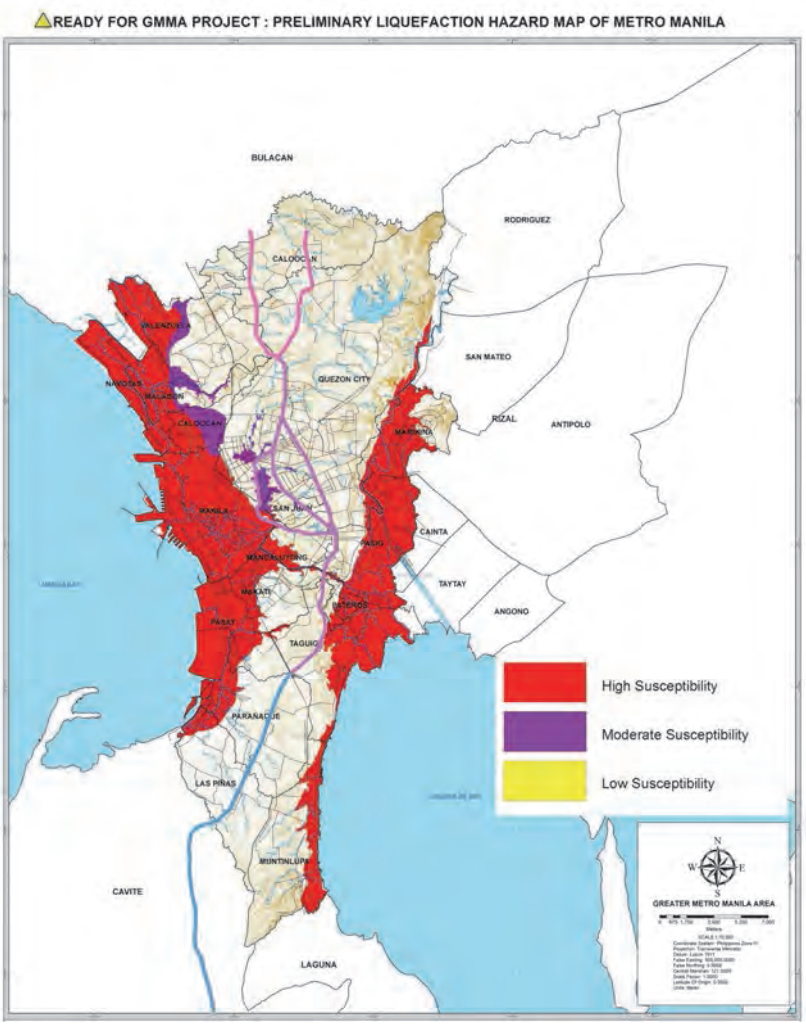


Source: *Hazard Assessment by Institute of Volcanology and Seismology (PHIVOLCS) with modification made by JICA Study Team*

Figure 11.1.2.1-10 Relationship between Target Project Area and Intensity Distribution (M7.2)

(b) Liquefaction

The relationship between the target project area of the Study and the forecast of liquefaction due to earthquakes are shown in Figure 11.1.2.1-11. Although most of the areas is considered to be free from possibility of liquefaction, some part of Option 3 in Central Zone and south part of Central Zone runs near or on the areas with potential of liquefaction. If a route a part of which is within the potential area of liquefaction is selected, proper measures shall be taken, e.g. constructing underground structures at deep underground to avoid the impact of liquefaction, soil improvement where possible, etc.



Source: *Hazard Assessment by Institute of Volcanology and Seismology (PHIVOLCS) with modification made by JICA Study Team*

Figure 11.1.2.1-11 Relationship between Target Project Area and Liquefaction Area by Earthquake

(c) Tsunami

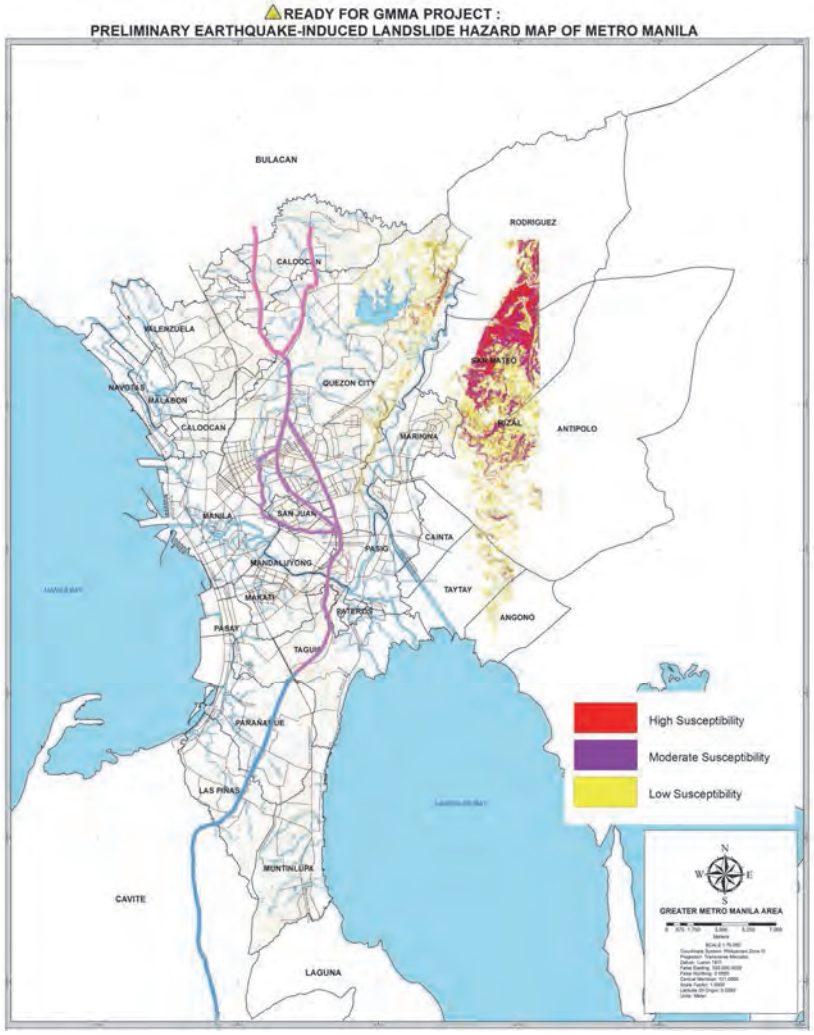
The relationship between the target project area and the forecast of Tsunami due to earthquake is shown in Figure 11.1.2.1-12. It is considered that measures for Tsunami is not necessary or limited to minimum in the target project area.

Source: *Hazard Assessment by Institute of Volcanology and Seismology (PHIVOLCS) with modification made by JICA Study Team*

Figure 11.1.2.1-12 Relationship between Target Project Area and Tsunami Area by Earthquake

(d) Land sliding

The relationship between the target project area and the forecast of Land sliding due to earthquakes is shown in Figure 11.1.2.1-13. It is considered that measures for Land sliding is not necessary or limited to minimum in the target project area.

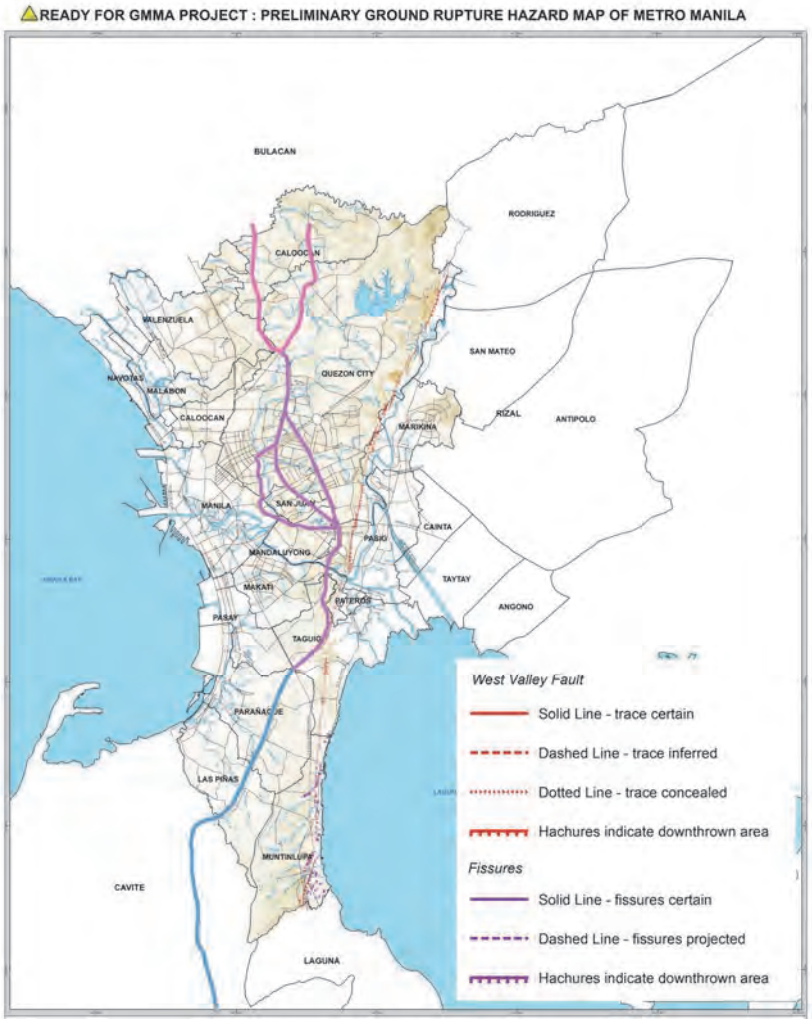


Source: *Hazard Assessment by Institute of Volcanology and Seismology (PHIVOLCS) with modification made by JICA Study Team*

Figure 11.1.2.1-13 Relationship between Target Project Area and Land Sliding Area by Earthquake

(e) Fault

The target project area partly crosses faults. When designing the structures for Mega Manila Subway, it is considered that measures against faults shall be taken.



Source: *Hazard Assessment by Institute of Volcanology and Seismology (PHIVOLCS) with modification made by JICA Study Team*

Figure 11.1.2.1-14 Relationship between Target Project Area and Faults

11.1.2.2 Conclusion

Before carrying out the design of the structures, it is necessary to consider and summarize the seismic design policy and how seismic design can be incorporated in the design. It is also and most important to establish a plan to stop trains and resume operation at earthquake once the revenue operation is commenced.

11.2 Recommendation for Prevention and Mitigation against Natural Disaster

11.2.1 Measures against Flooding

If a large-scale flooding occurs and the subway facilities are inundated, there may be a serious damage to subway users and stations staff and train operations being stopped, causing high economic and social impacts. Therefore, necessary measures against flood and inundation need to be taken.

The inundation to underground structures has the risk characteristics unlike the inundation to ground structures as follows:

- Difficult to understand the ground conditions

  Because underground space is isolated from the ground, it is difficult to obtain correct and timely information from the ground. If the information correction of the disaster situation is delayed, the decision of situation will be difficult. Thus, it is the tendency that the start of the evacuation of passengers and stations staff in the underground station is delayed.

- Limited evacuation route

  Evacuation direction from the underground level is limited to the doorways and connected buildings. Influx pathway of flooded water and evacuation routes overlap each other. Flooded water flows into the underground space from the stairs, thus evacuation by stairs against incoming water is difficult.

- Less time after start of flooding and inundation

  Underground space is closed and limited, thus flooding speed is faster compared to the ground.

11.2.1.1 During Construction

In case of flooding during the construction, there is a high possibility that the works would be interrupted, and more importantly that there would be accidents and/or casualties of workers at the construction site. Therefore, it is necessary to take appropriate flood countermeasures during the construction of underground structures. Some of the measures during construction are as described below:

(1) During excavation work

Topographic and sewage condition as well as the past experience of floods around construction site shall be considered and install the required number of pumps at construction site.

(2) During shield work

When the shield machine is immersed in water by flood, construction is interrupted for a long time. Therefore, it is very important not to let water penetrate into the tunnel. Steel plates, etc. for shutting out water should be installed at all of the openings as shown in Figure 11.2.1.1-1.

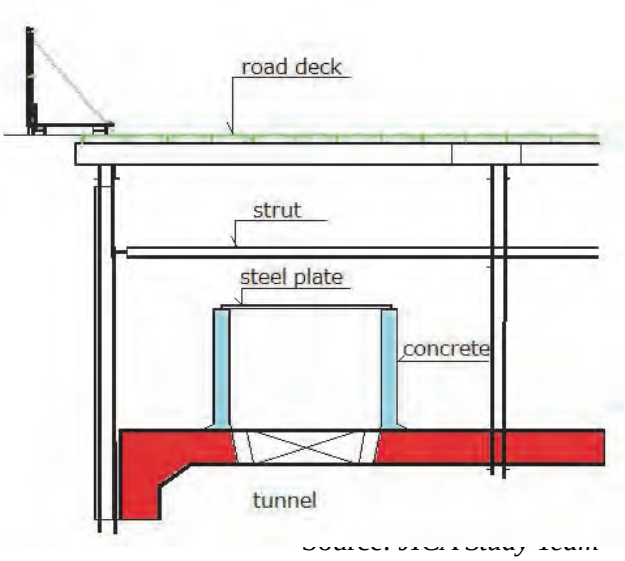


Figure 11.2.1.1-1 Steel plate for Shutting-out Water

(3) During E&M works

After the civil works is completed, installation of electrical and machinery facilities will start. If the electrical and machinery facilities are flooded by water, time of opening is significantly delayed. Steel plates, etc. for shutting out water should be installed at all of the openings in the same way as the shield work.

(4) Others

(a) Establishment of evacuation manual

In preparation for flooding, a manual stating how to ensure the evacuation route, the emergency contact system, etc. must be established before the commencement of construction works at site and disseminated to all construction works.

(b) Training

Based on the evacuation manual, all employees must receive regular training how to cope with flood.

(c) Education

All employees must receive regular education related to the flood, for example flood damage at the construction site in the past.

d) Use of online system of weather information

To obtain accurate information of the weather and flooding in a short time, online system of weather information should be adopted.

11.2.1.2 During Operation

During the flood, the invasion routes of the water entering the underground facilities are three. The first route is station entrances, the second is air ventilations, and the third is tunnel entrances connected to the ground level.

(1) Station Entrance

There are some measures to prevent flooding at the station entrances. Entrances can be positioned higher than the sidewalk at locations where flooding is a threat. Removable water-stop panels can be installed at the entrances in case the water level is expected to be higher than the floor level at the entrance.

The method of installation of the water-stop panels is shown in Figure 11.2.1.2-1.

Source: *Tokyo Metro*

Figure 11.2.1.2-1 Removable Water-stop Panels at Station Entrance

Source: *Tokyo Metro*

Figure 11.2.1.2-2 Flood Prevention Iron Door at Raised Station Entrance

Recently in subways of Tokyo, a new type of entrance is adopted which is surrounded by a tempered glass, and has a waterproof iron door instead of the conventional shutter. By closing the door, it is completely sealed entrance

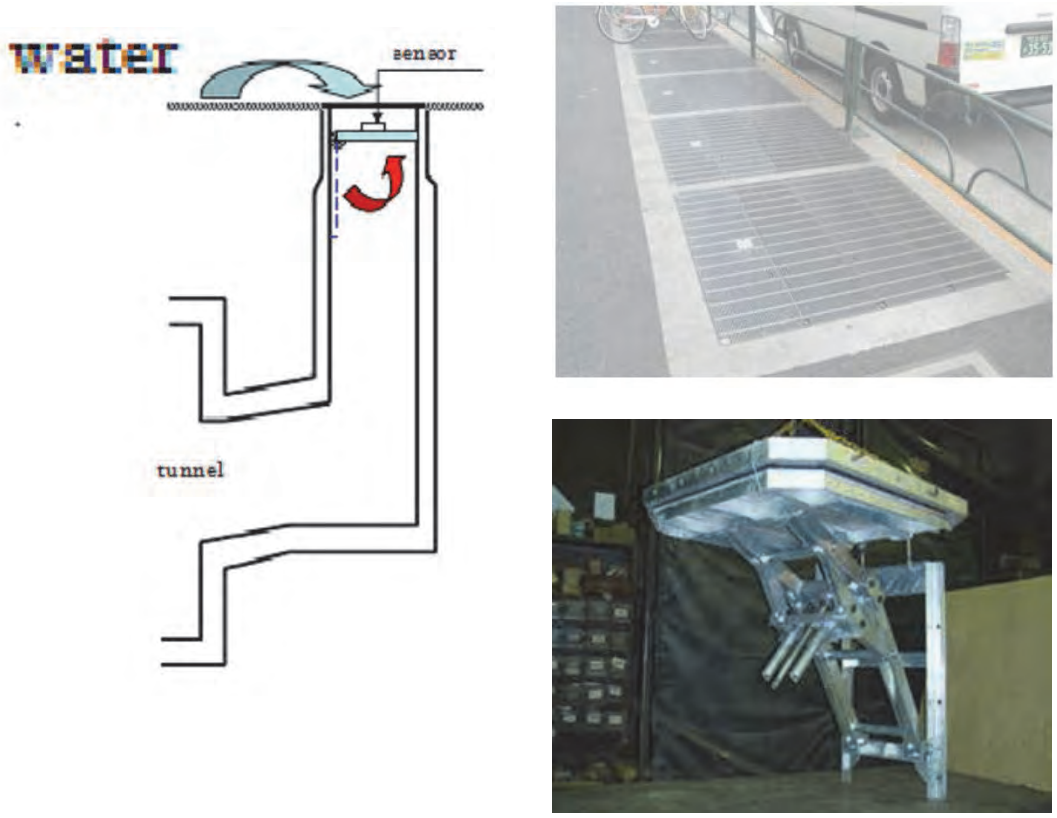
Source: *Tokyo Metro*

Figure 11.2.1.2-3 New Type Entrance of Subway Station in Tokyo

(2) Ventilation

The height of ventilation shaft is normally designed higher than the design high water level of the area where the ventilation is constructed. However, such measures cannot be applied to ventilations installed on roads. If the height of the opening is lower than the design high water level, flood prevention machine shall be installed at the entrance of the duct. The flood prevention machine is capable of closing door automatically by remote control from operation panel at each station, manual operation in the field, or immersion sensor.

Figure 11.2.1.2-4 Ventilation Tower



Source: *Tokyo Metro*

Figure 11.2.1.2-5 Flood Prevention Machine of Ventilation Duct at Road

(3) Tunnel Entrance of Mainline

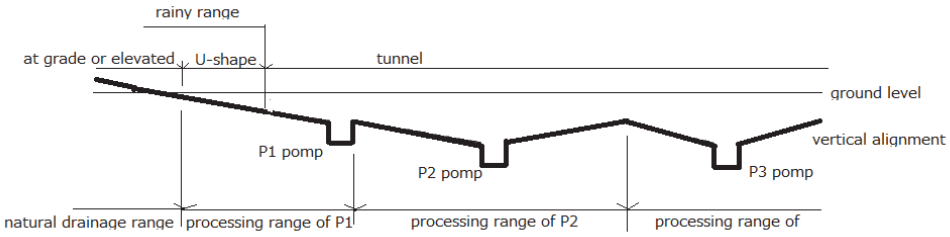
At the transition section from elevated to underground structures, one of the measures against inundation is the provision of waterproof wall and pumps. Waterproof wall taller than the design high water level in the respective area can be installed around the transition section. Since the rainwater inside waterproof walls enters into the tunnel section, a pump room that can pump out the rainwater shall be installed inside the tunnel. In addition to this, there is also a method of installing waterproof iron doors to prevent from water entering into the mainline.

Source: *Tokyo Metro*

Figure 11.2.1.2-6 Waterproof Wall at Grade Section (outside measure)

Source: *Tokyo Metro*

Figure 11.2.1.2-7 Waterproof Wall at Grade Section (inside measure)



Source: *Tokyo Metro*

Figure 11.2.1.2-8 Concept of Pump Installation

Source: *Tokyo Metro*

Figure 11.2.1.2-9 Waterproof Iron Door in Mainline Track

(4) Signage board

In order to be always aware of the prompt action at the time of flooding, a signage board that displays the above sea level can be installed at the station entrances.

Source: *Tokyo Metro*

Figure 11.2.1.2-10 Example of Signage for Station Entrance Height

(5) Others

(a) Establishment of manual

In preparation for flooding, a manual which contains emergency response, how to ensure the evacuation route, the emergency contact system, etc. must be established and disseminated to all station staff and employees of railway operation company.

(b) Training

Based on the manual, all employees must receive regular training how to cope with flood.

(c) Education

All employees must receive regular education related to the flood, for example flood damage in the past.

(d) Use of the online system of weather information

To obtain accurate information of the weather and flooding in a short time, online system of weather information should be adopted.

11.2.1.3 Measures in Thailand

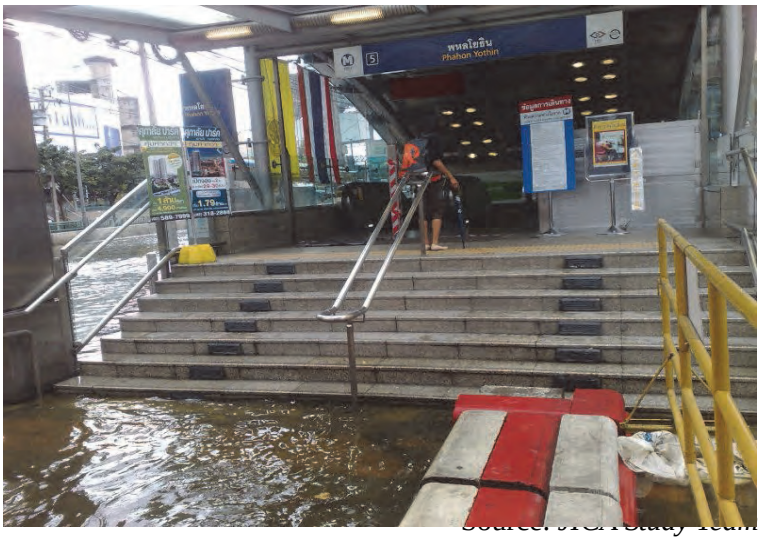
The flood measures for subway in Bangkok, Thailand was designed and constructed through technology cooperation and transfer by Japan. Bangkok has been affected by serious flooding in 2011, but the subway was maintained in operation as usual during the inundated period.

Source: *JICA Study Team*

Figure 11.2.1.3-1 Removable Water-stop Board of Station Entrance in Bangkok

Source: *JICA Study Team*

Figure 11.2.1.3-2 Removable Water-stop Panels installed at Station Entrance in Bangkok



Source: JICA Study Team

Figure 11.2.1.3-3 Higher Entrance of Station in Bangkok

11.2.2 Measures against Earthquakes

The Philippines is one of the countries where earthquake and volcanic activities are active in the world. The damage caused by earthquakes have often occurred in the past. Although underground structures are relatively strong to earthquakes, earthquakes measures is an essential element. In operating lines, after the earthquake has occurred, it is very important to confirm the safety of passengers and station staff as well as railway facilities and to resume railway operation as soon as possible for the benefit of railway users.

11.2.2.1 During Design Phase

The Seismic design largely influences the design of structures, and have been incorporated in earthquake-prone countries, e.g., Japan, the United States and New Zealand etc.

Particularly in Japan, the seismic design methods have been seriously studied and revised based on the experience of the Great Hanshin-Awaji Earthquake of 1995 and the Great East Japan Earthquake of 2011, and thus the seismic design method in Japan is considered as the highest level in the workd.

In the design phase of underground structures, it is essential to apply appropriate seismic design method.

11.2.2.2 During Construction and Operation

During the earthquake, underground structures are less likely to be affected compared to the ground structures, thus the construction of underground structures is considered to be relatively strong to earthquake impact.

One of the anticipated problems during the operation is that many people in the underground space feel anxiety, and tend to try to escape from the underground space to the ground rushing to doorways and stairs that may cause unnecessary chaos.

(1) Installation of seismometer

When a strong earthquake occurs, trains shall be immediately stopped safely, which can be achieved with an early earthquake warning system developed and in operation in Japan. In order to grasp the detailed situation of trains on the mainline, seismometers can be installed at several locations along the mainline.

(2) Establishment of early earthquake warning system

When the earthquake value exceeds the standard value, the early earthquake warning system can immediately stop all trains. Also a system to perform inspection and to resume operation in a short period from the sections where safety is confirmed should be established. ,

(3) Others

(a) Establishment of manual

In preparation for earthquake, a manual which contains emergency response, how to ensure the evacuation route, the emergency contact system, etc. must be established and disseminated to all employees of the railway operation company.

(b) Training

Based on the manual, all employees must receive regular training how to cope with earthquake.

(c) Education

All employees must receive regular education related to earthquake.

