3.3 Travel Demand Forecast Results for the UMRT Line 5/BRT Corridor

3.3.1 Outline of the Travel Demand Forecast

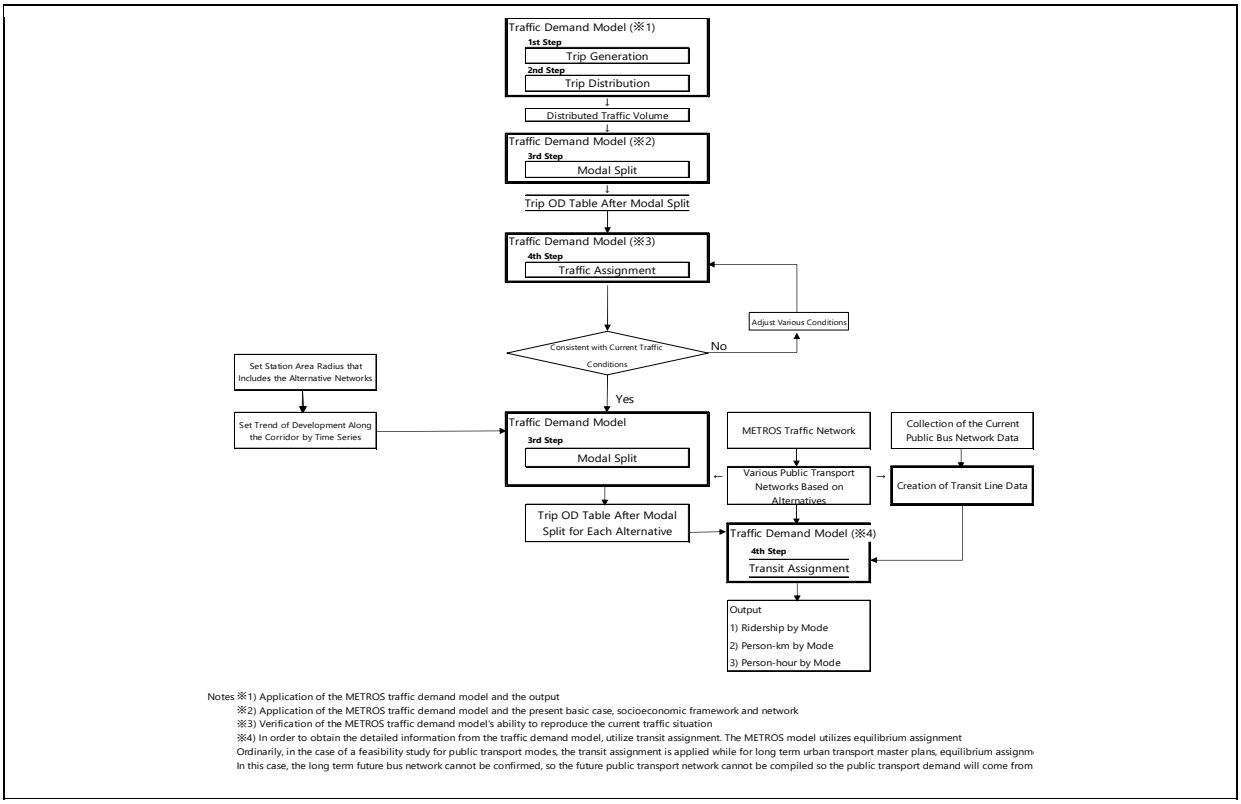
A traditional 4-step travel demand forecast model was applied for this study utilizing the existing database and forecast model from the METROS study. In the METROS forecast model, in the traffic assignment step, all modes were assigned via equilibrium assignment, however, for this study, transit assignment was added to enhance the METROS forecast model in order to estimate a realistic forecast of the public transport demand. This time, all other non-public transport modes were assigned using equilibrium assignment. An outline of the travel demand forecast model used in this study showing which steps were reused from the METROS study and which steps were added is shown as follows.

3.3.1.1 Equilibrium Assignment

Equilibrium assignment is usually a tool for intra-city transport masterplans. In this case, the aim is the long term transport master plan and the present bus lines would not usually be considered for the long term future plan. Therefore, all the available road links for buses should be available for future bus routes based on passenger demand using equilibrium assignment.

3.3.1.2 Transit Assignment

On the other hand, transit assignment is selected for studies that have a short term main target like the timing of opening for public transport lines or a public transport feasibility study. Usually it is assumed that present bus lines on the present public transport network will not change significantly by the time of the opening of a new public transport line in the network in the future. Transit assignment calculates the actual situation of public transport in detail by utilizing a set of detailed parameters such as transfer resistance, line capacity, operating velocity and type of bus stop.



Source: Study Team

Figure 3.3.1 Outline of the Travel Demand Forecast Model used in this Study

The base year and target years of the demand forecast were the same as the METROS study at 2013, 2020 and 2030 respectively. There were 5 options for the network alternatives and on the UMRT Line 5/BRT corridor, there were 2 transit options, either UMRT implementation or BRT implementation.

The differences between the 2 transit options (UMRT and BRT) for the estimation of the travel demand forecast are as follows.

1) Speed of the Transit Options
   - UMRT: Maximum speed of 80 km/h (based on the TEDI-MP, which was approved by the Prime Minister in Decision No. 1259/QD-TTg on July 26, 2011)
   - BRT: Maximum speed of 70 km/h while average operational speed was set at approximately 38 km/h
2) Alignment of the Transit Options
   - UMRT: Completely separated exclusive right of way
   - BRT: Partially separated exclusive right of way via a dedicated lane on the Thang Long Road (this means that road capacity was reduced on the section of road where the BRT route was)

For other public transport modes, the following assumptions were set for the travel demand forecast.

1) Distance Between Bus Stops for Regular Buses and the BRT
   - On the UMRT Line 5/BRT corridor, currently, regular bus routes No. 71 and 74 are in operations and the average distance between bus stops is approximately 1.65 km. For the proposed BRT, the bus stop distance was set at 2.0 km to keep the higher operating speed

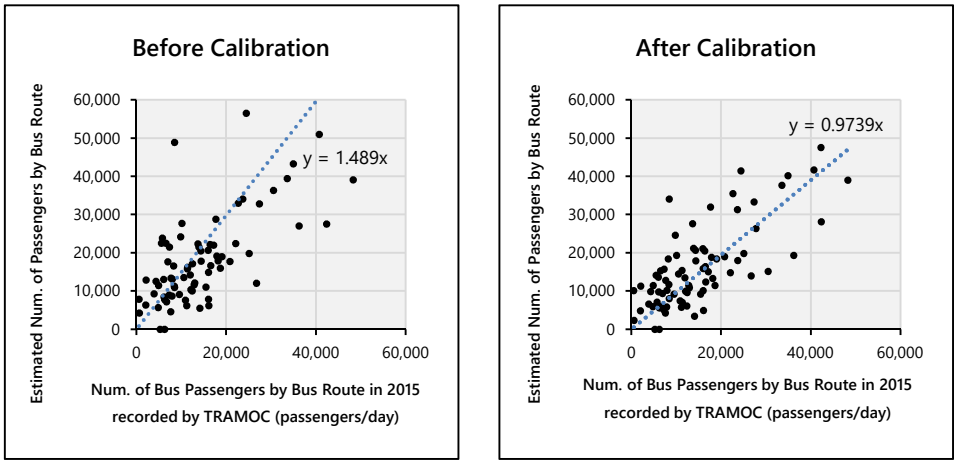
- For the 2.0 km distance in BRT stops, the average operating speed of the BRT was about 40-45 km/h and it would take 30 minutes to reach Hoa Lac from Ring Road 3

2) Operating Speed for Transit Modes
   - If there is an alternative UMRT/national railway route for an existing bus or BRT route, the demand for that route will be reduced by the lower operating speed of the bus or BRT
   - For national railway routes, the operating speed was set as 70-80 km/h. This value follows the values used in the PPP-FS report (in the PPP-FS report, they obtained the value from the TEDI-MP)
   - In this study, the existing regular bus routes No. 71 and 74 which are operating on the same corridor as the proposed UMRT Line 5/BRT are kept for the demand forecast. The higher operating speed of the UMRT/BRT makes the passengers shift from the competing existing bus routes No. 71 and 74 while a lower operating speed causes a smaller passenger shift
3) Frequency and Fleet Capacity
   - The transit assignment calculates passenger demand on public transport routes with the available transfer point parameters such as the transfer time cost coefficient, congestion cost coefficient and wait time cost coefficient
   - The operating frequency and fleet capacity were set differently among the modes with UMRT having the highest frequency and capacity and BRT and regular bus having less
   - Parameters from past studies in Vietnam were used and these parameters were calibrated for the present situation
4) Maximum Number of Transfers
   - The maximum number of transfers was set at 6 for public transit modes, if the number of transfers exceeds 6, the trip is not assigned to the public transport network
   - For example: If there was a trip from an origin to destination that is only 0.5 km away and it took more than 6 transfers to get to the destination from the origin by a public transit mode (assume a public transit trip distance of 6 km), then this would not be logical as the person would probably walk the 0.5 km to get from their origin to their destination so in this case, according to the maximum number of transfers rule set, this public transit trip calculated in the transit assignment would not be assigned to the public transport network

3.3.2 Transit Assignment Calibration

Calibration of the present day situation is a very important first step of the traffic assignment stage. An error in the calculation of the present situation will be expanded by the future socioeconomic framework if the traffic assignment model is not calibrated for the present day situation.

Calibration for this study was done such that the estimated present day bus demand from the model was compared to the recorded annual bus ridership data in 2015 from TRAMOC and adjusted so that the model approximately matched the recorded data. Calibration was done by adjusting the operating speed of each bus route until the estimated bus demand approximately matched the recorded bus demand.



Source: Study Team

Figure 3.3.2 Results of the Transit Assignment Calibration

Figure 3.3.2 as shown above has a linear trend line with the intercept at 0.0. If the average daily ridership by bus routes is converted from the recorded annual passenger numbers in 2015 from TRAMOC is the same as the estimated demand of the bus routes, the trend of the linear trend line will be almost 1.0.

It was 1.489 before calibration which means that the average daily estimated demand from each bus route was 1.489 times higher than the actual average daily ridership in 2015. Calibration of each bus route was done by modifying the operating speed and when the operating speed of a bus route is modified, the daily estimated demand from other bus routes changes as well. This is because passengers' can transfer to other faster bus routes to reach their destination.

After calibration of the bus routes, the trend was 0.9739 and this is close to the 1.0 value. This means that the estimated daily ridership by bus route is closer to the actual present situation than before calibration.

3.3.3 Settings for the Travel Demand Forecast

The settings for the travel demand forecast are as follows.

1) Future public bus routes and the fare system is assumed to be the same as the present
2) The implementation schedule for the UMRT lines in Hanoi will follow the same schedule as the METROS study except for Line 5 and is shown as follows.

Table 3.3.1 UMRT Implementation Schedule for the Target Years of 2020 and 2030

UMRT	2020 Network	Official 2030 Network	Realistic 2030 Network[1)]
Line 1	–	○	○
Line 2	○	○	○
Line 2A	○	○	○
Line 3	○	○	○
Line 4	–	○	–
Line 6	–	○	–
Line 7	–	○	–
Line 8	–	○	–

Note: 1) It is assumed that by 2030, realistically, only UMRT Lines 1, 2, 2A and 3 will be opened for operations. The BRT on the Line 5 corridor was assumed to have the fare of VND 10,000 + VND 500/km.
Source: Data Collection Survey in Major Cities in Vietnam (METROS), JICA, 2016

3) The options for the Alternative BRT Routes follows the options selected in Chapter 4
4) The fare scheme for the UMRT is the same as the METROS study such that the first boarding is VND 20,000 and the fare increases by VND 1,000/km (distance-based fare)
5) The fare scheme for the World Bank-funded BRT line is set at VND 7,000 which is the same as the existing regular bus system fare and opening of this line is set for 2016
6) The future road network is based on the "Roads/Expressway plus All Planned UMRT (Do-Maximum)" scenario from the METROS study (see METROS Final Report Volume II: Hanoi Study Area, Part B: Main Text, 7.2, 4))

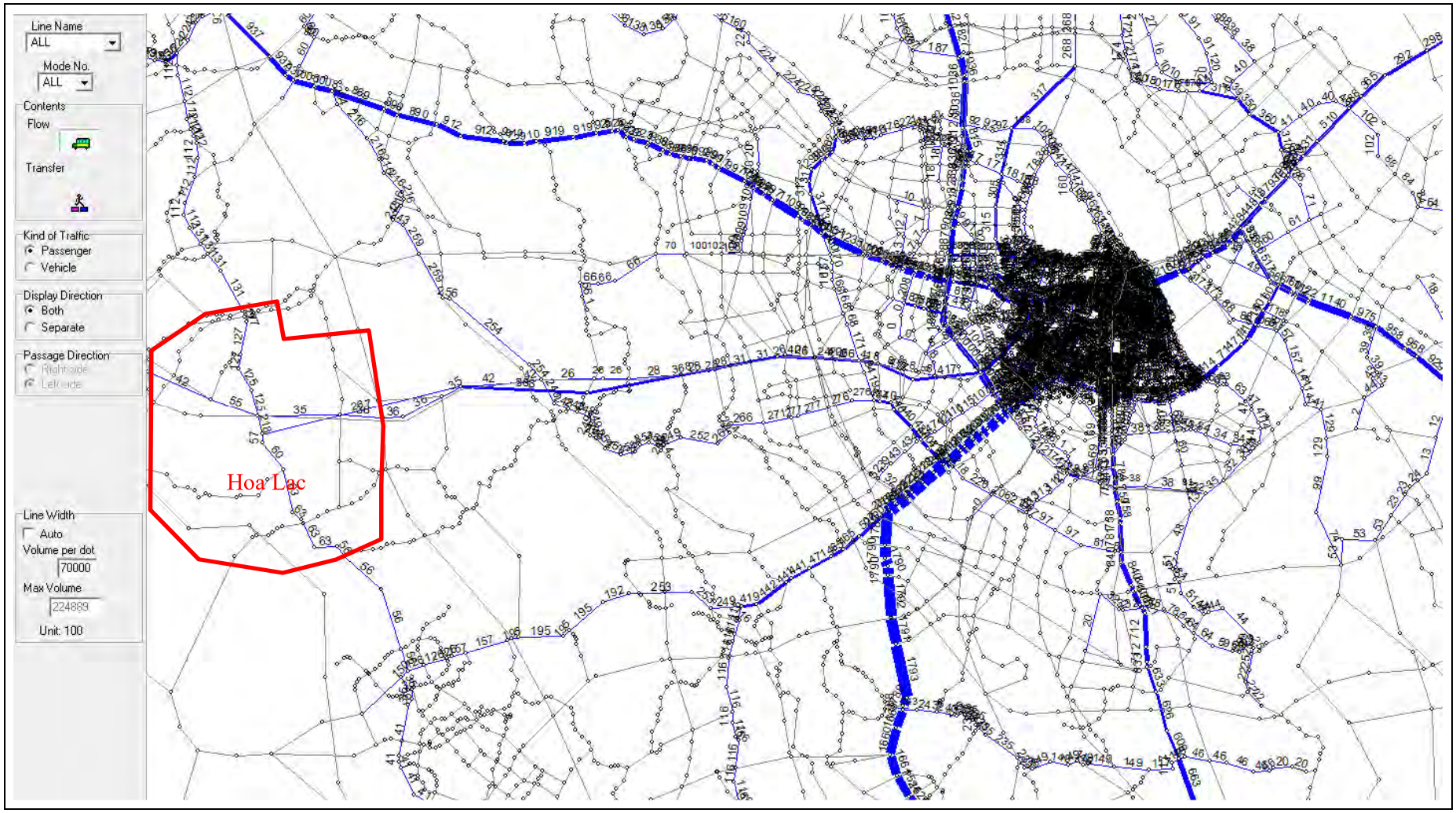
3.3.4 Results from the Travel Demand Forecast

The cases that were set for the travel demand forecast in this study are as follows.

1) Two target years, 2020 and 2030
2) BRT implementation is assumed for the UMRT Line 5/BRT corridor

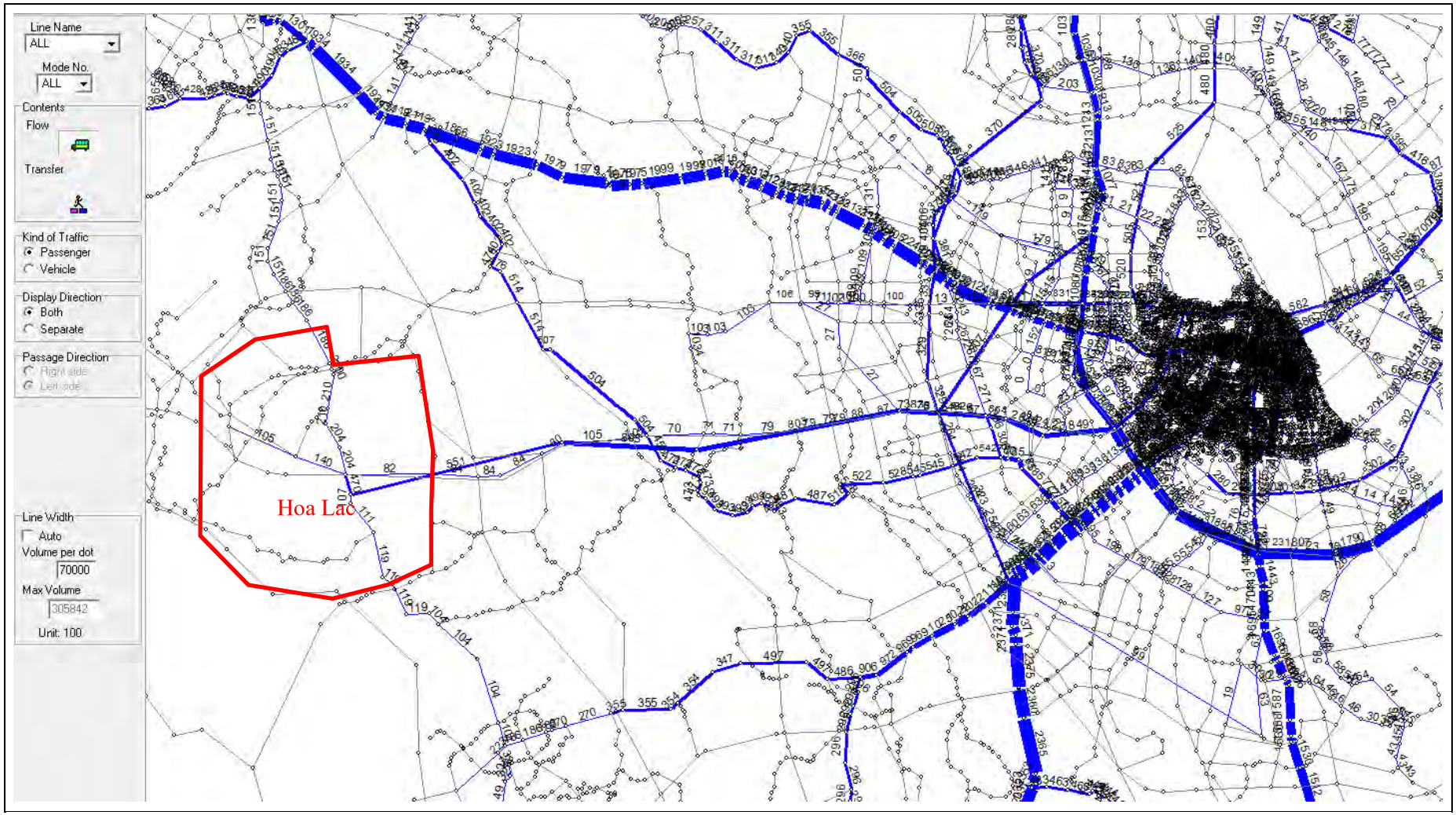
3.3.4.1 Future Public Transport Demand in Hanoi with the Implementation of BRT on the UMRT Line 5/BRT Corridor

Figure 3.3.3 and Figure 3.3.4 shows the future public transport demand in Hanoi by implementing the BRT on the UMRT Line 5/BRT corridor for 2020 and 2030. Demand is calculated for daily passengers and the unit is 100 passengers/day. Also, by 2030, it is assumed that all UMRT lines (Line 1, 2A, 3, 4, 6, 7, 8) will be provided and the BRT on the UMRT Line 5/BRT corridor will have the fare of VND 10,000 + VND 500/km.



Source: Study Team

Figure 3.3.3 Future Hanoi Public Transport Demand by Implementing the BRT on the UMRT Line 5 Corridor in 2020



Source: Study Team

Figure 3.3.4 Future Hanoi Public Transport Demand by Implementing the BRT on the UMRT Line 5 Corridor in 2030

3.3.4.2 Future Road Traffic Demand with the Implementation of the BRT on the UMRT Line 5/BRT Corridor

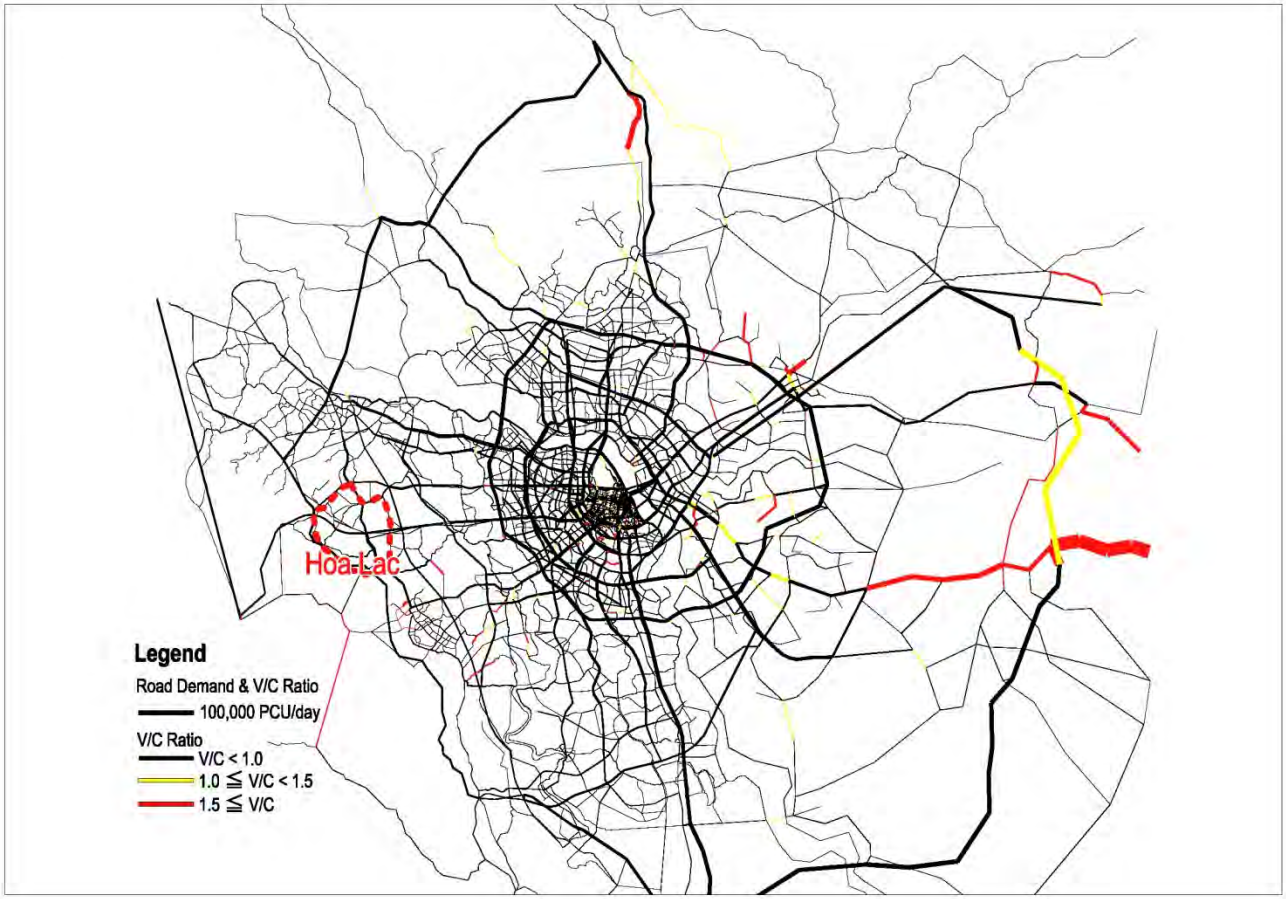
Figure 3.3.5 and Figure 3.3.6 shows the future road traffic demand with the implementation of BRT Option 1 on the UMRT Line 5/BRT corridor.

Section volume is displayed by line width, and congestion V/C[3] is displayed by line color. In the case where the section volume equals capacity, the V/C should be 1.0. If V/C is larger, the road section will become more congested. These two figures shows daily traffic volume and the V/C is the daily average congestion.

Source: Study Team

Figure 3.3.5 Future Road Traffic Demand with the Implementation of the BRT on the UMRT Line 5 Corridor in 2020

[3] V/C: Volume Capacity Ratio, this is the congestion factor.



Source: Study Team

Figure 3.3.6 Future Road Traffic Demand with the Implementation of the BRT on the UMRT Line 5 Corridor in 2030

4 Identification of the Alternative BRT Routes

The target area of this study is the corridor between the central area of Hanoi and the Hoa Lac area where the Hoa Lac High Tech Park and the new campus of the Vietnam National University are under development. Due to the recent rapid increase in the population of the city, traffic volume has increased leading to serious traffic congestion being observed on major arterial roads in the city. Based on such circumstances, the Hanoi People's Committee (HPC) approved a plan to develop 5 satellite towns (Hoa Lac, Son Tay, Xuan May, Phu Xuan, Soc Son) in the suburban area of the city. The Hoa Lac satellite town was planned as a science, technology and academic area with a planned population of 600,000 by 2030.

The construction of the UMRT Line 5 was officially approved by the HPC along the corridor as mentioned above. The feasibility of the UMRT-Line 5 under the study titled "The Preparatory Survey on Hanoi City Urban Railway Construction Project, Line 5 (hereinafter referred to as the "PPP-FS")" by JICA in 2013 and it was concluded that project implementation would be financially difficult due to its huge construction costs and the prospect of lower than expected traffic demand. Accordingly, the study suggested that it was necessary to accelerate urban development along the corridor along with the implementation of measures to promote the usage of public transport.

Due to the difficulties in implementing the UMRT Line 5 in this corridor, the HPC has requested assistance from JICA to evaluate the possibility of implementing a Bus Rapid Transit (BRT) line on the corridor to build up demand for the planned and eventual construction of the UMRT Line 5.

In this study, the JICA Study Team has collected the basic information that is required to proceed in a further detailed feasibility study. The alternative routes of the BRT are examined in this chapter.

4.1 Planning Policy on Alternative BRT Routes

The passenger demand of the proposed BRT line is expected to be converted to that of the UMRT Line 5 in the future. Therefore, a majority of the BRT route should be similar with the alignment of the UMRT Line 5 or should pass by the proposed UMRT Line 5 stations. Also, the BRT should be operated so as to not to interfere with the construction of the UMRT Line 5 when it happens.

According to the PPP-FS of the UMRT Line 5 in 2013, the type of the structure of the UMRT Line 5 between Ho Tay and Ring Road 3 was not determined and two options were proposed: elevated viaduct and underground tunnel. In the meantime, an at-grade alignment was selected for the section between Ring Road 3 and Hoa Lac along the Thang Long Expressway.

In 2015, JICA conducted the "Data Collection Survey on Railways in Major Cities in Vietnam (METROS)". In this study, the shield tunnel structure was selected for the section between Ho Tay and Ring Road 3. In the METROS study, the type of structure for the alignment of the UMRT Line 5 in the central area of Hanoi was selected by taking into consideration the connection with the underground stations from the UMRT Line 2.

In this study, the JICA Study Team has referenced the results from the METROS study and assumed that the underground section and at-grade section of the UMRT Line 5 would be constructed underneath the existing arterial roads in the central area of Hanoi (Ho Tay to Ring Road 3) and within the existing center median (20 m width) of the Thang Long Expressway from Ring Road 3 to Hoa Lac.	 (Source: Zing VN) Median Space of the Thang Long Expressway

4.1.1 Setting of Starting and End Points of the BRT Route

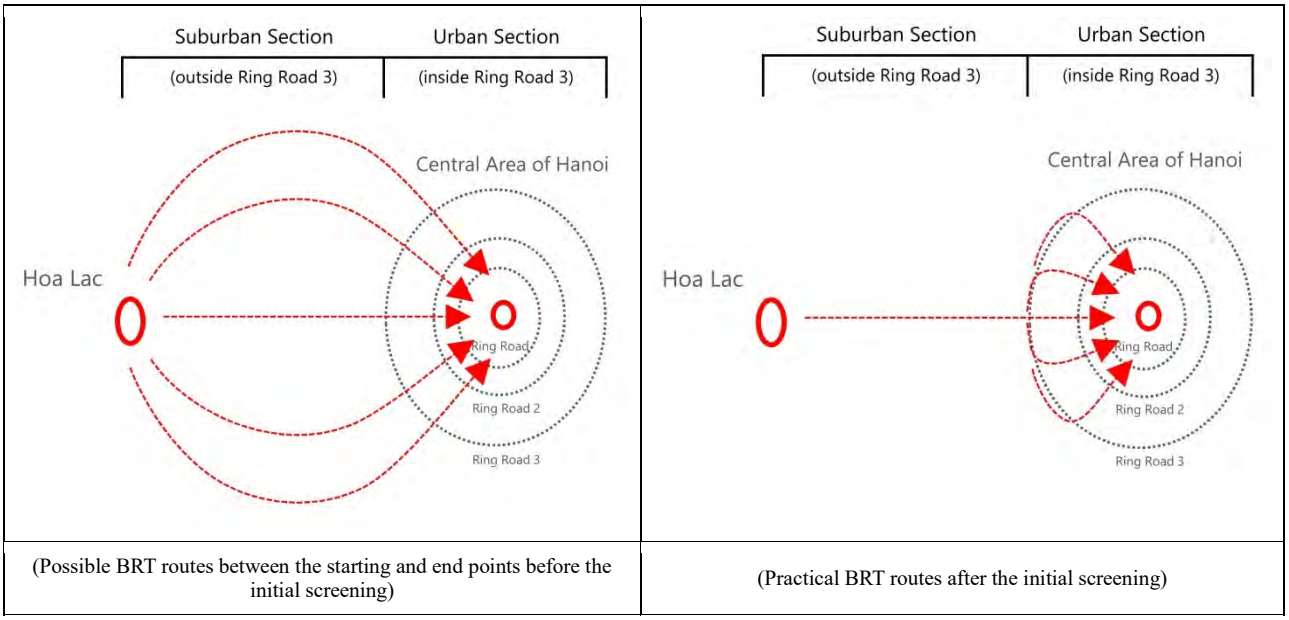
The Hoa Lac satellite town area currently under development has been set as the end point of the alternative BRT routes as well as the terminus station of the UMRT Line 5. In general, the exclusive lanes on existing arterial roads will be allocated to the BRT and this may result in traffic congestion for private vehicles to the reduced number of lanes.

Also, for the corridor in the central area of Hanoi (from Ho Tay to Ring Road 3), there is already an existing public bus network. Thus, it is not absolutely required for the BRT to be introduced inside the central area of Hanoi (inside Ring Road 3). Accordingly, the JICA Study Team has proposed two options for the starting point of the BRT line, one from Ring Road 3 and the other from Ho Tay.

4.1.2 Alternative BRT Routes in the Section outside Ring Road 3

There are many alternative routes that connect the starting the end points as mentioned above as shown in the figure on the left in Figure 4.1.1. However, the route not following the Thang Long Expressway and its service roads will not be realistic due to the social and environmental impacts from the large scale road widening or new road construction. Moreover, in the area outside of the Thang Long Expressway, urban development is not promoted according to the master plans and as a result, there will be less traffic demand. Therefore, the alternative routes outside Ring Road 3 will follow the Thang Long Expressway.

The center median of the Thang Long Expressway and the separation buffer strip between the expressway and its service roads has sufficient width to accommodate the required infrastructure for a BRT line. The detailed configuration to use the median and the strips (i.e., dedicated lanes, bus stops, etc.) will be studied later based on a definitive route.



(Possible BRT routes between the starting and end points before the initial screening)

(Practical BRT routes after the initial screening)

Source: Study Team

Figure 4.1.1 Alternative BRT Routes in the Section outside Ring Road 3

4.1.3 Alternative BRT Routes in the Section inside Ring Road 3

The alternative routes inside Ring Road 3, urban section of the BRT line, have been studied based on the following basic conditions.

1) Selection of routes based on the existing road network
2) Selection of routes such that the routes will be connected to the existing and planned public transport network

4.1.3.1 Selection of Routes on the Existing Road Network

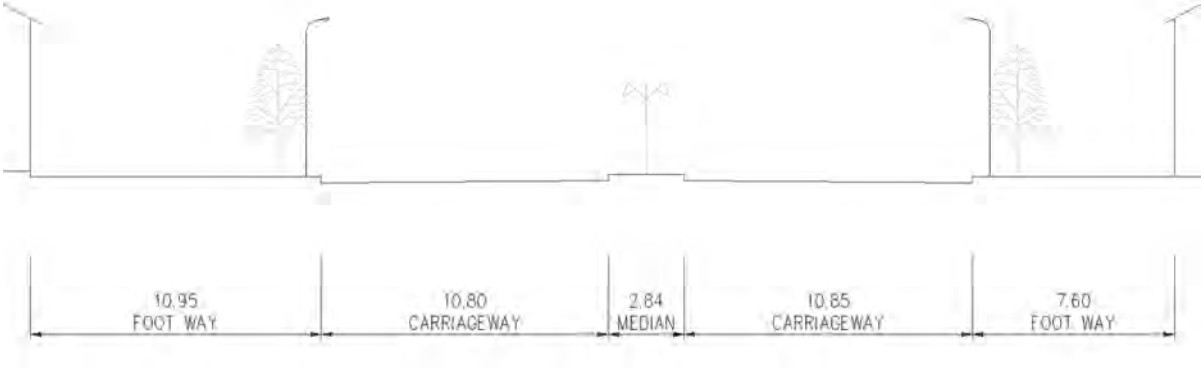
Large scale land acquisition for the new alignment of the BRT line is unrealistic especially in the central area of Hanoi. Therefore, alignment of the BRT line is selected such that minimum land acquisition is required and utilizes existing road space.

In general, there is the possibility of introducing exclusive lanes for the BRT on roads which have more than 3 lanes for each direction and if 2 lanes or more can be kept for regular traffic. If 2 lanes for regular traffic cannot be secured, serious traffic congestion will be the result because if there were disabled vehicles on the road or on-street parking, traffic flow will be seriously disrupted. As a result, if the BRT were implemented where an exclusive BRT lane takes away 1 of the lanes on a 2 lane road, the traffic condition will become worse than before the introduction of the BRT.

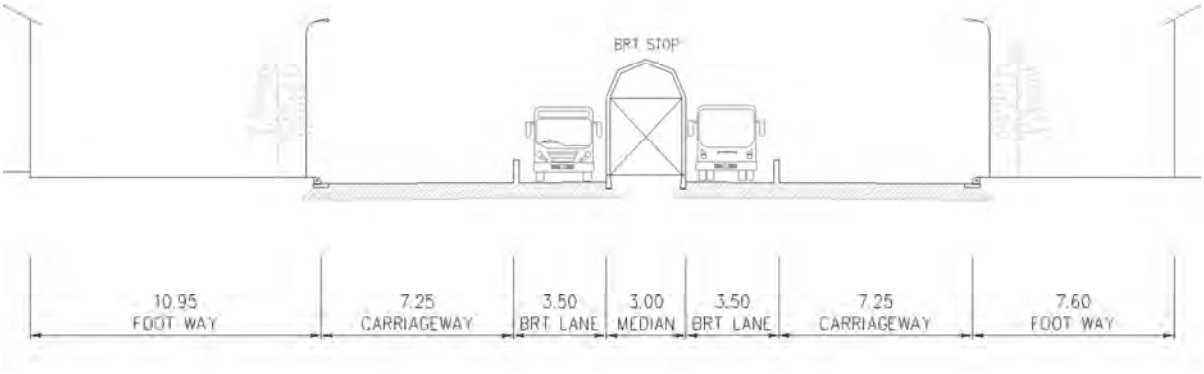
The first BRT line to be introduced in Hanoi supported by the World Bank's program, the Hanoi Urban Transport Development Project, 2007-2016 (HUTDP) will be completed soon in mid-2016. However, the issues as mentioned above are already apparent before the opening of the BRT line.

The typical cross sections, before and after construction for the World Bank BRT line are shown as follows.

Before the Construction of the World Bank BRT Line



After the Construction of the World Bank BRT Line



Source: Hanoi Department of Transport (Presentation material from the HUTDP, 2006)

Figure 4.1.2 Typical Cross Section of the World Bank BRT Line

The comments and observations from the JICA Study Team with regards to the World Bank BRT line as follows.

Table 4.1.1 Comments on the World Bank BRT Line from the JICA Study Team

Items	Comments
Cross Sections	Due to the impact of causing congestion from the reduction of lanes for regular traffic, exclusive BRT lanes originally planned for the entire route will only be implemented on limited sections. As a result, the service level of the BRT will be lower than planned.
Bus Stops	The stations for the BRT were constructed within the existing center median space. Accordingly, the stations can only be used by BRT vehicles equipped with left sided doors. On the other hand, the regular city buses are equipped with right sided doors and these regular buses will continue to use the outer lane to approach bus stops. As a result, serious traffic congestion is anticipated due to both BRT and regular buses stopping at different lanes for pick up and drop off passengers. (See photo below)
Intersections	Along the BRT route, flyovers were built to cross the major intersections. However, some of the flyovers were not designed to accommodate vehicles such as trucks and buses. As a result, the BRT vehicles are forced to cross the at-grade intersections underneath the flyovers and the level of service of the BRT will decrease (See photo below). Bus priority signals will be installed providing priority for buses to pass intersections.

Source: Study Team

View of BRT station

Flyover only for light weight vehicles

Source: Study Team

Figure 4.1.3 Current Situation along the World Bank BRT Line

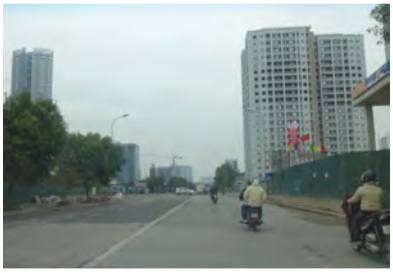
As a result, the alternative routes proposed in this study that uses the existing road network inside the central area of Hanoi are based on the following conditions.

1) Existing roads with more than 6 lanes for both directions
2) Existing roads with 4 lanes in both directions but with a wide centre median strip that could accommodate the BRT exclusive lanes and stations

The photos in the next page show the current condition of the targeted existing roads for the selection of the alternative routes for the BRT in the central area of Hanoi.

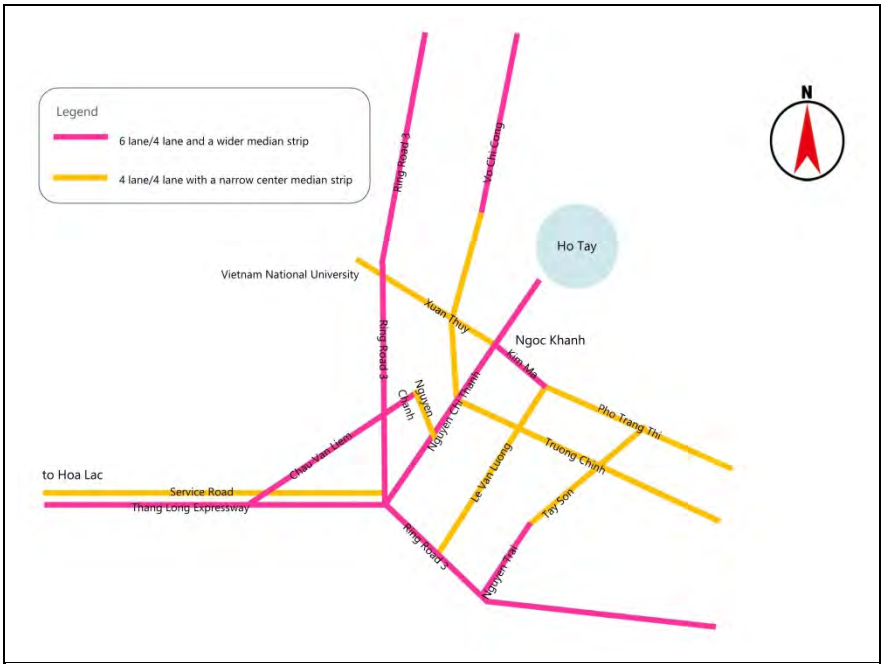
The existing road which satisfies the above mentioned conditions is Nguyen Chi Thanh Road only. This road connects the starting point of the Thang Long Expressway and Ho Tay.

Also, Ring Road 3 which has more than 6 lanes could be an option for the alternative BRT route for connecting to the existing city public bus network and the future UMRT network.

		
(Thang Long Expressway) Dual 3 lane road with a wide center median (20 m width) reserved for the UMRT Line 5	(Service Road of the Thang Long Expressway) 2 lanes with a buffer separator from the expressway, public bus No. 71, 74 in operation	(Chau Van Liem Steet) 4 lanes without a median, flyover over the expressway
		
(Ring Road 3) Dual 3 lane road with wide center median for the elevated Ring Road 3	(Nguyen Chanh Street) Narrow 4 lane road through the newly developing urban area	(Xuan Thuy Street) 1 lane operation during the construction of the UMRT Line 3
		
(Nguyen Chi Thanh Street) Dual 2 lane road with a wide median (17 m width) and a wide shoulder for parking vehicles	(Le Van Luong Street) Dual 2 lane road with a median, World Bank BRT line currently under construction	(Nguyen Trai Street) Dual 3 lane road with a median for the UMRT Line 2A that is currently under construction
		
(Tay Son Street) Narrow dual 2 lane road without a median	(Truong Chinh Street) 2 lane road without a median	(Kim Ma Street) Wide 4 lane road without a median

Source: Study Team

Figure 4.1.4 Current Condition of Arterial Roads in the Study Area

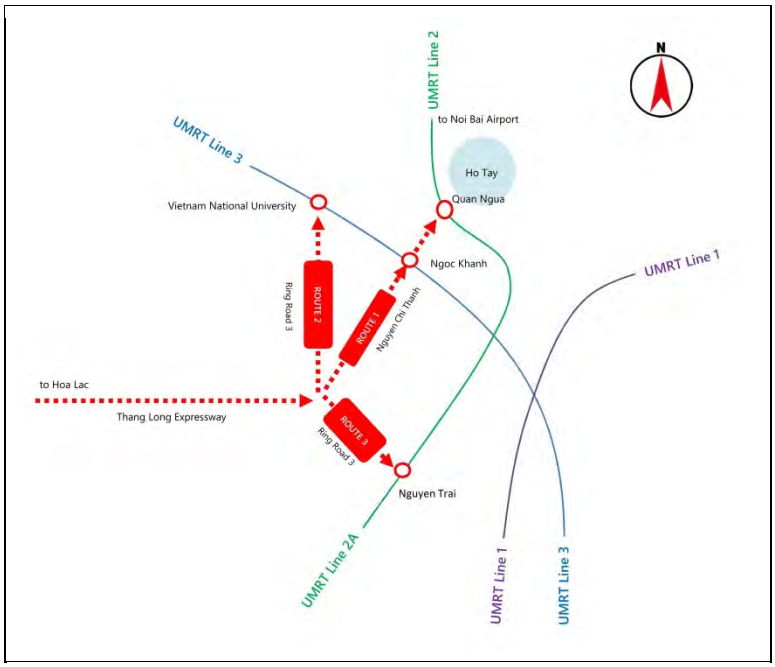


Source: Study Team

Figure 4.1.5 Number of Lanes of Arterial Roads in the Study Area

4.1.3.2 Selection of Routes for Connections to the Planned UMRT Network

The possible routes which could be connected with the planned UMRT network are shown below.



Source: Study Team

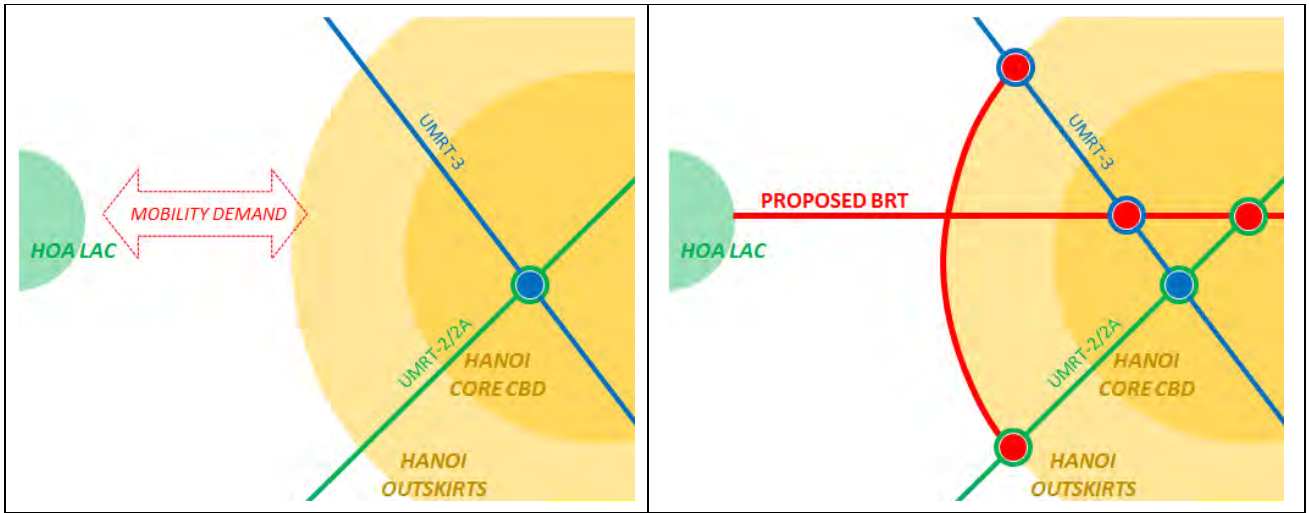
Figure 4.1.6 Possible Routes to Connect with the Planned UMRT Network

Hanoi, which currently relies mainly on private transport such as cars and motorbikes is now trying to shift towards public transport oriented urban development for the city's sustainable development in the future.

Transit Oriented Development (TOD) is one of the urban development policies that could help achieve the objective of Hanoi as stated above and TOD has been promoted as part of the development of UMRT projects.

There are many debates whether urban development should be implemented before public transport lines are developed or after. TOD as proposed by the eminent urban planner Peter Calthorpe says that public transport could be used as a catalyst for accelerating urban development. There are many examples that support this theory including the Rosslyn-Ballston corridor in Arlington, Virginia in the United States.

The alternative BRT routes proposed in this study will connect the central area of Hanoi with the Hoa Lac satellite town and the passenger demand from the BRT line is expected to eventually build up to require the construction of the UMRT Line 5. In the selection of the alternative BRT routes, the connection with other UMRT lines (i.e., Lines 1, 2, 3) needs to be considered. ROUTE-1 in Figure 4.1.6 will have connections with UMRT Lines 2 and 3 while ROUTE-2 and ROUTE-3 will have connections with UMRT Line 3 and Line 2A, respectively.



(Transport Nodes in the Current Plan) | (Transport Nodes with the Proposed BRT)

Source: Study Team

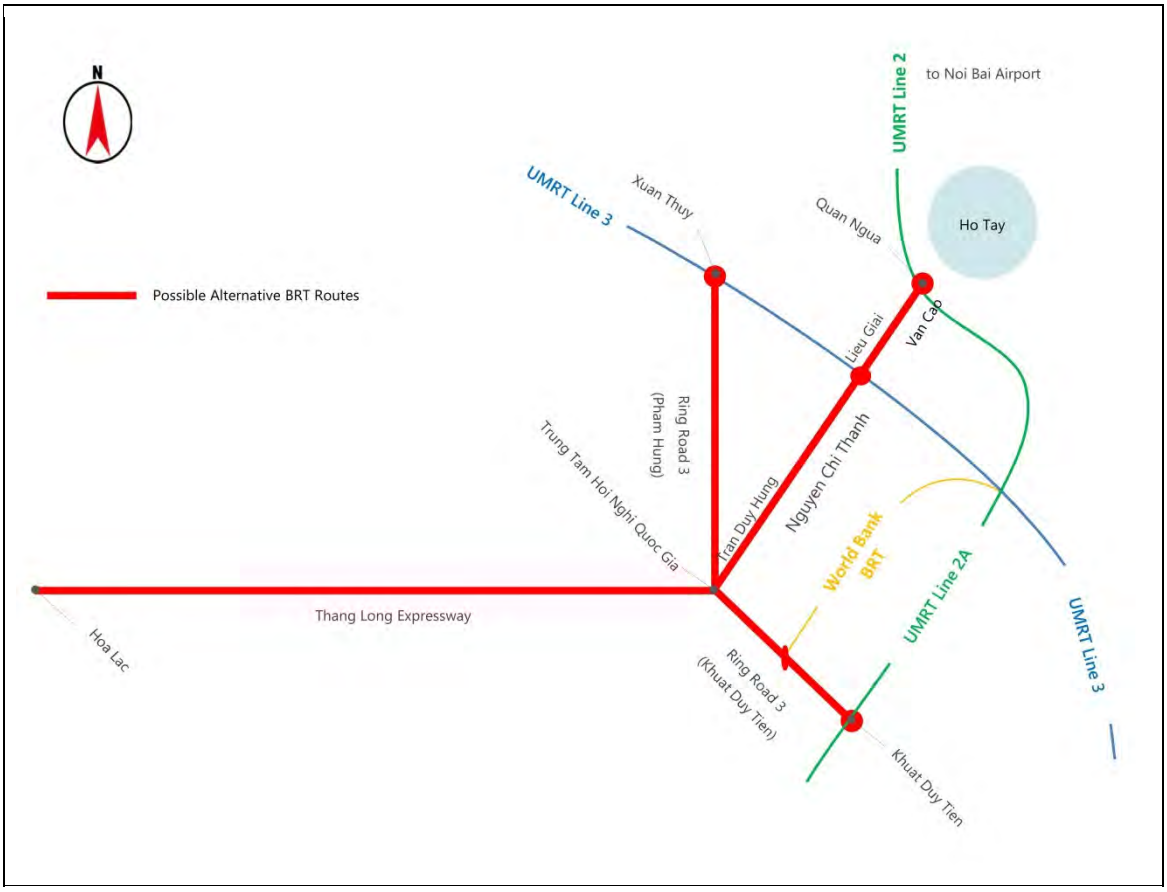
Figure 4.1.7 Comparison between Transport Nodes in the Current Plan and with the Proposed BRT

4.2 Selection of the Alternative BRT Routes

Based on the basic planning policy as mentioned above, alternative BRT routes have been selected. The future passenger demand of the BRT will differ significantly from whether there is an exclusive lane for the BRT or not. The presence of an exclusive lane is a key element in the design of the cross-section of the BRT route.

Thus, instead of examining multiple numbers of possible alignments like in highway design, the selection of the alternative BRT routes was conducted by considering a limited number of routes based on the number of lanes available.

Superimposing Figure 4.1.5 and Figure 4.1.6, the list of possible alternative BRT routes can be narrowed down to 3 main routes as shown in Figure 4.2.1. From these 3 main routes, taking into account the service plan of the BRT, different options for the alternative BRT routes are examined.



Source: Study Team

Figure 4.2.1 Possible Alternative BRT Routes

4.2.1 Alternative BRT Route outside Ring Road 3 (Suburban Section)

The alternative route in the Hoa Lac area is tentatively set to circulate around both the Hoa Lac High Tech Park and the Vietnam National University (VNU) campus. The proposed route is shown in Table 5.2.29 in Chapter 5. The detailed route inside the area will be determined during the further planning stage by discussions with both the Hoa Lac High Tech Park and the VNU.

For the alternative BRT route outside Ring Road 3, the Thang Long Expressway and the service roads along the expressway are candidates. Each service road has only 2-lanes and the regular public bus (No. 71, 74) is currently operating on these roads. Introducing the BRT on the service roads will provide passengers with a higher level of service than the regular public bus routes (No. 71, 74) that are currently operating but introducing the BRT on the service roads will require additional lanes to ensure the BRT high quality of service. Since introducing BRT on the service road will result in land acquisition along the road, it is not practical. Accordingly, the dual 3 lane Thang Long Expressway is the definitive route for BRT in the suburban section.

A traffic demand forecast was done (see Chapter 4) to estimate the congestion using the volume-to-capacity ratio (V/C ratio) on the Thang Long Expressway in the target year of 2030 for 2 cases, dual 3 lanes for regular traffic and dual 2 lanes for regular traffic with 1 exclusive lane in each direction reserved for the BRT. The results are shown as follows.

Table 4.2.1 Estimated Demand and Congestion on the Thang Long Expressway for Utilizing the Existing Road Space

	Options for Utilizing the Existing Road Space on the Thang Long Expressway	
	Dual 3 Lanes for Regular Traffic	**Dual 2 Lanes for Regular Traffic, Dual 1 Lane for BRT Exclusive Traffic**
Traffic Volume (PCU/day)	73,863	73,863
Road Capacity (PCU)	95,400	63,600
V/C Ratio	0.77	**1.16**

Source: Study Team

According to the estimated traffic demand in 2030, there will be permanent traffic congestion (V/C ratio >1.0) in the peak hours if the exclusive BRT lanes are constructed within the existing 6 lane road space of the expressway. Therefore, implementation of BRT exclusive lanes within the existing 6 lane road space is not recommended.

As a result, there are only 2 options feasible for the alternative BRT routes outside Ring Road 3 and they are shown as follows.

1) Non-exclusive BRT lanes within the existing 6 lane road space of the Thang Long Expressway
2) New construction of additional exclusive BRT lanes on the Thang Long Expressway

4.2.1.1 Non-Exclusive BRT Lanes within the Existing 6 Lane Road Space

This option is similar to "intra-suburban commuter/highway bus" services. BRT vehicles would be running on the Thang Long Expressway with regular traffic and bus stops would be constructed along the right side of the expressway.

4.2.1.2 New Construction of Additional Exclusive BRT Lanes

Since the provision of BRT exclusive lanes within the existing 6 lane road space of the Thang Long Expressway is not recommended due to forecasted congestion problems, if exclusive BRT lanes are considered, they need to be newly constructed beside the existing road space.

Source: Study Team

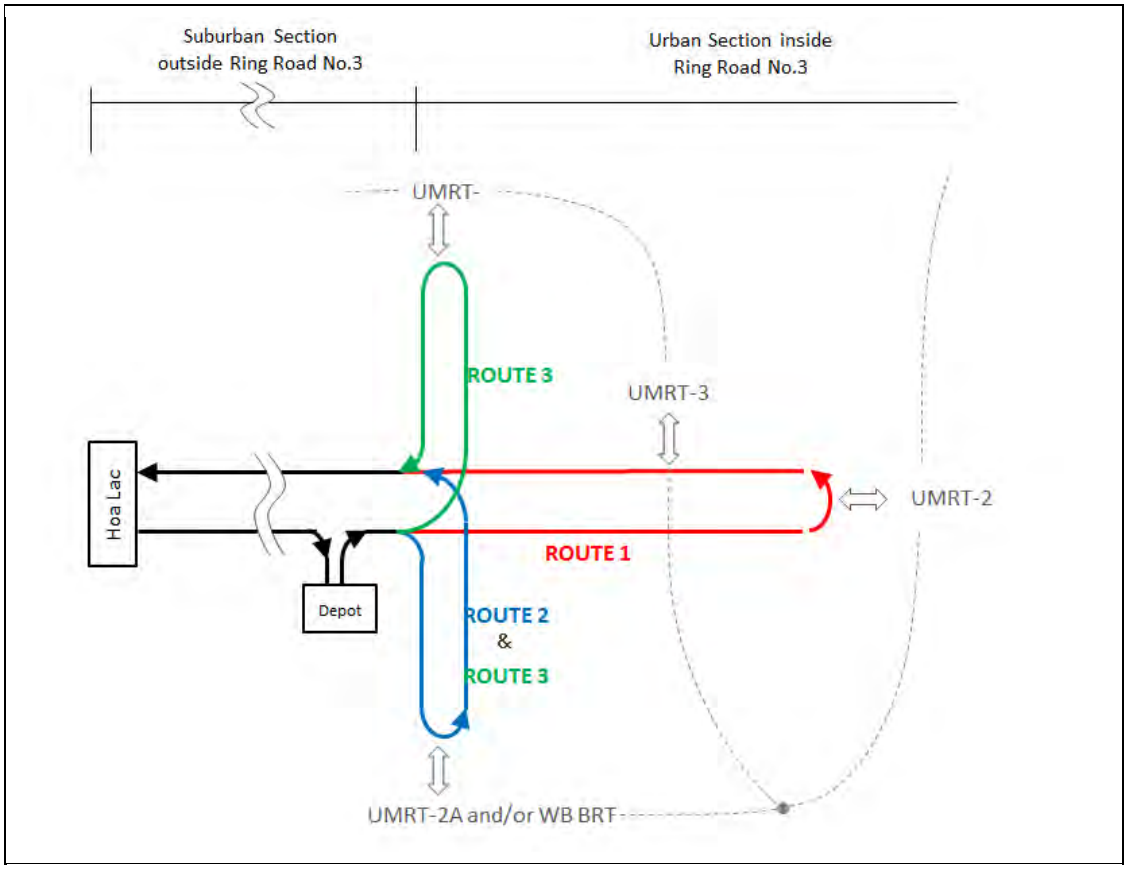
Figure 4.2.2 Necessity of Additional Lanes for BRT on the Expressway

4.2.2 Alternative BRT Route inside Ring Road 3 (Urban Section)

The alternative BRT routes inside Ring Road 3 in the central area of Hanoi (urban section) should be well connected with the existing regular bus network along with the planned UMRT Lines 1, 2, 2A and 3 and the World Bank funded BRT line.

Figure 4.2.4 shows the possible alternative BRT routes in the urban section. In addition, a depot for the BRT vehicles will be required. Since the area inside Ring Road 3 is densely built up it will be difficult to find adequate open space for the depot. Therefore, in the stage examining the alternative route and related passenger demand forecast, the area outside Ring Road 3 near the intersection with Le Quang Dao Street was tentatively selected as the site for the depot.

The alternative BRT routes in the urban section are shown in the following figure and table.



Source: Study Team

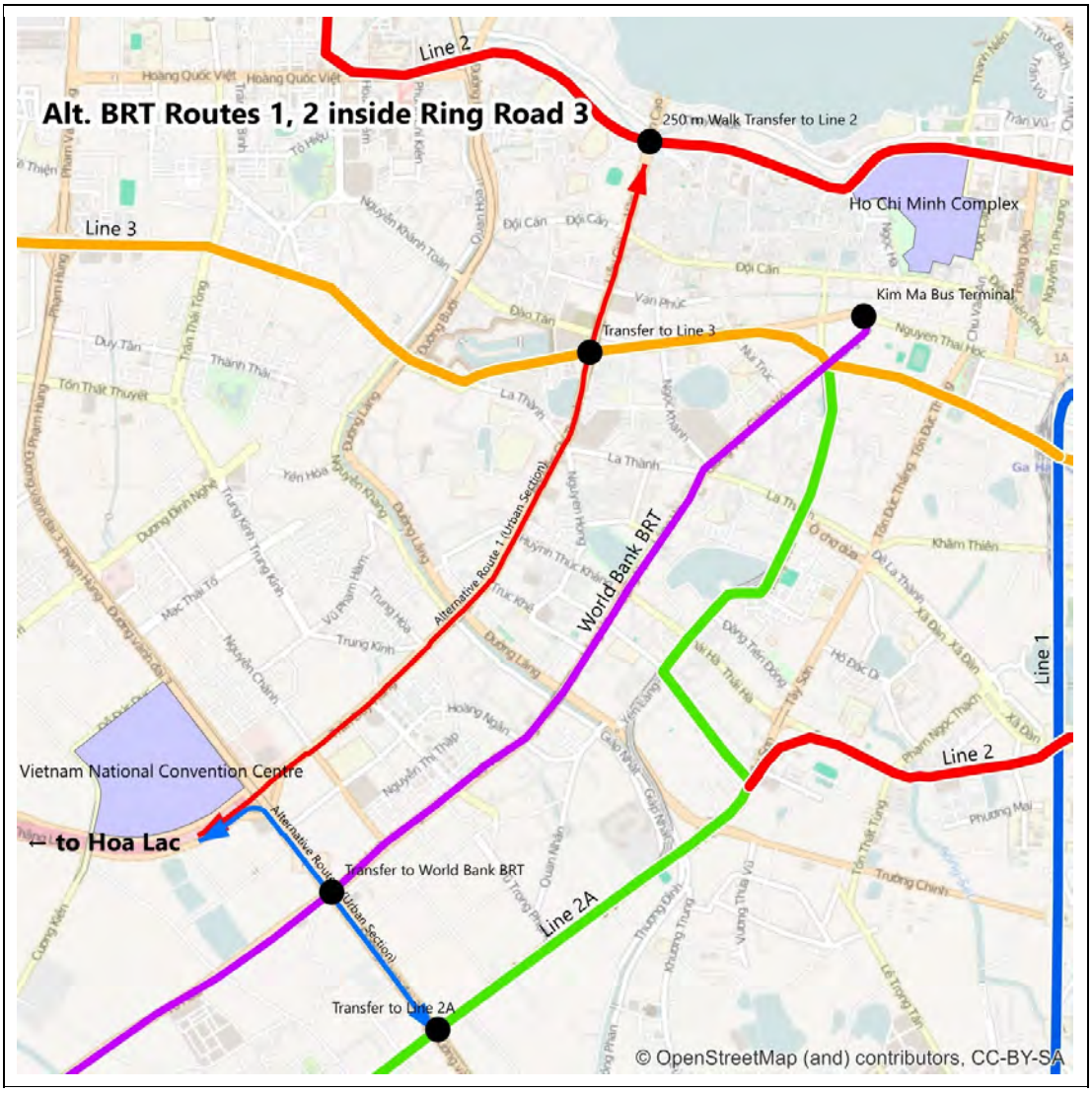
Figure 4.2.3 Alternative BRT Routes in Urban Section

Table 4.2.2 General Features of the Alternatives BRT Routes in the Urban Section

Alternative BRT Route inside Ring Road 3		General Features of the Alternatives BRT Routes
Route 1	Vietnam National Convention Center (VNCC) > Ho Tay > VNCC	• Route along Tran Duy Hung St., Nguyen Chi Thanh St., Lieu Giai St. and Van Cao St. toward Ho Tay • Connection with UMRT Line 2 and UMRT Line 3 • BRT exclusive lane and BRT stations to be constructed within the existing center median strip.
Route 2	VNCC > UMRT Line 2A Station/World Bank BRT Station > VNCC	• Route along Khuat Duy Tien St. and Nguyen Trai St. • Connection with the UMRT Line 2A and the World Bank BRT line
Route 3	2 branches: VNCC > UMRT Line 2A Station/World Bank BRT Station > VNCC VNCC > UMRT Line 3 > VNCC	• For one branch of the BRT line inside the urban section, it follows the same route as Route 2 of the alternatives and connects with the UMRT Line 2A • For the other branch, it goes north along Duong Pham Hung St. towards the Vietnam National University and connects with the UMRT Line 3

Source: Study Team

The following figures present the above mentioned schematic alternative routes on the map.



Source: Study Team

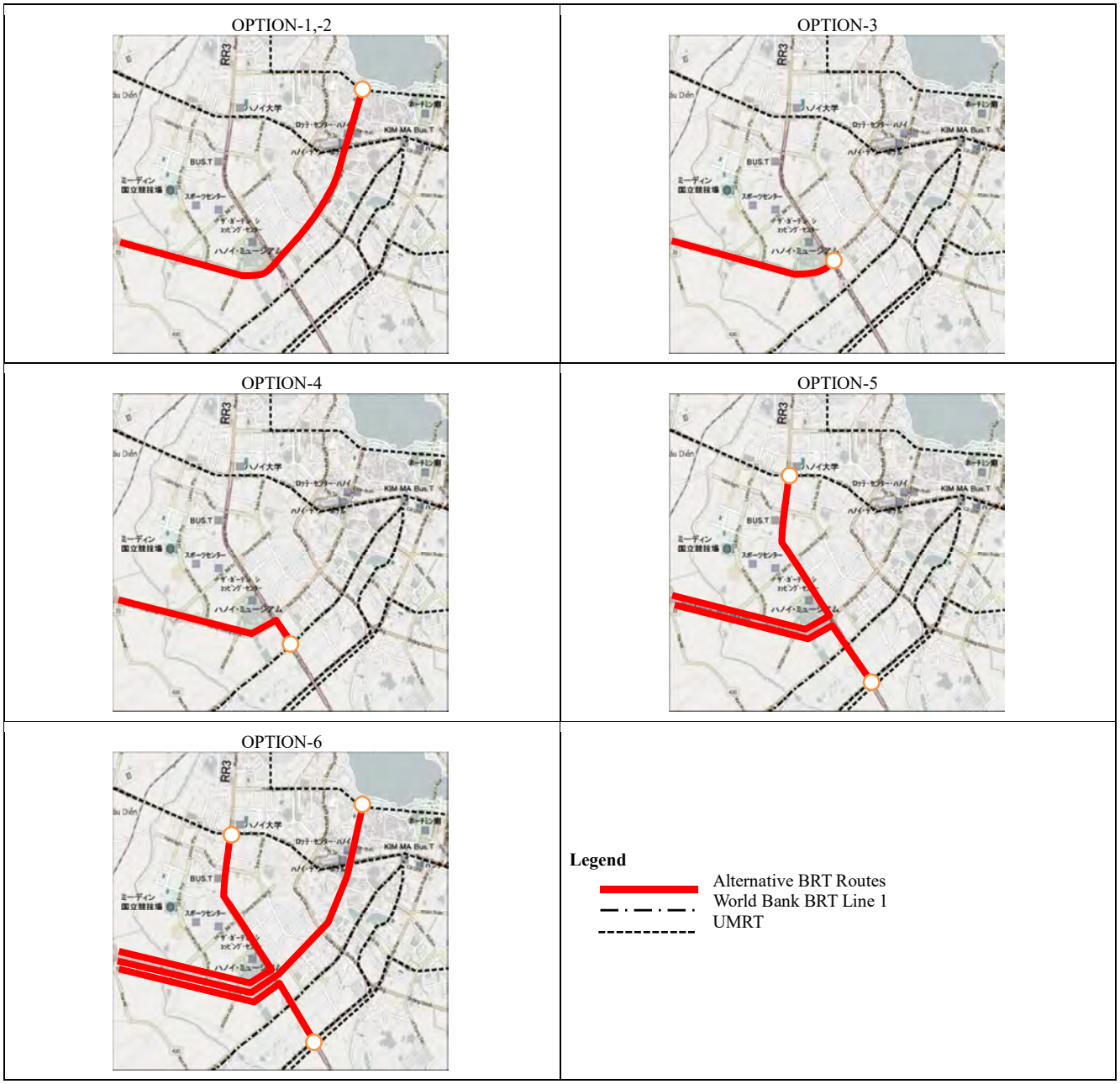
Figure 4.2.4 Alternative BRT Routes 1 and 2 inside Ring Road 3

Source: Study Team

Figure 4.2.5 Alternative BRT Route 3 inside Ring Road 3

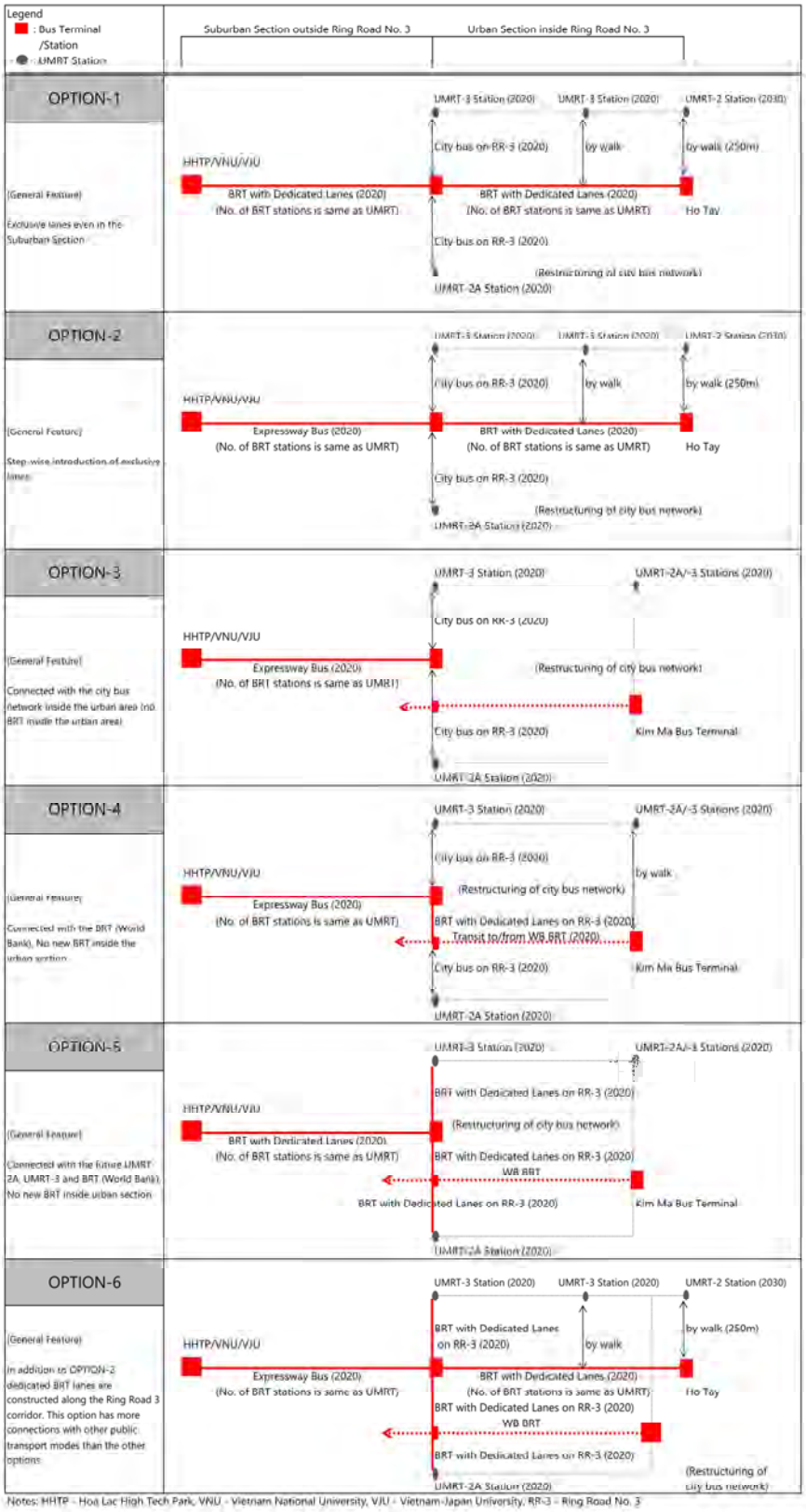
4.2.3 Options for the Alternative BRT Routes

Based on the above considerations, the options for the alternative BRT routes that have been selected are summarized in Figure 4.2.7. OPTION-1 and OPTION-2 was prepared based on Route 1 in Table 4.2.2, OPTION-4 and OPTION-5 was prepared based on Route 2 and Route 3 respectively. OPTION-6 is the combination of OPTION-2 and OPTION-5 which have the most number of connections with other public transportation systems in the city.



Source: Study Team

Figure 4.2.6 Routing of the Alternative BRT Routes



Source: Study Team

Figure 4.2.7 Options for the Alternative BRT Routes

5 Technical Evaluation of the Alternative BRT Routes

5.1 Estimated Demand Forecast for the Alternative BRT Routes

Table 5.1.1 shows a summary of the demand forecast for all cases of the alternative BRT routes. The indicators for each of the cases for target years 2020 and 2030 are as follows.

1) Total Passengers
   - Daily number of passengers estimated for the BRT
2) Farebox Revenue
   - Daily fare revenue using the scheme the following schemes
     - 10,000 VND + 500 VND/km (Basic Fare)
     - 5,000 VND + 250 VND/km (50% of the Basic Fare)
     - 20,000 VND + 1,000 VND/km (200% of the Basic Fare)
     - 16,0000 VND + 800 VND/km (160% of the Basic Fare)
3) Maximum Section Volume
   - Maximum daily number of passengers on the BRT by section on the UMRT Line 5 Corridor
4) PCU x km (PCU = Passenger Car Units)
   - Daily number of vehicles x km by Passenger Car Units
5) PCU x hr
   - Daily number of vehicles x km by Passenger Car Units
6) V/C
   - Volume Capacity Ratio, the congestion factor

Table 5.1.1 Summary of the Travel Demand Forecast

Target Year	UMRT Lines Operating	Transit Mode	Fare (VND)	BRT Route Options	UMRT Line 5/BRT Corridor			Road Network				Remarks
					Daily Passengers (1,000 pax/day)	Farebox Revenue (billion VND/day)	Max. Pax in a Section (100 pax/day)	PCU x km (1,000)	PCU x hr (1,000)	Average Velocity (km/h)	V/C	
2020	2,2A, 3	–	–	Do Nothing	–	–	–	93,331	2,783	33.5	0.20	
		BRT	10,000 +500 km	Option 1 & 2	65	1.25	470	93,585	2,804	33.4	0.17	Bus Line 71, 74 Freq. 50%
				Option 3	22	0.42	182	93,456	2,794	33.4	0.17	Bus Line 71, 74 Freq. 50%
				Option 4	21	0.41	170	93,222	2,784	33.5	0.17	Bus Line 71, 74 Freq. 50%
				Option 5	24	0.47	208	93,616	2,799	33.5	0.17	Bus Line 71, 74 Freq. 50%
				Option 6	87	1.64	531	94,851	2,846	33.3	0.17	Bus Line 71, 74 Freq. 50%
			5,000 +250 km	Option 1 & 2	110	0.95	815	93,585	2,804	33.4	0.17	Bus Line 71, 74 Freq. 50%
			20,000 +1,000 km	Option 1 & 2	30	1.34	249	93,585	2,804	33.4	0.17	Bus Line 71, 74 Freq. 50%
			16,000 +800 km	Option 1 & 2	41	1.37	314	93,585	2,804	33.4	0.17	Bus Line 71, 74 Freq. 50%
2030	1, 2, 2A, 3, 4, 6, 7, 8	–	–	Do Nothing	–	–	–	158,211	5,041	31.4	0.28	
		BRT	10,000 +500 km	Option 1 & 2	127	2.50	840	157,479	5,029	31.3	0.26	Bus Line 71, 74 Freq. 50%
				Option 3	58	1.13	533	157,804	5,046	31.3	0.26	Bus Line 71, 74 Freq. 50%
				Option 4	88	1.80	617	157,995	5,043	31.3	0.26	Bus Line 71, 74 Freq. 50%
				Option 5	105	2.10	863	159,530	5,101	31.3	0.27	Bus Line 71, 74 Freq. 50%
				Option 6	161	3.34	1,177	159,880	5,106	31.3	0.27	Bus Line 71, 74 Freq. 50%
			5,000 +250 km	Option 1 & 2	196	1.76	1,217	157,479	5,029	31.3	0.26	Bus Line 71, 74 Freq. 50%
			20,000 +1,000 km	Option 1 & 2	60	2.67	509	157,479	5,029	31.3	0.26	Bus Line 71, 74 Freq. 50%
			16,000 +800 km	Option 1 & 2	80	2.72	615	157,479	5,029	31.3	0.26	Bus Line 71, 74 Freq. 50%
	1, 2, 2A, 3	–	–	Do Nothing	–	–	–	153,450	4,981	30.8	0.27	
		BRT	10,000 +500 km	Option 1 & 2	130	2.62	922	152,718	4,969	30.7	0.26	Bus Line 71, 74 Freq. 50%
				Option 3	45	0.86	367	153,043	4,987	30.7	0.26	Bus Line 71, 74 Freq. 50%
				Option 4	86	1.82	716	153,233	4,984	30.7	0.26	Bus Line 71, 74 Freq. 50%
				Option 5	108	2.19	922	154,768	5,042	30.7	0.26	Bus Line 71, 74 Freq. 50%

Source: Study Team

5.1.1.1 Public Transport Indicators from the Travel Demand Forecast

With regards to the indicators from the travel demand forecast results. Higher total numbers of passengers and farebox revenues are better for public transport. The maximum section volume is used as an indicator for the operational plan of the transit options (UMRT or BRT) Higher maximum section volume generally means that larger numbers of rail cars (or bus vehicles) will be required and this indicator is for calculating rolling stock (or bus vehicle) costs.

5.1.1.2 Road Traffic Indicators from the Travel Demand Forecast

Next are road traffic indicators. The total number of road-based trips in the study area was assigned by equilibrium assignment for each case. Lower PCU x km, PCU x hr and V/C are better as road traffic indicators. The road traffic indicators are used in the economic/financial evaluation analysis for calculating vehicle operating cost and travel time cost.

5.1.1.3 Findings from the Travel Demand Forecast

The daily total number of passengers on the BRT ranges from 60,000 to 160,000 in 2030 depending on the route and this is lower than the travel demand forecasts from the previous studies.

The first reason is that transit assignment is utilized in this study for the traffic assignment step along with equilibrium assignment for road traffic. This means that passengers are able to transfer between bus routes or UMRT lines at bus stops and UMRT stations. Transit assignment is stricter with regards to transfers than the equilibrium assignment utilized in the previous studies. The aim of utilizing transit assignment was to more accurately model the existing transfer situation of public transport.

The second reason is that the target public transport mode share was set in previous studies. In the METROS study, the UMRT mode isn't used by only public transport trips only. If the UMRT was more convenient for bicycle, motorcycle and car users, those users would shift to use the UMRT.

The lower demand of the BRT on the UMRT Line 5 corridor is a result of transit assignment on the public transport network of the trips estimated from the output from the mode choice model. This explains why the demand of the BRT on the UMRT Line 5 corridor is less than that of previous studies.

The existing bus routes competing with the UMRT Line 5 corridor should usually be rerouted when the corridor is either implemented as a BRT or UMRT. The aim for this is to concentrate the passenger demand to the targeted line (either BRT or UMRT) so that the project will be financially sustainable in terms of ridership.

In this study, the existing bus routes 71 and 74 are operating in parallel with the UMRT Line 5 corridor and compete with this corridor. Usually, the existing bus route 71 and 74 should be removed for establishing the business case for the UMRT Line 5 corridor project.

However for bus routes 71 and 74, between the central area of Hanoi and Hoa Lac, the bus routes overlap with the UMRT Line 5 corridor but at Hoa Lac, the bus routes 71 and 74 branches north and south respectively and do not overlap with the UMRT Line 5 corridor.

If bus routes 71 and 74 were removed, then there would be no public transport access to the areas north and south of the Hoa Lac area. Therefore, for this study, rerouting of the existing bus routes 71 and 74 isn't considered but on the sections of bus route 71 and 74 which compete with the UMRT Line 5 corridor, the

frequency of the bus service was assumed to be reduced to 50% to match the expected decline in demand on these 2 bus routes with the opening of the BRT on the UMRT Line 5 corridor.

5.2 Planning of BRT Facilities

UMRT Line 5 is planned along the proposed BRT route. Decision No. 519 dated 31 March 2016 by the Prime Minister gave approval for the construction of the UMRT Line 5 in the period between 2020 and 2030. The route planning and facilities planning of the proposed BRT should be conducted on the assumption that the UMRT Line 5 will be constructed by 2030.

5.2.1 Basic Policies for the Planning of Facilities

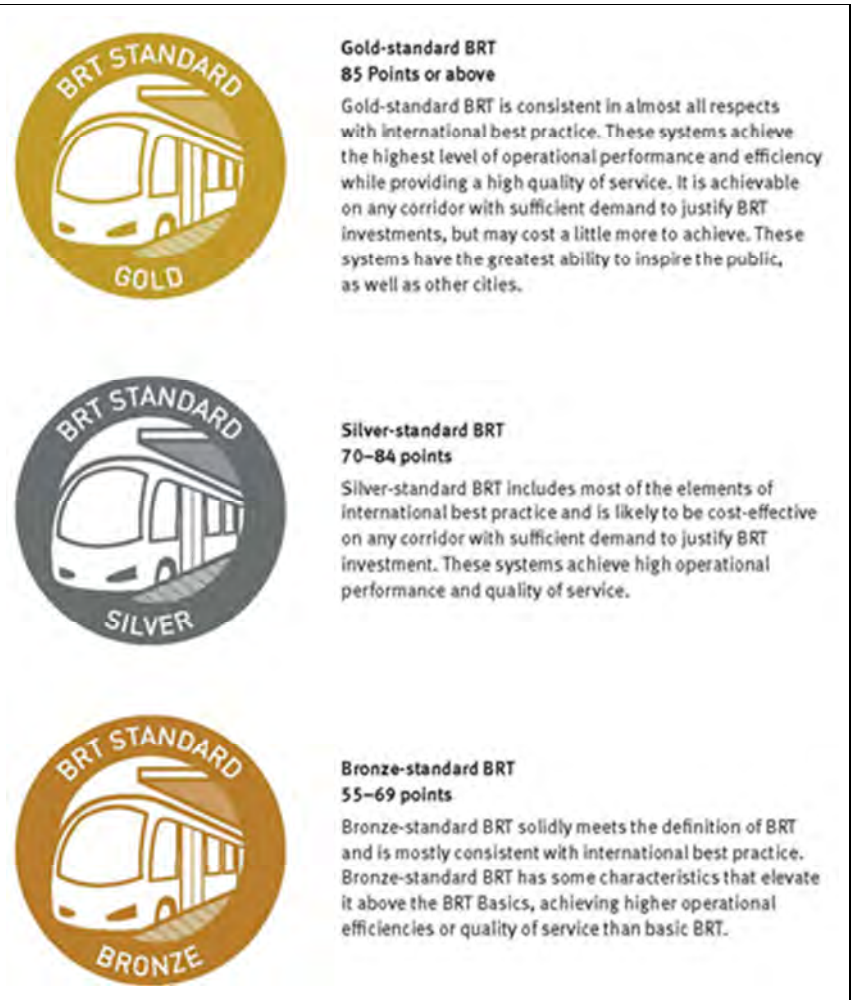
It is expected that the passenger demand of the proposed BRT would be transferred into the demand for the UMRT Line 5. After the start of service for the UMRT Line 5, the operation of the BRT route will be discontinued due to a duplication of public transport services. Therefore, in the route planning and facilities planning of the BRT project, the basic policy was not to propose an overbuilt or excessive system.

There are no technical standards for BRT in Vietnam. Also no international standards have been officially adopted.

The design guidelines from the American Public Transit Association's (APTA) "Designing Bus Rapid Transit Running Ways", the standard for BRT proposed by the Institute for Transportation and Development Policy (ITDP) and other guidelines are referenced in the planning and design of this proposed BRT.

"The BRT Standard" proposed by the ITDP has a rating system (See figure on the left) and the evaluation of "GOLD", "SILVER" or "BRONZE" is given to the BRT systems which fulfill certain conditions.

The required conditions to fulfill the BRT system in the BRT Standard are summarized in Figure 5.2.2.



Source: The BRT Standard, 2014 Edition , ITDP

Figure 5.2.1 BRT Rating System by the Institute for Transportation and Development Policy (ITDP)

Source: ITDP Website (https://www.itdp.org)

"Required Conditions to be Fulfilled by a BRT System" **(**Source: ITDP Web. Site (https://www.itdp.org))

1) Busway Alignment: Dedicated BRT lanes ensure that buses can bypass traffic jams. The separated right-of way can be enforced through the use of delineators, colorized pavement, or camera enforcement. Median-aligned busways minimize the risk of delays caused by turning movements and parked vehicles.
2) Off-board Fare Collection: Off-board fare collection reduces boarding time and prevents revenue leakage.
3) Intersection Treatments: Forbidding turns across the bus lanes and simplifying signal cycles reduce delays. Traffic signal priority activated by an incoming BRT vehicle can increase speeds in low-frequency systems.
4) Platform-level Boarding: The bus floor and station platform should be at the same height to minimise boarding and alighting times. Reducing vehicle-to-platform gaps ensures easy access for the disabled and the elderly.

Figure 5.2.2 BRT Required Conditions Proposed by the ITDP

In the above mentioned rating system, the "Gold Standard BRT" designation was given to the world famous BRT system in Curitiba, Brazil. Curitiba was developed by strictly controlling urban planning based on the BRT system.

Since the standard from the ITDP was prepared based on such a high-standard system, the criteria of the ITDP cannot simply be applied to Asian countries.

It is necessary to maintain the present number of lanes for major arterial roads in Asian megacities. The road widening will be quite difficult due to land acquisition and resettlement and installation of BRT exclusive lanes on narrow arterial roads will induce worsened traffic congestion.

Source: blogs.worldbank.org/transport
(Curitiba's Urban Planning based on the BRT System)

The study team refers to those international guidelines but does not propose BRT facilities of excessive standards taking into account the fact that the BRT will be discontinued after the commencement of service of the UMRT Line 5. In addition, even if the BRT is discontinued, the remaining BRT facilities should effectively be utilized by the current city bus network or by the general road traffic (i.e., passenger cars, motorcycles, etc.).

In the BRT project funded by the World Bank that is under construction along Lang Ha Street in Hanoi, a dedicated lane that had been originally designed has become difficult to apply for most of the proposed route. This is due to the fact that the dedicated lanes will reduce the number of lanes for passenger cars which will induce worsening traffic congestion. In this study, the lessons learned from the World Bank BRT route shall be referred to in order to minimize the impact of BRT facilities on the general traffic.

Accordingly, the following basic policies of facilities planning are defined. On the basis of these policies, the service level of the proposed BRT system should be maximized.

The BRT system shall be planned according to the following policies:

- Policy 1: To avoid pursuing excessively high-standards in consideration of the possible future discontinuation of the BRT
- Policy 2: To effectively utilize the BRT facilities even after the discontinuation of the BRT operation
- Policy 3: To minimize the negative impact of the BRT on general traffic

5.2.2 Route Planning

Identification of the different proposed route options for route planning was conducted and is shown in detail in Chapter 4.

5.2.2.1 Route Planning in the Urban Section

Route Planning in the Urban Section:

- OPTION-1, OPTION-2: Exclusive BRT lanes and BRT stations in the existing center median (from Van Cao to Tran Duy Hung Street) with pedestrian bridges for passenger access
- OPTION-3: Not applicable for the urban section
- OPTION-4, OPTION-5: Exclusive BRT lanes and BRT stations in the existing center median (along Ring Road No. 3) with underground pedestrian walkways for passenger access
- OPTION-6 (Combination of OPTION-2 and OPTION-5): Exclusive BRT lanes and BRT stations in the existing center median (from Van Cao to Tran Duy Hung Street and along Ring Road No. 3) with pedestrian bridges and underground pedestrian walkways for passenger access to BRT stations

It is not practical to construct new roads or widen existing roads for the BRT service since land acquisition and resettlement will be required. Therefore, the BRT exclusive lane should be constructed within the right-of-way of the existing roads. Each of the alternative routes proposed in Chapter 4 are basically 6-lane roads and/or 4-lane roads with a wide center median.

Replacing existing traffic lanes to BRT exclusive lanes will induce traffic congestion by reducing the road capacity for the general traffic. (See Table 5.2.1 for confirmation of the road capacity) Therefore, it is reasonable not to utilize existing lanes for the BRT exclusive lane but to construct new exclusive BRT Lanes within the space on the available median strip. As the ITDP proposed, the BRT exclusive lanes will contribute to high level of services for the BRT.

The typical road cross sections for the alternative routes of OPTION-1, OPTION-2 and OPTION-6 has a wide center median (width = 17 m).

Source: Study Team

Figure 5.2.3 Existing Condition of Van Cao and Nguyen Chi Thanh Street

Palm trees are currently planted on the center median. On the other hand, very old mahogany trees are currently planted in the median strip of the World Bank BRT route as shown the following photos.

(World Bank Route: Mahogany trees along Lang Ha Street)

(Proposed Route: Palm trees along Lieu Giai Street)

Source: Study Team

Figure 5.2.4 Planting in the Center Medians of the Proposed Route and the World Bank BRT Route

For the World Bank BRT route, the cutting of the mahogany trees was not done and therefore BRT exclusive lanes on that section of the BRT route will be not implemented.

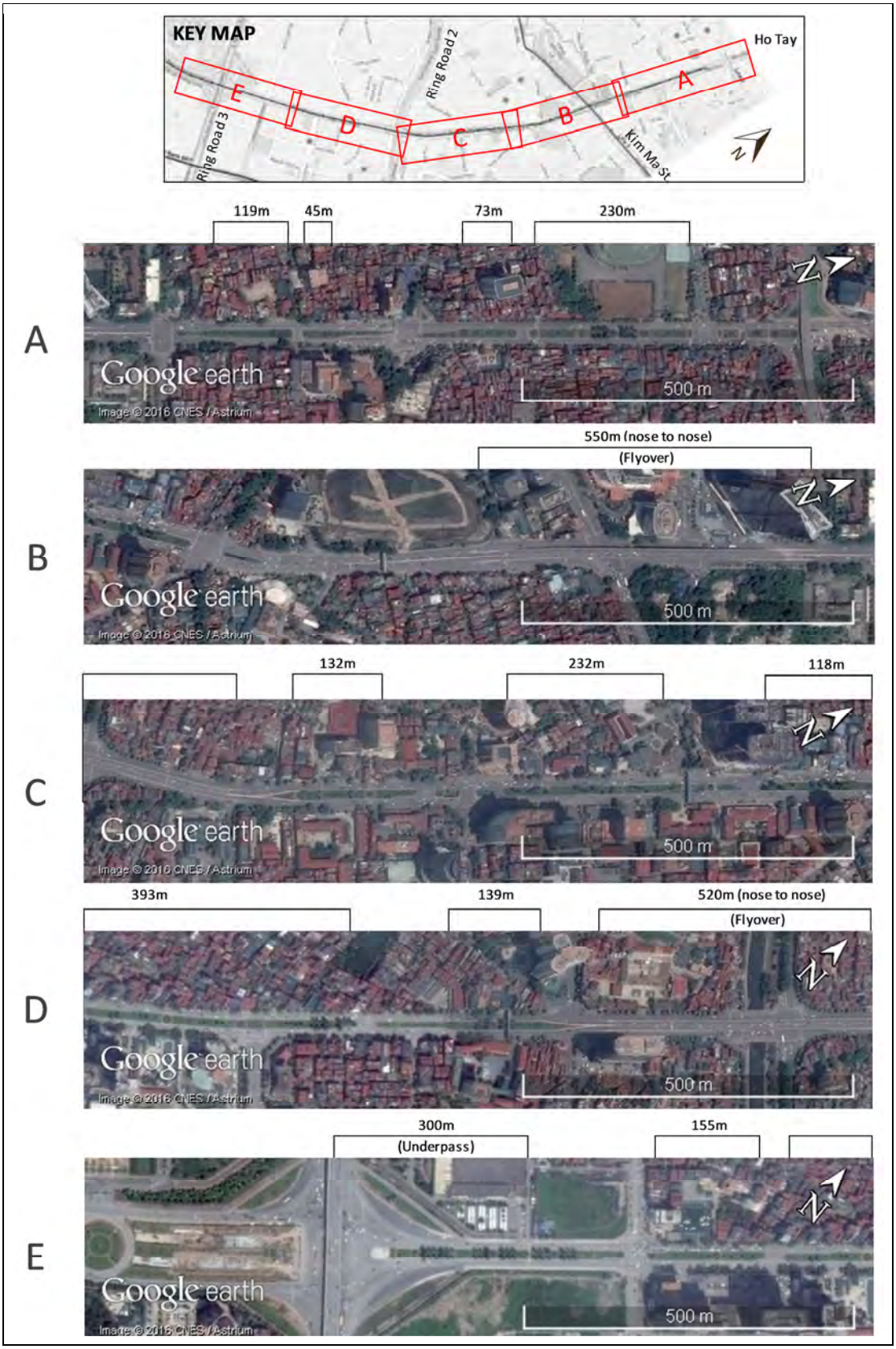
(BRT Station and BRT Route)

(Passenger Access to the BRT station)

Source: Study Team

Figure 5.2.5 BRT Exclusive Lane and the BRT Stations for the World Bank BRT Route

There are two flyovers and an underpass along the route of OPTION-1 and OPTION-2. The approaching sections for these structures does not have a center median as presented in the below figure. Along the total length of the urban section which is 4.7 km long (100%), 35% of the urban section (1,636 m) has the full 17 m width required for the exclusive BRT lanes while 29% of the urban section consists of the flyovers and underpasses (1,370 m). Accordingly, 64% (35% + 29%) of the congested road in the urban section can be avoided when the BRT is operated in exclusive BRT lanes in the center median and on the flyovers and underpasses. The remaining 36% of the urban section is located in the at-grade intersections where the center median (separator) cannot be provided. Public transport priority signals (PTPS) for buses should be installed for these sections.



Source: Study Team

Figure 5.2.6 Length of the Center Median and Flyover and Underpasses in the Urban Section

The degree of saturation of the general traffic lanes has been estimated in the case of 6-lane operations and 4-lane operations. The road capacity is going to be saturated (more than 1.0) in 2020 when the number of the general traffic lanes reduces to 4 lanes when 2 lanes are occupied by the BRT exclusive lanes.

Table 5.2.1 Degree of Saturation on OPTION-1, OPTION-2 and OPTION-6

	Name of Road (Distance from Ho Tay)			
	Van Cao St. (500 m)	**Liau Giai St. (1500 m)**	**Nguyen Chi Thanh St. (2500 m)**	**Tran Duy Hung St. (4000 m)**
Traffic Volume (PCU/day)	45,000 (2020) 49,600 (2030)	60,400 (2020) 62,900 (2030)	63,700 (2020) 68,500 (2030)	57,000 (2020) 63,300 (2030)
Degree of Saturation (6 lanes in total)	0.58 (2020) 0.64 (2030)	0.78 (2020) 0.81 (2030)	0.82 (2020) 0.89 (2030)	0.74 (2020) 0.82 (2030)
Degree of Saturation (4 lanes in total)	0.87 (2020) 0.96 (2030)	**1.17 (2020)** **1.22 (2030)**	**1.24 (2020)** **1.33 (2030)**	1.11 (2020) **1.23 (2030)**
Notes: PCU (Passenger Car Unit) , Peak Hour Ratio=10%, Lane Direction Ratio=50% Lane Capacity=1,289 pcu/hour/lane =2,200 (base capacity) x 0.93 (sight clearance) x 0.70 (side friction) x 90% (adjustment by JST to convert from Japan to Vietnam)				

Source: Study Team

Accordingly, it is not recommended to convert a part of the general traffic lanes for exclusive or priority BRT lanes.

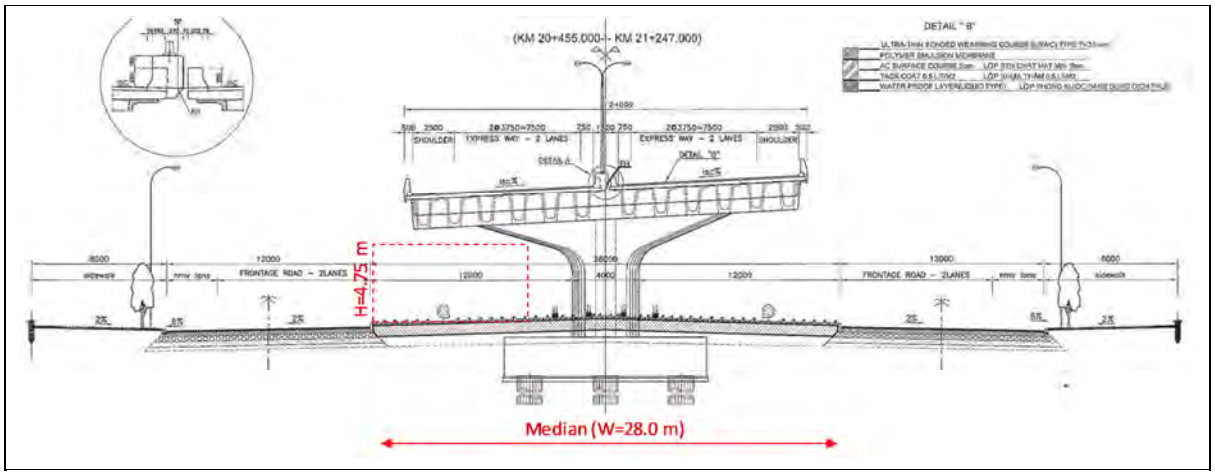
In this study, the construction of new exclusive BRT lanes in the center median is proposed. Even after the discontinuation of the BRT operation by replacing it with the UMRT Line 5, the newly constructed exclusive BRT lanes can be converted for general traffic usage. As shown in Table 5.2.1, the degree of saturation for the 6-lane road will become nearly 1.0 and further road widening might be considered in the future.

As well as the exclusive BRT lanes, the BRT stations also will be constructed in the center median strip. Pedestrian bridges will be required for passenger access to the stations. Since the proposed arterial road (Van Cao-Lieu Giai-Nguyen Chi Thanh-Tran Duy Hung) is constantly congested, additional pedestrian crossings on the road should be avoided.

The above planning is based on the planning policies (Policy 2 and 3) as mentioned in Section 5.2.1 of this chapter.

The proposed roads for OPTION-4, OPTION-5 and OPTION-6 along the Ring Road No. 3 also have wide center median strips (width =28 m). On the median of these roads, the elevated highway along Ring Road No. 3, was constructed as shown in the following figure.

The height clearance under the elevated highway is more than the 4.75 m as specified by the Vietnamese design guideline for arterial roads. Therefore, it will be possible for BRT buses to run underneath the elevated highway.

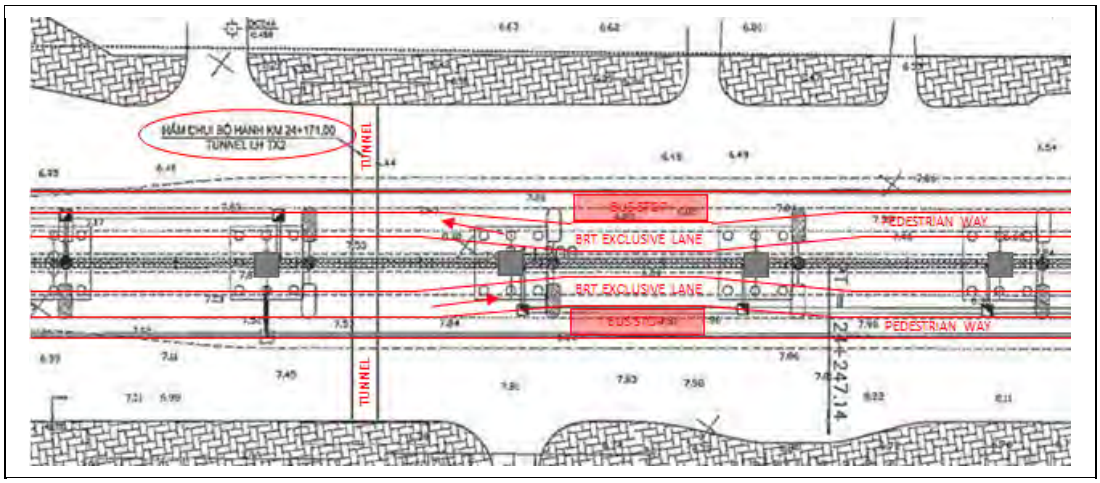


Source: Study Team based on the drawing provided by PMU Thang Long, MOT

Figure 5.2.7 Median and Clearance Height under the Elevated Highway on Ring Road 3

The width of the center median could accommodate not only the exclusive BRT lanes but also the BRT stations within the available width of 28 m. As explained in a latter section of this chapter (see Section 5.3), the buses with right side doors are proposed in this study (which is the same as the current buses used in the city).

Figure 5.2.7 presents the conceptual layout of the BRT station under the elevated structure of Ring Road No. 3.



Note: The length of the bus stop is 23 m and this is based on the length of an articulated bus (L = 18m). For the approach taper length (25 m each), the Japanese design manual, "Douro Kouzourei", was used as a reference.

Source: Study Team

Figure 5.2.8 BRT Facilities Layout under Ring Road No. 3

The degree of saturation of the general traffic lanes for OPTION-4, OPTION-5 and OPTION-6 has been estimated in the case of 6 lane operations, 4 lane operations and 2 lane operations as shown in Table 5.2.2. The "4 lane case" is the current lane configuration. The "2-lane case" is prepared in case of allocating 2 general traffic lanes for the exclusive BRT lanes. The "6-lane case" is based on the assumption of further widening of the road in the future.

The traffic congestion generated by construction activities would be minimized by utilizing the wider center median (W = 17 m for OPTION-1, 2, 6 and W=28 m for OPTION-4, 5, 6).

The road capacity of the "4-lane case" in the current condition will be nearly saturated (0.99-1.05, around 1.0) even in 2020 and the "2-lane case" will be saturated before 2020. Accordingly, it is not recommended to change a part of the general traffic lanes into exclusive or priority BRT lanes.

Table 5.2.2 Degree of Saturation for OPTION-4 and OPTION-5

	Duong Pham Hung (OPTION-4, 5)	**Khat Duy Tien (OPTION-4)**
Traffic Volume (PCU/day)	53,900 (2020) 78,100 (2030)	51,300 (2020) 74,800 (2030)
Degree of Saturation (4-lane in total)	1.05 (2020) 1.51 (2030)	0.99 (2020) 1.45 (2030)
Degree of Saturation (2-lane in total)	2.09 (2020) 3.03 (2030)	1.99 (2020) 2.90 (2030)
Degree of Saturation (6-lane in total)	0.70 (2020) 1.01 (2030)	0.66 (2020) 0.97 (2030)
Note: PCU (Passenger Car Unit) , Peak Hour Ratio=10%, Lane Direction Ratio=50% Lane Capacity=1,289 pcu/hour/lane =2,200 (base capacity) x 0.93 (sight clearance) x 0.70 (side friction) x 90% (adjustment by JST to convert from Japan to Vietnam)		

Source: Study Team

In case of providing the exclusive or priority BRT lane, it is possible to put the lane on the outer lane of the arterial road, however, this lane configuration will not be recommended since the on and off ramps of the Ring Road No. 3 is placed on the outer lane of the arterial road and also the exclusive or priority BRT lane in the outer lane will conflict with the non-motorized vehicles running on the outer lane (See Figure 5.2.6 for the non-motorized vehicle lane).

Therefore, the construction of the new exclusive BRT lanes in the center median is proposed for this route as well.

As indicated in Table 5.2.2, the "4 lane case" is going to be saturated (DS[1] = 0.99-1.05, around 1.0) toward 2020 and is going to be saturated (DS = 1.45-1.51 >1.25) in 2030. Road widening in the center median is not practical as mentioned above and the widening might be conducted to utilizing the sidewalk space (width = 8.0 m).

BRT stations will be constructed in the center median as well as the exclusive BRT lane as proposed in Figure 5.2.7. At-grade pedestrian crossings or underground pedestrian crossings will be proposed for passenger access to the stations. It is difficult to construct overhead pedestrian bridges under the elevated Ring Road No. 3 due to a lack of the clearance height on the arterial road. (see Figure 5.2.8)

[1] DS = Degree of Saturation

Source: Study Team

Figure 5.2.9 Not Sufficient Clearance Height under Pedestrian Bridge

Accordingly, the exclusive BRT lane and BRT stations on the center median is proposed for the section along Ring Road No.3. Also underground pedestrian crossings are proposed for passenger access to these BRT stations.

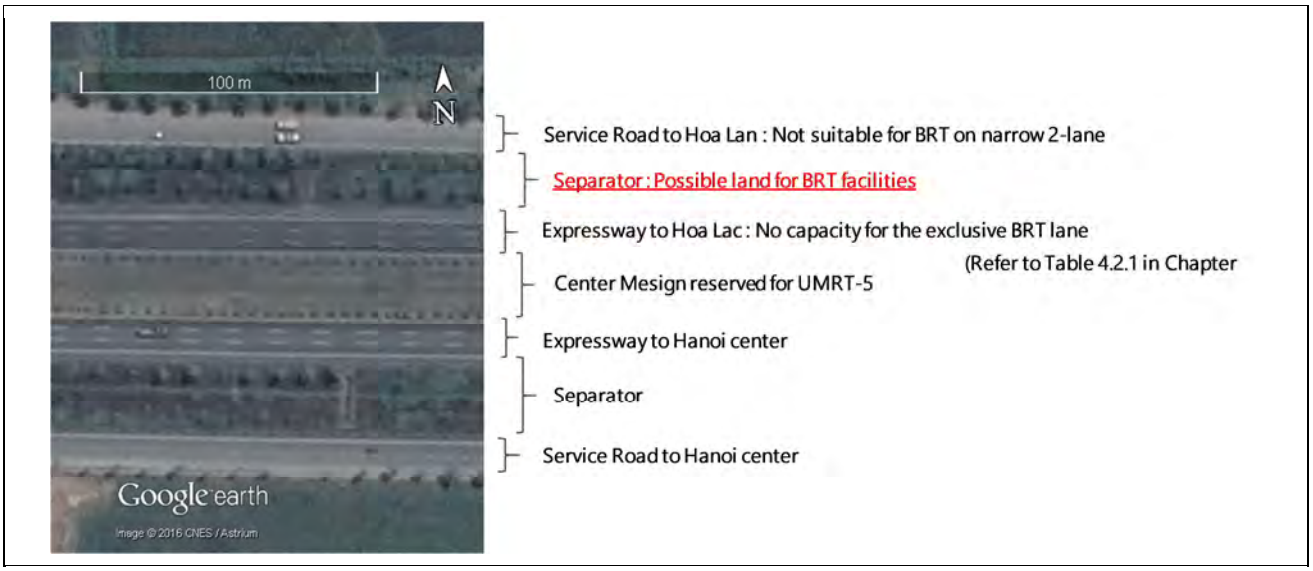
The UMRT Line 5 in the urban section is proposed to be built as a subway using bored tunnels. Therefore the proposed BRT facilities will largely be unaffected by the construction of the UMRT. However, UMRT Line 5 stations will need to be constructed using the cut-and-cover method and so sections of the road for the BRT route will be affected.

5.2.2.2 Suburban Section (Thang Long Expressway)

Route Planning in the Suburban Section :

- OPTION-1: Widening of the expressway for the BRT exclusive lanes and BRT stations with pedestrian bridges for passenger access
- OPTION-2 to 5: Expressway bus service within the available lanes with BRT bus stations and pedestrian bridges for passenger access
- Interchanges: Integration of the ramps of the existing interchanges in the Hoa Lac Area

As mentioned in Chapter 4, traffic congestion will be constantly induced if the BRT exclusive lanes are constructed within the existing 6 lanes of the expressway. Using up existing lanes for the provision of the BRT exclusive lanes is not recommended. The wide center median strip along the expressway is reserved for the construction of the UMRT Line 5 in the future.

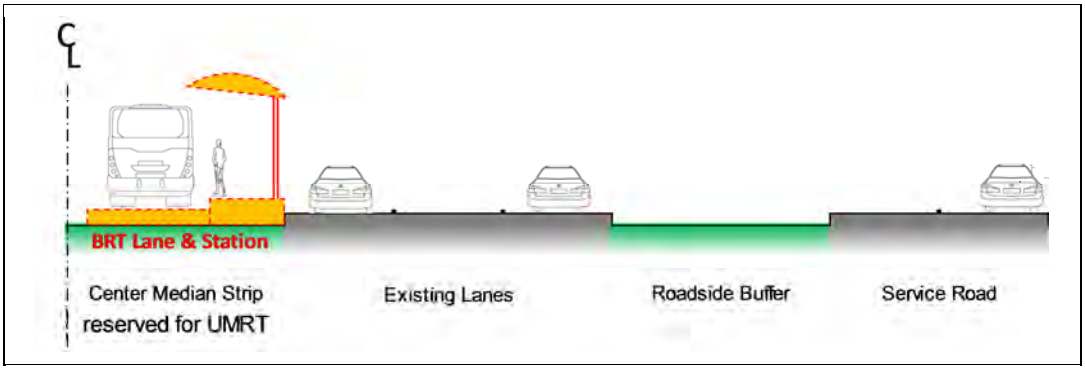


Source: Study Team, Google Earth

Figure 5.2.10 Horizontal Layout of Thang Long Expressway and Service Road

Since the provision of BRT exclusive lanes within the existing 6-lane is not recommended as explained in Chapter 4, additional lanes should be constructed to provide the exclusive lanes for the BRT.

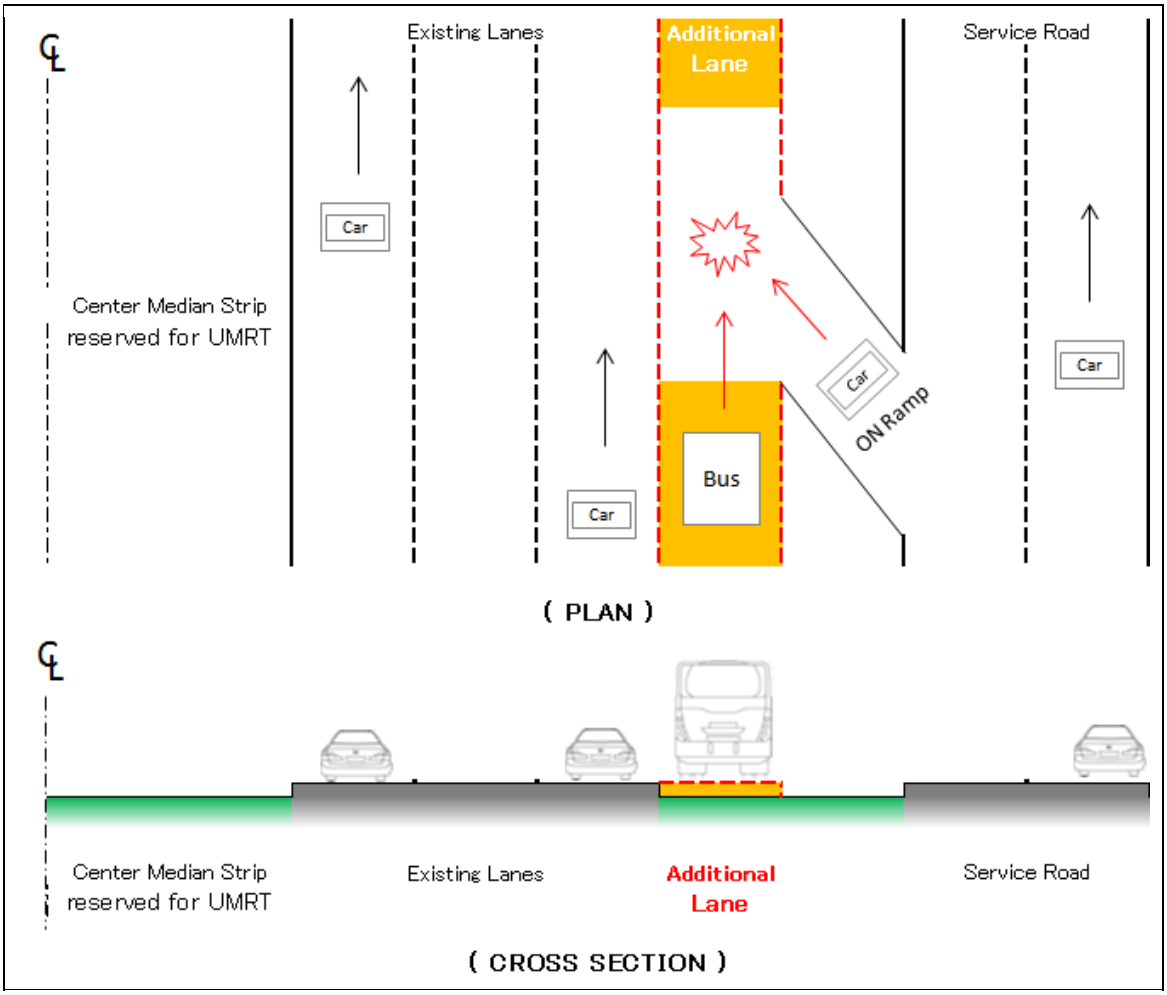
According to the "BRT Basic" by ITDP as introduced in Section 5.2.1, the best recommended lane configuration of the BRT is to provide the exclusive lanes on the median side of the road. However, the center median strip of the Thang Long Expressway is reserved for the future UMRT Line 5 and the construction of the additional lanes in the center median strip will result in the dismantlement of the rigid paved lanes.



Source: Study Team

Figure 5.2.11 BRT Exclusive Lane within the Existing Median Strip of the Expressway

Therefore, instead of the center median strip, the separator strips between the expressway and the service roads will be appropriate for the construction of the additional lanes. The BRT lane should be in the lower speed lane adjacent to the existing outer lane, and the additional lanes can be constructed as the exclusive lanes but the section around the merging/diverging of the interchange's on and off ramps should be available for mixed traffic.



Source: Study Team

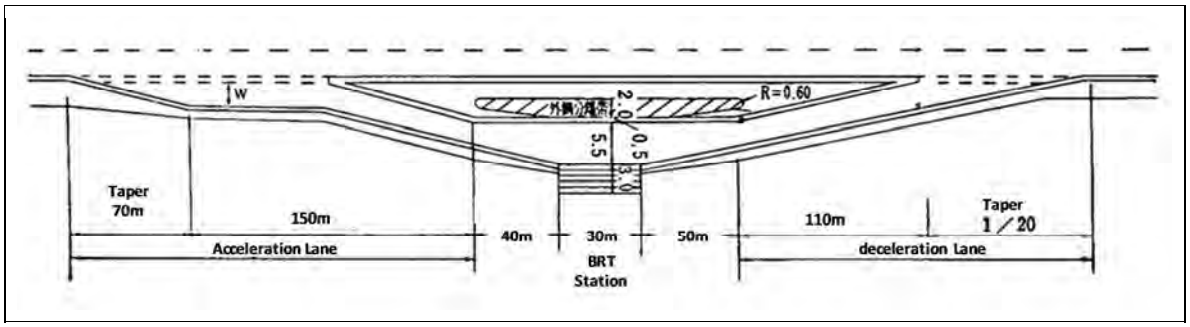
Figure 5.2.12 Conceptual Layout of the Additional Lane on the Thang Long Expressway

On the other hand, rather than the exclusive BRT lane, the BRT could also run on the general lanes just like the expressway bus service commonly provided for the mid and long distance trips.

As indicated in Table 4.2.1 in Chapter 4, the road capacity of the 6 lane expressway will be able to accommodate enough of the future traffic volume in 2030. The expressway bus operation is the minimum cost option which conforms to the basic policy as proposed in Section 5.2.1.

The vehicle speeds on the Thang Long Expressway is very fast and the disruption of high speed traffic flow by the slow buses will induce traffic congestion and traffic accidents. Therefore, the BRT stations should be placed away from the high speed lanes of the expressway.

Bus stations shall be constructed in the slow speed lane (i.e., outer lane) and the possible available space will be the median separator between the expressway and the service road. In addition, acceleration and deceleration lanes shall be provided for the smooth transition to/from the faster speed lanes of the expressway.



Source: Japanese Expressway Design Guideline, NEXCO

Figure 5.2.13 Example of a BRT Station along the Expressway (Pit Type)

Pedestrian bridges will be required for both the exclusive BRT lane and the express bus operation. The pedestrian bridges could be used for station access for the UMRT Line 5 in the future. The construction of the pedestrian bridges conforms to the planning policy, Policy 2, as proposed in Section 5.2.1 of this chapter.

The UMRT Line 5 is proposed to be built within the existing center median of the Thang Long Expressway. The proposed BRT facilities are to be constructed in the buffer corridor between the expressway and the service road. Accordingly, the BRT facilities will be unaffected by the construction of the UMRT.

5.2.3 Intersection Planning

Intersection Planning:

- Existing flyovers to be used for the BRT and no additional flyovers to be constructed
- Bus priority measures at the signalized intersections
- Integration of the ramps of the existing interchanges in Hoa Lac Area

5.2.3.1 Flyovers

There are many flyovers in the city. Figure 5.2.12 shows the location and the design loading condition of the flyovers around the alternative routes of the proposed BRT.

No.	Name of Flyovers (not official name)	Heavy Vehicle Restriction	Design Live Load
1	Nguyen Chi Tanh - Lang Flyover	No restriction	HL-95
2	Lang Ha - Le Van Luong Flyover	Prohibition of truck use	0.65 x HL-95
3	Lang Ha - Thai Ha Flyover	Prohibition of truck and bus use	0.50 x HL-95
4	Kim Ma Flyover	Prohibition of truck use	0.65 x HL-95
5	Thai Ha Flyover	Prohibition of truck and bus use	0.50 x HL-95
6	Dai Co Viet - Hue Flyover	Prohibition of truck and bus use	0.50 x HL-95

Source: Study Team

Figure 5.2.14 Flyovers and Loading Restriction

There are 2 flyovers along the proposed route of OPTION-1 and OPTION-2. Nguyen Chi Tanh-Lan Flyover was designed with the truck loading of HL-95 as specified by the MOT. There is no loading restriction and heavy vehicle such as trucks can run on the flyover. The BRT running on this flyover could pass over the 2 congested intersections below.

The design loading of the Kim Ma Flyover is "65%" of the HL-95 according to the design report provided by the HDOT. Actually there is sign board to restrict truck passing through this flyover.

(Sign Board on Kim Ma Flyover)

6.2 **Thiết kế cầu và các công trình**

6.2.1 *Quy mô thiết kế*

Chi tiết các bộ phận công trình xem trong phần giải pháp thiết kế cầu và công trình.

6.2.2 *Các tiêu chuẩn kỹ thuật chủ yếu*

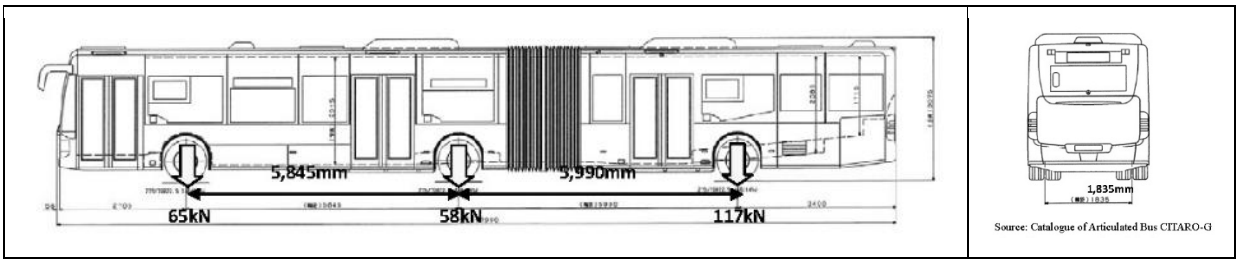
- Bề rộng cầu B=16m;
- Bề rộng phần xe chạy B=15m;
- Tiêu chuẩn thiết kế cầu 22TCN 272-05;
- "Tải trọng và tác động - Tiêu chuẩn thiết kế" TCVN 2737:1995
- Tiêu chuẩn "Thiết kế công trình chịu động đất" TCXDVN 375:2006
- Hoạt tải thiết kế cầu vượt: tải trọng trục 0.65HL93;
- Người đi bộ : 0.003MPa;
- Lực va xe vào trụ: 1800kN;
- Tĩnh không các đường chui dưới cầu: H=4.75m;

(Design Report of Kim Ma Flyover)

Source: Study Team, Design Report of Kim Ma Flyover borrowed from HDOT, HPC

Figure 5.2.15 Loading Restriction on Kim Ma Flyover

The Kim Ma Flyover was constructed across the 2 major congested intersections in the city. Therefore it is important for BRT planning to check the loading of heavy BRT vehicles such as articulated bus shown in Figure 5.2.14 below.



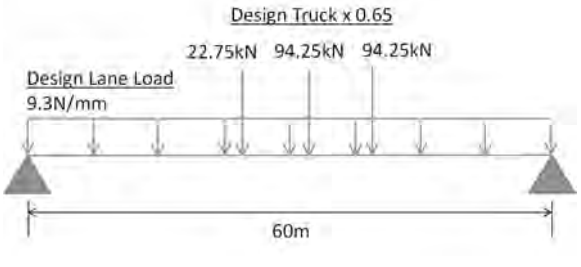
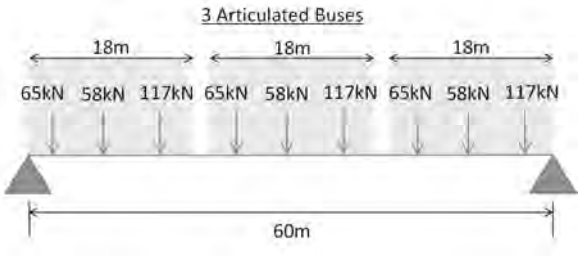
Source: Catalogue of Articulated Bus, CITARO-G, Mercedes Benz

Figure 5.2.16 Loading Condition of Articulated Bus

In order to verify the effect by the design vehicular live load of the articulated bus, a technical estimation of the total load using a simple model has been conducted.

The Kim Ma Flyover is a 3-span continuous bridge (3@60 =180 m). At the main span, a simple calculation was done for 1 span (60 m). The calculation result of the original design vehicular live load and the articulated bus are presented in Figure 5.2.15. The length of the articulated bus is nearly 18 m in total and 3 articulated buses vehicles can be loaded on the 60 m span bridge at the same time as shown in the following figure.

The loading by articulated buses (total 720 kN) is still smaller than the original design vehicular live load (769.25 kN), based on this preliminary calculation, passing of articulated buses will be acceptable on the Kim Ma Flyover.

A) Original Design Loading	B) Articulated Bus Loading
	
Total Load: Design Truck : 22.75 + 94.25+ 94.25 = 211.25kN Design Lane Load : 9.3 x 60,000 = 558kN Total : 211.25 + 588 = **769.25kN**	Total Load: Load by 1 Bus : 65 + 58 + 117 = 240kN Number of Buses : 3 Buses Total : 240 x 3 = **720.00kN**

Source: Study Team

Figure 5.2.17 Loading Calculation of Articulated Bus

The Vietnamese design standard, TCVN272-05, Section 5 mentioned the application of 65% of the HL-93 loading standard as follows:

"...the HL-93 loading is excessively onerous for small bridges on narrow, rural roads in Vietnam (Class IV and below), where it is physically difficult or impossible for large trucks to travel. Accordingly, the option has been included in the new Specification for the Owner to specify a lower truck and tandem axle load - either 50% or 65% of the basic value"

Actually, there is a restriction of heavy trucks entering in the city center of Hanoi so the application of 65% of HL-93 to the Kim Ma Flyover is technically and economically reasonable.

2 flyovers along the route of OPTION-1 and OPTION-2 accept the passing of heavy BRT vehicles (i.e., articulated buses). Accordingly, the existing flyovers should be utilized as for the running of the BRT as much as practically possible and no additional construction of flyovers is proposed to conform with the planning policy, Policy 1, as proposed in Section 5.2.1 of this chapter.

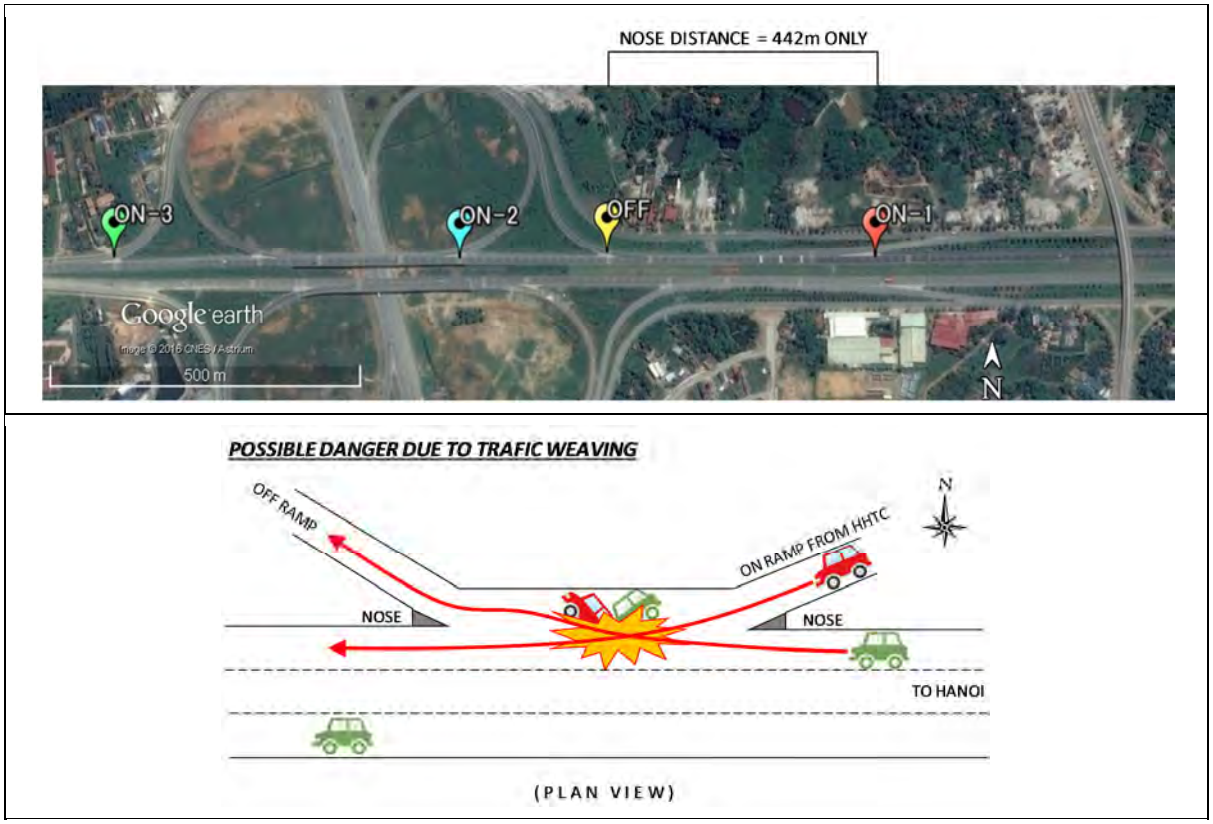
5.2.3.2 At-Grade Intersections

Bus priority measures at the signalized intersections should be undertaken and the conceptual measures are explained in the Section 5.5 of this chapter.

The proposed UMRT Line 5 structure is planned as a shield tunnel along the arterial road. The UMRT route and the stations have been planned to avoid the existing underground structures such as the foundation piles of the flyovers and underpasses that cross Ring Road No. 3. Further additional flyovers will disrupt the UMRT construction so additional flyovers is not proposed for the BRT project in conforming to the planning policy, Policy 1, proposed in Section 5.2.1 of this chapter.

5.2.3.3 Other Road Crossing (Interchanges)

There is a cloverleaf type interchange in the Thang Long Expressway in Hoa Lac as shown in Figure 5.2.16. In addition to this interchange, a full diamond type interchange is provided for the Hoa Lac High-Tech Park and the interval of these interchanges is too close. For instance, as shown in Figure 5.2.16, the distance between the on ramp from the Hoa Lac High Tech Park ("ON-1" in the figure) and off ramp of the cloverleaf interchange ("OFF" in the figure) is only 442 m. Generally, a length of more than 600 m is required to avoid a conflict due to traffic weaving. The current layout of these ramps will induce traffic accidents in the future.



Source: Study Team, Google Earth

Figure 5.2.18 Possible Danger of Traffic Weaving at the Hoa Lac Interchange

One of the solutions to settle this issue is to close the on ramp ("ON-1" in the figure) and the function of this ramp could be merged with the other ramps ("ON-2" and "ON-3" in the figure).

5.2.4 Bus Stop Planning

Bus Stop Planning :

- Bus stops near the planned UMRT stations to accelerate urban development for the future UMRT Line 5
- Supplementary bus stops in case of long intervals between the planned UMRT stations
- Bus stops designed for buses with right side doors

5.2.4.1 Layout of Bus Stops

The number of bus stops for the city regular bus is 11 bus stops along the route of OPTION-1, OPTION-2 and OPTION-6 between Van Cao St. and Tran Duy Hung St. where the length is around 4,700 m. Thus the average interval of bus stops is 472 m. In general, the operational time of bus services become longer when the number of bus stops are increased due to the low speed that is required to approach the bus stops and the required boarding and alighting times.
The BRT is expected to provide a higher level of service than the regular city buses and the interval of bus stops is generally longer than the city buses. For instance, the World Bank BRT currently under construction is a 14,348 m route with 21 bus stops and the average interval of bus stops is 682 m.

The demand of the proposed BRT in this study is expected to be carried over to the future UMRT Line 5 and the improvement of public transportation by the BRT will accelerate urban development along the corridor of the proposed UMRT Line 5. Therefore the bus stops of the BRT are planned near the planned UMRT stations.

Accordingly the newly constructed facilities such as pedestrian bridges and parking for motorbikes could be continuously used for the UMRT. The concept of the bus stop layout conforms to the, Policy 2, as proposed in the Section 5.2.1 of this chapter. The average interval of the UMRT Line 5 in the urban section is approximately 1,200 m.

The NACTO (National Association of City Transportation Officials) recommends that the desirable interval of bus stops to be 0.75 mile (=1,200 m).

Table 5.2.3 Layout of Bus Stops in the Urban Section

(Unit : m)

	BRT Stations in Urban Area				
	BS-1	BS-2	BS-3	BS-4	BS-5
Distance	0+100	1+200	2+400	3+900	4+700
MRT Station	Ho Tay	Kim Ma	Lang Trung	Trung Kinh	Trung Hoa
MRT Station Distance	0	1,100	1,200	1,500	800
BRT Station Distance	0	1,100	1,200	1,500	800

Source: Study Team

Urbanization is progressing along the Thang Long Expressway but large demand for public transportation has not been seen yet. The proposed BRT is expected to accelerate the urban development along the corridor of the proposed UMRT and the bus stops of the BRT are planned near the planned UMRT stations in the suburban section as well.

Table 5.2.3 shows the proposed layout of bus stops in the suburban section. Supplementary bus stops are provided in case of the long interval between the planned UMRT stations (Song Phuong – Quoc Oai and West

Quoc Oai – Hoa Lac). The supplementary bus stops are proposed around the existing villages or the on-going urban development sites.

In the area of around the Hoa Lac High Tech Park and the Vietnam National University, the bus stops are proposed to have the same interval as in the urban area (i.e., 1,200 m).

Table 5.2.4 Layout of Bus Stops in the Suburban Section

(Unit : m)

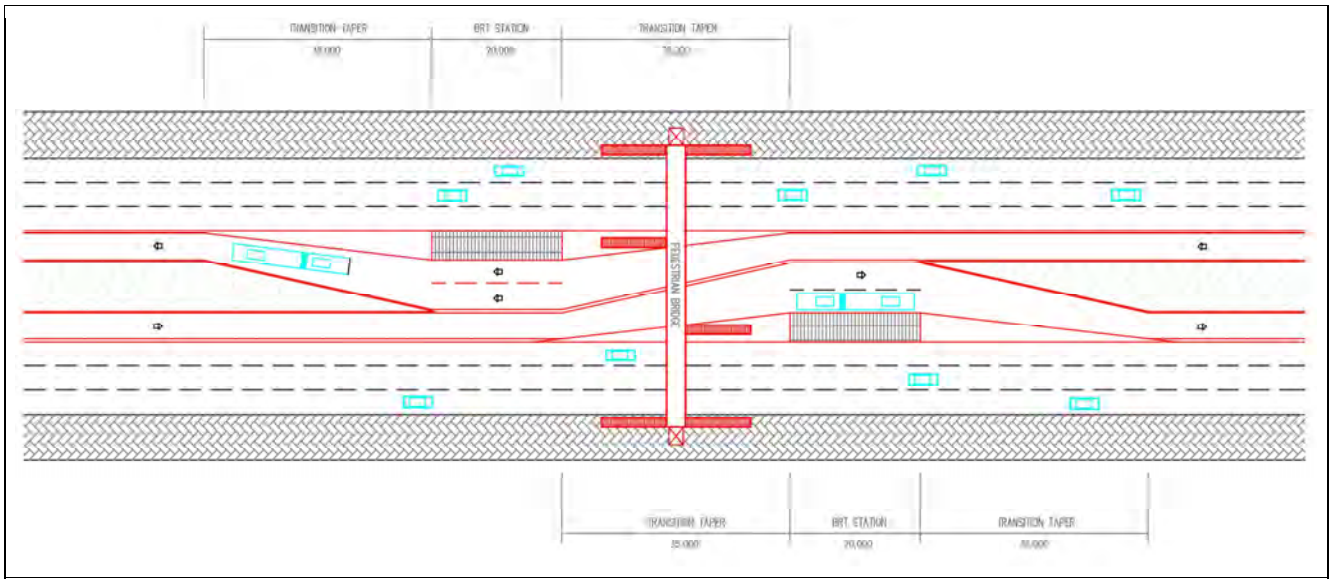
	BRT Stations in Suburban Area							
	BS-6	BS-7	BS-8	BS-9	BS-10	BS-11	BS-12	BS-13
Distance	6+400	8+600	10+500	11+800	13+600	14+600	**17+600**	20+500
MRT Station	Me Tri	Giao Quang	Tay Mo	An Tho	An Khanh	Song Phuong	na	Quoc Oai
MRT Station Distance	1,700	2,200	1,900	1,300	1,800	1,000	na	5,900
BRT Station Distance	1,700	2,200	1,900	1,300	1,800	1,000	3,000	2,900

	BRT Stations in Suburban Area			BRT Stations in HHTP & VNU Area				
	BS-14	BS-15	BS-16	BS-17	BS-18	BS-19	BS-20	BS-21
Distance	23+700	**27+700**	31+800	34+000	35+000	36+100	37+400	38+700
MRT Station	West Quoc Oai	na	Hoa Lac	na	na	na	na	na
MRT Station Distance	3,200	na	8,100					
BRT Station Distance	3,200	4,000	4,100	2,200	1,000	1,100	1,300	1,300

Source: Study Team

5.2.4.2 Bus Stop Design

The proposed BRT vehicles have right side doors which is the same as the existing buses that are used in Hanoi. This concept is based on the planning policy, Policy 1 and 2, as proposed in Section 5.2.1 of this chapter. The BRT vehicles can be continuously used on the regular bus network also when the BRT service is discontinued after the opening of the UMRT Line 5.



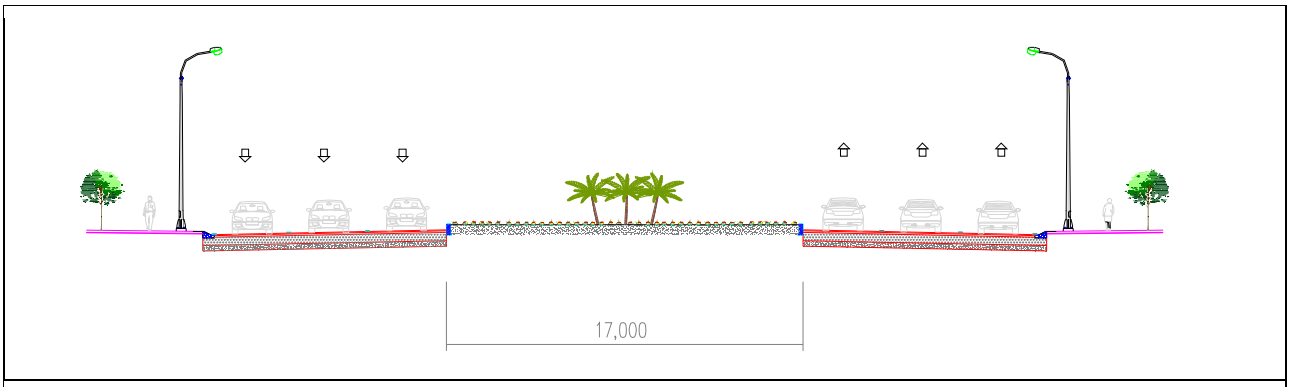
Source: Study Team

Figure 5.2.19 Bus Stop Design in the Urban Section

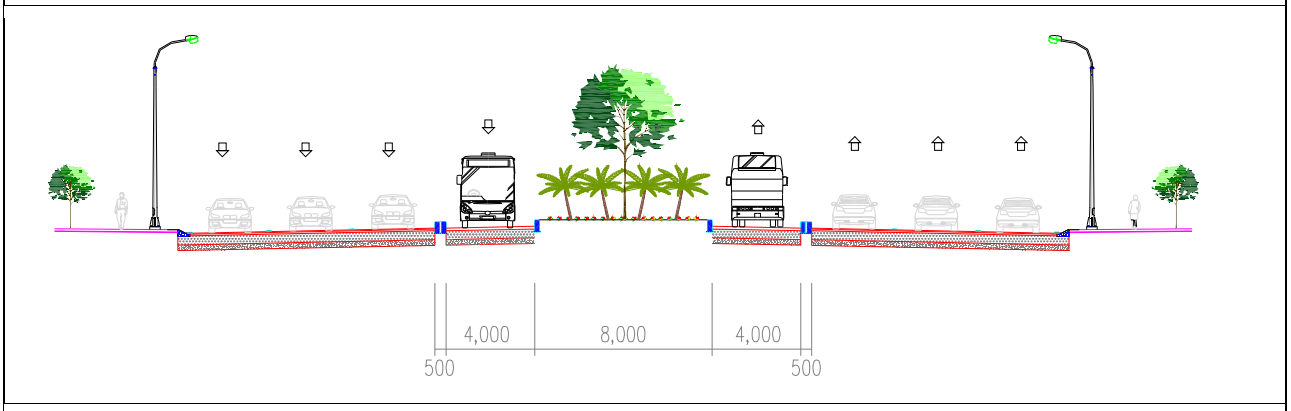
The bus stop design for the suburban section is introduced in Section 5.2.2.2 of this chapter. The pit-type bus stop is proposed to separate the bus stops from the high speed expressway lanes. The proper accelerating and deceleration lanes should be provided for the smooth transition to/from the bus stops.

5.2.5 Typical Cross Sections and Plan Layouts

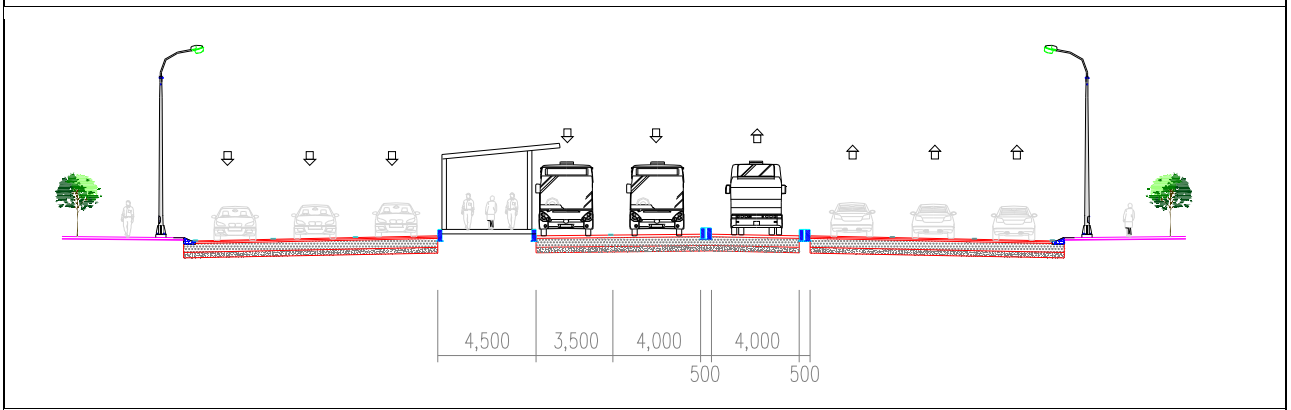
The typical cross sections of the urban section (Van Cao St. to Tran Duy Hung St., the urban section along the Ring Road No. 3 and the suburban section are shown below.



(Current Condition)



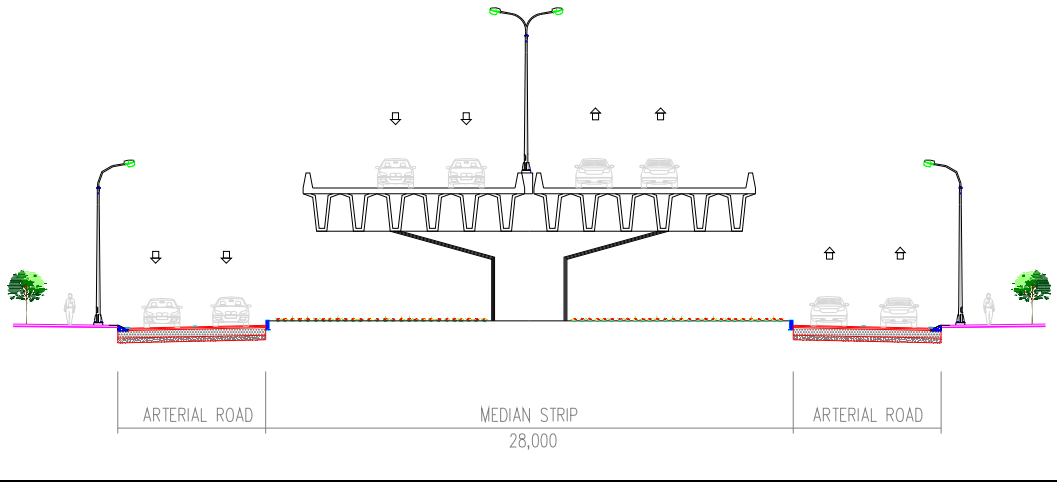
(BRT in the Median Strip: Standard Section)



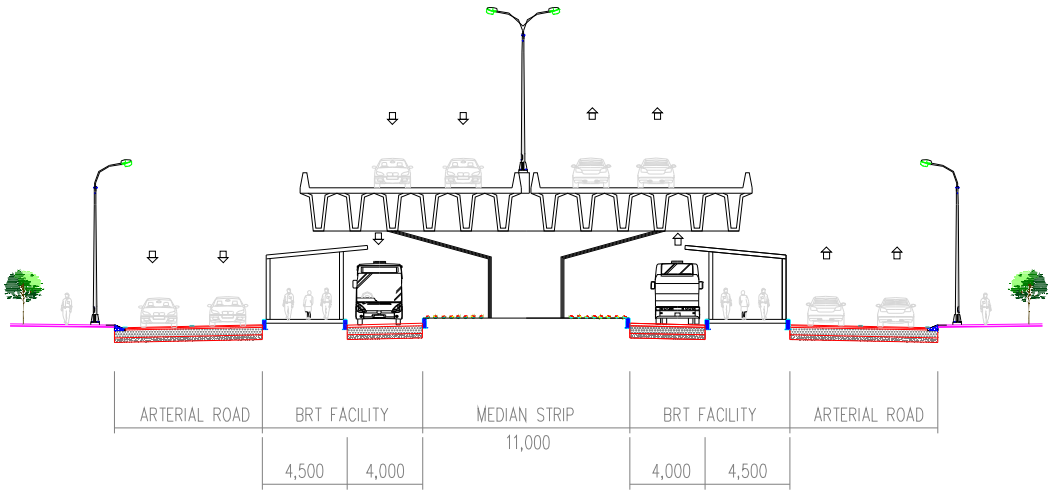
(BRT in the Median Strip: BRT Station Section)

Source: Study Team

Figure 5.2.20 Cross Sections in the Urban Section (Van Cao St. to Tran Duy Hung St.)



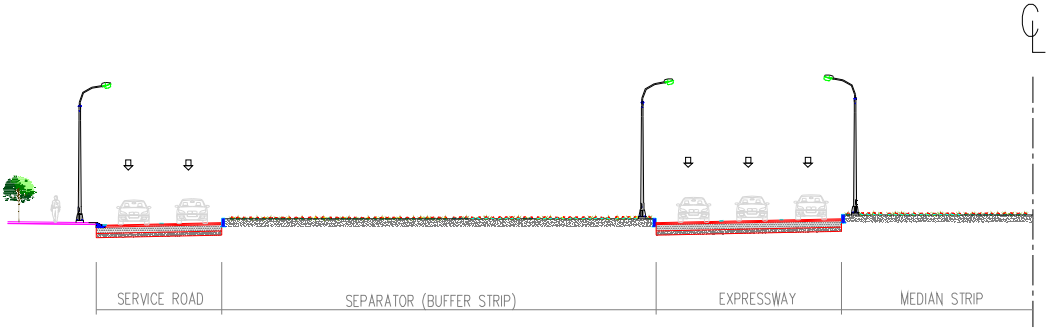
(Current Condition)



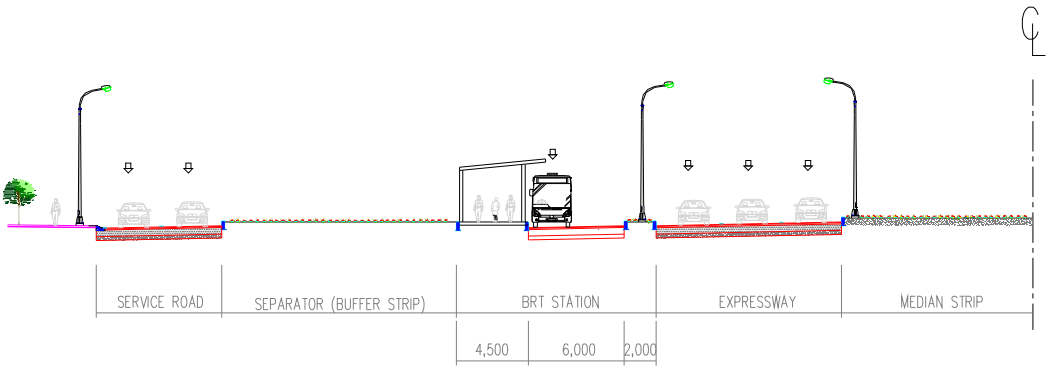
(BRT in the Median Strip: BRT Station Section)

Source: Study Team

Figure 5.2.21 Cross Sections in the Urban Section (along Ring Road No. 3)



(Current Condition)

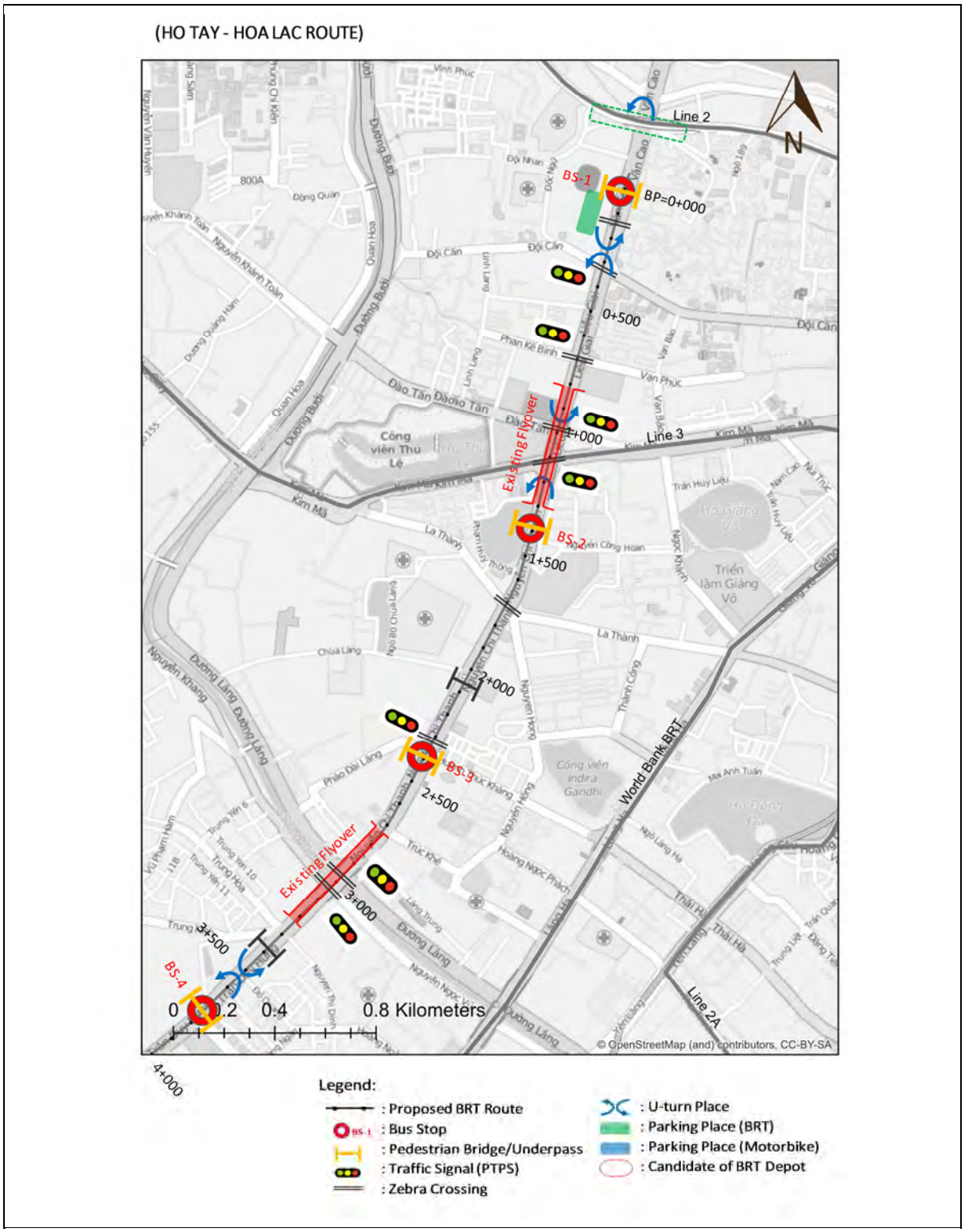


(BRT Station on Buffer Strip)

Source: Study Team

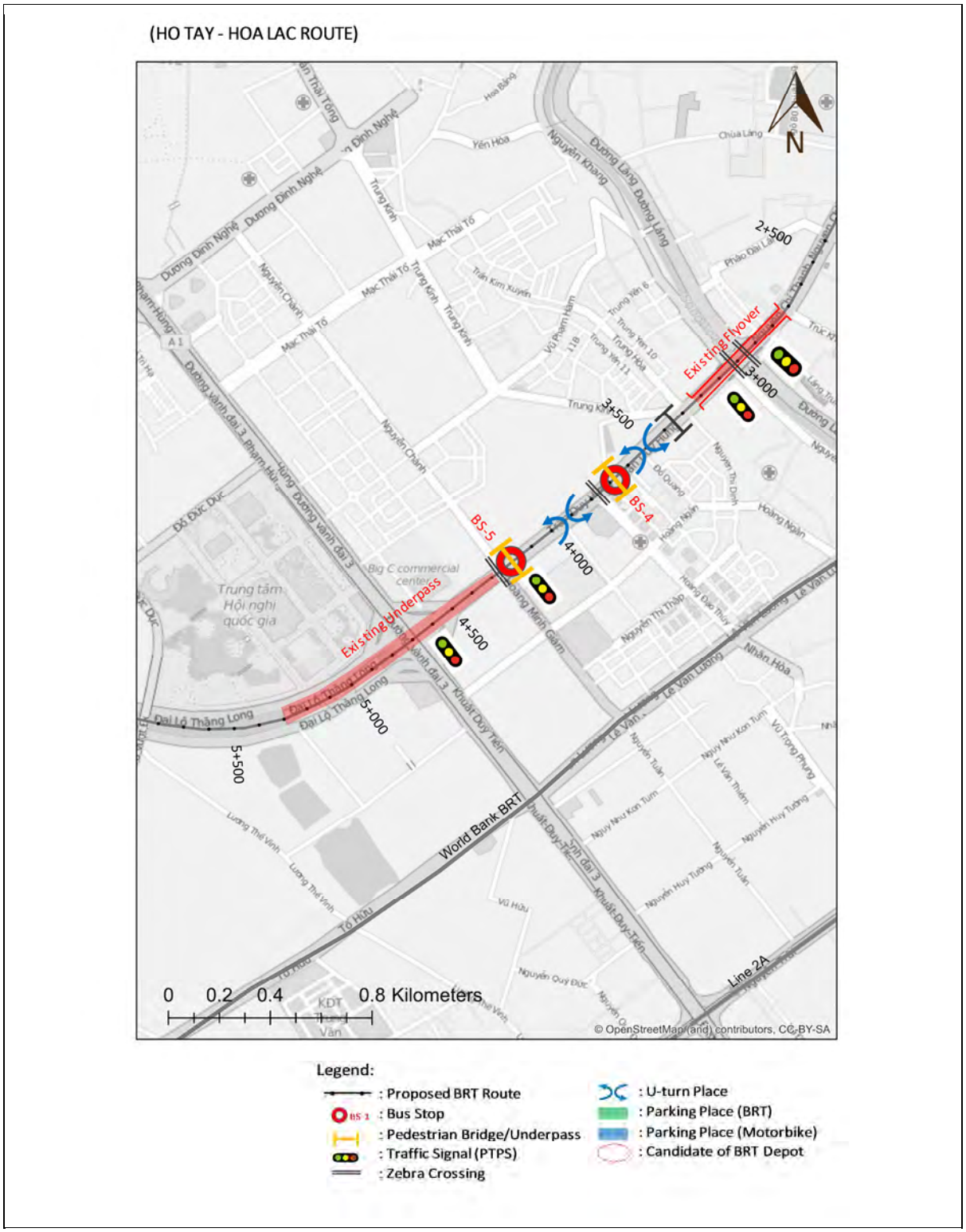
Figure 5.2.22 Cross Sections in the Suburban Section (Thang Long Expressway)

Layout maps of the proposed BRT facilities are shown below.