(d) Measures for railway users who cannot go back home

In case the cease of subway operation due to earthquake prevents passengers going back home, the railway operation company shall prepare drinking water, blankets, mats, portable toilets, etc. at all stations and provide them to those in needed and allow them to stay temporarily at the station until the restart of the railway operation, or the provision of alternative transportation.

11.2.3 Conclusion

With regard to flooding, it is considered that the target project area of the Study is located in the area where the potential risk of flooding is very unlikely or limited to minimum. However, in preparation for the worst case, it is recommended that facilities/equipment that are less expensive, such as removable water-stop panels for station entrances, waterproof walls at transition sections, etc. should be provided in the Project.

With regard to earthquake, it is considered that the target project area of the Study is not located in the area of occurrence of Tsunami and landslides caused by earthquakes. However, considering the worst case scenario, necessary provision shall be made, such as application of seismic design in design of railway structures, provision of less expensive facilities/equipment as measures against flooding and inundation, raise of station entrances for underground stations, etc., taking into account the cases applied in subways of Japan which have been developed in years to overcome potential natural disaster and in which various new and state-of-the-art technologies have been adopted.

Chapter 12

REVIEW OF SOCIAL AND ENVIRONMENTAL CONSIDERATION

Chapter 12 PREVIEW OF ENVIRONMENTAL AND SOCIAL CONSIDERATION

12.1 Review of Natural Conditions and Social Characteristics at Project Area

12.1.1 Current Environmental Conditions along Each Option Route

The project is the construction of a railway with underground and elevated structures that goes from the south to the north passing through the center of the Metro Manila. In the whole section (approximately 60km), the Phase 1 areas are mostly occupied by the Central Business Districts (CBDs), where the areas are highly developed as urban commercial and residential area. In the Phase 2 (North Zone and South Zone), the areas close to both north/south ends of the Phase 1 section are comparatively high density areas with commercial, industrial and residential buildings. On the other hand, the sections near both north/south ends of the option routes are still rural areas, thus there are various environmental conditions in the vicinity of the option routes. In this Study, the current conditions on the option routes were investigated by site visits and review of existing documents to find the issues on the environmental and social considerations for the implementation of the Mega Manila Subway Project (MMSP).

(1) Phase 1 North Side

The section between Mindanao Avenue-Quirino Highway Station and North Avenue Station, which is at the north side of the Phase 1 section, is a high density area where low-rise residences and commercial facilities are mixed. (Figures 12.1.1-1 and 12.1.1-2)

Source: *JICA Study Team*

Figure 12.1.1-1 Tandang Sora Ave. Area

Source: *JICA Study Team*

Figure 12.1.1-2 Mindanao Ave-Quirino Highway Station Area

(2) Phase 1 Central Zone (Alternatives)

The central part of the Central Zone, i.e. section between North Avenue Station and Ortigas North Station, has three option route alignments.

Regarding the Option 1, which is along EDSA with wide road width, the north side of Cubao Station is surrounded by low to mid-rise residential and commercial buildings which are located closely each other (Figure 12.1.1-3). Various areas exist together from dense small houses to gigantic shopping malls. The south of Cubao Station is a business and commercial district where many mid to high-rise buildings stand together. There are also some green areas in this section, such as golf course.

Regarding the Option 2, the section between North Avenue Station and Timong Avenue Station is a business and commercial district where mid to high-rise buildings stand together.

The section between Timing Avenue Station and Greenhills Station is mainly residential area which consists mostly of low-rise residences. The section between Greenhills Station and Ortigas North Station is mainly commercial area (Figure 12.1.1-4). There are some large shopping malls around Ortigas North Station.

Regarding the Option 3, the section between North Avenue Station and Araneta Avenue Station is a business and commercial district where mid to high-rise buildings stand closely. On the other hand, the section between Araneta Avenue Station and Jose Rizal University Station is a down town which still remains an old townscape. The area is crowded with small scale commercial buildings along narrow streets (Figure 12.1.1-5). The section between Jose Rizel University Station and Ortigas North Station is a commercial and residential area. There are some large shopping malls around Ortigas North Station.

Source: *JICA Study Team*

Figure 12.1.1-3 Quezon Ave. Station Area (Option 1)

Source: *JICA Study Team*

Figure 12.1.1-4 Greenhills Station Area (Option 2)

Source: *JICA Study Team*

Figure 12.1.1-5 Jose Rizal University Station Area (Option 3)

(3) Phase 1 South Side

The section between Ortigas North Station and Ortigas South Station is a central district of business and commerce activities (Figure 12.1.1-6). Mid to high-rise buildings stand together along Meralco avenue. The section between Ortigas South Station and Kalayaan Avenue Station is mainly occupied by dense low-rise houses. The MMSP route passes under Passig River in this section. The section between Kalayaan Avenue Station and

Bonicafio Global City Station is a newly developing area (Figure 12.1.1-7). The section between Bonicafio Global City Station and FTI Station goes partly under C-5 road and partly under residential area where houses (low-rise) are very crowded. There are also some warehouses and factories near FTI Station.

Source: *JICA Study Team*

Figure 12.1.1-6 Ortigas North Station Area

Source: *JICA Study Team*

Figure 12.1.1-7 BGC Station Area

(4) Phase 2 North Side

The north side of the Phase 2 has two option route alignments, one along the existing road and another running through areas mostly without existing roads.

(a) Option A

Option A route is on arterial roads almost throughout the entire section. Although Option A route does not require the acquisition and clearance of new lands, acquiring lands along the corridor will be required to construct piers for the elevated structures in the middle of the existing roads. The vicinity of Option A route has been already developed and the roadsides are medium density. However, the section between L.Langit Road Station and Zabarte Road Station is outskirts and remains some green areas (Figure 12.1.1-8). Land acquisition will be required in some sections of Option A, i.e. some residences along Zabarte Road between L. Langit Road Station and Camirin Road Station, residential and commercial buildings around Zabarete Road Station, commercial buildings around Novaliches Station (Figure 12.1.1-9), etc.

Source: *JICA Study Team*

Figure 12.1.1-8 Camarin Road Station Area

Source: *JICA Study Team*

Figure 12.1.1-9 Novaliches Station Area

(b) Option B

Since Option B route is off the existing roads almost throughout the entire section, large scale land acquisition will be required. The section between Bahay Pare Road Station and Mt. Samat Road Station is a low density area, and occupied by agricultural lands and woods (Figure 12.1.1-10). It is a rural area which remains natural environment. The section between Mt. Samat Road Station and Llano Road Station is a low density area, and occupied by agricultural lands, unused land and/or factories (or agricultural facilities). The section between Llano Road Station and Gen. Luis Station is occupied by low-rise buildings comprising newly developed residences and factories. The section between Gen. Luis Station and Mindanao Avenue-Quirino Highway Station is an industrial area, and occupied mainly by factories and industrial facilities (Figure 12.1.1-11). Besides residences are scattered and the density is medium.

Source: *JICA Study Team*

Figure 12.1.1-10 Bahay Pare Road Station Area

Source: *JICA Study Team*

Figure 12.1.1-11 Tatalon Station Area

(5) Phase 2 South Side

The south side of the Phase 2 has two option route alignments by structural type, either entirely elevated or combination of elevated and underground. However, the corridor of both route alignments are exactly the same.

The section between FTI Station and Dona Soledad Avenue Station is mainly high density residential area (Figure 12.1.1-12). There are large factories near FTI Station. Since most of the section is off the existing roads, large scale land acquisition will be required. The section between Dr. Arcadio Santos Avenue Station and Alabang-Zapote Road Station consists of medium density residential areas and unused lands including bare ground, where the whole section is off the existing roads. The section between Alabang-Zapote Road Station and Talon Singko Station goes through medium dense residential area on the existing road. The section between Talon Singko Station and Molino Road Station goes through medium dense residential area and unused land including bare ground, where the whole section is off the existing roads. The section between Molino Road Station and Governor's Drive Station is rural and agricultural land where natural environment still remains (Figure 12.1.1-13). The route alignment in this section goes on the existing road through low density residential areas and agricultural lands. The route of the railway penetrates some agricultural lands or undeveloped lands.

Source: *JICA Study Tean*

Figure 12.1.1-12 Dona Soledad Avenue Station Area

Source: *JICA Study Tean*

Figure 12.1.1-13 Paliparan Road Station Area

12.2 Potential Environmental and Social Impact due to MMSP

12.2.1 Impacts and Requirements on Environmental Considerations

(1) Phase 1

The vicinity in the Phase 1 section has been already developed. The areas include lands with various purposes, such as residence, office building, commercial building and factory. Since all option routes are planned as underground railway, the environment condition on the ground will not directly affect the railway. The entrances and ventilation facilities at stations located at the ground level are relatively small scale facilities, and the existence of those facilities will not affect the environment of the area. Three option routes in the Central Zone have few differences in terms of environmental and social considerations necessary to be taken into account.

(2) Option A: North Side of Phase 2

The vicinity of Option A route has been already developed and does not remain natural environment. Therefore, the implementation of the MMSP will not generally cause degradation of natural environment to the areas along the route. On the other hand, elevated railway may have negative impacts, such as noise, sunshine and landscape, to residences along the route.

The expansion of the width of the existing roads will be required throughout the section, and the route runs off the existing roads at some locations. The land acquisition may cause involuntary resettlement to quite a lot of people residing in the area.

There is no subject which requires special consideration, such as preserved area or vulnerable facility.

(3) Option B: North Side of Phase 2

Natural environment still remains in the north side of Option B route. To secure the exising natural environment, appropriate considerations will be required. There are many factories along Option B route. The construction work of the MMSP may diffuse toxic substances which might be accumulated in the ground of some factories. Considerations on soil pollution and waste management will also be required.

Land acquisition will be required throughout Option B route, and may cause large scale involuntary resettlement.

(4) South Side of Phase 2

The section between FTI Station and Molino Road Station is mainly occupied by high-medium dense residential area. The vicinity of the route has been already developed, and natural environment is not remained. Since the vicinity is mainly residential area, elevated railway may cause negative impacts, such as noise, sunshine and landscape, to the residences along the route.

The section between Molino Road Station and Governor's Drive Station is a suburban or rural area where natural environment still remains. Because of low density area, the MMSP would not seriously affect the existing living environment. However, appropriate considerations to maintain the existing natural environment will be required.

Beside the expansion of the existing roads, large scale land acquisition will be required at some locations. The land acquisition may cause large scale involuntary resettlement.

Areas which require special consideration such as preserved area and vulnerable facility are not found.

There are many factories within the route, thus the construction work may diffuse toxic substances which might be accumulated in the ground of some factories. Considerations on soil pollution and waste management will also be required.

12.2.2 Required Land Acquisition Area and Estimated Number of Involuntary Resettlement

Since the MMSP option routes, regardless of the option, have long length and go through urban areas and residential areas of outskirts, land acquisition and resettlement is unavoidable. The scales of land acquisition, Project Affected Houses (PAHs) and Project Affected Persons (PAPs) are different among route options and also among sections of each option.

For the implementation of the Phase 1 of the MMSP, station facilities including entrances and ventilation spaces will be required at the ground level, thus land acquisition will be required for such facilities unless the pavement along the existing roads could be utilized. However, since the scale of the land acquisition is small, the expected number of (physical) resettlements would not be large. In the Phase 2 implementation, land acquisition on areas off the existing roads (or its right of way) may cause certain volume of involuntary resettlements. Involuntary resettlements might be also required in areas where setback of some properties along the existing roads will be required, which result in the demolition of the existing houses/buildings and thus resettlement to other places.

The scales and the costs required for the land acquisition, the number of PAHs and PAPs are estimated under following conditions:

- Width of ROW is 12m through the entire section. Regarding the elevated sections, the width of piers require the setback (1.5 m) on both roadsides to expand the road width by 3 meters.
- The dimension of elevated stations is 4,200sq.m (210 m x 20 m), and that of underground stations is 1,000sq.m (10 m x 15m each for 4 entrances and 20 m x 20 m for ventilation facility per station).
- The number of PAHs is estimated by counting buildings within the ROW on the satellite image provided by Google (Google Earth).
- It is assumed that PAHs have average 6 persons (PAPs).[1] The persons of industrial and

[1] Average size of household around Metro Manila is shown as 4-5 in Draft Resettlement Action Plan for North-South Commuter Rail Project (2014, JICA)

commercial facilities are excluded as PAPs because they are not the subjects of physical resettlement and the estimation of the number is very difficult.

- It is assumed that the average dimension of affected residences is 100 m^2 of floor areas, and that of commercial buildings and factories are 1,000 m^2.
- Land costs are cited from the zonal values of BIR (Bureau of Internal Revenue).
- Costs of necessary compensation are cited from the Draft Action Plan for North-South Commuter Rail Project (2015, JICA). The data for Manila area is used for consideration for Phase 1 implementation, whereas the data of Balacan is used for Phase 2.
- The route alignments of underground sections would cause no involuntary resettlement. However, compensations for usage of subterranean spaces under privately owned lands and buildings on and/or above the ground are required under the current legislation of the Philippines.

The scales of land acquisition and resettlement are shown in Table 12.2.2-1.

Table12.2.2-1 Estimated Land Acquisition and Resettlement on MMSP

Phase	Route Alignment Option	Land Acquisition		Resettlement		
		Dimension (ha)	Cost (Million Php)	Number of PAHs	Number of PAPs	Compensation for structure (million Php)
Phase1	1	11.3	8,582	568	3,012	874
	2	14.0	8,603	714	3,702	1,303
	3	12.4	9,312	652	3,270	1,364
	Depot (North)	16.0	640	182	1,008	53
Phase2	North A	7.0	1,158	1,020	5,586	224
	North B	12.2	686	437	2,256	302
	South a	25.2	1,129	1,777	9,204	782
	South b	22.6	911	1,646	8,580	762
	Depot (South end)	16.0	400	0	0	0

Source: *JICA Study Team*

Regarding Phase 1, three route options have almost the same scale of land acquisition and resettlement since all route options are planned underground.

Regarding the north section of Phase 2, although Option A requires less land acquisition than Option B, the cost of land acquisition and the number of PAHs and PAPs of Option A are more than those of Option B. The reason is that although Option B is almost off the existing roads and requires more land acquisition, Option A also requires setback of properties at dense roadsides and the unit costs of lands in these areas are higher than those of Option B.

12.3 Policy and Current Situation of Land Acquisition and Resettlement Action Plan

12.3.1 Laws and Legislations on Social Consideration

The main laws and regulations on land acquisition and involuntary resettlement in the Philippines are summarized in Table 12.3.1-1.

Table 12.3.1-1 Relevant Laws on Land Acquisition and Involuntary Resettlement in the Philippines

Laws	Provisions
The Philippine Constitution of 1987	• Private property shall not be taken for public use without just compensation. (Article III, Bill of Rights, Section 9) • Urban or rural poor dwellers shall not be evicted nor their dwelling demolished, except in accordance with law and in a just and humane manner. No resettlement of urban or rural dwellers shall be undertaken without adequate consultation with them and the communities where they are to be relocated. (Article XIII, Urban Land Reform and Hosing, Section 10)
Republic Act No. 7160 *(Local Government Code of 1991)*	• The power of eminent domain by the local government unit may not be exercised unless a valid and definite offer has been previously made to the owner, and such offer was not accepted.
Republic Act No. 7279 *(Urban Development and Housing Act of 1992)*	• The mandate of this Act is to uplift the conditions of the underprivileged and homeless citizens in urban areas and in resettlement areas by making available to them decent housing at affordable cost, basic services, and employment opportunities. • Socialized housing or resettlement areas shall be provided by the LGUs or the National Housing Authority (NHA) in cooperation with the private developers and concerned agencies with the basic services and facilities.
Republic Act No. 8974 *(An Act to Facilitate the Acquisition of Right-of-Way [2000])*	• This Act establishes a uniform basis for determining just compensation for immediate possession of the property involved in eminent domain proceedings. Whenever it is necessary to acquire real property for the ROW or location for any national government infrastructure project through expropriation, the appropriate implementing agency shall conduct mainly monetary compensation for land acquisition from the legitimate owners. • The government through the NHA, in coordination with the LGUs and implementing agencies concerned, shall establish and develop squatter relocation sites, including the provision of adequate utilities and services such as water, electricity, sanitation and transportation.
Indigenous Peoples' Rights Act (IPRA) of 1997	• The IPRA sets conditions, requirements, and safeguards for plans, programs, and projects affecting Indigenous Peoples. It spells out and protects the rights of Indigenous Peoples.
Executive Order (EO) No.1035, 1985	• EO 1035 provides the procedures and guidelines for the expeditious acquisition by the government of private real properties or rights thereon for infrastructure and other government development projects. • Financial assistance to displaced tenants, cultural minorities and settlers equivalent to the average annual gross for the last 3 years and not less than PhP 15,000 per ha.

Source: *JICA Study Team*

12.3.2 Current Situation of Land Acquisition and Resettlement Action Plan

The Philippines has no unified authorities who deal with land acquisition and resettlement. Each project proponent implement the land acquisition and the resettlement individually. Regarding land acquisition, project proponents have implemented them basically under Republic Act No. 8974.

Illegal settlers are handled under Republic Act No.7279. Project proponents cannot force them into involuntary resettlement without providing relocation sites. Local Government Units (LGUs) of the project site are responsible for PAPs and for providing relocation sites. National Housing Authority (NHA) assists LGUs on the development and preparation of suitable and appropriate relocation sites.

The existing relocation sites near the Metro Manila are shown in Table 12.3.2-1. Recently, the capacity of relocation sites have become tight. Project proponents are required to keep minimize the number of PAPs when planning new projects.

Table 12.3.2-1 Existing Relocation Sites near Metro Manila

Site	Location	Notes
San Jose Del Monte Heights	Brgy. Muzon, San Jose Del Monte, Bulacan	
Pandi Residence	Brgy. Mapulang Lupa, Pandi, Bulacan	
Disiplina Village	Brgy. Bignay Valenzuela City	Under Planning (to be completed by 2016)
New Candidate Site	Brgy. Lambikan, Marilao	Proposed Site (to be constructed in 2016)

Source: *JICA Study Team*

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Chapter 13

PRELIMINARY PROJECT EVALUATION

Chapter 13 PRELIMINARY PROJECT EVALUATION

13.1 Preliminary Economic Evaluation of Mega Manila Subway Project

13.1.1 Approach/Methodology

The JICA Study Team has conducted incremental discounted cash flow analysis to assess the economic viability of the Mega Manila Subway Project (MMSP or the Project). The Economic Internal Rates of Return (EIRRs) and Economic Net Present Values (ENPVs) were calculated to determine the viability of each of the proposed route options. The analysis focused on the assessment of the "with-project" and "without-project" scenarios to measure the incremental impact of the Project. The duration of the Project was assumed to be 45 years, including the construction period of 5 years for Phase 1 from 2020 and the operating period of 40 years starting in 2025. Phase 2 construction of 5 years is included in the operating period, where the commencement of Phase 2 is planned to be 2035.

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

13.1.2 Comparison of Benefits and Costs

(1) Economic Costs of the Project

The economic costs were determined by deducing all taxes and price contingencies included in the financial cost and by applying the shadow wage rate to the unskilled labor component of the investment cost. Economic costs were estimated to be equivalent to about 85% of the financial cost. The conversion factor applied to the operating and maintenance (O&M) costs was also assumed at 85%. Table 13.1.2-1 shows the cost of Option A1a as an example.

Table 13.1.2-1 Estimated Project Economic Cost of Option A1a

Unit: Million USD (2015 constant price)

Items	Phase 1	Phase 2
Civil Structures	2,291.95	1,162.29
Trackwork	72.53	99.68
Rolling Stock	269.93	762.17
E&M Systems	310.52	384.94
Physical Contingency	247.49	232.73
Consultants Cost	332.93	271.59
Land Acquisition and Compensation	207.82	68.04
Total Project Cost	3,733.17	2,981.44

Source: *JICA Study Team*

(2) Economic Benefits of Project

The main economic benefits of the MMSP are the savings owing to the reduction in Vehicle Operating Cost (VOC) and Travel Time Cost (TTC). The construction of the MMSP is expected to reduce traffic volume along and surrounding railway corridor, which in turn will result in shorter travel times and faster vehicle operating velocity. The shorter travel time translates into lower travelling time costs, while the faster vehicle velocity implies lower operating costs. The values of these economic benefits will be based on the willingness to pay for time cost and VOC per trip. Additional economic benefits that may be included in the analysis are accident cost savings, reduction in carbon dioxide emissions and avoided road maintenance cost.

In the process of calculating the core benefits of the Project, the unit VOCs and TTCs were estimated. The unit VOCs were based on the average operating costs of the representative set of vehicles (Table 13.1.2-2). The cost items that were considered in the computation were: (1) fuel cost, (2) lubricant cost, (3) tire cost, (4) repair cost, (5) depreciation cost, (6) capital opportunity cost, (7) overhead cost, and (8) crew cost. The results of the computation were consolidated and expressed as a function of travel speed.

Table 13.1.2-2 Unit VOC in the Philippines, 2014

(Unit: USD per 1,000 kilometer)

	Speed (km/hour)	Private Car	Jeepney	Standard Bus	Truck
Economic	5	696	1,127	2,186	4,540
	10	427	656	1,257	2,529
	20	284	416	785	1,517
	30	234	340	635	1,098
	40	208	297	558	899
	50	195	297	547	808
	60	197	321	574	758
	70	204	356	620	747
	80	215	396	675	775
Cost	90	231	429	725	829

Source: *JICA Study Team*

The estimates of unit TTCs were based on the mode of transportation across household income groups. The monthly TTC per mode of transportation was the weighted average of household income with percentage of vehicle ownership as weights. (Table 13.1.2-3) However, these values represented the value of time while working and not the travel time cost. The average value of travel time per mode of transportation was the product of value of time per hour and the share of business trip and “to work” trip. Unit TTCs were assumed to grow in line with per capita GRDP of the Mega Manila area.

Table 13.1.2-3 Present and Future Time Value of Passengers

(Unit: USD per hour)

Mode	Private Car	Public		
		LRT	Jeepney	Bus
2014	2.85	1.99	1.99	1.99
2020	3.76	2.63	2.63	2.63
2025	4.77	3.34	3.34	3.34
2034	6.93	4.84	4.84	4.84
2035	7.15	4.99	4.99	4.99
2045	9.61	6.71	6.71	6.71

Source: *JICA Study Team*

Environmental improvement due to the decrease of Greenhouse Gas (GHG) emission is also considered as an important benefit of the MMSP. Detail description of the effect of the reduction of GHG by introducing the MMSP is referred in Table 13.1.2-4. The effect of the reduction of GHG emission is very important in particular from the view point of environment, but the benefit created by the reduction of GHG emission is very small compared with other benefits and the construction cost of the MMSP. Thus, the effect of the reduction of GHG emission does not much exercise influence on the economic evaluation in this Study.

Table 13.1.2-4 Estimated Reduction of GHG Emission

Unit: GHG ton/year

Option	Year		
	2025	2035	2045
A1	30,299	430,859	789,892
A2	92,882	477,594	904,445
A3	91,403	463,430	828,474
B1	30,299	431,239	744,839
B2	92,882	356,405	713,801
B3	91,403	484,370	679,966

Source: *JICA Study Team*

The current trend of the economic analysis for transport projects tend to include the health benefit, which is a benefit to people in terms of their health due to the reduction of vehicles on roads and thus the reduction of harmful substances in the air that have negative impact to the people's health. On the other hand, it is a trend of nowadays to consider disruption cost as well, where the cost of loss during the construction period due to disruption to traffic movement by closure of some sections on roads required for construction of elevated structures, station structures for underground sections and shafts for tunnel boring machines to enter into the underground space. These costs will be considered as benefits in the economic analysis to be carried out in the next phase, i.e. Feasibility Study, together with the above mentioned costs.