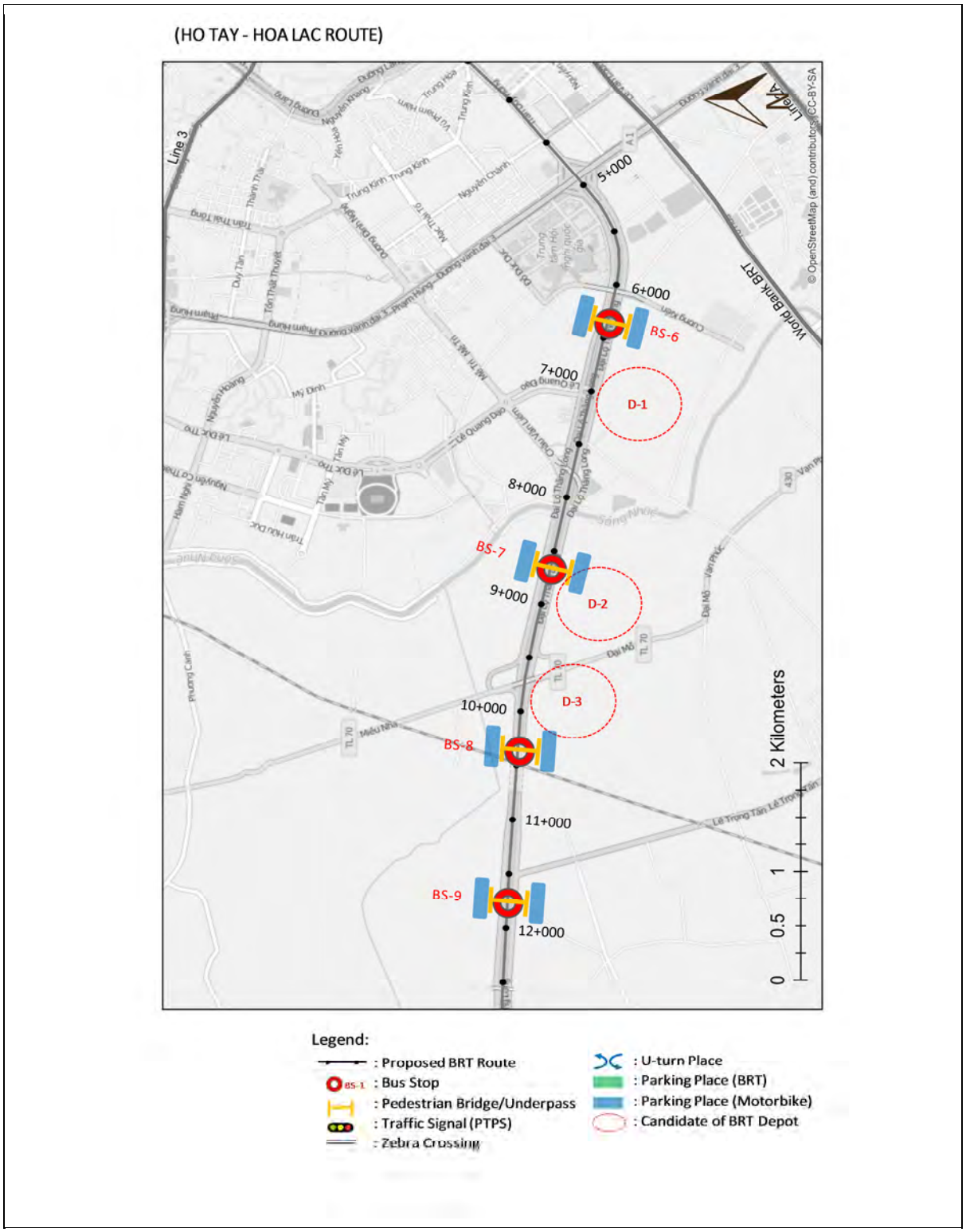
Source: Study Team

Figure 5.2.23 BRT Facilities Layout Map (1 of 9)



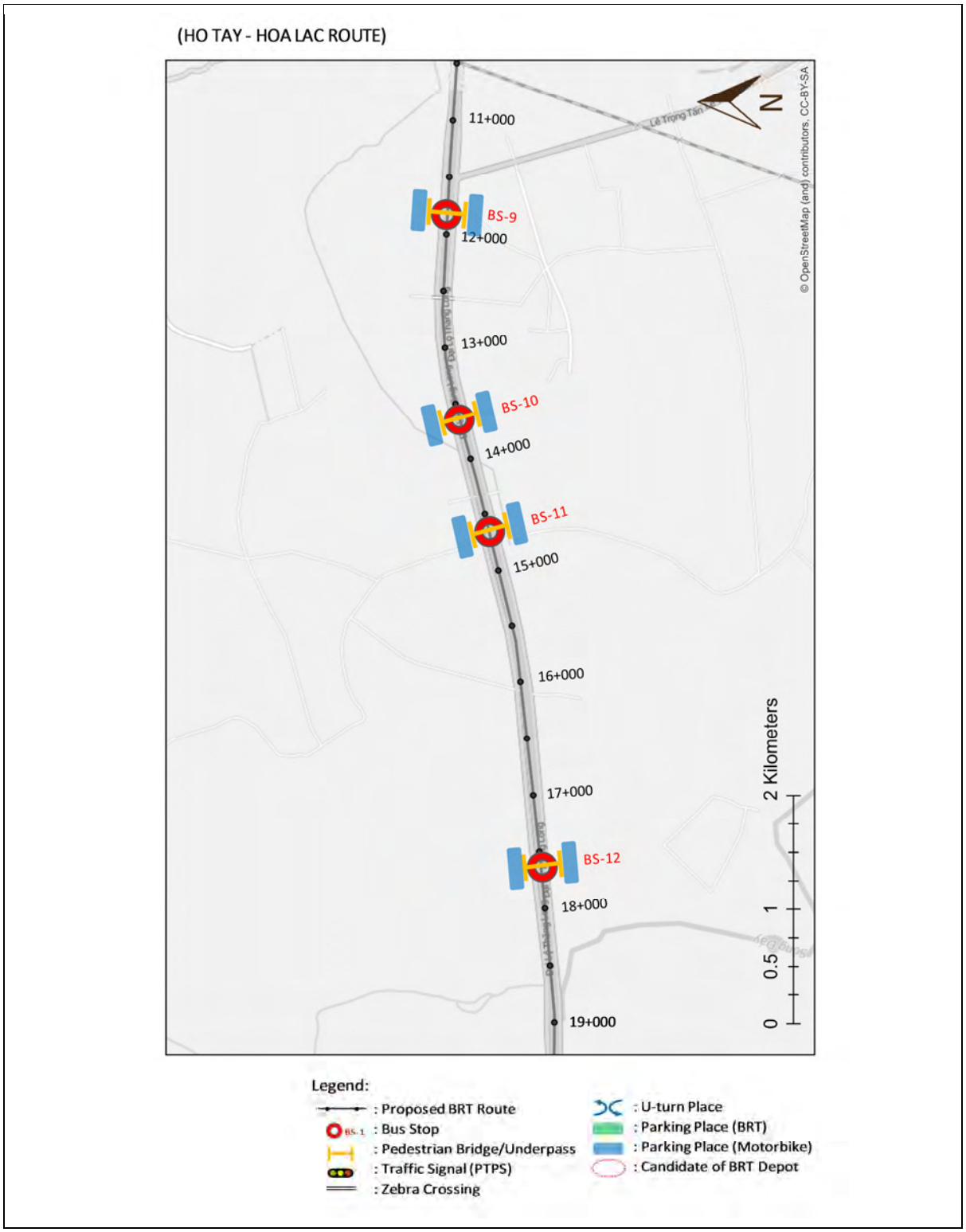
Source: Study Team

Figure 5.2.24 BRT Facilities Layout Map (2 of 9)



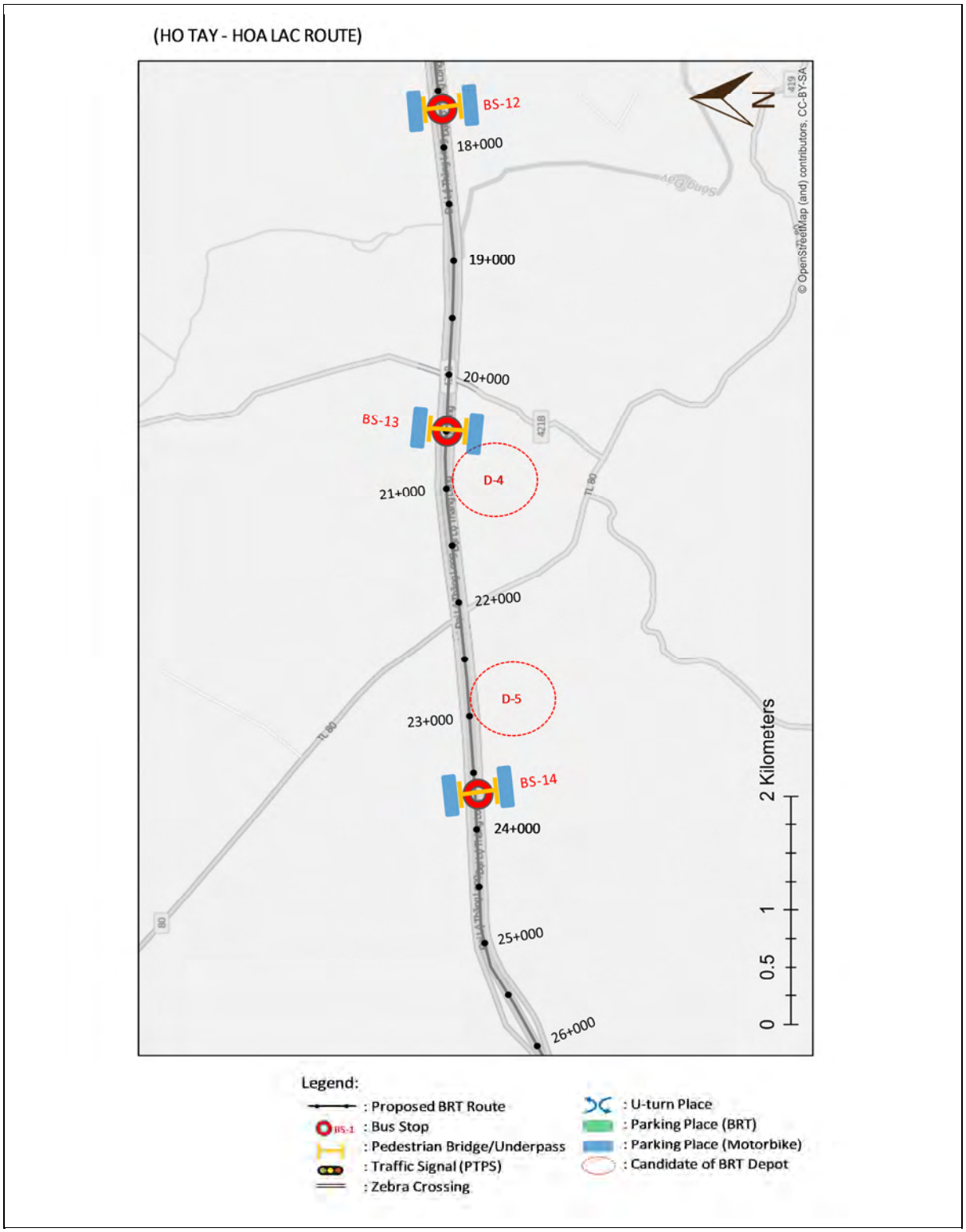
Source: Study Team

Figure 5.2.25 BRT Facilities Layout Map (3 of 9)



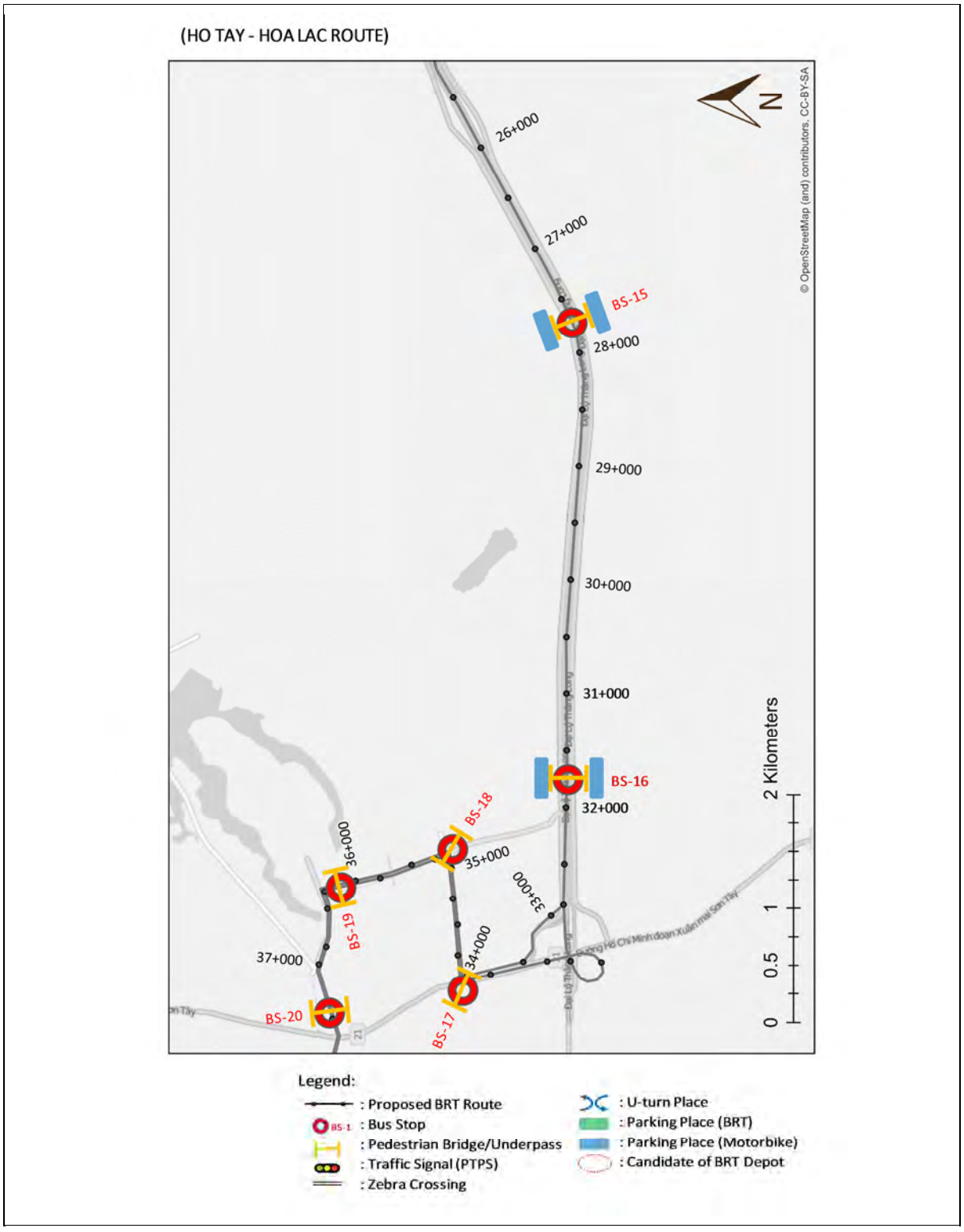
Source: Study Team

Figure 5.2.26 BRT Facilities Layout Map (4 of 9)



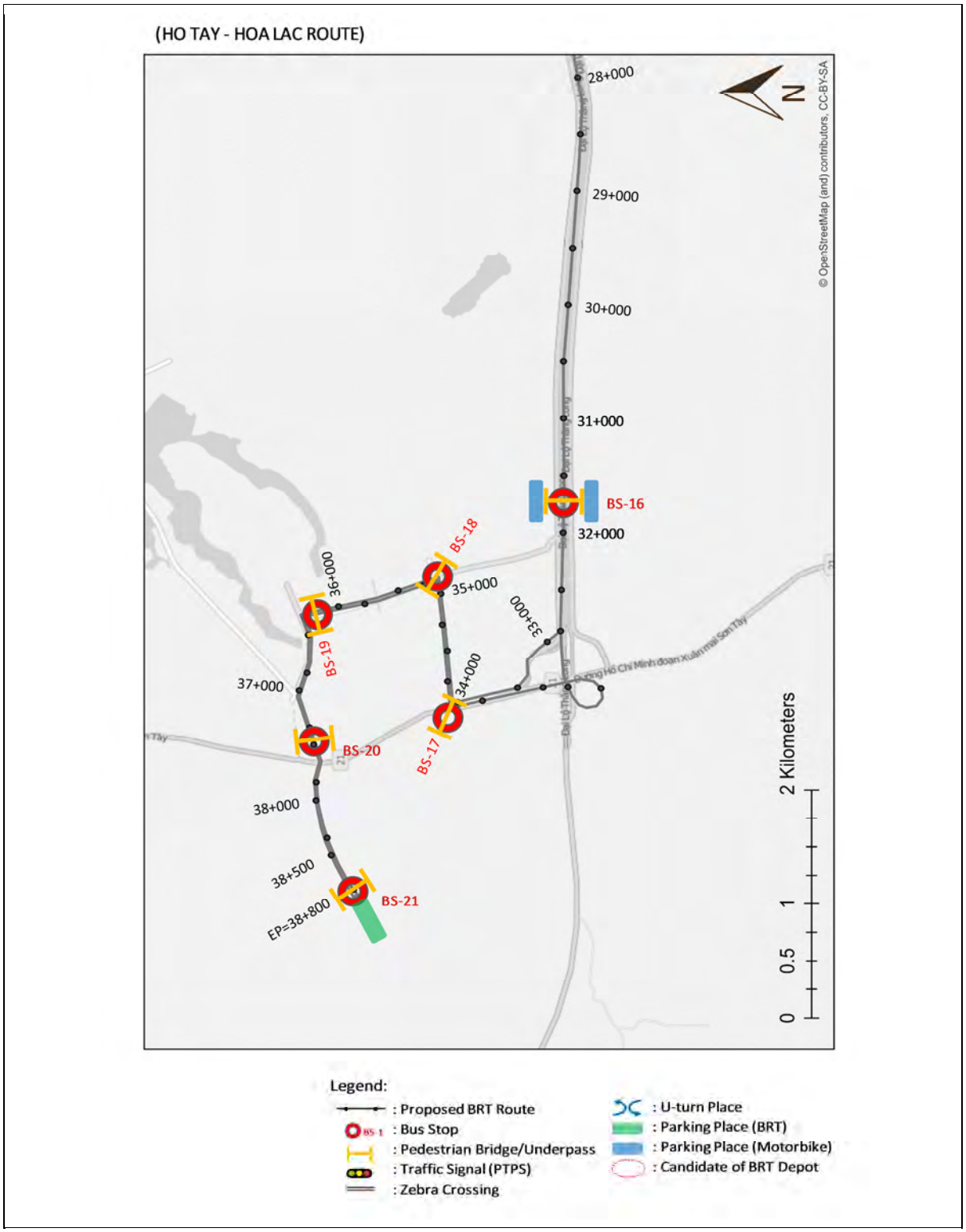
Source: Study Team

Figure 5.2.27 BRT Facilities Layout Map (5 of 9)



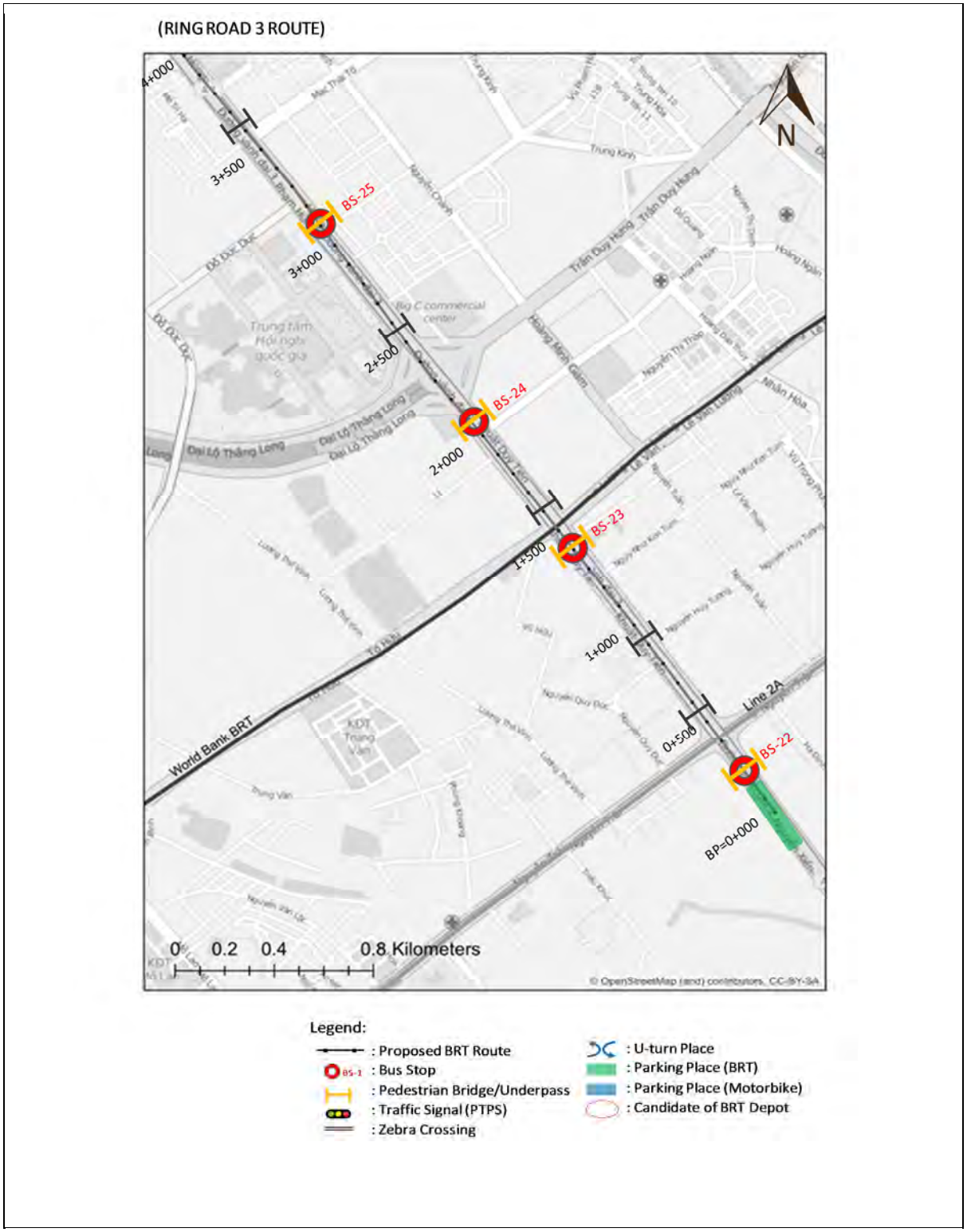
Source: Study Team

Figure 5.2.28 BRT Facilities Layout Map (6 of 9)



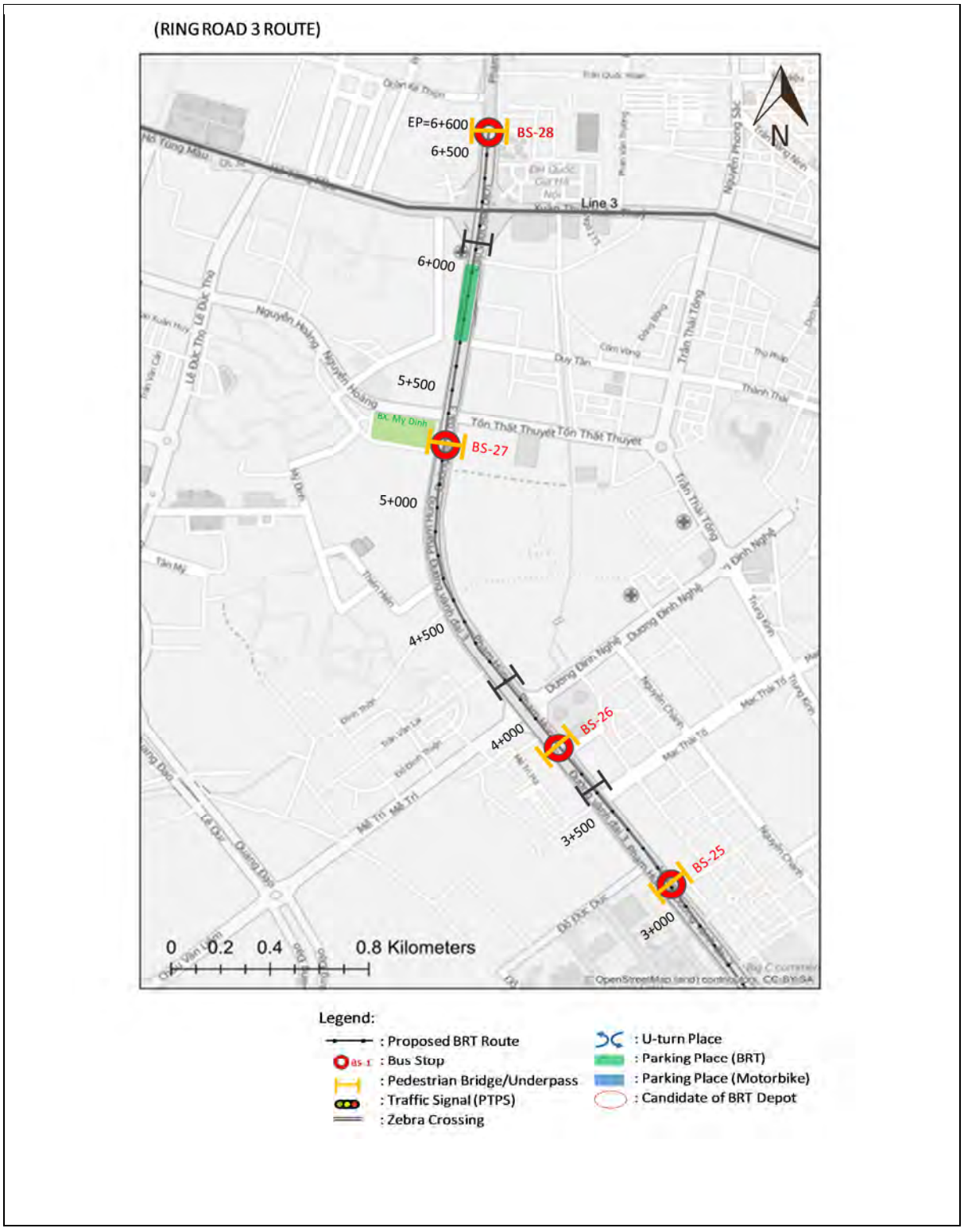
Source: Study Team

Figure 5.2.29 BRT Facilities Layout Map (7 of 9)



Source: Study Team

Figure 5.2.30 BRT Facilities Layout Map (8 of 9)



Source: Study Team

Figure 5.2.31 BRT Facilities Layout Map (9 of 9)

5.2.6 Depot Planning

Depot Planning:
- Depot with 150 bus parking slots in the suburban section
- Parking places with 5 slots at the beginning and ending points of the route for time-schedule adjustment

5.2.6.1 Location and Function of Depot

The required functions of the proposed depot for the BRT system are shown in Table 5.2.5.

Table 5.2.5 Required Depot Facilities

Depo Function		Unit	Quantity		Intended Use
Office	Office	㎡	300		Operation manegement,Ticket Sale office
	Maintenance Office	㎡	200		Maintenance manegement
	Driver Room	㎡	1,500		Dressing and rest room of Drivers
	Meeting Room	㎡	300		
	Warehouse	㎡	200		
	Cafeteria	㎡	500		For Welfare
	Total	㎡	3,000	1/2	3 Floor (Ground Floor is MoterBike Parking)
Maintenance Place	Maintenance Field	㎡	600		For regular inspection and maintenance
	Triple Lift		1		For efficient maintenance of articulated bus
	Maintenance Equipment		1		For efficient maintenance of articulated bus
Covered Garage		㎡	1,200		Storage of unused buses
Parking pavement	For Existing Bus	㎡	10,000	125 buses	（12m×4m≒50㎡）／1 standard bus
	For BRT	㎡	5,200	26 buses	（20m×4m≒80㎡）／1 Articurated bus
	For Driver's Car	㎡	1,950	150 cars	（5m×2.5m≒13㎡）／1 car
	Total	㎡	17,150		
Automatic Washing machine		㎡	600	2 Lane	Automatic, Water strage,drinege facilities
Gas station		㎡	440	4 Lane	For Diesel
Total		㎡	21,490		

Source: Study Team

It is difficult to find a large open space for the required 21,490 m^2 (approximately 150 m x 150 m) in the urban area and a possible candidate location is proposed along the Thang Long Expressway as shown in Figure 5.2.18.
Although urbanization is progressing along the expressway, there are still plenty of open spaces which will not require resettlement of residents. In order to ensure the easy accessibility, the candidate locations of the depot are selected near the interchanges of the expressway and the U-turn facility of the service road of the expressway as proposed in Figure 5.2.18.

(Candidate Location : 5 places along Thang Long Expressway)

(Candidate : Alt-01, Alt-02, Alt-03)

(Candidate : Alt-04, Alt-05)

Source: Study Team

Figure 5.2.32 Proposed Candidate Locations for the BRT Depot

The urbanization of Hanoi is gradually progressing toward the outskirts. The passenger volume of the BRT near the center of Hanoi will be larger than that of the outskirts area and the main passenger demand will be commuters to the center of Hanoi. The BRT should collect these commuters in the morning.

In order to reduce the forwarding distance of buses, the location of the depot should be in the outskirts from the middle point of the expressway. Therefore, the recommended location of the depot is Alt-04 or Alt-05 as shown in Figure 5.2.18.

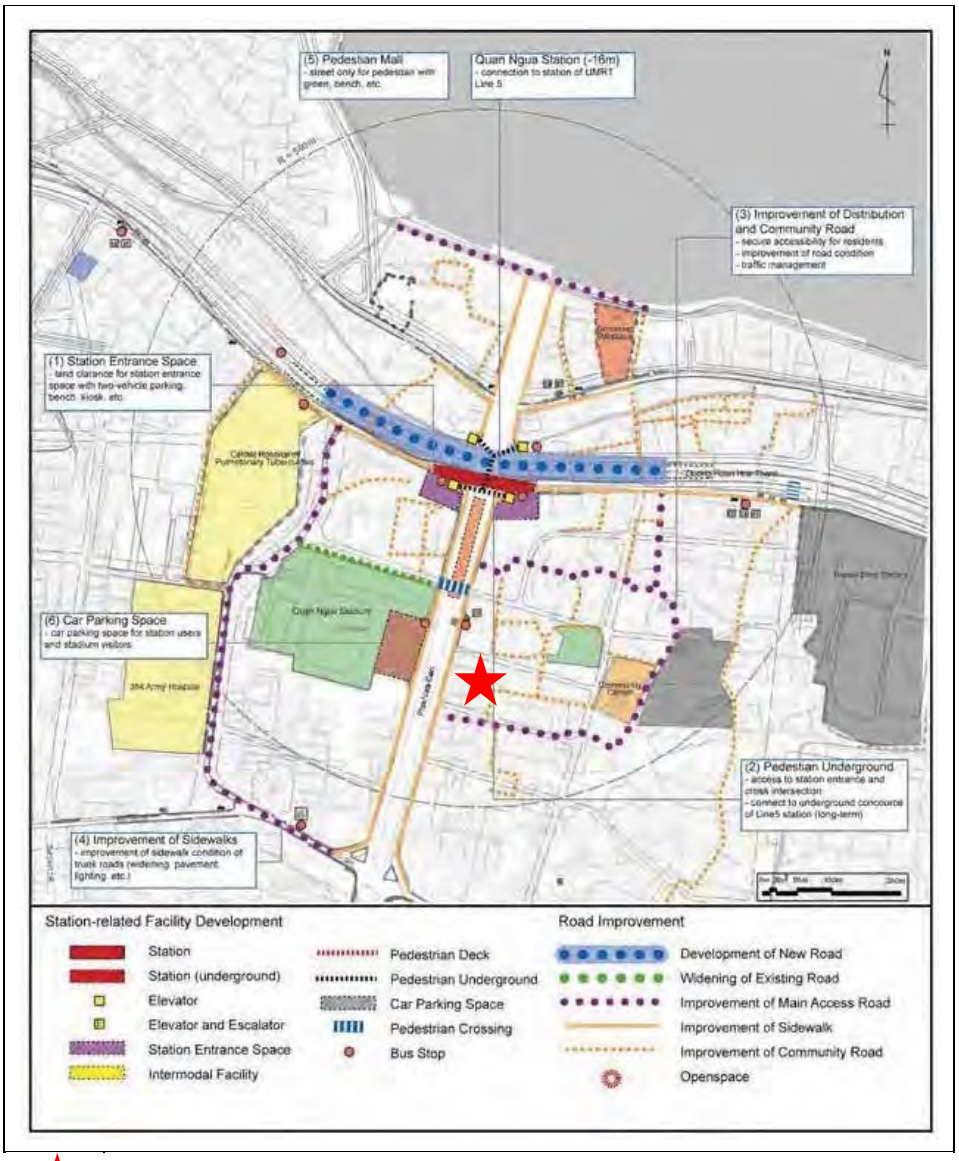
5.2.6.2 Parking Places for Adjustment of the Time Schedule

During the BRT operations, time adjustment might be required to follow the designated tine-schedule of BRT.

In this study, 5 vehicles of waiting buses are assumed. (Waiting time/head interval = 15 minutes/3 minutes interval)

A parking place at the ending point of the route is inside the Hoa Lac High Tech Park of the Vietnam National University campus and plenty of open space will be available.

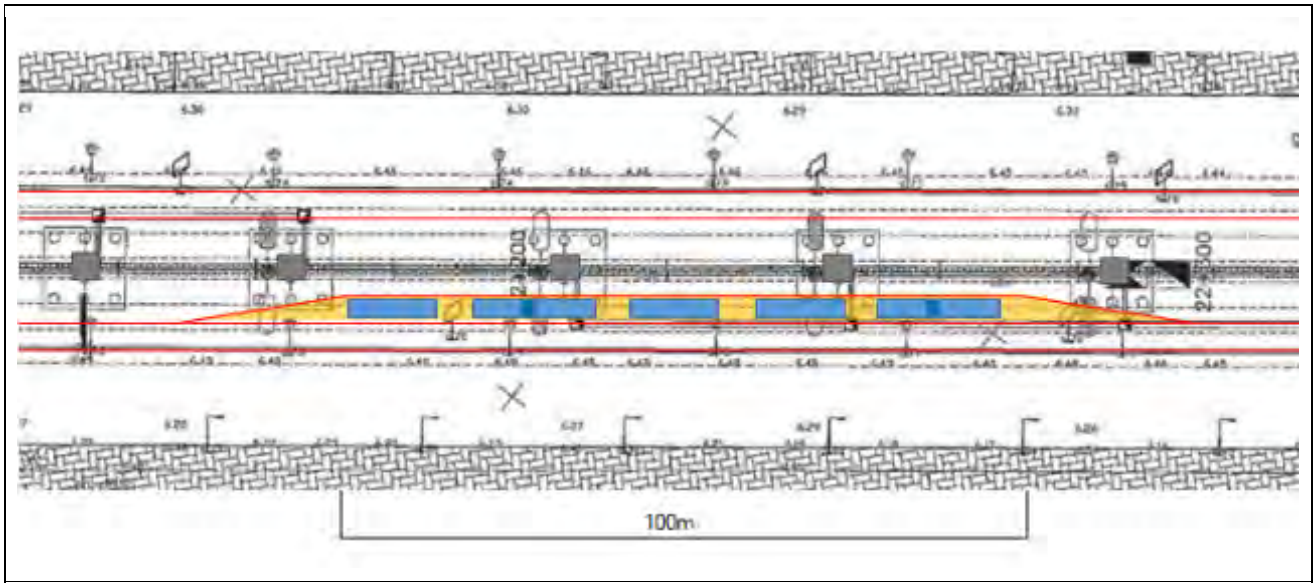
On the other hand, the candidate locations for the parking places in the urban section are proposed as shown below.



: Proposed location of parking place (more than 5 parking slots)

Source: Project for Studying the Implementation of Integrated UMRT and Urban Development for Hanoi in Vietnam (HAIMUD 2)

Figure 5.2.33 Parking Place near Quan Ngua Stadium (OPTION-1, OPTION-2, OPTION-6)



Source: Study Team

Figure 5.2.34 Parking Places for OPTION-4, OPTION-5 and OPTION-6

5.3 Examination of the BRT Operational and Fleet Plan

5.3.1 Assumptions

For the examination of the operational and fleet plan of the BRT, the fare setting for the initial travel demand forecast, locations for the bus stops as well as the rated speed of the vehicles are defined as follows.

5.3.1.1 Setting of the Fare

In the central area of Hanoi, for short distance city public buses, the fare is set at a flat rate of VND 7,000 while for medium length routes, the fare is set at either a flat rate of VND 8,000 or VND 9,000 or the fare is by zone. For this proposed BRT, there are 2 existing bus routes, No. 71 and No. 74. For No. 71, the fare is by zone and from the My Dinh Bus Terminal all the way to Hoa Lac, the fare costs VND 15,000. For No. 74, the fare is set at a flat rate of VND 9,000.

On the other hand, in the METROS study, in 2030, the fares for the UMRT lines are set at VND 20,000 + VND 1,000/km. The premise for this fare setting is that the bus fares in 2030 will be set at a flat rate of VND 10,000 and that the fare of the UMRT is assumed to be double that of buses.

For this proposed BRT, in terms of service and speed, compared to regular buses, it is faster but compared to the UMRT, it is slower. So the fare is set at between the regular public buses and the proposed 2030 UMRT fare at VND 10,000 + VND 500/km.

For the sensitivity analysis of the fares, the UMRT fare was set at VND 20,000 + VND 1,000/km while the regular public buses were set at VND 5,000 + VND 250/km. The patterns for the different fare settings for the travel demand forecast are shown in the following table.

Table 5.3.1 Options for the Different Fare Settings for the BRT for the Travel Demand Forecast

		Fare Setting for the Alternative Routes	Fare Setting Sensitivity Analysis		
Options		**A**	**B**	**C**	**D**
Preconditions	Fore for the regular buses and the World Bank BRT (2030 prices)	10,000 VND (Same as METROS study in 2030)	10,000 VND (Same as METROS study in 2030)	10,000 VND (Same as METROS study in 2030)	10,000 VND (Same as METROS study in 2030)
	Fare for this proposed BRT	10,000 VND + 500 VND/km	5,000 VND + 250 VND/km (30 km = 12,500 VND, around the same fare as existing bus No. 74)	20,000 VND + 1,000 VND/km	16,000 VND + 800 VND/km
	Number of operating buses for existing bus route No. 71 and No. 74	▲50%	▲50%	▲50%	▲50%
BRT (2020 and 2030)		Option-1, Option-2	Option-1, Option-2	Option-1, Option-2	Option-1, Option-2
		Option-3	–	–	–
		Option-4	–	–	–
		Option-5	–	–	–
		Option-6	–	–	–

Source: Study Team

5.3.1.2 Regarding the Location of the Bus Stops

For the bus stops for this proposed BRT, the stops are located roughly in the same location as the stations for the proposed UMRT Line 5, however, in the Hoa Lac area, there are 2 long sections between stations for the proposed UMRT Line 5, so in the case of the BRT, bus stops were added in the middle of these 2 sections.

Figure 5.3.1 BRT Bus Stop Locations between Ho Tay and Ring Ring 3

Figure 5.3.2 BRT Bus Stop Locations between Ring Road 3 and An Khanh

Figure 5.3.3 BRT Bus Stop Locations between Song Phuong and Quoc Oai

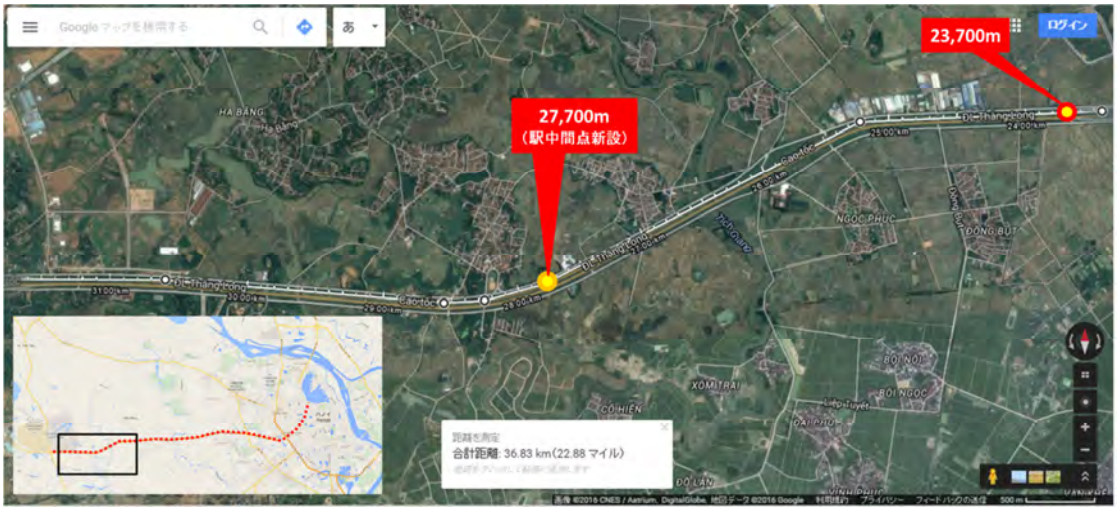


Figure 5.3.4 BRT Bus Stop Locations between West Quoc Oai to Hoa Lac

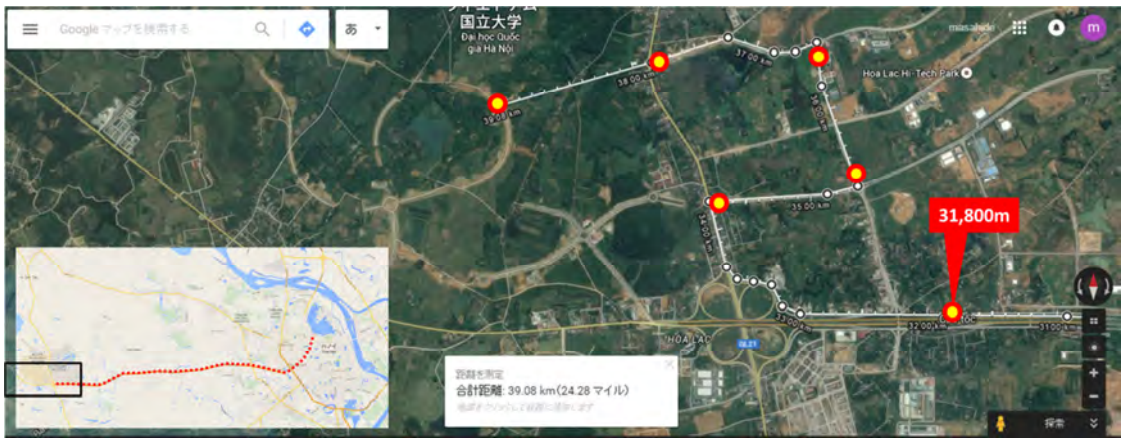


Figure 5.3.5 BRT Bus Stop Locations in the Hoa Lac Area

5.3.1.3 Bus Operating Speed by Section

For the various options, the BRT bus stop location, section length and structure of the bus stops are shown in the following table.

Table 5.3.2 Summary of the BRT Bus Stop Locations, Section Length and Bus Stop Structure for the Various Options

UMRT Phase	BRT Alternative Routes								UMRT Station No.	BRT Station No.	Station Name	Distance (m)	Distance between UMRT Stations	Distance Between BRT Stops	Road Name	Structure of Bus Stops
	Option-1, Option-2	Option-3	Option-4	Option-5		Option-6										
	Ho Tay	Ring Road 3	World Bank BRT	UMRT-2A	UMRT-3	Ho Tay	UMRT-2A	UMRT-3								
-	-	-	-	-	●	-	-	●			Dai Hoc Honoi	4,000		1,000	Duong Vanh Dai 3 (Ring Road 3)	Along the center median
-	-	-	-	-	●	-	-	●			Ben Xe MyDinh	3,000		1,000		Along the center median
-	-	-	-	-	●	-	-	●			Duong Dinh Nghe	2,000		1,000		Along the center median
-	-	-	-	-	●	-	-	●			Hanoi Museum	1,000		1,000		Along the center median
-	-	-	-	●	-	-	●	-			QL6-RR3	2,000		800	Duong Vanh Dai 3 (Ring Road 3)	Along the center median
-	-	-	●	●	-	-	●	-			LeVanLuong-RR3	1,200		1,200		Along the center median
Phase 1	Construction of Entire Line	-	-	-	-	Construction of Entire Line	-	-	Start Pt.	Start Pt.		0				
		-	-	-	-		-	-	RS-1	BS-1	Ho Tay	0	0	0	Van Cao	Along the center median
		-	-	-	-		-	-	RS-2	BS-2	Kim Ma	1,400	1,400	1,400	Lieu Giai	Along the center median
		-	-	-	-		-	-	RS-3	BS-3	Lang Trung	2,400	1,000	1,000	Nguyen Chi Thanh	Along the center median
		-	-	-	-		-	-	RS-4	BS-4	Trung Kinh	3,650	1,250	1,250	Tran Duy Hung	Along the center median
		Construction Up to Ring Road 3, Connect with UMRT Line 8	Construction Up to Ring Road 3, Connection with the World Bank BRT	Construction Up to Ring Road 3, Connection with UMRT Line 2A	Construction Up to Ring Road 3, Connection with UMRT Line 3		Construction Up to Ring Road 3, Connection with UMRT Line 2A	Construction Up to Ring Road 3, Connection with UMRT Line 3	RS-5	BS-5	Trung Hoa	4,200	550	550	Tran Duy Hung (Inside of Ring Road 3)	In the separator strips between the expressway and service road
									RS-6	BS-6	Me Tri	6,400	2,200	2,200	Thang Long Expressway	In the separator strips between the expressway and service road
									RS-7	BS-7	Giao Quang	8,600	2,200	2,200		In the separator strips between the expressway and service road
									RS-8	BS-8	Tay Mo	10,500	1,900	1,900		In the separator strips between the expressway and service road
									RS-9	BS-9	An Tho	11,800	1,300	1,300		In the separator strips between the expressway and service road
									RS-10	BS-10	An Khanh	13,600	1,800	1,800		In the separator strips between the expressway and service road
Phase 2									RS-11	BS-11	Song Phuong	14,600	1,000	1,000		In the separator strips between the expressway and service road
										BS-12		17,600		3,000		In the separator strips between the expressway and service road
									RS-12	BS-13	Quoc Oai	20,500	5,900	2,900		In the separator strips between the expressway and service road
									RS-13	BS-14	West Quoc Oai	23,700	3,200	3,200		In the separator strips between the expressway and service road
										BS-15		27,700		4,000		In the separator strips between the expressway and service road
									RS-14	BS-16	Hoa Lac	31,800	8,100	4,100		In the separator strips between the expressway and service road
–	BRT	BRT	BRT	BRT	BRT	BRT	BRT	BRT	–	BS-17	HHTP-1-QL21	34,300		2,500		On the side of the road
										BS-18	HHTP-2	35,500		1,200		On the side of the road
										BS-19	HHTP-3	36,400		900		On the side of the road
										BS-20	VJU	37,800		1,400		On the side of the road
										BS-21	VNU	38,800		1,000		On the side of the road

Note: The phases for the UMRT Line 5 as well as the station numbers are referenced from the report "The Preparatory Survey on Hanoi City Urban Railway Construction Project (Line 5)", JICA, 2013.
HHTP – Hoa Lac High Tech Park, VJU – Vietnam-Japan University, VNU – Vietnam National University
Source: Study Team

On the Thang Long Expressway, the BRT bus stops are located in pit-style bus stops on the right side of the expressway. Therefore, the buses need leave the expressway to enter the bus stop and merge back with the expressway traffic when leaving the pit-style bus stop. Based on the maximum speed of 70 km/h on the expressway and the long length for the decrease and increase in speed as the bus enters and leaves the pit-style bus stops, the rated speed was calculated.

Inside Ring Road 3, and in the section up to Ho Tay, the buses will run on a new exclusive lane to be installed in the centre median and based on the maximum operating speed of 40 km/h along with the assumption that PTPS will decrease the waiting time of the red signal phases and taking into consideration the length for the decrease and increase in speed as buses stop at bus stops, the rated speed in this section was also calculated.

Furthermore, for the stopping time at each bus stop, taking into consideration fare collection and one man operations, at each of the bus stops, at extra 1 minute was added.

In the METROS study, from the observed average trip length and travel time of buses and based on the effect of bus stopping at bus stops and delays from traffic signals, the average rated speed was set at 17 km/h. For the section of the route within Ring Road 3, if exclusive bus lanes along with PTPS were installed, it would be possible to realize a rated speed of 21 km/h for the BRT.

The rated speed for the various options is shown in the table as follows.

Table 5.3.3 BRT Rated by Section of the Route

BRT Alignment Option:			Option-1. Option-2	Option-3	Option-4	Option-5		Option-6		
Starting Point for Each Option:			Ho Tay	Ring Road 3	World Bank BRT	UMRT-2A	UMRT-3	Ho Tay	UMRT-2A	UMRT-3
Inside Ring Road 3	Stopping Time	(min)	4.0		1.0	2.0	4.0	4.0	2.0	4.0
	Travel Time	(min)	**13.3**		3.4	6.2	12.4	13.3	6.2	12.4
	Distance	(km)	**4.7**		1.2	2.0	4.0	4.7	2.0	4.0
	Rated Speed	(km/h)	21.2		21.2	19.4	19.4	21.2	19.4	19.4
Outside Ring Road 3	Stopping Time	(min)	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
	Travel Time	(min)	**61.5**	61.5	61.5	61.5	61.5	61.5	61.5	61.5
	Distance	(km)	**34.3**	34.3	34.3	34.3	34.3	34.3	34.3	34.3
	Rated Speed	(km/h)	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5
Total	Stopping Time	(min)	19.0	15.0	16.0	17.0	19.0	19.0	17.0	19.0
	Travel Time	(min)	74.8	61.5	64.9	67.7	73.9	74.8	67.7	73.9
	Distance	(km)	39.0	34.3	35.5	36.3	38.3	39.0	36.3	38.3
	Rated Speed	(km/h)	31.3	33.5	32.8	32.2	31.1	31.3	32.2	31.1

Thang Long Expressway	Stopping Time	(min)	**10.0**
	Travel Time	(min)	43.1
	Distance	(km)	27.6
	Rated Speed	(km/h)	38.4

Note: The travel time includes the stopping time
Source: Study Team

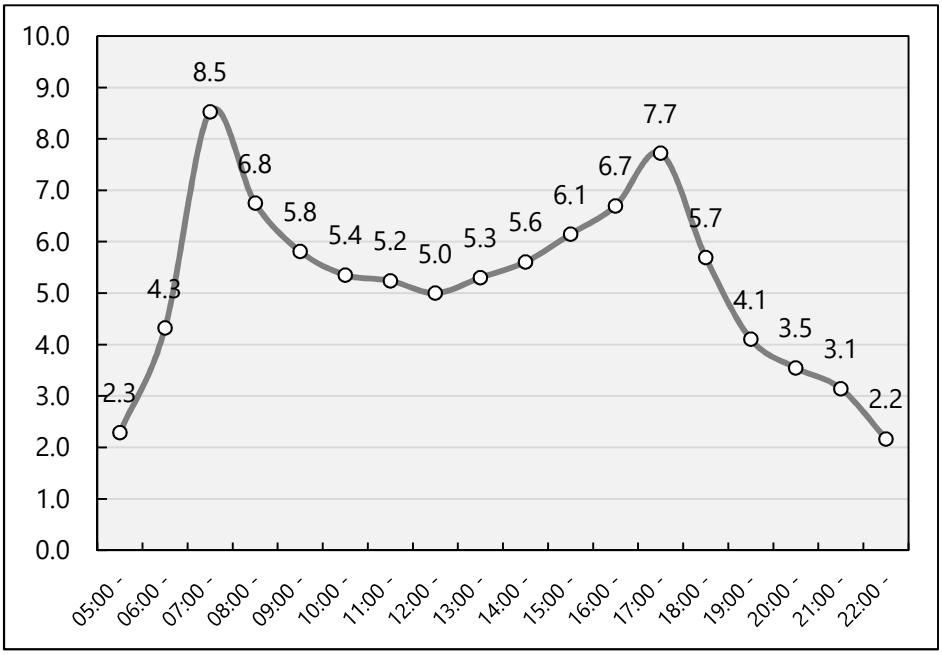
5.3.2 BRT Operational and Fleet Plan

5.3.2.1 Required Number of BRT Vehicles

For this number of BRT vehicles that should be introduced, from the increase in the population along the route of the BRT and the increase in in the number of workers at the Vietnam National University-Hanoi and the Hoa Lac High Tech Park, it is necessary to meet the increased passenger demand. The number of BRT vehicles to be introduced will be based on considering the maximum number of passengers on the vehicles as well as the period of introduction for the BRT.

For the setting of the number of BRT vehicles, based on the estimation of the number of passengers by time period from the travel demand forecast (see Chapter 3), the number of required BRT vehicles was calculated from the peak hour ridership (1 hour of the day with the highest number of ridership).

For the proportion of passengers by time period for 1 day, the time period distribution from the screenline survey of the urban area from the METROS study was referenced to. It was estimated that the demand in the peak period comprised of 10% of the total demand. In the case for the off peak time period, the proportion of the demand was estimated at 7.5% of the total demand so this demand is 75% of the peak time period's demand.



Source: METROS Study

Figure 5.3.6 Traffic Volume by Time Period from the Screenline Survey in the Central Area

For the calculation of the necessary number of BRT vehicles and based on the estimated maximum number of passengers from the travel demand forecast, the following equations were used for the calculation.

$$Number\ of\ Passengers\ at\ the\ Peak\ Hour\ (both\ directions, people)$$
$$= Number\ of\ BRT\ Passengers\ \times Peak\ Hour\ Time\ Period\ Proportion$$

$$Number\ of\ Required\ Vehicles\ at\ the\ Peak\ Hour\ (one\ way, vehicles)$$
$$= Number\ of\ Passengers\ at\ the\ Peak\ Hour\ \div Number\ of\ Passengers\ in\ Each\ Vehicle$$

$$Operating\ Headway\ (minutes) = 60\ minutes\ \div Number\ of\ Required\ Vehicles\ at\ the\ Peak\ Hour$$

$$Number\ of\ Required\ Vehicles\ (vehicles)$$
$$= Number\ of\ Vehicles\ Required\ in\ the\ Peak\ Period$$
$$+ (Round\ Trip\ Time + Round\ Trip\ Time\ for\ the\ Standby\ Vehicle - Peak\ Hour)$$
$$\div Off\ Peak\ Operating\ Headway$$

From the results of the traffic volume survey from the METROS study, the distribution of the passenger demand during the peak hour is not uniform, there is a tendency for passenger demand to be concentrated in 30 minutes and before and after these 30 minutes, the demand is reduced.

As a result, during this 30 min peak time period, it is planned for high carrying capacity articulated buses to be introduced and in the other time periods, it is planned for normal buses to be introduced. Also, during the calculation of the required number of vehicles for operations, unlike trains, operations would be difficult with a passenger load of 100%, so calculation was done for the maximum passenger load of 85% and the registered number of required vehicles also includes 10% for spare vehicles.

In the case where a combination of standard and articulated buses is used, the number of required BRT vehicles is shown in the following table.

Table 5.3.4 Number of Required BRT Vehicles (Combination of Standard and Articulated Buses)

BRT Fare (VND)				10,000 + 500*Distance										5,000 + 250*Distance	
Option				Option 1 & 2		Option 3		Option 4		Option 5		Option 6		Option 1 & 2	
Year				2020	2030	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030
BRT Demand Estimate (Number of passengers per day)				64,844	127,436	22,000	58,000	21,000	88,000	24,000	105,000	87,000	161,000	110,000	196,000
Largest Number of Passengers/direction		A		23,523	42,450	9,100	26,650	8,500	30,850	10,400	43,150	26,556	58,860	40,750	60,850
Number of Passengers at the Peak Hour (Largest number of passengers)		B	A*10%	2,352	4,245	910	2,665	850	3,085	1,040	4,315	2,656	5,886	4,075	6,085
Vehicle Capacity	Articulated Bus	C		140	140	140	140	140	140	140	140	140	140	140	140
	Standard Bus	D		90	90	90	90	90	90	90	90	90	90	90	90
Number of Vehicles Required at the Peak 30 min.	Articulated Bus	E	B/2/C*85%	10	18	4	11	4	13	4	18	11	25	17	26
	Standard Bus	F	B/2/D*85%	15	28	6	17	6	20	7	28	17	38	27	40
Number of Vehicles for the Peak Hour	Total	G	E+F	25	46	10	28	10	33	11	46	28	63	44	66
Headway (minutes)	Peak Hour	H	60/G	2.4	1.3	6.0	2.1	6.0	1.8	5.5	1.3	2.1	1.0	1.4	0.9
	Off-Peak	I	※	2.6	1.5	6.7	2.3	6.7	2.0	5.7	1.4	2.3	1.0	1.5	1.0
1 Way Distance (km)		J		39.0	39.0	34.3	34.3	35.5	35.5	38.3	38.3	39.0	39.0	39.0	39.0
Speed (km/h)		K		31.3	31.3	33.5	33.5	32.8	32.8	31.1	31.1	31.3	31.3	31.3	31.3
Travel Time / 1 Way (minutes)		L	J/K*60	75	75	62	62	65	65	74	74	75	75	75	75
Travel Time / 2 way (minutes)		M	(L+15)*2	180	180	154	154	160	160	178	178	180	180	180	180
Total Number of Vehicles Required for Operations		N	G+(M-60)/I	72	129	25	69	25	85	32	130	81	179	125	186
	Articulated Bus	O	E	10	18	4	11	4	13	4	18	11	25	17	26
	Standard Bus	P	N-O	62	111	21	58	21	72	28	112	70	154	108	160
Total Number of Vehicles Required for the Depot (Includes Reserve Vehicles)		Q	R+S	80	143	29	77	29	95	36	144	90	198	138	205
	Articulated Bus	R	O*1.1	11	20	5	13	5	15	5	20	13	28	19	29
	Standard Bus	S	P*1.1	69	123	24	64	24	80	31	124	77	170	119	176

Note: Equation for calculating the off-peak headway: In the off-peak periods, the standard buses will be operated. Assuming that in the peak period that all operating buses will be standard buses, the peak headway was calculated and an off-peak ratio of 0.75 was applied to the peak headway for standard buses to calculate the off-peak headway.
Source: Study Team

Also, in the case where only standard buses are used, the number of required BRT vehicles is shown in the following table.

Table 5.3.5 Number of Required BRT Vehicles (All Standard Buses)

BRT Fare (VND)				10,000 + 500*Distance										5,000 + 250*Distance	
Option				Option 1 & 2		Option 3		Option 4		Option 5		Option 6		Option 1 & 2	
Year				2020	2030	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030
BRT Demand Estimate (Number of passengers per day)				64,844	127,436	22,000	58,000	21,000	88,000	24,000	105,000	87,000	161,000	110,000	196,000
Largest Number of Passengers/direction		A		23,523	42,450	9,100	26,650	8,500	30,850	10,400	43,150	26,556	58,860	40,750	60,850
Number of Passengers at the Peak Hour (Largest number of passengers)		B	A*10%	2,352	4,245	910	2,665	850	3,085	1,040	4,315	2,656	5,886	4,075	6,085
Vehicle Capacity	Articulated Bus	C													
	Standard Bus	D		90	90	90	90	90	90	90	90	90	90	90	90
Number of Vehicles Required at the Peak 30 min.	Articulated Bus	E	B/2/C*85%	0	0	0	0	0	0	0	0	0	0	0	0
	Standard Bus	F	B/2/D*85%	31	55	12	35	12	41	14	57	35	77	54	80
Number of Vehicles for the Peak Hour	Total	G	E+F	31	55	12	35	12	41	14	57	35	77	54	80
Headway (minutes)	Peak Hour	H	60/G	1.9	1.1	5.0	1.7	5.0	1.5	4.3	1.1	1.7	0.8	1.1	0.8
	Off-Peak	I	※	2.6	1.5	6.7	2.3	6.7	2.0	5.7	1.4	2.3	1.0	1.5	1.0
1 Way Distance (km)		J		39.0	39.0	34.3	34.3	35.5	35.5	38.3	38.3	39.0	39.0	39.0	39.0
Speed (km/h)		K		31.3	31.3	33.5	33.5	32.8	32.8	31.1	31.1	31.3	31.3	31.3	31.3
Travel Time / 1 Way (minutes)		L	J/K*60	75	75	62	62	65	65	74	74	75	75	75	75
Travel Time / 2 way (minutes)		M	(L+15)*2	180	180	154	154	160	160	178	178	180	180	180	180
Total Number of Vehicles Required for Operations		N	G+(M-60)/I	78	138	27	77	27	93	35	142	88	193	135	200
	Articulated Bus	O	E	0	0	0	0	0	0	0	0	0	0	0	0
	Standard Bus	P	N-O	78	138	27	77	27	93	35	142	88	193	135	200
Total Number of Vehicles Required for the Depot (Includes Reserve Vehicles)		Q	R+S	86	152	30	85	30	103	39	157	97	213	149	220
	Articulated Bus	R	O*1.1	0	0	0	0	0	0	0	0	0	0	0	0
	Standard Bus	S	P*1.1	86	152	30	85	30	103	39	157	97	213	149	220

Note: Equation for calculating the off-peak headway: In the off-peak periods, the standard buses will be operated. Assuming that in the peak period that all operating buses will be standard buses, the peak headway was calculated and an off-peak ratio of 0.75 was applied to the peak headway for standard buses to calculate the off-peak headway.
Source: Study Team

5.3.2.2 Operating Plan

The operating plan for 2020 and 2030 for the BRT was calculated based on the peak and off peak operating headway and the required number of vehicles calculated for these 2 time periods as well as considering that the total vehicle occupancy is 85% of the demand and that the operating time is from 5:00 (departure from Vietnam National University-Hanoi) to 24:00 (departure from Ho Tay). The operating plan for the different patterns for a combination of standard and articulated buses and for standard buses only is shown in the following tables.

Table 5.3.6 Number of Operating BRT Vehicles by Time Period in 2020 (Combination of Standard and Articulated Buses)

2020: Option 1 & 2 (Fare = 10,000 + 500×Distance)											
Time Period	5h	6h	7h	8h	9h	10h	11h	12h	13h	14h	Total
Number of Trips (1 way) by Standard Bus	24	15	24	24	15	24	24	15	24	24	213
Number of Trips (1 way) by Articulated Bus		10			6			6			22
Time Period	15h	16h	17h	18h	19h	20h	21h	22h	23h		Total
Number of Trips (1 way) by Standard Bus	24	15	24	24	24	10	11	10	5		147
Number of Trips (1 way) by Articulated Bus		10				6					16
											398

Source: Study Team

Table 5.3.7 Number of Operating BRT Vehicles by Time Period in 2030 (Combination of Standard and Articulated Buses)

2030: Option 1 & 2 (Fare = 10,000 + 500×Distance)											
Time Period	5h	6h	7h	8h	9h	10h	11h	12h	13h	14h	Total
Number of Trips (1 way) by Standard Bus	42	28	42	42	24	42	42	24	42	42	370
Number of Trips (1 way) by Articulated Bus		18			12			12			42
Time Period	15h	16h	17h	18h	19h	20h	21h	22h	23h		Total
Number of Trips (1 way) by Standard Bus	42	28	42	42	42	15	20	17	9		257
Number of Trips (1 way) by Articulated Bus		18				12					30
											699

Source: Study Team

Table 5.3.8 BRT Operating Headway and Number of Services (Combination of Standard and Articulated Buses)

BRT Fare (VND)		10,000 + 500*Distance										5,000 + 250*Distance	
Option		Option 1 & 2		Option 3		Option 4		Option 5		Option 6		Option 1 & 2	
Year		2020	2030	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030
BRT Demand Estimate (Number of passengers per day)		64,844	127,436	22,000	58,000	21,000	88,000	24,000	105,000	87,000	161,000	110,000	196,000
Total Number of Vehicles Required for Operations		72	129	25	69	25	85	32	130	81	179	125	186
Total Required Number of Vehicles		80	143	29	77	29	95	36	144	90	198	138	205
Headway (minutes)	Peak Hour	2.4	1.3	6.0	2.1	6.0	1.8	5.5	1.3	2.1	1.0	1.4	0.9
	Off-Peak	2.6	1.5	6.7	2.3	6.7	2.0	5.7	1.4	2.3	1.0	1.5	1.0
1 Way Distance (km)		39.0	39.0	34.3	34.3	35.5	35.5	38.3	38.3	39.0	39.0	39.0	39.0
Speed (km/h)		31.3	31.3	33.5	33.5	32.8	32.8	31.1	31.1	31.3	31.3	31.3	31.3
Travel Time / 1 Way (minutes)		75	75	62	62	65	65	74	74	75	75	75	75
Number of Trips (1 way)	Standard Bus	360	627	139	409	139	473	170	643	406	868	623	903
	Articulated Bus	38	72	14	40	14	47	14	72	43	98	61	97
	Total	398	699	153	449	153	520	184	715	449	966	684	1,000
Number of Trips (Roundtrip)		796	1,398	306	898	306	1,040	368	1,430	898	1,932	1,368	2,000
Total Running Distance (km/day)	Standard Bus	28,080	48,906	9,535	28,057	9,869	33,583	13,022	49,254	31,688	67,704	48,594	70,434
	Articulated Bus	2,964	5,616	960	2,744	994	3,337	1,072	5,515	3,354	7,644	4,758	7,566
	Total	31,044	54,522	10,495	30,801	10,863	36,920	14,094	54,769	35,042	75,348	53,352	78,000

Source: Study Team

Table 5.3.9 Number of Operating BRT Vehicles by Time Period in 2020 (Standard Buses Only)

2020: Option 1 & 2 (Fare = 10,000 + 500×Distance)											
Time Period	5h	6h	7h	8h	9h	10h	11h	12h	13h	14h	Total
Number of Trips (1 way) by Standard Bus	24	31	24	24	24	24	24	24	24	24	247
Number of Trips (1 way) by Articulated Bus											0
Time Period	15h	16h	17h	18h	19h	20h	21h	22h	23h		Total
Number of Trips (1 way) by Standard Bus	24	31	24	24	24	19	11	10	5		172
Number of Trips (1 way) by Articulated Bus											0
											419

Source: Study Team

Table 5.3.10 Number of Operating BRT Vehicles by Time Period in 2030 (Standard Buses Only)

2030: Option 1 & 2 (Fare = 10,000 + 500×Distance)											
Time Period	5h	6h	7h	8h	9h	10h	11h	12h	13h	14h	Total
Number of Trips (1 way) by Standard Bus	42	55	42	42	42	42	42	42	42	42	433
Number of Trips (1 way) by Articulated Bus											0
Time Period	15h	16h	17h	18h	19h	20h	21h	22h	23h		Total
Number of Trips (1 way) by Standard Bus	42	55	42	42	42	33	20	17	9		302
Number of Trips (1 way) by Articulated Bus											0
											735

Source: Study Team

Table 5.3.11 BRT Operating Headway and Number of Services (Standard Buses Only)

BRT Fare (VND)		10,000 + 500*Distance										5,000 + 250*Distance	
Option		Option 1 & 2		Option 3		Option 4		Option 5		Option 6		Option 1 & 2	
Year		2020	2030	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030
BRT Demand Estimate (Number of passengers per day)		64,844	127,436	22,000	58,000	21,000	88,000	24,000	105,000	87,000	161,000	110,000	196,000
Total Number of Vehicles Required for Operations		78	138	27	77	27	93	35	142	88	193	135	200
Total Required Number of Vehicles		86	152	30	85	30	103	39	157	97	213	142	220
Headway (minutes)	Peak Hour	1.9	1.1	5.0	1.7	5.0	1.5	4.3	1.1	1.7	0.8	1.1	0.8
	Off-Peak	2.6	1.5	6.7	2.3	6.7	2.0	5.7	1.4	2.3	1.0	1.5	1.0
1 Way Distance (km)		39.0	39.0	34.3	34.3	35.5	35.5	38.3	38.3	39.0	39.0	39.0	39.0
Speed (km/h)		31.3	31.3	33.5	33.5	32.8	32.8	31.1	31.1	31.3	31.3	31.3	31.3
Travel Time / 1 Way (minutes)		75	75	62	62	65	65	74	74	75	75	75	75
Number of Trips (1 way)	Standard Bus	419	735	160	472	160	545	193	755	472	1,018	719	1,052
	Articulated Bus	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**419**	**735**	160	472	160	545	193	755	472	1,018	719	1,052
Number of Trips (Roundtrip)		838	1,470	320	944	320	1,090	386	1,510	944	2,036	1,438	2,104
Total Running Distance (km/day)	Standard Bus	32,682	57,330	10,976	32,379	11,360	38,695	14,784	57,833	36,816	79,404	56,082	82,056
	Articulated Bus	0	0	0	0	0	0	0	0	0	0	0	0
	Total	32,682	57,330	10,976	32,379	11,360	38,695	14,784	57,833	36,816	79,404	56,082	82,056

Source: Study Team

From the above, in the case where a combination of articulated and standard buses are introduced for BRT operations, the number of required vehicles is less than the case for all standard buses. However, the vehicle investment cost will be higher while the total running distance (operating cost) will be less. On the other hand, in the case where all standard buses are introduced, the number of required vehicles will be more than the case for the combination of articulated and standard buses but the vehicle investment cost will be lower and the total running distance (operating cost) will be greater.

Based on the comparison between the sum of the vehicle investment cost and operating cost for the two options, the case of the combination of articulated and standard buses is just 3% higher than the case for all standard buses.

However, from continued economic growth in Vietnam, it is expected that labour costs (which form a portion of the operating costs) will rise. The option of a combination of articulated and standard buses will require less bus drivers and so in this case, the vehicle investment cost and operating cost can be reduced compared to the case of all standard buses.

For this reason, the estimated project costs will only be calculated for the case of the combination of articulated and standard buses.

5.3.2.3 Fleet Plan

(1) Location of the Doors of the BRT Vehicles

For BRT systems in various countries, depending on the cross section of the exclusive lane and the location of the bus stops, the following table shows the various types of BRT vehicles with different configurations for the location of the doors. On the other hand, for regular buses that operate on regular city streets, for driving on the right hand side of the road, the doors for bus vehicles are located on the right side of the bus.

Table 5.3.12 Type of Bus Vehicles by Location of the Doors

Door Location	Characteristics	Cross Section of the BRT Route
Right Side Door	Merit ① In addition to BRT exclusive lanes, it is possible to allow passengers to board and alight on regular bus stops ② For one man operations of the bus, the driver can visually confirm the opening and closing of the doors for safety ③ Regular city buses can run on the exclusive BRT lanes to allow passengers to board and alight	① The BRT exclusive lane needs to be located on the side of the road next to the sidewalk ② If the BRT exclusive lane is located on the center median, then the bus stops must be located at both sides (right of the lane). If the width of the road is insufficient, the locations of the bus stops would be located in a staggered position (not facing each other). Example from Seoul. ③ If center island bus stops is installed for the center median of the road, then the BRT needs to operate on the opposite direction of regular traffic
	Demerit ① In the case of one man operations, for the collection of cash fares, the driver has to spend time and effort and therefore the rated speed is decreased	
Left Side Door	Demerit ① Not possible to allow passengers to board and alight on regular bus stops ② Due to no mass production, the price of the vehicles could rise due to the need for modifications and certification from the country for this type of bus is necessary ③ In the case of one man operations, it is not possible to collect fares on board ④ For one man operations, not possible to install equipment to confirm for safety for the doors in the interior and exterior of the buses (direct viewing mirrors). There are no examples in Japan of this.	For center island bus stops in the center median, the BRT exclusive lanes would be located on either side of the island and the BRT vehicles would operate on the same direction as the regular traffic
Doors on Both Sides	Merit ① In addition to BRT exclusive lanes, it is possible to allow passengers to board and alight on regular bus stops ② If fare collection/payment is done at the bus stops/stations, then the bus stopping time is decreased	For center island bus stops in the center median, the BRT exclusive lanes would be located on either side of the island. However, in the case of one man operations, for fare collection, fare gate equipment is necessary and construction of such equipment in the bus stops is necessary.
	Demerit ① Due to no mass production, the price of the vehicles could rise due to the need for modifications and certification from the country for this type of bus is necessary ② In the case of one man operations, if there are no facilities for fare collection at the bus stops, then it is not possible to collect fares on board (because of the left side doors) ③ For one man operations, not possible to install equipment to confirm for safety for the doors in the interior and exterior of the buses (direct viewing mirrors). There are no examples in Japan of this.	

Source: Study Team

For the proposed BRT, in the section from Ho Tay to Ring Road 3, the location of putting the BRT exclusive lane on the center median was examined and on this section of the route, it is desirable for regular public buses to share the usage of the BRT exclusive lane with the BRT vehicles.

Because regular public buses have doors on the right side of the bus vehicles, it is not possible to share usage of center median island bus stops. However, if the bus stops were located on either side of the BRT exclusive lane (facing each other) or if the bus stops were located in the staggered position (not facing each other), then it would be possible to share the bus stop facilities between the BRT and the regular public buses.

Source: Study Team

Figure 5.3.7 Opposite Facing Bus Stops on the BRT Exclusive Lane in Seoul, South Korea

Therefore, for this proposed BRT, it is desirable to use non-custom buses with doors on the right side instead of custom bus vehicles with doors on both sides of the vehicle.

(2) Type of Buses

There are two types of buses that are currently produced in every country in the world and they are standard buses and articulated buses and the characteristics are shown in the following table. Standard buses are used in the urban areas of every country in the world and since standard buses are produced on a larger scale, volume-wise, they are cheaper than articulated buses. However, the passenger carrying capacity of standard buses is limited so during the peak demand time period, many numbers of standard buses are needed for operations.

On the other hand, articulated buses have a passenger carrying capacity that is 1.5 to 2 times that of standard buses. However, due to the traffic environment and the legal constraints with regards to the maximum size of buses, there are countries where articulated buses are not widely used. Compared to standard buses, the price for articulated buses is higher because they are not produced in large volumes.

Table 5.3.13 Type of Buses for the BRT

Type	Standard Bus	Articulated Bus
Appearance		
Length	10.5 m-12 m	18 m-20 m
Number of Doors (for 1 side)	2-3	3-4
Vehicle Capacity	60-90 (Seats = 23-38)	140-170 (Seats = 42-58)

Source: Study Team

(3) Floor Height and Step Type for the Bus Vehicles

For the proposed BRT, for the sharing of bus stops with regular buses and for recommending the introduction of mass produced bus vehicles with doors on the right side, examination of the floor height and step type for center median bus stops will be excluded.

Currently, among the types of vehicles produced around the world, there are 3 types of buses based on the floor height and they are categorized as “two-step, one-step and no-step”. In developed countries, the proportion of elderly people among the entire population has increased and in order to eliminate barriers for disabled people, barrier-free public facilities are required in society.

With regards to the characteristics of the 3 types of floor heights for buses, they are shown in the following table. The “no-step” vehicle was developed for the purposes of following the barrier-free concept and so the structure of this vehicle is that it is easy for passengers to get on and off the bus. In comparison with the typical two-step bus, the structure of the no-step bus is more complicated so the no-step bus is more expensive.

For example, in Japan, there are subsidies by government agencies to promote the barrier-free concept in a legal aspect. If bus operators wish to purchase a no-step bus vehicle, the bus operators can receive the difference between the purchase price of the two-step and no-step vehicles.

In Vietnam, depending on the construction of public transport facilities, it is assumed that the current young generation of motorbike users would use public transport in the future. However, for the time being, there are not urgent needs in society for barrier-free facilities.

However, it is likely that the average age of Vietnam will rise and the number of elderly people to increase from now onwards. Along with steadily promoting modal shift, it is necessary to promote the barrier-free concept from the viewpoint of preventing passengers from falling when boarding and alighting the bus. Also, for the current bus vehicles used in Hanoi, the one-step buses are already commonly seen.

From the above, although there are no problems in initially introducing one-step bus vehicles, in the future, there should be an aim to introduce no-step bus vehicles.

Furthermore, as of July 2016, there are no no-step buses in operation in Hanoi and there are no subsidies for the purchase of buses (including one-step buses). On the other hand, the subsidy policy in Hanoi as mentioned in Section 2.9.4 is based on covering the difference between the farebox revenue and the operating cost of each bus route. The operating cost includes the depreciation for purchased bus vehicles.

Table 5.3.14 Difference in Steps for BRT Vehicles

	Two-step	One-step	No-step
Appearance:			
Floor Height:	800 mm-1,100 mm	500 mm-600 mm	300 mm-382 mm
Features:	• Since there are 2 steps at the entrance, boarding the bus becomes a barrier for disable persons and the elderly • For elderly persons, it takes time to board and accidents regarding falls occurs • The floor is level for the entire vehicle • Installing seats over the tire assembly of the bus is easy	• Getting on and off is easy because there is no less step than the two-step bus • At the rear of the vehicle, there is an extra step (the floor is not level for the entire bus vehicle)	• Because there is no step in the entrance of the bus, getting on and off is easy for anyone • If the bus stops beside the curb of the road, there is no grade difference between the height of the curb and the interior of the bus • The vehicle is lowered via the tilting function that is enabled by air suspension • At the rear of the vehicle, there are two steps • The minimum ground clearance is low and if the difference in grade between the approach and departure angle is high, then the road needs to be modified
For Wheelchair Users	• Requires installation of a lift, if a lift is not installed, 4 people are required to lift the wheelchair up to the bus	• From the installation of a slope plate, wheelchair users are able to board the bus, the slope plate is installed by fixing a bracket to the vehicle floor	• From the installation of a slope plate, wheelchair users are able to board the bus, the slope plate is installed by fixing a bracket to the vehicle floor
Cost:	Around 18-20 million yen	Around 22-25 million yen	Around 24-27 million yen

Source: Study Team

(4) Regarding the Regulation of Emissions for the Selection of Vehicles

In Hanoi, from the increasing numbers of motorbikes and cars, concentrations of particulate matters as well as carbon dioxide levels are going over the environmental baseline in multiple locations and air pollution is becoming a serious problem because of vehicle emissions.

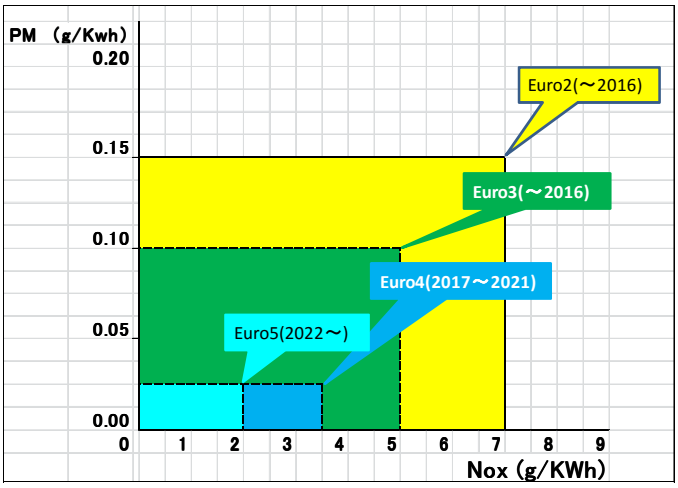
In Vietnam, the road map (work schedule) for toughening the regulation of vehicle emissions is based on Decision 49/2011/QD-TTg from the Prime Minister dated January 2011. In this decision, for vehicles produced in Vietnam and for imported vehicles, the European "Euro 4" vehicle emissions standard is due to be applied from January 2017. Furthermore, the "Euro 5" standard is due to be applied from January 2022.

In the case of the implementation of this proposed BRT, the implementation period is around 2020, so for the proposed BRT, bus vehicles with engines that meet the "Euro 4" emissions standard need to be supplied.

When procuring a diesel engine that meets the "Euro 4" emissions standard, there is a possibility that the low sulfur diesel fuel which is good for the performance of the diesel engine may not be supplied, so when considering the selection of the diesel engine bus vehicle, the vehicle manufacturer as well as the supplier of the refined diesel need to be carefully consulted with.

(In Japan, based on the new long term regulation from the 2007 vehicle emissions standard, the "Euro 4" level was enforced since 2005 and oil refiners have supplied the low sulfur diesel fuel which is suitable for this type of engine)

Furthermore, in Vietnam with regards to the compressed natural gas (CNG) engine buses which are more environmentally friendly and are currently being diffused in Ho Chi Minh City, because the stable supply of CNG from the origin to Hanoi is far, at this moment, CNG buses are not expected to be widely used in Hanoi. Therefore, CNG buses are excluded as a candidate for the procurement of BRT vehicles.



Source: Study Team

Figure 5.3.8 Road Map for Vehicle Emissions Standards in Vietnam

(5) Vehicle Specification

For the implementation of this proposed BRT, the specification (vehicle size, capacity, chassis structure, engine) of standard buses and articulated bus vehicles in Vietnam is shown in the following table for bus vehicles that can be procured via domestic production or from import.

Table 5.3.15 Vehicle Specifications for Standard and Articulated Buses in Vietnam

		一般バス Normal Bus	連節バス Articulated Bus
Overall dimension	Length	11～11.5 m	18～20 m
	Width	～2.5 m	2.5～2.55 m
	Height	～3.3 m	～3.3 m
Kerb weight of vehicle		11 t	17 t
Gross vehicle weight		16 t	24.5 t
Axle weight(Kg)	Front	6 t	6.5 t
	Centre	-	6 t
	Rear Drive	10 t	～12 t
Max speed		100 Km/h	70 Km/h
Minimum Turning Radius		9 m	9.5 m
Passenger Capacity	Seats	35	20+25=45
	Standing	45	55+30=85
	Total	80	130～140
Floor Steps	Two Steps	○	-
	One Step	○	○
	Non Step	○	○
Engine-Type	Diesel / CNG	Deisel ／ CNG	Deisel ／ CNG
	Displaement	11,000～12,000 CC	11,000～12,000 CC
	Output	210 Kw／2000 rpm	260 Kw／2000 rpm
	Max.torque	1100 N･m／1400 rpm	1600 N･m／1100 rpm
Suspension	Reaf／Air	Reaf spring / Air Suspension	Air Suspension

Source: Study Team

(6) Procurement and Maintenance

Regarding the source for the vehicle specification for standard buses as stated in the previous section, in Vietnam, the Saigon Transportation Mechanical Corporation (SAMCO) and the Truong Hai Auto Corporation (THACO) imported engine chassis for buses made by Hyundai and Daewoo of South Korea to assemble the vehicle bodies.

On the other hand, although the market share of bus vehicles from Japanese manufacturers is low, Hino Motors has imported engines and chassis for right hand drive vehicles for assembly in Vietnam and these parts are assembled, manufactured and sold by SAMCO and THACO.

Also, with regards to the specification for articulated buses, the study team received a reply from the Mitsubishi Fuso Truck and Bus Corporation which has a track record of delivering Mercedes Benz Citaro G bus vehicles in Japan and the company says that it could export them to Vietnam or outsource the sales to its affiliate, Mercedes-Benz Vietnam.

With regards to the maintenance and management of buses, there is a sufficient after service organization for buses manufactured by Hyundai because they occupy an overwhelming share of the bus vehicles market in southern Vietnam. Also, Mercedes-Benz Vietnam is able to supply parts. The company can offer after service because it sells the bus vehicles made by Mitsubishi Fuso Truck and Bus Corporation.

Also, in addition to bus vehicles, passenger information systems and onboard equipment such as fare collection machines and driver recorders for preventing crimes are necessary. These types of equipment can be locally procured in Vietnam.

5.4 Examination of the Operations Management and Fare Collection Systems

5.4.1 Operations Management

5.4.1.1 Operations Management from Utilizing Distance Tracking Devices (In Vehicle GPS)

In Vietnam, based on Article 12 of Government Decree No. 91/2009/ND-CP, from 2012 onwards, all new bus vehicles are required to have distance tracking devices such as in-vehicle GPS.

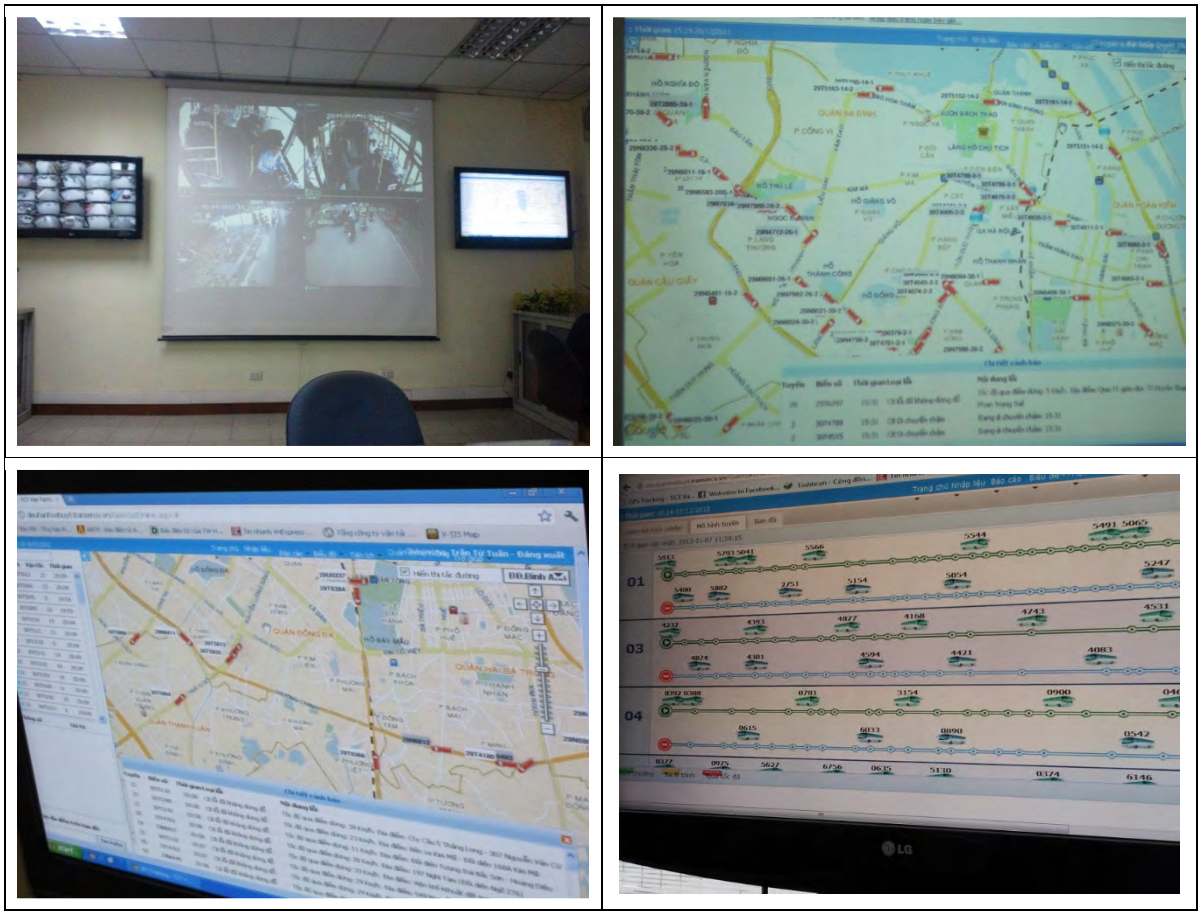
From the installation of in-vehicle GPS devices, the location data for each bus can be periodically sent to a server and from accessing a website, the location of the buses can be tracked in real time via Google Maps.

In Hanoi for TRANSERCO, the operations management department has already implemented the real time system for the confirmation of operating conditions.

The functions from the GPS devices that can be used for operations management are as follows:

1) Confirmation of the bus stop locations and the operating conditions of the bus
2) Warnings if the speed goes over the specified limit
3) Departure/arrival scheduling, calculation of the bus speeds and travel time, determining the headways of routes, number of stops and the time for the opening the closing of doors (in the case if this system is introduced for 1,000 vehicles, the annual cost would be VND 1 billion)

Because the distance tracking devices are required by law, in this proposed BRT, it is possible implement the same system.



Source: Study Team

Figure 5.4.1 TRANSERCO Bus Operating Centre

5.4.1.2 Operations Management from Utilizing In Vehicle Bus Cameras

In Hanoi, Ho Chi Minh City as well as Binh Duong Province, a portion of buses has 4 in-vehicle high precision cameras installed. TRANSERCO in Hanoi has installed in vehicle cameras in buses where video can be sent back to the bus operations surveillance division in real time via mobile data and multiple monitors in the control center can monitor the road traffic conditions as well as the situation inside the bus vehicle. Through this system, the safety conditions inside the bus, customer service of the driver and conductor as well as the manners of the passengers can be monitored.

Source: Study Team

Figure 5.4.2 Bus In-Vehicle Camera

Also, for the BECAMEX TOKYU BUS in Binh Duong Province, 5 cameras are installed on buses for crime prevention: 2 inside the vehicle, 3 facing the outside (1 installed inside the bus and 2 installed on the exterior of the bus). The cameras normally record video and if a traffic accident occurs, the video can be downloaded from the hard drive and the reasons for the traffic accident can be analyzed so train the bus driver to prevent the same thing from happening again.

The method of collecting recorded video data like for the BECAMEX TOKYU BUS is standard practice among the bus operators of Japan. However, the method of Hanoi where the video data is sent by mobile data back to a control center is not implemented in Japan.

Source: Study Team

Figure 5.4.3 Monitoring of the Bus via the In-Vehicle Cameras

For the confirmation of the stable bus operations in Japan, from the introduction of a bus navigation service that utilizes GPS for passengers, the bus operations center can view data that is only viewable for bus operators. From this, the bus operations center can confirm the operating conditions on every bus route by bus number.

Also, for the road congestion information, via intelligent transport systems, the congestion condition as well as the traffic information can be viewed by the Internet.

From the introduction of the bus navigation service, a fixed regular cost for data communications is required. However, the data transmission volume from real time cameras is large but there is a low necessity for real time camera tracking, so in reality the cost burden for data communications is low.

With regards to the confirmation of the operating conditions, the distance tracking devices (in vehicle GPS) is sufficient for this purpose. It is desirable that the bus cameras be used for the purpose of preventing traffic accidents in an ex-post evaluation and not for sending real time data to a centralized operations center.

5.4.2 Fare Collection System

5.4.2.1 Fare Collection in Vietnam and Future Trends

The fare collection method in Hanoi currently is that first, the passenger pays cash to the conductor in the bus, then, passengers receive from the conductor receipt (ticket) based on the laws and regulations. In the buses of Ho Chi Minh City, one-man operation is gradually being introduced where the fare box is installed on the driver's seat side of the entrance. After the passengers have put cash in the fare box, the driver distributes the receipts (ticket) to passengers. The drivers' burden also increases for one man operations because the driver also needs to return the change to passengers if the passengers do not pay the exact amount.

Even in developed countries, prior to economic growth, fare collection by the conductor had been implemented. However, from the fact that labor costs was raised along with the rapid economic growth of the past, profitability of the bus business has deteriorated and bus operators changed to one-man operation of only the driver. In order to improve the efficiency, automation of fare collection has been promoted.

For the fare collection system in each country, the situation is different depending on the type of bills and coins of each country, but in the case of Japan, automation has progressed steadily for buses. In the fare collection machines of Japan, it is possible to return the change from the bill and coins and to exchange coins from bills by the passengers themselves. This service is unique to Japan.

On the other hand, in European countries such as the UK, France and Germany, one man operation was carried out at an early stage and this was before the widespread adoption of smart cards so automation of fare collection was not promoted. Because bus operators did not offer services such as exchange of bills and coins, passengers became used to the habit of preparing the exact fare in advance by themselves.

The fare collection method varies greatly with the development of IT, in the 1990s, prepaid cards replaced paper tickets and from the 2000s, in Japan, smart cards have replaced prepaid cards. With the advent of the smart card, to use transportation services, there is no need for the user to purchase a ticket in cash and trips on multiple modes can be done with a single smart card thus reducing boarding the alighting time and making operations smoother.

In the future, due to the economic growth in Vietnam, one man bus operations will be necessary due to the rise in labour costs and it will be necessary to construct a fare collection method which abolishes the role of the conductor.

From the introduction of a smart card system for fare collection, convenience on the side of users is improved as well as for bus operators where the labour burden is reduced for drivers for one man operation.

Currently, the UMRT Line 1 is under construction in Ho Chi Minh City and it is planned for the smart card to be introduced for automatic fare collection. For the BRT line that connects to the UMRT Line 1 at the Suoi Tien Terminal station of Line 1, the smart card will also be introduced so that convenience is improved for public transport users when they switch modes from rail to bus.

5.4.2.2 Fare Collection Method

There are 2 methods to collect fares using the smart cards for the BRT:

1) On-Board Fare Collection: Every bus vehicle is equipped with equipment for fare collection
2) Off-Board Fare Collection: Fare gates similar to those used for metros are installed at bus stations located in the centre median of roads

The 2 methods are compared in the following table:

Table 5.4.1 Fare Collection Methods for the BRT

	On-Board Fare Collection (in-vehicle fare collection)	Off-Board Fare Collection (use fare gates)
Type of Station	Typical bus stops located on the side of the street	Stations located in a centre island configuration in the center median of the road (if staggered stations for each operating direction of the BRT is used, the cost will double)
Number of Stations/Number of Buses	If there are more stations than buses, on-board fare collection is cheaper	If there are more buses than stations, the investment cost is lower
Necessary Equipment	• Reader/writer • Farebox • Automatic deposit machine	• Automatic fare gates • Automatic ticket vending machines • Back office for equipment • Backup power supply/communications network
Facilities	Security is not a concern as the devices are located in the vehicles	It is necessary to provide platform doors and security cameras to prevent unauthorized access into the stations
Operational Challenges	For one man bus operations, the driver must deal with collecting the fares	Fare settlement is required at each station
Advantages	Low cost	Shortens the boarding and alighting time
Disadvantages	Long boarding and alighting time	High cost

Source: Study Team

5.4.2.3 Smart Card System

General Automatic Fare Collection System

In each country, automatic fare collection (AFC) systems are utilized for public transport systems such as the UMRT and BRT. Even in Vietnam, for upcoming UMRT and BRT projects, it was decided to use smart cards for ticketing. The hierarchical model for equipment configuration for the AFC is shown in the following figure.

Level	Name of Equipment		Image	Function *
5	CCHS			-Clearing and Settlement Manage the daily / monthly clearing data for each operators. -Card Information Management Manage the most up-to-date data of IC card based on the data received from lower level. -Blacklist Management Manage the most up-to-date blacklist and deliver it to the lower levels. -Relaying data in lower level
4	AFC	Operator Server		-Revenue Management Manage the daily / monthly revenue data **for each operators**. -Statistics Management Manage the daily / monthly statistical data **for each operators**. -Relaying data in higher/lower level
3		Line Server		-Revenue Management Manage the daily / monthly revenue data **for each lines**. -Statistics Management Manage the daily / monthly statistical data **for each lines**. -Relaying data in higher/lower level
2		Station Server, Bus Depot Server		-Revenue Management Manage the daily / monthly revenue data **for each stations and depots**. -Statistics Management Manage the daily / monthly statistical data **for each stations and depots**. -Relaying data in higher/lower level
1		AFC Equipment		-Communicating with IC card wirelessly and updating data in IC card. -Creating data for servers in higher level.
0		Ticket Media		-Holding Card ID, Usage Data, etc. -Communicating with equipment wirelessly.

* Sometimes, functions of CCHS are exist in the level 3 or 4

Note: IC card = smart card
Source: Study Team

Figure 5.4.4 General System Hierarchy for the AFC

Generally, the types of smart cards varies depending on the read and write method, payment method, place of usage, etc. In this study, the contactless and prepaid type smart card used for public transport is described as the "Transport Smart Card". The transport smart card that is equipped with the electronic money function usable in retail stores is categorized as the "Comprehensive Smart Card".

a) Read and Write Method

Two types, contact and contactless, are considered. For the ticket for public transport, the processing speed is important, thus the contactless smart card is generally adopted.

b) Payment Method

It is largely categorized into two types, prepaid and postpaid. The prepaid smart card is often adopted as the tickets for public transport.

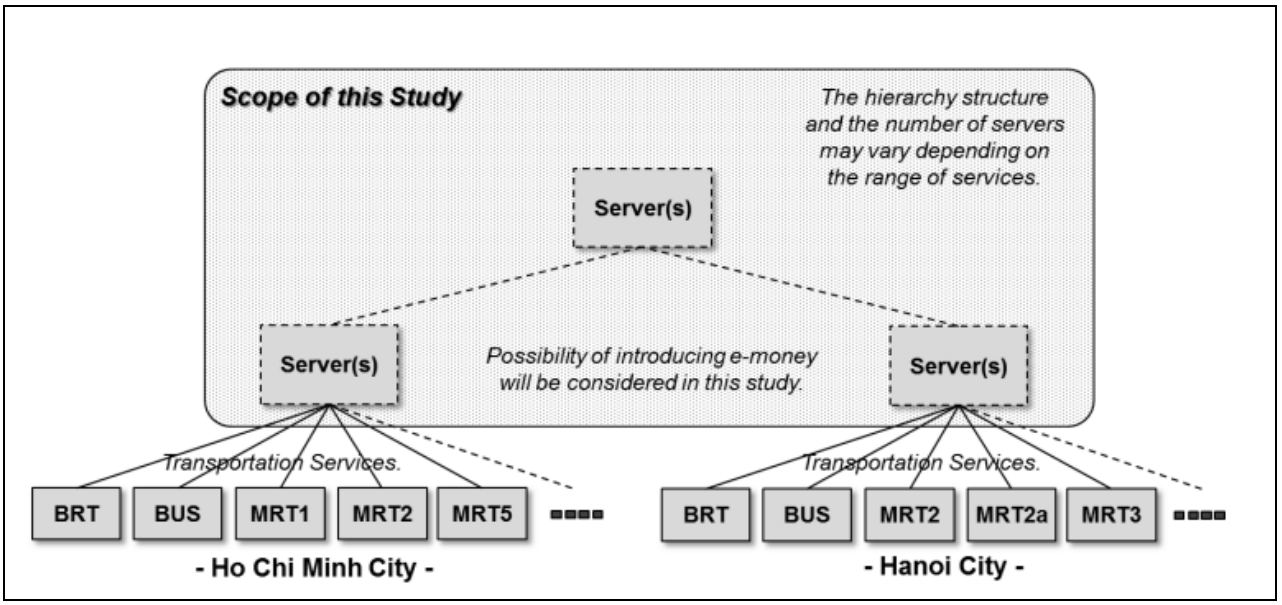
c) Place of Usage

It is often used as a ticket for public transport and micropayment at retail stores.

Regarding the "Data Collection Survey on E-Money and Transport Smart Card"

On July 2014, the study titled the "Data Collection Survey on E-Money and Transport Smart Card" was implemented. The purpose of the study to gather and arrange the necessary information to for considering the way of implementing transport smart cards in Vietnam that could improve the convenience for passengers and allow passengers to utilize different transport modes with one fare project.

For this study, summary information from the "Data Collection Survey on E-Money and Transport Smart Card" related to the smart card system for Hanoi public transport is extracted as follows. The following figure shows the structure of the study "Data Collection Survey on E-Money and Transport Smart Card"



Source: Data Collection Survey on E-Money and Transport Smart Card, JICA, 2014

Figure 5.4.5 Study Scope of the Data Collection Survey on E-Money and Transport Smart Card

Current Conditions and Plans for the Smart Card in Hanoi

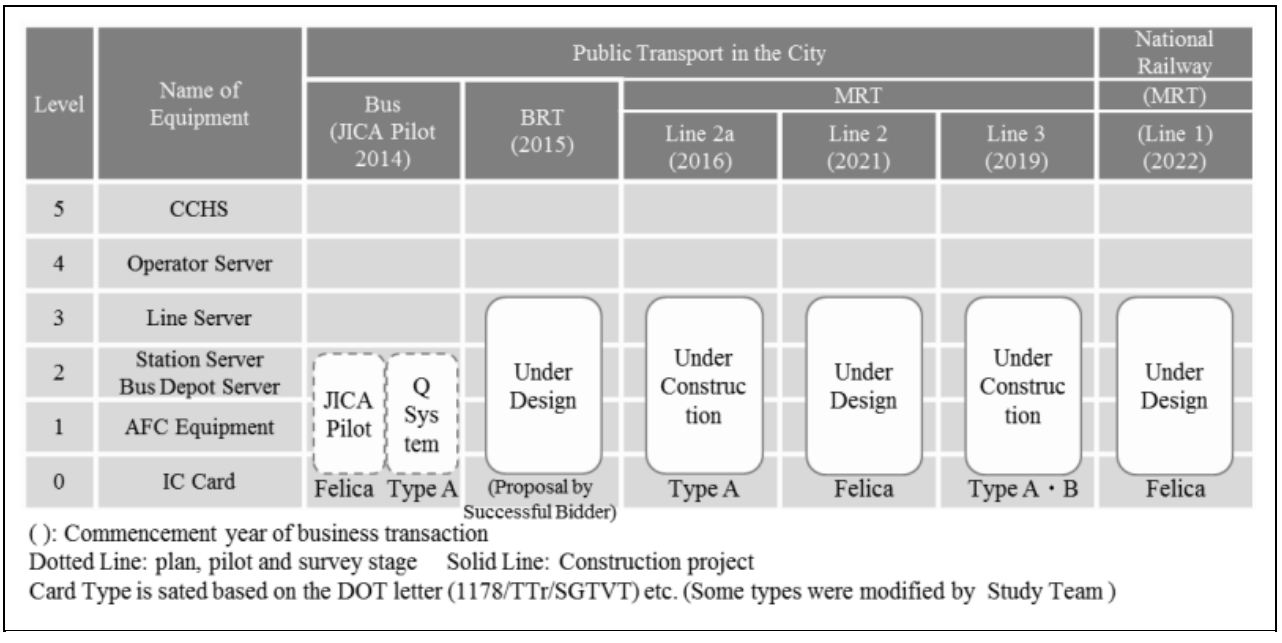
<Conditions of the Transport Smart Card and Smart Card Devices>

In Hanoi, BRT (14.2km construction as "Vietnam - Hanoi Urban Transport Development Project" by World Bank support) and MRTs will start operation sequentially. All of these new transport modes will be equipped with smart card equipment until the level 2 or 3. MRT operators who will be managing line 2a, 2 and 3 is currently being established with JICA support. For the BRT, existing bus operator (Transerco) will operate it at the start-up period, and then put to tender and award concessions for the operation.

For bus system, the Q-system which consists of GPS and auto-fare system by Transerco and city's electric company group (Hanel) is noted by DOT (Department of Transport) letter "Request for approval and issuance of framework of fare policy and ticket technology to be applied to the public transportation network in Hanoi" (1178/TTr/SGTVT dated Aug 23, 2013). At this moment, however, no actual progress is observed.

As an active project, the pilot program in "Project for Improving Public Transportation in Hanoi (Sep 2011 to Aug 2014)" by JICA is notable. Through this program, IC cards will be implemented on one bus route in July 2014.

As for the MRT 1, although it is under Hanoi people committee's management according to Railway Law (35/2005/QH11), its operation is handled by VNR (Vietnam Railways) as stated in "Conclusion of MOT - Mr. Dao Dinh Binh - and Chairman of HPC - Mr. Nguyen Quoc Trieu - at the meeting approving the general project of "Hanoi Elevated Railway, line Ngoc Hoi - Yen Vien" and structural project of Nhat Tan bridge" (519/TB-BGTVT-UBHN, Oct 2005). For this reason, the transport mode excluded the MRT Line 1 is described from this subsection.

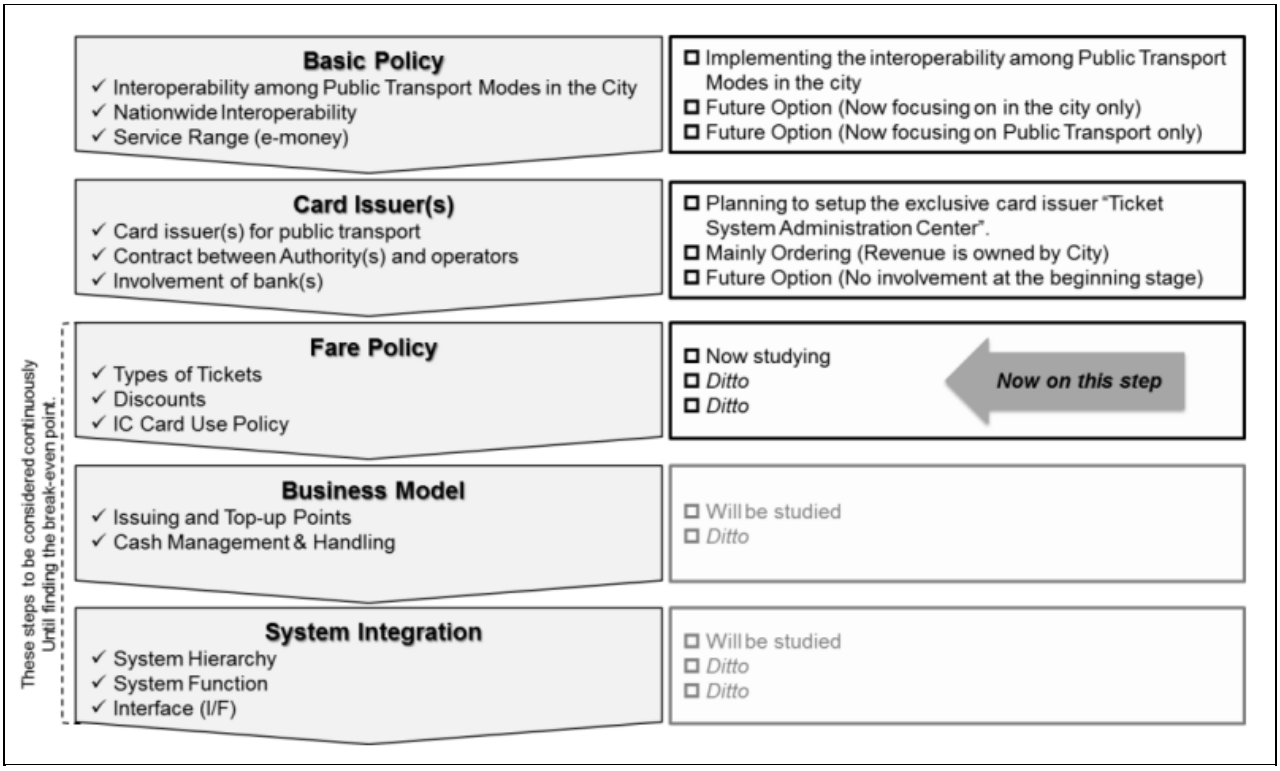


Source: Data Collection Survey on E-Money and Transport Smart Card, JICA, 2014

Figure 5.4.6 Situation of Smartcard Systems for Public Transport Projects in Hanoi

<Situation of Interoperable Smart Cards>

Different types of NFC (Near Field Communication) at the lowest level (Level 0) will be implemented, since the design work of construction projects has been conducted without sufficient coordination. Based on this background, in the donor meeting held in HPC on Jul 2, 2014, Hanoi city accepted IC cards recommended by respective donors. However Hanoi city also requested them to install multi-terminals which are applicable to all NFC types for all transportation modes. At the time of preparing this report, basic policy and a card issuing body have already been decided, and fare policy such as type of ticket is under study.



Source: Data Collection Survey on E-Money and Transport Smart Card, JICA, 2014

Figure 5.4.7 Situation of Interoperable Smartcards in Hanoi

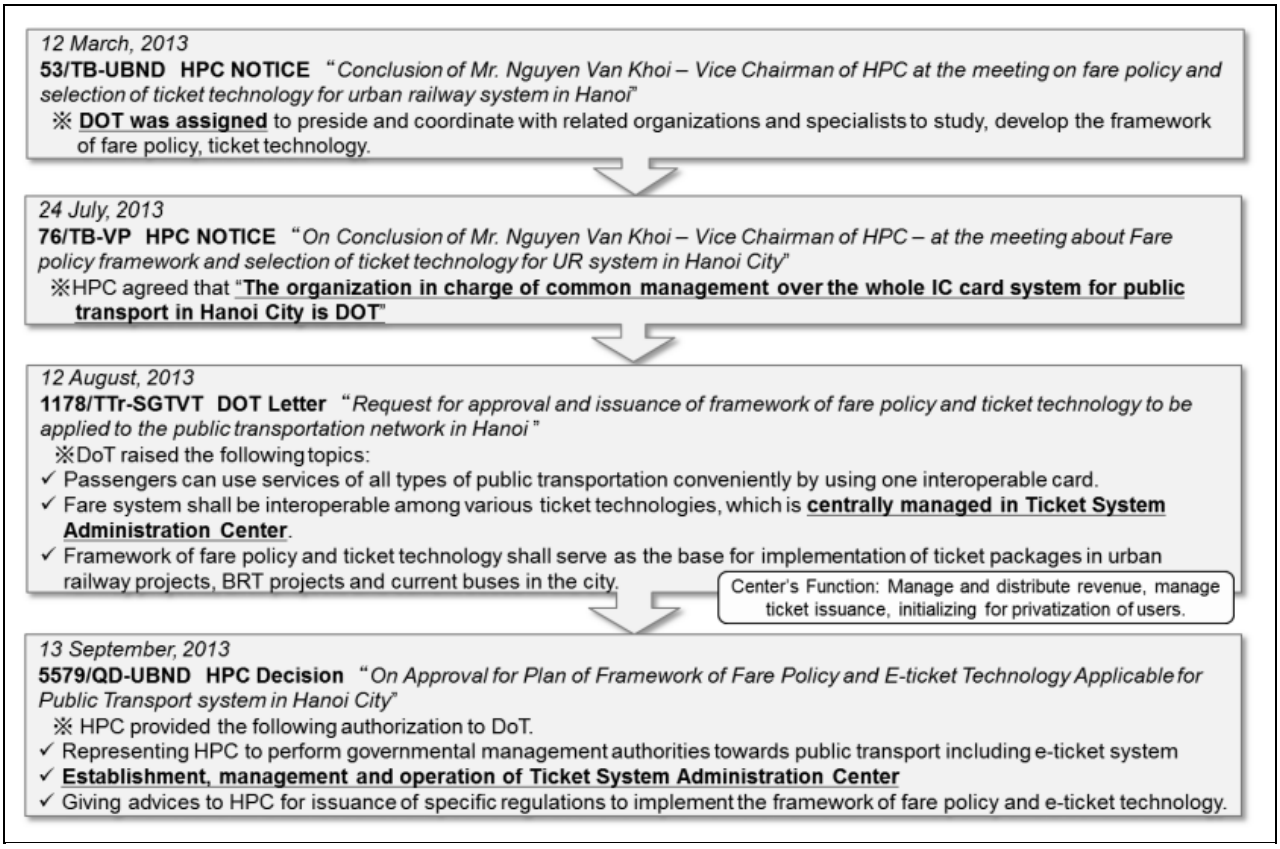
<Card Issuing Body>

In Hanoi, the fare management structure is now under development based on the concept of "Integrated Fare Collection" which is proposed as a part of the establishment plan of PTA (Public Transport Authority) suggested by the World Bank.

This direction has been accelerated by HPC notice (53/TB-UBND) issued in March 2013. DOT was assigned as an organization in charge of common management over the whole IC card system for public transport in Hanoi City. In August 2013, in response to this notice, DOT proposed the Ticket System Administration Center (hereinafter referred to as the Center) which has the following functions.

This proposal was basically approved by HPC Decision (5579/QD-UBND, Sep 2013) and the department of home affair (DOHA) was instructed to give advices and submit HPC for approval of organization of operation and functions of the Center when PTA has not been established.
The major functions of the Center as proposed by the DOT:

1) Managing and distributing revenue
2) Managing ticket issuance
3) Initializing for privatization of users



Source: Data Collection Survey on E-Money and Transport Smart Card, JICA, 2014

Figure 5.4.8 Events Leading up to the Setup of the Ticket System Administration Center in Hanoi

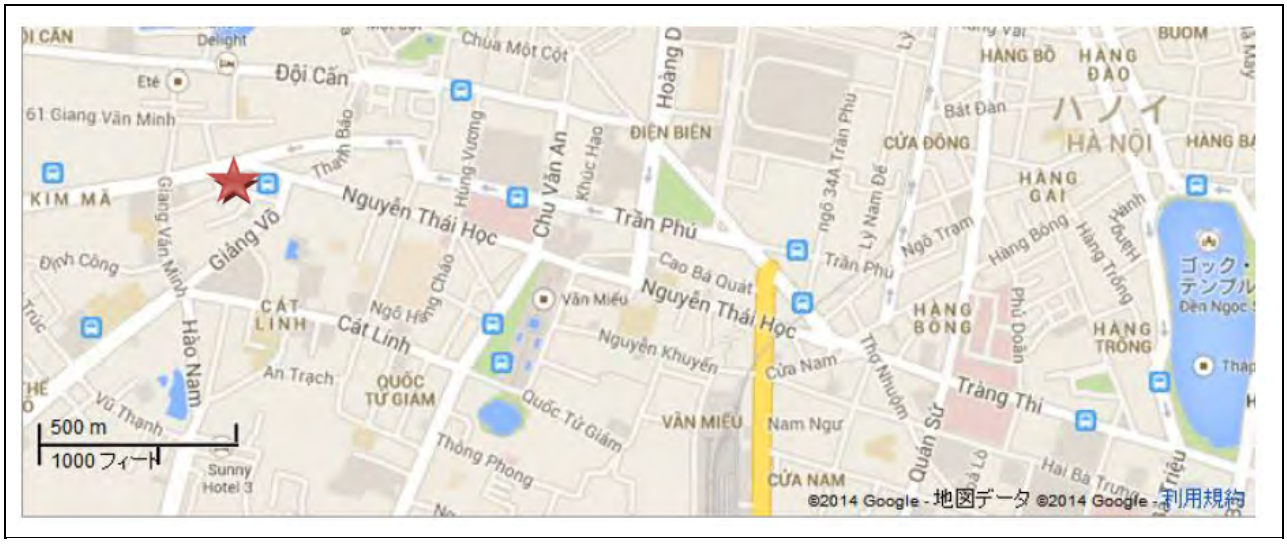
Authorities	Role
DOT	To coordinate with related departments and organizations (incl. coordination during the implementation of fare package in public transport development projects.) To represent HPC to perform governmental management authorities towards public transport, including e-ticket system via the establishment, management and operation of Ticket system Administration Center To give advices to HPC for issuance of specific regulations to implement the framework of fare policy and e-ticket technology.
DOIC	To evaluate the design of ticket systems of public transport development projects, in order to ensure the interoperability.
HAPI	To give advices to HPC during the formation, evaluation of projects and tendering, in order to ensure that the implementation of ticket packages in public transport projects
DOST	To provide comments in terms of technology aspect for selected ticket system(s) to be used for public transport network.
DOHA	To submit HPC for approval of organization of operation and functions of Ticket System Administration Center.
DOF	To issue specific guidance documents regarding the management, allocation of revenue and subsidy policies for public transport lines using e-ticket.
Projects	To obey requirements, regulations in the approved Framework of fare policy and ticket technology.

Source: HPC Decision 5579/QD-UBND

Source: Data Collection Survey on E-Money and Transport Smart Card, JICA, 2014

Figure 5.4.9 Authorities Related to the Setup of the Ticket System Administration Centre

In the meeting with DOT dated Apr 2, 2014, the study team [for "Data Collection Survey on E-Money and Transport Smart Card"] confirmed that the center will be formed in the building which is being constructed as a part of the package 4d of BRT project supported by the World bank (Nguyen Thai Hoc street (see the following figures). However, the support for the establishment of the center and the system implementation is not covered by the World Bank. Therefore, other supports are required.



Source: Data Collection Survey on E-Money and Transport Smart Card, JICA, 2014

Figure 5.4.10 Location of the Kim Ma BRT Terminal


Source: Data Collection Survey on E-Money and Transport Smart Card, JICA, 2014

Figure 5.4.11 Kim Ma BRT Terminal as of April 2016

Master Plan for the Upper System Implementation in Vietnam

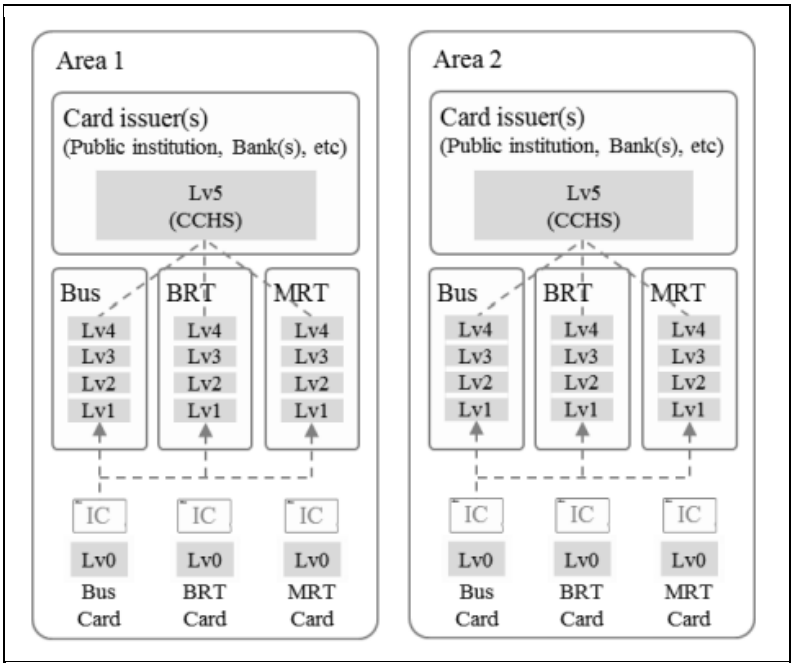
<Developmental Stage towards Nationwide Interoperable Transport>

The urban public transport modes are now being constructed in Hanoi and Ho Chi Minh City. In these projects, the implementation of smart cards for ticket system has been decided. Under these circumstances, it seems that the regular usage of smart cards will be started in transport industry, and then expanding to the e-money market. Vietnam is similar to Japan geographically, it has major cities scattered in narrow land extending from north to south. Both countries also have the same structure of urban transport management: in Vietnam, the urban transport is being managed by provincial people committees and in Japan by local operators. Thus, both public transports are identified locally. Given this situation, the expansion of transport smartcards in Vietnam can be patterned after the footprint of transport smartcards in Japan, though there is a difference in legal framework.

The way toward nationwide interoperable transport includes the following 4 steps:

1st Stage: Smart cards for transportation start operation in each district
2nd Stage: Settlement service for comprehensive smart cards to starts in stores in each district
3rd Stage: Direct connection of comprehensive smart card systems to starts among the districts
4th Stage: Interoperable service of comprehensive smart cards to starts nation-wide

In the first stage, smart cards for transportation services (which are already in budget of construction projects) will start in each district. Upper system in this stage is supposed to be constructed and operated by the card issuers (such as public organizations and banks) of each district (see the following figure).

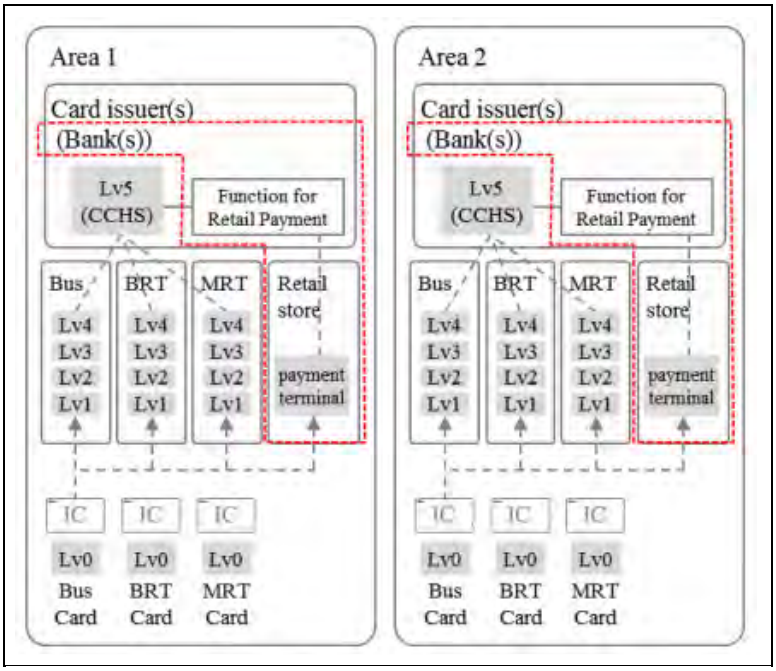


Source: Data Collection Survey on E-Money and Transport Smart Card, JICA, 2014

Figure 5.4.12 System Overview of Comprehensive Smart Cards (1st Step)

In the second stage comprehensive smart card settlement service at stores inside stations and markets is to be started in each district, to expand convenience for the users. POS terminals are to be facilitated in each store and the upper system will add functions for settlement (see the following figure).

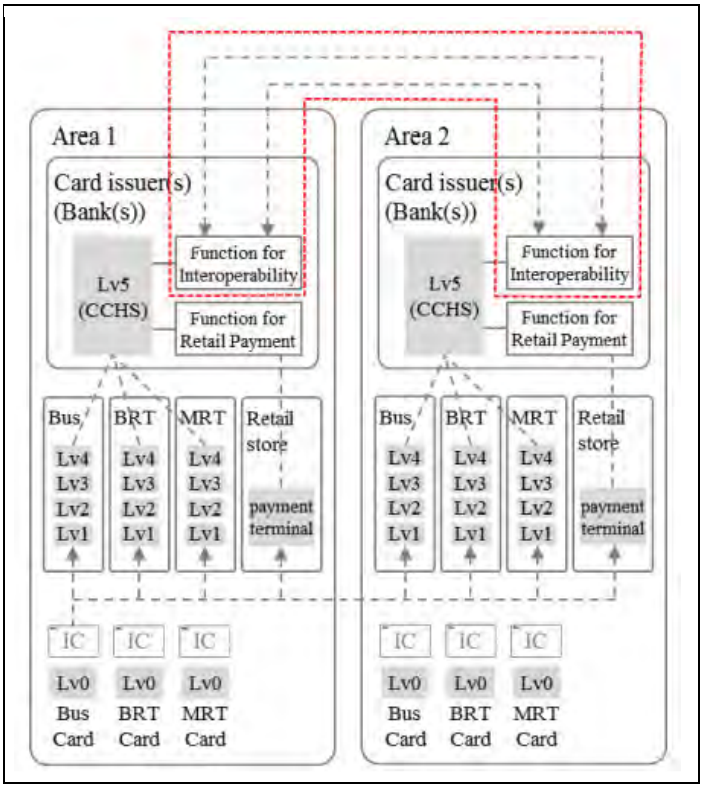
The management of the upper system, including card issuance is restricted to commercial banks at this stage, since there are service providers other than public transportation who are involved.



Source: Data Collection Survey on E-Money and Transport Smart Card, JICA, 2014

Figure 5.4.13 System Overview of Comprehensive Smart Cards (2nd Step)

In the third stage, interoperable function for the comprehensive smart card is added to the systems and equipment, and the function of mutual data transfer among the districts is added to the upper system. Thus the upper system installed in each district is directly connected with each other and this enables the smart card to be used in each district (see the following figure).

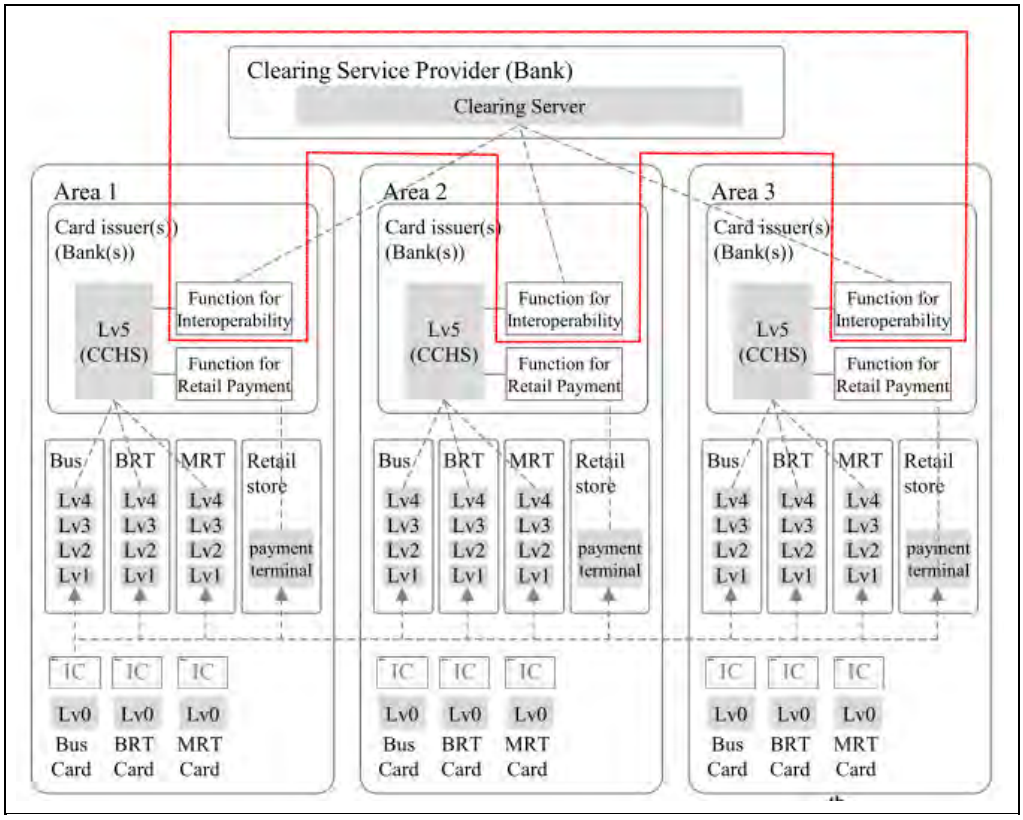


Source: Data Collection Survey on E-Money and Transport Smart Card, JICA, 2014

Figure 5.4.14 System Overview of Comprehensive Smart Cards (3rd Step)

Lv0-1 needs to be revised in case the NFC differs between the districts. Lv-4 needs to be revised in case the data format or encryption key differs between the districts.

In the fourth stage, interoperable service of comprehensive smart card starts nation-wide just like in Japan. Data would be transferred to the upper systems of other districts, via data transfer system which is operated by a third party (see the following figure).



Source: Data Collection Survey on E-Money and Transport Smart Card, JICA, 2014

Figure 5.4.15 System Overview of Comprehensive Smart Cards (4th Step)

Lv0-1 needs to be revised in case the NFC differs among the districts. Lv-4 needs to be revised in case the data format or encryption key differs among the districts.

It would be better to adopt common standard and data format from the first stage since the cost to realize interoperability among the systems of each district would be much higher if they are developed with totally different specifications.

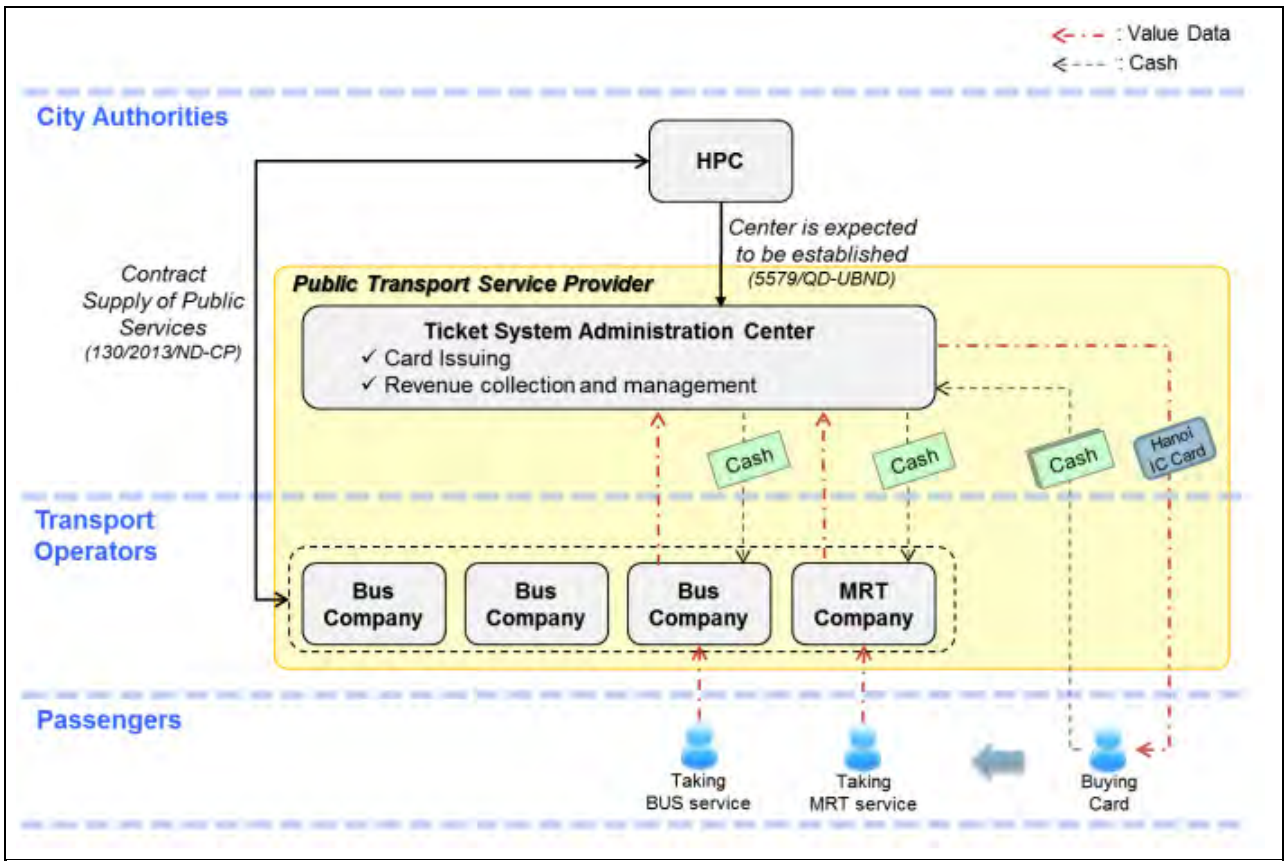
Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has developed "Common Standards and Design Guidance for Interoperable AFC System of Public Transportation" which is minimal basic technical foundation, such as framework of card format and data format to realize smart card interoperability among each transportation mode. This has been submitted it to MOT in February 2013, as one of the assistance to Vietnamese transportation. Furthermore, in March 2014, MLIT has developed "Investigation Report of 2013 on Development of Common Implementation Specifications over Multiple Lines for the Automatic Fare Collection System in Vietnam" which describes more detailed specifications such as smart card encode format, system operations and data flows, which are necessary to develop the common standard.

Making use of these intellectual properties from the first stage would be preparatory steps for future realization of interoperability with comparatively low cost.

<Comprehensive Smart Cards for Hanoi>

Hanoi is now planning to set up "Ticket System Administration Center (hereinafter referred to as the Center)" which will be an exclusive transport smart card issuer. Since the city is not going to consider an e-money function at the beginning stage, the study team understands that the business model for card issuing and settlement will be the scheme as described in the following figure.

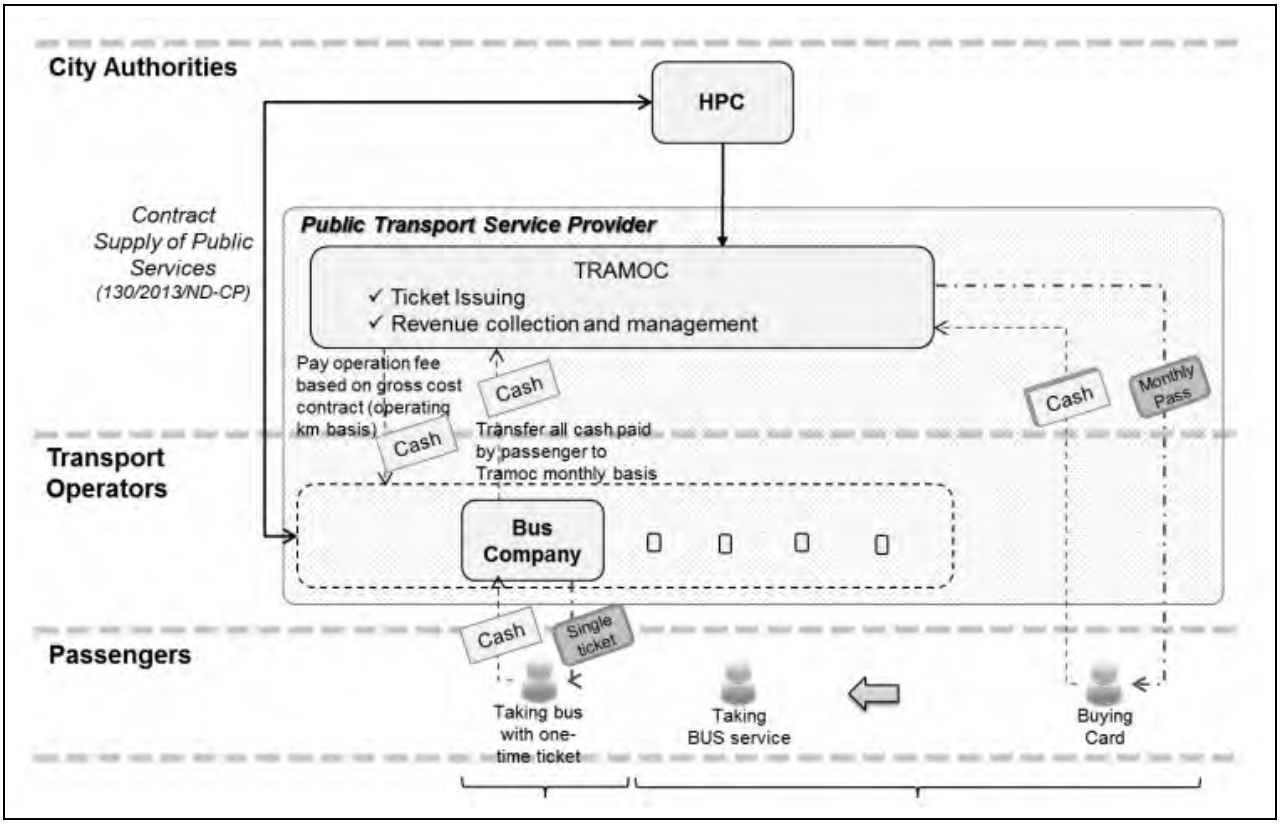
Card issuing and settlement business is governed by SBV Decision 20. However, as stipulated in the Decision: "Cards regulated in this Regulation do not cover types of cards issued by service providers for use in the payment for services by the issuing organizations themselves." The cards (see below figure) issued by "Ticket System Administration Center" to be used in the payment for public transport services by Hanoi, will not fall into the Decision 20. Therefore the smart card for Hanoi public transport will not be a bank card and they can be issued without the banks.



Source: Data Collection Survey on E-Money and Transport Smart Card, JICA, 2014

Figure 5.4.16 Business Model for the Hanoi Public Transport Smart Card

As for the bus, which is the existing public transport, TRAMOC (Hanoi Urban Transport Management and Operation Center) is an exclusive ticket issues. Thus, it would not be difficult to accommodate institutionally add the lines such as BRT and UMRT by following their scheme of the similar ticket issuance and revenue correction and management. (refer to the following figure)



Source: Data Collection Survey on E-Money and Transport Smart Card, JICA, 2014

Figure 5.4.17 Sales Model for the Bus Ticket on the Existing Public Transport in Hanoi

A part of sales task of monthly pass is also consigned to the bus company.

<More Detailed Matters with Regards to Smart Cards>

In the "Data Collection Survey on E-Money and Transport Smart Card" in sections 5.2.2 to 5.2.6, more detailed matters with regards to smart cards in Vietnam were compiled by the study team of that project upon confirmation of the information with the DOT and TRAMOC.

For more details, please refer to the following sections of Chapter 5 of the "Data Collection Survey on E-Money and Transport Smart Card".

5.2.2 Main Roles of the Centre
5.2.3 Upper System Overview
5.2.4 Organization of the Centre
5.2.5 The Milestones of the Establishment of the Centre
5.2.6 Cost for the Implementation, Operation and Replacement of the Upper System
5.2.7 Interoperability with the UMRT Line 1

Regarding the Smart Card Pilot Project from the "Project for Improving Public Transportation in Hanoi (TRAHUD2)" by JICA

The pilot project was implemented from July 2014 to July 2015 and a summary of the pilot is described as follows:

- Bus Route: No. 6, Ben Xe Giap Bat Ban-Xe Thuong Tin/Cau Gie operated by TRANSERCO
- Number of Bus-Vehicle Devices: 26
- Commuter Pass Sales Points: 20 locations inside the city
- Number of Issued Smart Cards: Around 200,000
- Smart Card Type: Felica AES by Sony
- Format:
  - The commuter pass recognition method from the "Technical Interoperability Regulation" and "Interoperability Specification" that was developed with the support of Japan's Ministry of Land, Infrastructure, Transport and Tourism was used. From different operating areas for bus operators, the expiry date of commuter passes are recorded electronically and when passengers use the smart card on the buses, the bus-vehicle devices verifies the validity of the commuter pass with the date stored on the bus-vehicle device
- Smart Card Design:
  - For bus routes where bus-vehicle devices are not installed on the buses, it is necessary for the conductor to visually inspect the smart card. The smart card also has spaces to attach stickers showing that passengers have purchased their monthly commuter pass.

Smart card design

Pamphlet explaining the start of the service

Bus-vehicle devices

Figure 5.4.18 Smart Card Pilot Project in Hanoi

Regarding the "Project for Supporting the Interoperability of Transport Smart Cards in Hanoi" that is currently being formulated by JICA

This project is the result of a preliminary survey that was implemented by JICA in December 2015. At this point in time, the project is still being formulated and consultations are ongoing with the Hanoi DOT. The contents of this project have not yet been publicly released yet.

In Hanoi, currently, UMRT Lines 2A and 3 and the World Bank BRT line are under construction and the type of smart card that will be used are ones that are promoted by the various country donors of aid funding. As a result, the city of Hanoi has requested to the various donors that they provide automatic fare gates and bus-vehicle devices that are capable of reading and writing multiple formats of smart cards that follow near field communications (NFC) standards.

However, the smart card technical standards are different for each country. In order for interoperable operations between different types of smart cards that will be used for the UMRT, BRT and regular buses, a unified technical standard for the settlement of funds from a smart card issuing center as well as the construction of a server to handle the upper level interoperability settlement of funds function. So far, concrete plans and consultations have not progressed for these 2 necessary items for enabling interoperability of different types of smart cards.

For this study, the interoperable technical regulation that enables the usage of one smart card over various transport modes as well as the contents from the "Data Collection Survey on E-Money and Transport Smart Card, JICA, 2014" are described. It is thought that the "Ticket System Administration Centre" and the Upper

Level System as described on the "Data Collection Survey on E-Money and Transport Smart Card" applies for this study.

5.4.2.4 Fare Collection Method for the BRT in this Study

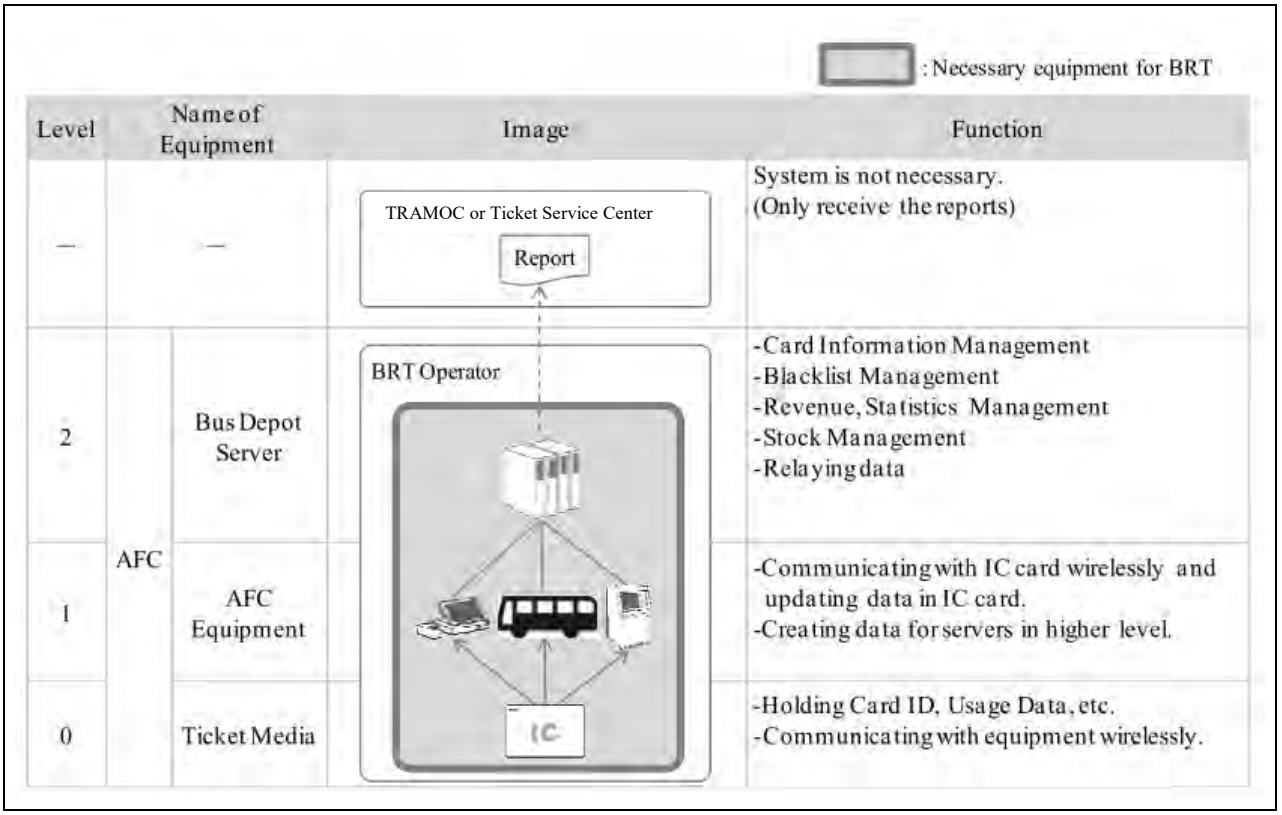
Necessary Equipment for the BRT

As the usage point and number of cards expand, it is necessary to expand the system structure of AFC. In the future, the BRT smart card of this study will connect with the other AFC (smart card) in surrounding areas. The way toward interoperable smart card for the transportations includes the following 2 steps.

1st Stage: Start usage of smart cards for this BRT line
2nd Stage: Begin interoperation with the UMRT, BRT and buses of Hanoi

<1st Stage>

At the phase of commencement of the smart card for the BRT, it is assumed that there will only be ONE (1) BRT line and ONE (1) bus depot. In this case, the minimum requirement for the AFC system would be Level 0/1/2 and Level 3/4/5 is unnecessary.



Source: Study Team

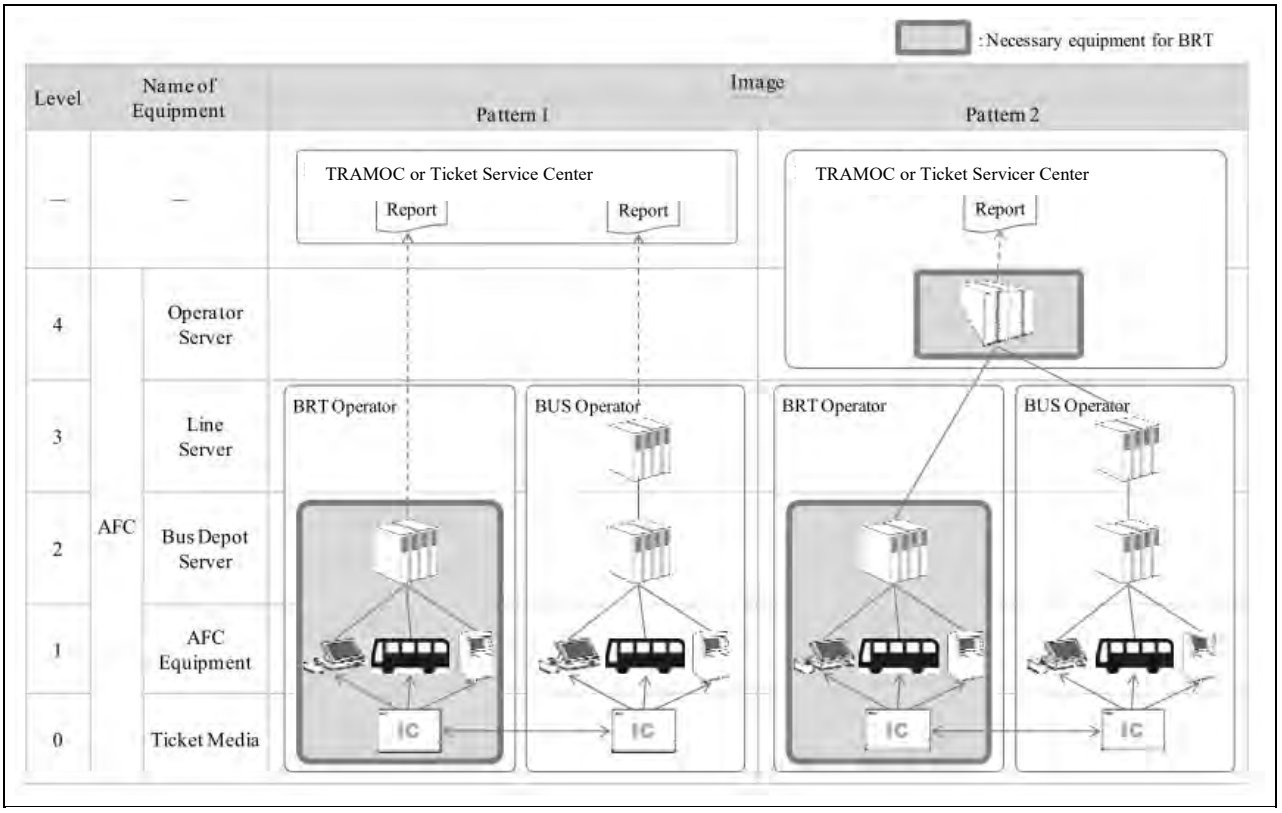
Figure 5.4.19 Necessary Equipment for the 1st Stage

As the interoperation with Hanoi buses start, the hierarchical model for the AFC system is as shown in the following figure. In this figure, there are two model patterns as suggestions.

The 1st pattern involves Level 0/1/2/3 with no Level 4 in the model. In this case, BRT operator and bus operator will produce their own revenue and statistics report and submit the reports to the Ticket System

Administration Centre on their own. The Ticket System Administration Centre will have to manually aggregate the data from the reports that were submitted for the overall data.

The 2nd pattern on the other hand, will have Level 0/1/2/3 at the bus AFC system, with additional Level 4 that is mutually shared between BRT and bus AFC system. BRT operator and bus operator will produce their own revenue and statistics report and submit the reports to Level 4. Aggregation of the overall reports and data can be automatically sent to the Ticket System Administration Centre from Level 4.



Source: Study Team

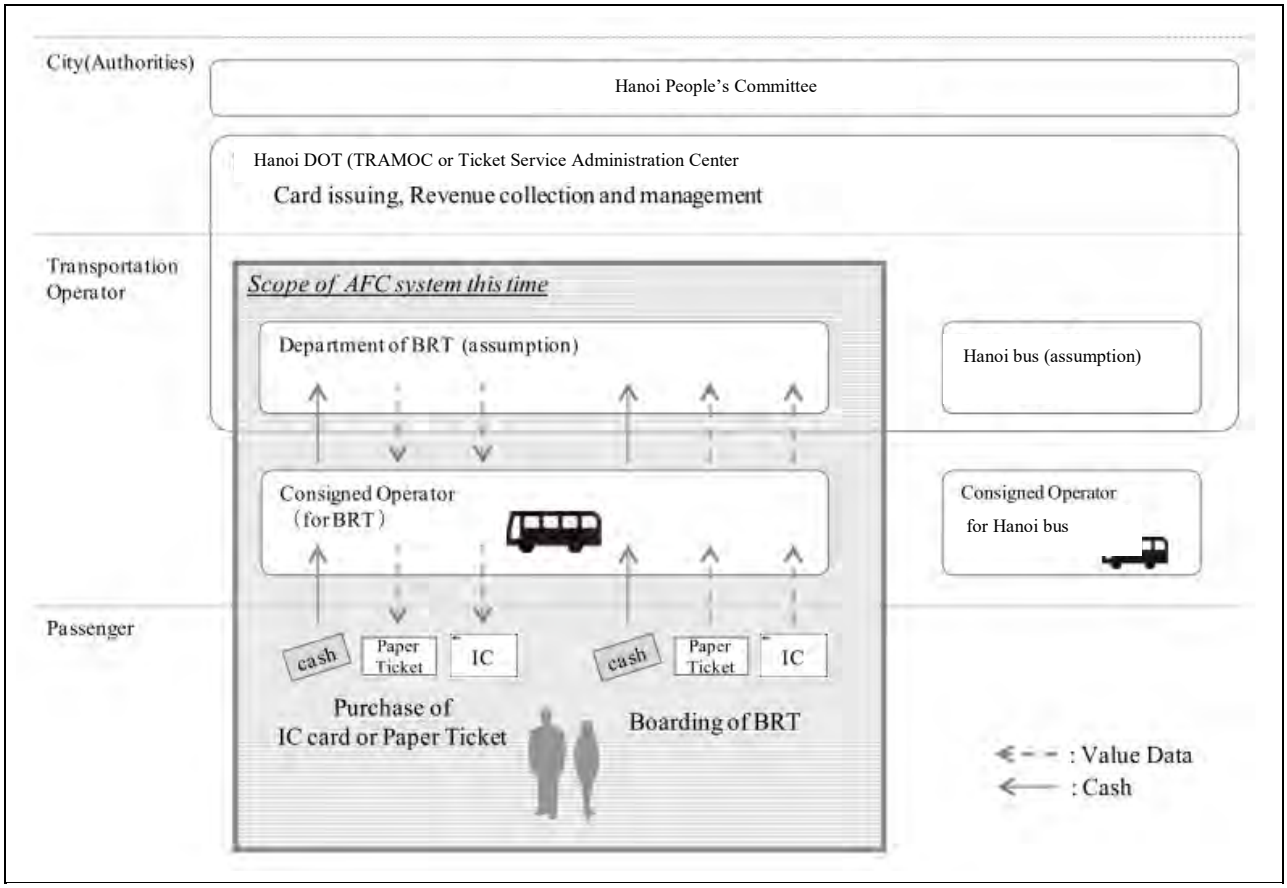
Figure 5.4.20 Necessary Equipment for the 2nd Stage

Requirements for the AFC

Requirements for AFC are described below.

<Roles for each Organization>

It is considered that the BRT is operated by a consigned operator under the management of the Hanoi DOT (TRAMOC or the Ticket Service Administration Centre). For this reason, it is assumed that the actor who actually issues transportation smart cards, sales paper tickets, and processes boarding of BRT will be the consigned operator. There also can be two options, one of them is that the Hanoi DOT gathers and manages money received by the sales of smart cards and paper tickets, and the other is that the consigned operator does. The figure below shows the roles of each organization when the Hanoi DOT (TRAMOC or the Ticket Service Administration Centre) gathers and manages the money.