13.1.3 Economic Evaluation

(1) Cost Benefit Analysis

The results of the economic analysis are shown in Table 13.1.3-1. EIRR of all proposed route options yielded the social discount rate set at 15% by the National Economic and Development Authority (NEDA). This indicates that all of the proposed route option are economically viable. The results also show large ENPV. (refer to Appendix E for details)

Table 13.1.3-1 Results of Economic Valuation

Option	Indicator	Result
A1a	EIRR (%)	17.3%
	ENPV(USD million)	42.01 million USD
	B/C Ratio	17.49
A2a	EIRR (%)	17.1%
	ENPV(USD million)	45.07 million USD
	B/C Ratio	18.47
A3a	EIRR (%)	17.2%
	ENPV(USD million)	44.91 million USD
	B/C Ratio	17.33
B1a	EIRR (%)	17.6%
	ENPV(USD million)	44.81 million USD
	B/C Ratio	18.44
B2a	EIRR (%)	16.9%
	ENPV(USD million)	44.28 million USD
	B/C Ratio	18.03
B3a	EIRR (%)	17.3%
	ENPV(USD million)	42.25 million USD
	B/C Ratio	16.20

A1b	EIRR (%)	17.3%
	ENPV(USD million)	41.98 million USD
	B/C Ratio	17.27
A2b	EIRR (%)	16.7%
	ENPV(USD million)	44.82 million USD
	B/C Ratio	16.87
A3b	EIRR (%)	16.9%
	ENPV(USD million)	44.67 million USD
	B/C Ratio	15.91
B1b	EIRR (%)	17.2%
	ENPV(USD million)	44.56 million USD
	B/C Ratio	16.83
B2b	EIRR (%)	16.6%
	ENPV(USD million)	44.04 million USD
	B/C Ratio	16.48
B3b	EIRR (%)	16.9%
	ENPV(USD million)	42.00 million USD
	B/C Ratio	14.89

Source: *JICA Study Team*

(2) Sensitivity Analysis

A sensitivity analysis was carried out for the highest EIRR option (Option B1a) and lowest EIRR option (Option B2b) to determine the sensitivity of EIRR to changes in costs and benefits. The results show that some cases will not render the project economically viable. (Those with grey shade in Tables 13.1.3-2 and 13.1.3-3 show that the cases are not economically viable.)

Table 13.1.3-2 Sensitivity Analysis of Economic Evaluation (Option B1a)

Benefit/Cost		Change in Economic Cost		
		Base Case	+10%	+20%
Change in Economic Benefit (%)	Base Case	17.6%	16.9%	16.2%
	-10%	16.8%	16.1%	15.5%
	-20%	15.9%	15.2%	14.6%

Source: *JICA Study Team*

Table 13.1.3-3 Sensitivity Analysis of Economic Evaluation (Option B2b)

Benefit/Cost		Change in Economic Cost		
		Base Case	+10%	+20%
Change in Economic Benefit (%)	Base Case	16.6%	15.9%	15.3%
	-10%	15.8%	15.1%	14.5%
	-20%	14.9%	14.3%	13.7%

Source: *JICA Study Team*

13.2 Preliminary Financial Evaluation of Mega Manila Subway Project

13.2.1 General

The main purpose of the financial project analysis is to examine the financial viability of the Project from the viewpoint of the implementation body.

As a first step of the financial analysis, based on the estimation in terms of revenues, investment cost and operation/maintenance costs, Financial Internal Rate of Return (FIRR) is calculated regardless of fund raising conditions and without interest cost in which the initial investment is assumed to be made without any subsidized loan as well as any grant subsidies from the government.

13.2.2 Fare System and Demand Forecast of MMSP Passenger

The operation revenue of the project are estimated based on the results of the transport demand forecast, in which the distance proportional system of fare is applied to examine the price-demand relationship under the several assumptions of fare system as shown in Table 13.2.2-1.

Table 13.2.2-1 Assumption of Fare System

Unit: Peso

Fare	Amount
Entry Fee per Passenger	37.50
Distance Proportional Fee per Km	2.8/km

Source: *JICA Study Team*

Table 13.2.2-2 shows the results of fare revenue based on the transportation demand forecast.

Table 13.2.2-2 MMSP Passenger Fare Revenue

Unit: Million USD/year

Option	2025	2035	2045
A1a	159.49	1,023.04	1,904.29
A2a	148.58	1,020.90	1,925.10
A3a	172.27	1,108.69	2,098.71
B1a	159.49	1,104.54	1,971.54
B2a	148.58	1,114.20	2,027.60
B3a	172.27	1,260.07	2,189.27
A1b	159.49	1,023.04	1,904.29
A2b	148.58	1,020.90	1,925.10
A3b	172.27	1,108.69	2,098.71
B1b	159.49	1,104.54	1,971.54
B2b	148.58	1,114.20	2,027.60
B3b	172.27	1,260.07	2,189.27

Source: *JICA Study Team*

13.2.3 Project Cash Flow

(1) Cost

Based on the cost estimate of the MMSP described in Chapter 8, the investment cost of infrastructure and operation/maintenance costs are distributed to annual allocation.

a) Prices: Constant price in 2015 is used. Inflation is not taken into account both in revenue and cost estimates during the evaluation period to calculate the FIRRs.

b) Evaluation period of Project: Until 36 years after the start of the operation of the MMSP.

c) Cost: Initial investment cost, replacement cost of capital and O&M costs for infrastructure and the MMSP operation services are included.

d) Additional investment cost for rolling stocks due to the increase in passenger demand is estimated when it is necessary.

e) Replacement costs of rolling stock, signaling and other electric and mechanical facilities are estimated based on the life period of the facilities.

(2) Revenue

a) Passenger Revenue

The revenue of the Project is calculated based on the results of the demand forecast. The passenger demand will be saturated when passenger trips of the MMSP per day reach the transport capacity limitation of the railway.

b) Other Revenue

Other revenue from the related business associated with the MMSP operation, such as Kiosk and advertisement, cannot be and thus were not assumed in this Study.

(3) Project Cash Flow

As a first step of the financial analysis, based on the estimation in terms of revenues, investment cost and O&M costs, the Financial Internal Rate of Return (FIRR) including the payment of VAT regardless fund raising conditions without interest cost, in which the initial investment is done without any loan or any subsidies from the government, were carried out. The results of each route option are shown in Table 13.2.3-1. The stream of the cash flow of each route option during the project period is shown in Appendix E. The value of FIRR ranges from 8.64% to 9.39%. On the other hand, the current interest rate in the Philippine is considered to be PHBOR[1] (7-8%) plus 2-3% in accordance with the degree of risk, which implies that around 10% would be the minimum required FIRR to be financially viable. Therefore, it is considered difficult to find the commercial viability for the MMSP.

Table 13.2.3-1 FIRR of MMSP

Option	FIRR
A1a	9.20%
A2a	9.08%
A3a	9.11%
B1a	9.39%
B2a	9.38%
B3a	9.35%
A1b	9.13%
A2b	8.64%
A3b	8.71%
B1b	8.97%
B2b	8.95%
B3b	9.22%

Source: *JICA Study Team*

[1] Philippines Inter Bank Offered Rate

Chapter 14

PROJECT IMPLEMENTATION SCHEMES AND FINANCIAL PLANS

Chapter 14 FINANCIAL PLAN AND PROJECT IMPLEMENTATION SCHEME

14.1 Preliminary Consideration on Financial Plan

The Economic Internal Rates of Return (EIRRs) of all proposed route options yielded the social discount rate set at 15% by the National Economic and Development Authority (NEDA) as described in Chapter 13 in detail. This indicates that the proposed route options are economically viable and thus the government of the Philippine should implement the Mega Manila Subway Project (MMSP or the Project) in terms of the national economy. However, the results of FIRRs also described in Chapter 13 indicate that it is difficult for the "Implementation Body" to implement this MMSP without any support of the government of the Philippines.

14.1.1 Viability by Private Funds

The resulted FIRRs of the MMSP estimated at around 9% are not attractive enough for the private sector to implement the MMSP by their own funds. Huge capitals (approximately 9,200 Million USD) are required to implement the MMSP, so the private sector have to shoulder high investment cost and the entire portion of the market risk of the Project. Thus, the private sector would not have interest in implementing the MMSP by their own funds, judging from the results of the value of preliminary FIRR and the estimated investment cost. Moreover, full cost recovery by the private sector may result in tariffs higher than the potential commuter's willingness and ability to pay.

14.1.2 Viability by Government Budget of the Philippines

The Government of the Philippines set at 3.5% from 2014 to 2022 (and 5.0% thereafter) of the Gross Domestic Product (GDP) as the estimated investment cost to be spent for all types of infrastructure though historically, government's allocation for infrastructure and other capital outlays have not gone beyond 2.3% of the GDP since 1995 until 2013. Table 14.1.2-1 indicates that the value of the GDP and the estimated allocations of the government cash disbursement for infrastructure and other capital outlays.

Table 14.1.2-1 GDP and Cash Disbursement for Infrastructure and Other Capital Outlays

Unit: Million USD

	2012	2013	2014	2015*
GDP (nominal)	240,440	262,757	284,930	308,030
Historically estimated budget for infrastructure (2.2%)	4,897 (2.04%)	5,958 (2.27%)	5,699	6,161
Spending target (3.5%)	8,758	9,522	9,973	10,781
Spending target (5.0%)	12,512	13,604	14,247	15,401

Note: Values of masked column are actual values.
Values of plane column are estimated values.

Source: *IMF (Values in 2015 are estimate) and "Fiscal Statistics Handbook (1994～2013)", Department of Budget and Management*

On the other hand, the estimated project cost of the MMSP is approximately 9,200 Million USD, varying among options, as described in detail in Chapter 8. Historical annual cash disbursement for the infrastructure development implies that the required investment cost for the implementation of the MMSP is apparently huge compared to the national budget for the infrastructure development. In case of spending target (3.5% or 5.0%), only the MMSP almost occupies the total annual budget for the infrastructure development in the past few years. It is not practical and realistic to implement the MMSP by only the government budget of the Philippines.

14.1.3 Funding Opportunities

As described in Chapters 14.1.1 and 14.1.2 above, it is difficult to implement the MMSP by only the government budget of the Philippines or by the private funds, judging from the situation of the national government finance in the Philippines, the estimated financial rate of return, etc.

The MMSP may be implemented under a Public-Private Partnership (PPP) arrangement or financed through the official development assistance (ODA) of other country, such as Japan, where the interest of the loan is kept low. If implemented under the PPP scheme, the private proponent will most likely require full cost recovery of the investment cost, O&M cost, capital expenditures and loan amortization, which the PPP law of the Philippines stipulates that the government is prohibited to take a share of more than 50% of the total project cost. Given the huge capital requirements required, the private proponent may be unwilling to shoulder the entire portion of the market risk of the Project unless some forms of guarantees are provided by the national government.

If the project will not attract interest of the private sector, then it can be financed by the ODA, provided either by bilateral agreement or by multilateral agencies. One possible funding strategy is to use a combination of the public sector financing, i.e. ODA, and the PPP arrangement to arrive at a workable project package. In effect, there will be three sources of funds; the public sector, the ODA and the private sector.

Another viable funding approach is the separation of the construction and the ownership of the basic railway infrastructure, the procurement of rolling stock and E&M systems. The former will be responsibility of the public sector, while the latter will be assigned to the private sector on a concession basis. ODA loan can be used by the public sector to finance the construction of infrastructure, i.e. civil structures, stations, depot, railway track, escalators/elevators, and others.

14.2 Preliminary Consideration on Project Implementation Scheme

Large scale infrastructure projects, in the past, usually rely on pure public funding with budgets by the implementing agencies. Foreign funds have been also often infused to a large extent by the ODA.

Due to a lack of fiscal resource and the need to accelerate the infrastructure development, the PPP mode of implementation has evolved and has been bringing in more projects to be realized.

14.2.1 Cases in Other Countries

Possible implementation schemes are presented here in consideration of the situation of the MMSP as well as examples of cases in other countries. Table 14.2.1-1 indicates that the outline of MRT in 3 urban cities in Southeast Asia.

Table 14.2.1-1 Outline of MRT in 3 Urban Cities in Southeast Asia

	Bangkok	**Kuala Lumpur**	**Manila**
	Blue Line	Star	MRT Line 3
Sponsor	MRTA under Ministry of Transport (central government)	EPU under PM's Department (central government)	DOTC under central government
Concessionaire and major shoreholder	BMCL CH Karnchang (Thai construction company)	STAR Gov't, Taylor, Woodrow/Adtranz	ELC 4 Filipino property developers
Concession	Equipment/ops BOT for 25 years, Civil Works funded by Japanese ODA Loan	BOO (review after 60 years)	BLT for 25 years in return for guaranteed revenue stream + property upside

	Bangkok	**Kuala Lumpur**	**Manila**
	Blue Line	Star	MRT Line 3
Cost (Billion USD)	3.1 (of which concessionaire at 0.6)	0.9	0.7
Financing ● Government ● Equity ● Foreign debt ● Domestic debt	 80% (land/civil works) 6% 5% 9%	 0% 20% 0% 80% (incl. gov't support loan)	 0% (Gov't repay 100% under the lease) 28% 56% 16%

Source: *World Bank (2004)*

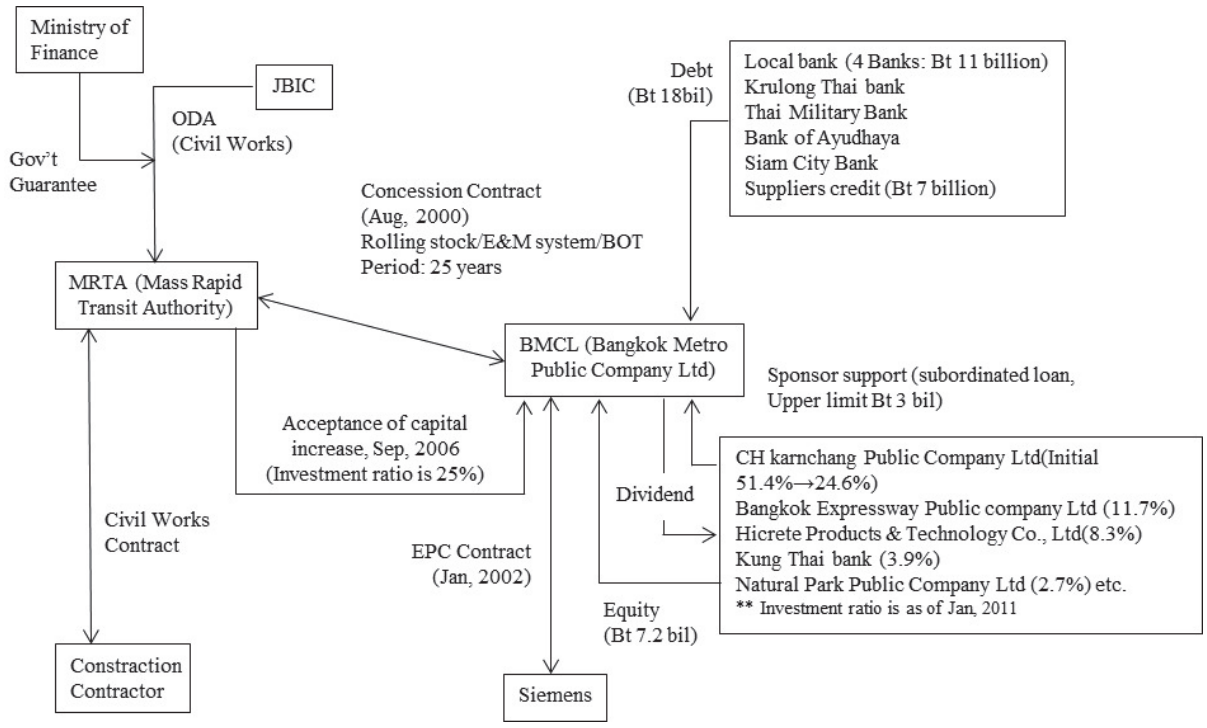
As described in Table 14.2.1-1, there are wide range of implementation schemes in PPP, e.g. Build-Operate-Transfer (BOT), Build-Own-Operate (BOO), Build-Lease-Transfer (BLT), etc. Application of BLT in transportation sector is a rare case, although it was adopted in Manila's MRT Line 3. Concession period varies among projects, ranging from 25 years to 60 years. Originally, the established period of the concession had a big impact on the final profit of the business operator, however, concession period has not been theoretically established. Method of fund raising in cases of Bangkok and Manila much relied on the foreign capital, whereas most of fund raising in Kuala Lumpur's case relied on domestic finance. Civil works of the Blue Line (subway of 20 km distance) in Bangkok were implemented by the Japanese ODA loan, thus the loan proportion from the government was high among the overall project cost. However, other MRTs were implemented only by the loan from the private sector.

14.2.2 Overview of Specific Cases in Other Countries

Overview of the case of Blue Line Project, Bangkok, Thailand as shown in Table 14.2.1-1 and the case of Delhi Metro Project, India, both of which were partly financed by Japanese ODA Loan, are described below.

(1) In case of Blue Line Project in Bangkok, Thailand

Blue Line Project in Bangkok was implemented by two-tiered method.



Source: *PPIAF, World Bank*

Figure 14.2.2-1 Project Implementation Scheme of Blue Line in Bangkok

The MRTA (Mass Rapid Transit Authority of Thailand) was established in 1992 under the Ministry of Transport of the Kingdom of Thailand to facilitate the urban railways in Bangkok, having started from the implementation of Blue Line.

Civil Works were carried out from 1996 to 2002 with the total amount of 222.2 billion yen as a loan from the Japanese government.

Concession contract (period 25 years) was concluded between the MRTA and the BMCL (Bangkok Metro Public Company Ltd.). Based on this concession contract, the BMCL has been responsible for 25 years' train operation and maintenance activities of all railway facilities after the completion of the procurement and the installation of rolling stock and E&M systems, which was included as a part of the concession contract. The net-cost model, where fare revenue goes into the BMCL at first and then some portion of the fare revenue is paid to the MRTA in accordance with the ratio as stipulated in the concession contract, which is typically known as the "track access charge". Therefore, the BMCL (Concessionaire) undertakes the risk of passenger demand during the concession period.

(2) Delhi Metro Project in India

Delhi Metro Project often comes on as a successful example of the Japanese ODA Loan (or Yen Loan) financed project. There are number of reasons why this project has been considered as successful. One thing is that the project was completed within the scheduled time for the first time as public works project in India. The construction of the project started in 1998 and partially completed in 2002, far ahead of the originally planned schedule.

In Phase I of the project, Japanese ODA loan was initially offered to the Government of India in February 1997, and the construction started in October 1998. After that, the Delhi Metro was sequentially opened for each finished section. Initial opening of a part of the Line 1 between Tis hazari Station and Shadara Station (approx. 8.3 km) was made in

December 2002, and the last part of the project, i.e. Line 3 between Barakhamba Station and Indraprastha Station (approx. 3.0 km) was finally opened in November 2006. The Phase 2 of the project commenced subsequently.

Table 14.2.2-1 Phase 1 of Delhi Metro Project

Line	Configuration	Number of Station *( ) shows the number of stations financed by Yen Loan	Distance ( ) shows the length of sections financed by Yen Loan
Line 1	Elevated (17.5 km) Above ground (4.5 km)	21 stations (21 stations)	22 km (22 km)
Line 2	Underground (11 km)	10 stations (10 stations)	11 km (11 km)
Line 3	Elevated (29.93 km) Underground (2.17 km)	31 stations (31 stations)	32.1 km (32.1 km)

Note: Total length of Phase 1 is 65.10 km (Yen loan portion is approx. 58.6 km.)

Source: *JICA Study Team*

Table 14.2.2-2 Phase 2 of Delhi Metro Project

Line	Configuration	Number of station ( ) shows the number financed by yen loan	Distance ( ) shows the distance financed by yen loan
Line 1 (Extension)	Elevated (3.09 km)	3 stations (3 stations)	3.09 km (3.09 km)
Line 2 (Extension)	Underground (13.47 km) Elevated (20.34 km)	24 stations (19 stations)	33.81 km (26.31 km)
Line 3 (Extension)	Elevated (14.57 km) Above ground (2.00 km) Underground (1.26 km)	13 stations (7 stations)	17.83 km (10.83 km)
Line 4	Elevated (8.74 km)	7 stations (5 stations)	8.74 km (6.17 km)
Line 5	Elevated (18.46 km)	16 stations (16 stations)	18.46 km (18.46 km)
Line 6	Elevated (13.91 km) Underground (6.10 km)	15 stations (15 stations)	20.01 km (20.01 km)
Airport Link	Underground (10.35 km) Elevated (12.34 km)	5 stations (0 station)	22.69 km (0 km)

Note: Total length of Phase 2 is 128.06 km. (Yen Loan portion is approx. 82.69 km.)

Source: *JICA Study Team*

Implementation Scheme (Offering Result of Japanese ODA Loan)

As mentioned above, all Delhi Metro lines are not implemented with coverage by the Japanese ODA Loan. The coverage of the Japanese ODA Loan was civil works in Delhi area; however only included underground civil works, electricity, signal/communication, track and train cars. Airport Link Project in Phase 2 was not covered by the Japanese ODA Loan since it was implemented under PPP scheme, where civil structures were implemented by the Delhi Metro Rail Corporation with finance of the Government of India, but the procurement of rolling stock, signalling system, communication systems and trackwork was implemented by a concessionaire named DAME (Delhi Airport Metro Express).

Table 14.2.2-3 Implementation Scheme of Delhi Metro

Investment source	Phase 1	Phase 2
Japanese ODA Loan	60%	49%
Central Government of India	14%	21%
Delhi Territory	14%	21%
Interest-free Loan by Central Government	5%	7%
Revenue from Real Estate Development	7%	2%

Source: *JICA Study Team*

As described in Table 14.2.2-3, more than half of the Phase 1 and the Phase 2 Projects was covered by the Japanese ODA Loan, and thus the role of the Japanese ODA Loan was an indicator of its significance to the implementation of large-scale infrastructure project. However, the portion of Japanese ODA Loan in Phase 2 was smaller than that of Phase 1 because Phase 2 included lines constructed outside of Delhi area and also the Airport Link Project was not covered by the Japanese ODA Loan.

Offering Amount of Japanese ODA Loan

Table 14.2.2-4 and Table 14.2.2-5 show the offering amount of the Japanese ODA Loan in Phase 1 and Phase 2 of the Delhi Metro Project.

Table 14.2.2-4 Offering Amount of Japanese ODA Loan in Phase 1

	Date of Signature of L/A	Loan Amount (Million Yen)
First stage	1997.2.25	14,760
Second stage	2001.3.30	6,732
Third stage	2002.2.13	28,659
Fourth stage	2003.3.31	34,102
Fifth stage	2004.3.31	59,296
Sixth stage	2005.3.31	19,292
Total		162,841

Source: *JICA Study Team*

Table 14.2.2-5 Offering Amount of Japanese ODA Loan in Phase 2

	Date of Signature of L/A	Loan Amount (Million Yen)
First stage	2006.3.31	14,900
Second stage	2007.3.30	13,583
Third stage	2008.3.10	72,100
Fourth stage	2009.3.31	77,753
Fifth stage	2010.3.29	33,640
Total		211,976

Source: *JICA Study Team*

The Japanese ODA Loan was offered 11 times inclusive of both Phase 1 and Phase 2, and approximately 375,000 million yen in total was offered to the Government of India, where approximately 163,000 million yen was for Phase 1 and approximately 212,000 million yen for Phase 2.

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Chapter 15

SUMMARY OF ROUTE CONSIDERATION FOR MEGA MANILA SUBWAY PROJECT

Chapter 15 SUMMARY OF ROUTE CONSIDERATION FOR MEGA MANILA SUBWAY PROJECT

15.1 Summary of Route Consideration

Previous chapters have described the results of the route consideration from various aspects, which can be summarized as shown in Table 15.1-1.

Table15.1-1 Summary of Route Consideration

Item	A1a	A2a	A3a	B1a	B2a	B3a	A1b	A2b	A3b	B1b	B2b	B3b
Route Length (km)												
Phase 1	22.66	23.71	27.00	22.66	23.71	27.00	22.66	23.71	27.00	22.66	23.71	27.00
Phase 2	36.44	36.44	36.44	36.16	36.16	36.16	36.44	36.44	36.44	36.16	36.16	36.16
Overall	59.10	60.15	63.44	58.82	59.87	63.16	59.10	60.15	63.44	58.82	59.87	63.16
Length by Structural Type (km)												
Phase 1												
Underground	21.76	22.81	26.10	21.76	22.81	26.10	21.76	22.81	26.10	21.76	22.81	26.10
Elevated	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Phase 2												
Underground	1.19	1.19	1.19	1.19	1.19	1.19	14.42	14.42	14.42	14.42	14.42	14.42
Elevated	35.25	35.25	35.25	34.97	34.97	34.97	22.02	22.02	22.02	21.74	21.74	21.74
Overall												
Underground	22.95	24.00	27.29	22.95	24.00	27.29	36.18	37.23	40.52	36.18	37.23	40.52
Elevated	36.15	36.15	36.15	35.87	35.87	35.87	22.92	22.92	22.92	22.64	22.64	22.64
No. of Station by Type (Nos.)												
Phase 1	13	13	15	13	13	15	13	13	15	13	13	15
Underground	12	12	14	12	12	14	12	12	14	12	12	14
Elevated	1	1	1	1	1	1	1	1	1	1	1	1
Phase 2	14	14	14	14	14	14	14	14	14	14	14	14
Underground	0	0	0	0	0	0	5	5	5	5	5	5
Elevated	14	14	14	14	14	14	9	9	9	9	9	9
Overall	27	27	29	27	27	29	27	27	29	27	27	29
Underground	12	12	14	12	12	14	17	17	19	17	17	19
Elevated	15	15	15	15	15	15	15	15	15	15	15	15

Item	A1a	A2a	A3a	B1a	B2a	B3a	A1b	A2b	A3b	B1b	B2b	B3b
Preliminary Passenger Demand (Pax./Day)												
2025 (Phase 1)	421,142	385,886	477,762	421,142	385,886	477,762	421,142	385,886	477,762	421,142	385,886	477,762
2035 (Phase 2)	1,470,307	1,475,763	1,567,959	1,652,449	1,665,617	1,776,130	1,470,307	1,475,763	1,567,959	1,652,449	1,665,617	1,776,130
2045	2,048,487	2,058,646	2,204,897	2,185,281	2,256,920	2,385,042	2,048,487	2,058,646	2,204,897	2,185,281	2,256,920	2,385,042
Preliminary Estimated Revenue (Mil. USD/Year)												
2025 (Phase 1)	159	149	172	159	149	172	159	149	172	159	149	172
2035 (Phase 2)	1,023	1,021	1,109	1,105	1,114	1,260	1,023	1,021	1,109	1,105	1,114	1,260
2045	1,904	1,925	2,099	1,972	2,028	2,189	1,904	1,925	2,099	1,972	2,028	2,189
Preliminary Project Cost Estimate (Mil. USD)												
Phase 1	4,466	4,530	5,125	4,466	4,530	5,125	4,466	4,530	5,125	4,466	4,530	5,125
Phase 2	3,651	3,687	3,724	3,755	3,792	3,859	4,690	4,727	4,764	4,795	4,831	4,899
Overall	8,117	8,217	8,849	8,221	8,322	8,984	9,156	9,256	9,888	9,261	9,361	10,024
Preliminary Economic and Financial Analysis (%)												
EIRR	17.3	17.1	17.2	17.6	16.9	17.3	17.3	16.7	16.9	17.2	16.6	16.9
FIRR	9.20	9.08	9.11	9.39	9.38	9.35	9.13	8.64	8.71	8.97	8.95	9.22
Project Affected Persons (PAP) (Nos.)												
Phase 1	4,020	4,710	4,278	4,020	4,710	4,278	4,020	4,710	4,278	4,020	4,710	4,278
Phase 2	14,790	14,790	14,790	11,460	11,460	11,460	14,166	14,166	14,166	10,836	10,836	10,836
Overall	18,810	19,500	19,068	15,480	16,170	15,738	18,186	18,876	18,444	14,856	15,546	15,114
Project Affected Houses (PAH) (Nos.)												
Phase 1	750	896	834	750	896	834	750	896	834	750	896	834
Phase 2	2,797	2,797	2,797	2,214	2,214	2,214	2,666	2,666	2,666	2,083	2,083	2,083
Overall	3,547	3,693	3,631	2,964	3,110	3,048	3,416	3,562	3,500	2,833	2,979	2,917

15.2 Description of Each Route Option

Since the above 12 options are combination of 2 options in North Zone, 3 options in Central Zone and 2 options in South Zone, it would be more realistic and understandable to describe the characteristics of each option by zone, rather than the combined route option for all zones. Based on the results of the studies described in previous chapters and Table 15.1-1 above, the characteristics of options in each zone can be described as follows:

Central Zone (Phase 1)

Option 1 is the shortest in length among 3 options thus lowest in cost, whereas Option 3 is the longest thus highest in cost. Option 3 has the highest passenger demand due to its longest length and 2 more stations than other options. Option 1 shows the lowest in PAP and PAH due to construction along the existing roads in almost entire sections between North Avenue Station and Ortigas North Station. There is no significant difference in EIRR and FIRR among 3 options and those of all options are higher than the social discount rate of 15% set by the NEDA. Option 1 runs in parallel with the existing MRT Line 3, whereas there is no parallel operation of other railways in Options 2 and 3. There is also a plan to develop BRT along EDSA. Existing and future development plans of rail and other public transport modes should be carefully considered to select the optimal route for the Central Zone during the Feasibility Study.

North Zone (Phase 2)

The lengths of both options (A and B) are almost the same and the numbers of station of each option are also the same. Construction cost of Option B is slightly higher than that of Option A due to more number of high elevated stations. Option B has more passenger demand than Option A although there is no existing road along Option B. Due to more passenger demand thus higher in revenue, EIRR and FIRR of Option B are slightly higher than those of Option A, although both are higher than the social discount rate of 15% set by the NEDA. PAP and PAH of Option A are higher than those of Option B due to necessity of road widening along dense area, however more land acquisition is required in Option B as there is no existing road along the route and accordingly the construction of roads along the railway will be required.

South Zone (Phase 2)

There is no difference in length and the number of station between Option “a” and Option “b” since the horizontal alignment is the same for both options. Passenger demand is also the same for both options. Construction cost of Option “b” is higher due to underground section in some section, and thus EIRR and FIRR of Option “a” are higher than those of Option “b”. PAP and PAH of Option “a” is higher than those of Option “b” due to construction of roads for the elevated structures in some section with no existing roads, although the magnitude of difference in PAP and PAH between Option “a” and Option “b” is relatively small. A concern in Option “a” is the realization of road construction for the elevated structures in some section since the area along the section crosses the residential complex with many privately owned houses. Delay in the project implementation due to land acquisition for the road construction as well as the construction of railway elevated structures is also another concern. On the other hand, there is another concern in Option “b” whether the railway in suburban area can be costly underground structures although the implementation would be easier as long as the compensation issue for use of subterranean space can be timely solved.

Chapter 16

RECOMMENDATIONS FOR NEXT STEP OF MEGA MANILA SUBWAY PROJECT

Chapter 16 RECOMMENDATIONS FOR NEXT STEP OF MEGA MANILA SUBWAY PROJECT

As previously described, this Study is an “Information Collection Survey”, not a “Feasibility Study”, which is the next step of this Study. In order to select the optimal and most feasible option during the Feasibility Study among options presented in this Study, following issues should be carefully considered in the Feasibility Study.

16.1 Demand Forecast

In the Feasibility Study, the demand forecast shall be made with the updated road and rail network plan in Mega Manila with the latest database produced in JICA’s MUCEP study. There is an uncertainty in the future plans for new railway projects, extension projects of existing railways and projects of other transport mode, e.g. AGT, BRT, etc. However, in consultation with DOTC and other relevant agencies, the latest available transport network plan at the time of the Feasibility Study shall be applied in updating the demand forecast.

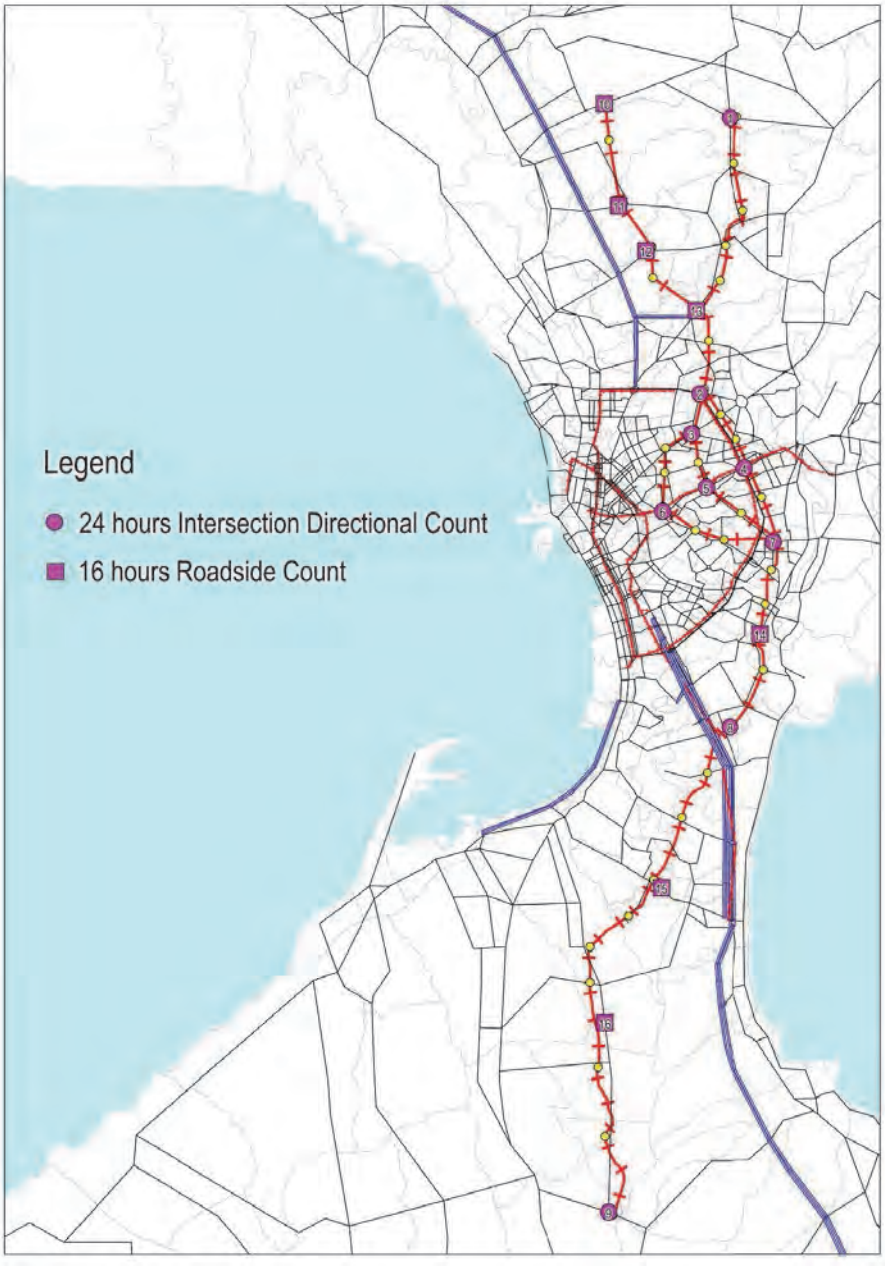
Additional benefit/cost required in the economic analysis will need to be considered during the Feasibility Study, which are the Health Benefits and the Disruption Cost since the Health Benefit was considered in the economic analysis for the MRT 7 project according to DOTC and the Disruption Cost has been required to be considered in the NEDA ICC process according to DPWH. In the calculation of the Disruption Cost, detailed consideration for each route option will be required, i.e. which section will be closed for how many lanes, how long and in which year, etc. In order to consider the above, more detailed route alignment for each option needs to be studied to understand the exact location of station and its entrances, locations of shaft for tunnel boring or shield machines, etc. as the necessary lanes and their locations that need to be closed during the construction stage depend on the locations of station and its entrances as well as the method for station construction.

In order to estimate the Disruption Cost, traffic survey (traffic counting) will be required to calibrate the impact of the road traffic during the construction with intersection directional count at 24 hours and roadside count at 16 hours a day. It is expected that a few months will be required to prepare for the survey and the selection of the company to carry out the survey including contracting, counting at site and inputting data. A specialist for traffic survey will also be required in the study team. Micro simulation to analyze the length of traffic jam may be also required, which will increase the workload of the traffic survey. In addition, a survey of the length of traffic jam on the existing roads needs to be also carried out.

Figure 16.1-1 shows the proposed locations of the traffic counting for route options of the MMSP.

16.2 Soil Investigation

For the selected route option, soil investigation (boring test) needs to be conducted at locations of each proposed station as well as at locations between stations to enable design of detailed route alignment as well as appropriate civil and station structures considering the existing geological conditions.



Source: *JICA Study Team*

Figure 16.1-1 Proposed Location of Traffic Counting during Feasibility Study

16.3 Project Cost Estimate

Preliminary Project Cost was estimated in this Study based on the unit cost of underground structures, underground stations, elevated structures, elevated stations, trackworks, depot, rolling stock and railway systems, with variance in some underground stations, elevated structures and elevated stations in accordance with its depth and height compared to the standard ones. Although the cost estimate was made referring to the past studies of similar railways in the Philippines as well as engineering estimates and actual contract amount of similar projects in other countries, more precise cost estimate will be required during the Feasibility Study, considering more detailed horizontal and vertical alignment, station locations considering the geological conditions and locations of existing buildings, construction method to be applied for underground works which may affect the unit cost, railway systems to be included with rough quantity of each facility and equipment, etc.

16.4 Economic and Financial Analysis

In this Study, Vehicle Operating Cost (VOC) and Travel Time Cost (TTC) were considered as the benefit to the implementation of the project in the economic analysis. In the economic analysis in the Feasibility Study, Health Benefit and Disruption Cost (during construction period) will also need to be considered as benefit/impact to the project implementation. In addition, confirmation on with and without cases of other projects that have certain effects to the MMSP shall be also made.

Subway project promotes the change of road transport to rail transport, which are considered to result in reduction of fossil fuel consumption and greenhouse effect gas accordingly. Therefore, the subway project can be considered as the project to ease climate change and both governments shall share the same understanding on this. Thus, the estimated volume of reduction of greenhouse effect gas due to the implementation of the MMSP shall be calculated.

Financial analysis for the project shall be carried out with the updated revenue based on the updated demand forecast, expected revenue from non-railway business activities, updated project cost and O&M cost with consideration in Life Cycle Cost in the Feasibility Study.

16.5 Environmental and Social Impact Considerations

Preliminary environmental and social consideration was made in this Study to grasp the existing conditions along the routes of each option and to roughly calculate the magnitude of the impact of the railway construction to the areas surrounding each option route with rough calculation of Project Affected Persons (PAPs) and Project Affected Houses (PAHs). Subway project is considered to be subject to Category A of the JICA Guidelines for Environmental and Social Considerations (April 2010) as it is related to the railway sector and is highly influential. Therefore, in the Feasibility Study, further detailed environmental and social considerations shall be carried out in line with the said guideline.

16.5.1 Preparation of Draft Environmental Impact Assessment (EIA) Report

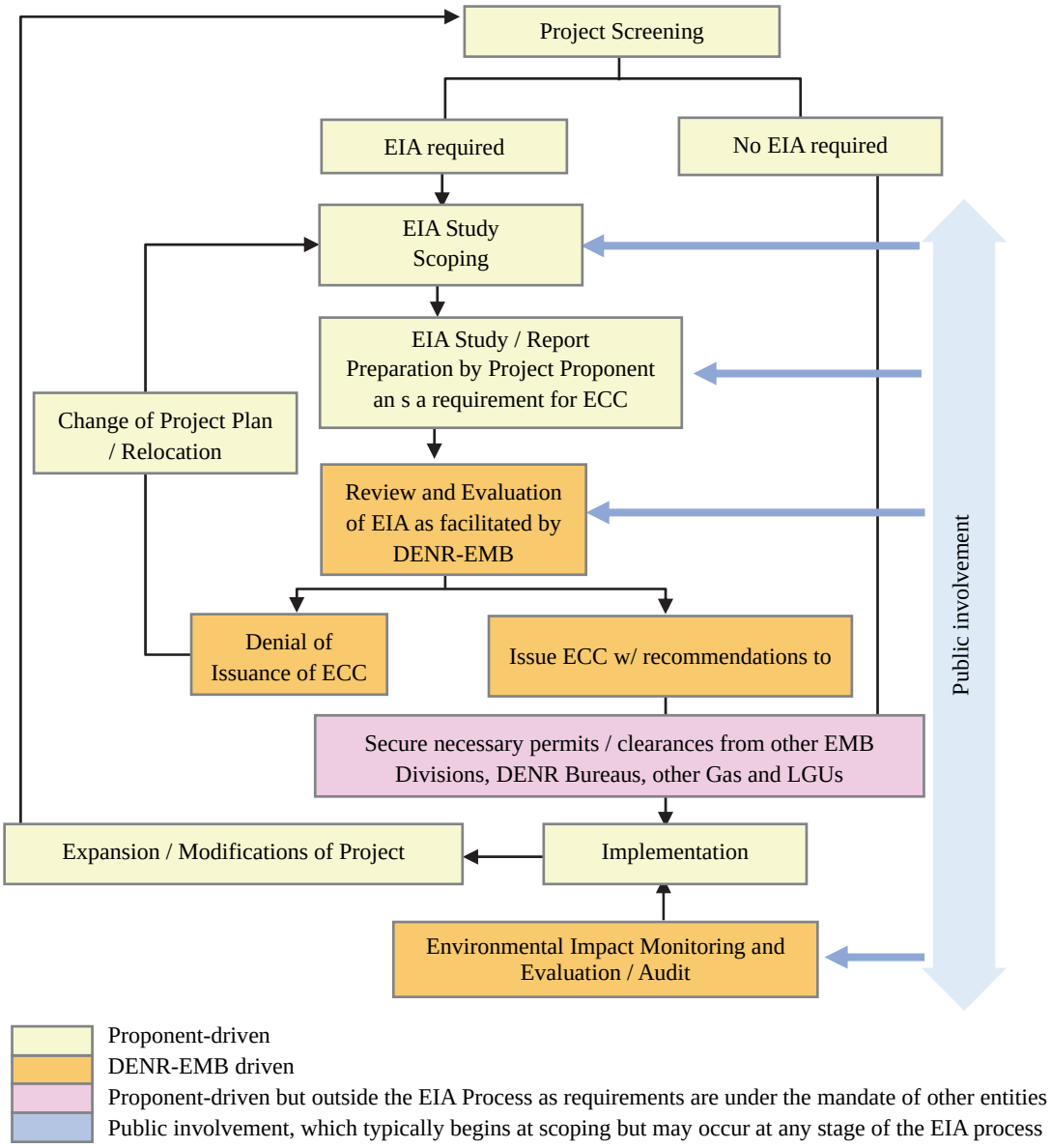
The Consultant assists the GOP in the preparation of an Environmental Impact Assessment (EIA) report[1] and the acquisition of Environmental Compliance Certificate (ECC). The EIA report is assumed to be required to meet the Annex B of the World Bank OP4.01 and the requirements of the Philippines' EIA framework. Flow of EIA process in the Philippines is as shown in Figure 16.5.1-1.

16.5.2 Preparation of Draft Resettlement Action Plan (RAP)

The Consultant shall assist the GOP in the preparation of a Resettlement Action Plan (RAP) based on the above mentioned JICA Guidelines. The Consultant shall conduct a socio-economic survey (census, property and land, livelihood), and prepare the RAP including the Annex A of the World Bank OP4.12.[2]

[1] The project corresponds to the new project which is "NECA" (Non-Environmentally Critical Area) and "ECPs" (Environmentally Critical Projects) on the Philippines' EIA system. Therefore the acquisition of ECC will require the submission of EIS (Environmental Impact Statement).

[2] The GOP has the relevant laws on land acquisition. However, the GOP and DOTC have not prepared the laws or system on involuntary resettlements. Therefore the RAP is implemented mainly along JICA Guidelines.



Source: *JICA Study Team*

Figure 16.5.1-1 Flow of EIA Process in the Philippines

16.5.3 Screening

The Project is a construction of a subway in the NCR. The implementation of the Project is assumed to cause air and water pollution, noise and vibration, waster, etc. during the construction and water pollution, noise and vibration, and ground sinkage after the completion, thus proper measurement shall be taken. In addition to the impacts on the social conditions including land acquisition and involuntary resettlements, there may be an impact on the economic activities including road traffic during construction. Therefore, the EIA and RAP reports will be required to be prepared which meet the requirement of the Category A of JICA guideline.

16.6 Operation and Maintenance Plan

In the Feasibility Study, further study regarding the operation and maintenance plan will be required to identify the organization and staffing required to operate and maintain the Mega Manila Subway after the commencement of the revenue operation, including who shall be the entity to carry out operation

and maintenance. In addition, as proposed in Chapter 10, the establishment of the Mega Manila Subway Project Management Office inside the DOTC shall be discussed with DOTC during the Feasibility Study, so that the further steps required after the completion of the Feasibility Study can be properly taken with continuity.

As to the establishment of the Philippines Railway Agency (PRA) as also proposed in Chapter 10, discussions shall be made with DOTC. If DOTC is positive to establish the PRA, necessary steps and procedures shall be consulted with DOTC and other relevant agencies.

In designing the civil structures as well as rolling stock and railway systems, "Life Cycle Cost" shall be considered for easier maintenance and saving in overall operation and maintenance cost. Although the initial procurement cost might be a bit higher, designs based on the life cycle cost is worth considering since it brings about significant benefit to the railway operator in the long term.

16.7 Project Implementation Scheme

Chapter 14 proposed the implementation of the Mega Manila Subway Project jointly by public and private sectors due to its magnitude of the project. Since it will be required to determine the funding scheme of the project at the end of the Feasibility Stage, further consideration shall be made how each portion of the project, i.e. procurement of civil works, rolling stock and railway systems, and operation and maintenance afterwards, can be implemented. Particular attention shall be made to the extent and portion(s) of the involvement of the private sector in order to maximize the utilization of its capability, yet maintaining the sufficient quality in civil structures, rolling system and railway systems as well as proving friendly and convenient services during operation. Proper scheme to enable efficient maintenance activities shall be taken into consideration as the sustainability in railway operation and maintenance is one of the most required factors in implementing a new railway project. Discussions with other relevant agencies, e.g. NEDA, DOF, DBM, etc., will be required to determine the funding and project implementation scheme to be applied to the Mega Manila Subway Project and a consensus needs to be obtained from those relevant agencies. In addition, consideration of possibility to cooperate with other international financing agencies, such as Asian Development Bank shall be made.

In case the PPP (Public-Private Partnership) scheme applicable to the implementation of the MMSP needs to be considered, PPP schemes applied in similar railway projects in the past in the Philippines and other countries shall be studied and the optimal PPP scheme for the MMSP shall be proposed. In most of the cases in railway projects implemented by PPP scheme, actual profits to the project implementation body (concessionaire) have been lower than originally expected. Therefore, careful attention shall be paid in considering the introduction of the PPP scheme to the MMSP in a practical and realistic manner, particularly the demarcation of tasks and responsibilities between the government and the private, subsidies to be provided by the government, and/or rights to be given to the private in terms of commercial development at and surrounding stations as well as along the route alignment.

In addition, possibility of potential non-railway business shall be proposed to decrease the burden to the project implementation body, regardless of the project implementation entirely by the public or partially with the private. Introduction of non-railway business to the MMSP from the beginning will contribute to the sustainable operation of the MMSP.

16.8 Transit Oriented Development

A station in Bonifacio Global City was chosen as the example to present the image of Transit Oriented Development, more precisely the development of multi modal facility at station interchanging with other transport, and the images are shown in Chapter 9 and Annex A. Non-rail business is one of the key factors to succeed sustainably in the railway project, thus the Mega Manila Subway Project shall be also implemented together with development of commercial facilities at and around some stations.

As the station structure and layout will be different if commercial facilities are to be developed with stations at the same time or even later, detailed studies need to be carried out to determine which station(s) shall be developed with commercial facilities, and how the station(s) and those commercial facilities shall be jointly developed. Demarcation of station structures and commercial facilities structures needs to be clearly made as the project cost to be borne by the Government does not include cost of development of commercial facilities.

16.9 Legal Impediments to Other Railway Lines and Transport Modes

There are several new railway lines and other transport modes, e.g. BRT, expressway, etc., as well as other infrastructure projects, e.g. Batmat Natural Gas Pipeline Project, Underground Waterway Project, etc., in Mega Manila, and some of them have been planned, or are being planned, near the potential route of the Mega Manila Subway. In case such new railway lines or other transport modes are implemented by the government agency, there should be no problem in determining the route for the Mega Manila Subway as long as all lines/modes complement each other to enhance the use of public transport. However, concessionaires comprising of private sector who implements, operates and maintains under concession agreement with the government agency are keen on implementing the railway/transport mode under the given conditions to ensure the planned and expected profit out of the operation of the railway/transport mode. Therefore, an investigation needs to be carried out if such condition include prohibition of the implementation of new railway/transport mode by the government near the route of the concessionaires' railway/transport mode. Mega Manila Subway Project must be planned without causing any impact on the given conditions to the concessionaires of the railway/transport mode.

16.10 Interface with Other Railway Lines and Transport Modes

In order to maximize the benefit and convenience of users of Mega Manila Subway as well as other railway lines and transport modes, the locations of stations for Mega Manila Subway, functioning as the common stations, where the Mega Manila Subway interchanges with other railway lines and/or transport modes, shall be properly planned with due consideration in the connectivity with the existing or planned stations of such other railway lines and/or transport modes running adjacent to and/or crossing the Mega Manila Subway.

16.11 Reference to and Brief Comparison with Similar Railway Projects

Referring to the completed detailed Feasibility Study and a brief comparison with other similar railway projects, e.g. Mass Transit System Loop (MTSL) being planned by the DOT, shall be made to verify and justify the appropriateness and feasibility of the result of the detailed Feasibility Study for the Mega Manila Subway Project. The most efficient and effective project implementation plan with the realistic and practical project scheme shall be established through various technical considerations, including value engineering, etc.