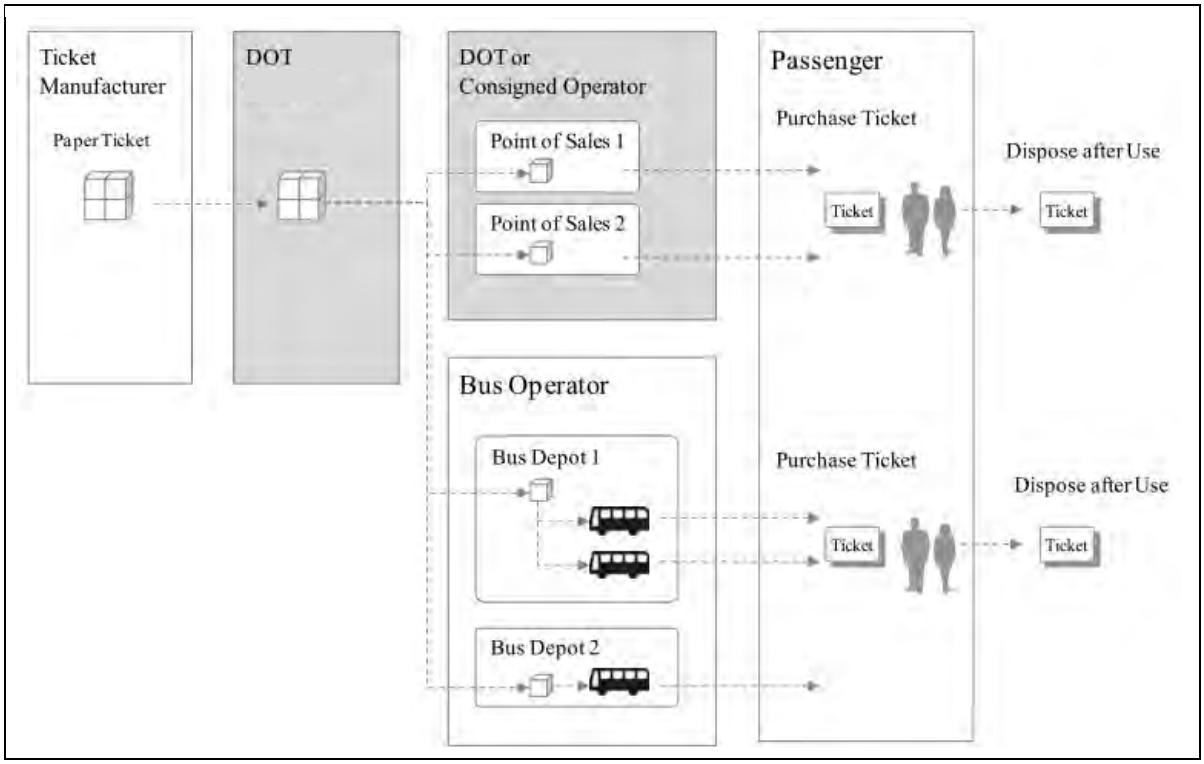


Source: Study Team

Figure 5.4.21 Conceptual Diagram of Roles for Each Organization

<Ticket Issue Management>

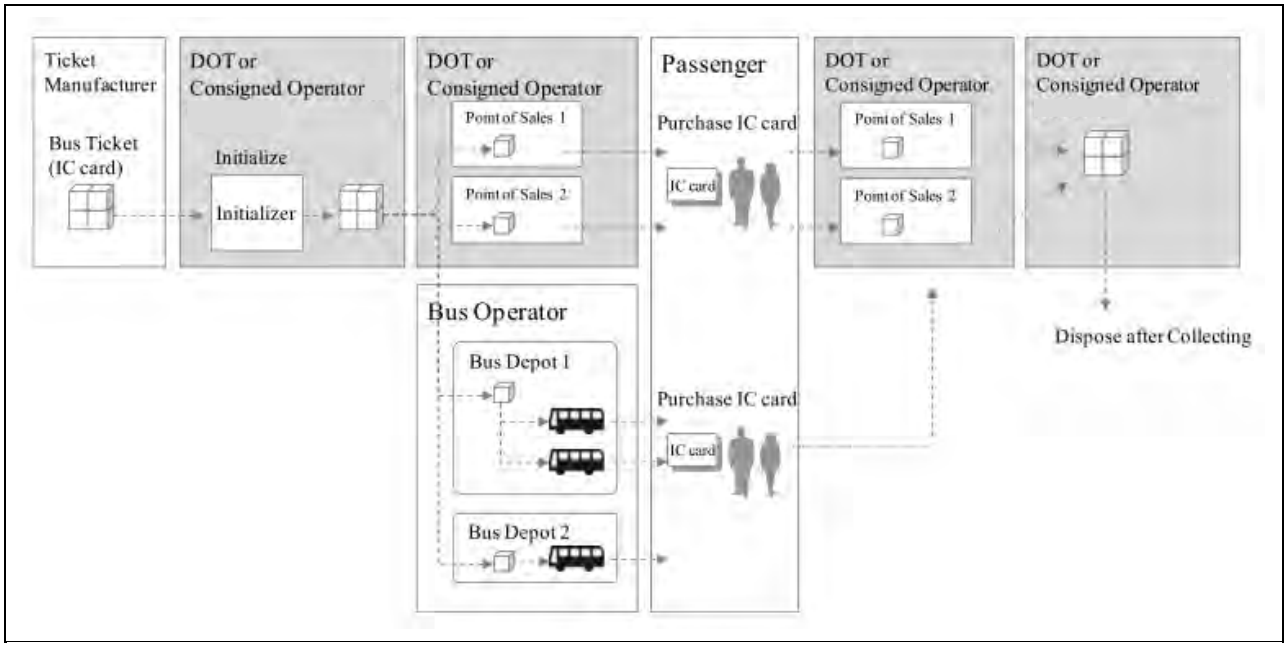
It is assumed that the issue of the ticket for BRT is performed at each point of sales by the Hanoi DOT (TRAMOC or the Ticket System Administration Center) responsible for the ticket management or the consigned operator. There are two cases about the procurement of smart cards, one of them is that TRAMOC or the Ticket System Administration Center is an exclusive ticket purchases, on the other hand, there are the case that others (such as staff at point of sales and bus operator) directly purchase from the ticket manufacturer. The figure below shows the flow when TRAMOC or the Ticket System Administration Center exclusively purchases tickets.



Source: Study Team

Figure 5.4.22 Operation of Issuing the Paper Ticket

It is assumed that the issue of the smart card for BRT is performed at each point of sales by TRAMOC or the Ticket Service Administration Center responsible for the ticket management or the consigned operator, as same as a paper ticket. It is also assumed that the transportation smart card is initialized by the Initializer (equipment to initialize the smart card) at TRAMOC, or the Ticket Service Administration Center or the consigned operator to be sold to the passengers at each point of sale.



Source: Study Team

Figure 5.4.23 Operation of Issuing of Smart Cards

Cost Allocation for the Bus Mounted Devices and Other Equipment

In Japan, where public transportation is well developed, bus-mounted devices (R/W) equipped with a smart card system and devices such as fare indicators and fare machines that can give change (hereafter referred to as “one-man operated bus devices”) are manufactured by two or three companies for the tens of thousands of buses operating throughout Japan. The cost per device is under two million yen.

Development of the bus-mounted devices (R/W) and the one-man operated bus devices manufactured in Japan began more than 40 years ago for automation in the one-man operation following the abolition of bus conductors. These are very Japan-specific, complicated devices developed through digitization of wide range of devices. There has been no track record of export to, and system development for the developing countries of Southeast Asia or the European countries that use simple fare collection.

If these Japan-made one-man operated bus devices are to be exported to Vietnam, the new development of expensive software will be required. For this BRT project, there will be less than 100 bus vehicles. The unit price will be expensive without the cost advantages of large-scale introduction.

Cost Allocation for the Operations of Charging the Smart Card with Money

In Japan, railway and bus public transportation networks are in place throughout the country. Most users add money to their prepaid cards at a nearby railway station, although this can also be done inside a bus.

In Hanoi and Ho Chi Minh City, railway systems are under development and a public transportation network has yet to be built. Although there are more than 40 locations in Hanoi where bus monthly tickets are sold, in the areas around stations, there are no places where users can add money (charge) onto the smart cards and so it is necessary to establish such facilities in order to spread the usage of smart cards for BRT users.

In particular, it is necessary to develop an automated payment machine that is compatible with Vietnamese banknotes in order to implement one-man operation. However, the Japanese bus machine manufacturers do not have this experience, and the cost of development by railway machine manufacturers will be extremely expensive in the absence of the cost advantages of large-scale introduction.

Adding money to prepaid cards can also be performed by a conductor without the automated machines. However, including a conductor on a bus will degrade the effect of the labor cost reduction due to one-man operation and will not contribute to the return on the expensive investment.

Cost-Effectiveness of the Smart Cards and Future Direction

As stated above, a public transportation network has not yet been developed. The investment efficiency is poor when the investment cost per unit cannot be reduced for the limited number of BRT vehicles.

On the other hand, for the examination of introducing a smart card system to all the bus vehicles on the regular bus network in Hanoi, if a Japanese-style smart card system were introduced to all of the bus vehicles in Hanoi either through the JICA project “Project for Supporting the Interoperability of Transport Smart Cards in Hanoi” or through a new yen loan, the upper system of this smart card system could be reused for this BRT project and the investment efficiency can be sufficient because of the mass production of bus-mounted devices.

However, if the Japanese-style smart card system is not adopted by the regular bus network of Hanoi and if this BRT project and the regular bus network utilizes the same smart card system (either Type A or Type B) then the investment effect will be large.

Regarding One-Man Operations and Measures for Abolishing the Role of Conductors

Currently on the public buses of Hanoi, in principle, inside the buses, the conductor collects the fares and it can be said that the stopping time at bus stops is at a minimum.

Upon the implementation of one-man operations, it takes a period of time to transition to smart card payments from cash payments from passengers so it is necessary to pay attention that in the case of Ho Chi Minh City where one-man operations has been trialed, the labour required from the driver to deal with returning change for fares can distract the driver from safe driving.

For this BRT project and for the public buses of Hanoi, in the case of introduction of smart cards, the time it takes for passengers who use cash to switch over to smart cards takes more than 5 years in the case of Japan. During this period, from the viewpoint of securing safe driving from the driver and to lighten the labour load for the driver, it is necessary to continue to employ conductors to collect cash fares as well as to process smart card payments.

Also, for one-man operations, it is not possible to immediately reshuffle the existing conductor staff. In Japan, it took around 10 years to reduce the conductor staff either through a natural reduction from retirement of staff and also not recruiting new conductor staff. As the number of passengers using smart cards increases, the need for conductors will gradually decrease and once the proportion of passengers using smart cards increases to a high number, that is the time to implement one-man operations.

From the above, for this BRT project, conductors should be considered to deal with cash payment of fares as well as for smart card payments.

This is the same situation for drivers. As the UMRT lines open, parallel bus routes will be reorganized and it is assumed that the total number of bus vehicles will decrease and there will be an excess of bus drivers. These excess personnel can be transferred to the business offices of the BRT operating company.

5.5 Examination of the Traffic Management Plan

In order to realize the smooth operations of the BRT and as part of the traffic management plan, a public transportation priority system (PTPS) was examined.

The PTPS is a system that supports the priority running of public transport and includes the installation of exclusive lanes and priority traffic signals for public transport vehicles.

The main benefits PTPS are as follows:

- Secure reliable bus operations
- Reduce the stopping time for buses at intersections
- Secure the safe operations for buses
- Improve the convenience for bus passengers while also promoting bus usage

In this section, the following will be examined: the effect that installing an exclusive BRT lane on regular lanes will have on the management of traffic intersections and the implementation of priority signals for the BRT.

5.5.1 The Current Conditions of Traffic Management and the Management of Buses

5.5.1.1 Current Conditions of the Traffic Management (Signal System) in Hanoi

Currently, Hanoi has more than 900 intersections in which traffic lights are installed in 265. The traffic lights connect to the traffic control centre in Tran Hung Dao St. for monitoring and control. With regards to PTPS, currently, there is no such system installed. Issues with regards to the PTPS are described in Section 5.5.4.

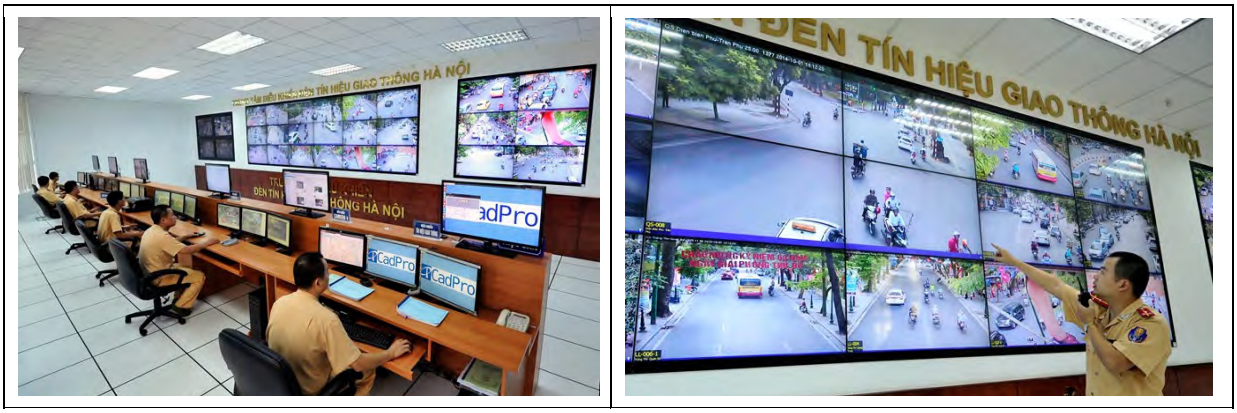
Source: Study Team

Figure 5.5.1 Traffic Signals in Hanoi

The traffic management system in Hanoi (traffic signs and cameras in the intersections) was originally put into operations in 1996 for the purpose of securing smooth traffic management and traffic safety. In the fiscal year of 2015, approximately VND 231 billion (US$10.88 million) was invested to build a new system. The traffic management system equipment is located in the Hanoi Department of Transport and is operated by the traffic police. Repair and maintenance work is done in cooperation with the two aforementioned agencies.

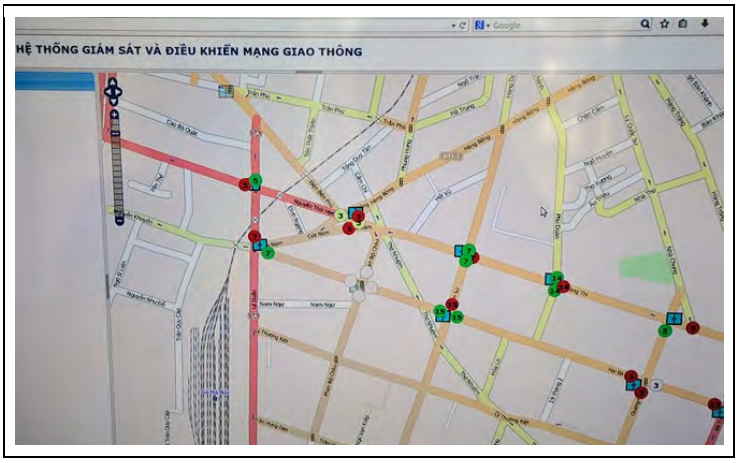
The control center operates a system of 450 surveillance cameras. The cameras observe and measures traffic flow from the control center. Afterwards, the control centre will be able to automatically adjust the signal light cycle to match the volume of vehicles on the road, thus alleviating traffic jams.

This camera system can also detect traffic violations and capture the number plates of vehicle. The camera system allows operators to track traffic patterns and adjust traffic lights with the click of a button in addition to detecting traffic violations.



Source: HDOT

Figure 5.5.2 Traffic Control Center of Hanoi



Source: HDOT

Figure 5.5.3 Interface for Controlling the Signal Cycle

As mentioned, Hanoi has a system of 450 cameras including 50 cameras for monitoring, 300 cameras for measuring traffic volume and 100 cameras for monitoring for traffic violations. The cameras are installed in 152 intersections.

Source: HDOT

Figure 5.5.4 Traffic Surveillance Cameras in Hanoi

5.5.1.2 Current Conditions of the Bus Exclusive/Priority Lanes in Hanoi

In Hanoi, there are two exclusive lanes for buses including the Nguyen Trai St. exclusive bus lane and the Yen Phu-Thanh Nien exclusive bus lane.

(1) Nguyen Trai St. Exclusive Bus Lane

The Nguyen Trai St. exclusive bus lane was put into operation in 2004. The lane is 5 km long and starts from Nga Tu So intersection. The exclusive bus lane is located on the right side of traffic lanes and on the left side of the non-motorized lane. The bus stop is located on the roadside.

Along Nguyen Trai St., there are a lot of T-junctions. The vehicle from these T-junction goes through the exclusive lane to merge with the traffic on the main roadway. This causes conflicts with the bus traffic flow and accidents occur often.

The structure of the road pavement was damaged after a period of use. The main reason is that the asphalt pavement is not rigid enough for the weight of the bus.

Currently, in order to save road space for the construction work of the Cat Linh-Ha Dong UMRT line, the exclusive bus lane is open for all vehicle modes. Congestion usually occurs along this corridor in the peak hour.

Source: Study Team

Figure 5.5.5 Nguyen Trai St. Exclusive Lane

(2) Yen Phu-Thanh Nien Exclusive Bus Lane

The 1.3 km long Yen Phu-Thanh Nien exclusive bus lane was put into operation in January 2014. This lane is located in front of Yen Phu Road, starts from the Long Bien Bus Terminal to the intersection of Thanh Nien-Nghi Tam-Yen Phu. The total investment budget is VND 13 billion and was funded by the Ile de France region. Along the lane, there are 4 bus stops which are located in the median. This exclusive bus lane serves bus routes No. 4, 8, 23, 31, 41, 50, 54, 55, 58 and 86.

Source: Study Team

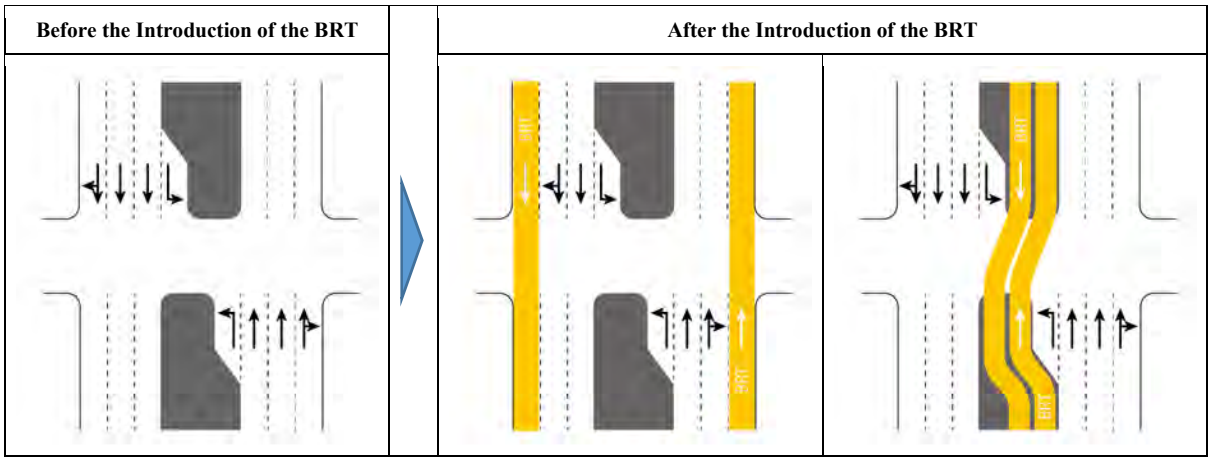
Figure 5.5.6 Yen Phu-Thanh Nien Exclusive Bus Lane

5.5.2 Examination of the Effect of Bus Exclusive Lanes on Traffic Intersections

5.5.2.1 Examination Method

(1) Purpose of the Examination

The purpose of the examination is to analyze the effect that installation of BRT exclusive lanes will have on the treatment of intersections. Furthermore, the traffic intersection analysis uses the methodology from Japan. A simplified analysis was done using measureable data from a simplified traffic volume survey (evaluation by the different traffic lanes was not conducted).



(2) Indicators for the Traffic Intersection Analysis

For the traffic intersection analysis, the following 2 indicators are used.

1) Saturation Degree of the Intersection

The saturation degree of the intersection is the total value of the demand factor (proportion of the actual traffic volume at the entrance of the intersection and the saturation flow rate[*1]) of the right of way (traffic flow from each direction).

In Japan, if the saturation degree of the intersection reaches 0.9[*2] or greater, at the entrance of the intersection of each lane, long traffic queues would be produced and congestion at the traffic intersections would become bigger. In Hanoi, even during the red traffic cycle, there are many vehicles that cross the intersection; as a result, the saturation degree of the intersection is set at 1.0 for reference. The saturation degree of the intersection is calculated from the traffic volume, signal cycle and the physical arrangement of the intersection.

*1 Saturation Flow Rate: Assume that an intersection's approach signal were to stay green for an entire hour, and the traffic was as dense as could reasonably be expected. The number of vehicles that would pass through the intersection during that hour is the saturation flow rate.

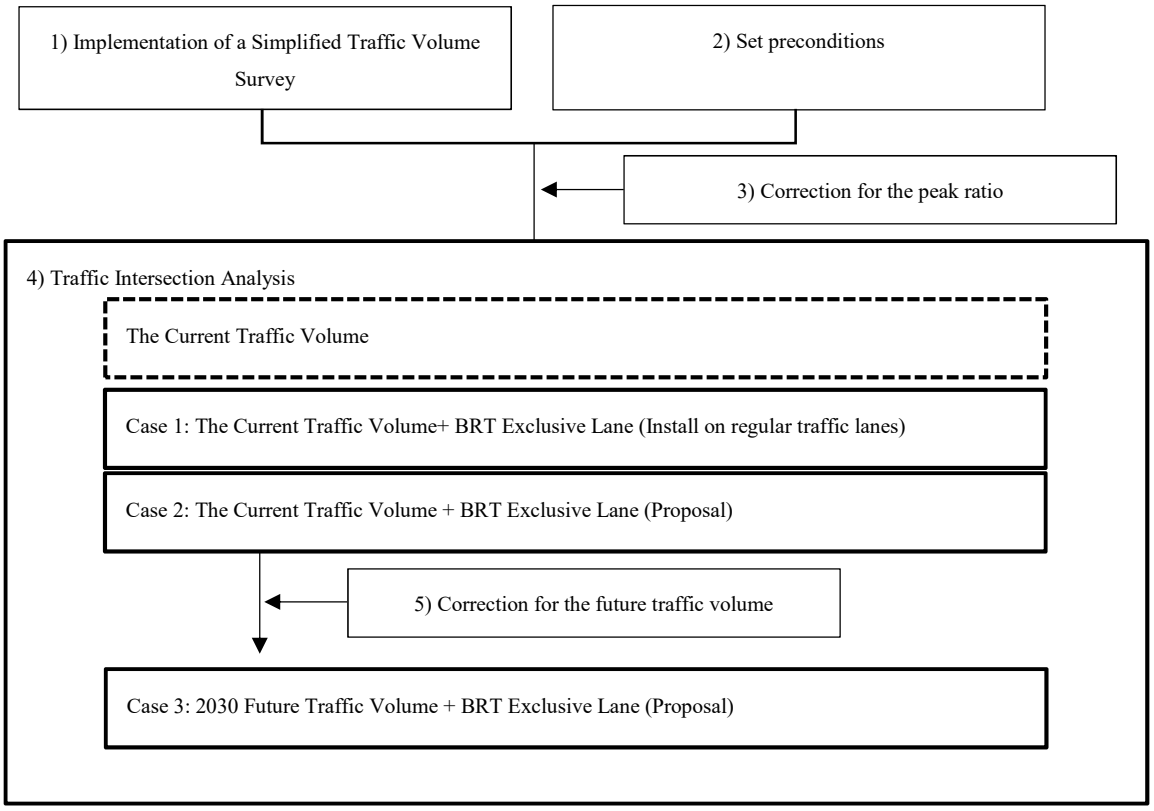
*2 Meaning of 0.9: During 1 cycle of the traffic signal, from the yellow and red phase, in every direction there is the time where traffic cannot pass (clearance time). Typically, the clearance time during 1 cycle is around 10%. The reference value of 0.9 is the difference between 10% and the total value.

2) Congestion Factor

The congestion factor is the proportion between the actual traffic volume and the traffic capacity (number of vehicles that can pass in 1 hour). The traffic capacity is calculated during the process of calculating the saturation degree of the intersection. In this study, the congestion factor was calculated for each direction of the intersection, however, for more detailed examination, the congestion factor needs to be calculated for each traffic lane. If the congestion factor is greater than 1.0, congestion will occur in the intersection.

(3) Examination Methodology

For Option 1 and Option 2, it is possible to propose the use of the center median for the BRT exclusive lane and for the BRT to go over the intersections via overpasses and underpasses. For this reason, not only will the BRT exclusive lane be examined for the case of installation over regular traffic lanes, but it was also examined for the case for the center median, the "Proposal". With regards to the traffic intersection analysis, it was done according to the following flowchart.



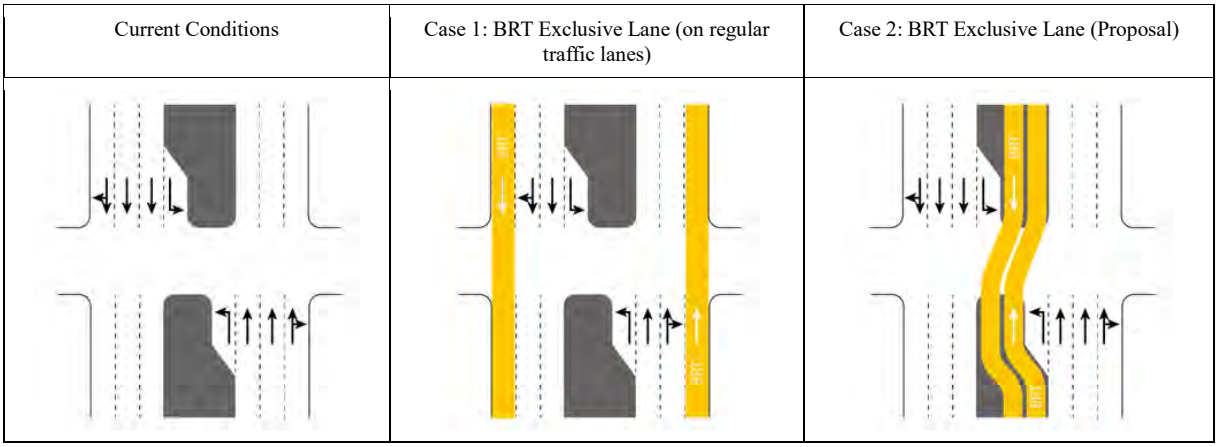


Figure 5.5.7 Flowchart of the Traffic Intersection Analysis

1) Implementation of the Simplified Traffic Volume Survey

For the alternative BRT routes along Ring Road 3 and on the route of the UMRT Line 5/BRT corridor and for the targeted intersections with traffic signals, the study team conducted a simplified traffic volume survey.

The main contents of the survey are the following 3 items:

a) Traffic volume
b) Traffic signal cycle
c) Lane composition of the intersection

The intersections that were considered in the simplified traffic volume survey are shown in the following figure. For traffic intersections with traffic signals, there were 9 locations located along the route for Option-1, Option-2 and Option-6 and 7 locations for Option-4, Option-5 and Option-6

Figure 5.5.8 Locations of the Traffic Intersections in the Simplified Survey

Table 5.5.1 The List of Traffic Intersections for Analysis

Option-1, Option-2, Option-6	
1	UMRT 5 - Doi Can
2	UMRT 5 - Van Phuc
3	UMRT 5 - Dao Tan
4	UMRT 5 - Kim Ma
5	UMRT 5 - Huyen Thuc
6	UMRT 5 - Lang
7	UMRT 5 - Nguyen Khang
8	UMRT 5 - Hoang Minh
9	UMRT 5 - Ring Road 3

Option-4, Option-5, Option-6	
1	Ring Road 3 - UMRT 2A
2	Ring Road 3 - World Bank BRT
3	UMRT 5 - Ring Road 3
4	Ring Road 3 - South of Bao Tang Ha Noi
5	Ring Road 3 - Do Duc Duc
6	Ring Road 3 - Duong Dinh Nghe
7	Ring Road 3 - Nguyen Hoang/Ton That Thuyet

2) Set Preconditions

For the base value of the saturation flow rate for the signalized intersection, the saturation flow rate as shown below was used. The saturation flow rate numbers were corrected based on the influence effect of the traffic conditions for the traffic intersection.

For the influence factor, the following were taken into consideration: configuration of the intersection (angle of the traffic intersection and visibility), composition of the vehicles (number of large vehicles and motorbikes, etc.) and large numbers of left and right turning vehicles.

Table 5.5.2 Saturation Flow Rate Base Value for Signalized Intersections

Type of Lane	Saturation Flow Rate (PCU/1 hour green cycle phase)
Through Traffic	2,000
Left Turn	1,800
Right Turn	1,800

This simplified traffic volume survey did not measure the traffic volume of motorbikes. Based on the METROS study and viewing the actual situation on the ground, the traffic volume of motorbikes was assumed to be 3 times the traffic volume of car vehicles.

Table 5.5.3 Representative Traffic Modes of the Old Administrative Boundaries of Hanoi

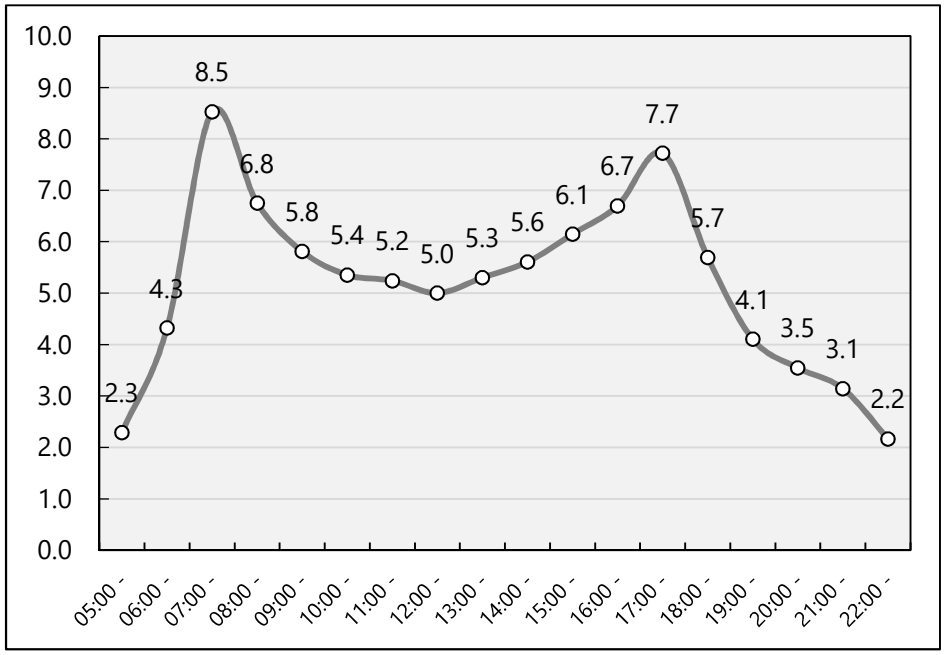
	2005		2013		2013/2005		Estimate
	Vehicles (1,000)	Proportion (%)	Vehicles (1,000)	Proportion (%)			
Cars	1,598	24%	2,056	19%	1.3	→	20%
Motorbikes	4,078	62%	6,785	64%	1.7	→	60%
Motorized Vehicles	869	13%	1,730	16%	2.0	→	20%
Total	6,545	100%	10,571	100%	1.6		

Source: METROS Study

3) Correction for the Peak Ratio

For the simplified traffic volume survey, for each traffic intersection, the traffic was only measured during 1 hour of the survey day and so this surveyed hour does not necessarily correspond to the peak period. Utilizing the existing traffic volume data by time period from the METROS study, the peak traffic volume was calculated.

Looking at the distribution of the traffic volume by time period, the peak ratio (proportion of the peak hour traffic volume and the daily traffic volume) was 8.5% and this occurred during the morning at 7:00.



Source: METROS Study

Figure 5.5.9 Traffic Volume by Time Period from the Screenline Survey in the Central Area

4) Approach for the Traffic Intersection Analysis

After correction for the peak ratio from the results of the simplified traffic volume survey and considering the before and after of the introduction of the BRT exclusive lanes, the saturation degree of the intersection as well as the congestion factor by direction was calculated.

In the case where the first lane (see the following figure) is used as the BRT lane, the through traffic lanes on the road will be reduced. With regards to the influence on the intersection, the intersection will be evaluated based on the saturation degree of the intersection and the congestion factor by direction.

For example, for traffic intersection No. 1 for Option-1, Option-2, the results are shown as follows. At this intersection, the effect of the introduction of the BRT exclusive lane can be estimated as follows.

a) At the A-C directions where the BRT exclusive lane is set, the traffic capacity is reduced by 35% (before the introduction of the BRT exclusive lane: 2,220 vehicles/hour, after: 1,450 vehicles/hour)

b) From the introduction of the BRT exclusive lane, the saturation degree of the intersection is increased from 0.938 to 1.134. If the saturation degree of the intersection goes over 1.0, at the entrance to the intersection for every direction, queues will form and traffic will be delayed.

c) On the C direction, the congestion factor rises from 0.86 to 1.32. Typically, if the congestion factor rises above 1, congestion is caused.

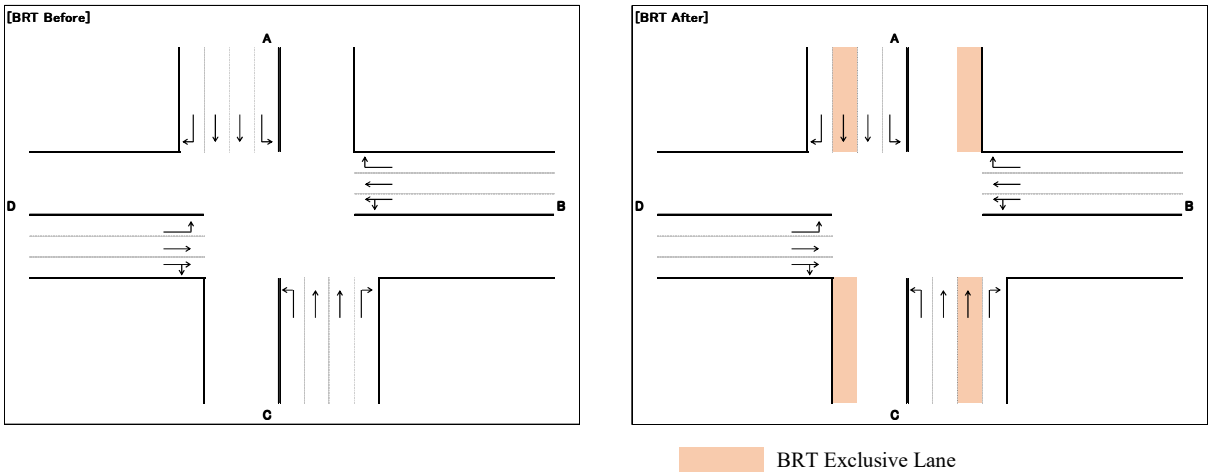


Figure 5.5.10 Example of the Introduction of the BRT Exclusive Lane (Intersection No. 1 for Option-1, Option-2)

Table 5.5.4 Example of the Results of the Traffic Intersection Analysis (Before the installation of the BRT exclusive lane)

Current Traffic Volume

	Cycle 1	Cycle 2	Cycle 3
Approaches	A-C (Left)	A-C (Straight, Right)	B-D
Saturation Flow Rate	A: Straight 1800 * 0 = 0 Left Turn 1600 * 1 = 1600 Right Turn 1600 * 0 = 0 Straight + Right 1600 * 0 = 0 Straight + Left 1500 * 0 = 0 Straight + Right + Left Turn 1400 * 0 = 0 1600 C: Straight 1800 * 0 = 0 Left Turn 1600 * 1 = 1600 Right Turn 1600 * 0 = 0 Straight + Right 1600 * 0 = 0 Straight + Left 1500 * 0 = 0 Straight + Right + Left Turn 1400 * 0 = 0 1600	A: Straight 1800 * 2 = 3600 Left Turn 1600 * 0 = 0 Right Turn 1600 * 1 = 1600 Straight + Right 1600 * 0 = 0 Straight + Left 1500 * 0 = 0 Straight + Right + Left Turn 1400 * 0 = 0 5200 C: Straight 1800 * 2 = 3600 Left Turn 1600 * 0 = 0 Right Turn 1600 * 1 = 1600 Straight + Right 1600 * 0 = 0 Straight + Left 1500 * 0 = 0 Straight + Right + Left Turn 1400 * 0 = 0 5200	B: Straight 1800 * 1 = 1800 Left Turn 1600 * 0 = 0 Right Turn 1600 * 1 = 1600 Straight + Right 1600 * 0 = 0 Straight + Left 1500 * 1 = 1500 Straight + Right + Left Turn 1400 * 0 = 0 4900 D: Straight 1800 * 1 = 1800 Left Turn 1600 * 0 = 0 Right Turn 1600 * 1 = 1600 Straight + Right 1600 * 0 = 0 Straight + Left 1500 * 1 = 1500 Straight + Right + Left Turn 1400 * 0 = 0 4900
Traffic Volume by Direction	A: 580 C: 580	A: 1920 C: 1920	B: 1010 D: 1010
Necessary Green Phase Ratio	A: 36.3% (580 / 1600) C: 36.3% (580 / 1600)	A: 36.9% (1920 / 5200) C: 36.9% (1920 / 5200)	B: 20.6% (1010 / 4900) D: 20.6% (1010 / 4900)
Current Green Phase Ratio	A: 22.7% C: 22.7%	A: 42.7% C: 42.7%	B: 34.7% D: 34.7%
Traffic Capacity	A: 360 C: 360	a) A: 2220 C: 2220	B: 1700 D: 1700
Congestion Factor	A: 1.61 C: 1.61	b) A: 0.86 C: 0.86	B: 0.59 D: 0.59
Saturation Degree of the Intersection		c) 0.938 ← 36.3% + 36.9% + 20.6%	

Table 5.5.5 Example of the Results of the Traffic Intersection Analysis (After the installation of the BRT exclusive lane)

Current Traffic Volume + BRT Exclusive Lane (on the regular traffic lane)

	Cycle 1	Cycle 2	Cycle 3
Approaches	A-C (Left)	A-C (Straight, Right)	B-D
Saturation Flow Rate	A: Straight 1800 * 0 = 0 Left Turn 1600 * 1 = 1600 Right Turn 1600 * 0 = 0 Straight + Right 1600 * 0 = 0 Straight + Left 1500 * 0 = 0 Straight + Right + Left Turn 1400 * 0 = 0 1600 C: Straight 1800 * 0 = 0 Left Turn 1600 * 1 = 1600 Right Turn 1600 * 0 = 0 Straight + Right 1600 * 0 = 0 Straight + Left 1500 * 0 = 0 Straight + Right + Left Turn 1400 * 0 = 0 1600	A: Straight 1800 * 1 = 1800 Left Turn 1600 * 0 = 0 Right Turn 1600 * 1 = 1600 Straight + Right 1600 * 0 = 0 Straight + Left 1500 * 0 = 0 Straight + Right + Left Turn 1400 * 0 = 0 3400 C: Straight 1800 * 1 = 1800 Left Turn 1600 * 0 = 0 Right Turn 1600 * 1 = 1600 Straight + Right 1600 * 0 = 0 Straight + Left 1500 * 0 = 0 Straight + Right + Left Turn 1400 * 0 = 0 3400	B: Straight 1800 * 1 = 1800 Left Turn 1600 * 0 = 0 Right Turn 1600 * 1 = 1600 Straight + Right 1600 * 0 = 0 Straight + Left 1500 * 1 = 1500 Straight + Right + Left Turn 1400 * 0 = 0 4900 D: Straight 1800 * 1 = 1800 Left Turn 1600 * 0 = 0 Right Turn 1600 * 1 = 1600 Straight + Right 1600 * 0 = 0 Straight + Left 1500 * 1 = 1500 Straight + Right + Left Turn 1400 * 0 = 0 4900
Traffic Volume by Direction	A: 580 C: 580	A: 1920 C: 1920	B: 1010 D: 1010
Necessary Green Phase Ratio	A: 36.3% (580 / 1600) C: 36.3% (580 / 1600)	A: 56.5% (1920 / 3400) C: 56.5% (1920 / 3400)	B: 20.6% (1010 / 4900) D: 20.6% (1010 / 4900)
Current Green Phase Ratio	A: 22.7% C: 22.7%	A: 42.7% C: 42.7%	B: 34.7% D: 34.7%
Traffic Capacity	A: 360 C: 360	a) A: 1450 C: 1450	B: 1700 D: 1700
Congestion Factor	A: 1.61 C: 1.61	b) A: 1.32 C: 1.32	B: 0.59 D: 0.59
Saturation Degree of the Intersection		c) 1.134 ← 36.3% + 56.5% + 20.6%	

5) Correction for the Future Traffic Volume

Based on the current results of the traffic intersection analysis, from the growth rate of the future traffic volume, the future traffic volume is set and the examination of the treatment of the intersections with the installation of the BRT exclusive lane is conducted.

a) Current Traffic Volume: Traffic volume corrected with the peak ratio from the simplified traffic volume survey
b) Future Traffic Volume: The 2020 and 2030 traffic volume calculated from the travel demand forecast model

The future traffic volume growth rate for all of the alternative options is shown as follows.

Table 5.5.6 Future Traffic Volume Growth Rate for Option-1, Option-2, Option-6

Unit: 10,000 vehicles

	Currently	2020	2030
Average	4.2	4.4	4.6
Ho Tay-Kim Ma	3.6	3.9	4.1
Kim Ma-Duong Lang	4.1	4.3	4.5
Duong Lang-Ring Road 3	4.8	5.0	5.2
Growth Rate:	**1.00**	**1.06**	**1.10**

Table 5.5.7 Future Traffic Volume Growth Rate for Option-4, Option-5, Option-6

Unit: 10,000 vehicles

	Currently	2020	2030
Average	2.7	2.6	2.5
Growth Rate:	**1.00**	**0.96**	**0.93**

For the future estimated traffic volume, it was assumed that by 2020, the UMRT Lines 2, Line 2A and Line 3 and the BRT (Option-1, Option-2, Option-6) are constructed and by 2030, UMRT Lines 1-4 and 6-8 as well as the BRT (Option-1, Option-2, Option-6) are constructed and that this traffic volume includes trips that will be shifted to public transport modes. Also, it was assumed that there will be a full build out of the planned road network in Hanoi and so in the future, there will be a trend of the easement of traffic congestion. This is why the future traffic volume growth rate is decreased on Ring Road 3 (Option-4, Option-5, Option-6)

5.5.2.2 Results of the Traffic Intersection Analysis

(1) For Option-1, Option-2, Option-6

In the case a BRT exclusive lane is established, the estimation of the effects that will occur are shown as follows.

Case 1: The Current Traffic Volume+ BRT Exclusive Lane (Install on regular traffic lanes)

- From the establishment of a BRT exclusive lane on the regular traffic lanes for Option-1, Option-2, Option-6 it is estimated that almost all of the intersections will have a saturation degree of the intersection that goes over 1.0.
- In particular, at the intersection between Option-1, Option-2, Option-6 and Ring Road 3 (Intersection No. 9, Intersection No. 4, Kim Ma), the saturation degree of the intersection and congestion factor will rise and it is estimated that there will be congestion at these intersections

Case-2: The Current Traffic Volume + BRT Exclusive Lane (Proposal)

- From the establishment of the BRT exclusive lane on the center median and through the use of an underpass on intersection No. 9 and an overpass on intersections No. 3-4, 6-7 and simplification of the signal cycle from the restriction of left turns at intersection No. 8, impact on regular traffic can be avoided.
- Furthermore, at Kim Ma (where there are many facilities that attract customers) and intersection No. 4, for the convenience of BRT users and looking at the viewpoint of achieving profitability for the bus operator, instead of passing through and overpass, it is desirable for the BRT to run at-grade under the overpass. However, there are issues with traffic management with this approach so there are merits and demerits as well.

Table 5.5.8 Results of the Traffic Intersection Analysis for Option-1, Option-2, Option-6

Case-1: Current Traffic Volume + BRT Exclusive Lane (installed on the regular traffic lanes)

No.	1	2	3	4	5	6	7	8	9
Traffic Volume	6,960	4,910	7,340	9,220	8,910	7,190	4,030	7,500	9,160
Capacity	7,020	5,980	6,640	5,940	7,940	5,970	3,940	9,000	6,210
Congestion Factor	0.99	0.82	**1.11**	**1.55**	**1.12**	**1.20**	**1.02**	0.83	**1.48**
Saturation Degree of the Intersection	**1.092**	0.734	**1.430**	**1.657**	**1.120**	**1.331**	**1.053**	**1.076**	**1.054**

Case-2: Current Traffic Volume + BRT Exclusive Lane (Proposal)

No.	1	2	3	4	5	6	7	8	9
Traffic Volume	6,960	4,910	7,340	9,220	8,910	7,190	4,030	7,500	9,160
Capacity	8,560	7,780	7,380	6,540	7,940	5,970	3,940	11,890	6,810
Congestion Factor	0.81	0.63	0.99	**1.41**	**1.12**	**1.20**	**1.02**	0.63	**1.35**
Saturation Degree of the Intersection	0.898	0.585	**1.332**	**1.438**	**1.120**	**1.331**	**1.053**	0.978	0.898

Case-3: Future Traffic Volume + BRT Exclusive Lane (Proposal)

No.	1	2	3	4	5	6	7	8	9
Traffic Volume	7,660	5,400	8,090	10,140	9,810	7,900	4,430	8,250	10,100
Capacity	8,560	7,780	7,380	6,540	7,940	5,970	3,940	11,100	6,810
Congestion Factor	0.89	0.69	**1.10**	**1.55**	**1.24**	**1.32**	**1.12**	0.74	**1.48**
Saturation Degree of the Intersection	0.989	0.643	**1.464**	**1.582**	**1.233**	**1.464**	**1.157**	**1.080**	0.991

※ Bold Font: Congestion Factor, Saturation Degree of the Intersection > 1.0

※ Blue Font: BRT passes through via underpasses/overpasses

Figure 5.5.11 Results of the Traffic Intersection Analysis for Case 2: Current Traffic Volume + BRT Exclusive Lane (Proposal) for Option-1, Option-2, Option-6

(2) For Option-4, Option-5, Option-6

In the case that the BRT exclusive lane is established on Ring Road 3, the estimation of the effects that will occur is shown as follows.

Case 1: The Current Traffic Volume+ BRT Exclusive Lane (Install on regular traffic lanes)

- From the establishment of the BRT exclusive lane on regular traffic lanes for Option-4, Option-5, Option-6 it is estimated that many traffic intersections will have a saturation degree of the intersection that exceeds 1.0. In particular, in the section between intersection No. 1 and intersection No. 3, the saturation degree of the intersection and congestion factor are estimated to be high and it is estimated that there will be congestion at these intersections

Case-2: The Current Traffic Volume + BRT Exclusive Lane (Proposal)

- Utilizing the centre median space for the establishment of the BRT exclusive lanes, the effect on regular traffic at intersections can be avoided and it is estimated that for many intersections, the saturation degree of the intersection can be restrained to below 1.0. However, for intersection No. 3, the congestion factor is estimated to be high, and during the peak periods, there is the possibility of congestion that will last for many hours.
- However, for the future (in 2030), based on the estimation results, overall congestion will be eased.

Table 5.5.9 Results of the Traffic Intersection Analysis for Option-4, Option-5, Option-6

Case-1: Current Traffic Volume + BRT Exclusive Lane (installed on the regular traffic lanes)

No.	1	2	3	4	5	6	7
Traffic Volume	9,290	9,640	9,160	3,830	3,970	7,790	7,120
Capacity	7,680	7,470	5,010	3,030	4,050	9,310	8,480
Congestion Factor	**1.21**	**1.29**	**1.83**	**1.26**	0.98	0.84	0.84
Saturation Degree of the Intersection	**1.222**	**1.178**	**1.231**	**1.246**	**1.161**	0.817	**1.067**

Case-2: Current Traffic Volume + BRT Exclusive Lane (Proposal)

No.	1	2	3	4	5	6	7
Traffic Volume	9,290	9,640	9,160	4,240	3,970	7,790	7,120
Capacity	8,590	8,350	6,810	5,070	6,450	10,670	9,920
Congestion Factor	**1.08**	**1.15**	**1.35**	0.84	0.62	0.73	0.72
Saturation Degree of the Intersection	**1.081**	**1.027**	0.898	0.899	0.811	0.712	0.995

Case-3: Future Traffic Volume + BRT Exclusive Lane (Proposal)

No.	1	2	3	4	5	6	7
Traffic Volume	8,600	8,940	8,480	3,550	3,680	7,220	6,600
Capacity	8,590	8,350	6,810	5,070	6,450	10,670	9,920
Congestion Factor	**1.00**	**1.07**	**1.25**	0.70	0.57	0.68	0.67
Saturation Degree of the Intersection	**1.000**	0.952	0.832	0.834	0.753	0.659	0.924

※ Bold Font: Congestion Factor, Saturation Degree of the Intersection > 1.0

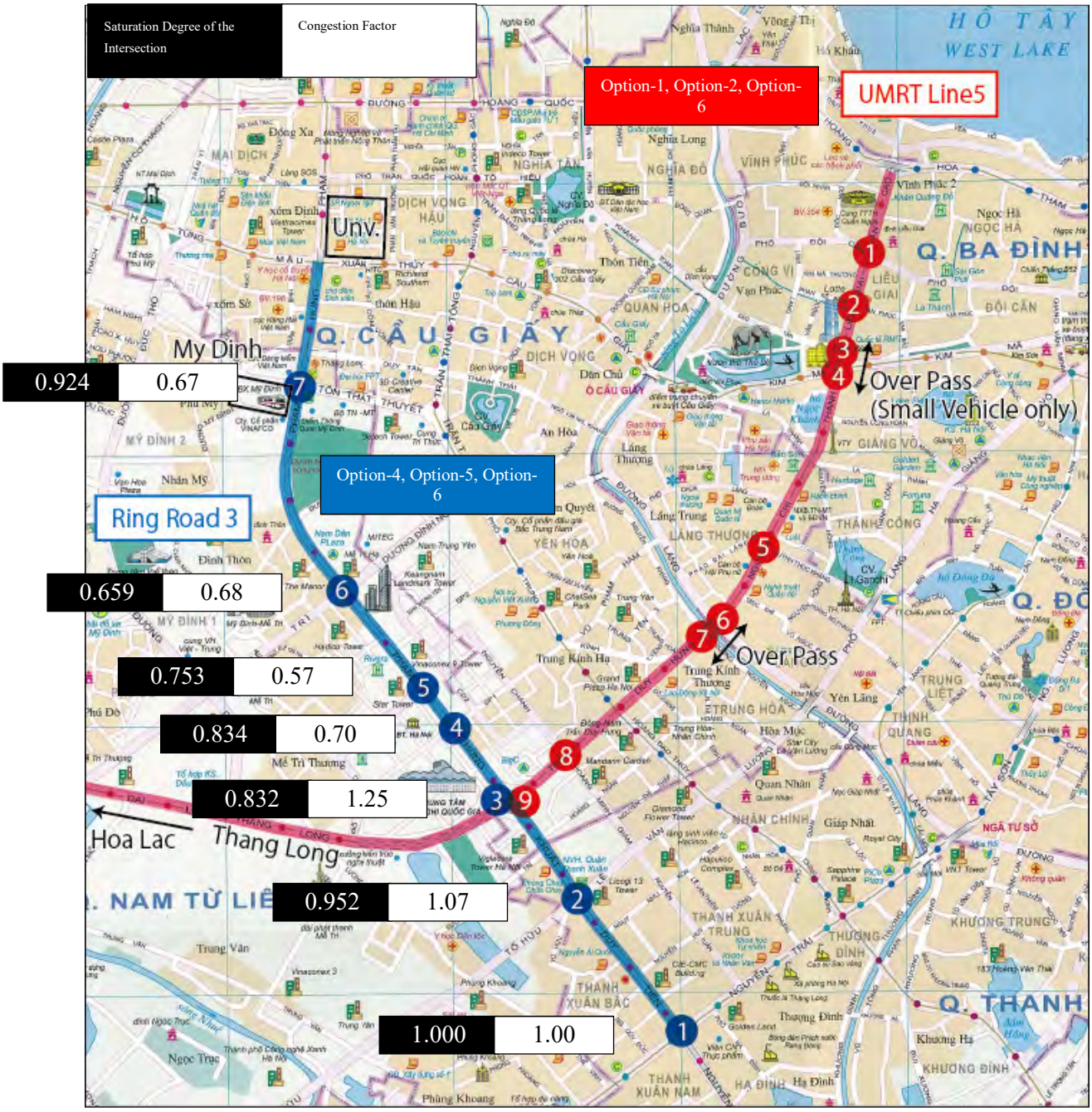


Figure 5.5.12 Results of the Traffic Intersection Analysis for Option-4, Option-5, Option-6 for Case-3: Future Traffic Volume (2030) + BRT Exclusive Lane (Proposal)

5.5.2.3 Issues with Regards to the Treatment of Traffic

(1) Position of the BRT Exclusive Lane at the Intersections

Regarding the location for the installation of the BRT exclusive lane, in addition to the traffic intersection analysis, the impact on the road capacity differs depending if the BRT exclusive lane is installed on the regular traffic lanes (① to ③) and if the BRT exclusive lane was installed on the centre median, lane ④.

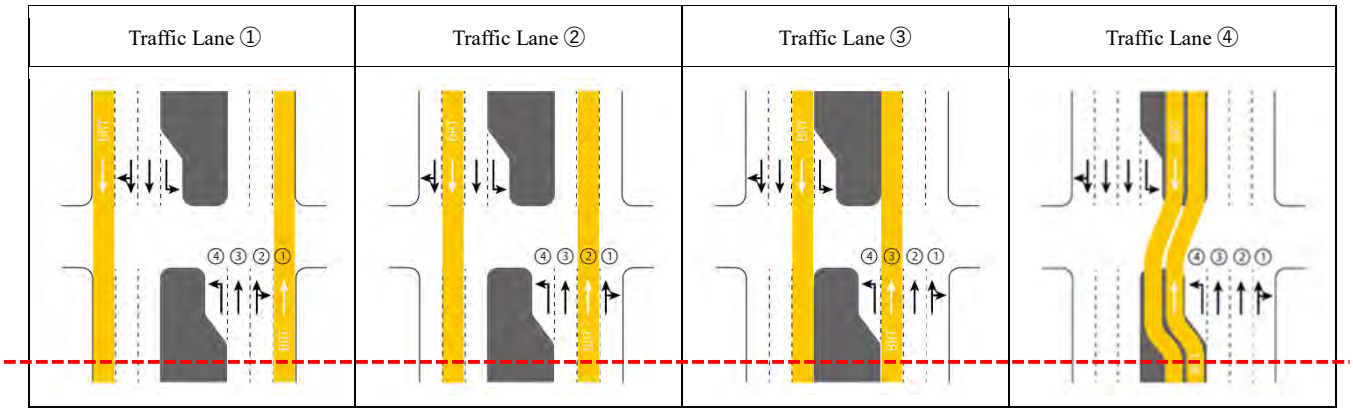


Figure 5.5.13 Position of the BRT Exclusive Lanes at the Intersection

In the case that the BRT exclusive lane is installed on traffic lanes ① to ③, the through traffic capacity (section of road between intersections) will be decreased from 3 lanes to 2 lanes and the traffic capacity will decrease by 2/3.

On the other hand, if the BRT exclusive lane is installed on the centre median (traffic lane ④), then the traffic carrying capacity of the road will not be decreased and it is possible to secure the operating space for the BRT. For that reason, for each option, the centre median space is available to be utilized and it is proposed that the BRT exclusive lanes be installed in the centre median space.

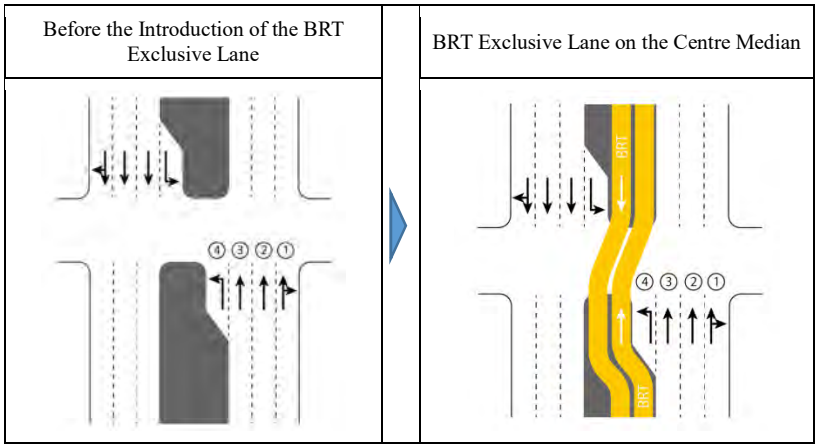


Figure 5.5.14 Position of the BRT Exclusive Lane at the Centre Median

(2) Regarding the Necessity of a Traffic Volume Survey

For this study, the effect of the traffic volume inflow to the intersection only was examined in a simplified manner. However, for traffic intersections, there are various elements that effect the treatment of traffic such as the effect of oncoming traffic, right and left turns, pedestrians and the passing through method of motorbikes. As a result, it is necessary to consider these effects upon the installation of the BRT exclusive lane.

Therefore, for example, the following items to be examined in a traffic volume survey would be effective.

- Survey Time Period: Implemented at the same time as the BRT operation time period
- Survey Items: Traffic volume of motorized vehicles
- Type of Vehicles to be Surveyed: Large trucks, small trucks, buses, passenger cars, taxis and motorbikes
- Survey Locations: The traffic intersections along the UMRT Line 5/BRT corridor and on Ring Road 3
- Counting Method: Every 15 minutes or every hour (by lane, by direction)

5.5.3 Examination of Bus Priority Traffic Signals

5.5.3.1 Overview of Bus Priority Traffic Signals

PTPS is a system that controls the combination of traffic regulation measures such as bus priority/exclusive lanes and traffic signal devices. Typically, an in-vehicle device installed on the buses sends a signal to an infrared beacon installed on the roadside and this signal causes the green phase on the traffic signal to be prolonged or causes the red phase to be shortened. From this, the delay time required for buses to cross an intersection can be reduced or eliminated. In addition, the infrared beacons can detect regular traffic that use the bus priority/exclusive lanes to give them a warning.

The results from the introduction of this system are that the waiting time from the traffic signals are reduced causing the required travel time on the bus routes to be reduced as well. From this, stable bus operations are secured, convenience for bus passengers is improved and this also promotes usage of the buses.

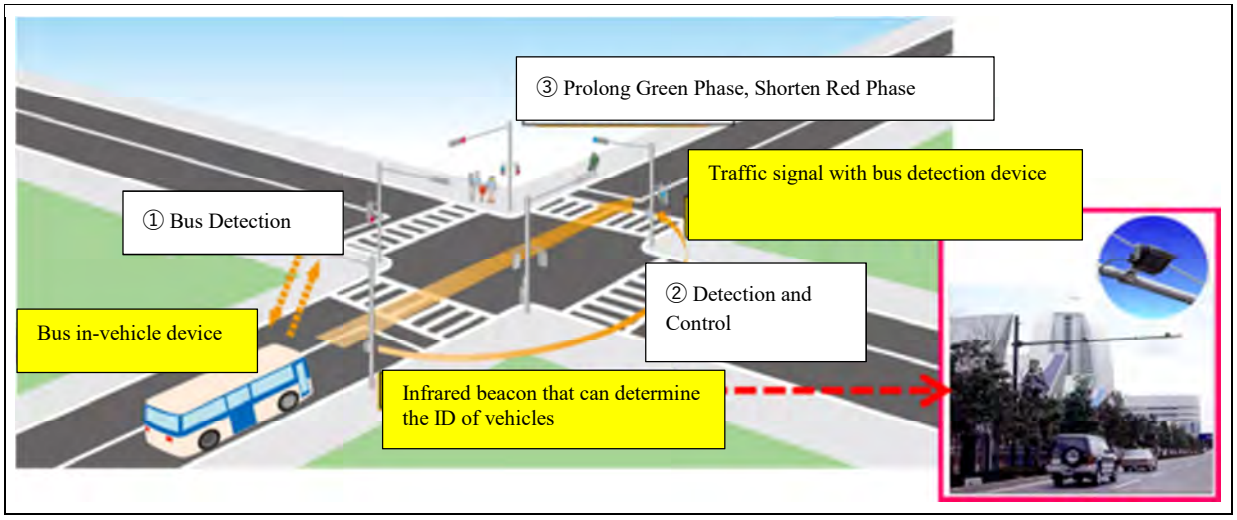


Figure 5.5.15 Overview of the PTPS

5.5.3.2 Reduction of Bus Travel Time Due to the Installation of Bus Priority Signals

(1) For Option-1, Option-2, Option-6

The UMRT Line 5/BRT corridor in the urban area of Hanoi (Option-1, Option-2, Option-6) is approximately 5 km from the end of the Thang Long Expressway and Ring Road 3 (intersection No. 1) to near Ho Tay. Assuming an average operating speed of the BRT at 15 km/h, the one way estimated travel time in this section is around 20 minutes.

On this section of the BRT route, there are 9 intersections, the total red phase time per 1 cycle adds up to around 10-11 minutes. Supposing that if at all intersections traffic had to stop at the red phase and that if a bus signal priority system was installed so that buses could pass through smoothly through this red phase, then on the one way travel time for buses in this section, there would be a maximum reduction of 10 minutes. As a result, the total travel time during this section could be reduced by 50%.

(sec)

Southbound			Intersection No.	Northbound		
Red	Green	Total		Red	Green	Total
43	32	75	8	43	32	75
45	45	90	7	45	45	90
75	20	95	6	75	20	95
75	15	90	5	75	15	90
35	55	90	4	35	55	90
121	39	160	3-2	141	19	160
85	60	145	3-1	105	40	145
30	35	65	2	30	35	65
100	20	120	1	100	20	120
609	321	930		649	281	930

(sec)

Figure 5.5.16 Red and Green Phase Times on the Intersections for Option-1, Option-2, Option-6

(2) For Option-4, Option-5, Option-6

The proposed route along the Ring Road 3 (Option-4, Option-5, Option-6) for the BRT is approximately 6 km long. Assuming an average travel speed of 15 km/h for the BRT, then required travel time is 24 minutes.

On this route, there are 7 intersections and the total red phase time per 1 cycle adds up to 7-8 minutes. Supposing that if at all intersections traffic had to stop at the red phase and that if a bus signal priority system was installed so that buses could pass through smoothly through this red phase, then on the one way travel time for buses in this section, there would be a maximum reduction of 8minutes. As a result, the total travel time during this section could be reduced by 30%.

(sec)

Southbound		
Red	Green	Total
58	39	97
55	41	96
20	60	80
46	60	106
50	70	120
113	37	150
93	60	153
435	367	802

Intersection No.

7
6
5
4
3
2
1

(sec)

Northbound		
Red	Green	Total
58	39	97
55	41	96
20	60	80
46	60	106
70	50	120
113	37	150
106	47	153
468	334	802

Figure 5.5.17 Red and Green Phase Times on the Intersections for Option-4, Option-5, Option-6

5.5.4 Issues With Regards to the Introduction of PTPS

For the World Bank BRT project, for the introduction of PTPS, procurement has already been conducted and out of 32 intersections, 14 intersections already have PTPS systems constructed and the rest are scheduled to be completed by June 2016 (based on information obtained by the study team as of April 2016). Therefore, the city of Hanoi and related organizations already understand the concept of PTPS and the conditions are favorable for the introduction of PTPS for this BRT project.

On the other hand, with regards to the introduction of PTPS, there are a number of issues. Based on the experience of the World Bank BRT project, the issues identified are as follows:

(1) Suitability of the ITS Technology for the Existing Traffic Management System

One of the successful points of PTPS is the ability of PTPS to dynamically control the traffic signals based on the actual traffic conditions as well as coordinating the traffic signals for a number of intersections on the same road. For this reason, in addition to this BRT project, it is necessary to consider the suitability of PTPS for Hanoi's entire traffic management system as well as to carefully consider the selection of the ITS technology to enable the PTPS.

(2) Impact on Traffic Congestion Outside of the BRT Route

On the World Bank BRT project, from the bus priority signals, there are worries that the traffic congestion will get worse due to longer waiting times at intersections for regular traffic because of the bus priority signals.

For this problem, a traffic volume survey needs to be conducted and the current as well as future traffic demand needs to be estimated based on reliable traffic data. In addition, microsimulations need to be conducted at focus points along the proposed BRT routes to determine the detailed effect of bus priority signals on the traffic.

Also, based on the quantitative results, it is necessary to explain the results effectively to related organizations and citizens about the effects of this system to secure the stable operations of the BRT.

(3) Issues With Cost

For a city without a traffic control centre and without interlocking control of various signals and in the case of installing a PTPS at each intersection, the cost per one PTPS unit is around 25 million yen (approximately US$230,000) based on the actual cost and installation in Japan.

On the other hand, in Japan, there are many local authorities where there is a traffic control centre and where there is interlocking control with various signals and in this case, it would require an investment of around 1 billion-10 billion yen (US$9.2 million-92 million).

In Hanoi, there is already a traffic control centre in operation that controls intersection signals and monitors traffic via surveillance cameras. In the case there a PTPS system is introduced, the study team estimates that it would cost around 100 million yen (US$930,000) to retrofit the existing system.

5.6 Estimated Project Costs

5.6.1 Project Cost Components and Cost Estimation Methodology

In this section, the project costs for the evaluation of the preferred alternatives will be roughly estimated by multiplying the quantities based on the facility and operation plans by the unit costs established referring to similar studies and etc. The components of the project costs and methodology for setting the unit cost are shown in the following table, and detail is presented from 5.6.2.

Table 5.6.1 Project Cost Components and Cost Estimation Methodology

Item		Content	Cost Estimation Methodology
Initial Facilities Cost	Civil Works	Exclusive lane (embankment, bridge, culvert), public transport priority system: PTPS (stand-alone type), Bus stops, motorbike parking, Elevated footpath, Underground footpath	Use the unit cost per square meter or meter etc. referred to in similar studies and the Vietnamese standard unit cost to calculate the costs
	Depot	Office, facilities for maintenance of vehicles, facilities for fueling, washing stations and parking stations	Referred to the construction cost of similar construction to calculate the costs
	Vehicles	Diesel type (standard, articulated bus)	Quotation from the manufacturer
	Fare Collection System	Boarding ticket machines, Destination display devices, Fare boxes	Quotation from the manufacturer
Cost for Additional Facilities and Renewal Cost during O&M phase	Vehicles	Additional costs for the addition of new vehicles to meet increased demand and costs for fleet renewal	Quotation from the manufacturer
	Fare Collection System	Additional costs due to addition of new vehicles	Quotation from the manufacturer
Operation & Maintenance Cost	Operation and Maintenance Cost for Civil and Depot facilities	Cost for the repairs and maintenance of civil works	Calculation based on the proportion of the initial costs for the civil works referring Vietnamese standard 22TCVN211-93
	Bus Operation Cost	Labour costs, fuel costs, maintenance costs etc. related to bus operation	Calculation based on the actual operation costs of bus companies in Hanoi, then establish the unit cost per km
Engineering Costs		FS, Detailed Design, Tendering Assistant, Construction Supervision	Calculation based on a proportion of the initial costs, namely 15%
Local Administration Costs		If the project is implemented via ODA, the implementation organizations from the Vietnamese side is required to bear the costs	
Land Acquisition Costs		Costs if it is necessary for land acquisition for the construction of civil works and depot	Land price in Hanoi from 2015-2019, which was officially announced by Hanoi PC (Decision 96/2014/QD-UBND)
Tax		Corporate Income Tax, Value Added Tax etc.	Consider in financial analysis (refer to Chapter 6)
Contingency		Physical and Price Escalation	Consider in financial analysis (refer to Chapter 6)

Source: Study Team

5.6.2 Quantity of Facilities

5.6.2.1 Quantity of Civil Works

A rough estimation of the quantities based on the facility plan proposed in Section 5.2: BRT Facilities Plan is summarised in the following table.

Table 5.6.2 Quantity of Civil Works for Each Option

OPTION-1

Area	Item	Unit	Quantity	Description of Item
Urban Area (Exclusive lane)	BRT exclusive lane	m^2	38,400	length 3.1 km, width 3.5m x 2-lane, 3-lane at bus stop section, bus waiting space
	PTPS	num.	9	stand-alone type
	Bus stop	num.	5	roof, bench, digital signage
	Elevated footpath	num.	5	length 45 m, width 4.0 m, with 4 elevators
Suburban Area (Exclusive lane)	BRT exclusive lane	m^2	196,700	length 28.1 km, width 3.5 m x 2-lane, asphalt pavement, highway miscellaneous
	Bridge (Widening)	m^2	10,320	bridge, culvert, total number of 39 and total length 1,290 m
	Bus stop (on expressway)	num.	11	roof, bench, digital signage
	Bus stop (inside HHTP)	num.	5	roof, bench, digital signage
	Elevated footpath	num.	11	length 75 m, width 4.0 m, with 2 elevators
	Motorbike parking	num.	11	300 motorbikes at both sides, total area of 1,800m^2, with roof and ticket system

OPTION-2

Area	Item	Unit	Quantity	Description of Item
Urban Area (Exclusive lane)	BRT exclusive lane	m^2	38,400	length 3.1 km, width 3.5 m x 2-lane, 3-lane at bus stop section, bus waiting space
	PTPS	num.	9	stand-alone type
	Bus stop	num.	5	roof, bench, digital signage
	Elevated footpath	num.	5	length 45 m, width 4.0 m, with 4 elevators
Suburban Area (Expressway bus)	Bus stop (on expressway)	num.	11	access lane, roof, bench, digital signage
	Bus stop (inside HHTP)	num.	5	roof, bench, digital signage
	Elevated footpath	num.	11	length 75 m, width 4.0 m, with 2 elevators
	Motorbike parking	num.	11	300 motorbikes at both sides, total area 1,800 m^2, with roof and ticket system

OPTION-3

Area	Item	Unit	Quantity	Description of Item
Suburban Area (Expressway bus)	Bus Stop (on expressway)	num.	11	access lane, roof, bench, digital signage
	Bus Stop (inside HHTP)	num.	5	roof, bench, digital signage
	Elevated footpath	num.	11	length 75 m, width 4.0 m, with 2 elevators
	Motorbike parking	num.	11	300 motorbikes at both sides, total area 1,800 m^2, with roof and ticket system

OPTION-4

Area	Item	Unit	Quantity	Description of Item
Central Area (Exclusive lane under RR3 viaduct)	BRT exclusive lane	m^2	10,800	length 0.8 km, width 3.5m x 2-lane, 3-lane at bus stop section, bus waiting space
	PTPS	num.	2	stand-alone type
	Bus stop	num.	2	roof, bench, digital signage
	Underground footpath	m^2	360	length 60 m, width 3 m, at each bus stop
Suburban Area (Expressway bus)	Bus Stop (on expressway)	num.	11	access lane, roof, bench, digital signage
	Bus Stop (inside HHTP)	num.	5	roof, bench, digital signage
	Elevated footpath	num.	11	length 75 m, width 4.0 m, with elevators
	Motorbike parking	num.	11	300 motorbikes at both sides, total area 1,800 m^2, with roof and ticket system

OPTION-5

Area	Item	Unit	Quantity	Description of Item
Central Area (Exclusive lane under RR3 viaduct)	BRT exclusive lane	m^2	80,400	length 6.6 km, width 3.5 m x 2-lane, 3-lane at bus stop section, bus waiting space
	PTPS	num.	7	stand-alone type
	Bus stop	num.	7	roof, bench, digital signage
	Underground footpath	m^2	1,260	length 60 m, width 3 m, at each bus stop
Suburban Area (Exclusive lane)	BRT exclusive lane	m^2	196,700	length 28.1 km, width 3.5 m x 2-lane, asphalt pavement, highway miscellaneous
	Bridge (Widening)	m^2	10,320	bridge, culvert, total number of 39 and total length 1,290m
	Bus Stop (on expressway)	num.	11	roof, bench, digital signage
	Bus Stop (inside HHTP)	num.	5	roof, bench, digital signage
	Elevated footpath	num.	11	length 75 m, width 4.0 m, with 2 elevators
	Motorbike parking	num.	11	300 motorbikes at both sides, total area 1,800 m^2, with roof and ticket system

OPTION-6

Area	Item	Unit	Quantity	Description of Item
Central Area (Exclusive lane under RR3 viaduct)	BRT exclusive lane	m^2	136,800	length 11.3 km, width 3.5 m x 2-lane, 3-lane at bus stop section, bus waiting space
	PTPS	num.	16	stand-alone type
	Bus stop	num.	12	roof, bench, digital signage
	Elevated footpath	num.	5	length 45 m, width 4.0 m, with 4 elevators
	Underground footpath	m^2	1,260	length 60 m, width 3 m, at each bus stop under viaduct section
Suburban Area (Expressway bus)	Bus Stop (on expressway)	num.	11	access lane, roof, bench, digital signage
	Bus Stop (inside HHTP)	num.	5	roof, bench, digital signage
	Elevated footpath	num.	11	length 75 m, width 4.0 m, with elevators
	Motorbike parking	num.	11	300 motorbikes at both sides, total area 1,800 m^2, with roof and ticket system

Common

Area	Item	Unit	Quantity	Description of Item
Suburban Area (Expressway bus)	Development land for depot	m^2	21,490	softground treatment, embankment and pavement
	Facilities for depot	site	1	office, maintenance garage, car wash, fuel station, parking etc.

Note: PTPS - Public transport priority systems, HHTP - Hoa Lac High Tech Park, RR3 - Ring Road 3

Source: Study Team

5.6.2.2 Quantity of Depot Facilities

The depot area with an area of approximately 2.1ha is required for the operation of 150 buses. Offices, vehicle maintenance, vehicle washing and the gas station will also be located on the site of the depot. The details of the depot are shown in the following table.

Table 5.6.3 Quantity of the Depot Facilities (Common for Each Option)

Depot Function		Unit	Quantity		Intended Use
Office	Office	㎡	300		Operation management, Ticket Sale office
	Maintenance Office	㎡	200		Maintenance management
	Driver Room	㎡	1,500		Dressing and rest room of Drivers
	Meeting Room	㎡	300		
	Warehouse	㎡	200		
	Cafeteria	㎡	500		For Welfare
	Total	㎡	3,000		3 Floor (Ground Floor is Motorbike Parking)
Maintenance Place	Maintenance Field	㎡	600	6 lanes	For regular inspection and maintenance
	Triple Lift		1		For efficient maintenance of articulated bus
	Maintenance Equipment		1		For efficient maintenance of articulated bus
Covered Garage		㎡	1,200		Storage of unused buses
Parking pavement	For Existing Bus	㎡	10,000	125 buses	(12m×4m≒50㎡)／1 standard bus
	For BRT	㎡	5,200	26 buses	(20m×4m≒80㎡)／1 Articulated bus
	For Driver's Car	㎡	1,950	150 cars	(5m×2.5m≒13㎡)／1 car
	Total	㎡	17,150		
Automatic Washing machine		㎡	600	2 Lanes	Automatic, Water storage and drainage facilities
Gas station		㎡	440	4 Lanes	For Diesel
Total Area		㎡	21,490		

Source: Study Team

5.6.2.3 Quantity of BRT Bus and Fare Collection Systems

The investment plan of buses with the fare collection system is made based on the demand for each option. The required number of buses with the fare collection system for a 30-year operation period is summarised in the following table.

Table 5.6.4 Quantity of Buses with the Fare Collection System for Each Option (Assuming a 30-Year Operation Period)

OPTION		OPTION-1&2	OPTION-3	OPTION-4	OPTION-5	OPTION-6
Bus(10 years use)	Articulated bus (vehicles)	60	39	45	60	84
	Standard bus (vehicles)	369	195	240	375	510
Vehicle-mounted device for Smart Card (10 years use, units)		429	234	285	435	594
System Server for Smart card (renewal in 5 years, units)		5	5	5	5	5

Note: Based on the demand where the fare was set at 10,000 VND +500 VND/km
Source: Study Team

5.6.2.4 Quantity of Operation and Maintenance Cost for Civil and Depot Facilities

As described in Section 5.6.1, this cost is calculated based on the proportion of the initial costs for the civil works and depot facilities referring to the Vietnamese standard. Refer to Section 5.6.3.2 for the details.

5.6.2.5 Quantities of Bus Operation Cost

The total running distance for the 30-year operation period for each option is shown in the following table.

Table 5.6.5 Running Distance of the BRT Bus for an Operation Period of 30 Years

OPTION	Total Running Distance (km)		Total (km)
	Articulated Bus	Standard Bus	
OPTION-1	58,784,856	514,236,528	573,021,384
OPTION-2	58,784,856	514,236,528	573,021,384
OPTION-3	28,223,961	288,299,046	316,523,007
OPTION-4	32,030,940	345,612,806	377,643,746
OPTION-5	55,850,898	502,300,210	558,151,109
OPTION-6	79,317,420	704,530,008	783,847,428

Source: Study Team

5.6.3 Setting of the Unit Rate

5.6.3.1 Unit Rate of the Civil Works, Depot, Bus and the Automatic Fare Collection System

The unit rates are set by referring to the results from other studies, the Vietnamese standard unit cost (No. 1161/QD-BXD from October 15, 2015) issued by the Ministry of Construction (MOC) and quotations from the manufacturers. The unit rates of major work items are summarised in the following table. The ratio between foreign and local currencies is also estimated in order to consider inflation in the financial analysis.

Table 5.6.6 Unit Rate of Civil Works, Depot, Bus and the Automatic Fare Collection System

(In VND Currency)

Unit: million VND

Item		Unit		Unit Rate	Currency Portion		Major Works Included
					Foreign	Local	
BRT exclusive lane	Build in the median in the urban area	Area of the lane	m^2	2.24	9.0%	91.0%	Earth work, asphalt pavement, road marking, traffic signs, utility relocation etc.
	Widen the road side in the suburban area	Area of the lane	m^2	3.41	17.0%	83.0%	Earth work, softground treatment, asphalt pavement, road marking, traffic signs, utility relocation etc.
	Widen the median in the suburban area	Area of the lane	m^2	1.68	11.0%	89.0%	Asphalt pavement, road marking, traffic signs, utility relocation etc.
Bridge/culvert	Widening of the existing structure in suburban area	Widening area	m^2	39.82	15.0%	85.0%	Foundation, substructure and superstructure
PTPS	Standalone type	Intersection	num.	5,092.00	76.3%	23.7%	4 traffic signals with LED for vehicles, 8 signals with LED for pedestrians, traffic control system and the vehicle-mounted devices
Bus stop	Bus stop		num.	378.37	8.7%	91.3%	Equipped with roof and benches, include bus stops at the up and down lanes
	Access road to bus stop, bus stops		num.	10,480.37	11.1%	88.9%	Access road with a length of 540 m, bus stop with roof and benches, include bus stops at up and down lanes
Motorbike parking	Arrange beside bus stop in the suburban area		num.	3,950.75	36.8%	63.2%	Total area 1800 m^2 at both sides, earth work, pavement, roof and ticket system
Elevated footpath	Stairs		num.	350.00	10.0%	90.0%	Foundation, substructure, stairs
	Bridge part	Bridge area	m^2	80.22	15.0%	85.0%	Foundation, substructure and superstructure
	Elevator		num.	762.00	75.3%	24.7%	Foundation, equipment for the elevator
Underground footpath	Arrange with the bus stop under RR3 viaduct	Culvert area	m^2	19.83	15.0%	85.0%	Excavation, box culvert, filling, elevator and lighting
BRT vehicles	Articulated buses	Body	num.	16,294.40	100.0%	0.0%	Body
	Standard buses	Body	num.	3,258.88	0.0%	100.0%	Body
AFC	Server system at office	System	package	244,416.00	100.0%	0.0%	System design, server
	Vehicle-mounted device	Equipment	num.	1,425.76	100.0%	0.0%	Vehicle-mounted device

Note: AFC - Automatic Fare Collection System, PTPS - Public Transport Priority System

Source: Study Team

(In JPY Currency)

Unit: 1,000 yen

Item		Unit		Unit Rate	Currency Portion		Major Works Included
					Foreign	Local	
BRT exclusive lane	Build in the median in the urban area	Area of the lane	m^2	11.0	9.0%	91.0%	Earth work, asphalt pavement, road marking, traffic signs, utility relocation etc.
	Widen the road side in the suburban area	Area of the lane	m^2	16.8	17.0%	83.0%	Earth work, softground treatment, asphalt pavement, road marking, traffic signs, utility relocation etc.
	Widen the median in the suburban area	Area of the lane	m^2	8.2	11.0%	89.0%	Asphalt pavement, road marking, traffic signs, utility relocation etc.
Bridge/culvert	Widening of the existing structure in suburban area	Widening area	m^2	195.5	15.0%	85.0%	Foundation, substructure and superstructure
PTPS	Standalone type	Intersection	num.	25,000	76.3%	23.7%	4 traffic signals with LED for vehicles, 8 signals with LED for pedestrians, traffic control system and the vehicle-mounted devices
Bus stop	Bus stop		num.	1,858	8.7%	91.3%	Equipped with roof and benches, include bus stops at the up and down lanes
	Access road to bus stop, bus stops		num.	51,455	11.1%	88.9%	Access road with a length of 540 m, bus stop with roof and benches, include bus stops at up and down lanes
Motorbike parking	Arrange beside bus stop in the suburban area		num.	19,397	36.8%	63.2%	Total area 1800 m^2 at both sides, earth work, pavement, roof and ticket system
Elevated footpath	Stairs		num.	1,718	10.0%	90.0%	Foundation, substructure, stairs
	Bridge part	Bridge area	m^2	393.9	15.0%	85.0%	Foundation, substructure and superstructure
	Elevator		num.	3,741	75.3%	24.7%	Foundation, equipment for the elevator
Underground footpath	Arrange with the bus stop under RR3 viaduct	Culvert area	m^2	97.4	15.0%	85.0%	Excavation, box culvert, filling, elevator and lighting
BRT vehicles	Articulated buses	Body	num.	80,000	100.0%	0.0%	Body
	Standard buses	Body	num.	16,000	0.0%	100.0%	Body
AFC	Server system at office	System	package	1,200,000	100.0%	0.0%	System design, server
	Vehicle-mounted device	Equipment	num.	7,000	100.0%	0.0%	Vehicle-mounted device

Note: AFC - Automatic Fare Collection System, PTPS - Public Transport Priority System

Source: Study Team

5.6.3.2 Unit Rate of the Operation and Maintenance Cost for Civil and Depot Facilities

The operation and maintenance cost of the civil and depot facilities that will occur during the 30 year operation period were calculated based on the time period and extent of the maintenance based on the Vietnamese standard of 22TCVN211-93 as shown in the following table.

Table 5.6.7 Guidelines for the Estimation of the Maintenance Costs

Item and Time Period	Road Maintenance	Bridge Maintenance
Annual Maintenance	0.55% of the road construction cost	0.1% of the bridge construction cost
Repair (every 5 years)	5.1% of the road construction cost	1% of the bridge construction cost
Major Repair (every 15 years)	42% of the road construction cost	2% of the bridge construction cost

Source: Vietnamese standard 22TCVN211-93

5.6.3.3 Unit Rate of the Bus Operation Cost

The actual expenses of the operation cost for public buses in Hanoi in 2015 is shown in column (a) of the following table and is used for the estimation of the running cost per km of the BRT, both for standard and articulated buses with some adjustments as described below:

- Costs related to salary is increased by 12.9% because of inflation from 2015 to 2016 (Prime Minister's Decision with regards to the minimum salary)
- Fuel consumption of the articulated bus is assumed at two times of that of the standard bus, and lubricant, tire and repair cost of the articulated bus is 1.5 times of that of the standard bus. This is based on the Japanese bus operator's experience.

Based on the above adjustment, the unit rate (VND/km) of the BRT is shown in column (b) and (c) of the following table, namely 19,150VND/km for the standard bus and 25,900VND/km for the articulated bus. It is noted that basic depreciation is deducted from the total cost because it will be counted separately as the bus vehicle cost in the financial analysis.

Table 5.6.8 Actual Operation Cost of Hanoi Public Buses in 2015 and Estimation of the BRT Running Cost

Unit: VND/km

Cost Component		Actual Expenses of Hanoi Public Buses in 2015 (a)	BRT Running Cost in 2016		Note: Adjustment of cost
			Standard bus (b)	Articulated bus (c)	
A.	Direct cost	17,843	18,935	25,364	
	Salary, social insurance, medical insurance, meal allowance etc.	8,465	9,557	9,557	(b)=(C)=(a) x 112.9%
	Insurance for civil liability	16	16	16	
	Basic depreciation	1,855	1,855	1,855	
	Fuel	5,352	5,352	10,704	(c)=(b)x200%
	Lubricant	210	210	315	(c)=(b)x150%
	Tire	515	515	773	(c)=(b)x150%
	Repair	1,430	1,430	2,145	(c)=(b)x150%
B.	Interest (5% of A)	892	947	1,268	
C.	Other cost (station fee)	106	106	106	
D.	Management cost for workshop	166	166	166	
E.	General management cost	848	848	848	
Total		19,855	21,002	27,753	
	⇒		19,147	25,898	Deduction of "Basic depreciation"
Unit running cost per km for this BRT project			19,150	25,900	Rounded number

Source: Report of actual expenses for the application of subsidies in 2015 by the Hanoi public buses

5.6.3.4 Unit Rate of the Land Acquisition Cost

In this BRT project, land acquisition is not required for constructing the BRT exclusive lanes, bus stops etc. because it will be built within the right of way of the existing roads except for the depot which is planned to be built along the Thang Long Expressway on a site with a land area that is approximately 2.1 ha. As proposed in Section 5.2.6, 5 sites are proposed as candidate locations for the depot.

The published land price for each of the candidate locations is based on the announcement from the Hanoi People's Committee (HPC) and is shown in the following table. The land price gets higher as one goes closer to the central are of Hanoi. In terms of land use, the price increases based on the following order: agricultural land, non-agricultural land and commercial service land.

Since the exact location for the depot will not be determined in this study, the price of the commercial service land of Alt-4, which is 4,872,000VND/m^2 or 23,920JPY/m^2, is tentatively applied for the calculation of the land acquisition cost and for the economic/financial evaluation.

Table 5.6.9 Land Price in Hanoi from 2015-2019 as Announced by the Hanoi People's Committee

(In VND Currency)

Candidate Location for the Depot	Area (District)	Land Price (VND/m^2) each Category		
		Agricultural Land*1/	Non-Agricultural Land	Commercial Service Land*2/
Alt-01	Tu Liem District	252,000	17,707,000	21,248,000
Alt-02	Tu Liem District	252,000	12,709,000	15,299,000
Alt-03	Tu Liem District	252,000	12,709,000	15,299,000
Alt-04	Quoc Qai District	135,000	4,060,000	4,872,000
Alt-05	Quoc Qai District	135,000	3,220,000	3,864,000

Notes:
*1/ 50% must be added for agricultural land in the residential area. This price excludes the compensation cost of perennial crops and construction buildings on land. The compensation price shall be based on the current price regulation from the Hanoi Department of Finance. Compensation not required for annual plants such as rice.
*2/ Commercial services land includes land area where the landlord can build commercial businesses, services and other facilities catering for trading, such as car repair shops and etc.

Source: Decision 96/2014/QD-UBND

(In JPY Currency)

Candidate Location for the Depot	Area (District)	Land Price (JPY/m^2) each Category		
		Agricultural Land*1/	Non-Agricultural Land	Commercial Service Land*2/
Alt-01	Tu Liem District	1,237	86,935	104,321
Alt-02	Tu Liem District	1,237	62,397	75,113
Alt-03	Tu Liem District	1,237	62,397	75,113
Alt-04	Quoc Qai District	663	19,933	23,920
Alt-05	Quoc Qai District	663	15,809	18,971

Notes:
*1/ 50% must be added for agricultural land in the residential area. This price excludes the compensation cost of perennial crops and construction buildings on land. The compensation price shall be based on the current price regulation from the Hanoi Department of Finance. Compensation not required for annual plants such as rice.
*2/ Commercial services land includes land area where the landlord can build commercial businesses, services and other facilities catering for trading, such as car repair shops and etc.
1 JPY=203.68 VND, Selling Rate of the State Bank of Vietnam on 31 May, 2016

Source: Decision 96/2014/QD-UBND

5.6.4 Rough Project Costs

5.6.4.1 Project Cost

The project cost is summarised as the initial cost including the feasibility study, detailed design and construction work, project preparation and construction stage and the costs that will occur during the 30 year operation phase including the addition and renewal of facilities and equipment and the operations and maintenance (O&M) cost.

The O&M cost in the item of “Civil Works and Depot Facilities” refers to the costs related to the repair of the pavement etc. The O&M cost in the item of “BRT, AFC” refers to bus operation costs including the driver’s salary, fuel etc.

Table 5.6.10 Summary of the Rough Project Costs by Phase

(In VND Currency)

Unit: million VND

ITEM	OPTION	Project Preparation and Construction Stage	Operation Phase (30 years)	
		Initial Cost	Addition/Renewal Cost	O&M Cost
Civil Works and Depot Facilities	OPTION-1	1,749,256	0	837,209
	OPTION-2	778,066	0	325,488
	OPTION-3	549,892	0	203,714
	OPTION-4	592,165	0	233,940
	OPTION-5	1,764,462	0	901,392
	OPTION-6	1,061,766	0	545,311
BRT, AFC	OPTION-1	886,008	3,127,911	11,370,157
	OPTION-2	886,008	3,127,911	11,370,157
	OPTION-3	537,104	2,289,568	6,251,927
	OPTION-4	551,158	2,592,635	7,448,087
	OPTION-5	675,607	3,366,428	11,065,587
	OPTION-6	1,037,546	4,062,196	15,546,071
Engineering and Local Administration Cost	OPTION-1	395,290	0	0
	OPTION-2	249,611	0	0
	OPTION-3	163,049	0	0
	OPTION-4	171,498	0	0
	OPTION-5	366,010	0	0
	OPTION-6	314,897	0	0
Land Acquisition for the Depot	Common for all options	104,699	0	0

Note: Present Cost as of 2016
AFC – Automatic Fare Collection System

Source: Study Team

(In JPY Currency)

Unit: million JPY

ITEM	OPTION	Project Preparation and Construction Stage	Operation Phase (30 years)	
		Initial Cost	Addition/Renewal Cost	O&M Cost
Civil Works and Depot Facilities	OPTION-1	8,588	0	4,110
	OPTION-2	3,820	0	1,598
	OPTION-3	2,700	0	1,000
	OPTION-4	2,907	0	1,149
	OPTION-5	8,663	0	4,426
	OPTION-6	5,213	0	2,677
BRT, AFC	OPTION-1	4,350	15,357	55,824
	OPTION-2	4,350	15,357	55,824
	OPTION-3	2,637	11,241	30,695
	OPTION-4	2,706	12,729	36,568
	OPTION-5	3,317	16,528	54,328
	OPTION-6	5,094	19,944	76,326
Engineering and Local Administration Cost	OPTION-1	1,941	0	0
	OPTION-2	1,226	0	0
	OPTION-3	801	0	0
	OPTION-4	842	0	0
	OPTION-5	1,797	0	0
	OPTION-6	1,546	0	0
Land Acquisition for the Depot	Common for all options	514	0	0

Note: 1 JPY=203.68 VND, Selling Rate of the State Bank of Vietnam on 31 May, 2016
Present Cost as of 2016
AFC – Automatic Fare Collection System

Source: Study Team

Table 5.6.11 shows the project costs demarcated between the portion eligible for ODA and the non-eligible portion that needs to be financed by the Vietnamese government and bus operator for reference.

Table 5.6.11 Summary of Rough Project Costs by Financial Resources

(In VND Currency)

Unit: million VND

OPTION	ODA (Eligible Portion)				Non-Eligible (by VN Government, Bus Operator)					Total (1)+(2)
	Engineering (DD, CS)	Civil Works and Depot Facilities	BRT, AFC	Sub-Total (1)	FS, Local Administration Cost	Land Acquisition	Addition and Renewal of BRT/AFC	O&M Cost	Sub-Total (2)	
OPTION-1	250,350	1,749,256	886,008	2,885,614	144,939	104,699	3,127,911	12,207,366	15,584,916	18,470,530
OPTION-2	158,087	778,066	886,008	1,822,161	91,524	104,699	3,127,911	11,695,645	15,019,780	16,841,941
OPTION-3	103,265	549,892	537,104	1,190,261	59,785	104,699	2,289,568	6,455,642	8,909,694	10,099,954
OPTION-4	108,616	592,165	551,158	1,251,939	62,883	104,699	2,592,635	7,682,026	10,442,243	11,694,183
OPTION-5	231,807	1,764,462	675,607	2,671,875	134,204	104,699	3,366,428	11,966,980	15,572,311	18,244,186
OPTION-6	199,435	1,061,766	1,037,546	2,298,747	115,462	104,699	4,062,196	16,091,381	20,373,739	22,672,486

(In JPY Currency)

Unit: million yen

OPTION	ODA (Eligible Portion)				Non-Eligible (by VN Government, Bus Operator)					Total (1)+(2)
	Engineering (DD, CS)	Civil Works and Depot Facilities	BRT, AFC	Sub-Total (1)	FS, Local Administration Cost	Land Acquisition	Addition and Renewal of BRT/AFC	O&M Cost	Sub-Total (2)	
OPTION-1	1,229	8,588	4,350	14,167	712	514	15,357	59,934	76,517	90,684
OPTION-2	776	3,820	4,350	8,946	449	514	15,357	57,422	73,742	82,688
OPTION-3	507	2,700	2,637	5,844	294	514	11,241	31,695	43,744	49,587
OPTION-4	533	2,907	2,706	6,147	309	514	12,729	37,716	51,268	57,414
OPTION-5	1,138	8,663	3,317	13,118	659	514	16,528	58,754	76,455	89,573
OPTION-6	979	5,213	5,094	11,286	567	514	19,944	79,003	100,028	111,314

Note: 1 JPY=203.68 VND, Selling Rate of the State Bank of Vietnam on 31 May, 2016
Present cost as of 2016
FS – Feasibility Study, DD – Detailed Design, CS – Construction Stage, AFC – Automatic Fare Collection System
Source: Study Team

5.6.4.2 Disbursement Schedule

In order to estimate the disbursement schedule of the project cost, assumptions regarding the project implementation schedule including the construction schedule were required.

Figure 5.6.1 shows construction schedule of the civil works and depot and procurement/installation schedule of the BRT and automatic fare collection system in the initial stage. The construction period of OPTION-1 and 5 was estimated at 32 months because of the larger work volume in the construction of 30 km of BRT exclusive lanes in the suburban area. On the other hand, the construction period of the other options is 24 months.

OPTION-1

Section	Item	Month 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 30 31 32 33 34 35 36
Central Area (Exclusive lane)	BRT exclusive lane	
	PTPS	system design&procurement … installation
	Bus Stop	
	Elevated footpath	
Suburban Area (Exclusive lane)	BRT exclusive lane	
	Widening bridge	
	Bus stop beside expressway	
	Bus stop inside HTP	
	Elevated footpath	
	Motorbike parking	
Depot, BRT/AFC	Development land for depot	
	Office, facilities of Depot	procurement … building & installation & trial operation
	BRT Bus	procurement … registration & trial operation
	AFC	system design … installation & trial operation

OPTION-2

Section	Item	Month 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 30 31 32 33 34 35 36
Central Area (Exclusive lane)	BRT exclusive lane	
	PTPS	system design&procurement … installation
	Bus Stop	
	Elevated footpath	
Suburban Area	Bus stop beside expressway	
	Bus stop inside HTP	
	Elevated footpath	
	Motorbike parking	
Depot, BRT/AFC	Development land for depot	
	Office, facilities of Depot	procurement … building & installation & trial operation
	BRT Bus	procurement … registration & trial operation
	AFC	system design … installation & trial operation

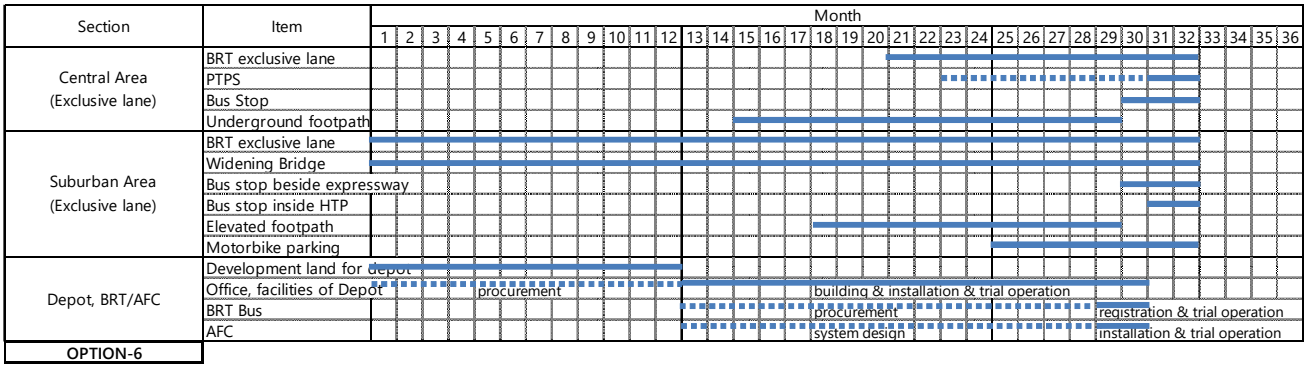
OPTION-3

Section	Item	Month 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 30 31 32 33 34 35 36
Suburban Area	Bus stop beside expressway	
	Bus stop inside HTP	
	Elevated footpath	
	Motorbike parking	
Depot, BRT/AFC	Development land for depot	
	Office, facilities of Depot	procurement … building & installation & trial operation
	BRT Bus	procurement … registration & trial operation
	AFC	system design … installation & trial operation

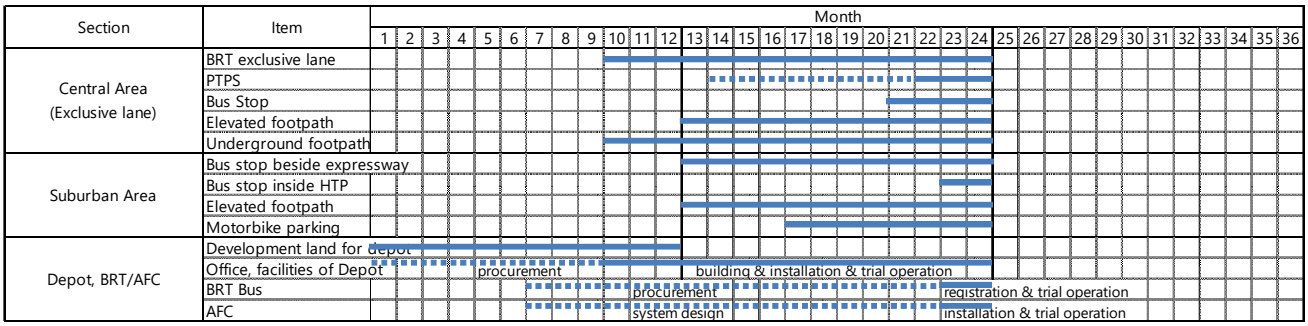
OPTION-4

Section	Item	Month 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 30 31 32 33 34 35 36
Central Area (Exclusive lane)	BRT exclusive lane	
	PTPS	system design&procurement
	Bus Stop	
	Underground footpath	
Suburban Area	Bus stop beside expressway	
	Bus stop inside HTP	
	Elevated footpath	
	Motorbike parking	
Depot, BRT/AFC	Development land for depot	
	Office, facilities of Depot	procurement … building & installation & trial operation
	BRT Bus	procurement … registration & trial operation
	AFC	system design … installation & trial operation

OPTION-5



OPTION-6



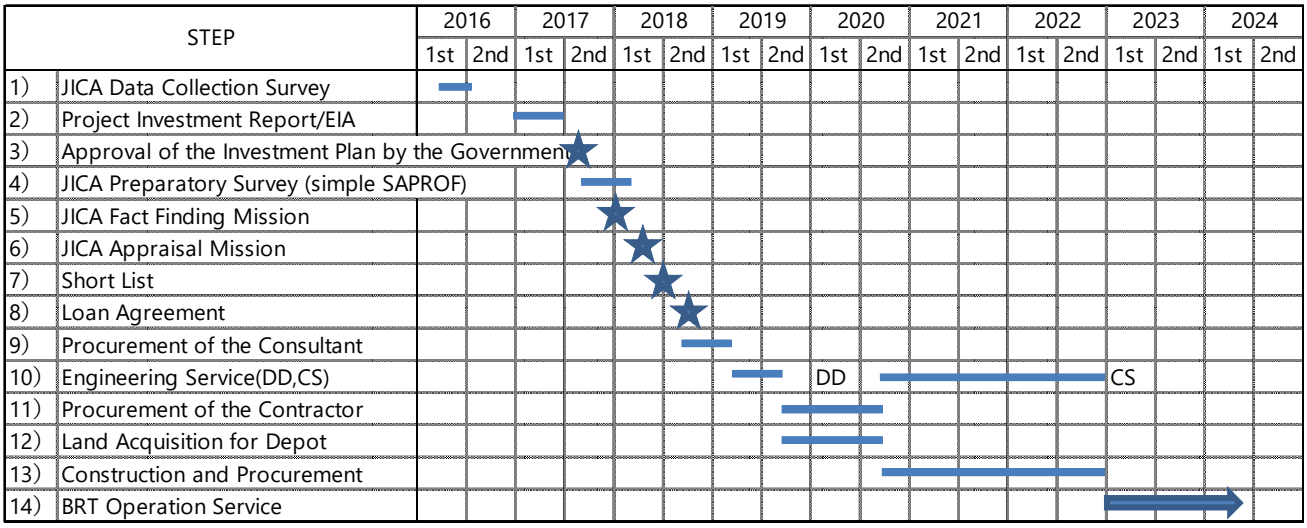
Note: PTPS – Public Transport Priority System, HTP – Hoa Lac High Tech Park, AFC – Automatic Fare Collection System

Source: Study Team

Figure 5.6.1 Construction and Procurement Schedule

Figure 5.6.2 shows the assumed project implementation schedule in the case where ODA is applied. After this study, preparation for the project investment report and its approval process in the Vietnamese side, loan agreement, detailed design and construction etc. will be implemented and the BRT can start operations from the year of 2023.

In this assumption, the disbursement schedule is prepared and summarised in Figure 5.6.3 for the economic and financial analysis in Chapter 6.



Note: DD – Detailed Design, CS – Construction Stage

Source: Study Team

Figure 5.6.2 Assumed Project Implementation Schedule

OPTION-1 Unit: million VND

Item	Currency Portion	Preparation & Construction Stage				Operation Stage																																Total
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	
		1	2	3	4	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	30	
Engineering Cost, Local Administration	F.C portion	83,011	18,447	36,894	36,894																															175,245
Cost and Other Costs	L.C portion	91,575	37,553	45,458	45,458																															220,045
Land Acquisition Cost	F.C portion		0																																	0
	L.C portion		104,699																																	104,699
Initial Facilities Cost (Civil Works &	F.C portion		57,536	96,005	207,288																															360,829
Depot)	L.C portion		264,247	440,705	683,474																															1,388,426
Initial & Additional Facilities Cost (BRT	F.C portion				612,262	23,423	29,126	24,849	7,129	23,423	26,275	27,700																									774,187
Bus, AFC)	L.C portion				273,746	13,036	26,071	16,294	16,294	13,036	19,553	22,812																									400,842
Renewal Cost (BRT Bus, AFC)	F.C portion										244,416	0	0	0	367,846	23,423	273,542	24,849	7,129	23,423	26,275	27,700	244,416	0	367,846	23,423	29,126	24,849	251,545	23,423	26,275	27,700				2,037,206
	L.C portion										0	0	0	0	273,746	13,036	26,071	16,294	16,294	13,036	19,553	22,812	0	0	273,746	13,036	26,071	16,294	16,294	13,036	19,553	22,812				801,684
Maintenance Cost of Civil Works and	F.C portion					578	578	578	578	6,004	578	578	578	578	6,004	578	578	578	578	39,824	578	578	578	578	6,004	578	578	578	578	6,004	578	578	578	6,004	83,716
Depot Facilities	L.C portion					5,205	5,205	5,205	5,205	54,032	5,205	5,205	5,205	5,205	54,032	5,205	5,205	5,205	5,205	358,413	5,205	5,205	5,205	5,205	54,032	5,205	5,205	5,205	5,205	54,032	5,205	5,205	5,205	54,032	753,493
Operational Cost	F.C portion																																			0
	L.C portion					275,484	292,548	309,612	326,676	343,740	360,804	377,868	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	11,370,157
Total	F.C portion	83,011	75,983	132,899	856,444	24,001	29,704	25,427	7,707	29,427	271,269	28,278	578	578	373,850	24,001	274,120	25,427	7,707	63,247	26,853	28,278	244,994	578	373,850	24,001	29,704	25,427	252,123	29,427	26,853	28,278	578	578	6,004	3,431,183
	L.C portion	91,575	406,499	486,163	1,002,679	293,725	323,824	331,111	348,175	410,808	385,562	405,885	400,137	400,137	722,710	413,173	426,208	416,431	416,431	766,381	419,690	422,949	400,137	400,137	722,710	413,173	426,208	416,431	416,431	462,000	419,690	422,949	400,137	400,137	448,964	15,039,346
		174,586	482,482	619,062	1,859,123	317,726	353,528	356,538	355,882	440,235	656,831	434,163	400,715	400,715	1,096,560	437,174	700,328	441,858	424,138	829,628	446,543	451,227	645,131	400,715	1,096,560	437,174	455,912	441,858	668,554	491,427	446,543	451,227	400,715	400,715	454,968	18,470,530

OPTION-2 Unit: million VND

Item	Currency Portion	Preparation & Construction Stage				Operation Stage																																Total
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	
		1	2	3	4	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	30	
Engineering Cost, Local Administration	F.C portion	52,418	11,649	23,297	23,297																															110,661
Cost and Other Costs	L.C portion	57,827	23,713	28,705	28,705																															138,950
Land Acquisition Cost	F.C portion		0																																	0
	L.C portion		104,699																																	104,699
Initial Facilities Cost (Civil Works &	F.C portion			20,388	177,101																															197,489
Depot)	L.C portion			56,420	524,158																															580,577
Initial & Additional Facilities Cost (BRT	F.C portion				612,262	23,423	29,126	24,849	7,129	23,423	26,275	27,700																									774,187
Bus, AFC)	L.C portion				273,746	13,036	26,071	16,294	16,294	13,036	19,553	22,812																									400,842
Renewal Cost (BRT Bus, AFC)	F.C portion										244,416	0	0	0	367,846	23,423	273,542	24,849	7,129	23,423	26,275	27,700	244,416	0	367,846	23,423	29,126	24,849	251,545	23,423	26,275	27,700				2,037,206
	L.C portion										0	0	0	0	273,746	13,036	26,071	16,294	16,294	13,036	19,553	22,812	0	0	273,746	13,036	26,071	16,294	16,294	13,036	19,553	22,812				801,684
Maintenance Cost of Civil Works and	F.C portion					229	229	229	229	2,386	229	229	229	229	2,386	229	229	229	229	15,120	229	229	229	229	2,386	229	229	229	229	2,386	229	229	229	2,386	32,546
Depot Facilities	L.C portion					2,062	2,062	2,062	2,062	21,474	2,062	2,062	2,062	2,062	21,474	2,062	2,062	2,062	2,062	136,084	2,062	2,062	2,062	2,062	21,474	2,062	2,062	2,062	2,062	21,474	2,062	2,062	2,062	21,474	292,942
Operational Cost	F.C portion																																			0
	L.C portion					275,484	292,548	309,612	326,676	343,740	360,804	377,868	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	394,932	11,370,157
Total	F.C portion	52,418	11,649	43,685	812,660	23,652	29,355	25,078	7,358	25,809	270,920	27,929	229	229	370,232	23,652	273,771	25,078	7,358	38,543	26,504	27,929	244,645	229	370,232	23,652	29,355	25,078	251,774	25,809	26,504	27,929	229	229	2,386	3,152,089
	L.C portion	57,827	128,412	85,125	826,609	290,582	320,681	327,968	345,032	378,250	382,419	402,742	396,994	396,994	690,152	410,030	423,065	413,288	413,288	544,052	416,547	419,806	396,994	396,994	690,152	410,030	423,065	413,288	413,288	429,442	416,547	419,806	396,994	396,994	416,406	13,689,852
		110,245	140,061	128,810	1,639,269	314,234	350,036	353,046	352,390	404,059	653,339	430,671	397,223	397,223	1,060,384	433,682	696,836	438,366	420,646	582,595	443,051	447,735	641,639	397,223	1,060,384	433,682	452,420	438,366	665,062	455,251	443,051	447,735	397,223	397,223	418,792	16,841,941

OPTION-3 Unit: million VND

Item	Currency Portion	Preparation & Construction Stage				Operation Stage																																Total
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	
		1	2	3	4	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	30	
Engineering Cost, Local Administration	F.C portion	34,240	7,609	15,218	15,218																															72,285
Cost and Other Costs	L.C portion	37,773	15,490	18,751	18,751																															90,764
Land Acquisition Cost	F.C portion		0																																	0
	L.C portion		104,699																																	104,699
Initial Facilities Cost (Civil Works &	F.C portion			20,388	110,902																															131,290
Depot)	L.C portion			56,420	362,183																															418,602
Initial & Additional Facilities Cost (BRT	F.C portion				419,784	23,423	23,423	7,129	21,997	24,849	5,703	41,143																									567,451
Bus, AFC)	L.C portion				117,320	13,036	13,036	16,294	9,777	16,294	13,036	13,036																									211,829
Renewal Cost (BRT Bus, AFC)	F.C portion										244,416	0	0	0	175,368	23,423	267,839	7,129	21,997	24,849	5,703	41,143	244,416	0	175,368	23,423	23,423	7,129	266,413	24,849	5,703	41,143				1,623,734
	L.C portion										0	0	0	0	117,320	13,036	13,036	16,294	9,777	16,294	13,036	13,036	0	0	117,320	13,036	13,036	16,294	9,777	16,294	13,036	13,036				423,658
Maintenance Cost of Civil Works and	F.C portion					146	146	146	146	1,526	146	146	146	146	1,526	146	146	146	146	9,232	146	146	146	146	1,526	146	146	146	146	1,526	146	146	146	146	1,526	20,371
Depot Facilities	L.C portion					1,315	1,315	1,315	1,315	13,738	1,315	1,315	1,315	1,315	13,738	1,315	1,315	1,315	1,315	83,085	1,315	1,315	1,315	1,315	13,738	1,315	1,315	1,315	1,315	13,738	1,315	1,315	1,315	13,738	183,343
Operational Cost	F.C portion																																			0
	L.C portion					119,627	134,259	148,892	163,524	178,157	192,790	207,422	222,055	222,055	222,055	222,055	222,055	222,055	222,055	222,055	222,055	222,055	222,055	222,055	222,055	222,055	222,055	222,055	222,055	222,055	222,055	222,055	222,055	222,055	222,055	6,251,927
Total	F.C portion	34,240	7,609	35,606	545,904	23,569	23,569	7,275	22,143	26,375	250,265	41,289	146	146	176,894	23,569	267,985	7,275	22,143	34,081	5,849	41,289	244,562	146	176,894	23,569	23,569	7,275	266,559	26,375	5,849	41,289	146	146	1,526	2,415,131
	L.C portion	37,773	120,189	75,170	498,253	133,978	148,611	166,501	174,617	208,189	207,141	221,773	223,370	223,370	353,113	236,406	236,406	239,664	233,147	321,434	236,406	236,406	223,370	223,370	353,113	236,406	236,406	239,664	233,147	252,087	236,406	236,406	223,370	223,370	235,793	7,684,823
		72,013	127,798	110,776	1,044,157	157,547	172,180	173,776	196,760	234,565	457,406	263,062	223,516	223,516	530,008	259,975	504,391	246,939	255,290	355,514	242,255	277,695	467,932	223,516	530,008	259,975	259,975	246,939	499,706	278,463	242,255	277,695	223,516	223,516	237,320	10,099,954

OPTION-4 Unit: million VND

Item	Currency Portion	Preparation & Construction Stage				Operation Stage																																Total
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	
		1	2	3	4	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	30	
Engineering Cost, Local Administration	F.C portion	36,015	8,003	16,007	16,007																															76,031
Cost and Other Costs	L.C portion	39,730	16,292	19,722	19,722																															95,467
Land Acquisition Cost	F.C portion		0																																	0
	L.C portion		104,699																																	104,699
Initial Facilities Cost (Civil Works &	F.C portion			20,388	121,986																															142,374
Depot)	L.C portion			56,420	393,371																															449,791
Initial & Additional Facilities Cost (BRT	F.C portion				424,062	24,849	27,700	26,275	24,849	41,143	27,700	27,700																									624,278
Bus, AFC)	L.C portion				127,096	16,294	22,812	19,553	16,294	13,036	22,812	22,812																									260,709
Renewal Cost (BRT Bus, AFC)	F.C portion										244,416	0	0	0	179,646	24,849	272,116	26,275	24,849	41,143	27,700	27,700	244,416	0	179,646	24,849	27,700	26,275	269,265	41,143	27,700	27,700				1,737,388
	L.C portion										0	0	0	0	127,096	16,294	22,812	19,553	16,294	13,036	22,812	22,812	0	0	127,096	16,294	22,812	19,553	16,294	13,036	22,812	22,812				521,418
Maintenance Cost of Civil Works and	F.C portion					166	166	166	166	1,733	166	166	166	166	1,733	166	166	166	166	10,742	166	166	166	166	1,733	166	166	166	166	1,733	166	166	166	166	1,733	23,394
Depot Facilities	L.C portion					1,496	1,496	1,496	1,496	15,596	1,496	1,496	1,496	1,496	15,596	1,496	1,496	1,496	1,496	96,674	1,496	1,496	1,496	1,496	15,596	1,496	1,496	1,496	1,496	15,596	1,496	1,496	1,496	15,596	210,546
Operational Cost	F.C portion																																			0
	L.C portion					134,593	153,331	172,068	190,806	209,544	228,282	247,020	265,758	265,758	265,758	265,758	265,758	265,758	265,758	265,758	265,758	265,758	265,758	265,758	265,758	265,758	265,758	265,758	265,758	265,758	265,758	265,758	265,758	265,758	265,758	7,448,087
Total	F.C portion	36,015	8,003	36,394	562,055	25,015	27,866	26,441	25,015	42,876	272,282	27,866	166	166	181,379	25,015	272,282	26,441	25,015	51,885	27,866	27,866	244,582	166	181,379	25,015	27,866	26,441	269,431	42,876	27,866	27,866	166	166	1,733	2,603,465
	L.C portion	39,730	120,992	76,142	540,190	152,382	177,638	193,117	208,596	238,176	252,590	271,328	267,254	267,254	408,450	283,548	290,066	286,807	283,548	375,468	290,066	290,066	267,254	267,254	408,450	283,548	290,066	286,807	283,548	294,390	290,066	290,066	267,254	267,254	281,354	9,090,717
		75,745	128,995	112,537	1,102,244	177,397	205,504	219,558	233,611	281,052	524,872	299,194	267,420	267,420	589,829	308,563	562,348	313,248	308,563	427,353	317,932	317,932	511,836	267,420	589,829	308,563	317,932	313,248	552,979	337,266	317,932	317,932	267,420	267,420	283,087	11,694,183

OPTION-5	Unit: million VND																																						
Item	Currency Portion	Preparation & Construction Stage				Operation Stage																																			Total
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	
		1	2	3	4	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	30				
Engineering Cost, Local Administration	F.C portion	76,862	17,080	34,161	34,161																																		162,265
Cost and Other Costs	L.C portion	84,792	34,771	42,091	42,091																																		203,746
Land Acquisition Cost	F.C portion		0																																				0
	L.C portion		104,699																																				104,699
Initial Facilities Cost (Civil Works &	F.C portion		57,536	92,069	192,410																																		342,014
Depot)	L.C portion		264,247	421,695	736,505																																		1,422,447
Initial & Additional Facilities Cost (BRT	F.C portion				486,592	49,698	48,272	48,272	31,978	30,552	48,272	33,404																											777,040
Bus, AFC)	L.C portion				189,015	32,589	29,330	29,330	32,589	29,330	29,330	35,848																												407,361
Renewal Cost (BRT Bus, AFC)	F.C portion										244,416	0	0	0	242,176	49,698	292,688	48,272	31,978	30,552	48,272	33,404	244,416	0	242,176	49,698	48,272	48,272	276,394	30,552	48,272	33,404						2,042,912
	L.C portion										0	0	0	0	189,015	32,589	29,330	29,330	32,589	29,330	29,330	35,848	0	0	189,015	32,589	29,330	29,330	32,589	29,330	29,330	35,848						814,722
Maintenance Cost of Civil Works and	F.C portion					618	618	618	618	6,405	618	618	618	618	6,405	618	618	618	618	43,280	618	618	618	618	6,405	618	618	618	618	6,405	618	618	618	618	6,405	90,139
Depot Facilities	L.C portion					5,562	5,562	5,562	5,562	57,649	5,562	5,562	5,562	5,562	57,649	5,562	5,562	5,562	5,562	389,518	5,562	5,562	5,562	5,562	57,649	5,562	5,562	5,562	5,562	57,649	5,562	5,562	5,562	5,562	57,649	811,253
Operational Cost	F.C portion																																						0
	L.C portion					189,734	219,259	248,784	278,309	307,834	337,359	366,885	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	396,410	11,065,587
Total	F.C portion	76,862	74,616	126,230	713,163	50,316	48,890	48,890	32,596	36,957	293,306	34,022	618	618	248,581	50,316	293,306	48,890	32,596	73,832	48,890	34,022	245,034	618	248,581	50,316	48,890	48,890	277,012	36,957	48,890	34,022	618	618	6,405	3,414,370
	L.C portion	84,792	403,718	463,786	967,611	227,885	254,151	283,676	316,460	394,814	372,251	408,295	401,972	401,972	643,074	434,561	431,302	431,302	434,561	815,258	431,302	437,820	401,972	401,972	643,074	434,561	431,302	431,302	434,561	483,389	431,302	437,820	401,972	401,972	454,059	14,829,816
		161,655	478,334	590,016	1,680,774	278,201	303,041	332,566	349,056	431,771	665,557	442,317	402,590	402,590	891,656	484,877	724,608	480,192	467,157	889,089	480,192	471,842	647,006	402,590	891,656	484,877	480,192	480,192	711,573	520,347	480,192	471,842	402,590	402,590	460,465	18,244,186

OPTION-6	Unit: million VND																																						
Item	Currency Portion	Preparation & Construction Stage				Operation Stage																																		Total
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	
		1	2	3	4	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	30				
Engineering Cost, Local Administration	F.C portion	66,128	14,695	29,390	29,390																																		139,604
Cost and Other Costs	L.C portion	72,951	29,915	36,213	36,213																																		175,293
Land Acquisition Cost	F.C portion		0																																				0
	L.C portion		104,699																																				104,699
Initial Facilities Cost (Civil Works &	F.C portion			26,653	221,848																																		248,502
Depot)	L.C portion			116,439	696,826																																		813,264
Initial & Additional Facilities Cost (BRT	F.C portion				695,364	49,698	30,552	29,126	65,992	30,552	33,404	48,272																											982,960
Bus, AFC)	L.C portion				342,182	32,589	29,330	26,071	29,330	29,330	35,848	29,330																												554,010
Renewal Cost (BRT Bus, AFC)	F.C portion										244,416	0	0	0	450,948	49,698	274,968	29,126	65,992	30,552	33,404	48,272	244,416	0	450,948	49,698	30,552	29,126	310,408	30,552	33,404	48,272						2,454,752
	L.C portion										0	0	0	0	342,182	32,589	29,330	26,071	29,330	29,330	35,848	29,330	0	0	342,182	32,589	29,330	26,071	29,330	29,330	35,848	29,330						1,108,020
Maintenance Cost of Civil Works and	F.C portion					374	374	374	374	3,875	374	374	374	374	3,875	374	374	374	374	26,181	374	374	374	374	3,875	374	374	374	374	3,875	374	374	374	374	3,875	54,531
Depot Facilities	L.C portion					3,365	3,365	3,365	3,365	34,877	3,365	3,365	3,365	3,365	34,877	3,365	3,365	3,365	3,365	235,629	3,365	3,365	3,365	3,365	34,877	3,365	3,365	3,365	3,365	34,877	3,365	3,365	3,365	3,365	34,877	490,780
Operational Cost	F.C portion																																						0
	L.C portion					340,790	370,034	399,278	428,521	457,765	487,009	516,253	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	545,497	15,546,071
Total	F.C portion	66,128	14,695	56,044	946,603	50,072	30,926	29,500	66,366	34,427	278,194	48,646	374	374	454,823	50,072	275,342	29,500	66,366	56,733	33,778	48,646	244,790	374	454,823	50,072	30,926	29,500	310,782	34,427	33,778	48,646	374	374	3,875	3,880,349
	L.C portion	72,951	134,614	152,652	1,075,221	376,744	402,729	428,714	461,217	521,972	526,222	548,948	548,862	548,862	922,555	581,451	578,192	574,933	578,192	810,456	584,710	578,192	548,862	548,862	922,555	581,451	578,192	574,933	578,192	609,703	584,710	578,192	548,862	548,862	580,373	18,792,137
		139,079	149,310	208,696	2,021,823	426,816	433,655	458,214	527,583	556,399	804,416	597,594	549,236	549,236	1,377,378	631,523	853,534	604,433	644,558	867,189	618,488	626,838	793,652	549,236	1,377,378	631,523	609,118	604,433	888,974	644,130	618,488	626,838	549,236	549,236	584,248	22,672,486

Note: F. C. – Foreign Currency, L. C – Local Currency

Source: Study Team

Figure 5.6.3 Disbursement Schedule of the Project Cost (In VND currency)

5.7 Regarding Fare Revenues of the BRT

5.7.1 Fare Scheme is the Existing Public Buses

In Hanoi, the fare scheme for buses which included public subsidies was enacted from 2005 and for 7 years the cost was set at 3,000 VND for a Single Ticket when the distance of the trip did not exceed 25 km. On October 1, 2012, due to rising fuel costs and inflation, the cost was increased to 5,000 VND for a Single Ticket for the same distance and from May 2014, the cost for a Single Ticket was changed to the numbers as shown in Table 5.7.1. Also, for bus route No. 71 which will compete with the BRT in this study, a flat fare is not used, instead, a distance-based fare is used. For bus route No. 74, it follows the fare scheme as shown in the following table and a Single Ticket costs 9,000 VND and a "Monthly Ticket" is also available for purchase.

Table 5.7.1 Hanoi Public Bus Fare Scheme (May 2014 Revision)

Type	Classification		Fare (VND)	Remarks
Single Ticket	Distance < 25 km		7,000	
	25 km Distance < 30 km		8,000	
	30 km Distance		9,000	
Monthly Ticket	Priority	Single Route	55,000	Student Industrial park workers Over 60 years old
		Muiti Route	100,000	
	Normal	Single Route	100,000	
		Muiti Route	200,000	
	Group	Single Route	70,000	Over 30 people
		Muiti Route	140,000	
Free	Under 6 years old		0	
	Over 75 years old			
	Disabled people			

Source: Study Team

Furthermore, on May 31, 2016, according to an announcement from the Department of Transport, they plan to reduce the rising subsidies for the bus and to cover the fuel costs, insurance costs and various maintenance costs by implementing a revision of the fare scheme. However, they have not released detailed information with regards to the exact fares that is to be changed.

5.7.2 Number of Monthly Tickets Sold and Ridership of the Public Buses

In Hanoi, the number of monthly tickets sold in one year for 2015 and the annual ridership is shown in Table 5.7.2.

With regards to the ridership, the number of passengers using Single Tickets was based on the number of tickets sold from the cash fare. For the number of passengers using Monthly Tickets the following calculation method was used.

The number of "Single Route" Monthly Tickets sold was multiplied by 60.8 trips/month (average monthly theoretical number of trips = 365 days ÷ 12 months × 2 trips/day) to obtain the number of passengers who use "Single Route" Monthly Tickets while the number of "Multi Route" Monthly Tickets sold was multiplied by 152.2 trips/month (based on the assumption that passengers transferred 2.5 times for each one way trip for 60.8 trips/month, 60.8 trips/month × 2) to obtain the number of passengers who use "Multi Route" Monthly Tickets.

Table 5.7.2 Number of Monthly Tickets Sold and Ridership for Hanoi Public Buses

Bus No.	Name of Bus Route	Number of Monthly Tickets Sold						Number of Passengers (Ridership)			
		Single Route			Multi Route			Single Ticket Passengers	Monthly Tickets Passengers		Total Number of Passengers
		Priority	Normal	Group	Priority	Normal	Group		Single Route	Multi Route	
		55,000 VND	100,000 VND	70,000 VND	100,000 VND	200,000 VND	140,000 VND	7,000 ～9,000 VND	(a+b+c) *60.8	(d+e+f) *152.2	
		A	B	C	D	E	F	G	H	I	J
1	BX Gia Lâm - BX Yên Nghĩa	1,475	3,676	11	38,459	7,823	156	2,368,733	314,388	7,069,565	9,752,686
2	Bác Cổ - BX Yên Nghĩa	4,890	11,992	127	76,769	15,623	311	2,483,237	1,034,828	14,106,660	17,624,725
3A	BX Giáp Bát - BX Gia Lâm	539	983	0	22,884	4,653	93	1,952,374	92,654	4,205,370	6,250,398
3B	BX Giáp Bát - KĐT Vincom	103	191	0	3,073	625	12	144,547	17,892	564,740	727,179
4	Long Biên - BX Nước Ngầm	2,072	1,672	3	20,178	4,120	82	787,357	227,894	3,709,470	4,724,721
5	KĐT Linh Đàm - Phú Diễn	1,134	964	5	12,295	2,498	50	684,780	127,818	2,257,980	3,070,578
6	BX Giáp Bát - Cầu Giẽ / Thường Tín / Phú Minh	11,571	8,405	0	85,095	17,323	346	1,708,138	1,213,772	15,625,565	18,547,475
7	Cầu Giấy - Nội Bài	1,217	6,880	1,114	51,500	10,492	209	2,219,816	560,026	9,462,570	12,242,412
8	Long Biên - Đông Mỹ	5,644	6,858	135	58,161	11,834	235	1,748,173	769,116	10,689,850	13,207,139
・	・	・	・	・	・	・	・	・	・	・	・
・	・	・	・	・	・	・	・	・	・	・	・
・	・	・	・	・	・	・	・	・	・	・	・
A	Total for 50 Bus Routes	98,228	133,648	3,344	1,393,979	283,267	5,635	61,050,253	14,311,474	256,108,665	331,470,392
B	Total for 17 Ordered Bus Routes	27,369	30,476	141	332,990	67,577	1,345	10,535,787	3,528,448	61,179,525	75,243,760
C	Total for 5 Socialized Bus Routes	17,961	8,042	7	117,750	23,795	473	1,754,710	1,582,836	21,616,965	24,954,511
	Total Bus Network (A+B+C)	143,558	172,166	3,492	1,844,720	374,639	7,453	73,340,750	19,422,758	338,905,155	431,668,663

Source: Study Team based on extracted data from TRAMOC

5.7.3 Fare Revenue from Buses and the Average Fare per Passenger

The fare revenue by bus route and for the entire bus system was obtained from TRAMOC and includes the calculation of subsidies. The Monthly Ticket revenues was calculated by multiplying the number of Monthly Tickets sold as shown in Table 5.7.2 by the unit price of the tickets. For the revenues of the Single Tickets, this was calculated by subtracting the Monthly Ticket revenues from the total revenues. The figures for the bus revenues are shown in Table 5.7.3.

From dividing the Single Ticket revenues by the number of Single Tickets sold, the average unit price of the Single Tickets was calculated. At the same time, the total fare revenue was divided by the total annual ridership to calculate the average fare per passenger.

For the entire public bus system, the average ticket price for Single Tickets is 8,101 VND and when Monthly Tickets are included, the average ticket price becomes 2,038 VND. Therefore, the average ticket price per person is 25.2% (2,038 VND/8,101 VND) of the Single Ticket price when Monthly Tickets are included.

Table 5.7.3 Fare Revenue from Buses in Hanoi and the Average Fare per Passenger

No.	Bus Route	Revenues (VND)									Average Fare/Person
		Single Ticket		Monthly Ticket						Total (Including Subsidies)	
				Single Route			Multi Route				
				Priority	Normal	Group	Priority	Normal	Group		
		7,000～9,000 VND		55,000 VND	100,000 VND	70,000 VND	100,000 VND	200,000 VND	140,000 VND		
		K =S-(M～R)	L =K/G	M 55,000*A	N 100,000*B	O 70,000*C	P 100,000*D	Q 200,000*E	R 140,000*F	S	S/J
1	BX Gia Lâm - BX Yên Nghĩa	17,659,568,425	7,455	81,125,000	367,600,000	770,000	3,845,900,174	1,564,696,857	21,788,563	23,541,449,019	2,414
2	Bác Cổ - BX Yên Nghĩa	21,412,218,142	8,623	268,950,000	1,199,200,000	8,890,000	7,676,927,466	3,124,554,722	43,509,679	33,734,250,009	1,914
3	BX Giáp Bát - BX Gia Lâm	16,349,090,257	8,374	29,645,000	98,300,000	0	2,288,397,106	930,690,213	12,954,113	19,709,076,689	3,153
4	BX Giáp Bát - KĐT Vincom	904,765,795	6,259	5,665,000	19,100,000	0	307,317,101	124,932,271	1,740,555	1,363,520,722	1,875
5	Long Biên - BX Nước Ngầm	5,931,249,295	7,533	113,960,000	167,200,000	210,000	2,017,843,468	824,023,815	11,469,076	9,065,955,653	1,919
6	KĐT Linh Đàm - Phú Diễn	5,515,566,927	8,055	62,370,000	96,400,000	350,000	1,229,456,828	499,546,977	6,962,303	7,410,653,035	2,413
7/8	BX Giáp Bát - Cầu Giẽ / Thường Tín / Phú Minh	17,353,148,181	10,159	636,405,000	840,500,000	0	8,509,484,524	3,464,512,449	48,418,472	30,852,468,625	1,663
9	Cầu Giấy - Nội Bài	19,852,409,792	8,943	66,935,000	688,000,000	77,980,000	5,150,023,882	2,098,425,270	29,287,969	27,963,061,913	2,284
10	Long Biên - Đông Mỹ	13,998,643,440	8,008	310,420,000	685,800,000	9,450,000	5,816,061,092	2,366,767,485	32,943,673	23,220,085,691	1,758
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A	Total 50 Bus Routes	519,319,263,412	8,506	5,402,540,000	13,364,800,000	234,080,000	139,397,926,271	56,653,476,464	788,841,997	735,160,928,144	2,218
B	Total for 17 Ordered Bus Routes	60,926,051,656	5,783	1,505,295,000	3,047,600,000	9,870,000	33,298,993,890	13,515,412,320	188,328,364	112,491,551,229	1,495
C	Total for 5 Socialized Bus Routes	13,898,808,390	7,921	987,855,000	804,200,000	490,000	11,775,049,839	4,758,911,217	66,249,639	32,291,564,084	1,294
	Total Bus Network (A+B+C)	594,144,123,458	8,101	7,895,690,000	17,216,600,000	244,440,000	184,471,970,000	74,927,800,000	1,043,420,000	879,944,043,458	2,038

Source: Study Team based on data from TRAMOC

5.7.4 Estimated Fare Revenue for this BRT by Alternative Routes

The fare revenues for the BRT in this study were calculated based on the forecasted traffic demand of the line as shown in Table 5.1.1. The fare revenues was based on the fare scheme of a base fare of 10,000 VND + 500 VND/km. Conceptually, this corresponds to the Single Ticket scheme as shown in Figure 5.7.1 but does not consider the Monthly Ticket fare scheme.

With regards to whether or not Monthly Tickets can be applied to this BRT like in the existing fare scheme as shown in Table 5.7.1, a careful examination is necessary because it could result in a large decrease in fare revenues and this could affect the operational profitability of this BRT.

On the other hand, based on the actual fare revenues as shown in Table 5.7.2, in the current conditions where there is insufficient public transport, the number of Monthly Ticket (discounted tickets) users is extremely large. In the case where UMRT line construction is progressing and this BRT is constructed, based on the modal shift of motorbike users, the public transport modal share will rise and it is conceivable that Single Ticket (non-discounted tickets) users will rise.

For the detailed examination of the fare scheme, this will need to be conducted during the feasibility study stage. In this study, the economic and financial analysis was premised on the assumption of "50% of the ridership using Monthly Tickets and fares for the Monthly Tickets are ½ that of the Single Tickets". Based on this assumption, the fare revenue including Monthly Tickets was estimated at 75% of the Single Ticket-only fare revenues based on the forecasted ridership of the BRT. (See Table 5.7.4)

However, in the case where a fare scheme with the Monthly Tickets with large discounts is introduced, the operational profitability of this BRT cannot be guaranteed. For maintaining the sustainability of this BRT, the investment cost for infrastructure should be separated and covered from the general finances and it is required for subsidies to be applied like in the current bus system of Hanoi.

Table 5.7.4 Daily Fare Revenue for the BRT in this Study

(million VND/day)

		Year	Option-1, Option-2	Option-3	Option-4	Option-5	Option-6
Demand Forecast (100% using Single Tickets)	A	2020	1,254	417	410	473	1,643
		2030	2,497	1,126	1,801	2,098	3,338
Economic and Financial Analysis (50% using Single Tickets and 50% using Monthly Tickets)	A*0.75	2020	940	313	307	355	1,233
		2030	1,873	845	1,350	1,574	2,503

Source: Study Team

6 Economic and Financial Analysis

6.1 Economic Analysis

6.1.1 Economic Analysis Methodology

In the economic analysis, the socio-economic feasibility of implementation the BRT project is evaluated by calculating the amount of economic benefit and economic cost for implementing the BRT project (With case) and for the case of not implementing the BRT project (Without case) and then comparing the two cases.

The Economic Internal Rate of Return (EIRR), Cost Benefit Ratio (CBR), and the Economic Net Present Value (ENPV) were calculated as evaluation indicators.

6.1.2 Economic Costs

In the economic analysis, it is necessary to convert all the costs and benefits which are calculated in market prices into economic prices excluding transfer items such as tax, customs duty, and etc.

The cost of implementation of this project consists of the project cost and the cost for operations and maintenance (refer to Chapter 5.6 – Estimated Project Costs).

In the calculation of the economic cost, firstly the Value Added Tax (VAT) is excluded and then the economic cost was calculated by multiplying 0.85, which is the Standard Conversion Factor (SCF) that is generally used in infrastructure projects in Vietnam. Inflation is not considered in economic analysis.

6.1.3 Economic Benefits

Various effects, such as the reduction of travel time, vehicle operating cost, and number of traffic accidents are the expected economic benefits with the introduction of the BRT. In this analysis, the benefits of “reducing travel time” and “decreasing travel cost” were calculated based on data availability, precision of measurement and the possibility of being able to calculate these items in monetary terms.

(1) Benefits from the Reduction of Travel Time

Benefits from the reduction of travel time is calculated by subtracting the total travel time cost of implementing the BRT project (With case) from total travel time cost of not implementing the BRT project (Without case).

Benefits from the Reduction of Travel Time = (Travel Time Cost without the BRT Project) − (Travel Time Cost with the BRT Project)

The travel time cost was calculated by multiplying the travel time and traffic volume with the value of time.

Travel Time Cost (VND) = Value of Time (VND/PCU・hr) × Travel Time (hr) × Traffic Volume (PCU)

(2) Benefits from the Reduction of Vehicle Operating Costs

Benefits from the reduction of vehicle operating costs was calculated by subtracting the total vehicle operating cost from implementing the BRT project (With case) from the total vehicle operating cost of not implementing the BRT project (Without case). In calculating the benefits from the reduction of the vehicle operating cost, items excluding the reduction of the travel time cost from improved travel conditions are the target.

Benefits from the Reduction of Vehicle Operating Costs = (Vehicle Operating Costs with the BRT Project) − (Vehicle Operating Costs without the BRT Project)

The vehicle operating cost is calculated by multiplying the travel distance and traffic volume with the unit cost of vehicle operations.

Vehicle Operating Cost (VND) = Unit Cost of Vehicle Operations (VND/PCU・km) × Travel Distance (km) × Traffic Volume (PCU)

6.1.4 Results and Evaluation of the Economic Analysis

(1) Preconditions

Common preconditions for the economic analysis are shown in Table 6.1.1. The JICA Study Team conducted an evaluation of each OPTION of the BRT project based on these conditions.

Table 6.1.1 Preconditions for the Economic Analysis

Item	Precondition	Remarks
Social Discount Rate	12%	-
Construction Period	From 2019 to 2022	-
Project Period	From 2023 to 2052	For 30 years
Base year for Cost	2016	Not considered inflation

Source: Study Team

The results from the travel demand forecast in the case that this BRT project is implemented is shown in Chapter 3 – Travel Demand Forecast Methodology.

The unit cost of the Travel Time Cost and Vehicle Operating Cost for each vehicle classifications was referenced from the JICA study titled “Data Collection Survey on Railways in Major Cities in Vietnam (METROS)”. Both unit costs are shown in Table 6.1.2 and Table 6.1.3.

Table 6.1.2 Unit Cost of Travel Time Costs

Year	Motorcycle (USD/hr)	Car (USD/hr)	Bus (USD/hr)
2020	2.39	3.55	1.91
2030	3.54	5.25	2.82

Source: Data Collection Survey on Railways in Major Cities in Vietnam (METROS), JICA, 2016

Table 6.1.3 Unit Cost of Vehicle Operating Costs (VOC)

Unit:: USD/1,000 km

Speed	Motorcycle	Car	Bus	Truck
5 km/h	147	779	1,560	1,531
10 km/h	86	461	929	903
20 km/h	54	293	604	580
30 km/h	43	234	496	436
40 km/h	37	202	439	366
50 km/h	34	186	432	338
60 km/h	34	185	457	332
70 km/h	35	190	496	344
80 km/h	36	197	541	372
90 km/h	38	209	581	414

Source: Data Collection Survey on Railways in Major Cities in Vietnam (METROS), JICA, 2016

(2) Results and Evaluation of the Economic Analysis

The economic effect and impact of the implementation of the BRT project was analyzed based the different alternative route option for the BRT. Table 6.1.4 shows the results of the economic analysis for each option.

For every option, the EIRR is over 12%, the CBR is over 1.0, and the ENPV is positive. It became clear that the effect of operating the BRT for each option is high from the socioeconomic viewpoint. In addition, the following results can be mentioned when comparing each of the options with the indicators.

- OPTION-3 has the highest EIRR and CBR and OPTION-6 has highest ENPV.
  - The project cost of OPTION-3 is lowest for all options. On the other hand the benefit is double of the project cost. That is, the EIRR and CBR are relatively high because the benefits are relatively higher than the project cost.
  - While OPTION-6 has a high project cost, the benefits is approximately double of other options. Therefore, the difference of cost and benefit is big (total benefit is the highest among other options) and the ENPV is high.
  - This has shown that OPTION-3 has a suitable EIRR, while OPTION-6 has a suitable ENPV. The EIRR of OPTION-6 is lower than OPTION-3, but its ENPV is 1.7 times bigger.
- OPTION-1, OPTION-2, and OPTION-5 have the result of relatively low CBRs because they are subjected to the influence of project cost.
- OPTION-3 and OPTION-4 have overall high results because the BRT operating cost of them is lower than other options and the growth benefits from these two options is larger than the others.

Table 6.1.4 Results from the Economic Analysis

Indicators	OPTION-1	OPTION-2	OPTION-3	OPTION-4	OPTION-5	OPTION-6
Economic Internal Rate of Return (EIRR)	15.6%	19.4%	32.8%	29.2%	18.4%	24.9%
Cost Benefit Ratio (CBR)	1.1	1.3	1.9	1.7	1.2	1.7
Economic Net Present Value (ENPV)	590	908	1,916	1,555	872	3,255
※The calculation procedure for each of the indicators are as follows: EIRR = (Discount rate when the Economic Net Present Value becomes zero) CBR (B/C) = (Present Value of Benefits) ÷ (Present Project Value of the Costs) ENPV = (Present Value of Benefits) − (Present Project Value of the Costs)						

Source: Study Team

(3) Sensitivity Analysis

A sensitivity analysis for each option was conducted where the EIRR was calculated when the benefits and costs were increased or reduced by 10%, 15% and 20% to see the feasibility of the project in the event of the occurrence of economic risks. The results are shown in the following table.

- The reduction of benefits has a larger impact than the reduction of cost in every option
- OPTION-3, OPTION-4, and OPTION-6 have a high elasticity because the EIRR for these options is over 12% (even if the project cost increases and the benefits decreases). Even though OPTION-6 has a high project cost, from the sensitivity analysis, it is assumed that OPTION-6 will have high economic effects when compared to the scale of the project cost

OPTION-1		Benefit			
		Base	-10%	-15%	-20%
Cost	Base	15.6%	12.7%	11.8%	9.5%
	+10%	13.0%	10.1%	8.5%	6.8%
	+15%	11.7%	8.9%	7.3%	5.6%
	+20%	10.6%	7.7%	6.1%	4.3%

OPTION-2		Benefit			
		Base	-10%	-15%	-20%
Cost	Base	19.4%	16.0%	15.0%	12.4%
	+10%	16.4%	13.1%	11.3%	9.4%
	+15%	15.0%	11.7%	9.9%	8.0%
	+20%	13.6%	10.4%	8.6%	6.7%

OPTION-3		Benefit			
		Base	-10%	-15%	-20%
Cost	Base	32.8%	29.1%	27.9%	25.1%
	+10%	29.4%	25.8%	24.0%	22.0%
	+15%	27.9%	24.4%	22.5%	20.6%
	+20%	26.5%	23.0%	21.2%	19.3%

OPTION-4		Benefit			
		Base	-10%	-15%	-20%
Cost	Base	29.2%	25.4%	24.2%	21.3%
	+10%	25.7%	22.1%	20.1%	18.1%
	+15%	24.2%	20.6%	18.7%	16.7%
	+20%	22.7%	19.1%	17.2%	15.3%

OPTION-5		Benefit			
		Base	-10%	-15%	-20%
Cost	Base	18.4%	15.0%	13.9%	11.1%
	+10%	15.3%	11.9%	10.0%	7.9%
	+15%	13.9%	10.4%	8.5%	6.3%
	+20%	12.5%	9.0%	7.0%	4.8%

OPTION-6		Benefit			
		Base	-10%	-15%	-20%
Cost	Base	24.9%	22.3%	21.5%	19.5%
	+10%	22.5%	20.0%	18.7%	17.3%
	+15%	21.5%	19.0%	17.6%	16.3%
	+20%	20.4%	18.0%	16.7%	15.3%

Source: Study Team

Figure 6.1.1 Results of the Sensitivity Analysis

6.2 Financial Analysis

6.2.1 Financial Analysis Methodology

The objective of the financial analysis is to consider the financial feasibility of the BRT project by comparing the cost (financial cost) with the market price fare revenue. The financial situation during project implementation when the project is implemented based on the different alternative route options was simulated, analyzed, and evaluated by the financial model. In detail, the simulation was conducted from the opening year to completion year depending on some preconditions. The Financial Internal Rate of Return (FIRR) was calculated in this analysis.

6.2.2 Preconditions

The preconditions for the financial analysis for this project are shown in Table 6.2.1.

Table 6.2.1 Preconditions of Financial Analysis

Item	Precondition	Remarks
Construction Period	From 2019 to 2022	-
Project Period	From 2023 to 2052	For 30 years
Base Year for the Cost	2016	Considered inflation

Source: Study Team

6.2.3 Cost for the Implementation of the BRT Project

The construction and operation cost for this BRT project was used for the financial analysis. Table 6.2.2 shows the cost for each of the project options. The details for the different project options are shown in Chapter 5.5 - Technical Evaluation of the Alternative BRT Routes.

Table 6.2.2 BRT Project Cost

	OPTION-1	OPTION-2	OPTION-3	OPTION-4	OPTION-5	OPTION-6
Cost（2018～2052） Unit: million yen	90,684	82,688	49,587	57,414	89,573	111,314
※VAT: Standard tax rate (10%), Corporate tax: Exemption (based on the “Vietnam - Hanoi Urban Transport Development Project” (World Bank, 2007))						

Source: Study Team

6.2.4 Project Revenue

The revenue of this project was assumed to come from the fare revenue from the target section of the BRT project. The fare of 10,000 VND + 500 VND/km (refer to Section 5.3.1.1) was used for the calculation of the project revenue. The ridership numbers used comes from the travel demand forecast from this study; however, the fare revenue was calculated assuming that half of the passengers were children. The revenue for each of the options is shown in Table 6.2.3.

Table 6.2.3 Fare and Revenue of the BRT Project

	OPTION-1	OPTION-2	OPTION-3	OPTION-4	OPTION-5	OPTION-6
Base Fare (VND/passengers)	10,000					
+ per 1 km (VND/passengers)	500					
Revenue (2018～2052, Unit: million yen)	95,997	95,997	42,748	67,365	78,490	128,199

Source: Study Team

6.2.5 Inflation Rate

The inflation rate of the foreign currency and local currency was set at the average of the forecasted rate from 2019 to 2021 based on the inflation rate from the World Economic Outlook Databases (International Monetary Fund: IMF).

Table 6.2.4 Inflation rate of Local and Foreign Currency

Year	Japan (%)	Vietnam (%)
2019	0.928	3.4
2020	1.004	3.8
2021	1.218	4
Average (2019-2021)	1.05	3.73

Source: World Economic Outlook Databases (International Monetary Fund)

6.2.6 Exchange Rate

The exchange rate which was used for this project was set at the rate from the State Bank of Vietnam from the date of May 31, 2016.

Table 6.2.5 Exchange Rate

1 USD =	22,597 VND
1 JPY =	203.68 VND

Source: The State Bank of Vietnam (May, 2016)

6.2.7 Results and Evaluation of the Financial Analysis

As a result of the financial analysis based on the preconditions mentioned above, the calculated Financial Internal Rate of Return (FIRR) of the BRT project for the various project options is shown in Table 6.2.6.

The FIRR of OPTION-2, OPTION-4, and OPTION-6 are relatively high while that of OPTION-1, OPTION-3, and OPTION-5 is low. The difference between revenue and cost for OPTION-2, OPTION-4, and OPTION-6 is large, that is, the FIRR becomes high because passenger demand is large compared with the cost. Meanwhile, the demand of the other options is lower compared to the costs.

The difference between revenue and cost for OPTION-3 and OPTION-5 is negative so the FIRR is low because for these options, profitability cannot be obtained. In particular, the FIRR of OPTION-3 is negative because financial situation is a deficit balance during the evaluation period of 30 years.

Although it is difficult for an organization or the private sector to operate the entire BRT project in a financially independent basis, the private sector might be able to operate the BRT project by using government assistance subsidies.

It is desirable to operate OPTION-1 with government assistance for the initial costs and operating subsidies while for OPTION-3 and OPTION-5, it is desirable for the public sector to implement operations.

Table 6.2.6 Results of the Financial Analysis

Indicator	OPTION-1	OPTION-2	OPTION-3	OPTION-4	OPTION-5	OPTION-6
Financial Internal Rate of Return (FIRR)	6.06%	10.48%	-0.16%	10.40%	0.18%	10.56%

Source: Study Team

7 Environmental and Social Consideration/Gender Consideration

7.1 Briefing of the Project

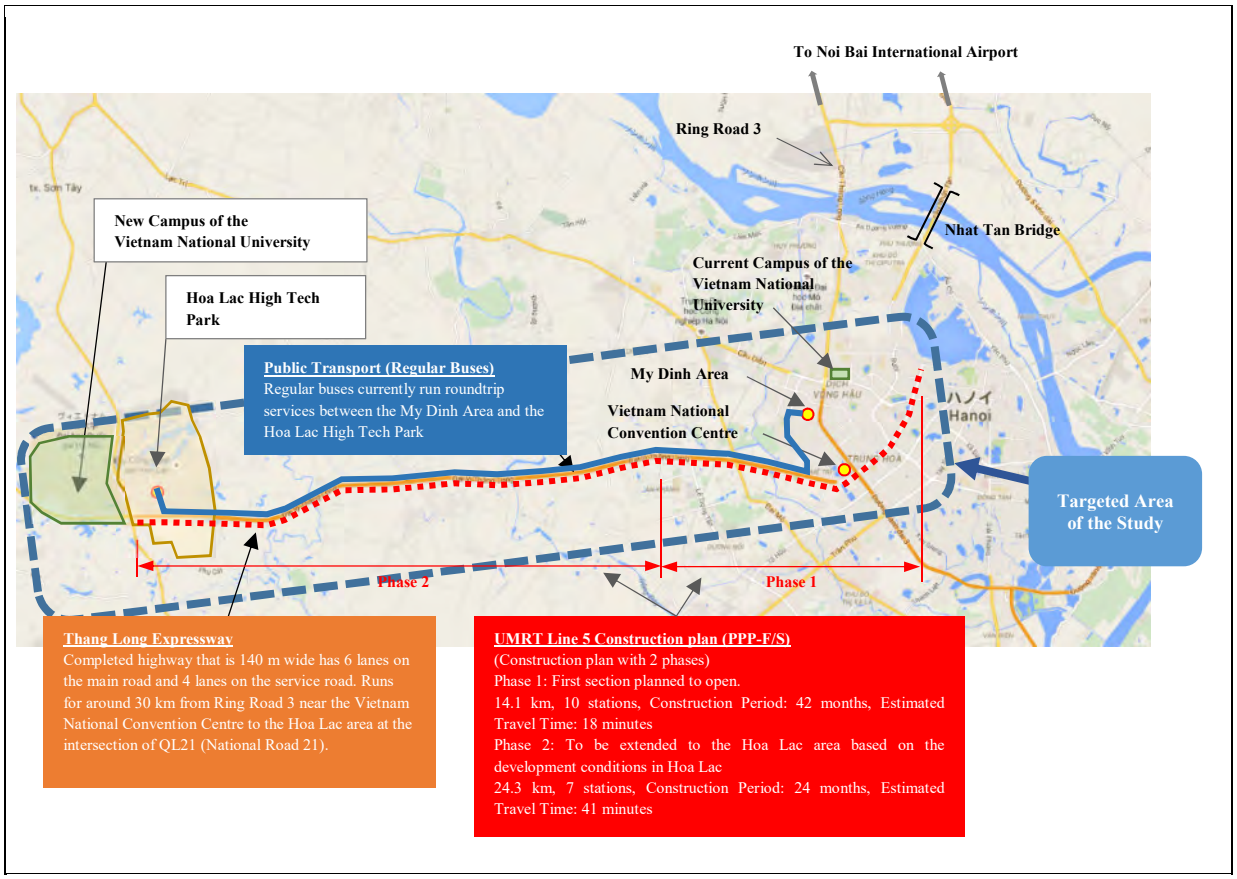
7.1.1 Project Outline

This project is a study on establishment of a bus rapid transit (BRT) between the centre of Hanoi and the Hoa Lac Satellite town in the west of Hanoi, as shown in the below figure.

Hoa Lac Satellite town is expected to have a population of 600,000 people in 2030, according to the Construction Master Plan of Hanoi City to 2030, Vision to 2050 (Decision 1259/QD-TTg dated July 26, 2011). The town will include two major items: the Hoa Lac High Tech Park and the Vietnam National University. The demand for travel of employees and students in the Hoa Lac High Tech Park and the Vietnam National University will be very high once the park and the university are developed completely.

In the meantime before construction and operation of UMRT Line 5 connecting the centre of Hanoi and Hoa Lac Satellite Town, a BRT route in lieu of the UMRT Line 5 should be considered.

Currently, there are two regular bus routes, No. 71 and No. 74, which run from My Dinh bus terminal along the service roads of the Thang Long Expressway to Son Tay township with the frequency of about 30 minutes/vehicle. It was reported that regular buses cannot satisfy the demand of people for traveling to/from the centre of Hanoi.



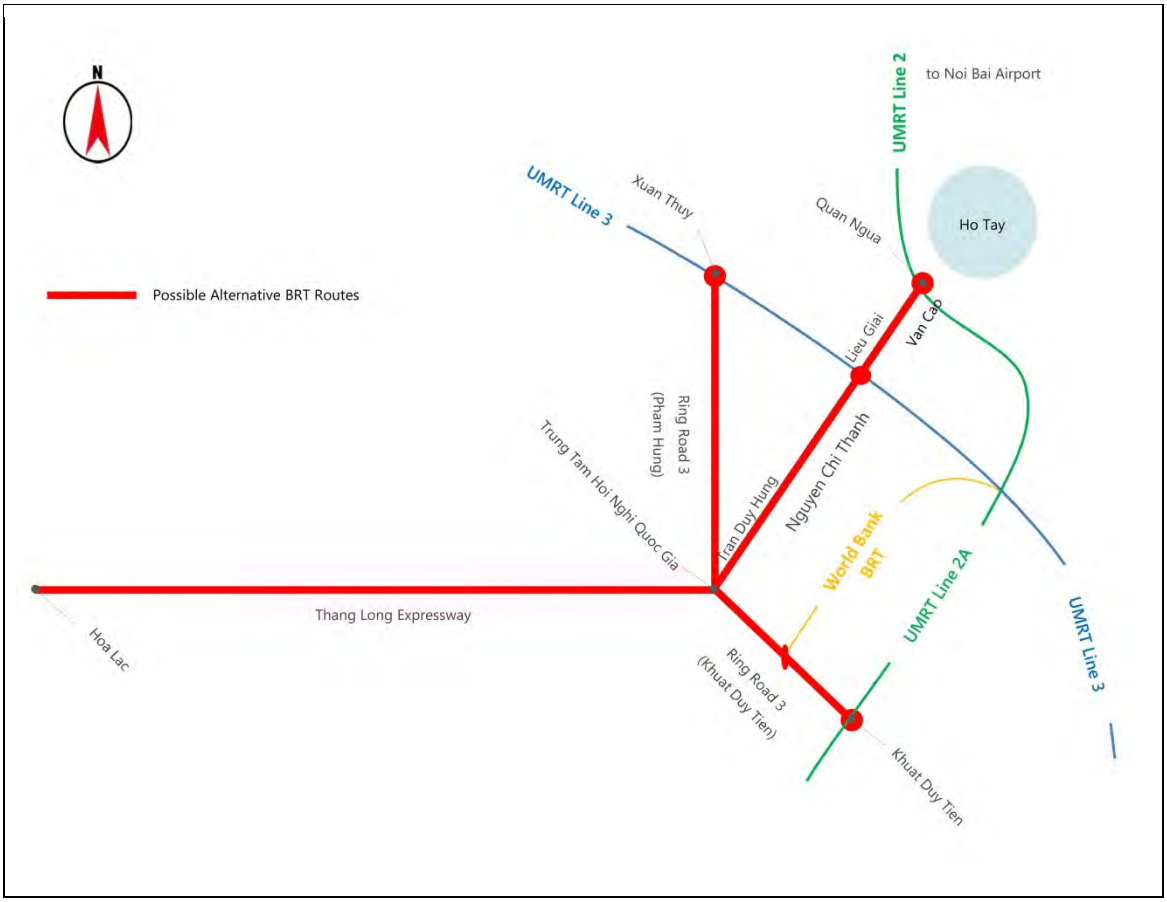
Source: Study Team

Figure 7.1.1 Target Study Area

7.1.2 Proposed BRT Routes

For connecting between the centre of Hanoi and Hoa Lac, the study steam has proposed different options for the BRT route.