16.12 Public Relation Unit

Although the benefit of having subway is not to mention, a subway construction project requires huge investment cost, which may make up certain ratio of the country's budget for the overall investment in infrastructure development. Therefore, the implementation of the subway project shall be carefully proceeded not to cause negative impression to the people of the Philippines. Thus, from the Feasibility Study stage, public relation activities shall be carried out in order to propagate the benefit of implementing subway project to those directly and indirectly affected by the subway project and to obtain acknowledgement and consensus for the implementation of the project from public. To continuously carry out such activities starting from the Feasibility Study until the completion of the MMSP, establishment of Public Relation Unit, comprising DOTC, other relevant agencies and the consultants (during their engagement period) is recommended.

APPENDICES

APPENDIX A
Examples of Integrated Development
and Mechanism of Schemes for Integrated Development in Japan

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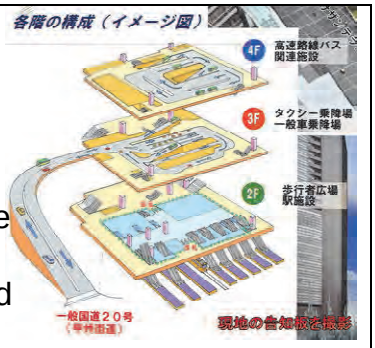
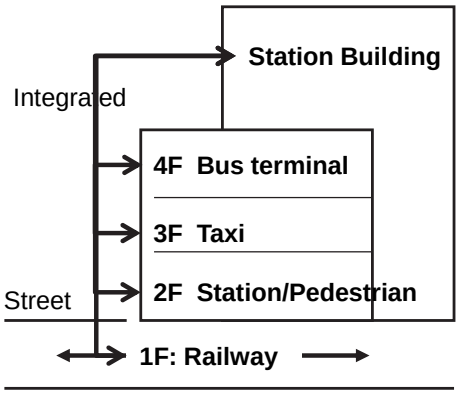
Table App-A (1) Examples of Integrated Development in Japan

■ Example of Integrated/Multimodal Terminal Development in Japan



TOKYO: Shinjuku Station

- 3 million passenger/day
- South exit is currently under construction to integrate the bus terminal and station square
- Constructing the artificial ground above railway and build station square (2F), Taxi (3F) and bus terminal (4F).

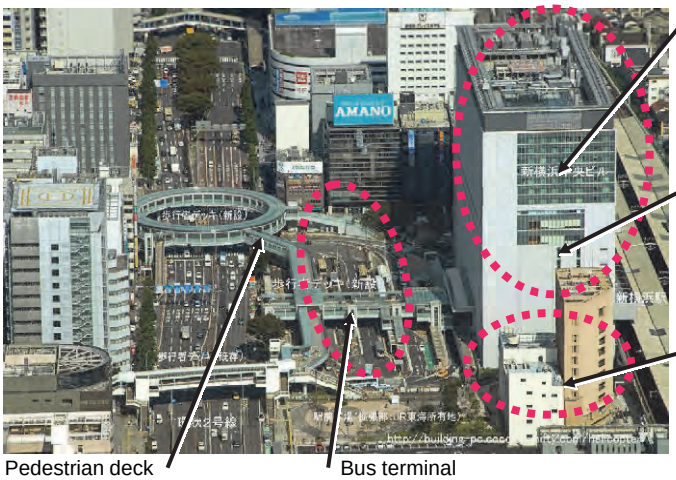


Source: MLIT (http://www.ktr.mlit.go.jp/toukoku/saisei/shinjuku/)

■ Example of Integrated/Multimodal Terminal Development in Japan

YOKOHAMA: Shin-Yokohama Station

- Shin-Yokohama station has three urban rail lines (incl. Shinkansen) and bus terminal, It has 220 thousand passenger/day
- Shin-Yokohama station was developed as an integrated terminal.



Pedestrian deck

Bus terminal

Hotel (upper floor of station building)

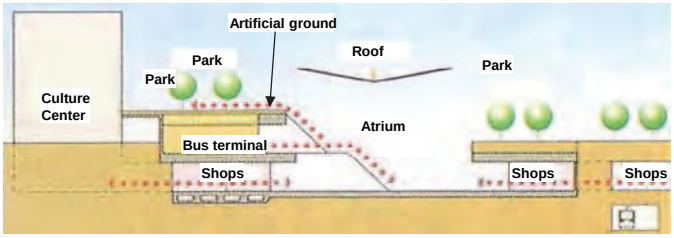
Shops (middle floor)

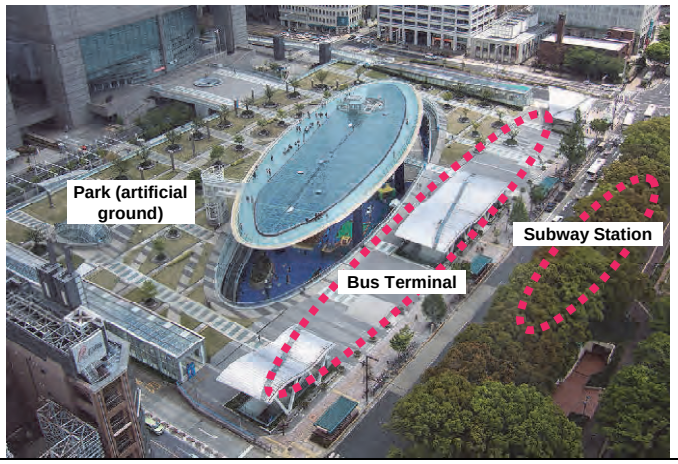
Concourse (ground floor)

■ Example of Integrated/Multimodal Terminal Development in Japan

NGOYA: Sakae Station

- Sakae district is one of CBDs in Nagoya.
- Bus terminal and subway station was integrated with the park using artificial ground and adjoining buildings.

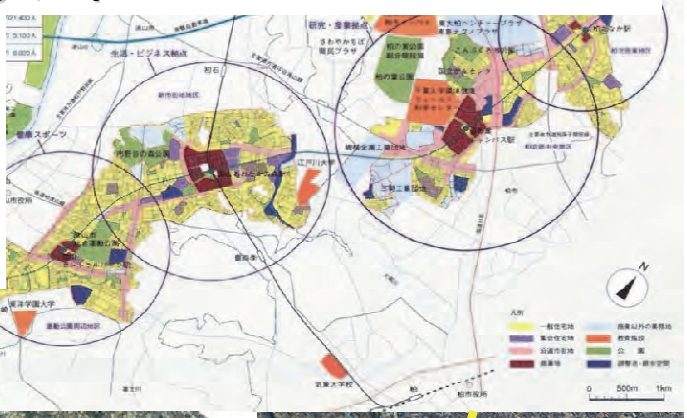


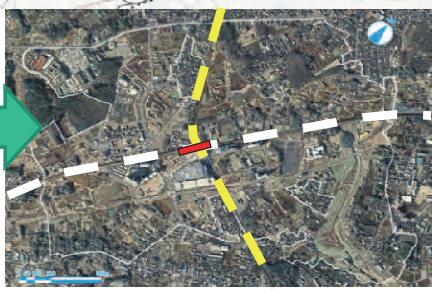


Bus Terminal (under artificial ground)

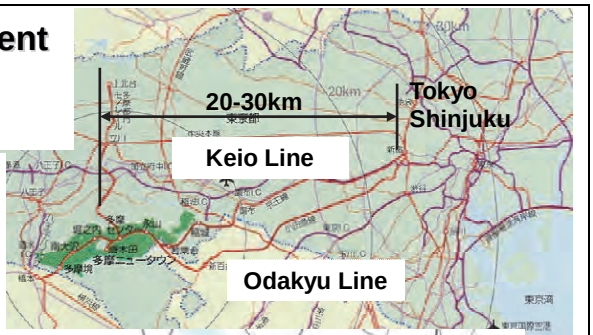
■ Example of Integrated Development of New Town and Railway in Suburban Area in Tokyo, Japan

- **Tsukuba Express** (Open in 2005)
  - Number of stations: 20
  - Total length: 58.3km
- **Urban Development by Land Readjustment**
  - Development area: 2,908ha
  - Planning population: 237,000

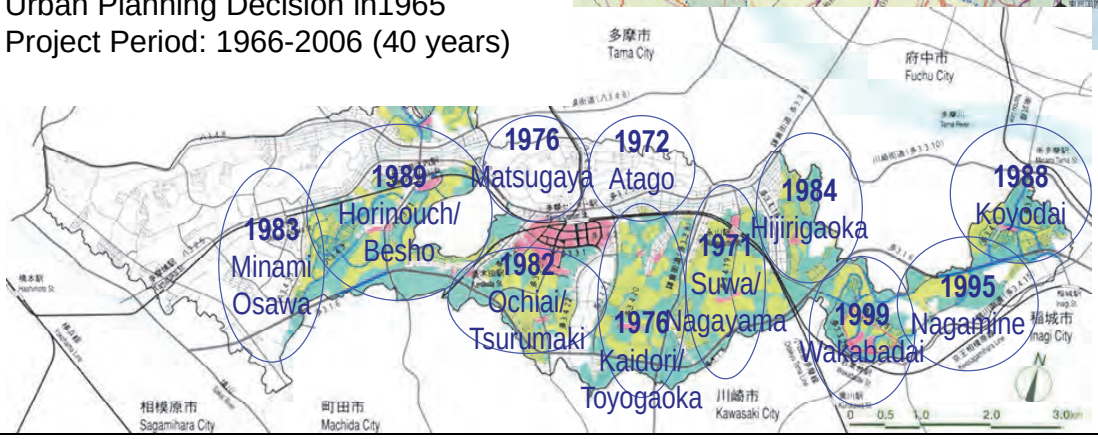




■ Example of Integrated Development of New Town and Railway in Suburban Area in Tokyo, Japan

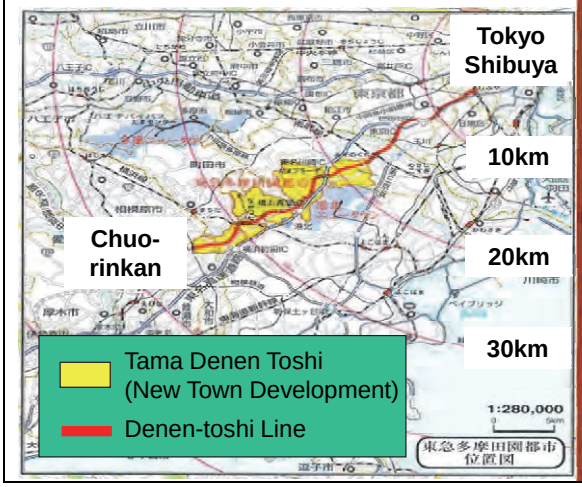


➢ **Tama New Town Development**
- New town development by Government
- Development area: 3,000ha
- Planning population: 200,000
- Urban Planning Decision in1965
- Project Period: 1966-2006 (40 years)

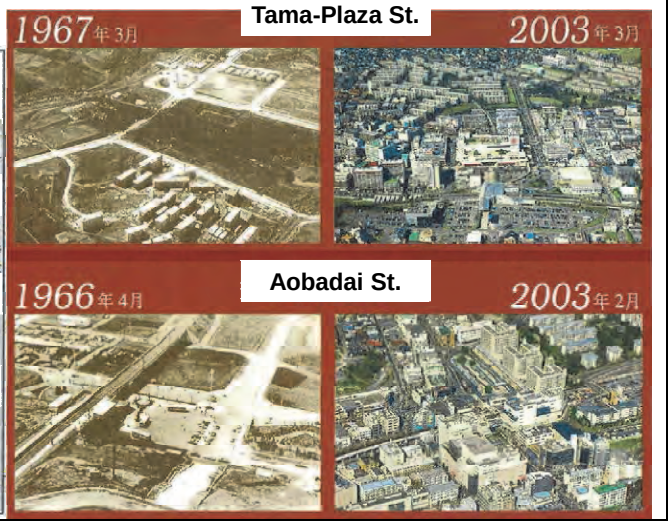


■ Example of Integrated Development of New Town and Railway in Suburban Area in Tokyo, Japan

➢ **Tokyu Denen-Toshi Line**
- Number of stations: 27
- Total length: 31.5km
- Open in 1977

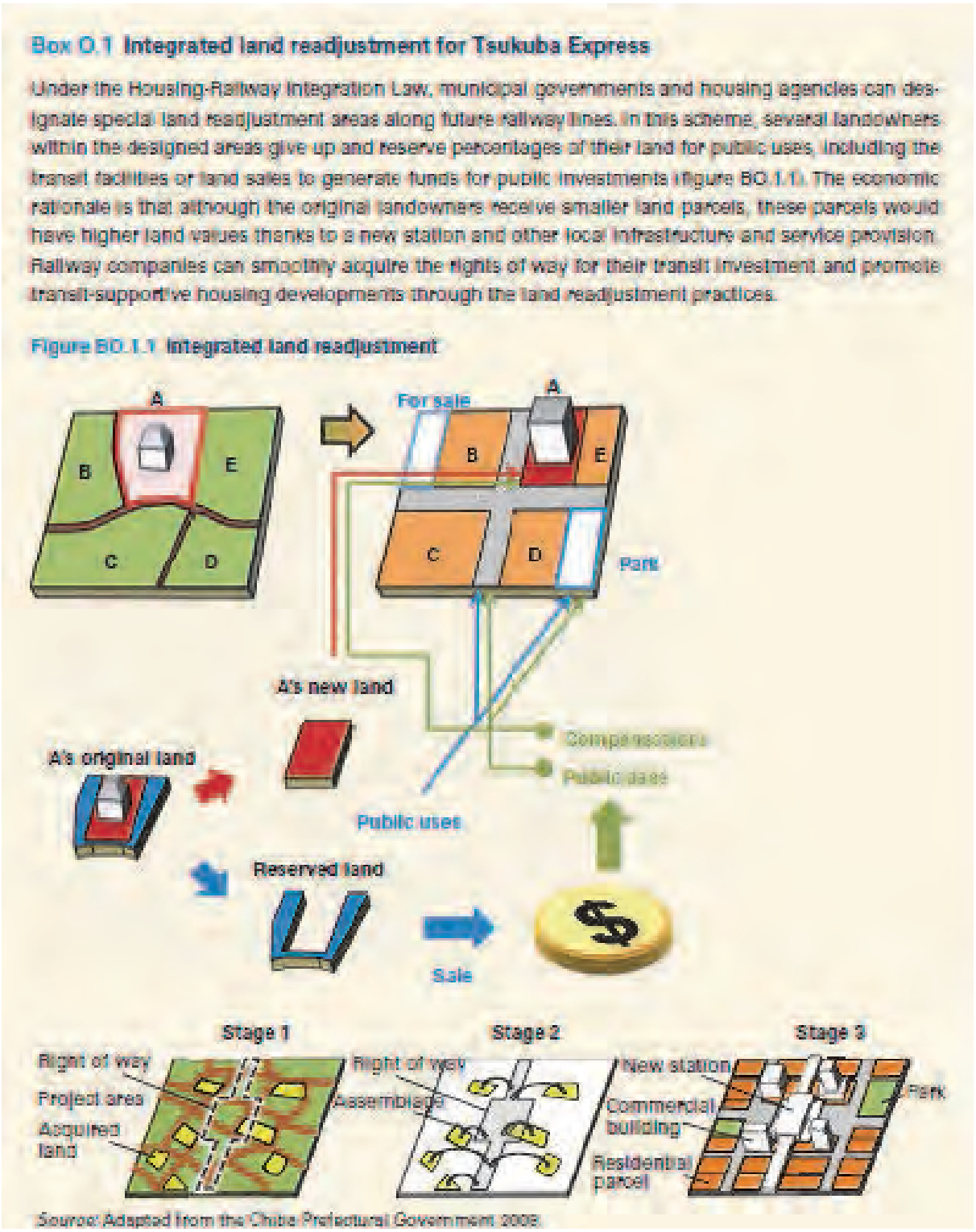


➢ **Tama Denen Toshi Development**
- New Town Development by Tokyu Group
- Since 1953



Source: *JICA Study Team*

Table App-A (2) Development Schemed for TOD in Japan
(a) Land Readjustment Scheme



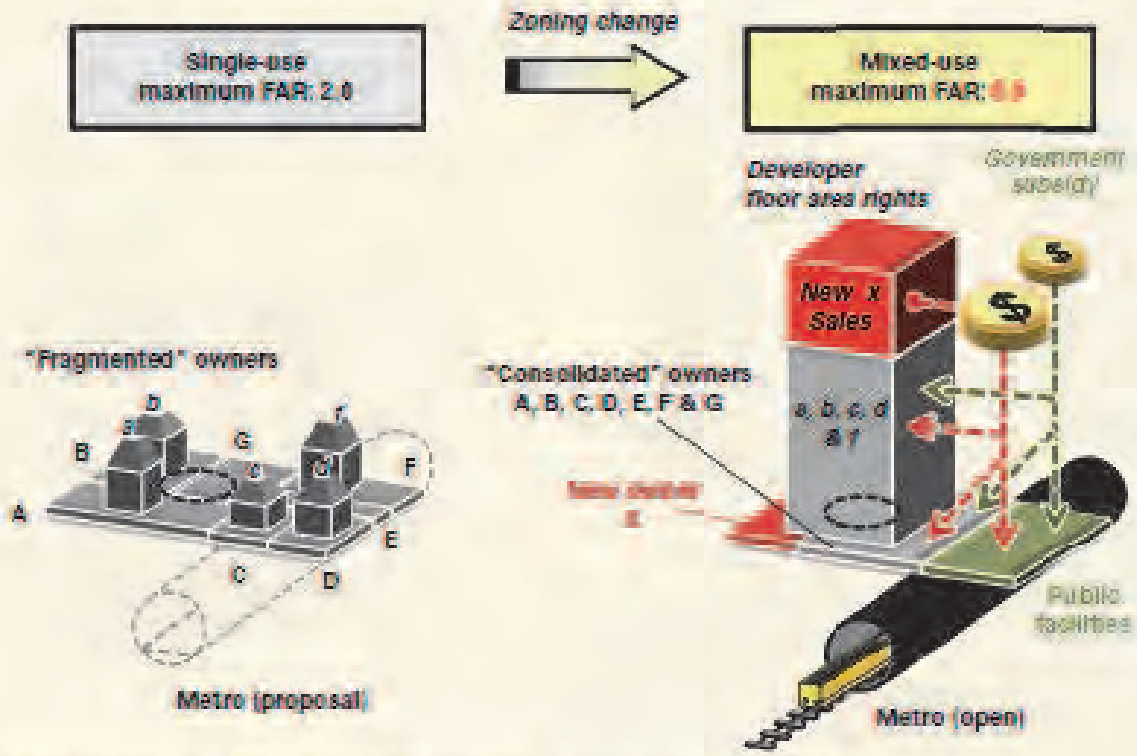
Source: *Financing Transit Oriented Development with Land Value, World Bank Group*

(b) Urban Redevelopment Scheme

Box O.2 Inclusive urban redevelopment scheme, Japan

Under the Urban Redevelopment Law, landholders, tenants, and developers can create development opportunities in built-up areas, typically where a transit station exists or has newly opened. To capture the potential accessibility benefits conferred by the transit station, the local government first converts zoning codes from single use to mixed use with higher floor area ratios (figure BO.2.1).

Figure BO.2.1 Inclusive urban redevelopment scheme, Japan (hypothetical)



Source: Adapted from Ministry of Land, Infrastructure, Transport, and Tourism 2013.
Note: FAR = floor area ratio.

Before the urban redevelopment project, the site consisted of several small parcels owned by individual landowners and occupied with different tenants. Most houses are one- or two-story structures because each parcel is too small to replace the old building with a taller building, and the landowners do not have the capital or expertise to do so. This urban redevelopment project consists of construction of a taller, higher-quality building on land prepared by assembling small parcels; construction of an underground metro station; and provision of public infrastructure (such as wider roads, a station plaza, and amenities). The national government finances a third of site survey, land assembly, and open space foundation costs, using the national general budget, and half the public infrastructure costs using the roadway special fund. Through this process, the original landholders and building

(continued next page)

Box O.2 Inclusive urban redevelopment scheme, Japan *(continued)*

owners are entitled to keep the property rights of floor spaces in the new building that are valued as equal to their original property (though sometimes one developer will purchase all the property rights from the original owners to accelerate the redevelopment). The "surplus" floor area permitted by the municipal government is sold to new property owners to substantially cover the costs of land assembly, new building(s), and public facilities within the district.

Table BO.2.1 presents respective stakeholder's contribution to the land value and their benefit received through the urban redevelopment undertaking.

Table BO.2.1 Stakeholder contributions and benefits

Stakeholders	Contribution	Benefit
Landholders (A, B, C, D, E, F & G)	Land parcel for the new building	Joint ownership of land for the new building (sections A, B, C, D, E, F & G) with higher access and better local infrastructure and service provision
Building owners (a, b, c, d & f)	Old buildings and housing units	Ownership of the new building (sections a, b, c, d & f) with higher access and better local infrastructure and service provision
Developer	Capital and property development expertise	Profit from section X and from surplus FAR
Transit agency	Construction of transit station	Transit-supportive environment/increased ridership
National government	Subsides for land assemblage and road construction	Save road and other public infrastructure construction costs
Local government	Change in zoning code (from single use to mixed use with higher FAR)	Yields higher property tax revenue; promotes local economic development; builds townships resilient to natural disasters

Note: FAR = floor area ratio.