Mainly, BRT vehicles will run from Hoa Lac to the Vietnam National Convention Center by using the Thang Long Expressway in the suburban section (outside Ring Road No. 3), while the vehicles can use different routes in the urban section (inside Ring Road No. 3), including: (1) Tran Duy Hung-Nguyen Chi Thanh-Lieu Giai-Van Cao route, (2) Vietnam National Convention Center (VNCC) to Khuat Duy Tien-Le Van Luong interchange by using Khuat Duy Tien road, in order to connect to World Bank BRT route, and (3) VNCC to Khuat Duy Tien-Nguyen Trai and Mai Dich interchanges along Ring Road No. 3 (Khuat Duy Tien and Pham Hung roads), as shown in the below figure.



Source: Study Team

Figure 7.1.2 Possible Alternative BRT Routes

The BRT route in the suburban section can use the outer lane of the Thang Long Expressway or construction of new exclusive lanes in buffer separators (mostly width > 20 m) between the Thang Long Expressway and service roads.

The BRT route in the urban section will require the construction of new exclusive lanes in the center median of the existing roads. Note that the width of center median on Tran Duy Hung-Nguyen Chi Thanh-Lieu Giai-Van Cao roads is 17 m and the width of center median of Ring Road No. 3 is 28 m. Detailed information and description of each alternative can be found in Section 7.5.1.

7.1.3 BRT Facilities

One depot with an area of 21,490 m^2 will be required to be built to serve for multi purposes, including management, parking, maintenance of vehicles, washing, and fuel supply. The depot will be established in an agricultural field along the Thang Long Expressway to minimize the resettlement requirement.

Bus stops will be built in the center median of the existing roads in the urban section and in buffer separators between the Thang Long Expressway and service roads in the suburban section. The interval distance between bus stops will be 1,200 m in the urban section and in between 1,000 and 4,100 m in the suburban section. There will be total 21 bus stops for the route from Hoa Lac to Van Cao.

Pedestrian bridges, underground or at-grade pedestrian crossings will be designed for the different route options, in order to convey passengers from bus stops to the pavement of the existing roads.

The project will employ two types of BRT vehicles: standard buses (length of 10.5-12 m, vehicle capacity of 60-90 passengers) and articulated buses (length of 18-20 m, vehicle capacity of 140-170 passengers). The total required number of vehicles will vary from 77 to 198 vehicles in 2030, dependent on the alternatives.

7.2 Categorization and the EIA/IEE Requirements

7.2.1 Categorization

According to the JICA Guidelines for Environmental and Social Considerations (2010), this project can be classified as Category B. The project is not likely to have significant adverse impacts on the environment and society in terms of its sectors, characteristics, and areas. Generally, potential adverse impacts of the project are site-specific; and in most cases, normal mitigation measures can be designed more readily.

7.2.2 EIA/IEE Requirements

The JICA Guidelines for Environmental and Social Considerations (2010) requires an Initial Environmental Examination (IEE) for Category B projects. Therefore, this project is subject to an IEE examination following JICA Guidelines.

According to Vietnamese laws and regulations on Environmental Impact Assessment, including the "Decree Stipulating on Environmental Protection Planning, Strategic Environmental Assessment, Environmental Impact Assessment and Environmental Protection Plans" from the Vietnamese Government (Decree 18/2015/ND-CP dated February 14, 2015), as well as consultation results with the Environmental Protection Agency of Hanoi (Hanoi EPA) under the Department of Natural Resources and Environment of Hanoi (Hanoi DONRE), the procedure of the Environmental Impact Assessment (EIA) is required for this BRT project if it includes one of the following items:

i) New construction of expressways or motor vehicle roads of Grade I to III
ii) New construction of bridges with a length of 500 m or above
iii) New construction of bus terminals with an area of 5 ha or above
iv) New construction of workshops for the maintenance and repair of motor vehicles with a capacity of 500 vehicles/year or above

It is apparent that the requirement of an Environmental Impact Assessment (EIA) or Environmental Protection Plan (EPP) procedure is dependent on the project content itself. At the time being, this project has six different alternatives with options for the BRT route and construction of new lanes on the existing roads. Every alternative also includes the construction of a depot with a workshop for the maintenance of vehicles.

The detailed examination for the EIA/EPP requirements for the alternatives of the project, in terms of road construction, depot and vehicle workshop, is conducted in the following section.

Some alternatives include construction of new lanes on Thang Long Expressway, Ring Road No. 3, and Tran Duy Hung to Van Cao streets; others do not require construction of new lanes. Ring Road No. 3 and Tran Duy Hung to Van Cao streets are important dual 3 lane and dual 2 lane roads in Hanoi which can be classified as main urban roads (according to TCXDVN 104:2007 of Ministry of Construction on Specifications of Design for Urban Roads), which can be equivalent to motor vehicle road of Grade II and III (according to TCVN 4054:2005 Specifications for Design of Motor Vehicle Roads) in terms of road function, number of lanes, width of lanes, width of pavement and center median. Therefore, the project alternatives which include construction of exclusive lanes on the Thang Long Expressway, Ring Road No. 3, or Tran Duy Hung to Van Cao streets are subject to the requirement of the EIA procedures.

Considering the depot which will be built in every alternative, the depot will have an area of 21,490 m^2 that is smaller than the area of 5 ha, a threshold value required for EIA procedure in Decree 18/2015/ND-CP.

However, the depot will include a maintenance area of 600 m^2 for the regular inspection and maintenance of vehicles in the fleet of BRT vehicles. As detailed in the following table, the total number of vehicles in 2030 will vary from 77 to 198 vehicles, dependent on the alternatives.

Using a regulation that each vehicle must implement regular inspection and maintenance after running at most 12,000 km, as specified in Circular 66/2014/TT-BGTVT of Ministry of Transport on Economic-Technical Norms on Public Transportation by Means of Bus, the number of vehicle maintenance times in 2030 will vary from 937 to 2,292 times of vehicles, which is higher than the threshold value of 500 vehicles/year prescribed in Decree 18/2015/ND-CP. Therefore, the workshop for the maintenance of vehicles and thus the depot item are subject to the requirement of the EIA procedure.

Table 7.2.1 Number of Maintenance for Vehicles in 2030

Alternative	Total Running Distance (km/day)	Total Number of Vehicles	Average Running Distance (km/day/vehicle)	Running Distance per each Time of Maintenance (km/times)	Number of Maintenance times for each Vehicle per year (times/year)	Total Number of Maintenance Times per Year (times of vehicle/year)
Option 1&2	54,522	143	381.3	12,000	11.6	1,658
Option 3	30,801	77	400.0	12,000	12.2	937
Option 4	36,920	95	388.6	12,000	11.8	1,123
Option 5	54,769	144	380.3	12,000	11.6	1,666
Option 6	75,348	198	380.5	12,000	11.6	2,292

Source: Study Team

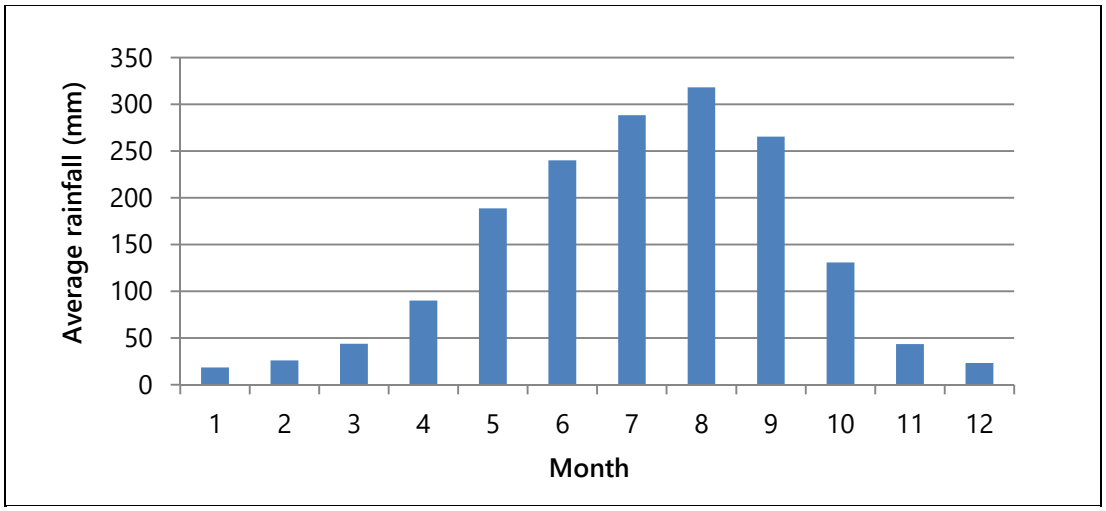
On the whole, the BRT project will need to undergo an Environmental Impact Assessment procedure due to the construction of new lanes on expressway or roads of Grade I to III and construction of motor vehicle workshops with a capacity of higher than 500 vehicles/year as required by Decree 18/2015/ND-CP of the Vietnamese government.

7.3 Environmental Baseline and Social Conditions

7.3.1 Climate

Hanoi features a typical climate of northern Vietnam, a humid subtropical climate where summers are hot and abundant of rainfall and winters are cool and dry. Generally, hot weather lasts from May to September with an average temperature of 28.1 C while cool weather is from November to March with an average temperature of 18.6 C, according to the "Hanoi Statistical Year Book 2014". Two intermediate months, including April and October, have an average temperature of 24-25°C. The average annual temperature is 23.6°C and the mean annual relative humidity is 79%. The highest temperature was 42.8 °C recorded in May 1926, and the lowest temperature was 2.7 °C recorded in January 1955.

Annual rainfall is 1680 mm with a majority received in the summer. There are on average 139 days with rain annually. Rainy season lasts from May to September. Rainfall precipitated during these 5 months accounts for 77.5% of the total annual rainfall. Average monthly rainfall in many years recorded at Hanoi station is presented in the following figure.



Source: Center of Hydro-Meteorological Documentation

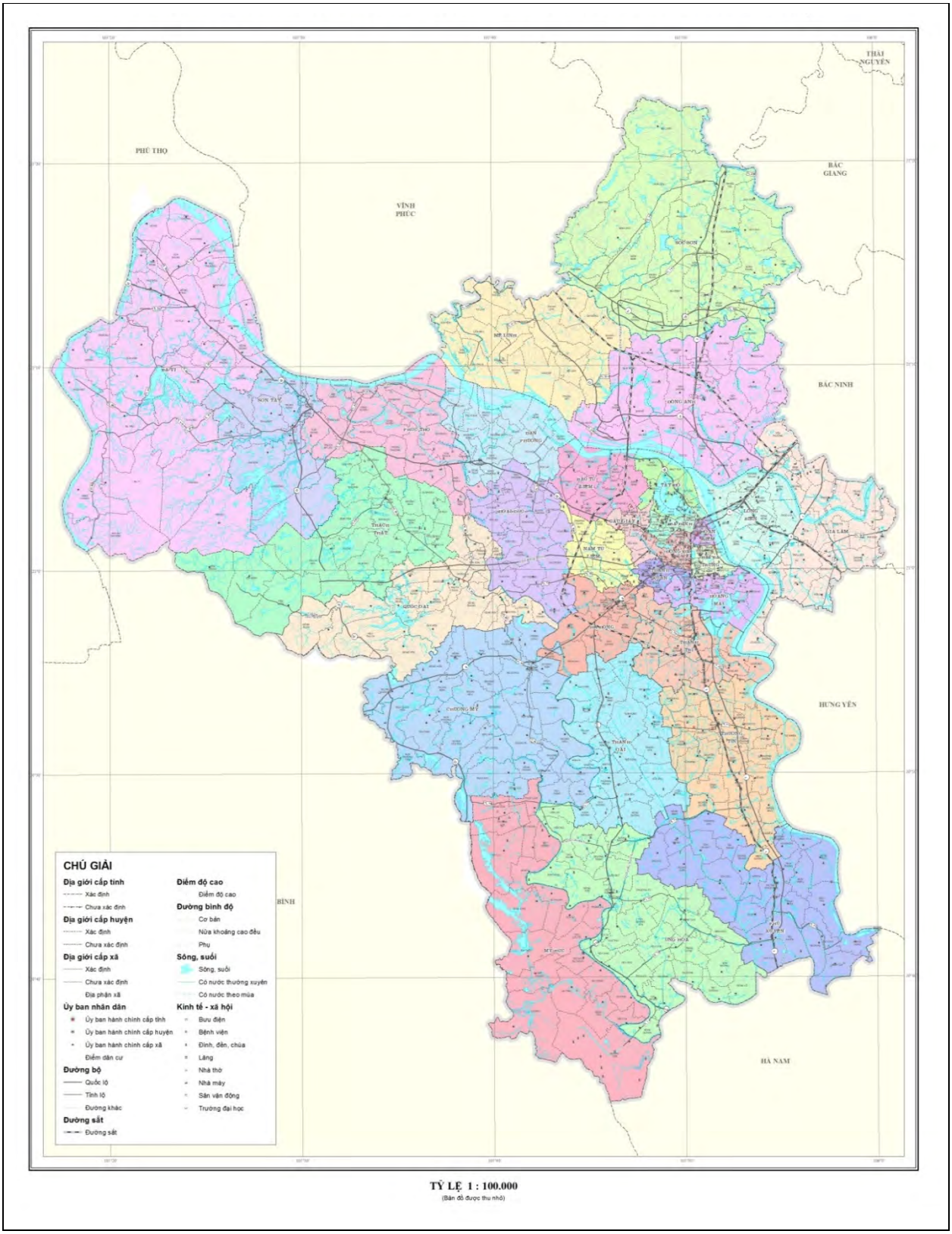
Figure 7.3.1 Average Monthly Rainfall from 1898-2011 at Hanoi Station

7.3.2 Topography

According to the "Overall Report on Environmental Status of Hanoi during the Period of 2011-2015", Hanoi contains three basic kinds of terrain, including the delta area, midland area and mountainous zone. In general, the terrain is gradually lower from the north to the south and from the west to the east, with the average height ranging from 5 to 20 m above the sea level. The hills and mountainous zones are located in the northern and western part of the city. The highest peak is at Ba Vi Mountain with a height of 1281 m, located in the western part of the region.

The proposed BRT route lies in the east-west direction, connecting the center of Hanoi located in the delta areas with Hoa Lac that is located in the midland area in the west of the city.

The eastern part of the BRT route passes through the crowded urban areas of central Hanoi which includes Ba Dinh, Dong Da, Cau Giay, and Thanh Xuan districts, as shown in the following figure of the administrative map of Hanoi. The western end of the route, located in Thach That District, belongs to midland areas. The middle part of the route located in the delta area is characterized by agricultural fields and rural residential villages, which have been urbanizing rapidly.



Source: Hanoi DONRE, 2015

Figure 7.3.2 Administrative Map of Hanoi

7.3.3 Geology

The geology of Hanoi features with Quaternary sediments, including Pleistocence and Holocence. According to the monograph "Hanoi Geology and Minerals", Vu Nhat Thang (Ed.), published in 2003, the following five formations can be found in the project area.

Le Chi formation (aQ_1^1 lc): early Pleistocene, the oldest formation of Quaternary sediments of Hanoi. This formation is distributed under the depth of 45 m. The thickness of the formation varies from 2.5 to 24.5 m, consisting fluvial with pebble, granule mixed with sand, a little clayey silt, and plant remains.

Hanoi formation (a, apQ_1^{2-3} hn): middle-late Pleistocene, C^{14} = 30,155±300 years. This formation is distributed in terrace 2 of Red River in Xuan Mai, Thach Thai, Hoa Lac, Kim Anh, Da Phuc, and Tam Nong. The thickness of the formation varies from 2.6 to 47 m, consisting proluvio-alluvial with pebble, granule, and quartz-cherty breccia-granule interblended with pebble and granule.

Vinh Phuc formation (a, $albQ_1^{3b}$ vp): late Pleistocene. Firstly, Vinh Phuc formation was regarded as sediments formed during a cycle of marine deposition. Later studies showed that it was formed in different periods with different origins such as fluvial, fluvio-marine, and marine. The thickness of this formation varies from 0 to 38 m. This formation consists of grey silty clay mixed with quartz breccia and grit, pinkish-gray clayish silt bearing plant remains, small-grained sand, interbeds of cross-bedded clay, silt, clay, and lateritized variegated silt and clay.

Hai Hung formation (lb, mQ_2^{1-2} hh): early-middle Holocene C^{14} = 7190±85 – 4145±50 years. The thickness of this formation varies from 2 to 35 m. This formation consists of marine, swampy, lacustrine, fluvial with silty sand with remains of plant, wood and mollusc shells, and dark gray silty clay bearing plant detritus.

Thai Binh formation (a, $albQ_2^3$ tb): late Holocene. The thickness of this formation varies from 3 to 35 m. This formation consists of polygenic (marine, fluvio-marine, eolo-marine, marine-marshy and fluvial), silt, sand bearing fragments of mollusc shells, black-gray clayish silt, yellow clay, and sand intercalated with chocolate sand and silt.

7.3.4 Rivers

The project area features four main rivers, including the Day, Nhue, Tich and To Lich rivers. While the BRT route runs east-west, the four rivers flow almost from northwest to southeast. Each river will cross the BRT route once. The sequence of four rivers from west to east is Tich, Day, Nhue, and To Lich rivers, respectively, among which the Day River is the largest and the most important one while the others are its tributaries.

Day River has a total length of 237 km and a drainage basin of more than 7500 km^2, according to "Overall Report on Environmental Status of Hanoi City During the Period of 2011-2015". The river used to be a distributary of the Red River. It starts from Cam Dinh gate and flows through Hanoi, Ha Nam, Ninh Binh, and Nam Dinh provinces, and finally discharges into the Gulf of Tonkin. Regarding the project area, the Day River makes a natural border between Quoc Oai and Hoai Duc districts and it crosses the BRT route at km 13.6 of the Thang Long Expressway.

Nhue River is a tributary of the Day River with a length of 76 km and a drainage area of 1075 km^2, according to the official portal for environmental monitoring of the Nhue-Day river basin of the Vietnam Environment Administration (http://lvsnhue.cem.gov.vn/). It starts from the Lien Mac spillway dam of the Red River, flows through Bac Tu Liem, Nam Tu Liem, Ha Dong, Thanh Tri, Thanh Oai, Thuong Tin, Phu Xuyen districts of

Hanoi, Duy Tien district of Ha Nam province and finally joins into the Day River at Phu Ly city of Ha Nam province. Nhue River crosses the BRT route at km 3.2 of the Thang Long expressway in Phu Do commune, Nam Tu Liem district.

Tich River is another tributary of the Day River with a length of 110 km and a drainage area of 1330 km^2. It originates from Ba Vi Mountain, flows through Ba Vi, Son Tay, Phuc Tho, Thach That, Quoc Oai, Chuong My districts of Hanoi and finally joins into the Day River at Ba Tha junction (Phuc Lam commune, My Duc district, Ha Noi city). Tich River crosses the BRT route at about km 21.3 of the Thang Long Expressway in Ngoc Liep commune (Quoc Oai district).

To Lich river is a small tributary of Nhue River. The river starts at the Phan Dinh Phung outlet of Ho Tay (West Lake) and runs through the center districts of Hanoi. The river length is 14.6 km and its drainage is 77.5 km^2. The river crosses the BRT route at Trung Hoa Bridge which connects Tran Duy Hung and Nguyen Chi Thanh streets.

7.3.5 Soil

The project area is located in a large and high plain that was formed by the Red River and its distributaries such as the Day, Nhue, and Tich Rivers. According to "Soil and Land Statistical Data in 2010" of Hanoi DONRE, yellowish red soil group occupies the largest area in the project area, following by the Fluvisols group, swampy soil, peat soil and deposit valley soil group.

The texture of the yellowish red soil group varies from sandy loam to light clay and from slightly acidic to very acidic. The content of the total and available nutrients is quite high in the top soil layer of yellowish red soil but lower in the subsoil layers.

The Fluvisols group ranges from moderately acidic to slightly acidic; the soil nutrient content varies from medium to quite rich in the top soil layer. The swampy soil and peat soil group has strong Gley layer; its soil structure is destroyed and the soil pH varies from acidic to very acidic. The nutrient content of these soils varies from quite high to high values. The deposit valley soil group varies from acidic to very acidic. Its soil nutrient content and exchangeable base content are low; its soil texture varies from light loam to medium loam.

It is noted that the BRT route will be established on existing roads, such as Nguyen Chi Thanh, Lieu Giai, Van Cao, Pham Hung, Khuat Duy Tien roads and the Thang Long Expressway. In some circumstances, the median strips of the roads will be renovated to prepare for exclusive lanes for the buses.

Pedestrian bridges and bus stops could be built in the median strips and pavements of the roads. Accordingly, construction of the roads (if any) and auxiliary facilities will be made on the previously prepared foundation of the constructed roads, which was prepared by different construction materials rather than the native soil. The depot, however, would be constructed in an agricultural field beside the Thang Long Expressway.

7.3.6 Protected Areas

Ba Vi National Park with an area of 10,815 ha was established in 1991, located in the 3 districts of Hanoi (Ba Vi, Thach That, and Quoc Oai districts) and two districts of Hoa Binh province (Luong Son and Ky Son districts), according to the official site of the Ba Vi National Park (http://vuonquocgiabavi.com.vn/).

The buffer zone of the park belongs to the administrative areas of 16 communes, including 7 communes of Ba Vi district (Ba Vi, Ba Trai, Tan Linh, Khanh Thuong, Minh Quang, Van Hoa, Yen Bai), 3 communes of Thach That district (Tien Xuan, Yen Trung, Yen Binh), 1 commune of Quoc Oai district (Dong Xuan), 1 commune of Luong Son district (Lam Son), and 4 communes of Ky Son district (Yen Quang, Phu Minh, Phuc Tien, Dan Hoa). However, it is confirmed that the protected area of the park does not overlap with the area of the proposed BRT route and the proposed depot in Thach Hoa commune (Thach That district).

7.3.7 Trees and Plants

Some species of tropical evergreen trees are planted in the median strips of Van Cao, Lieu Giai, Nguyen Chi Thanh, Tran Duy Hung streets, and Thang Long Expressway such as Cuban Royal Palm (*Roystonea regia*), Fountain Palm (*Livistona chinensis*), Areca Palm (*Dypsis lutescens*), Indochina Dragon Plum (*Dracontomelon duperreanum*) and Royal Poinciana (*Delonix regia*), as shown in the following figures. All of trees planted in median strips of roads are considered as urban trees and usually not listed in the IUCN red list of threatened species.

Cuban Royal Palm (*Roystonea regia*) on Van Cao Street

Fountain Palm (*Livistona chinensis*) near the Japanese embassy on Lieu Giai Street

Royal Poinciana (*Delonix regia*) on the Thang Long Expressway

Indochina Dragon Plum (*Dracontomelon duperreanum*) on the Thang Long Expresway

Source: Study Team

Figure 7.3.3 Photos of Some Trees on the Thang Long Expressway, Lieu Giai and Van Cao Streets

Some common species of agriculture and fruit plants are grown in agricultural fields along the Thang Long Expressway in Hoai Duc, Quoc Oai and Thach That districts such as rice, maize, cabbage, Chinese peas, apple, mango, litchi, and some flowers. The following figure shows an image of a rice field along the Thang Long Expressway in Quoc Oai district.

Source: Study Team

Figure 7.3.4 Rice Field along the Thang Long Expresway in Quoc Oai district (Hanoi)

7.3.8 Air Quality

Ambient air quality data in the BRT project area was collected from the Department of Natural Resources and Environment of Hanoi (Hanoi DONRE). The ambient air quality data are presented in the following section for two different groups: the urban and suburban areas; the division of the two areas is made based on the location of Ring Road No. 3.

7.3.8.1 Air Quality in the Urban Area

Monitoring results (1-hour average) of ambient air quality data in the Hanoi urban area recorded in September, 2015 are presented in the following table. The recorded parameters included TSP, NO_2, SO_2, CO, and benzene.

In comparison with the national technical regulations on ambient air quality (QCVN 05:2013/BTNMT and QCVN 06:2009/BTNMT), the ambient air quality recorded in September, 2015 at interchanges along the proposed BRT routes showed that TSP and benzene concentrations at all monitored sites exceeded the allowance values. NO_2 concentrations measured at most of monitored sites along Ring Road No. 3 exceeded the allowance values, whereas NO_2 concentrations at interchanges along Tran Duy Hung and Nguyen Chi Thanh streets still complied with the standard value. Similarly, SO_2 concentrations measured along Ring Road No. 3 exceeded the QCVN value, whereas the pollutant level recorded along Tran Duy Hung and Nguyen Chi Thanh streets still complied with the QCVN value, except for the Lieu Giai-Kim Ma interchange. Note that SO_2 concentrations at the concerned urban roads were close to the QCVN value. CO concentrations measured at all monitored sites were lower than the QCVN value. The higher CO concentrations were recorded at Khuat Duy Tien-Nguyen Trai interchange and My Dinh bus terminal, which were a bit lower than the standard value.

Table 7.3.1 Monitoring Results (1-hour average) of Ambient Air Quality in Hanoi in September 2015

Monitoring Location	TSP	NO_2	SO_2	CO	Benzene
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
Lieu Giai – Kim Ma interchange	1,222*	189	372	14,217	28.3
Nguyen Chi Thanh – La Thanh interchange	474	151	312	14,473	30.4
Nguyen Chi Thanh – Lang interchange	518	135	287	12,083	28.4
Tran Duy Hung – Pham Hung interchange	585	126	276	11,011	24.3
Khuat Duy Tien – Nguyen Trai interchange	634	218	394	25,358	38.6
Mai Dich interchange	890	194	380	17,497	29.1
My Dinh bus terminal**	-	239	509	26,486	41.5
QCVN 05:2013/BTNMT & QCVN 06:2009/BTNMT	**300**	**200**	**350**	**30,000**	**22**

Notes:
*: The concentration was actually measured at Lieu Giai – Phan Ke Binh interchange
**: The concentration was measured in 2014 and data were extracted from "Overall report on environmental status of Hanoi city during the period of 2011-2015"

Source: Hanoi Center for Environmental and Natural Resources Monitoring and Analysis

7.3.8.2 Air Quality in the Suburban Area

According to the "Overall Report on Environmental Status of Hanoi during the Period of 2011-2015", monitored concentrations (1-hour average) of TSP, NO_2, SO_2, and CO at Quan Hoa ward (Cau Giay district) and Tay Mo ward (Nam Tu Liem district) in 2014 were lower than the standard values specified in QCVN 05:2013/BTNMT. According to the "Thang Long Expressway Monitoring Results 2011", five locations along the Thang Long Expressway were monitored for air quality (TSP, NO_2, SO_2, and CO) in February, 2011. 3 out of the 5 monitoring locations recorded a level of TSP higher than the QCVN value. Concentrations of NO_2, SO_2 and CO at the five monitoring locations were lower than the standard values.

7.3.9 Water Quality

Surface water quality of some water bodies in the project area were measured by the Hanoi Center for Environmental and Natural Resources Monitoring and Analysis (Hanoi CENMA) including some lakes in the urban area, rivers in the urban area and rivers in the suburban area.

7.3.9.1 Lakes in the Urban Area

The following table presents water quality data of Ngoc Khanh and Thu Le lakes monitored in August, 2015. Ngoc Khanh Lake is located beside Nguyen Chi Thanh St., while Thu Le Lake is next to the Daewoo Hotel. Comparing to B1 class of QCVN 08-MT:2015/BTNMT (water quality suitable for irrigation), the water quality of Thu Le Lake mostly complied with the standard, except for COD and nitrite. Ngoc Khanh Lake showed a worse case with more parameters noncompliant with the allowance values, including DO, COD, ammonium, nitrate, nitrite, phosphate, surfactant, and total coliform. The results indicated that Ngoc Khanh Lake was polluted with nutrients, surfactants and coliform.

Table 7.3.2 Monitoring Results of Water Quality in Lakes in Hanoi in August 2015

No.	Parameter	Unit	Ngoc Khanh Lake	Thu Le Lake	QCVN 08-MT:2015/BTNMT B1 class
1	T	°C	28.0	29.5	-
2	pH	-	7.8	7.4	5.5-9
3	DO	mg/l	2.9	4.9	≥ 4
4	Turbidity	NTU	23.7	9.5	-
5	BOD_5	mg/l	14	15	15
6	COD	mg/l	31	31	30
7	TSS	mg/l	24	19	50
8	Ammonium (NH_4^+)	mg N/l	4.46	0.4	0.9
9	Nitrate (NO_3^-)	mg N/l	14.3	2.1	10
10	Nitrite (NO_2^-)	mg N/l	0.268	0.14	0.05
11	Phosphate (PO_4^{3-})	mg P/l	0.79	0.05	0.3
12	Iron (Fe)	mg/l	0.48	0.20	1.5
13	Surfactant	mg/l	0.63	0.18	0.4
14	Total oil & grease	mg/l	0.6	0.9	1
15	Total phenol	mg/l	0.0084	0.0084	0.01
16	Total Coliform	MPN/100ml	$9.3x10^4$	$9x10^2$	7500

Source: Hanoi Center for Environmental and Natural Resources Monitoring and Analysis

7.3.9.2 Water Quality of To Lich River

The following table presents the water quality of To Lich River, which runs through the urban area of Hanoi in August 2015. Two monitored points are located upstream and at the crossing point between the proposed BRT route (along Tran Duy Hung and Nguyen Chi Thanh streets) and To Lich River. The concentrations of a number of parameters, including BOD, COD, ammonium, nitrite, phosphate, surfactant, oil & grease, and coliform, significantly exceeded the coresponding allowance values (B2 class of QCVN 08-MT:2015/BTNMT, water quality suitable for transportation) at both monitoring points. The results indicated that To Lich River was severely polluted with organic compounds, nutrients, surfactants, and coliform.

Table 7.3.3 Monitoring Results of Water Quality of To Lich River in Hanoi in August 2015

No.	Parameter	Unit	Giay Bridge	Trung Hoa Bridge	QCVN 08-MT:2015/BTNMT B2 class
1	T	^oC	31.0	31.0	-
2	pH	-	7.3	7.2	5.5-9
3	DO	mg/l	3.1	3.2	≥ 2
4	Turbidity	NTU	78.0	81.0	-
5	BOD_5	mg/l	65	91	25
6	COD	mg/l	151	184	50
7	TSS	mg/l	44	30	100
8	Ammonium (NH_4^+)	mg N/l	6.75	19.7	0.9
9	Nitrate (NO_3^-)	mg N/l	0.5	0.7	15
10	Nitrite (NO_2^-)	mg N/l	0.058	0.055	0.05
11	Phosphate (PO_4^{3-})	mg P/l	3.32	2.18	0.5
12	Iron (Fe)	mg/l	0.66	0.75	2
13	Surfactant	mg/l	2.48	3.09	0.5
14	Total oil & grease	mg/l	1.7	1.5	1
15	Total phenol	mg/l	0.0185	0.0196	0.02
16	Total Coliform	MPN/100ml	$4.6x10^6$	$4.6x10^6$	1000

Source: Hanoi Center for Environmental and Natural Resources Monitoring and Analysis

7.3.9.3 Water Quality of Tich River

The water quality of Tich River monitored in August 2015 is shown in the following table. Two monitored points are located at Can Kiem commune (Thach That district) and Liep Tuyet commune (Quoc Oai), which are upstream and downstream of the crossing point between the proposed BRT route (along the Thang Long Expressway) and Tich River, respectively. The table showed that the concentrations of ammonium, nitrate, and nitrite at the two monitoring points exceeded the corresponding allowance values (B1 class of QCVN 08-MT:2015/BTNMT, water quality suitable for irrigation). The results indicated that the Tich River was polluted with nutrients, which might be caused by the wash-out of nitrogen fertilizers from the surrounding agricultural fields.

Table 7.3.4 Monitoring Results of Water Quality of Tich River in Hanoi in August 2015

No.	Parameter	Unit	Can Kiem Commune	Liep Tuyet Commune	QCVN 08-MT:2015/BTNMT B1 class
1	T	ºC	32.0	32.0	-
2	pH	-	7.2	7.2	5.5-9
3	DO	mg/l	5.1	5.1	≥ 4
4	Turbidity	NTU	18.0	19.0	-
5	BOD_5	mg/l	9	10	15
6	COD	mg/l	21	22	30
7	TSS	mg/l	19	23	50
8	Ammonium (NH_4^+)	mg N/l	3.30	3.78	0.9
9	Nitrate (NO_3^-)	mg N/l	21.4	17.2	10
10	Nitrite (NO_2^-)	mg N/l	0.063	0.073	0.05
11	Phosphate (PO_4^{3-})	mg P/l	0.07	0.06	0.3
12	Iron (Fe)	mg/l	0.85	0.77	1.5
13	Surfactant	mg/l	0.12	0.08	0.4
14	Total oil & grease	mg/l	0.5	0.4	1
15	Total phenol	mg/l	0.0055	0.0068	0.01
16	Total Coliform	MPN/100ml	$7x10^2$	$4x10^2$	7500

Source: Hanoi Center for Environmental and Natural Resources Monitoring and Analysis

7.3.10 Soil Quality

According to the "Overall Report on Environmental Status of Hanoi during the Period of 2011-2015", there have been 45 residual storage of pesticides in 16 districts in Hanoi, including Ba Vi, Thach That, Quoc Oai, and Nam Tu Liem districts. The residual storage of pesticides may cause soil in the surrounding area to be contaminated. In addition, some intensive farming areas for vegetable and flowers, where pesticides are used excessively, may be contaminated with different types of pesticides.

The research on "Evaluation of Toxic Residues in Soil of Key Vegetable Production Areas" in 2010 by Pham Quang Ha, Bui Thi Phuong Loan et al. has confirmed the occurrence of pesticides in soil in different districts of Hanoi, as summarized in the following table.

Table 7.3.5 Occurrence of Pesticide Residues in Soil of Vegetable Production Areas in Suburban Hanoi

Group	Pesticides	Percentage of soil sample containing pesticides	Areas (district) found with contaminated samples
Organophosphorus	1. Methidathion	40.0% (16/40 samples)	Ba Vi, Son Tay, Thach That, Phuc Tho, Hoai Duc, Chuong My, Thuong Tin
	2. Profenofos		
	3. Chlorpyrifos		
	4. Fenitrothion		
Pyrethroid	5. Cypermethrin	37.5% (15/40 samples)	Thach That, Phuc Tho, Dan Phuong, Hoai Duc, Chuong My, Thuong Tin, Thanh Oai
	6. Fenvalerate		
	7. Permethrin		
Triazole	8. Hexaconazole	22.5% (9/40 samples)	Phuc Tho, Hoai Duc, Chuong My, Thuong Tin
	9. Difenoconazole		
	10. Chlorothalonil		
Fiproles	11. Fipronil	32.5% (13/40 samples)	Hoai Duc, Chuong My, Thuong Tin, Thanh Oai

Source: "Evaluation of Toxic Residues in Soil of Key Vegetable Production Areas", Pham Quang Ha, Bui Thi Phuong Loan, et al. 2010.

7.3.11 Noise and Vibration

Noise levels at interchanges along the proposed BRT route in the Hanoi urban area were monitored by Hanoi CENMA in September 2015. The recorded noise levels, as presented in the below table, were all higher than the allowance levels specified in QCVN 26:2010/BTNMT with respect to the normal area during the period of 6 am–9 pm. The results indicated that interchanges along the proposed BRT routes were significantly polluted by noise from vehicles.

Table 7.3.6 Monitoring Results of Ambient Noise Level (8 am–5 pm) in Hanoi in September 2015

Point	Noise Level (L_{Aeq}, dB)
Lieu Giai – Kim Ma interchange	82
Nguyen Chi Thanh – La Thanh interchange	79.6
Nguyen Chi Thanh – Lang interchange	81.7
Tran Duy Hung – Pham Hung interchange	83.6
Khuat Duy Tien – Nguyen Trai interchange	83.8
Mai Dich interchange	85.1
QCVN 26:2010/BTNMT (6 am–9 pm)	**70**

Source: Hanoi Center for Environmental and Natural Resources Monitoring and Analysis

According to the "Thang Long Expressway Monitoring Results 2011", equivalent noise levels (L_{Aeq}) for five monitoring points along the Thang Long Expressway during the period of 8 am–6 pm varied from 72.7 to 74.4 dB. The recorded noise levels along the Thang Long Expressway in 2011 were also slightly higher than the allowance level specified in QCVN 26:2010/BTNMT. It can be said that the environment along Thang Long Expressway was slightly polluted by noise from vehicles.

7.3.12 Population and Gender

The total population of all 9 districts where the BRT route passes through was 2,288,200 people in 2014, accounting for 31.49% of the total population in Hanoi. The average population density of these districts was 4,340 persons/km^2 which was 1.97 times higher than the average population density of Hanoi. Females accounted for 48.50–52.30% of the average population of each district in the project area. The natural population growth rates of each district in the project area varied from 10.50% to 15.58%, while the average value of the project area was 12.53%. Details of population, density, sex ratio and natural population growth rate of districts in the project area in 2014 are shown in the following table.

Table 7.3.7 Population, Density, Average Female Population, Natural Population Growth Rates of Districts in the Project Area in 2014

Districts	Population (1,000 persons)	Average Female Population		Density (persons/km^2)	Natural Population Growth Rate (%)
		1,000 persons	%		
Ba Dinh	243.6	127.2	52.30	26,335	13.31
Cau Giay	256.3	129.1	50.83	21,305	11.80
Dong Da	407.7	211.5	51.88	40,934	11.35
Thanh Xuan	270.9	135.1	50.32	29,835	10.50
Nam Tu Liem	216.8	103.4	48.50	6,716	13.39
Bac Tu Liem	318.3	154.7	48.94	7,343	10.65
Hoai Duc	215.8	111.7	52.22	2,617	14.26
Quoc Oai	177.4	90.1	51.25	1,199	15.58
Thach That	197.6	100.5	51.33	1,070	11.96
Hanoi	**7,319.0**	**3,703.4**	**50.97**	**2,202**	**12.95**

Source: Hanoi Statistical Yearbook 2014

Note that the population in Hoa Lac Satellite Town was forecasted to up to 600,000 people in 2030 in the Construction Master Plan of Hanoi City to 2030, Vision to 2050 (Decision 1259/QD-TTg dated July 26, 2011). However, reaching the planned population of 600,000 in 2030 would be challenging, as judged in a JICA study titled “Data Collection Survey on Railways in Major Cities in Vietnam”.

7.3.13 Labor

According to the "Hanoi Statistical Yearbook 2014", the districts in the project area had a total 147,331 people working in non-farm individual businesses, 136,428 people working in non-state industries, and 108,091 people working in private trade and services. Details regarding the number of workers in each sector in the 9 concerned districts in the BRT project area in 2014 are shown in the following table.

Table 7.3.8 Labor in Some Private Sectors in the BRT Study Area in 2014

(Unit: persons)

Districts	Labour in Non-Farm Individual Businesses	Labour in Non-State Industries	Labour in Private Trade and Services
Ba Dinh	16,089	15,543	15,047
Cau Giay	15,190	12,050	14,472
Dong Da	17,640	19,533	16,145
Thanh Xuan	14,748	24,757	13,734
Nam Tu Liem	9,955	9,065	9,401
Bac Tu Liem	7,673	11,836	7,137
Hoai Duc	23,678	15,600	12,912
Quoc Oai	21,948	12,685	10,016
Thach That	20,410	15,359	9,227
Total of 9 Districts	**147,331**	**136,428**	**108,091**

Source: Hanoi Statistical Yearbook 2014

7.3.14 Ethnic Minorities

According to the Board of Ethnic Affairs under the People's Committee of Hanoi, it has been found that people of ethnic minorities are living in all 30 districts of Hanoi. The total number of people of ethnic minorities was about 68,000 people of 37 ethnic races, accounting for 0.9% total population of the city (7.2 million people) in 2014. Among ethnic minorities, H'mong people account for 78.5% (53,000 people), Tay for 8.8% (6,000 people), Dao for 3.6% (2,435 people), and Nung for 2.9% (2,000 people)[1].

Ethnic minorities living as a community were found in 152 villages/hamlets of 14 communes of 5 districts, including Ba Vi (7 communes), Thach That (3 communes), Quoc Oai (2 communes), Chuong My (1 commune) and My Duc (1 commune) districts. The total number of ethnic people living as a community is 52,791 people/12,304 households; most of them are H'mong and Dao. There are 2 extremely poor and difficult living communes, including Ba Vi commune (Ba Vi district) and An Phu commune (My Duc district). In addition, there are a total 26 hamlets which face to extremely difficult living conditions[2].

[1] Source: http://vietq.vn/3030-quan-huyen-o-ha-noi-deu-co-dong-bao-dan-toc-thieu-so-sinh-song-d44413.html

[2] Source: http://vietq.vn/3030-quan-huyen-o-ha-noi-deu-co-dong-bao-dan-toc-thieu-so-sinh-song-d44413.html

In Thach That district, there are total of 11,026 people of 13 ethnic minorities, accounting for 5.45% of the total district population. Most of the ethnic people in Thach That district are H'mong (10,880 people) and live in 3 mountainous communes, including Yen Trung, Yen Binh, and Tien Xuan. The remaining 146 people of 13 ethnic minorities live in 20 communes/towns in the district. H'mong people in Thach That district are native people, having a lot of valuable traditional and cultural values, such as customs, habits, behaviors, rituals, housing, dress and so on. In particular, arts like gongs, "sac bua" singing, "vi" singing and games such as "con" throwing, swinging, crossbows shooting are rich cultural and characteristic activities of H'mong people in Thach That[3].

Quoc Oai has 14 ethnic minorities living in 21 communes/towns of the district, accounting for 3.6% of the total population. The ethnic minorities include H'mong, Tho, Thai, Tay, Nung, Cao Lan, Dao, San Diu, Hoa, Kho me, Cham, Hre and Xa Pho. Most of ethnic people stay in Dong Xuan and Phu Man communes[4].

7.3.15 Local Economy

The gross domestic product of Hanoi at the current prices in 2014 was 514,449 billion VND, of which agriculture, forestry, and fishing accounted for 23,937 billion VND (about 4.7%). Industry and construction contributed for 214,245 billion VND (about 41.6%) and the services sector accounted for 276,267 billion VND (about 53.7%). The economy of Hanoi has steadily developed in recent years; the index of gross domestic product of the city at constant 2010 prices increased from 108.5% in 2010 to 111.3% in 2014, which were higher than those of the entire country. Industrial production of the city has experienced a rapid boom since 1990s with an average annual growth of 11.6% during the period of 2006-2010. Some economic facts of the districts in the BRT study area in 2014 are shown in the below table.

Table 7.3.9 Some Economic Facts of the Districts in the BRT Study Area in 2014

Districts	Production of cereals (ton)	Number of buffaloes (head)	Number of cattle (head)	Number of pigs (head)	Number of poultry (1,000 heads)	Total budget revenue (billion VND)	Total budget expenditure (billion VND)
Ba Dinh	-	-	-	-	-	1,694	1,123
Cau Giay	-	-	-	-	-	2,530	1,675
Dong Da	-	-	-	-	-	1,620	609
Thanh Xuan	-	-	-	-	-	1,853	731
Nam Tu Liem	-	-	-	-	-	1,207	701
Bac Tu Liem	-	-	-	-	-	1,830	448
Hoai Duc	30,206	613	2,757	57,776	453	1,078	633
Quoc Oai	66,942	1,556	4,663	80,628	2,240	895	668

[3] Source http://hanoi.gov.vn/30/-/hn/ZVOm7e3VDMRM/111101/2757827/10/huyen-thach-that-quan-tam-bao-ton-phat-huy-ban-sac-van-hoa-dan-toc-muong.html;jsessionid=7aOdGxTfi9JkORE2oa37n2x3.app2; http://daithachthat.gov.vn/dai-hoi-dai-bieu-dan-toc-thieu-so-huyen-thach-that-lan-thu-2_513.html

[4] Source: http://bandantoc.hanoi.gov.vn/chuyenmuc/chitietchuyenmuc/tabid/236/title/539/ctitle/156/Default.aspx?TopMenuId=0&keysearch=&cMenu0=0&cMenu1=156&cMenu2=0

Districts	Production of cereals (ton)	Number of buffaloes (head)	Number of cattle (head)	Number of pigs (head)	Number of poultry (1,000 heads)	Total budget revenue (billion VND)	Total budget expenditure (billion VND)
Thach That	62,493	3,139	4,123	64,467	1,329	908	586
Total of 9 Districts	**159,641**	**5,308**	**11,543**	**202,871**	**4,022**	**13,615**	**7,174**

Source: Hanoi Statistical Yearbook 2014

Some information about the socio-economic conditions in 2015 of Lieu Giai ward (Ba Dinh district), Me Tri ward (Nam Tu Liem district), and Thach Hoa commune (Thach That district) obtained through consultation meetings are presented in Appendix A.

7.3.16 Existing Infrastructure and Transportation Systems

The road transportation system in the project area is quite developed and organized. Main roads in the area include Thang Long Expressway, Ring Road No. 3, and Tran Duy Hung-Nguyen Chi Thanh-Lieu Giai-Van Cao Road.

The Thang Long Expressway has a width of 140 m and a length of 30 km, connecting the centre of Hanoi with Hoa Lac and the west of Hanoi and passing through Cau Giay, Nam Tu Liem, Hoai Duc, Quoc Oai, and Thach That districts. The Thang Long Expressway is a six lane expressway with four lanes of service roads.

Ring Road No. 3 has some sections located within the BRT study area, including Khuat Duy Tien and Pham Hung streets which are 3-dual-lane roads with a center median used for a viaduct with four lanes of expressway and two lanes for emergency parking.

Tran Duy Hung-Nguyen Chi Thanh-Lieu Giai-Van Cao Road with four lanes and a center median connects the Thang Long Expressway with the centre of Hanoi.

The other important roads in the area are Nguyen Chanh-Hoang Minh Giam Road, Ring Road No. 2.5 (Trung Kinh-Hoang Dao Thuy Road which is under construction), Ring Road No. 2 (Lang Road), Ring Road no. 1 (La Thanh Road), Cau Giay – Kim Ma Road, Doi Can, Hoang Hoa Tham, and Thuy Khue streets, which all make crossroads with the roads from Tran Duy Hung to Van Cao streets. Other important roads in the suburban section include Provincial Road No. 70 and National Road No. 21A (at the end of the Thang Long Expressway).

Hoa Lac High-Tech Park is the first and largest high-tech park in Vietnam with a total area of 1,586 ha (approximate 4,000 acres), located in the northwest area of Hanoi city. Hoa Lac High-Tech Park is located at the end of the Thang Long Expressway to the west.

The high-tech park is developed as a model of a science city, with over 200,000 people working and living and consists of the following main functional zones: research and development zone (R&D) of 229 ha, software zone of 76 ha, high-tech industrial zone of 549.5 ha, and education and training zone of 108 ha. Other areas include the central area of 50 ha and service area of 87.5 ha. Many universities, training centers, vocational schools, and industrial factories are located in the Hoa Lac High Tech Park.

7.3.17 Land Use

According to the "Hanoi Statistical Yearbook 2014", the total natural area of 9 districts in the BRT study area was 530.92 km^2, in which agricultural cropping land accounted for 198.98 km^2, forestry land for 42.86 km^2 (only located in Quoc Oai and Thach That districts), residential land for 81.29 km^2, specialized land for 161.78 km^2, and others for 32.37 km^2. Note that specialized land is non-agricultural land and used as land for governmental offices, land for security and defense purposes, public lands (e.g., transportation land, land under markets, school, hospitals, etc.), and non-agricultural lands for production and business (e.g., industrial zone, land for production and business, land under mining activities). The details of land use of districts in the BRT study area is shown in the following table. The percentage of agriculture cropping land of each district versus its total natural area is presented in parenthesis.

Table 7.3.10 Land Use Status of the Concerned Districts in the BRT Study Area in 2014 (unit: ha)

Districts	Natural Area	Specialized Land	Residential Land	Aquaculture Land	Forestry Land	Agriculture Cropping Land
Ba Dinh	925.0	514.0	322.3	-	-	3.0 (0.3%)
Cau Giay	1,203.0	675.5	413.5	-	-	12.6 (1.0%)
Dong Da	995.8	505.4	441.9	-	-	2.1 (0.2%)
Thanh Xuan	908.3	483.8	327.4	-	-	15.4 (1.7%)
Tu Liem	7,562.8	2,583.5	1,533.3	-	-	2,514.7 (33.2%)
Hoai Duc	8,246.8	1,787.0	1,929.5	115	-	4,102.8 (49.8%)
Quoc Oai	14,790.8	3,398.2	1,600.6	773	1,532.0	6,987.1 (47.2%)
Thach That	18,459.0	6,230.7	1,560.6	475	2,753.9	6,260.7 (33.9%)
Total of 9 Districts	**53,091.5**	**16,178.1**	**8,129.1**	**1,363**	**4,285.9**	**19,898.4 (37.5%)**

Source: Hanoi Statistical Yearbook 2014

7.3.18 Landscape

Hanoi was formed by the deposition of alluvial soils of the Red River and its distributaries including the Day, Nhue, and Tich rivers. The deposition has resulted in a number of lakes and swamps in the area, such as the West Lake (Ho Tay), Hoan Kiem, Thien Quang, Dong Da, Ngoc Khanh, Thu Le lakes and so on, forming a specific aquatic landscape of the city. In addition, Hanoi is surrounded by a variety of rivers and channels, such as the Nhue, To Lich, Lu, Set, and Kim Nguu rivers.

The urban area of Hanoi along the proposed BRT routes, including Ring Road No. 3 and Tran Duy Hung-Nguyen Chi Thanh-Lieu Giai-Van Cao streets has been urbanizing rapidly. The area is characterized with the concentration of a lot of high buildings, skyscrapers, and even supertall buildings, such as the Keangnam Land mark 72 (350 m) and Lotte Center Hanoi (267 m). Some flyovers have been constructed at Nguyen Chanh-Hoang Minh Giam-Tran Duy Hung interchange, Tran Duy Hung-Nguyen Chi Thanh-Lang interchange and Lieu Giai-Kim Ma interchange. In particular, a viaduct has been constructed in the center median of Ring Road No. 3. Along Tran Duy Hung-Nguyen Chi Thanh-Lieu Giai-Van Cao streets, a green area with palms,

flowers, and grass is constructed in the center median of the streets, as shown in the below figure. Grass and shrubs are planted under the viaduct along Ring Road No. 3 as well.

Source: Study Team

Figure 7.3.5 Landscape of Van Cao Street and its Center Median

The landscape in suburban area is characterized with rice fields and rural villages in the area of Hoai Duc, Quoc Oai, and Thach That districts. However, the area along the Thang Long Expressway in Nam Tu Liem and Hoai Duc districts has been urbanizing quickly with the settlement of many new urban areas. Along the Thang Long Expressway, the buffer separator between the expressway and service roads is a green area with some trees, shrub, and grass, as shown in the below figure.

Source: Study Team

Figure 7.3.6 Landscape of the Buffer Separator between the Thang Long Expressway and Service Roads

7.4 Legal and Institutional Framework on Environmental and Social Considerations

7.4.1 Legal System on the Environment

7.4.1.1 Relevant Laws and Regulations on the Environment

The law on environmental protection (Law 55/2014/QH13), approved on 23 June 2014, stipulates environmental protection activities, policies, measures and resources for environmental protection, as well as rights and obligation of authorities, organizations, households and individuals in environmental protection. Together with law on environmental protection, decrees, circulars and other legal documents have been enacted to stipulate and guide the issues related to environmental protection, as follows:

1. Law No. 55/2014/QH13 dated June 23, 2014 on environmental protection
2. Decree No. 19/2015/ND-CP dated February 14, 2015 of Government on detailing the implementation of articles of law on environmental protection.
3. Decree No. 18/2015/ND-CP dated February 14, 2015 of the Government on Environmental Protection Planning, Strategic Environmental Assessment (SEA), Environmental Impact Assessment (EIA) and Environmental Protection Plans (EPP).
4. Circular No. 27/2015/TT-BTNMT dated May 29, 2015 of MONRE on Strategic Environmental Assessment (SEA), Environmental Impact Assessment (EIA) and Environmental Protection Plans (EPP).

Environmental impact assessment shall be conducted in accordance with the above mentioned law, decrees, and circulars. The EIA procedure stipulated in Vietnamese law and regulations is summarized in the following table.

Table 7.4.1 Summary of the EIA Procedure according to Vietnamese Laws and Regulations

Items	Content	Regulation
Projects Subject to EIA	Projects that satisfy the required conditions: (20. Project includes construction of express way; road (Grade I to III); 50 km (or above) of mountainous G2rade-IV road; 22. Construction of bridge with a length of 500 m (or above); 24. Project includes construction of bus terminal of 5 ha (or above); 50. Construction of car workshop for maintenance and repair with a capacity of 500 vehicles per year or above; 109. Project includes relocation/resettlement of 300 households (or above))	Article 18 (Law on environmental protection); Article 12 and Appendix II (Decree 18/2015/ND-CP)
Timing for Execution	During the preparation stage of the project	Article 19 (Law on environmental protection)
	Certificate of investment registration, construction permit are only issued after the approval of EIA report	Article 25 (Law on environmental protection)
Content	1. Origin of the project, project owners, and the competent authority's approval of the project; method of the EIA. 2. Evaluation of technological choice, work items and any project activities which might cause negative impacts on the environment. 3. Assessment of the current status of natural and socio-economic environment of the project area, adjacent areas and demonstration of the suitability of the selected project site. 4. Assessment and forecast of waste sources, and the impact of the project on the environment and community health. 5. Assessment, forecast and determination of measures for managing the risks of the project posed to the environment and community health. 6. Waste management and disposal measures. 7. Measures for minimizing the impact of the project on the environment and community health.	Article 22 (Law on environmental protection; Article 12 of Decree No. 18/2015/ND-CP; Article 6 and Appendix 2.3 (Circular 27/2015/TT-BTNMT)

Items	Content	Regulation
	8. Consultation result. 9. Environmental management and monitoring programs. 10. Budget estimate for the construction of environmental protection facilities and implementation of environmental mitigation measures. 11. Organization for the implementation of environmental protection measures.	
Public Consultation	• Public consultation with commune-level people's committee (commune, town, ward) and influenced organizations at location of the project: by sending EIA reports and receiving feedback documents (within 15 working days) • Public consultation with local communities affected directly by the project activities: by holding consultation meetings with the involvement of representatives from commune-level fatherland front, socio-political organizations, socio-professional organizations, and population groups/village/hamlet.	Article 21 (Law on environmental protection); Article 12 (Decree 18/12015/ND-CP) Article 7 (Circular 27/2015/TT-BTNMT)
Review Committee and Approval Authority	• The EIA reports are examined by a review committee or by collecting opinions from relevant organizations (urgent cases only) • Approval authority shall depend on types of project, including 3 categories: 1. MONRE: approval for projects decided by the National Assembly, government, Prime Minister, or large-scale and important projects (Appendix III of Decree 18/2015/ND-CP) 2. Ministries: approval for projects decided by the organization itself 3. PPC: approval for projects on its area.	Article 23-24 (Law on environmental protection); Article 14 (Decree 18/12015/ND-CP)
Time Limit of Review	• 1st review: 45 working days for projects to be approved by MONRE; 30 working days for other projects. • 2nd review: 20 days after receiving revised EIA reports; deciding approval or not.	Article 25 (Law on environmental protection) Article 14 (Decree 18/12015/ND-CP)
Disclosure of Information	Environmental management plan shall be posted in public at headquarter of commune-level people's committee (where public consultation was taken place before)	Article 16 (Decree 18/12015/ND-CP)
Notes: MONRE: Ministry of Natural Resources and Environment; PPC: Provincial People's Committee		

Source: Study Team

7.4.1.2 Comparison between Vietnamese Law and the JICA Guideline on Environment

As mentioned above, the contents to be included in an EIA report are specified in Article 22 of the Law on Environmental Protection. They are largely in line with the requirement specified in the JICA Guidelines for Environmental and Social Considerations (2010), except that Vietnamese laws and regulations do not require an intensive comparison of alternatives and do not pay a significant attention on social impact assessment. To comply with JICA's guidelines, it is proposed that the further EIA study of the project shall include evaluation of alternatives including zero option and judgement of project activities with regards to social impacts on a variety of aspects as specified in the JICA Guidelines on Environmental and Social Considerations (2010).

7.4.1.3 National Technical Regulations on the Environment

A number of national technical regulations have been issued by MONRE to regulate the quality of different types of environment, including air, water, soil, noise and vibration and hazardous waste, as listed in the below table.

Table 7.4.2 National Technical Regulations on the Environment in Vietnam

Regulation	Content
QCVN 05:2013/BTNMT	National technical regulation on ambient air quality
QCVN 06:2009/BTNMT	National technical regulation on hazardous substances in ambient air
QCVN 08-MT:2015/BTNMT	National technical regulation on surface water quality
QCVN 09-MT:2015/BTNMT	National technical regulation on ground water quality
QCVN 14:2008/BTNMT	National technical regulation on domestic wastewater
QCVN 40:2011/BTNMT	National technical regulation on industrial wastewater
QCVN 03-MT:2015/BTNMT	National technical regulation on the allowable limits of heavy metals in the soils
QCVN 15:2008/BTNMT	National technical regulation on the pesticide residues in the soils
QCVN 07:2009/BTNMT	National technical regulation on hazardous substances thresholds
QCVN 50:2013/BTNMT	National technical regulation on hazardous thresholds for sludge from water treatment process
QCVN 26:2010/BTNMT	National technical regulation on noise
QCVN 27:2010/BTNMT	National technical regulation on vibration

Source: Study Team

7.4.2 Legal System on Land Acquisition and Resettlement

7.4.2.1 Relevant Laws and Regulations on Land

Vietnamese laws and regulations on land ownership, land acquisition, compensation, and resettlement include a variety of legal documents from the Constitution to the Laws, Decrees, Circulars, and Decisions of the Hanoi PPC. A list of legal documents related to land is presented as follows:

1. Constitution of Vietnam 2013
2. Law No. 45/2013/QH13 dated November 29, 2013: Land Law
3. Decree No. 43/2014/ND-CP dated May 15, 2014 of the Government on detailing a number of Articles of the Land Law
4. Decree No. 44/2014/ND-CP dated May 15, 2014 of the Government on providing methods to determine land price, to adjust land price brackets, land price board, and to valuate specific land price and land price consultancy activities.
5. Decree No. 47/2014/ND-CP dated May 15, 2014 of Government on compensation, support and resettlement upon land recovery by the State
6. Decree No. 102/2014/ND-CP dated November 10, 2014 of the Government prescribing administrative violations on land sector
7. Decree No. 16/2016/ND-CP dated March 16,2016 on management and use of official development assistance and concessional loans provided by foreign donors
8. Circular No. 36/2014/TT-BTNMT dated June 30, 2014 of MONRE on regulating method of valuation of land, preparation and adjustment of land price, specific land valuation and land valuation advisory
9. Circular No. 37/2014/TT-BTNMT dated June 30, 2014 of MONRE on regulating compensation, assistance and resettlement when the State acquires land.
10. Decision No. 21/2014/QD-UBND dated June 20, 2014 of Hanoi PPC on land acquisition, allocation, lease, and change the purpose of land use for implementation of investment project in Hanoi
11. Decision No. 23/2014/QD-UBND dated June 20, 2014 of Hanoi PPC on compensation, support, resettlement when the state acquires land in Hanoi
12. Decision No. 96/2014/QD-UBND dated December 29, 2014 of Hanoi PPC on land price in Hanoi city for application from January 01, 2015 to December 31, 2019.

7.4.2.2 JICA's Policy on Involuntary Resettlement

JICA's policy on involuntary inhabitant resettlement, as mentioned in Appendix 1 of the JICA Guidelines on Environmental and Social Considerations (2010), is described as follows:

1. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.
2. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by project proponents etc. in a timely manner. Prior compensation, at full replacement cost, must be provided as much as possible. Host countries must make efforts to enable people affected by projects and to improve their standard of living, income opportunities, and production levels, or at least to restore these to pre-project levels. Measures to achieve this may include: providing land and monetary compensation for losses (to cover land and property losses), supporting

means for an alternative sustainable livelihood, and providing the expenses necessary for the relocation and re-establishment of communities at resettlement sites.

3. Appropriate participation by affected people and their communities must be promoted in the planning, implementation, and monitoring of resettlement action plans and measures to prevent the loss of their means of livelihood. In addition, appropriate and accessible grievance mechanisms must be established for the affected people and their communities.
4. For projects that will result in large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.

7.4.2.3 Comparison between Vietnamese Law and JICA Guidelines

Recent laws, decrees and regulations on land acquisition, compensation, support and involuntary resettlement policies of the Government of Vietnam are mainly in line with that of JICA. There are, however, several differences between regulations of Vietnamese government and JICA guidelines on compensation, support for resettlement and restoration of livelihood for affected people, as presented in the following table.

Table 7.4.3 Key Differences between Vietnamese and JICA Policies on Land Acquisition and Resettlement

Main Issues	Vietnamese Laws and Regulations	JICA Guidelines	Proposed Project Policy
Land Compensation	• Compensation shall be made only for persons with legal land use right (Article 75 & 82, Land Law 2013) • PPC will consider to support for persons without legal land use right, according to each case. (Article 25, Decree 47/2014/ND-CP)	• All affected persons should be compensated for land acquisition, regardless of legal status of land use	• All affected persons should be compensated regardless of legal status
Compensation for Houses and other Structures	• Houses and other structures built on land violated land law or constructed illegally shall not be compensated (Article 92, Land Law 2013) • PPC will consider to support according to each case (Article 14, Decision 23/2014/QD-UBND of Hanoi city)	• All affected structures will be compensated according to replacement cost, regardless of legal status	• All affected structures will be compensated according to replacement cost
Compensation Amount	• The amount is to be determined according to the official land and structure valuation	• Full replacement cost should be provided as much as possible since the official price may not represent the full replacement cost	• Full replacement cost at the market value should be provided as much as possible
Compensation for Losing Income or Means of Livelihood	• Only support for household registering business certificate	• All loss of income shall be compensated	• All loss of income shall be compensated
Support for Livelihood Restoration	• Support for livelihood restoration; however no monitoring shall be made after finishing resettlement to ensure sufficient restoration of livelihood	• Support to restore at least the livelihood before the project started	• Support to restore at least the livelihood before the project started

Source: Study Team

In case there are some differences, the project will be implemented according to the guidelines for environmental and social considerations of JICA, which is in line with Decree 16/2016/ND-CP of Vietnamese government on management and use of official development assistance (ODA) and preferential loans (Article 51). In addition, clause 2 of Article 87 of Land Law 2013 specifies that "For projects receiving loan capital from international organizations with which Vietnamese government have an agreement on policy framework of compensation, support, and resettlement, the projects will be implemented according to the policy framework".

Note that, involuntary resettlement is not expected in this project. However, should it be necessary due to changes in the project design in the future, the project proponent will pay sufficient attention to the gaps between Vietnamese regulations and JICA policies to ensure that the project is in compliant with JICA's Environmental and Social Guidelines.

7.4.3 Role of Organizations for Environmental and Social Consideration

The role of governmental organizations with respect to environmental and resettlement procedures in Vietnam is summarized in the following table.

Table 7.4.4 Role of Organizations for Environment and Land Acquisition and Resettlement Procedure

Organization	Role for Environmental Procedures	Role for Land Acquisition and Resettlement Procedures
Ministry of Natural Resources and Environment (MONRE)	• Appraisal and approval for EIA of large-scale and important projects • Responsible for the procedures of EIA • Environmental monitoring data from national monitoring networks	• Stipulating and guiding on compensation, support and resettlement procedure
Ministry of Transport (MOT)	• Appraisal and approval for EIA of projects which are approved for investment by the MOT	
Hanoi People's Committee	• Appraisal and approval for EIA of projects in Hanoi city	• Stipulating and guiding on compensation, support and resettlement in Hanoi • Providing land valuation
Hanoi Department of Natural Resources and Environment (Hanoi DONRE)	• Organization for assessment of an EIA report which is subject to approval from the Hanoi PC • Confirmation for Environmental Protection Plan (EPP) of projects located in 2 districts or more • Provide environmental monitoring data • On-site Inspection against violation	• Guiding and checking implementation of land acquisition, compensation, support and resettlement
District People's Committee	• Confirmation for EPP of projects in the district area	• Appraisal and approval for land acquisition and resettlement plan
District Division of Natural Resources and Environment	• Guiding and checking implementation of EPP	• Involvement in appraisal for land acquisition and resettlement plan • Involvement in the council of land compensation, support and resettlement
Commune People's Committee	• Providing consultation opinions on EIA report • Hold public consultation meetings • Place for public announcement of environmental management plans after EIA approval • Confirmation for EPP of projects in the commune area, once authorized by the district PC.	• Involvement in the working group of compensation, support and resettlement

Source: Study Team

7.5 Comparison of Alternatives

7.5.1 Basic Concept for the Comparison of Alternatives

The purpose of comparison of alternatives is to select the most appropriate alternative with regards to the environmental and social considerations. There have been 6 proposed alternatives based on the selection of the BRT route and construction of exclusive lanes. Brief specification of six alternatives and the no project option are summarized in the following table (see Figure 7.1.2 for visualization of the alternatives).

Table 7.5.1 Description of the Alternatives

No.	Alternative	Suburban Section (Outside Ring Road No. 3, Hoa Lac-Vietnam National Convention Centre)		Urban Section (Inside Ring Road No. 3)	
		Road	Bus Stop and Pedestrian Crossing	Road	Bus Stop and Pedestrian Crossing
0	No Project Option	No project		No project	
1	Option-1	Route: Thang Long Expressway; Lane: Construction of exclusive lanes for BRT in buffer separators between the expressway and service roads	Bus stops in buffer separators; Pedestrian bridges for passengers	Route: Tran Duy Hung to Van Cao; Lane: Construction of exclusive lanes for BRT in the center median	Bus stops in the center median; Pedestrian bridges for passengers
2	Option-2	Route: Thang Long Expressway; Lane: No construction of exclusive lanes for BRT; exclusive lanes in 2030	Bus stops in buffer separators; Pedestrian bridges for passengers	Route: Tran Duy Hung to Van Cao; Lane: Construction of exclusive lanes for BRT in the center median	Bus stops in the center median; Pedestrian bridges for passengers
3	Option-3	Route: Thang Long Expressway; Lane: No construction of exclusive lanes for BRT; exclusive lanes due to demand in the future	Bus stops in buffer separators; Pedestrian bridges for passengers	No project activities	No project activities
4	Option-4	Route: Thang Long Expressway; Lane: No construction of exclusive lanes for BRT; exclusive lanes due to demand in the future	Bus stops in buffer separators; Pedestrian bridges for passengers	Route: Ring Road No. 3 from the Vietnam National Convention Center to Khuat Duy Tien-Le Van Luong interchange; Lane: Construction of exclusive lanes for BRT in the center median	Bus stops in center median; Underground or at-grade pedestrian crossing for passengers;
5	Option-5	Route: Thang Long Expressway; Lane: Construction of exclusive lanes for BRT in buffer separators between expressway and service roads	Bus stops in buffer separators; Pedestrian bridges for passengers	Route: Ring Road No. 3 from the Vietnam National Convention Center to Khuat Duy Tien-Nguyen Trai interchange and from NCC to Mai Dich interchange; Lane: Construction of exclusive lanes for BRT in the center median	Bus stops in center median; Underground or at-grade pedestrian crossing for passengers;
6	Option-6	Route: Thang Long Expressway; Lane: No construction of exclusive lanes for BRT; exclusive lanes due to demand in the future	Bus stops in buffer separators; Pedestrian bridges for passengers	Route: Tran Duy Hung to Van Cao; Ring Road No. 3 from the Vietnam National Convention Center to Khuat Duy Tien-Nguyen Trai interchange and from NCC to Mai Dich interchange;	Bus stops in center median; Pedestrian bridges for passengers along Tran Duy Hung to Van Cao; Underground or at-grade pedestrian crossing for passengers along RR No. 3

No.	Alternative	Suburban Section (Outside Ring Road No. 3, Hoa Lac-Vietnam National Convention Centre)		Urban Section (Inside Ring Road No. 3)	
		Road	Bus Stop and Pedestrian Crossing	Road	Bus Stop and Pedestrian Crossing
				Lane: Construction of exclusive lanes for BRT in the center median	

Source: Study Team

The proposed route in the suburban section (outside Ring Road No. 3) would be the Thang Long Expressway. The different options for the suburban section would be made by considering whether exclusive lanes for BRT would be built in the buffer separators between expressway and service roads.

The options for the urban section (inside Ring Road No. 3) varied from the no-project option to the selection of different routes.

The route in the urban section could be 4 options: (1) Tran Duy Hung to Van Cao, (2) along Ring Road No. 3 from the Vietnam National Convention Center (VNCC) to Khuat Duy Tien-Le Van Luong interchange, (3) along Ring Road No. 3 with 2 branches: from the VNCC to Khuat Duy Tien-Nguyen Trai interchange and from the VNCC to the Mai Dich interchange, and (4) a combination of all routes in the urban section: Tran Duy Hung to Van Cao, along Ring Road No. 3 from the VNCC to Khuat Duy Tien-Nguyen Trai interchange and Mai Dich interchange. The BRT route in the urban section would run on exclusive lanes which would be built in the center median of roads.

7.5.2 Comparison of Alternatives

By considering the proposed routes, organization of lanes, bus stops, and pedestrian crossings for each alternative with regards to the environmental and social aspects, comparison and evaluation of each alternative is summarized in the following table.

Note that every alternative would include bus stops built in the buffer separators or center median and pedestrian bridges or underground/at-grade crossing would be used to bring passengers to every bus stop. Each alternative also includes a depot area. Therefore, comparison of alternatives would focus mainly on the BRT routes and construction of exclusive lanes.

Table 7.5.2 Comparison and Evaluation of Alternatives Based on Environmental and Social Considerations

Alternative	Construction Stage		Operation Stage	
	Natural Environment	Social Environment	Natural Environment	Social Environment
No Project Option	• No impact due to construction		• Traffic congestion would be increased especially in the urban section, resulting in a higher emission of gas exhaust	• Constraining economic growth

Alternative	Construction Stage		Operation Stage	
	Natural Environment	**Social Environment**	**Natural Environment**	**Social Environment**
Option-1	• Adverse impacts due to construction of lanes in the Thang Long Expressway and Tran Duy Hung to Van Cao;	• Increasing traffic accident, adverse impacts to social security, transmission of diseases along the Thang Long Expressway and Tran Duy Hung to Van Cao	• Smooth travelling along Thang Long Expressway to Tran Duy Hung and Van Cao; • Emission of gas exhaust would be reduced	• Boosting economy and social services; • Reducing accidents due to exclusive lanes; • No impact to traffic on existing roads.
Option-2	• Adverse impacts due to the construction of lanes along Tran Duy Hung to Van Cao	• Increasing traffic accidents along Tran Duy Hung to Van Cao	• Smooth travelling along Thang Long expressway and Tran Duy Hung to Van Cao; • Emission of gas exhaust would be reduced.	• Some impacts to current traffic on the Thang Long Expressway. • A higher chance of accidents on the Thang Long Expressway, due to no exclusive lanes.
Option-3	• No impact by construction of new lanes		• Smooth travelling along Thang Long Expressway; • Traffic congestion would be increased in the urban section, resulting in a higher emission of gas exhaust.	• Some impacts to current traffic on the Thang Long Expressway; • High speed on the Thang Long expressway but slow movement in the urban area
Option-4	• Impact due to construction of lanes along Ring Road No. 3 from the VNCC to Khuat Duy Tien-Le Van Luong interchange	• Increasing traffic accident along Ring Road No. 3 from the VNCC to Khuat Duy Tien-Le Van Luong interchange	• Smooth travelling along Thang Long Expressway and Ring Road No. 3 from the VNCC to Khuat Duy Tien-Le Van Luong interchange; • Emission of gas exhaust would be reduced.	• Some impact to current traffic on Thang Long Expressway; • A higher chance of accidents on Thang Long expressway, due to no exclusive lanes. • Passengers need to transfer to WB BRT line to get to the centre of Hanoi
Option-5	• Impact due to construction of lanes along the Thang Long Expressway and Ring Road No. 3 from the VNCC to Khuat Duy Tien-Nguyen Trai and Mai Dich interchanges	• Increasing traffic accident along Thang Long Expressway and Ring Road No. 3 from the VNCC to Khuat Duy Tien-Nguyen Trai and Mai Dich interchanges	• Smooth travelling along the Thang Long Expressway and Ring Road No. 3 from the VNCC to Khuat Duy Tien-Nguyen Trai and Mai Dich interchanges; • Emission of gas exhaust would be reduced.	• Boosting economy and social services; • Reducing accidents due to exclusive lanes; • No impact to traffic on existing roads.
Option-6	• Impact due to construction of lanes along Thang Long Expressway and urban section routes: Tran Duy Hung to Van Cao, Ring Road No. 3 from VNCC to Khuat Duy Tien-Nguyen Trai and Mai Dich interchanges	• Increasing traffic accident along Thang Long expressway, Tran Duy Hung to Van Cao and Ring Road No. 3 from the VNCC to Khuat Duy Tien-Nguyen Trai and Mai Dich interchanges	• Smooth travelling along the Thang Long Expressway, Tran Duy Hung to Van Cao and Ring Road No. 3 from the VNCC to Khuat Duy Tien-Nguyen Trai and Mai Dich interchanges; • Emission of gas exhaust would be reduced.	• Boosting economy and social services; • Reducing accidents due to exclusive lanes; • No impact to traffic on existing roads.

Source: Study Team

The comparison was done mostly based on the difference between the Thang Long Expressway and roads in the urban section. The Thang Long Expressway currently has 3 lanes and rapid travelling of vehicles on this expressway has been guaranteed to date. Without exclusive lanes on the Thang Long Expressway, buses can move with high speeds and little impacts would be made to the current traffic of other vehicles.

In contrast, slow traffic movement has been observed for roads in the urban section. Traffic congestion has happened quite frequently on the concerned roads in the urban section, including Tran Duy Hung to Van Cao and Ring Road No. 3. Construction of exclusive lanes on roads in the urban section would significantly improve the level of service of buses and would not influence the current traffic on the roads.

7.5.3 Evaluation of Alternatives

Based on the comparison of alternatives, as aforementioned, the overall evaluation of alternatives was made with regards to environmental and social considerations in both the construction and operation stages. The following table shows the overall evaluation of the alternatives. The alternatives were evaluated using the rates of poor (1 point), medium (2 points), fair (3 points), good (4 points), and excellent (5 points).

Table 7.5.3 Overall Evaluation and Selection of Alternatives Based on Environmental and Social Considerations

Alternatives	Overall Evaluation	Rating	Selection
No Project Option	No impact due to construction; however the economic growth will be constrained and traffic congestion will be increased	Poor (1 point)	
Option-1	High impact during construction; higher positive impacts in operation stage (than Option-2)	Fair (3 points)	
Option-2	Lower impact during construction stage; most of the positive impacts can be achieved in the operation stage	Good (4 points)	Appropriate one (with the use of pedestrian bridges for conveying passengers)
Option-3	No impact during construction; however traffic congestion would still occur in the urban section	Medium (2 points)	
Option-4	Lower impact during the construction stage; most of positive impacts can be achieved in the operation stage	Good (4 points)	Less appropriate one, comparing to Option-2 (due to construction of underground pedestrian crossings)
Option-5	High impact during construction; higher positive impacts in operation stage (than Option-4)	Fair (3 points)	
Option-6	Higher impact during construction (than Option-2 and 4); higher positive impacts in the operation stage (than Option-2 and 4)	Good (4 points)	Appropriate one

Source: Study Team

The table shows that Option-2, Option-4, and Option-6 would be appropriate selections. The three options adopted the same option for the suburban section, whereas they had different routes for the urban section.

For the suburban section (Thang Long Expressway), once demand of traffic volume increases in the future, construction of exclusive lanes in buffer separators would be considered. Comparing between Option-2 and Option-4, Option-2 would be more preferable at this stage by considering the construction and operation of pedestrian crossings. Because construction and operation of pedestrian bridges in Option-2 would result in less negative environmental impacts as well as consume a lower capital investment than construction and operation of underground pedestrian crossings in Option-4.