Source: *Financing Transit Oriented Development with Land Value, World Bank Group*

APPENDIX B
Route Alignment Options

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Source: *JICA Study Team*

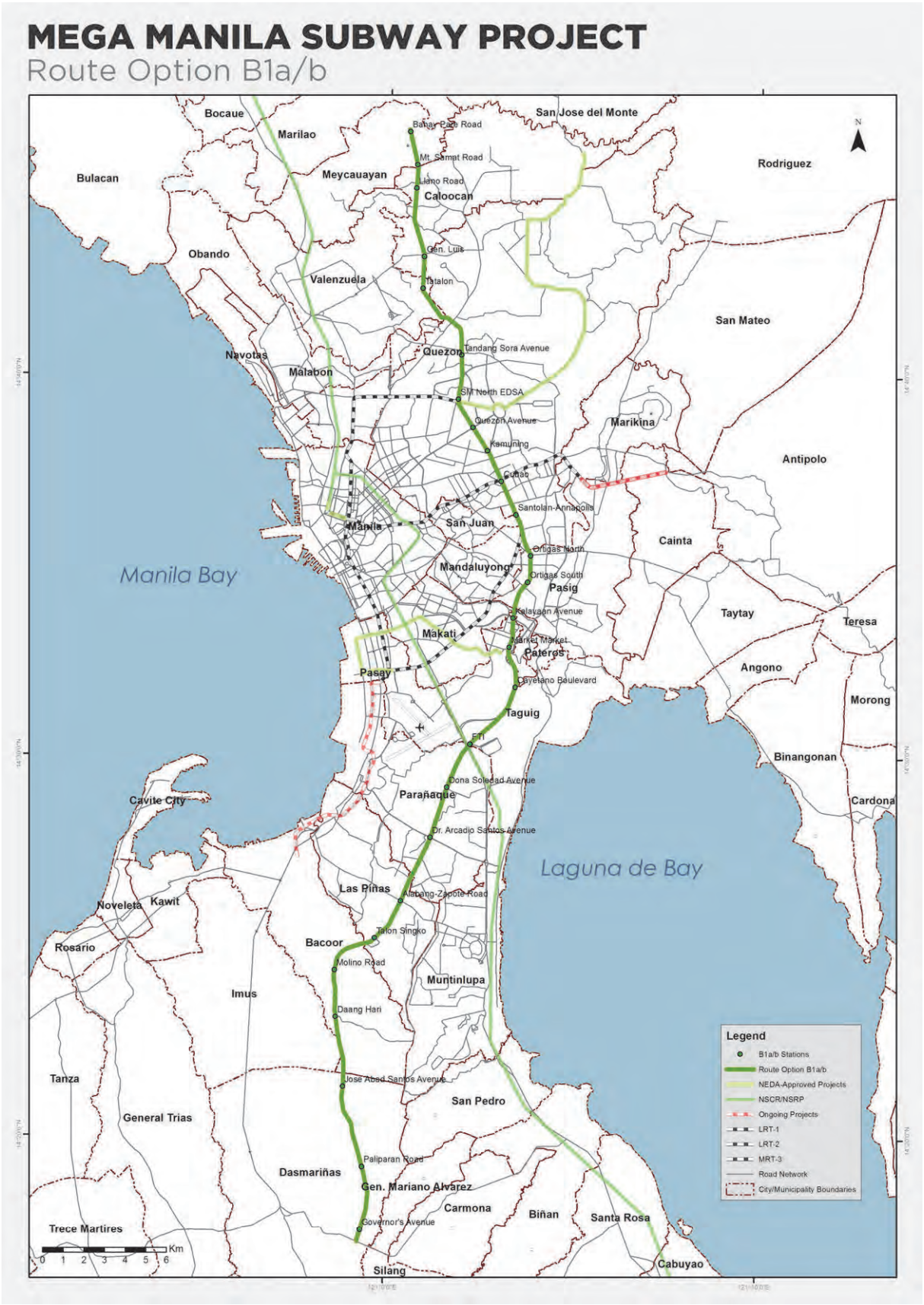
Figure App-B (1) Option A1a/b

Source: *JICA Study Team*

Figure App-B (2) Option A2a/b

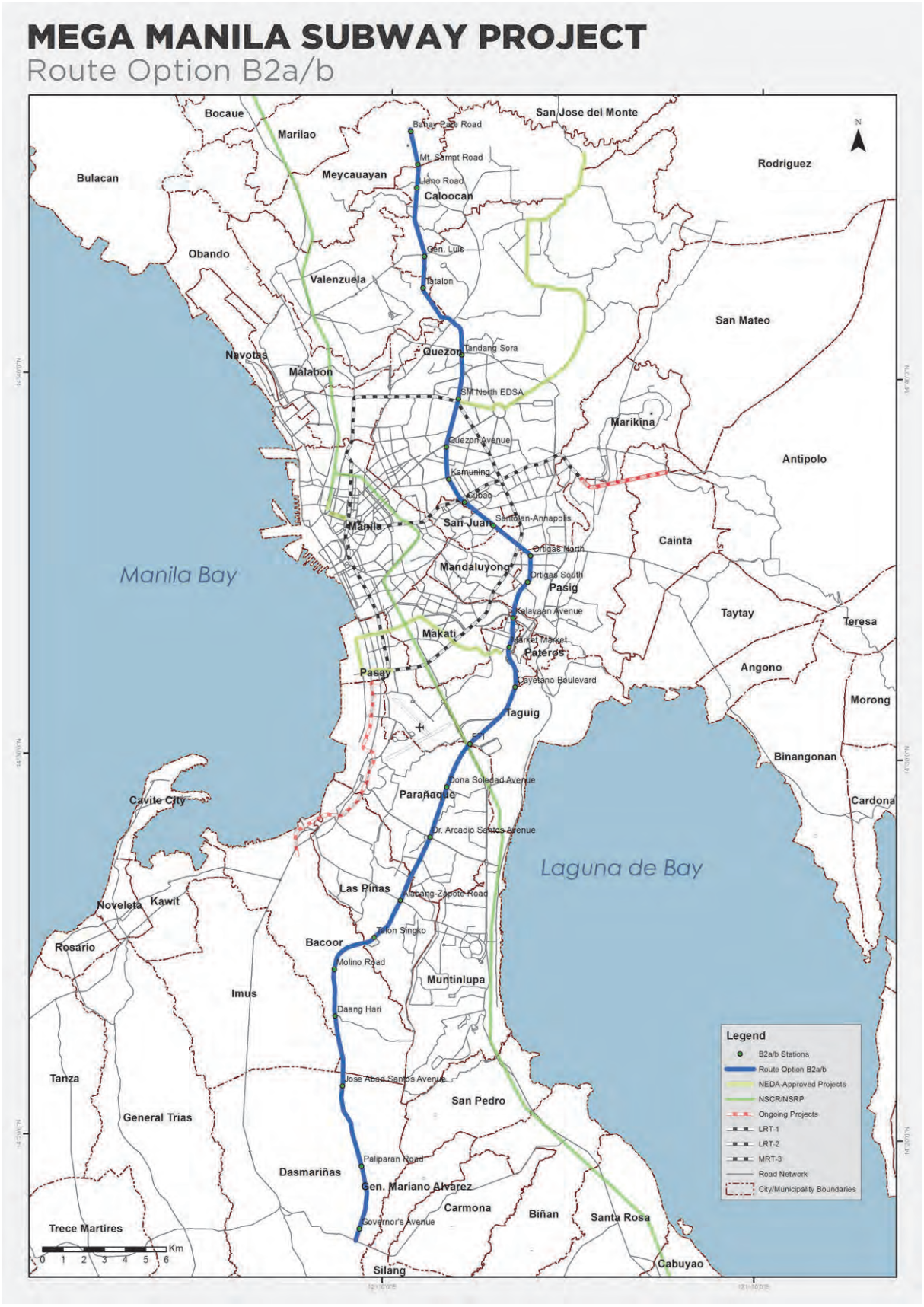
Source: *JICA Study Team*

Figure App-B (3) Option A3a/b



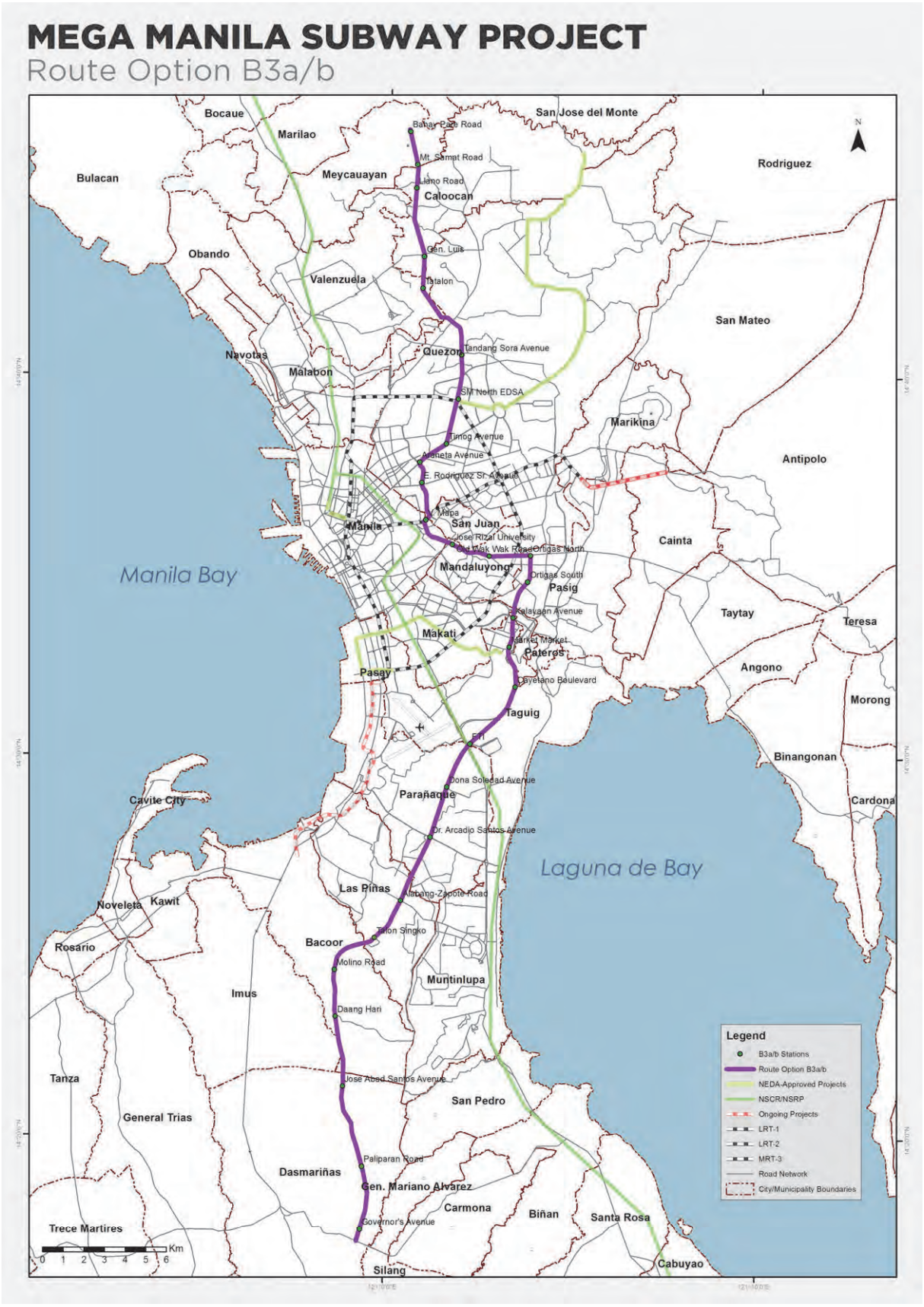
Source: *JICA Study Team*

Figure App-B (4) 4 Option B1a/b



Source: *JICA Study Team*

Figure App-B (5) Option B2a/b



Source: *JICA Study Team*

Figure App-B (6) Option B3a/b

APPENDIX C
Station OD Volume

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Table App-C (1) Station OD Volume (Phase 1: All Options for Year 2025)

Year: 2025

Option 1

	100 Passengers/day	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	Total
(6)	Mindanao_Avenue-Quirino_Highway	0	0	274	13	3	216	7	53	94	19	72	8	55	813
(7)	Tandang_Sora_Avenue	0	0	59	5	1	88	1	24	65	13	54	12	77	398
(8)	North_Avenue	225	78	0	0	0	0	0	8	12	6	12	15	36	393
(9)	Quezon_Avenue	21	6	0	0	0	0	0	6	4	4	10	11	14	76
(10)	Kamuning	3	0	0	0	0	0	0	8	12	3	6	10	99	141
(11)	Cubao	199	123	0	0	0	0	0	147	72	12	26	30	56	664
(12)	Santolan-Annapolis	10	3	0	0	0	0	0	1	0	0	0	3	16	34
(13)	Ortigas_North	48	23	7	6	6	153	0	0	6	1	38	7	78	374
(14)	Ortigas_South	100	72	6	2	6	61	1	9	0	1	19	6	80	363
(15)	Kalayaan_Avenue	20	13	6	4	3	13	0	1	0	0	0	0	9	69
(16)	Bonifacio_Global_City	72	60	11	9	7	26	0	40	7	0	0	0	29	262
(17)	Cayetano_Biylevard	8	7	14	9	16	31	3	7	3	0	0	0	0	98
(18)	FTI	57	36	26	9	138	43	39	78	63	10	28	0	0	528
Total		761	422	404	56	180	632	51	381	338	69	265	101	551	4,211

Option 2

	100 Passengers/day	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	Total
(6)	Mindanao_Avenue-Quirino_Highway	0	0	319	24	42	5	42	51	104	19	76	7	58	748
(7)	Tandang_Sora_Avenue	0	0	81	6	24	12	45	22	80	14	61	16	97	458
(8)	North_Avenue	311	92	0	0	1	4	53	7	7	6	13	23	47	565
(9)	Timog_Avenue	31	5	0	0	0	0	4	14	12	3	2	3	12	84
(10)	E._Rodrigues_Sr._Avenue	23	27	0	0	0	0	1	77	31	19	12	18	2	210
(11)	Gilmore	15	19	4	0	0	0	0	27	7	6	12	13	20	124
(12)	Greenhills	46	44	47	3	2	0	0	24	2	3	9	6	19	204
(13)	Ortigas_North	48	20	8	15	88	23	27	0	8	1	33	7	72	351
(14)	Ortigas_South	107	76	6	12	36	3	1	8	0	1	17	4	73	344
(15)	Kalayaan_Avenue	19	13	7	3	18	5	3	1	0	0	0	0	6	75
(16)	Bonifacio_Global_City	77	62	14	2	11	10	6	36	7	0	0	0	18	243
(17)	Cayetano_Biylevard	7	16	24	2	17	12	6	7	2	0	0	0	0	93
(18)	FTI	60	70	29	7	2	22	18	74	53	8	17	0	0	359
Total		747	445	538	74	242	97	205	349	312	79	251	97	423	3,859

Option 3

	100 Passengers/day	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	Total
(6)	Mindanao_Avenue-Quirino_Highway	0	0	405	11	16	10	248	14	33	11	40	11	7	7	44	856
(7)	Tandang_Sora_Avenue	0	0	86	2	7	25	112	21	9	3	26	5	2	7	20	323
(8)	North_Avenue	378	88	0	0	0	1	112	8	0	0	0	0	1	2	1	589
(9)	Timog_Avenue	12	2	0	0	0	0	1	0	0	0	0	0	0	0	3	18
(10)	Araneta_Avenue	21	8	0	0	0	0	2	0	0	30	28	10	7	7	8	121
(11)	E._Rodrigues_Sr._Avenue	12	21	2	0	0	0	0	0	1	64	44	12	11	11	6	186
(12)	V._Mapa	257	121	84	2	2	0	0	12	11	247	125	26	46	47	11	990
(13)	Jose_Rizal_University	15	18	7	0	0	0	12	0	0	15	5	4	5	6	15	100
(14)	Old_Wak_Wak_Road	33	13	1	1	0	1	12	0	0	41	3	0	1	2	12	122
(15)	Ortigas_North	12	3	0	0	31	70	241	15	37	0	7	1	38	7	75	537
(16)	Ortigas_South	42	28	0	0	23	47	112	4	0	7	0	1	11	4	74	354
(17)	Kalayaan_Avenue	10	5	0	0	8	13	27	5	0	1	0	0	0	0	4	74
(18)	Bonifacio_Global_City	7	2	1	0	6	12	48	8	1	41	7	0	0	0	17	149
(19)	Cayetano_Biylevard	7	6	2	0	6	12	49	8	3	7	2	0	0	0	0	102
(20)	FTI	42	16	0	0	6	6	9	15	12	76	54	4	13	0	0	255
Total		847	332	588	16	105	197	986	109	107	542	341	75	142	99	290	4,778

Note: Iimplementation of MMSP in Year 2025 will be Phase 1 only, i.e. any of Options 1, 2 or 3.

Source: *JICA Study Team*

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Table App-C (2) Station OD Volume (Phase 2: Option A1 for Year 2035)

Year: 2035

Option A1

100 Passengers/day	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	Total
(1) L._Langit_Road	0	135	192	169	31	79	22	89	12	6	73	5	21	12	5	10	1	12	0	0	2	0	2	0	0	0	1	880
(2) Camarin_Road	104	0	2	200	55	84	26	86	9	4	62	6	18	12	3	8	2	7	1	0	1	0	0	0	0	0	0	690
(3) Zabarte_Road	165	1	0	14	9	34	16	50	13	1	54	5	14	12	6	18	0	17	2	0	1	2	0	0	0	0	0	433
(4) Novaliches	183	167	20	0	0	89	17	74	3	6	52	1	5	6	5	7	1	9	1	0	1	1	0	0	0	0	1	649
(5) San_Bartolome	19	42	6	0	0	4	3	30	2	4	19	3	4	2	2	1	0	4	1	1	1	0	0	0	0	0	0	148
(6) Mindanao_Avenue-Quirino_Highway	103	96	41	68	4	0	3	96	1	11	48	2	16	13	3	6	2	13	3	3	4	2	2	0	0	0	0	542
(7) Tandang_Sora_Avenue	19	27	20	17	4	1	0	64	2	0	43	4	14	26	7	3	4	12	2	1	5	2	1	0	0	0	1	281
(8) North_Avenue	92	93	78	79	27	103	75	0	0	0	0	0	11	61	10	14	14	77	2	1	15	18	5	1	3	4	7	790
(9) Quezon_Avenue	7	9	13	3	2	4	1	0	0	0	0	0	0	11	4	3	6	22	1	1	17	7	4	1	1	2	4	123
(10) Kamuning	6	4	3	6	3	10	0	0	0	0	0	0	1	11	2	2	6	69	1	0	14	4	2	0	1	1	2	148
(11) Cubao	62	57	80	44	17	42	39	0	0	0	0	0	109	105	50	27	26	55	4	3	37	16	17	3	3	4	8	807
(12) Santolan-Annapolis	5	4	3	1	1	2	2	0	0	0	0	0	0	15	1	3	8	26	0	1	15	7	7	1	1	2	4	109
(13) Ortigas_North	21	16	12	5	1	14	15	20	2	1	116	0	0	6	1	4	6	65	7	2	22	14	15	2	1	2	3	373
(14) Ortigas_South	12	12	18	4	1	11	21	55	16	19	112	4	7	0	8	18	12	83	18	6	33	18	41	2	2	3	6	543
(15) Kalayaan_Avenue	4	2	5	5	1	4	5	8	3	3	36	0	3	5	0	0	0	30	1	0	21	13	20	3	2	3	5	180
(16) Bonifacio_Global_City	10	9	15	8	1	7	7	12	6	4	25	2	3	13	0	0	2	41	7	1	83	41	60	6	10	14	18	403
(17) Cayetano_Biylevard	1	2	0	0	0	2	3	15	7	8	30	5	6	7	0	2	0	17	0	0	4	3	10	3	1	2	3	130
(18) FTI	13	7	11	6	2	13	18	61	25	118	53	17	50	81	28	36	16	0	0	1	191	97	83	7	21	31	20	1,006
(19) Dona_Soledad_Avenue	0	1	3	1	0	3	2	3	1	1	6	1	6	19	1	5	0	0	0	0	29	20	73	5	10	10	0	199
(20) Dr._Arcadio_Santos_Avenue	0	0	0	0	0	3	1	1	0	1	4	0	2	7	1	1	0	0	0	0	46	52	30	2	4	5	0	160
(21) Alabang-Zapote_Road	2	1	1	0	0	4	4	15	12	18	33	22	25	31	17	101	4	184	31	54	0	0	34	2	2	3	13	614
(22) Talon_Singko	0	0	1	0	0	2	1	17	6	5	15	11	15	19	10	47	3	85	22	51	0	0	259	0	2	3	25	600
(23) Molino_Road	2	1	0	0	0	3	1	7	4	4	17	5	15	39	18	30	9	76	70	25	36	263	0	8	193	259	0	1,086
(24) Daang_Hari	0	0	0	0	0	0	0	2	0	1	3	0	1	2	3	4	3	5	5	2	2	0	8	0	20	86	19	166
(25) Jose_Abad_Santos_Avenue	0	0	0	0	0	0	0	2	1	1	3	1	1	2	2	11	1	22	10	3	2	2	193	20	0	4	457	739
(26) Paliparan_Road	0	0	0	0	0	0	0	4	2	1	5	2	2	3	2	15	2	32	9	4	3	3	261	92	4	0	924	1,371
(27) Governor's_Drive	1	0	0	1	0	0	1	7	3	3	7	4	3	6	4	16	3	23	0	0	14	23	4	20	459	932	0	1,535
Total	835	686	526	632	157	518	285	718	131	219	815	99	352	528	192	391	131	984	200	159	598	608	1,130	177	740	1,371	1,521	14,703

Source: *JICA Study Team*

Table App-C (3) Station OD Volume (Phase 2: Option A2 for Year 2035)

Year: 2035

Option A2

100 Passengers/day	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	Total
(1) L._Langit_Road	0	123	164	156	32	108	33	126	6	15	5	9	22	15	5	12	2	14	0	1	2	0	2	0	0	0	1	853
(2) Camarin_Road	95	0	9	156	50	108	31	106	4	14	3	9	13	17	3	10	2	8	1	0	1	0	0	0	0	0	0	639
(3) Zabarte_Road	178	2	0	11	12	53	24	61	5	17	6	6	10	14	5	13	0	9	3	0	1	2	0	0	0	0	0	432
(4) Novaliches	168	161	22	0	0	52	19	101	6	12	1	2	6	5	5	8	1	10	1	0	0	1	0	0	0	0	1	582
(5) San_Bartolome	29	47	7	0	0	25	19	49	2	5	1	3	4	5	2	2	1	5	1	1	1	0	1	0	0	0	0	211
(6) Mindanao_Avenue-Quirino_Highway	109	89	50	69	14	0	3	149	7	15	1	12	16	20	5	11	2	17	3	3	4	2	2	1	0	0	0	602
(7) Tandang_Sora_Avenue	44	53	42	20	5	1	0	106	6	28	4	17	13	37	9	6	5	25	2	1	5	2	2	0	0	0	1	435
(8) North_Avenue	121	98	65	115	39	137	152	0	0	4	27	87	3	44	11	9	21	102	1	1	45	32	12	3	5	7	16	1,158
(9) Timog_Avenue	6	4	5	8	2	7	3	0	0	0	0	5	18	18	3	2	3	7	1	1	6	3	0	0	0	1	1	104
(10) E._Rodrigues_Sr._Avenue	13	12	15	13	5	7	14	12	0	0	0	1	80	53	21	9	13	7	4	1	9	3	2	1	1	1	2	299
(11) Gilmore	4	5	8	4	3	2	7	25	0	0	0	0	36	23	9	10	9	10	3	0	7	3	1	2	1	1	2	174
(12) Greenhills	10	8	6	2	3	11	21	82	6	4	0	0	17	7	8	9	6	17	4	2	12	8	5	0	0	0	1	249
(13) Ortigas_North	23	16	13	7	4	16	26	2	20	83	23	19	0	17	2	2	9	49	7	2	39	20	20	2	2	3	5	430
(14) Ortigas_South	13	13	14	7	4	13	35	55	14	54	14	6	9	0	7	20	11	79	20	7	33	19	41	2	2	3	7	499
(15) Kalayaan_Avenue	5	3	4	6	2	4	9	9	3	19	6	6	2	4	0	0	0	27	1	1	19	11	18	4	2	2	4	173
(16) Bonifacio_Global_City	8	9	16	5	4	11	6	11	2	10	10	8	2	13	0	0	2	58	8	2	88	40	51	7	10	14	17	412
(17) Cayetano_Biylevard	1	1	0	0	0	2	6	21	3	13	7	6	9	6	0	2	0	28	0	0	4	2	10	3	1	2	2	129
(18) FTI	12	6	18	10	4	14	26	82	7	8	10	16	52	79	27	44	16	0	0	1	191	95	85	7	21	31	21	882
(19) Dona_Soledad_Avenue	0	1	2	1	1	3	3	2	1	4	3	4	7	20	1	6	0	0	0	0	26	21	71	4	10	9	0	200
(20) Dr._Arcadio_Santos_Avenue	0	0	0	0	1	3	3	1	1	1	0	1	2	6	1	2	0	0	0	0	46	50	40	2	4	6	0	171
(21) Alabang-Zapote_Road	2	1	1	0	1	4	6	45	4	10	9	14	47	34	17	104	4	172	29	51	0	0	38	2	2	3	12	610
(22) Talon_Singko	0	0	1	0	0	2	2	31	3	4	3	8	23	20	10	51	3	86	21	57	0	0	260	0	2	3	25	614
(23) Molino_Road	2	0	0	0	1	2	3	11	1	3	3	4	17	40	16	37	10	71	70	31	34	262	0	6	194	257	0	1,074
(24) Daang_Hari	0	0	0	0	0	0	0	2	0	1	1	1	1	2	4	6	3	5	4	2	2	0	6	0	20	89	20	170
(25) Jose_Abad_Santos_Avenue	0	0	0	0	0	0	0	5	0	1	1	0	3	2	2	12	1	20	11	4	2	2	194	20	0	4	454	739
(26) Paliparan_Road	0	0	0	0	0	0	0	7	1	2	1	0	4	4	2	17	2	30	9	6	3	3	256	93	4	0	934	1,378
(27) Governor's_Drive	1	0	0	1	0	0	2	16	1	3	2	1	7	7	4	17	3	20	0	0	13	23	3	21	456	940	0	1,541
Total	847	652	463	590	187	583	453	1,117	99	329	141	245	421	512	177	419	124	877	204	172	594	603	1,123	181	739	1,378	1,528	14,758

Source: *JICA Study Team*

Table App-C (4) Station OD Volume (Phase 2: Option A3 for Year 2035)

Year: 2035

Option A3

100 Passengers/day	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	Total
(1) L._Langit_Road	0	78	171	178	26	84	17	137	2	13	5	47	3	7	6	9	3	6	1	9	0	0	2	0	2	0	0	0	1	807
(2) Camarin_Road	74	0	0	194	55	77	28	116	0	8	3	31	5	3	2	5	2	3	1	4	0	0	0	0	0	0	0	0	0	615
(3) Zabarte_Road	154	1	0	21	2	23	23	101	1	10	7	41	6	5	2	6	2	7	0	7	2	0	1	2	0	0	0	0	0	423
(4) Novaliches	164	152	8	0	0	50	19	81	0	16	7	61	2	4	3	4	2	3	1	9	1	0	0	0	0	0	0	0	1	588
(5) San_Bartolome	31	66	6	0	0	9	4	37	0	4	2	15	1	1	1	2	2	0	0	2	1	1	1	0	0	0	0	0	0	188
(6) Mindanao_Avenue-Quirino_Highway	101	100	29	66	23	0	4	115	0	10	3	42	3	5	5	6	1	3	2	7	1	1	3	1	1	0	0	0	0	530
(7) Tandang_Sora_Avenue	29	28	22	14	1	1	0	119	0	4	7	58	9	8	3	14	4	2	3	6	1	1	4	1	1	0	0	0	1	342
(8) North_Avenue	147	125	77	80	37	136	113	0	0	13	27	208	56	5	0	7	1	1	4	25	0	0	16	15	5	1	1	2	4	1,107
(9) Timog_Avenue	1	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	8
(10) Araneta_Avenue	11	9	8	11	2	7	3	13	0	0	0	7	0	1	48	43	16	6	8	10	2	1	9	4	2	0	1	1	3	224
(11) E._Rodrigues_Sr._Avenue	8	8	10	6	4	4	10	23	0	0	0	2	0	2	68	45	16	10	9	22	4	2	9	3	2	1	1	1	3	272
(12) V._Mapa	59	50	48	49	25	53	56	142	0	6	4	0	13	14	214	117	48	38	35	36	9	3	34	18	19	4	3	5	7	1,108
(13) Jose_Rizal_University	3	6	2	1	1	4	8	54	1	0	0	18	0	0	19	12	10	12	9	14	2	1	5	2	3	1	0	1	2	191
(14) Old_Wak_Wak_Road	11	5	4	2	2	10	9	8	0	1	2	18	1	0	31	8	2	3	3	8	1	0	9	4	1	0	0	0	0	142
(15) Ortigas_North	8	5	6	2	4	6	3	0	0	45	82	209	17	32	0	8	4	3	10	58	9	2	72	38	23	3	5	8	12	673
(16) Ortigas_South	10	8	8	2	3	8	13	3	0	30	46	113	12	1	10	0	3	22	12	86	19	7	35	20	43	3	3	4	7	533
(17) Kalayaan_Avenue	2	2	3	3	2	2	2	1	0	11	14	29	10	1	1	2	0	0	0	32	1	1	18	12	17	2	1	2	4	174
(18) Bonifacio_Global_City	6	8	8	3	2	5	1	1	0	7	14	38	14	2	2	16	0	0	2	40	8	1	84	45	50	7	10	14	17	404
(19) Cayetano_Biylevard	1	2	0	0	1	2	3	4	0	7	10	33	9	4	15	6	0	2	0	27	0	0	4	3	9	3	1	2	2	150
(20) FTI	11	7	8	6	3	9	6	15	0	8	19	18	14	8	57	91	29	59	29	0	0	0	152	81	73	6	19	27	18	774
(21) Dona_Soledad_Avenue	0	0	3	1	1	1	1	0	0	2	5	4	3	1	10	20	1	5	0	0	0	0	26	20	66	5	8	7	0	188
(22) Dr._Arcadio_Santos_Avenue	0	0	0	0	1	2	1	0	0	0	2	1	0	0	3	6	1	1	0	0	0	0	57	52	43	2	5	6	0	184
(23) Alabang-Zapote_Road	2	1	1	0	1	4	5	16	0	9	10	31	6	11	78	33	16	96	4	136	27	60	0	0	24	3	2	3	11	592
(24) Talon_Singko	0	0	2	0	0	2	1	16	1	4	3	17	2	4	40	20	8	50	3	74	21	53	0	0	260	0	2	3	25	611
(25) Molino_Road	2	0	0	0	1	2	1	3	0	2	1	14	3	1	26	41	17	46	9	63	67	34	23	260	0	10	189	257	0	1,071
(26) Daang_Hari	0	0	0	0	0	0	0	1	0	0	1	2	1	0	4	3	2	7	3	7	5	2	3	0	10	0	15	91	20	176
(27) Jose_Abad_Santos_Avenue	0	0	0	0	0	0	0	1	0	1	1	3	0	0	6	3	1	11	1	17	10	5	2	2	189	15	0	0	452	721
(28) Paliparan_Road	0	0	0	0	0	0	0	2	0	1	1	5	1	0	8	4	2	16	2	26	9	7	3	3	260	110	0	0	901	1,361
(29) Governor's_Drive	1	0	0	1	0	1	1	4	0	2	3	6	2	0	15	7	3	18	3	19	1	0	12	24	0	22	454	924	0	1,524
Total	838	663	427	643	195	500	332	1,013	8	212	280	1,071	193	120	676	535	194	430	154	745	200	184	584	610	1,102	201	720	1,361	1,492	15,680

Source: *JICA Study Team*

Table App-C (5) Station OD Volume (Phase 2: Option B1 for Year 2035)

Year: 2035

Option B1

100 Passengers/day	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	Total
(1) Bahay_Pare_Road	0	238	87	49	156	72	34	77	9	1	53	0	26	13	6	1	2	14	1	1	3	0	3	0	0	1	1	848
(2) Mt._Samat_Road	252	0	0	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	402
(3) Llana_Road	79	0	0	279	0	61	40	29	3	3	30	1	20	9	5	2	2	0	0	0	0	0	0	0	0	0	0	565
(4) Gen._Luis	56	134	269	0	367	136	69	63	8	4	57	1	10	9	9	31	1	9	3	0	0	0	0	0	0	0	1	1,236
(5) Tatalon	106	0	0	337	0	146	186	25	0	0	49	1	14	15	8	4	2	7	2	0	2	1	2	0	0	0	1	908
(6) Mindanao_Avenue-Quirino_Highway	72	0	57	140	149	0	5	161	7	7	89	3	21	30	11	9	4	27	6	7	8	6	4	0	0	0	1	823
(7) Tandang_Sora_Avenue	37	0	34	68	231	1	0	171	7	0	118	1	23	46	14	6	7	18	4	2	8	2	3	0	1	1	2	805
(8) North_Avenue	96	0	37	65	26	180	167	0	0	0	0	0	7	36	4	10	15	48	2	1	16	18	7	1	3	4	8	750
(9) Quezon_Avenue	5	0	1	6	0	5	7	0	0	0	0	0	2	14	1	4	10	36	0	1	19	8	4	0	2	2	5	133
(10) Kamuning	2	0	4	5	1	8	0	0	0	0	0	0	1	14	2	2	8	47	2	0	13	4	2	0	1	1	2	119
(11) Cubao	47	0	31	50	54	75	102	0	0	0	0	0	78	108	38	34	30	68	7	3	33	14	17	1	3	4	9	807
(12) Santolan-Annapolis	5	0	3	2	3	7	3	0	0	0	0	0	0	3	0	2	4	14	1	0	9	4	5	0	0	1	2	66
(13) Ortigas_North	28	0	21	11	23	39	34	7	4	1	63	0	0	5	2	4	6	41	6	1	15	11	13	1	0	1	1	339
(14) Ortigas_South	18	0	10	17	12	26	45	25	14	12	80	4	5	0	5	23	11	78	18	7	34	19	41	3	2	4	7	520
(15) Kalayaan_Avenue	8	0	3	12	8	10	13	5	2	1	28	0	2	4	0	0	0	20	1	1	16	10	16	2	1	2	3	167
(16) Bonifacio_Global_City	4	0	3	22	4	10	7	7	5	3	33	4	3	15	0	0	2	55	8	4	94	42	52	5	9	14	18	422
(17) Cayetano_Biylevard	3	0	2	0	2	3	8	14	9	9	31	7	7	6	0	2	0	15	0	0	4	3	10	3	1	2	3	140
(18) FTI	17	0	0	9	2	27	31	58	23	84	46	21	44	77	31	38	24	0	0	0	191	93	82	7	22	32	19	979
(19) Dona_Soledad_Avenue	1	0	0	3	0	6	3	1	1	0	2	1	5	18	1	3	0	0	0	0	30	21	72	4	10	10	0	192
(20) Dr._Arcadio_Santos_Avenue	1	0	0	0	0	7	2	0	1	0	3	0	2	6	1	0	0	0	0	0	52	53	33	1	4	5	0	173
(21) Alabang-Zapote_Road	3	0	0	0	0	8	8	12	14	20	22	18	20	32	17	87	4	203	31	53	0	0	31	2	2	3	12	603
(22) Talon_Singko	0	0	0	0	0	5	3	18	8	6	11	9	14	19	10	40	3	99	22	54	0	0	262	0	2	3	25	612
(23) Molino_Road	3	0	0	0	1	5	3	5	5	2	11	4	11	38	18	35	9	74	70	27	32	264	0	9	196	258	0	1,081
(24) Daang_Hari	0	0	0	0	0	1	0	1	1	1	1	0	1	2	2	5	3	4	4	1	2	0	8	0	25	87	21	172
(25) Jose_Abad_Santos_Avenue	0	0	0	0	0	0	1	2	1	1	2	1	1	3	1	9	1	22	11	4	2	2	197	25	0	4	459	750
(26) Paliparan_Road	1	0	0	0	0	0	1	3	2	1	4	1	1	4	2	13	2	32	10	5	3	3	259	99	4	0	923	1,375
(27) Governor's_Drive	1	0	0	1	1	1	2	7	4	4	5	2	2	6	3	16	3	23	1	0	12	24	3	21	461	936	0	1,539
Total	844	373	564	1,225	1,042	839	774	692	126	161	738	79	320	533	190	379	151	956	209	172	598	601	1,125	186	750	1,374	1,521	16,524

Source: *JICA Study Team*

Table App-C (6) Station OD Volume (Phase 2: Option B2 for Year 2035)

Year: 2035

Option B2

100 Passengers/day	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	Total
(1) Bahay_Pare_Road	0	242	114	60	129	52	32	113	1	4	3	11	30	20	7	3	2	15	1	1	3	0	3	0	0	0	1	848
(2) Mt._Samat_Road	270	0	0	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	421
(3) Llana_Road	56	0	0	283	0	64	33	58	1	1	0	5	22	13	5	3	2	1	0	0	0	0	0	0	0	0	0	548
(4) Gen._Luis	65	137	303	0	342	139	63	97	3	14	5	3	12	10	17	25	1	9	3	0	0	0	0	0	0	0	1	1,250
(5) Tatalon	117	0	0	326	0	186	172	77	0	0	1	2	17	14	8	3	2	8	2	1	1	1	1	0	0	0	1	941
(6) Mindanao_Avenue-Quirino_Highway	57	0	67	144	184	0	6	241	5	12	4	18	32	36	12	9	4	28	6	7	8	5	4	1	0	0	1	893
(7) Tandang_Sora_Avenue	38	0	38	68	196	2	0	166	4	19	17	24	26	48	15	6	9	22	3	3	9	3	4	1	1	1	2	726
(8) North_Avenue	129	1	79	106	48	244	216	0	0	0	26	72	1	54	14	10	21	102	1	1	39	28	13	5	4	6	14	1,234
(9) Timog_Avenue	0	0	1	6	0	6	5	0	0	0	0	7	17	18	2	2	2	19	1	1	5	3	2	0	1	1	1	99
(10) E._Rodrigues_Sr._Avenue	4	0	2	11	1	9	17	9	0	0	0	1	51	38	15	10	10	7	3	1	7	3	2	1	1	1	2	203
(11) Gilmore	2	0	0	2	0	7	20	22	0	0	0	0	37	21	8	11	9	10	2	0	6	2	2	3	1	1	2	168
(12) Greenhills	14	0	7	4	2	20	27	70	8	3	0	0	17	10	6	10	6	16	3	2	12	7	5	0	0	0	0	250
(13) Ortigas_North	25	0	22	11	20	25	23	6	15	70	27	15	0	18	2	2	10	44	8	2	42	19	18	2	2	3	5	438
(14) Ortigas_South	18	0	12	17	14	33	45	61	17	42	16	8	9	0	7	24	13	95	18	7	31	17	41	3	2	3	7	559
(15) Kalayaan_Avenue	6	0	3	15	8	9	11	11	2	15	5	5	2	4	0	0	0	43	1	1	21	13	22	4	2	3	5	211
(16) Bonifacio_Global_City	2	0	3	22	3	8	8	11	2	11	10	9	2	19	0	0	2	45	5	0	89	41	55	8	9	13	16	395
(17) Cayetano_Biylevard	2	0	2	0	2	4	8	21	2	14	7	7	12	8	0	2	0	20	0	0	4	2	9	2	1	2	2	134
(18) FTI	17	0	0	10	4	26	23	94	6	8	9	17	44	91	39	51	19	0	0	1	168	87	92	10	19	27	20	883
(19) Dona_Soledad_Avenue	1	0	0	3	3	8	4	6	1	4	3	3	11	21	1	4	0	0	0	0	23	19	66	4	9	9	0	204
(20) Dr._Arcadio_Santos_Avenue	1	0	0	0	1	8	2	1	1	2	0	2	2	7	2	2	0	0	0	0	49	60	40	2	5	6	0	194
(21) Alabang-Zapote_Road	3	0	0	0	2	8	7	42	3	9	6	14	43	29	18	88	4	167	28	68	0	0	31	2	2	3	12	589
(22) Talon_Singko	0	0	0	0	0	5	2	29	3	3	2	8	21	19	12	42	2	81	21	57	0	0	256	0	2	3	24	594
(23) Molino_Road	3	0	0	0	2	5	4	11	2	3	2	4	19	37	18	41	9	75	62	33	29	254	0	7	192	256	2	1,071
(24) Daang_Hari	0	0	0	0	1	1	1	6	0	1	3	0	4	2	3	8	2	8	5	3	2	0	7	0	14	96	21	190
(25) Jose_Abad_Santos_Avenue	0	0	0	0	0	0	1	4	1	1	1	0	3	2	2	11	1	19	10	4	2	2	191	14	0	4	456	731
(26) Paliparan_Road	1	0	0	0	0	0	1	6	1	2	1	0	4	4	2	15	2	27	10	6	3	3	256	97	4	0	920	1,365
(27) Governor's_Drive	1	0	0	1	1	1	3	14	1	3	2	1	5	6	4	17	3	19	0	0	13	24	2	21	454	924	0	1,519
Total	834	381	654	1,239	965	871	734	1,178	79	238	149	237	440	550	219	399	134	881	193	198	567	595	1,121	190	726	1,364	1,517	16,656

Source: *JICA Study Team*

Table App-C (7) Station OD Volume (Phase 2: Option B3 for Year 2035)

Year: 2035

Option B3

100 Passengers/day	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	Total
(1) Bahay_Pare_Road	0	261	115	56	89	60	40	150	0	1	1	18	4	10	4	9	3	2	2	9	0	0	3	0	1	0	0	0	1	841
(2) Mt._Samat_Road	238	0	0	133	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	375
(3) Llana_Road	78	0	0	275	0	58	35	57	0	1	0	9	0	1	4	6	1	1	1	0	0	0	0	0	0	0	0	0	0	529
(4) Gen._Luis	64	141	250	0	335	151	72	98	1	4	9	65	5	4	4	7	4	20	0	7	2	0	0	0	0	0	0	0	1	1,245
(5) Tatalon	110	0	5	292	0	189	205	75	0	0	0	2	1	1	5	5	3	1	1	4	1	0	1	0	0	0	0	0	0	901
(6) Mindanao_Avenue-Quirino_Highway	63	0	64	134	173	0	5	271	0	9	6	88	8	14	10	24	4	7	4	19	3	3	9	6	2	1	0	0	1	930
(7) Tandang_Sora_Avenue	37	0	37	74	189	2	0	206	0	14	14	87	16	13	3	19	4	2	6	27	3	1	6	2	2	0	1	1	2	768
(8) North_Avenue	180	1	101	106	46	257	235	0	0	11	23	183	59	1	0	10	1	1	4	22	0	0	15	14	4	1	1	1	3	1,281
(9) Timog_Avenue	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	7
(10) Araneta_Avenue	2	0	1	7	0	7	12	25	0	0	0	5	0	1	36	39	14	6	9	10	2	1	11	5	2	0	1	2	3	202
(11) E._Rodrigues_Sr._Avenue	2	0	1	9	0	4	15	35	0	0	0	2	0	1	62	33	12	8	7	19	5	2	10	3	2	1	1	1	3	236
(12) V._Mapa	27	0	12	79	1	80	90	177	3	4	4	0	15	14	222	102	42	34	31	28	8	2	40	19	17	2	4	6	7	1,070
(13) Jose_Rizal_University	7	0	0	5	0	7	17	55	1	0	0	15	0	0	20	11	6	10	7	14	2	0	5	2	3	1	0	1	2	193
(14) Old_Wak_Wak_Road	15	0	1	4	0	16	15	3	2	1	1	16	1	0	28	9	2	2	2	7	1	0	8	3	1	0	0	0	0	138
(15) Ortigas_North	2	0	3	4	1	6	2	0	0	46	76	222	18	26	0	7	2	2	10	55	10	3	68	36	25	3	5	7	13	649
(16) Ortigas_South	6	0	4	9	2	13	11	2	0	38	44	107	10	1	11	0	4	20	11	89	19	7	34	19	41	3	3	4	7	517
(17) Kalayaan_Avenue	1	0	0	4	0	2	2	1	0	14	18	42	11	1	1	2	0	0	0	26	1	1	18	10	14	2	2	2	4	183
(18) Bonifacio_Global_City	3	0	3	24	1	7	1	0	0	8	11	39	14	2	2	14	0	0	2	44	9	2	87	42	52	6	10	14	15	413
(19) Cayetano_Biylevard	2	0	1	0	0	3	5	2	0	10	10	37	10	3	13	7	0	2	0	15	0	0	4	3	9	3	1	2	2	145
(20) FTI	12	0	0	8	0	15	10	5	0	10	19	14	16	8	64	86	31	49	24	0	0	0	141	81	64	6	17	25	15	722
(21) Dona_Soledad_Avenue	0	0	0	2	0	2	1	0	0	2	4	2	3	1	10	20	1	9	0	0	0	0	26	19	67	4	9	9	0	191
(22) Dr._Arcadio_Santos_Avenue	0	0	0	0	0	3	1	0	0	1	2	0	1	0	4	7	0	1	0	0	0	0	50	48	42	2	5	6	0	174
(23) Alabang-Zapote_Road	3	0	0	0	0	8	6	18	0	12	11	35	6	11	75	30	16	100	4	136	25	53	0	0	27	2	2	3	11	595
(24) Talon_Singko	0	0	0	0	0	6	2	15	1	5	4	18	2	4	38	19	8	48	3	69	19	51	0	0	265	0	2	3	24	607
(25) Molino_Road	2	0	0	0	0	2	1	3	0	3	1	12	3	1	22	38	15	42	9	61	63	34	24	263	0	9	193	261	0	1,063
(26) Daang_Hari	0	0	0	0	0	0	0	0	0	0	1	1	1	0	4	2	3	5	3	6	4	2	2	0	9	0	16	85	13	158
(27) Jose_Abad_Santos_Avenue	0	0	0	0	0	0	1	1	0	1	1	4	0	0	6	3	2	11	1	16	10	5	2	2	194	16	0	2	458	734
(28) Paliparan_Road	0	0	0	0	0	0	1	1	0	2	2	6	1	0	8	3	2	15	2	24	9	6	3	3	264	85	2	0	928	1,369
(29) Governor's_Drive	1	0	0	1	0	1	2	4	0	3	3	7	2	0	14	6	4	16	3	17	0	0	12	24	0	20	455	932	0	1,528
Total	856	403	600	1,227	840	903	786	1,207	10	200	265	1,039	207	117	669	520	182	416	144	726	198	174	580	606	1,108	165	730	1,369	1,514	17,761

Source: *JICA Study Team*

Table App-C (8) Station OD Volume (Phase 2: Option A1 for Year 2045)

Year: 2045

Option A1

100 Passengers/day	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	Total
(1) L._Langit_Road	0	49	198	266	58	193	47	195	24	3	94	12	31	21	16	18	2	22	1	0	2	0	2	0	0	1	2	1,257
(2) Camarin_Road	51	0	2	172	82	143	40	129	19	2	55	12	20	15	7	12	2	10	1	1	1	0	0	1	0	0	0	777
(3) Zabarte_Road	179	1	0	48	13	99	27	85	28	5	75	23	20	16	8	22	0	35	5	0	1	2	0	0	0	0	1	693
(4) Novaliches	285	198	29	0	0	109	32	123	7	2	42	6	7	6	7	8	0	11	2	0	0	1	0	0	0	0	1	876
(5) San_Bartolome	92	93	16	0	0	51	1	44	6	0	23	4	8	5	4	4	1	5	1	1	1	0	0	0	0	0	0	361
(6) Mindanao_Avenue-Quirino_Highway	241	155	58	110	18	0	4	146	19	3	72	15	26	27	16	19	3	26	10	6	5	3	5	1	0	0	2	989
(7) Tandang_Sora_Avenue	34	52	31	29	2	2	0	154	8	1	69	10	24	31	8	13	7	18	5	5	5	2	3	1	0	0	2	515
(8) North_Avenue	183	150	95	134	47	141	134	0	0	0	7	0	26	76	21	17	18	93	13	17	19	18	12	4	2	3	11	1,241
(9) Quezon_Avenue	24	15	24	6	4	28	11	0	0	0	0	0	10	21	8	6	6	50	8	6	16	6	5	2	1	1	10	266
(10) Kamuning	4	4	4	4	1	4	0	0	0	0	1	0	3	20	3	2	6	88	5	8	12	4	4	1	1	1	5	185
(11) Cubao	97	69	71	53	32	84	73	8	0	0	0	0	146	133	43	34	34	61	20	10	28	11	16	8	2	3	12	1,051
(12) Santolan-Annapolis	10	5	6	6	2	14	3	1	0	0	0	0	4	41	18	8	14	95	8	2	27	12	6	3	3	4	11	304
(13) Ortigas_North	30	26	19	9	9	28	25	32	13	4	167	1	0	14	6	9	12	42	9	2	29	12	16	6	1	2	8	532
(14) Ortigas_South	28	25	33	10	8	39	35	65	18	14	104	16	9	0	12	33	17	98	31	18	45	18	48	4	3	4	12	743
(15) Kalayaan_Avenue	14	5	8	13	6	17	10	12	5	1	37	9	4	5	0	0	0	34	3	3	38	17	29	7	2	3	10	294
(16) Bonifacio_Global_City	16	7	7	6	4	15	16	19	7	3	46	10	8	31	0	0	16	42	9	1	107	55	36	14	9	13	31	527
(17) Cayetano_Biylevard	2	3	2	0	1	4	7	14	6	6	36	12	16	11	0	18	0	36	4	1	8	4	11	4	1	2	4	213
(18) FTI	26	10	29	22	6	23	19	92	19	102	82	46	53	97	45	56	37	0	12	14	245	127	118	20	24	34	60	1,418
(19) Dona_Soledad_Avenue	2	2	4	4	3	7	6	17	6	5	19	5	17	39	9	9	4	0	0	0	43	26	101	10	17	24	4	383
(20) Dr._Arcadio_Santos_Avenue	1	1	0	0	2	5	7	17	5	9	7	3	2	13	3	2	0	3	0	0	86	58	51	11	5	7	4	302
(21) Alabang-Zapote_Road	2	1	1	1	1	4	5	18	12	14	37	23	42	51	32	93	9	245	29	69	0	0	20	3	3	4	14	734
(22) Talon_Singko	0	0	2	1	0	2	1	16	7	3	13	11	18	22	16	48	4	123	25	53	0	0	181	0	0	0	6	553
(23) Molino_Road	3	0	0	0	1	3	3	9	4	5	15	8	20	47	31	29	11	128	104	49	16	159	0	44	215	360	65	1,331
(24) Daang_Hari	0	1	0	0	0	1	1	3	2	1	6	4	6	6	7	14	4	19	11	11	3	0	42	0	20	139	63	364
(25) Jose_Abad_Santos_Avenue	0	0	0	0	0	0	0	2	1	0	4	2	2	3	2	9	1	24	15	4	3	0	217	20	0	0	613	923
(26) Paliparan_Road	1	0	0	0	0	0	1	3	1	1	5	2	3	4	3	12	2	36	24	7	4	0	361	143	0	0	1,029	1,643
(27) Governor's_Drive	2	0	1	1	1	1	3	12	4	13	13	6	10	15	8	23	4	53	5	5	14	4	96	69	615	1,036	0	2,012
Total	1,328	870	641	896	298	1,016	512	1,216	220	195	1,029	239	535	770	334	516	214	1,400	359	295	757	541	1,379	377	924	1,642	1,982	20,485

Source: *JICA Study Team*

Table App-C (9) Station OD Volume (Phase 2: Option A2 for Year 2045)

Year: 2045

Option A2

100 Passengers/day	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	Total
(1) L._Langit_Road	0	53	140	305	54	232	60	207	13	15	82	15	27	24	18	15	2	30	1	1	3	0	3	1	0	1	2	1,306
(2) Camarin_Road	38	0	0	183	109	164	50	144	8	11	45	8	14	18	10	13	2	15	1	1	1	0	0	0	0	0	0	835
(3) Zabarte_Road	207	0	0	15	7	100	41	110	11	28	49	11	15	21	16	21	0	37	7	0	2	2	0	0	0	0	1	702
(4) Novaliches	292	216	42	0	0	99	20	126	7	11	53	4	8	8	11	6	1	11	2	0	0	1	0	0	0	0	1	918
(5) San_Bartolome	52	90	14	0	0	42	5	44	3	7	25	3	5	6	5	7	1	6	2	0	1	0	0	0	0	0	0	317
(6) Mindanao_Avenue-Quirino_Highway	183	132	58	90	53	0	4	186	13	6	69	19	17	30	13	15	4	29	9	8	5	3	6	1	0	0	2	954
(7) Tandang_Sora_Avenue	47	55	34	15	5	2	0	161	7	11	76	19	12	33	9	10	7	29	4	5	7	2	4	1	0	1	4	560
(8) North_Avenue	215	168	131	136	52	135	141	0	6	1	49	68	11	53	13	9	20	128	20	26	41	25	13	3	3	5	26	1,501
(9) Timog_Avenue	11	7	9	4	3	5	4	2	0	0	2	6	33	17	6	2	3	6	1	0	6	4	1	1	1	1	1	136
(10) E._Rodrigues_Sr._Avenue	16	11	20	11	4	8	12	3	0	0	0	0	60	36	20	9	11	9	5	1	15	4	2	1	1	2	4	263
(11) Gilmore	73	56	54	58	16	45	38	57	3	0	0	26	157	95	59	31	31	52	17	6	37	13	15	4	3	5	15	966
(12) Greenhills	15	8	9	4	3	18	23	59	5	2	25	0	17	8	9	9	7	16	6	4	17	7	5	1	0	0	2	280
(13) Ortigas_North	25	12	19	10	4	16	18	17	29	59	183	18	0	9	9	13	17	53	14	2	51	21	25	6	3	4	19	656
(14) Ortigas_South	27	21	34	11	6	27	33	48	14	32	95	7	12	0	12	39	17	90	30	12	40	18	45	4	2	3	11	692
(15) Kalayaan_Avenue	14	6	12	16	3	14	6	6	4	12	16	4	3	5	0	0	0	43	5	4	38	18	28	6	2	3	12	282
(16) Bonifacio_Global_City	14	11	22	10	3	10	13	14	3	17	35	11	9	27	0	0	10	54	11	1	118	55	42	10	10	14	33	556
(17) Cayetano_Biylevard	2	2	0	0	0	2	7	20	3	12	34	7	27	13	0	13	0	36	4	0	8	4	12	4	1	2	5	220
(18) FTI	28	12	18	11	6	21	20	165	7	9	48	17	60	108	56	47	41	0	1	6	217	116	113	14	21	31	56	1,249
(19) Dona_Soledad_Avenue	1	1	5	2	2	9	7	17	1	8	23	6	17	31	13	7	4	0	0	0	27	24	96	8	16	24	4	355
(20) Dr._Arcadio_Santos_Avenue	1	1	1	0	1	7	8	26	1	2	7	3	4	11	7	1	0	2	0	0	83	62	55	11	7	9	4	315
(21) Alabang-Zapote_Road	3	1	1	1	1	4	7	40	4	16	30	19	63	46	29	119	9	207	30	82	0	0	11	2	3	4	14	745
(22) Talon_Singko	0	0	2	1	0	2	2	24	3	5	13	8	26	21	15	60	4	103	26	58	0	0	168	0	0	0	5	544
(23) Molino_Road	3	0	1	0	0	5	6	16	1	3	17	6	30	46	28	39	11	101	93	48	6	164	0	52	218	348	67	1,308
(24) Daang_Hari	1	0	0	0	0	1	1	5	1	1	7	1	9	5	7	11	4	11	8	11	2	0	41	0	22	128	59	335
(25) Jose_Abad_Santos_Avenue	1	0	0	0	0	0	0	3	0	1	3	0	4	3	2	11	1	18	17	6	3	0	218	22	0	0	611	925
(26) Paliparan_Road	1	0	0	0	0	0	1	5	1	2	4	1	6	4	3	16	2	28	25	9	4	0	349	138	0	0	1,047	1,645
(27) Governor's_Drive	2	0	2	1	1	3	3	26	1	4	12	3	16	14	9	29	4	42	5	5	14	4	92	60	611	1,058	0	2,020
Total	1,272	866	628	884	334	970	533	1,530	146	273	1,003	290	660	693	379	552	212	1,154	343	295	745	547	1,349	349	926	1,645	2,007	20,586

Source: *JICA Study Team*

Table App-C (10) Station OD Volume (Phase 2: Option A3 for Year 2045)

Year: 2045

Option A3

100 Passengers/day	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	Total
(1) L._Langit_Road	0	33	132	344	67	222	75	221	6	23	16	99	9	9	13	21	11	9	2	22	1	0	2	0	2	0	0	1	2	1,342
(2) Camarin_Road	37	0	0	140	88	152	69	130	0	13	11	48	9	3	5	13	5	5	1	9	1	1	1	0	0	0	0	0	0	744
(3) Zabarte_Road	143	0	0	21	12	83	58	123	3	11	15	66	11	5	6	11	5	10	0	14	5	0	1	2	0	0	0	0	1	608
(4) Novaliches	350	198	46	0	0	100	30	118	0	15	8	59	3	2	5	7	12	4	1	12	2	0	0	1	0	0	0	0	2	974
(5) San_Bartolome	52	94	24	0	0	39	12	50	0	4	3	20	2	2	5	4	2	2	0	5	2	1	1	0	1	0	0	0	1	326
(6) Mindanao_Avenue-Quirino_Highway	180	162	107	63	46	0	4	163	0	13	12	93	8	12	14	22	10	11	3	22	9	7	4	2	5	0	0	0	1	976
(7) Tandang_Sora_Avenue	59	56	31	20	3	2	0	262	0	35	21	103	19	9	6	20	4	8	6	13	4	6	6	2	4	1	0	1	3	704
(8) North_Avenue	184	174	132	142	46	178	173	0	0	36	29	188	68	11	4	41	3	5	12	113	12	17	24	17	9	2	2	2	15	1,642
(9) Timog_Avenue	4	0	3	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	13
(10) Araneta_Avenue	15	11	12	17	6	17	11	49	0	0	0	4	0	1	41	30	10	8	6	9	3	1	12	5	3	1	1	1	4	276
(11) E._Rodrigues_Sr._Avenue	11	11	14	8	5	10	16	43	0	0	0	2	0	2	121	77	38	23	13	28	18	4	17	5	4	1	2	3	6	479
(12) V._Mapa	72	59	77	59	34	76	72	162	0	7	7	0	17	18	242	155	57	56	38	36	29	7	66	30	18	5	4	6	19	1,428
(13) Jose_Rizal_University	5	9	10	1	1	6	12	67	2	0	0	19	0	0	39	29	20	21	13	14	6	1	8	3	3	1	1	1	4	295
(14) Old_Wak_Wak_Road	10	6	7	2	2	14	11	17	0	1	3	13	1	0	47	12	9	3	3	7	2	1	10	3	0	0	0	0	2	187
(15) Ortigas_North	12	7	8	4	3	7	3	6	0	39	119	241	39	34	0	10	6	10	23	67	13	3	73	32	27	6	5	6	26	827
(16) Ortigas_South	20	22	30	9	8	30	16	26	1	22	76	126	25	7	6	0	9	39	19	91	41	12	41	19	50	5	3	4	12	768
(17) Kalayaan_Avenue	11	7	6	15	3	15	4	2	0	8	36	51	21	9	4	4	0	0	0	44	6	2	37	17	25	5	3	4	12	351
(18) Bonifacio_Global_City	6	4	4	4	2	6	5	5	0	7	22	50	21	4	11	25	0	0	12	53	13	2	111	57	53	19	11	16	37	560
(19) Cayetano_Biylevard	2	2	0	1	0	3	5	11	0	6	16	39	14	5	28	16	0	15	0	26	4	0	8	4	12	4	1	2	4	228
(20) FTI	23	11	30	13	4	19	14	49	0	10	42	35	17	7	75	102	64	53	30	0	1	4	166	100	103	13	18	27	43	1,071
(21) Dona_Soledad_Avenue	1	1	5	1	1	7	3	15	0	3	16	21	7	1	21	41	15	13	4	0	0	0	38	25	102	11	17	24	4	396
(22) Dr._Arcadio_Santos_Avenue	1	1	1	0	1	8	6	21	0	1	5	8	1	1	5	10	7	5	2	5	0	0	82	55	43	10	5	7	4	295
(23) Alabang-Zapote_Road	2	1	2	0	1	4	5	24	0	13	19	70	8	11	83	45	36	107	9	169	37	74	0	0	15	2	3	4	14	757
(24) Talon_Singko	0	0	2	0	0	2	2	18	0	5	5	30	4	3	36	22	14	53	4	103	24	55	0	0	171	0	0	0	5	556
(25) Molino_Road	2	0	0	0	0	4	3	9	0	3	4	12	4	1	34	47	27	39	11	105	98	45	9	175	0	54	218	335	73	1,310
(26) Daang_Hari	0	0	0	0	0	0	0	2	0	2	2	3	1	0	7	5	8	12	4	13	10	9	2	0	47	0	20	140	60	348
(27) Jose_Abad_Santos_Avenue	0	0	0	0	0	0	0	2	0	1	2	4	1	0	6	3	2	11	1	17	16	5	3	0	219	20	0	0	609	922
(28) Paliparan_Road	1	0	0	0	0	0	0	2	0	1	3	6	1	0	8	4	3	16	2	26	25	8	4	0	338	153	0	0	1,042	1,644
(29) Governor's_Drive	2	0	2	1	1	1	2	15	0	5	6	13	4	2	21	14	10	28	4	39	5	4	14	4	95	60	611	1,059	0	2,021
Total	1,205	869	686	865	334	1,005	611	1,612	14	283	499	1,422	315	161	891	793	385	567	224	1,062	384	268	742	559	1,349	373	923	1,643	2,002	22,049

Source: *JICA Study Team*

Table App-C (11) Station OD Volume (Phase 2: Option B1 for Year 2045)

Year: 2045

Option B1

100 Passengers/day	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	Total
(1) Bahay_Pare_Road	0	66	44	102	221	103	42	175	6	3	56	9	32	24	15	11	2	23	1	1	3	0	3	1	0	1	2	945
(2) Mt._Samat_Road	73	0	0	169	0	1	2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	249
(3) Llana_Road	28	0	0	365	0	84	65	90	12	3	35	5	29	25	7	6	2	2	1	2	0	0	0	1	0	0	1	763
(4) Gen._Luis	102	166	359	0	538	204	79	98	7	5	46	9	9	11	18	25	1	10	4	0	0	0	0	0	0	0	2	1,695
(5) Tatalon	202	0	0	498	0	190	250	89	2	2	66	15	37	29	20	8	3	20	7	7	5	1	4	2	0	1	5	1,461
(6) Mindanao_Avenue-Quirino_Highway	101	1	84	216	167	0	7	194	12	4	128	20	36	51	26	24	6	43	18	12	8	5	8	1	0	0	3	1,175
(7) Tandang_Sora_Avenue	43	2	72	74	264	3	0	285	7	1	99	8	25	59	18	18	11	44	7	9	8	3	6	2	1	1	5	1,074
(8) North_Avenue	198	2	127	110	114	248	319	0	0	0	0	0	13	50	4	8	13	61	10	12	16	18	9	3	2	3	10	1,350
(9) Quezon_Avenue	7	0	12	6	3	12	4	0	0	0	0	0	6	16	1	3	4	34	8	7	16	7	6	2	1	1	7	163
(10) Kamuning	7	0	5	8	8	7	2	0	0	0	0	0	4	23	1	2	6	75	5	13	11	3	4	2	1	1	5	193
(11) Cubao	62	0	35	51	54	116	114	6	2	2	0	0	108	96	37	28	27	52	13	9	33	12	17	12	3	4	13	904
(12) Santolan-Annapolis	10	0	4	4	3	27	11	0	0	0	0	0	0	24	8	10	21	28	3	3	27	13	14	8	3	4	13	238
(13) Ortigas_North	31	0	32	14	36	31	30	15	5	3	117	1	0	5	3	6	7	37	9	3	28	11	16	9	1	2	8	462
(14) Ortigas_South	23	0	19	30	24	48	50	35	16	20	83	17	7	0	9	40	16	92	36	13	44	17	47	6	3	4	12	709
(15) Kalayaan_Avenue	11	0	8	16	15	29	14	5	2	2	31	1	3	5	0	0	0	74	5	2	33	17	23	5	2	3	9	314
(16) Bonifacio_Global_City	6	0	3	12	8	13	8	13	5	6	38	11	8	28	0	0	10	33	11	2	94	45	46	21	8	12	29	471
(17) Cayetano_Biylevard	3	0	2	1	4	5	10	16	7	9	36	14	13	12	0	14	0	23	4	0	8	3	11	4	1	2	4	207
(18) FTI	24	0	2	12	15	41	26	43	38	122	53	25	31	96	72	36	19	0	2	0	215	118	110	15	21	31	51	1,220
(19) Dona_Soledad_Avenue	1	0	0	4	5	15	6	16	12	6	19	4	17	36	9	8	4	2	0	0	21	25	106	53	16	25	4	415
(20) Dr._Arcadio_Santos_Avenue	1	0	2	0	2	10	8	16	7	10	8	3	2	12	4	1	0	2	1	0	75	48	30	46	4	6	4	304
(21) Alabang-Zapote_Road	3	0	0	0	5	8	8	19	14	22	32	23	27	47	35	94	9	210	25	79	0	0	35	2	3	4	15	720
(22) Talon_Singko	0	0	0	1	1	5	3	18	8	5	11	10	11	19	17	42	3	118	25	52	0	0	210	0	0	2	13	574
(23) Molino_Road	3	0	0	0	4	7	5	6	5	6	16	10	16	45	25	31	11	107	109	34	30	181	0	16	219	348	72	1,307
(24) Daang_Hari	1	0	0	0	2	2	1	3	2	2	10	4	13	5	5	15	4	15	53	45	2	0	12	0	21	135	42	392
(25) Jose_Abad_Santos_Avenue	0	0	0	0	0	0	1	2	1	1	3	1	2	3	2	9	1	21	16	3	3	0	218	21	0	0	606	917
(26) Paliparan_Road	1	0	0	0	1	0	1	3	2	2	4	2	2	4	3	13	2	30	27	5	4	2	348	137	0	0	1,044	1,637
(27) Governor's_Drive	2	0	1	2	9	4	3	10	5	19	11	5	7	13	8	24	4	43	5	4	15	11	89	43	607	1,050	0	1,994
Total	943	238	811	1,696	1,505	1,211	1,068	1,159	177	256	902	195	458	739	348	479	188	1,199	404	315	699	541	1,373	412	917	1,637	1,980	21,853

Source: *JICA Study Team*

Table App-C (12) Station OD Volume (Phase 2: Option B2 for Year 2045)

Year: 2045

Option B2

100 Passengers/day	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	Total
(1) Bahay_Pare_Road	0	112	117	94	157	119	39	163	1	4	21	12	26	17	9	8	2	22	0	1	2	0	2	0	0	1	2	931
(2) Mt._Samat_Road	99	0	0	153	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	257
(3) Llana_Road	81	0	0	363	0	111	68	123	0	0	14	11	27	20	6	6	2	3	0	1	0	0	0	0	0	0	0	837
(4) Gen._Luis	90	155	336	0	539	211	81	136	2	17	53	4	10	14	19	27	2	12	3	0	0	0	0	0	0	0	1	1,716
(5) Tatalon	152	0	0	442	0	192	238	158	0	0	6	5	31	25	15	4	3	13	5	6	4	1	3	1	0	0	4	1,312
(6) Mindanao_Avenue-Quirino_Highway	96	1	88	197	244	0	8	248	4	12	103	34	31	53	30	32	6	41	14	10	7	5	8	2	0	0	3	1,274
(7) Tandang_Sora_Avenue	43	2	76	95	283	3	0	239	7	30	94	30	18	55	16	14	12	56	7	11	9	3	7	2	1	1	5	1,120
(8) North_Avenue	178	1	156	141	160	266	292	0	0	5	63	50	3	45	6	8	20	161	14	19	36	25	20	6	4	5	21	1,705
(9) Timog_Avenue	5	0	2	7	0	16	14	0	0	0	0	5	21	16	3	1	3	12	1	1	4	3	1	1	1	1	1	118
(10) E._Rodrigues_Sr._Avenue	8	0	5	16	1	16	32	18	0	0	0	0	40	29	14	7	9	7	5	3	12	4	2	1	1	1	3	234
(11) Gilmore	25	0	15	42	11	83	86	68	6	0	0	17	140	88	58	25	28	44	15	8	26	11	16	8	2	3	11	836
(12) Greenhills	14	0	12	4	5	34	32	60	6	3	21	0	18	11	7	10	7	16	5	4	14	6	5	1	0	0	2	299
(13) Ortigas_North	22	0	24	8	28	29	26	6	33	46	163	16	0	12	4	4	16	40	10	3	50	18	21	10	3	4	18	615
(14) Ortigas_South	25	0	19	30	22	45	52	49	22	16	83	7	13	0	19	45	17	94	30	16	41	17	48	6	3	4	12	734
(15) Kalayaan_Avenue	9	0	8	19	15	26	15	3	3	10	26	6	5	11	0	0	0	46	4	6	42	20	31	9	3	4	14	332
(16) Bonifacio_Global_City	5	0	4	7	8	18	12	21	4	13	46	14	11	30	0	0	11	49	10	4	104	52	45	21	10	14	36	547
(17) Cayetano_Biylevard	2	0	2	1	3	4	12	20	3	9	37	8	28	17	0	15	0	35	5	0	8	3	11	4	1	2	4	236
(18) FTI	24	0	3	13	11	39	29	145	14	7	32	21	77	97	64	48	32	0	2	1	202	112	108	23	21	30	50	1,206
(19) Dona_Soledad_Avenue	1	0	0	4	6	14	7	22	1	9	14	6	17	35	9	9	5	2	0	0	37	33	98	17	17	24	4	392
(20) Dr._Arcadio_Santos_Avenue	1	0	1	0	2	10	12	23	0	2	7	4	5	12	5	1	0	2	0	0	99	62	45	19	5	7	4	330
(21) Alabang-Zapote_Road	3	0	0	1	4	7	10	42	5	16	28	19	57	44	33	111	8	179	43	84	0	0	31	3	3	4	14	750
(22) Talon_Singko	0	0	0	0	1	4	3	24	4	5	13	8	22	19	15	53	3	102	32	52	0	0	197	0	0	1	10	569
(23) Molino_Road	2	0	0	0	2	6	7	16	1	3	16	6	34	46	30	41	11	107	97	39	23	184	0	30	210	359	78	1,343
(24) Daang_Hari	0	0	0	0	1	1	1	5	1	1	7	1	16	6	8	17	4	21	17	23	3	0	35	0	24	148	50	392
(25) Jose_Abad_Santos_Avenue	0	0	0	0	0	0	1	4	1	1	3	0	4	3	2	10	1	19	17	5	3	0	210	24	0	0	600	907
(26) Paliparan_Road	1	0	0	0	1	0	1	5	1	2	4	1	6	4	3	14	2	28	26	6	4	1	360	141	0	0	1,017	1,626
(27) Governor's_Drive	2	0	1	1	3	2	4	26	1	4	10	3	15	13	9	26	4	40	4	4	14	9	93	52	601	1,013	0	1,953
Total	885	271	872	1,639	1,506	1,258	1,083	1,625	119	216	864	287	676	722	385	536	207	1,151	366	308	743	570	1,397	382	909	1,626	1,965	22,569

Source: *JICA Study Team*

Table App-C (13) Station OD Volume (Phase 2: Option B3 for Year 2045)

Year: 2045

Option B3

100 Passengers/day	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	Total
(1) Bahay_Pare_Road	0	105	69	108	174	103	43	189	4	8	4	37	7	9	14	15	4	4	2	17	1	0	2	0	2	0	0	0	1	921
(2) Mt._Samat_Road	90	0	0	162	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	256
(3) Llana_Road	31	0	0	322	0	116	63	130	0	1	1	16	1	2	12	15	4	3	1	2	0	1	0	0	0	0	0	0	0	723
(4) Gen._Luis	108	151	319	0	490	208	87	146	1	9	20	97	15	3	6	13	8	14	1	8	4	0	0	1	0	0	0	0	2	1,712
(5) Tatalon	159	0	0	466	0	194	231	152	0	1	1	17	1	2	17	14	9	8	2	15	7	3	4	0	3	1	0	0	3	1,313
(6) Mindanao_Avenue-Quirino_Highway	99	2	114	209	225	0	7	301	0	24	17	139	12	17	19	39	18	13	5	33	13	11	7	4	6	1	0	0	2	1,339
(7) Tandang_Sora_Avenue	55	2	71	91	270	3	0	273	0	18	27	164	23	15	19	39	7	15	10	40	7	10	8	2	5	1	1	1	4	1,180
(8) North_Avenue	214	1	161	138	169	356	306	0	0	12	32	208	71	9	4	29	4	5	12	74	11	16	23	18	10	3	2	2	13	1,903
(9) Timog_Avenue	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
(10) Araneta_Avenue	3	0	2	12	0	16	15	28	0	0	0	7	0	1	34	27	7	8	4	8	3	1	11	5	2	1	1	1	3	199
(11) E._Rodrigues_Sr._Avenue	3	0	1	17	0	22	30	36	0	0	0	13	0	2	100	69	29	20	11	28	10	3	15	4	3	2	1	2	5	426
(12) V._Mapa	44	0	14	82	9	145	122	231	0	8	3	0	22	17	219	145	51	53	33	43	24	10	62	27	21	7	4	5	16	1,418
(13) Jose_Rizal_University	6	0	1	7	1	13	22	78	1	0	0	24	0	0	34	28	20	23	12	16	5	1	7	3	4	1	1	1	4	313
(14) Old_Wak_Wak_Road	13	0	3	3	1	19	19	19	1	1	3	16	1	0	46	12	5	5	4	7	1	1	10	2	0	0	0	0	2	195
(15) Ortigas_North	19	0	12	7	7	19	14	7	0	43	90	222	32	35	0	17	5	21	25	69	12	4	72	32	27	9	5	7	24	834
(16) Ortigas_South	19	0	12	20	8	33	27	36	0	23	66	119	24	10	10	0	11	44	20	108	31	15	40	19	49	6	3	4	11	769
(17) Kalayaan_Avenue	10	0	5	15	5	22	8	4	0	6	30	50	22	11	4	5	0	0	0	49	7	3	34	18	28	7	2	4	12	362
(18) Bonifacio_Global_City	4	0	1	7	3	11	7	8	0	7	25	46	25	4	6	25	0	0	16	55	11	2	101	56	52	19	11	15	35	550
(19) Cayetano_Biylevard	2	0	2	1	2	5	7	10	0	5	14	41	14	6	24	19	0	20	0	38	4	0	8	4	11	4	1	2	4	249
(20) FTI	19	0	1	8	6	31	25	90	0	8	31	26	19	10	68	117	63	67	43	0	2	0	167	104	100	21	18	26	41	1,111
(21) Dona_Soledad_Avenue	1	0	0	3	1	12	5	15	0	2	9	13	5	1	17	30	13	11	4	2	0	0	25	29	93	18	16	24	4	354
(22) Dr._Arcadio_Santos_Avenue	1	0	1	0	3	9	11	19	0	1	3	8	1	2	4	12	4	1	0	1	0	0	73	58	46	19	5	7	4	295
(23) Alabang-Zapote_Road	2	0	0	0	3	8	7	24	1	11	18	60	7	10	76	45	34	105	9	162	26	71	0	0	22	2	3	4	14	724
(24) Talon_Singko	0	0	0	1	0	5	2	19	0	5	5	29	4	2	32	21	18	54	4	93	28	54	0	0	167	0	0	0	5	548
(25) Molino_Road	2	0	0	0	1	6	6	13	0	2	5	20	4	1	28	46	27	37	11	107	91	43	14	138	0	30	216	357	72	1,277
(26) Daang_Hari	0	0	0	0	0	1	1	3	0	1	3	8	2	0	10	5	5	11	4	23	16	21	2	0	37	0	23	128	57	362
(27) Jose_Abad_Santos_Avenue	0	0	0	0	0	0	1	2	0	1	2	4	1	0	5	3	2	11	1	17	15	5	3	0	216	23	0	0	597	910
(28) Paliparan_Road	1	0	0	0	0	0	1	3	0	1	3	5	1	0	8	4	3	16	2	25	24	8	4	0	359	152	0	0	1,007	1,625
(29) Governor's_Drive	2	0	1	2	2	3	4	15	0	3	6	13	3	2	19	13	9	28	4	35	4	4	14	4	97	59	598	1,033	0	1,975
Total	911	262	790	1,681	1,381	1,361	1,074	1,852	8	201	418	1,403	318	171	836	809	363	596	241	1,074	356	288	705	530	1,360	385	910	1,625	1,942	23,850

Source: *JICA Study Team*