Option-6 is a combination of both Option-2 and Option-5 in the urban section which may bring higher benefits to the traffic system of Hanoi. Further consideration would be made in the future to account for connection with other public transportation routes and impacts to traffic congestion in detail.

7.6 Scoping and Terms of Reference

7.6.1 Scoping for Environmental and Social Considerations

In order to assess the likely significant environmental and social impacts, conceivable adverse environmental and social impacts by the project were preliminary identified based on the project description and overall environmental and social conditions in the surrounding area. The impacts of pollution, natural environment, social environment, and other concerned issues were classified as A to D in accordance with the following criteria:

- A+/-: Significant positive/negative impact is expected
- B+/-: Positive/negative impact is expected to some extent
- C+/-: Extent of positive/negative impact is unknown (A further examination is needed, and the impact could be clarified as the study progresses)
- D: No impacts is expected

The environmental and social impact assessments were examined and conducted, in accordance with the scoping matrix below, for the impacts classified as A to D. The project was divided into two stages: i) construction stage and ii) operation stage. Table 7.6.1 shows preliminary results of scoping for pollution, natural environment, social environment, accident, and transboundary impacts/climate change in construction and operation stages.

Table 7.6.1 Results of Scoping for Environmental and Social Assessments

Category	No.	Impact items	Evaluation		Evaluation Reason
			Before/Under Construction (BC/UC)	Operation Stage (OS)	
Pollution	1	Air pollution	B-	B+	**BC/UC:** Emission gas from construction equipment and vehicles and dust from construction activities are anticipated to rise during the construction phase. **OS:** Air pollution by emissions from vehicles is expected to be reduced by easing traffic jams and the decrease in the number of private vehicles.
	2	Water pollution	B-	B-	**BC/UC:** Muddy water inflows to environment from bare land of construction site and drainage from the lodging of construction may occur. **OS:** Water pollution may possibly be caused by storm water from the depot.
	3	Waste	B-	B-	**BC/UC:** Solid waste from land excavation and building materials is anticipated to rise somewhat. **OS:** Waste may possibly be generated in bus stops and the depot.
	4	Soil pollution	C	C	**BC/UC:** The area of planned depot is now an agricultural field and may be contaminated due to agricultural activities. The excavation of land during construction stage may spread to contaminated soil to other areas. **OS:** Soil contamination may occur if waste and wastewater generated in the depot is not well controlled.
	5	Noise & Vibration	B-	B-	**BC/UC:** Increase of noise and vibration levels due to construction machines and vehicles may temporarily occur during the construction stage. **OS:** Noise and vibration will be generated by bus vehicles.
	6	Ground subsidence	D	D	Ground subsidence is not expected to occur because large scale excavation or intake of groundwater will not be made.
	7	Offensive odor	D	D	Offensive odor from construction work and activities in operation stage is not expected.
	8	Bottom sediment	D	D	No activities are foreseen to affect bottom sediment of the rivers during the construction and operation stage.
Natural Environment	9	Protected area	D	D	No protected area exists in and around the project site; thus the impact on protected area is not anticipated.
	10	Ecology	C	C	The BRT route will be installed along existing roads and the depot is planned to build in an area of agriculture field with low level of biodiversity. Therefore, significant impact of the project's activities on flora, fauna and ecosystem is not anticipated. However, detailed investigation should be carried out before construction and conservation of trees will be made as much as possible.
	11	Hydrology	D	D	**BC/UC:** No impact on hydrology is anticipated as the project does not make any changes to natural surface water and groundwater flows. **OS:** No activities are expected to cause any impact on hydrology.
	12	Topography, geology	D	D	No impact on topography & geology is anticipated as large scale excavation work is not planned during the project implementation.
Social Environment	13	Involuntary resettlement & land acquisition	B-	D	**BC/UC:** Involuntary resettlement is not involved in the project because roads and stations will be constructed in the existing road median strips. Land acquisition of farm lands is expected for construction of the planned depot. **OS:** No resettlement and land acquisition is required during operation stage of the project.
	14	Poor people	C	C	**BC/UC:** Existence of poverty group is not confirmed in the project area and its vicinity, but detail investigation is required for the planned depot area involving land acquisition. **OS:** The bus rapid transit will facilitate the poverty group to move long distances easily and smoothly.

Category	No.	Impact items	Evaluation		Evaluation Reason
			Before/Under Construction (BC/UC)	Operation Stage (OS)	
	15	Minority ethnic & indigenous people	C	C	It is not confirmed at the moment the inhabitation of ethnic minority or indigenous people in the project area and its vicinity. Detail investigation is required, especially for the planned depot area involving land acquisition.
	16	Local economy (employment & livelihood, etc.)	B-	C	**BC/UC:** While employment opportunities will be increased due to construction work, transformation of farm lands for the planned depot would result in a negative impact on the local economy. **OS:** Operation of the bus will increase the demand for employees and will indirectly promote growth of local economy owing to smooth transportation and easing of traffic jams.
	17	Land use and local resource use	D	D	Most of the project is planned over the road median strips with the depot being constructed in agricultural fields and therefore no significant impacts are foreseen in those aspects.
	18	Water use	D	C	**BC/UC:** Most of the project is planned over the road median strips and then no impact on water use is expected. **OS:** It is necessary to confirm if the depot needs a large quantity of water.
	19	Existing social infrastructure & social services	B-	B+	**BC/UC:** The social services around construction sites may be affected by execution of construction work and traffic of construction vehicles. **OS:** Positive impact to the social infrastructure is expected by upgrading the new road for the BRT.
	20	Social institutions (social capital & local decision-making institutions)	D	D	No impact on social institutions is anticipated during the implementation of the project. The project is decided through appropriate consultation between the Vietnamese Government and the city of Hanoi
	21	Uneven distribution of damage & benefits	C	C	It is not expected that the construction and operation of BRT route and stations may cause uneven distribution of benefit and damage to local people. However, detail investigation shall be carried out for the area of the planned depot involving land acquisition.
	22	Conflicts of interest in the region	C	C	Most of the project is planned over the road median strips and no conflict of interest is expected for the construction and operation of BRT route and stations. However, detail investigation shall be carried out for the area of planned depot involving land acquisition.
	23	Cultural heritage	D	D	No cultural heritage exists in the project area.
	24	Landscape	B-	C	**BC/UC:** Temporary influence to landscape is expected due to execution of construction work. **OS:** Impact to landscape due to the presence of bus stops in the road median strips and pedestrian bridges might be expected, thus enough considerations need to be paid.
	25	Gender	C	C	It is not clear at the moment. Considerations have to be paid that no gender discrimination will be taken place during the project implementation.
	26	Children's rights	C	C	It is not clear at the moment. However, considerations have to be paid that no children will be involved as workforce during construction and operation stages.
	27	Infectious diseases (HIV/AIDS, etc.)	B-	B-	**BC/UC:** The risk for disease transmission (HIV/AIDS) is expected to increase due to influx of workers during construction stage. **OS:** The risk for disease transmission (HIV/AIDS) is expected to increase due to mobilization of labor flux between Hoa Lac and Hanoi, as a result of smooth transportation.
	28	Working conditions (including occupational safety)	B-	B-	Negative impact on health and safety of workers during the construction stage and drivers in the operation stage may occur if appropriate measures to ensure occupational health and safety are not taken.
	29	Community health	B-	B-	Negative impact on community health during construction and

Category	No.	Impact items	Evaluation		Evaluation Reason
			Before/Under Construction (BC/UC)	Operation Stage (OS)	
					operation stages may occur if appropriate mitigation measures toward environment impacts (dust, exhaust gas) is not taken
Other	30	Accident	B-	C	**BC/UC:** Accidents may possibly be increased due to the traffic of construction vehicles. **OS:** It is anticipated that the decrease of private vehicles (e.g. motorbike) would reduce a number of accidents during the operation stage of the project.
	31	Transboundary impacts, climate change	C	C	**BC/UC:** The construction may contribute to global warming due to emission gases generated from the operation of construction machinery and vehicles. **OS:** The reduction of traffic jams and a number of private vehicles may contribute to the prevention of global warming.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

Source: Study Team

7.6.2 Terms of Reference for the Preparation of the EIA

According to the scoping results as above mentioned and environmental baseline and social conditions collected for the project area, the following tasks need to be carried out during the preparation of the environmental impact assessment of the project:

i) Reviewing existing environmental baseline data and social conditions
ii) Field survey on environmental and social considerations
iii) Prediction and assessment of environmental and social impacts
iv) Assessment of alternatives
v) Examination of mitigation measures
vi) Preparation of environmental monitoring plan
vii) Estimation of budget and financial resources
viii) Public consultation and stakeholder's meeting

Description of these tasks is detailed in the following sections.

7.6.2.1 Reviewing existing environmental baseline data and social conditions

A series of environmental baseline data and social conditions are required to be collected during the preparation of the EIA report, which would be utilized either for direct assessment of environmental and social impacts or preparation of the field survey plan and supporting the assessment later. Information and data required for collection are listed in the following table.

Table 7.6.2 Existing Environmental Baseline Data and Social Conditions Required for Collection

No.	Information	Detailed Items	Location	Period of Data
1	Climate	Type of climate, rainfall, temperature,	Hanoi	3-5 most recent years
2	Topography	Topography	Hanoi center to the west	Existing data
3	Geology	Geology	Hanoi center to the west	Existing data
4	Rivers	Hydrological data (flow direction, flow rate)	Tich, Day, and Nhue rivers	Rainy and dry season
5	Soil	Type of soil	Hanoi center to the west	Existing data
6	Air quality	NO_2, SO_2, CO, TPM, PM_{10}	Along BRT route	3-5 most recent years
7	Surface water quality	T, pH, DO, TSS, BOD, COD, NH_4^+, NO_3^-, PO_4^{3-}, oil & grease	Tich, Day, Nhue and To Lich rivers	3-5 most recent years
8	Groundwater quality	T, pH, COD, NH_4^+, NO_3^-, NO_2^-, As, E-coli	Along BRT route	3-5 most recent years
9	Soil quality	Heavy metals and pesticide	Along BRT route	3-5 most recent years
10	Noise and vibration	L_{Aeq} and L_v	Along BRT route	3-5 most recent years
11	Population & gender	Population, percentage of gender	Hanoi center to the west	3 most recent years
12	Labor	Labor, male & female labor	Hanoi center to the west	3 most recent years
13	Ethnic minorities	Racial, number of people for each racial, location	Hanoi center to the west	The most recent year
14	Local economy	Growth rate, distribution of industrial lines, living standard, poverty	Hanoi center to the west	The most recent year
15	Existing infrastructure	Transportation system	Hanoi center to the west	Current situation

No.	Information	Detailed Items	Location	Period of Data
16	Land use	Current situation and planning for land use	Hanoi center to the west	Current situation and future (5-10 years)
17	Landscape	Landscape	Along BRT route	Current situation

Source: Study Team

7.6.2.2 Field Survey on Environmental and Social Considerations

The survey items and their methods for the investigation of environmental and social consideration, of which impact items were rated as A, B or C by the scoping described in the previous section, are shown in Table 7.6.3.

Table 7.6.3 Terms of Reference for Field Survey for Environmental and Social Considerations

No.	Impact Item	Survey Item	Location	Frequency	Survey Method
1	Air quality	NO_2, SO_2, CO, TPM, PM_{10}	5 points along BRT route (2 points in urban section, 3 points in suburban section)	2 times (dry & rainy season), each time 1 week	Air quality automatic monitoring equipment (QCVN 05:2013/BTNMT)
2	Water quality	T, pH, DO, TSS, BOD, COD, NH_4^+, NO_3^- , PO_4^{3-}, oil & grease	4 points (river), 1 point (Ngoc Khanh lake)	2 times (dry & rainy season)	Sampling and laboratory analysis (QCVN 08-MT:2015/BTNMT)
3	Groundwater	T, pH, COD, NH_4^+, NO_3^-, NO_2^-, As, E-coli	1 point (depot area)	2 times (dry & rainy season)	Sampling and laboratory analysis (QCVN 09-MT:2015/BTNMT)
4	Soil quality	Heavy metals, pesticides	1 point (depot area)	2 times (dry & rainy season)	Sampling and laboratory analysis (QCVN 03-MT:2015/BTNMT & QCVN 15:2008/BTNMT)
5	Noise & vibration	L_{Aeq} and L_v	5 points along BRT route (the same location with air quality monitoring)	1 time (dry season), 24 hours duration of weekday & 24 hours of weekend	Noise and vibration monitoring equipment (QCVN 26:2010/BTNMT & QCVN 27:2010/BTNMT)
6	Traffic volume	Number and type of vehicle	5 points along BRT route (the same point with noise & vibration measurement)	1 time (dry season), 24 hours duration of weekday & 24 hours of weekend	Manual count
7	Ecology	Flora, fauna	The area along BRT route and depot area	2 times (dry & rainy season)	Field survey
8	Involuntary resettlement & land acquisition	Land use and households incurred land acquisition	Depot area	1 time	Document analysis and field survey
9	Socio-economic conditions	Poor, minority ethnic & indigenous people, employment, livelihood, income, living standard, local interest, gender	Depot area	1 time	Interview

Source: Study Team

7.6.2.3 Prediction and Assessment of Environmental and Social Impacts

Based on data collected during the field survey, prediction and assessment of environmental and social impacts shall be done, as presented in the following table.

Table 7.6.4 Plan for Prediction and Assessment of Environmental and Social Impacts

Category	No.	Impact Items	Prediction and Assessment Method	
			Before/Under Construction (BC/UC)	Operation Stage (OS)
Pollution	1	Air pollution	Impact is qualitatively predicted based on construction methods and characteristics of the project site	Air quality is quantitatively predicted based on air quality monitoring data, current and forecasted traffic volume; then compared to QCVN 05:2013/BTNMT
	2	Water pollution	Impact is qualitatively predicted based on applied construction methods and environmental management control	Impact is qualitatively evaluated based on proposed design and operation of the depot area and monitored water quality data; compared to QCVN 08-MT:2015/BTNMT (as necessary)
	3	Waste	Impact is qualitatively predicted based on applied construction methods and excavation volume	Impact is qualitatively evaluated based on the proposed design and operation of the depot area and stations
	4	Soil pollution	Impact is qualitatively predicted based on the field survey result of soil quality and applied construction methods	Impact is qualitatively evaluated based on the proposed design and operation of the depot area and soil quality data; compared to QCVN 03-MT:2015/BTNMT & QCVN 15:2008/BTNMT (as necessary)
	5	Noise & Vibration	Impact is qualitatively predicted based on the field survey result and applied construction methods	Noise and vibration level are quantitatively predicted based on field survey result, current and forecasted traffic volume; then compared to QCVN 26:2010/BTNMT & QCVN 27:2010/BTNMT
Natural Environment	6	Ecology	Impact is qualitatively predicted based on the field survey result of flora and fauna and construction plan	Impact is qualitatively predicted based on the field survey result and proposed design and operation plan of the project
Social Environment	7	Involuntary resettlement & land acquisition	Impact is qualitatively predicted based on the field survey result of land use and the project plan	No assessment
	8	Poor people	Impact is qualitatively predicted based on the field survey result of poverty groups and the land acquisition plan	Impact is qualitatively predicted based on the field survey result of poverty groups and the possibility that poor people will use BRT for movement
	9	Minority ethnic & indigenous people	Impact is qualitatively predicted based on the field survey result of minority ethnic and the land acquisition plan	Impact is qualitatively predicted based on the field survey result of minority ethnic and the compensation and support program
	10	Local economy (employment & livelihood, etc.)	Impact is qualitatively predicted based on the field survey result of land use, employment, livelihood, income and the land acquisition plan	Impact is qualitatively predicted based on employment plan of the project and the operation plan
	11	Water use	No assessment	Impact is qualitatively predicted based on demand on water use of the project
	12	Existing social infrastructure & social services	Impact is qualitatively predicted based on applied construction methods and traffic conditions in related roads	Impact is qualitatively predicted based on the project design
	13	Uneven distribution of damage &	Impact is qualitatively predicted based on field survey result of related households and land acquisition plan	Impact is qualitatively predicted based on field survey result of related households and plan for land acquisition, compensation and support

Category	No.	Impact Items	Prediction and Assessment Method	
			Before/Under Construction (BC/UC)	Operation Stage (OS)
		benefits		
	14	Conflicts of interest in the region	Impact is qualitatively predicted based on field survey result of local interest and land acquisition plan	Impact is qualitatively predicted based on field survey result of related households and plan for land acquisition, compensation and supports
	15	Landscape	Impact is qualitatively predicted based on the field survey result and construction methods	Impact is qualitatively predicted based on the field survey result and the project design
	16	Gender	Impact is qualitatively predicted based on field survey result of gender issue and construction methods	Impact is qualitatively predicted based on field survey result of gender issue and the project plan
	17	Children's rights	Impact is qualitatively predicted based on construction methods	Impact is qualitatively predicted based on the project design and operation
	18	Infectious diseases (HIV/AIDS, etc.)	Impact is qualitatively predicted based on construction methods and the project plan	Impact is qualitatively predicted based on the project design and operation
	19	Working conditions (including occupational safety)	Impact is qualitatively predicted based on construction methods and the project plan	Impact is qualitatively predicted based on the project design and operation
	20	Community health	Impact is qualitatively predicted based on construction methods and the project plan	Impact is qualitatively predicted based on the project design and operation
Other	21	Accident	Impact is qualitatively predicted based on construction methods and traffic conditions in related roads	Impact is qualitatively predicted based on the project design and operation mode
	22	Transboundary impacts, climate change	Impact is qualitatively predicted based on construction methods and the project plan	Impact is qualitatively predicted based on the project design and operation mode

Source: Study Team

7.6.2.4 Assessment of Alternatives

Examination of alternatives (including the no project option) would be done in terms of environmental and social considerations. Alternatives would be examined for environmental and social impacts during both the construction and operation stages. Advantages and disadvantages of each alternative would be determined and compared with each other. Finally, an overall evaluation would be made by synthesizing analyzed impacts from construction stage to operation stage to find out the most appropriate alternative.

7.6.2.5 Examination of Mitigation Measures

First, the prediction and assessment of environmental and social impacts of the project will be implemented separately for the construction and operation stage. If negative impacts caused by the project are forecasted, mitigation measures are considered to minimize the impacts. Mitigation measures will be proposed with regards to the content and methods of mitigation measures, implementation period, and implementer.

7.6.2.6 Preparation of Environmental Monitoring Plan

An environmental monitoring plan will be prepared and conducted to monitor the environmental change after the project implementation and the effectiveness of applied mitigation measures. The monitoring plan includes monitoring content, methods, period, frequency, location, and implementation structure.

7.6.2.7 Estimation of Budget and Financial Resource

Based on mitigation measures and monitoring plan proposed, budget and cost estimation for each measure and monitoring will be carried out.

7.6.2.8 Public Consultation and Stakeholder's Meeting

As specified in Decree 18/2015/ND-CP (Article 12) and Circular 27/2015/TT-BTNMT (Article 7), environmental impact assessment procedure must include public consultation with commune-level people's committee, influenced organizations, and local communities, as follows:

i) Public consultation with commune-level people's committee (commune, town, ward) and influenced organizations at the location of the project: by sending EIA reports and receiving feedback documents (within 15 working days)
ii) Public consultation with local communities affected directly by the project activities: by holding consultation meetings with the involvement of representatives from commune-level fatherland front, socio-political organizations, socio-professional organizations, and population groups/village/hamlet.

Public consultation will be held to collect opinions on the project activities and its environmental and social impacts as well as proposed countermeasures. Afterwards, the content of the EIA report and proposed countermeasures shall be revised with regards to stakeholder's opinions. The detailed description of public consultation is presented in the following table.

Table 7.6.5 Public Consultation with Affected Communes and Communities

Type of Consultation	Target Bodies	Procedure	Collection of Opinions
Commune-level people's committee and influenced organizations	• Directly affected communes, wards, and towns and, • Directly influenced organizations, which are located along the BRT route shall be consulted with	Sending documents (EIA reports and Request for consultation) to target bodies	Target bodies return feedback document within 15 days
Local communities	Representatives of directly affected communities: • commune-level fatherland front, • socio-political organizations, • socio-professional organizations, • population groups/village/hamlet Consultation meeting with local communities can be jointly held by several communes at the same time. For example, communes in the same district can be grouped together.	• Project proponent and commune people's committee together hold meetings with representatives of local communities • Project proponent will present project content, environmental and social impacts, and proposed mitigation measures	Opinions from representatives will be collected during the meeting, which are summarized in memos of meeting with signature of attendants

Source: Study Team

7.6.3 Draft EIA Schedule

In consideration with the environmental and social impact assessment procedure and amount of tasks that must be done during the EIA study, a draft EIA schedule for the project was proposed and presented in the below table. Total duration for the EIA study will be 6 months, for which 2 months will be spent for appraisal and approval of the EIA report.

Table 7.6.6 Draft EIA Schedule for the Project

Item	Month																							
	1				2				3				4				5				6			
1. Collection of project information																								
Examination of Project plan																								
Collection of existing data																								
2. Scoping																								
Preparation of Scoping Report																								
Preparation of TOR for field survey																								
3. Field Survey																								
Field survey in rainy season																								
Field survey in dry season																								
4. EIA																								
Preparation of Draft EIA Report																								
Public Consultation Meeting/Public Disclosure															▲									
Submission of draft EIA report for appraisal																								
5. Appraisal and approval of EIA report																								
Appraisal and comment on draft EIA report																	▲							
Revision of EIA report																								
Submission of final EIA report																								
Approval of final EIA report																								▲

Source: Study Team

7.6.4 Proposed Mitigation Measures

According to scoping results mentioned above, some preliminary mitigation measures for environmental and social impacts were proposed to minimize negative impacts as much as possible, as presented in the following table.

Table 7.6.7 Proposed Mitigation Measures against Environmental and Social Impact Items

No.	Impact Item	Mitigation Measures	Implementer
1	Air pollution	During construction: Proper measures to prevent dust spreading and generation of gas exhaust from construction machinery and vehicles, such as water spray at sites, washing vehicles, covers of vehicles, enclosure of construction site, avoiding intensive operation of construction machinery, idling of vehicles, regular inspection and maintenance of machinery and vehicles	Contractor
2	Water pollution	During construction: Settling ponds settled for collection of drainage; disposable septic tank for collection of domestic wastewater In operation: Drainage from depot is collected and treated properly; for example, oil separators/traps installed at drain inlets.	During construction: Contractor In operation: BRT operator
3	Waste	During construction: Excavated land and construction waste reused as much as possible; unused materials will be disposed properly. In operation: Waste generated in bus stops and depot will be collected, classified, and disposed properly.	During construction: Contractor In operation: BRT operator
4	Soil pollution	During construction: Soil survey will be carried out before excavation and foundation work. If soil is polluted, proper measures will be taken to prevent spreading of polluted soil. In operation: Mitigation measures for control of waste and wastewater will be done, thereby ruling out possibility of soil pollution	During construction: Project proponent In operation: BRT operator
5	Noise & vibration	During construction: Preventive measures will be conducted to avoid generation of high-level noise and blocking transmission to the surrounding environment. For example, avoiding construction during night time, installing noise insulation walls, use of low noise/vibration construction machinery In operation: Regular maintenance and inspection of vehicles to reduce noise generation from vehicles	During construction: Contractor In operation: BRT operator
6	Ecology	During construction: Field survey will be conducted thoroughly and carefully before construction. If threatened species are found, proper measures will be conducted to conserve the species, such as relocation of threatened trees. Conservation of trees and grass will be made as much as possible. Cutting and relocation of trees as well as transformation of grass will be required for permission by Department of Construction of Hanoi city. In operation: Trees and grass will be planted inside the depot as much as possible.	During construction: Project proponent In operation: BRT operator
7	Involuntary resettlement & land acquisition	During construction: Land acquisition will be done in agricultural field. Compensation and support to affected people will follow Vietnamese regulations and JICA guidelines on Environmental and Social Considerations in order to support affected people as much as possible to restore livelihood and recover their income.	Project proponent and Hanoi city
8	Poor people	During construction: Detail investigation will be made before land acquisition. If some affected people are poor, special support and care must be provided to assist them. In operation: Bus fare could be reduced for poor people to ensure accessibility of the service to poor people.	During construction: Project proponent In operation: BRT operator and Hanoi city
9	Minority ethnic & indigenous people	During construction: Detail investigation will be made before land acquisition. If some affected people are minority ethnic and indigenous people, special support and care must be provided to assist them In operation: Proper measures could be proposed and implemented to ensure accessibility of the service to minority ethnic & indigenous people	During construction: Project proponent In operation: BRT operator
10	Local economy (employment & livelihood, etc.)	During construction: Compensation and support to affected people will be taken to ensure the livelihood of affected people and to assist them in getting new jobs.	Project proponent
11	Water use	In operation: It is necessary to confirm if the depot will utilize a large quantity of water at the stage of detail design. Proper measures will be taken if this case happens.	Project proponent
12	Existing social	During construction: Construction execution plan will be made appropriately to	Contractor

No.	Impact Item	Mitigation Measures	Implementer
	infrastructure & social services	prevent construction vehicles concentration and traffic accident	
13	Uneven distribution of damage & benefits	During construction: Compensation and support to affected people will be taken adequately to not cause uneven distribution of benefit and damage. In operation: Project design and operation plan will be taken with consideration to ensure accessibility and usability of the service to different groups of people, especially for elders, lonely old women, women, children, disabled person, poor people. Recruitment of local people will be advertised widely and no discrimination will be made.	During construction: Project proponent In operation: BRT operator
14	Conflicts of interest in the region	During construction: Construction of lanes and bus stops will have no conflicts of interest. However, selection of depot and construction of pedestrian bridges, underground or at-grade pedestrian crossing could be subjected to conflict of interest to local people. Detail examination should be taken at the stage of stage designing. For example, pedestrian bridges should not be established in front of private houses and shops. In operation: Operation of depot and bus stops could result conflict of interests within the region. If the case happens, proper measures will be taken.	During construction: Project proponent In operation: BRT operator
15	Landscape	During construction: Temporary enclosures are installed at the construction yards. In operation: Landscaping, such as planting trees, will be examined at the stage of detail design. Landscaping will be taken into consideration as much as possible.	During construction: Contractor In operation: BRT operator
16	Gender	During construction: Detail consideration and examination will be made. Compensation and support to affect women and assisting them in getting new job will be taken to minimize negative impacts of the project. In operation: Design and operation of the BRT will be taken with consideration to ensure accessibility and usability of bus stops and vehicles for women, such as pregnant women.	During construction: Project proponent In operation: BRT operator
17	Children's rights	During construction: Detail consideration and examination will be made at the stage of detail design to ensure that playing ground of children and schools will not be affected by construction and establishment of BRT facilities. No children will be involved as workforce during construction. In operation: Design and operation of the BRT will be taken with consideration to ensure accessibility and usability of bus stops and vehicles for children.	During construction: Project proponent and Contractor In operation: BRT operator
18	Infectious diseases (HIV/AIDS, etc.)	During construction: Health and hygiene consideration and guidance on diseases for workers will be made. In operation: Enhancing propagation and communication to young and teenagers on HIV/AIDS and social evils. Strengthening capacity on security and supporting commune to minimize disorders and criminals.	During construction: Contractor In operation: BRT operator
19	Working conditions (including occupational safety)	During construction: Routine safety training is carried out to prevent accident at the construction sites In operation: Routine safety training for drivers during operation stage	During construction: Contractor In operation: BRT operator
20	Community health	During construction: Environmental mitigation measures will be taken adequately to prevent negative impacts to community health, such as dust, exhaust gases, noise, and traffic accident. In operation: Regular inspection and maintenance of vehicles will be taken to reduce exhaust gases.	During construction: Contractor In operation: BRT operator
21	Accident	During construction: Proper construction plan and safety training will be carried out to drivers to prevent traffic accident.	During construction: Contractor
22	Transboundary impacts, climate change	During construction: Regular inspection and maintenance of construction machinery and vehicles will be taken to prevent exhaust gases and reducing amount of fuel. In operation: Clean fuel and environmental-friendly buses will be purchased; regular inspection and maintenance of vehicles will be carried out.	During construction: Contractor In operation: BRT operator

Source: Study Team

7.7 Consultation Meeting with Stakeholders

7.7.1 Organization of Meetings

The study team held a number of consultation meetings with a variety of stakeholders, including the Hanoi Environmental Protection Agency under Hanoi DONRE, Management board of the Hoa Lac High-Tech Park, local governments and representatives from local organizations of three different communes and wards (Lieu Giai, Me Tri, Thach Hoa), in order to:

- Retrieve basic environmental and social data and information
- Consult on requirement of EIA/EPP procedure for the project
- Exchange opinions on the scoping results and the proposal of TOR for preparation of EIA report
- Collect opinions on the project and its environmental and social impacts

The following table summarizes the schedule and the implementation of consultation meetings which have been held by the study team in May 2016.

Table 7.7.1 Organization of Consultation Meetings with Stakeholders

No.	Stakeholders	Date of Meeting	Participants from Stakeholders	Content of the Meeting
1	Hanoi Environmental Protection Agency	May 17, 2016	• Department of project management and communication • Department of appraisal and EIA	• EIA/EPP requirement for the project • Scoping results and TOR for preparation of EIA • Retrieve environmental status reports
2	Management board of Hoa Lac hi-tech park	May 27, 2016	• Department of construction, planning and environment • Women and labor union	• Opinions on the project and environmental and social impacts • Proposal and ideas on the route of BRT
3	Lieu Giai ward (Ba Dinh district)	May 16, 2016	• People's committee of Lieu Giai ward • Fatherland front • Women union	• Opinions on the project and environmental and social impacts
4	Me Tri ward (Nam Tu Liem district)	May 31, 2016	• People's committee of Me Tri ward • Fatherland front • Women union	• Opinions on the project and environmental and social impacts
5	Thach Hoa commune (Thach That district)	May 27, 2016	• People's committee of Thach Hoa commune • Fatherland front • Women union	• Opinions on the project and environmental and social impacts

Source: Study Team

7.7.2 Summary of Meetings

Detailed contents of consultation meetings with the five stakeholders could be found in Appendix B and C.

The comments and suggestion from the Hanoi Environmental Protection Agency (Hanoi EPA) on EIA/EPP requirement for this project, contents of the scoping results and TOR for the preparation of the EIA have been already incorporated in the related sections of this report. Main comments and suggestion from the four remaining stakeholders, including the Hoa Lac High Tech Park, Lieu Giai ward, Me Tri ward, and Thach Hoa commune, are summarized, as follows:

1. All four stakeholders and organizations therein agreed with the establishment of the BRT connecting from Hoa Lac to Hanoi and realized that the project would bring benefits and positive impacts to themselves and people living in the area.
2. The stakeholders requested that the project proponent would strictly follow current laws and regulations on design, construction, environmental protection, land acquisition and compensation, and so on.
3. The project proponent was requested to implement adequately mitigation measures to minimize negative impacts, including environmental impacts, traffic accident, traffic congestion, security problems and livelihood influence, to local people during construction and operation stages.
4. During construction and operation stages, the project proponent and Hanoi should support and cooperate with the directly affected communities to cope with rising of social and security problems and environmental and sanitation impacts, in order to reduce traffic accidents, traffic congestion, social evils, disorders and criminals, and environmental issues, which would usually occur at construction sites and bus stops and the depot in operation stage.
5. The selection of the BRT route and bus vehicles, placement of bus stops, design of facilities should be examined carefully so that traffic congestion and traffic accident would be minimized and disorders and criminals at bus stops would be suppressed. Security camera could be installed at bus stops to minimize disorders and criminals.
6. Design and operation plan of the BRT should be examined carefully so that accessibility and usability of the service would be guaranteed for different groups of local people, especially for elders, pregnant women, children, and disabled persons. In addition, bus fare could be reduced for special people, such as poor and low-income people, student, and so on.
7. Lanes, bus stops, and pedestrian bridge/crossing should be built in public land and transportation land to minimize area for land acquisition. Bus stops and pedestrian bridge/crossing should not be built in front of private houses and shops, in order to minimize negative impacts to business and livelihood of local people.
8. Depot area was not recommended to be established in Lieu Giai ward, due to its limited available space and high density of residents.
9. Conservation of grass and trees should be made as much as possible, especially for urban area. Minimizing cutting trees and transformation of grass area should be taken into account, because these areas are essential for livelihood of local people, especially for elders, women, and children.
10. It was requested that the construction would be arranged in a suitable schedule to avoid peak hours, sleeping and relaxing hours, holidays, and weekends.
11. Regarding land acquisition, apart from following current laws and regulations on land acquisition, compensation and support, the project proponent could directly negotiate with affected people and reach an agreement on compensation price and support. Compensation

price and support should be sufficient for affected people to restore their livelihood and recover their income. If service land would be provided for affected people as compensation, service land should have suitable location and adequate infrastructure to facilitate production, business, and life of people. In addition to compensation and initial support for affected people, the project proponent should keep supporting affected people in getting job and assisting for improvement of their living standard even after the project is put in operation.

12. The project proponent and Hanoi were requested to support affected people through training, vocational training, and getting new jobs, especially for vulnerable and special people, including elders, lonely old women, women, disabled persons, and poor people. Special care and support must be paid on middle-age women whose working age is ending. Middle-age women would encounter a lot of difficulties to get new jobs, because they are too old to be vocationally trained and worked in a factory/company. Most of middle-age women could be only either hired for cleaning/sanitation or do freelance jobs.
13. Although young women can be vocationally trained and worked for factories and companies, the project proponent should have policies to give a priority to affected women in recruitment. Recruitment of affected people/women for unskilled or low-skilled jobs, such as waitress, sanitation, and other side jobs in bus stops and the depot should be considered.
14. The project proponent and Hanoi should conduct propagation and communication to young people and teenagers on preventing social evils.

8 Comparative Evaluation of the Alternative BRT Routes

8.1 Summary of the Economic and Financial Viability

A summary of the results from the economic and financial evaluation is shown in Table 8.1.1. Although the BRT project has many benefits for the public, if the project is not financially sustainable (no profitability), it will be difficult to continue the project.

However, the BRT is expected to provide many benefits for the public because this project will improve the convenience of using public transport. In addition to the benefits in terms of economic and financial aspects, this project will also improve accessibility and the service level of the transport system in Hanoi through the operation of the BRT. In addition, the BRT may induce an increase in the land value adjacent to the BRT route thus contributing to an increase in tax revenues.

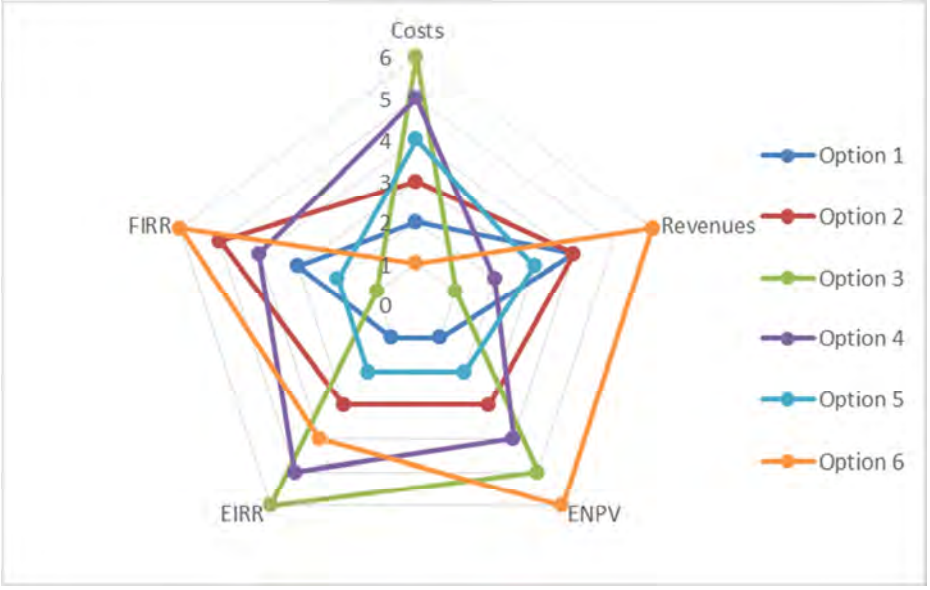
Table 8.1.1 Summary of Results of the Economic and Financial Analysis

		OPTION-1	OPTION-2	OPTION-3	OPTION-4	OPTION-5	OPTION-6
Economic Analysis	EIRR	15.6%	19.4%	32.8%	29.2%	18.4%	24.9%
	CBR	1.1	1.3	1.9	1.7	1.2	1.7
	NPV	590	908	1,916	1,555	872	3,255
Financial Analysis	FIRR	6.06%	10.48%	-0.16%	10.40%	0.18%	10.56%
Reference							
Cost (2018～2052) Unit: million yen		90,684	82,688	49,587	57,414	89,573	111,314
Benefit (2018～2052) Unit: million yen		95,997	95,997	42,748	67,365	78,490	128,199
Passengers Unit: 1,000 persons/day	2020	65	65	22	21	24	87
	2030	127	127	58	88	105	161
Growth of Passengers (2030/2020)		1.95	1.95	2.64	4.19	4.38	1.85

Source: Study Team

Figure 8.1.1 shows a radar chart where the economic and financial indicators for each option were ranked.

- The values for OPTION-1 and OPTION-5 are extremely low compared with the other options. OPTION-3 has a low project cost, but the feasibility of this option is low because the potential for profitability is not good.
- OPTION-2 has a relatively high project cost, but profitability is high because revenue income is also relatively high (all indicators are higher than the average from the other options).
- OPTION-4 has a lower project cost than the other options excluding OPTION-3 and has a high benefit, but revenue income is low.
- OPTION-6 has the highest project cost, but profitability is the highest because revenue income and economic benefits is relatively high.



※ Each indicator is ranked from 1 to 6 (1 = worse, 6 = best)
Source: Study Team

Figure 8.1.1 Radar Chart based on the Ranked Indicators

It is desirable for the BRT project to have many benefits for the public but the project cannot proceed if financial sustainability (high profitability) cannot be secured.

If operations of the BRT are entrusted to private company, revenue income becomes an important indicator. In light of this condition, OPTION-6 is the most suitable option because it has highest feasibility from the viewpoint of economic and financial aspects. If project investment is important, then OPTION-4 is suitable and if revenue income is important, OPTION-2 is the suitable option for this BRT project.

As mentioned above, although each of the options has merits and demerits, it is desirable that various effects such as the economic and financial aspects, accessibility, demand, and impact to the environment is considered in the feasibility study.

The distance between the central area of Hanoi and the Hoa Lac area is approximately 40 km and it is too far to commute by motorcycle. The existing bus route No. 74 is in operation between the My Dinh Bus Terminal and Xuan Khang via the Hoa Lac High Tech Park. According to the operation schedule of No. 74, the headway in the peak hour is 15 minutes but the schedule is flexibility adjusted depending on the number of

passengers. The major enterprises in the Hoa Lac High Tech Park such as Viettel, FTP, etc. are operating their own private bus services for their employees. After completion of this BRT project, the current private bus services operated by these private entities could be canceled or minimized.

(Public Bus Route No. 74 in front of the Viettel Tower)

(Private commuter buses operated by Viettel)

(Electric vehicles operated by FTP Company)

Source: Study Team

Figure 8.1.1 Current Transportation System in the Hoa Lac High Tech Park

8.2 Summary of the Comparative Evaluation for the Alternative BRT Routes

Based on the examination of the BRT routes as mentioned in the previous chapter, each of the alternative routes for the proposed BRT is compared in Table 8.2.1.

Table 8.2.1 Comparative Evaluation of Each Alternative BRT Route

Criteria		OPTION-1	OPTION-2	OPTION-3	OPTION-4	OPTION-5	OPTION-6
Outline of Alternative		Exclusive lane in urban/suburban section	Exclusive lane in urban section, expressway bus in suburban section	Expressway bus in suburban section, no line in urban section	Exclusive lane under RR-3, expressway bus in suburban section	Exclusive lane under RR-3 and in suburban section	Exclusive lane in urban section and under RR-3, expressway bus in suburban section
Connectivity with Other Public Transportation		With UMRT-2 and UMRT-3	With UMRT-2 and UMRT-3	None	With WB-BRT	With WB-BRT and UMRT-3 & 2A	With WB-BRT and UMRT-2, 2A & 3
Level of Service		Higher level through exclusive lane	Higher level by exclusive lane in urban section, intermediate level by high-speed express bus	No service in urban section, intermediate level by high-speed express bus	Higher level by exclusive lane in urban section, intermediate level by high-speed express bus	Higher level through exclusive lane	Higher level by exclusive lane in urban section, intermediate level by high-speed express bus
Passenger Demand	**2020**	65,000 pax/day	65,000 pax/day	22,000 pax/day	21,000 pax/day	24,000 pax/day	87,000 pax/day
	2030	127,000 pax/day	127,000 pax/day	58,000 pax/day	88,000 pax/day	105,000 pax/day	161,000 pax/day
Daily Revenue (VND)	**2020**	1,250 million	1,250 million	420 million	410 million	470 million	1,640 million
	2030	2,500 million	2,500 million	1,130 million	1,800 million	2,100 million	3,340 million
Project Cost (VND)		2,635,264 million	1,664,074 million	1,086,996 million	1,143,323 million	2,440,069 million	2,099,312 million
EIRR		15.6%	19.4%	32.8%	29.2%	18.4%	24.9%
FIRR		6.06%	10.48%	-0.16%	10.40%	0.18%	10.56%
Construction Difficulties		Impact to general traffic in urban and suburban section	Impact to general traffic in urban section	None	Impact to general traffic along RR-3	Impact to general traffic along RR-3 and suburban section	Impact to general traffic in urban section
Environmental Aspects		Congestion during construction and land for depot	Congestion during construction and land for depot	Land for depot	Congestion during construction and land for depot	Congestion during construction and land for depot	Congestion during construction and land for depot
Comparative Evaluation		High demand but high cost	High demand and mediate cost	Low demand	Low demand	High demand but high cost	Highest demand

Note: Project cost does not include operations and maintenance cost, engineering cost, administration cost and land acquisition cost.
Source: Study Team

8.3 Implementation Scheme

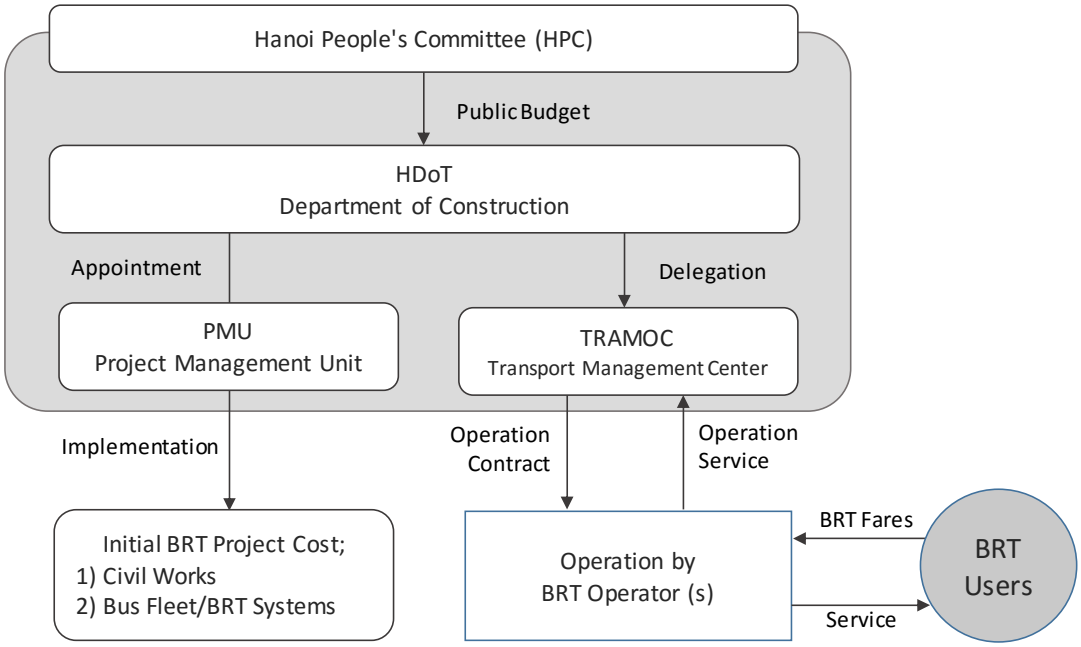
8.3.1 Basic Concept of Cost Sharing for the BRT Project in Hanoi

The results of the financial analysis has revealed that the entire project could not be operated only from the revenues generated from the project even though the FIRR of OPTION-2, OPTION-4 and OPTION-6 was estimated at 10.48%, 10.40% and 10.56% respectively. The financial support by implementing the entire or part of the initial investment cost as public works will encourage the participation of the private entities.

On the other hand, for OPTION-1, OPTION-3 and OPTION-5, it is realistic for these options to be implemented solely as public works.

Under the control of the Hanoi People's Committee (HPC), the current urban bus service is supervised by TRAMOC (Urban Transport Management and Operation Center) as a regulator. TRAMOC is a subordinate organization of the HDOT (Hanoi Department of Transport). The operation for each bus line is conducted by private or public corporation(s) under the supervision of TRAMOC. TRAMOC is designated as the core of a future Public Transport Authority (PTA) and the supervision of bus operations in Hanoi will continue to be implemented by TRAMOC as well as the World Bank-funded BRT project that is currently under construction.

Figure 8.3.1 presents the financial cost sharing scheme of the BRT project funded by the World Bank.



Source: Study Team

Figure 8.3.1 Cost Sharing Scheme of BRT funded by World Bank

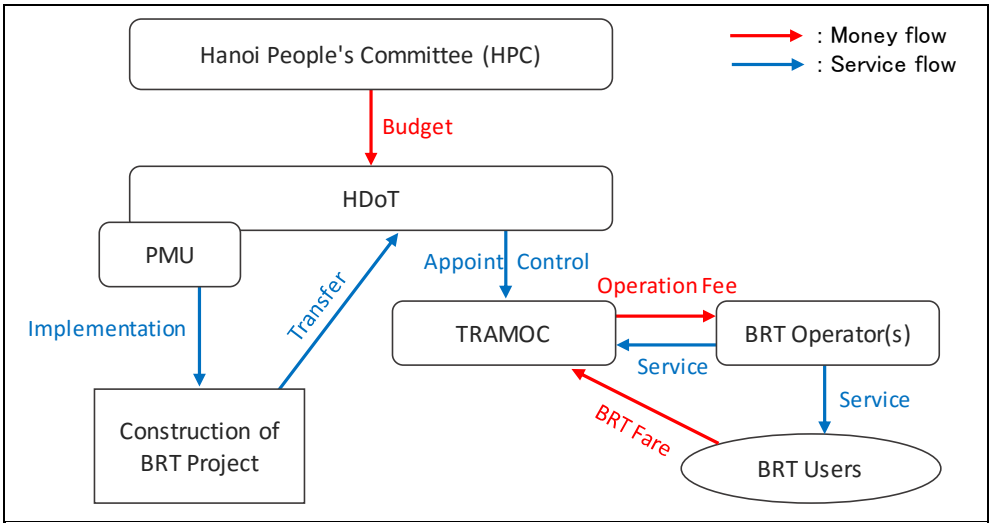
8.3.2 Proposed Implementation Scheme of the BRT Project

TRAMOC will have an initiative for the implementation of the public transport system in Hanoi. Thus, the most realistic implementation scheme of this BRT project is considered to be in the same manner as the BRT project funded by the World Bank. The cost sharing of this scheme is that the government will provide the infrastructure, the users will pay for the cost of service and the operator will provide an efficient service under the administrative management of TRAMOC.

This BRT project is designed to be connected with the future public transport system such as the World Bank BRT line, UMRT-2A and UMRT-3. Also the existing urban bus network will be required to be revised after the completion of this BRT project. The integrated management of the public transport system will be a prerequisite to maximize the convenience of using the system and to enhance the ridership of the system.

Figure 8.3.2 presents the proposed implementation scheme of for this project. The initial investment cost such as the construction of the BRT facilities and procurement of the proposed BRT vehicle is proposed to be funded by external funds such as Japanese ODA and the government budget. A PMU (Project Management Unit) will be established for the construction and the procurement of the initial investment of the project. Prior to the commencement of the service, the PMU will be demobilized and the project asset will be handed over to the HDOT who will be the owner of the project. The HDOT will appoint TRAMOC to be the regulator of the BRT service and private/government operator(s) will be selected via a tender process to provide the service to the public.

The maintenance of the civil works such as the exclusive BRT lanes, BRT stops, will be conducted by the government (HDOT).



Source: Study Team

Figure 8.3.2 Proposed Implementation Scheme of the Project

9 Proposal for the Preferred Alternative Route and Future Issues

9.1 Proposal for the Preferred Alternative Route

9.1.1 Significance of Public Transport and the Introduction of the BRT

In the existing densely populated urban area of Hanoi, with the progress of motorization, serious traffic congestion on the arterial roads is occurring and this has become a serious societal problem. There are plans to reduce the population density in these existing urban areas with plans for the construction of satellite towns. However, development of the transport network to connect these satellite towns with the existing urban area has been delayed and therefore development of the satellite towns has not progressed.

In the Hoa Lac Satellite Town, this satellite town is planned as an academic and research town that is centred on the Hoa Lac High Tech Park and the Vietnam National University Hanoi campus. It is expected that this satellite town will become a hub of academic research, not just for Hanoi but for the entire country of Vietnam. Therefore, the formulation of the transport axis on the Hanoi to Hoa Lac corridor takes on a meaning of significance.

In the Hoa Lac Satellite Town, the future population is expected to be 600,000. This satellite town is located approximately 40 km west of the central area of Hanoi and currently there are 2 public bus routes that are operating between the central area of Hanoi and Hoa Lac. However, it is difficult for the current service to meet the future passenger demand. Also, the 40 km length of the bus route is too long for a regular bus route (in Hanoi, the average length of bus routes is around 22 km).

In the Hanoi transport master plan, the UMRT Line 5 is planned but at this point in time, the schedule for the development of the Hoa Lac Satellite Town is not clear. Also, the traffic demand is small and a large investment for the construction is necessary so building the UMRT Line 5 at this time is premature. Also, large amounts of funds are being distributed for the construction of the UMRT Line 1, Line 2, Line 2A and Line 3 so for the time being, there are not enough financial resources for the construction of the UMRT Line 5.

On the other hand, for the BRT, the existing road infrastructure can be used and so a high level public transport service can be provided for a minimal investment cost. Also, the BRT lanes and the pedestrian walkways to cross the roads to access the BRT stations can be reused on a permanent basis for other purposes so there will be no waste in building such a transport system. From the BRT lanes, the speed of bus operations could be improved and from the introduction of articulated buses, compared to standard buses, large passenger carry capacities can be achieved.

The BRT can be constructed easily for lower construction costs and the scale of the bus vehicle fleet and operating frequencies are highly flexible so it is easy to adjust the capacity of the BRT to meet the variable passenger demand from the center of Hanoi to Hoa Lac and so it was determined that the BRT is a suitable mode of transport for this corridor. Furthermore, in the long term, according to the master plan, the construction of the UMRT Line 5 is necessary and until the UMRT line is constructed, the BRT can be used to promote development in the corridor to build up the ridership for the UMRT line.

9.1.2 Comparative Evaluation of the Alternative Routes

In this study, 6 alternative routes for the BRT were proposed based on the existing condition of the road network, traffic situation, and the urban development along the Hoa Lac-Hanoi corridor. These 6 alternative routes were then comparatively evaluated. For the 6 alternative routes, the suburban section from Ring Road No. 3 to Hoa Lac and the urban section from Ring Road No. 3 to Ho Tay were separately evaluated.

For the suburban section, the location of where to construct the BRT exclusive lanes on the existing Thang Long Expressway was examined and in the urban section, based on the traffic congestion situation, whether or not the BRT could be introduced on the existing roads was examined. Also, keeping in mind other public transport systems and the public transport network, the alternative routes were examined on a technical basis which included examination of the forecasted passenger demand, BRT operating plan, calculation of the preliminary construction costs, environmental and social considerations and an economic and financial analysis.

As a result, it was calculated that Option-6 and Option-2 and 4 had the highest economic benefits and therefore it was judged that there is a high possibility of implementation of these options. In particular, with regards to Option-6, operationally, the route is the longest and it has the highest operating cost, however, because it connects with UMRT Line 2, Line 2A, Line 3 and the World Bank BRT-1, it contributes towards forming the backbone of the public transport network. From the strengthening of the public transport network functions, it will be possible to access the Hoa Lac Satellite Town from the centre of Hanoi by public transport easily.

However, although the socioeconomic rate of return is high, the financial rate of return is not high. In the case where travel demand is low because of delays in urban development in Hoa Lac, there is the danger of operating deficits for the BRT and it is necessary for think about the possibility of providing operating subsidies.

9.1.3 Formulation of a Functional Public Transport Network and Effective Operations

For the corridor that is the target of this study, in the suburban section there are 2 regular bus routes in operation and in the urban section there are many regular bus routes in operation. Also, according to the master plan, in the future the backbone of the public transport network will be based on 8 UMRT lines. Among the UMRT lines and BRT lines in construction at the moment (Line 2, Line 2A, Line 3, BRT-1), there is only a transfer point between the BRT-1 and Line 2A at Kim Ma Station and Yen Nghia station. All other lines in construction are not connected with each other and therefore it is hard to reap the benefits of connectivity in the public transport network.

From the results of this study, in addition to connecting the central area of Hanoi with Hoa Lac Satellite Town on with an east-west connection, from the introduction of the BRT route on Ring Road No. 3, connectivity between the UMRT lines currently under construction with each other will be improved and a more comprehensive backbone of the public transport network will be formed.

Based on the concept of the backbone of the public transport network, it is important that regular bus lines that currently operate in parallel with the UMRT and BRT lines under construction be reorganized to act as feeders to these UMRT and BRT lines to avoid duplication of services. In Hanoi, the average length of regular bus routes are approximately 22 km and as regular bus routes become longer, operations management becomes more complicated due to effects from traffic congestion and there is a trend that service levels will decrease. From the separation of backbone functions of the public transport network and the feeder functions, the operating length of regular bus routes will become shorter and it will be possible to provide service levels that are higher. Also, from the planning of making public transport more effective, it is expected that this will contribute towards the mitigation of congestion in regular traffic.

From the planned separation of functions (backbone and feeder) of the public transport network, transfers will increase. To deal with this, the transfer facilities as well as the fare system need to be re-examined. Also, from the introduction of a smart card ticketing system, a smooth system for transfers will be possible.

9.1.4 Examination of Transport Hubs and Transit Oriented Development

Transit oriented development (TOD) can be used to promote usage of public transport in a walkable catchment area along with controlling private vehicle usage. In addition, TOD can be used to promote the formation of compact urban development around transit stations based on mixed land uses.

In Hanoi, the “Project for Studying the Implementation of Integrated UMRT and Urban Development for Hanoi in Vietnam (HAIMUD2)” was conducted by JICA in 2015 and in this study, 18 stations related to the Phase 1 construction of UMRT Line 1 and Line 2 were targeted for the creation of concept plans for integrated development of UMRT and urban development and for improving the transport situation.

In this study, the proposed BRT will have a connection with station C5: Quan Ngua of UMRT Line 2. This station is planned to be an underground station that will serve the traditional and dense residential area on the southwest area of Ho Tay (West Lake). In the TOD concept plan of the station surrounding area, it was proposed for the roads serving the residents of the surrounding area to be improved and to improve access to the station by constructing an underground parking lot and an underground pedestrian walkway.

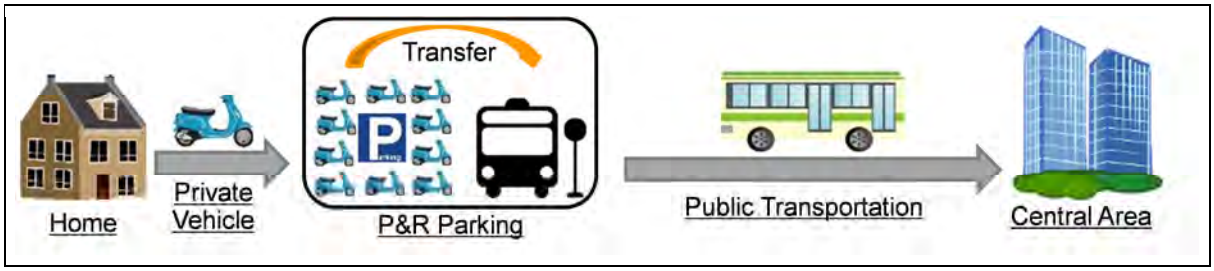
In addition, at the connecting points with UMRT Line 2A, Line 3 and BRT-1 as well as on the intersections on the east-west and north-south sections of this BRT route, it is expected that with the construction of transport hubs, some of these transport hubs will be candidates for TOD.

9.1.5 Park and Ride Facilities

The distance from the center of Hanoi to Hoa Lac Satellite Town is around 40 km and this distance exceeds the average travel distance of the motorbike (around 10-15 km) which is the main mode of transport currently in Vietnam. Currently, from the center of Hanoi to Hoa Lac, the Thang Long Expressway has already be completed and there is easy access to Hoa Lac by car, However, for city residents whose main mode of transport is the motorbike, access to Hoa Lac is difficult. Therefore the current situation is that there are limitations in mobility for ordinary citizens.

Due to the limitations in financial resources, it is difficult to construct the UMRT Line 5 so there is significance in introducing the BRT in this study. In order to maximize usage of this BRT, and based on the premise of using motorbikes and understanding the transport culture of Vietnam, it is necessary to consider appropriate measures for encouraging usage of this BRT.

One of the effective measures is the park and ride concept. In the park and ride concept, private vehicle users park their car or motorbike at facilities at the closest station or bus stops and take public transport to reach their destination. For the BRT proposed in this study, if park and ride were applied, motorbike parking facilities would be constructed near BRT stations and users could access the BRT stations by motorbikes and then transfer to the BRT to reach their destination.



Source: Study Team

Figure 9.1.1 Concept of Park and Ride

For the BRT which has a higher service level than regular buses, it is typical for the station spacing to be farther away than for regular bus stops.

In the central area of Hanoi, the average distance between bus stops for regular bus routes is around 430 m. On the other hand, for this proposed BRT, the average distance between BRT stations is around 1 km in the urban area of Hanoi and around 3 km in the suburban area. Because of the longer distance between stations, it is important to improve accessibility to the BRT stations. With the construction of motorbike parking facilities near BRT stations, park and ride is possible and it is expected that the catchment area of users from stations will be expanded.

Furthermore, if transport smart cards were used and for example if park and ride parking facilities were used within a fixed time period and if the user transfer to the BRT, it would be possible to apply a discount for using the park and ride facility.

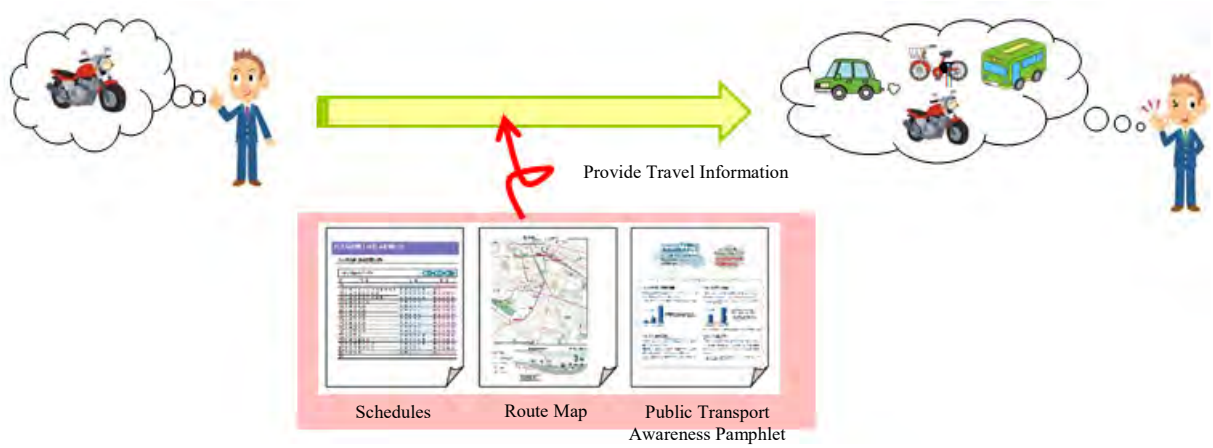
According to the basic policy for the planning of this proposed BRT (refer to Section 5.2), Policy 1 is “to avoid pursuing excessively high standards in consideration of the possible future discontinuation of the BRT” and Policy 2 is “to effectively utilize the BRT facilities even after the discontinuation of the BRT operation”. For the park and ride concept proposed in this chapter, even if the BRT is converted to the UMRT in the future, the park and ride facilities could continue to be used so it adheres to the basic policies as proposed in Section 5.2 of this study.

9.1.6 Efforts to Promote the Modal Shift from Private to Public Transport

In Hanoi, although there are plans for the UMRT and BRT, at this point in time, none of the planned lines have been opened for operations yet. As a result, there is no culture or custom of using a fixed route public transport line with fixed scheduled other than the regular public buses. Under these conditions, even when the proposed BRT opens for operations, there is concern about the difficulties in shifting from private to public modes. One of the methods to deal with this problem is to utilize mobility management.

Mobility management are efforts in changing the understanding and thinking from the user’s side in terms of transport and combined with the new construction or revision of a transport system, it is an effective transport measure to promote the modal shift to public transport.

Method of Mobility Management: A soft policy of letting users consider public transport usage by providing transport information in an easy to understand manner so that the user understands the various mode choices available for travel. This is in contrast to forcibly telling users to exercise self-control in using private modes.



Source: Study Team

Figure 9.1.2 Concept of Mobility Management

Through mobility management measures, the purpose is for users to recognize the benefits of public transport and will choose to use public transport among various different forms of transport options. For efforts in mobility management, in addition to this proposed BRT line, it is expected to have spillover effects for the entire public transport system including the World Bank BRT-1 and other UMRT lines. Furthermore, in Binh Duong Province in southern Vietnam, as a part of the technical cooperation project, a mobility management project is being implemented.

9.1.7 Consideration for Traffic Safety

The required elements of public transport are quickness, convenience and comfort and safety. For the safety indicator, it is difficult to quantify but for the continuation of this BRT, it is an extremely important element. Therefore, with regards to safety countermeasures for bus operations as well as for bus users, necessary efforts will be proposed.

For bus operation safety countermeasures, this refers to the training of bus operators, management of bus operators and accumulating operating data. For securing the day to day safe operations, it is indispensable for bus operators to have sufficient education and training. Moreover, from bus operations personnel, before the start of bus operations as well as after the start of operations, there should be a roll call to confirm the health conditions and drinking conditions of the bus operators as well as the results of the daily inspection of the bus vehicles and the weather and road conditions. Also, it is important to accumulate and manage bus operations data (operating conditions and location data) to set bus operations indicators for analysis.

Also, it is important to have safety management when the BRT is in operations. In particular, in the case of Vietnam the dominant vehicle on the road is the motorbike and motorbike users do not follow traffic rules and it is necessary to thoroughly have countermeasures to prevent incursion of motorbike users in the BRT exclusive lanes.

One of the safety countermeasures for bus users is to secure the safety of users when they access the BRT stations. In this proposed BRT, the BRT exclusive lanes as well as stations are planned to be established in the center median of roads. On these arterial roads, there are high traffic volumes and in order to avoid crossing the road at-grade, it is planned for users to access the stations via overhead or underground pedestrian walkways.

9.2 Future Issues

9.2.1 Revision of the Socioeconomic Indicators for the Travel Demand Forecast

In this study, the traffic database that was created for the METROS study was used, however, the METROS study targeted the entire metropolitan area of Hanoi as a master plan. With regards to the targeted BRT corridor in this study, a detailed examination has not been conducted. As a result, the commuter demand from the Hoa Lac Satellite Town to the center of Hanoi is large and the socioeconomic framework is based on a suburban residential structure.

In the previously mentioned satellite town, in the future the satellite town is positioned as an academic and research city and even with the socioeconomic framework, it is necessary to consider upcoming and future urban development along the BRT corridor. In the feasibility study of this BRT, it is necessary to revise the socioeconomic framework that acts as the base for a revised travel demand forecast.

9.2.2 Technical Examination based on Lessons Learnt from the World Bank BRT-1

For the World Bank funded BRT-1 that is currently under construction, it will operate on roads in Hanoi that is severely congested and as a result, it is difficult to implement BRT exclusive lanes like it was originally planned. Also, for at-grade intersections, even with the introduction of priority signals for the BRT, the priority signalling for the BRT is expected to have a negative effect on regular traffic in making the regular traffic more congested. Therefore for BRT-1, it will be difficult to have smooth bus operations when the line opens.

In this study, at the time of conducting the technical examination of the BRT, the lessons learnt from the World Bank BRT-1 project were taken into consideration and the impact on the existing traffic conditions were evaluated. Based on this evaluation, the adjustment of related facilities was then planned. However, there were still many problems with regards to the flow of traffic at intersections and traffic management in the urban section of the route. After the opening and operations of the BRT-1, it is important to observe the problems that may arise.

9.2.3 Construction of Transport Hubs

For the formation of a public transport network, construction of transport hubs is important. In particular, it is necessary to concretely examine the transfers between the UMRT lines and BRT-1 that are under construction along with the existing regular bus network. Also, with regards to the necessity for land acquisition and comprehensive urban development using the TOD concept at transport hubs, these are future issues that need to be tackled.

9.2.4 Fare Scheme and Fare Management

Along with the formation of the public transport network, in order to promote transfers, it is required to change the fare scheme and the fare collection system (towards a smart card system). Currently, in Hanoi, from the “Project for Supporting the Interoperability of Public Transport Smart Cards” that JICA conducted, there is a request to construct a fare management center using official development assistance funds and it is required to coordinate the fare scheme and fare collection system of the BRT with this project.

9.2.5 Examination of the Reorganization of the Regular Bus Routes

In the Hanoi transport master plan, along with the construction of the UMRT and BRT lines, there are plans to upgrade the entire service level of the bus system and to improve the convenience for bus users by revising the regular bus network and introducing a feeder bus system to the UMRT and BRT lines. In the HAIMUD2 study conducted by JICA, reorganization of regular bus routes that were duplicated with the construction of the UMRT Line 1 and Line 2 was examined and for UMRT Line 3, there is currently a technical cooperation project where reorganization of the bus routes is being examined. (However, at this point in time, the reorganization of the bus routes has not been approved)

For this study, on the Thang Long Expressway, there are currently 2 existing regular bus routes and in the urban section of the BRT route, there are multiple bus routes and transfer points. As a result, when this topic is examined in detail, it will be necessary to look into the reorganization of the regular bus routes that operate along this BRT line to act as a complementary/feeder service to the backbone of the public transport network (UMRT and BRT lines).

Furthermore, the two existing regular bus routes operating on the Thang Long Expressway compete directly with the BRT in this study so it is required for the section of these two existing bus routes that go further away from Hoa Lac to be broken off into feeder bus lines. For the section of these two existing bus routes that run along the Thang Long Expressway, it is required to reduce the distance between bus stops so that these two existing bus routes act as a local service for the BRT in this study. In addition, the introduction of new feeder bus services from the BRT stations to surrounding urban areas needs to be further examined.

9.2.6 Building Up the Operations Management System

The World Bank supported BRT-1 will be operated by TRANSERCO which is the operator of the existing bus lines. However, with regards to the operations management centre, it is established within the Kim Ma general public transport management center. Also, with regards to the BRT priority signals, the traffic police who are in charge of the traffic control center that operates the signals is also located in the Kim Ma general public transport management center. For the fare collection system that is based on the smart card, in addition to the BRT operations management center, it needs to be linked with the fare management center at TRAMOC and managed as one system. For this BRT, the detailed examination of the operations management system needs to be examined.

9.2.7 Inducing Urban Development along the BRT Corridor

One of the important issues in securing the ridership and by extension the operating profitability of the BRT is promoting urban development along the Hanoi to Hoa Lac corridor and the development of TOD at key transfer points. JICA has up to now supported the technical development of TOD, however, due to the fact that urban development and the development of transport infrastructure is handled by different organizations, it is the current reality that TOD has not been realized. It is required to extract the issues with regards to TOD, such as what needs to be done for developing a policy for TOD.

Appendix A: Land Use, Population, and Socioeconomic Data of Lieu Giai Ward, Me Tri Ward, and Thach Hoa Commune in 2015.

Table A.1 Land Use Status of Lieu Giai Ward, Me Tri Ward and Thach Hoa Commune in 2015

Items	Unit	Lieu Giai Ward	Me Tri Ward	Thach Hoa Commune
Area	Ha	67.07	467.30	3,291.42
Agriculture land	Ha	0.13	92.30	-
Non-agriculture land	Ha	66.94	353.95	-
Unused land	Ha	0.47		

Source: Report on Socio-economic conditions of Lieu Giai ward, Me Tri ward, and Thach Hoa commune in 2015

Table A.2 Population of Lieu Giai Ward, Me Tri Ward and Thach Hoa Commune in 2015

Items	Unit	Lieu Giai ward	Me Tri ward	Thach Hoa commune
Population	Person	21,428	25,666	8,722
Female population	Person	10,946	12,234	-
Population in working age	Person	11,054	-	-
Population density	Person/km^2	31,982	549	265
Population increasing rate	%	1.12	1.37	0.52

Source: Report on Socio-economic conditions of Lieu Giai ward, Me Tri ward, and Thach Hoa commune in 2015

Table A.3 Socioeconomic Data of Lieu Giai Ward, Me Tri Ward and Thach Hoa Commune in 2015

Contents	Unit	Lieu Giai ward	Me Tri ward	Thach Hoa commune
Budget revenue	billion VND	-	33.458	19.503
Budget expenditure	billion VND	-	18.635	15.949
Total production and business value	billion VND	-	-	1,082.417
Agriculture production	billion VND	-	-	122.540
Industry and handicraft production	billion VND	-	-	553.737
Services and trade sector	billion VND			406.14
Income per person in year*	million VND	-	-	45
Children attended kindergarten	%	-	-	71
Malnutrition children rate	%	-	-	9.6
Number of poor households	Households	-	-	59 (2.06%)
Number of nearly-poor households	Households	-	-	34 (1.18%)
*: Target to be achieved in 2016				

Source: Report on Socio-economic conditions of Lieu Giai ward, Me Tri ward, and Thach Hoa commune in 2015

Appendix B: Meeting Minutes for Consultation Meetings with the Hanoi EPA, Hoa Lac High Tech Park, Lieu Giai Ward, Me Tri Ward and Thach Hoa Commune in May 2016.

MEMORANDUM OF DISCUSSION
FOR
DATA COLLECTION SURVEY ON BRT IN HANOI

1. Subject:	EIA/EPP requirement, scoping results and TOR for preparation of EIA
2. Venue:	Hanoi Environmental Protection Agency (Tran Thai Tong street, Cau Giay district, Hanoi city)
3. Date/Time for survey	May 17, 2016, 14:20–16:15
4. Prepared by	Tran Thanh Than
5. Date of Preparation	May 17, 2016

MEMORANDUM OF DISCUSSION

Date of Preparation: 2016/05/17

1. Name of Organization:	Hanoi Environmental Protection Agency (Hanoi DONRE)
2. Name of Attendants:	
(Hanoi Environmental Protection Agency (Hanoi EPA)) Ta Ngoc Son / Deputy Head of Division of Project Management and Communication Nguyen T. T. T. Nhung / Deputy Head of Division of Appraisal and Assessment of Environmental Impacts (JICA Study team) Mr. Tran Thanh Than/ Local Consultant on Socio-economic Evaluation	
3. Date/ Time:	May 17, 2016 14:20–16:15
4. Agenda:	1) Introduction on project details 2) Discussion on EIA/EPP requirement for the project 3) Discussion on scoping results and TOR for preparation of EIA
5. Main opinions from Hanoi EPA:	

Opinions on EIA/EPP requirement for the project:

According to Appendix II of Decree 18/2015/ND-CP dated February 14, 2015, the project would be subject to the requirement of EIA procedure, if the project content includes one of the following items:

i) New construction of expressway or automobile roads of grade I to III
ii) New construction of bridge with a length of longer than 500 m
iii) New construction of bus terminal with an area of larger than 5 ha
iv) New construction of workshops for car maintenance and repair with a capacity of higher than 500 automobiles/year

If the project would be satisfied for the requirement of EIA procedure, the project must comply with prescriptions specified in Decree 18/2015/ND-CP, as follows:

1. Execution of environmental impact assessment (Article 12)
2. Requirement for organizations executing EIA (Article 13)
3. Appraisal and approval of EIA report (Article 14)
4. Remake EIA report (Article 15)
5. Responsibilities of project owner after EIA report is approved (Article 16)
6. Check and confirmation of environmental protection facilities served for operation stage of a project (Article 17)

If the project content would not satisfy the requirement of EIA procedure, the project would be subject to the requirement of Environmental Protection Plan (EPP), according to Decree 18/2015/ND-CP. For example, the project would not include new construction of road; instead, the project would utilize the existing roads of Thang Long expressway, Ring road No. 3, Tran Duy Hung, Nguyen Chi Thanh, Lieu Giai, and Van Cao; the project would build a depot with an area of less than 5 ha and a car workshop with a capacity of less than 500 cars/year.

If the project would be subject to the requirement of EPP procedure, the project must comply with regulations specified in Decree 18/2015/ND-CP, including Article 18 (registration of EPP), and Article 19 (confirmation of EPP).

Opinions on content of EIA for the project:

Based on Vietnamese laws and regulation on environmental protection and the documents received from the study team, Hanoi EPA requested the project proponent to add an impact assessment with

regards to community health for diseases caused by environmental pollution, especially for diseases caused by air pollution from transportation vehicles.

Hanoi EPA reminded that the project proponent would require for permission from Department of Construction, in accordance with Vietnamese laws and regulations, for relocation and new plantation of trees and transformation of grass in center median.

If the project would be subject to the requirement of EIA procedure, Hanoi EPA recommended that the project proponent would conduct ecology survey on trees and plants in the project area, in terms of distribution, location, quantity of each species, and categorization of species according to Vietnam Red book.

If the project would be subject to the requirement of EIA procedure, Hanoi EPA advised that the project proponent would require to conduct public consultation as regulated in Decree 18/2015/ND-CP (Article 12) and Circular 27/2015/TT-BTNMT (Article 7), as follows:

1. Consultation with people's committee of commune, town, ward which is directly affected by the project. The project owner would send EIA report to people's committee of commune, socio-professional organizations, socio-political organizations, population groups/village/hamlet. After receiving documents from the project proponent, people's committee of commune would hold public consultation meeting with the participation of different stakeholders in accordance with related laws and regulations.
2. Feedback and comments of consulted parties on the project must be sent back to the project owner within 15 working days from the date the commune people's committee received the request for consultation from the project owner. Consultation comments must be written in document as minutes of meeting which would be signed by all attendants. Minutes of meeting and lists of attendant would be submitted to the appraisal agency together with the EIA report.

END

Images of consultation meeting with Hanoi EPA
(May 17, 2016)

Picture 1: Consultation with Mr. Ta Ngoc Son (Deputy Head of Division of Project Management & Communication)

Picture 2: Consultation with Ms. Nguyen T. T. T. Nhung (Deputy Head of Division of Appraisal and Assessment of Environmental Impacts)

MEMORANDUM OF DISCUSSION
FOR
DATA COLLECTION SURVEY ON BRT IN HANOI

1. Subject:	Consultation on the project and its environmental and social impacts
2. Venue:	Headquarter of Hoa Lac hi-tech park (Thach Hoa commune, Thach That district, Hanoi city)
3. Date/Time for survey	May 27, 2016, 09:30–11:10
4. Prepared by	Tran Thanh Than
5. Date of Preparation	May 27, 2016

MEMORANDUM OF DISCUSSION

Date of Preparation: 2016/05/27

1. Name of Organization:	Hoa Lac hi-tech park (Thach Hoa commune, Thach That district, Hanoi city)
2. Name of Attendants:	
(Hoa Lac hi-tech park) Kim Giang Nam / Official of Division of Construction, Planning and Environment Le Thi Mai Dung / Vice Chairwoman of Women Union and Labor Union (JICA Study team) Mr. Bui Xuan Tung/ Expert of Environmental and Social Considerations Mr. Tran Thanh Than/ Local Consultant on Socio-economic Evaluation	
3. Date/ Time:	May 27, 2016 09:30–11:10
4. Agenda:	1) Introduction on project details 2) Discussion on the project content 3) Opinions on environmental and social impacts
5. Main opinions from Hoa Lac hi-tech park:	
Opinions from Management board of Hoa Lac hi-tech park: Management board of Hoa Lac hi-tech park totally agreed with the proposal of BRT project. The board requested that Hanoi city would rapidly develop public transportation connecting Hanoi city and Hoa Lac town in order to satisfy demand for transportation in the area. Currently, there is only one bus route (no. 74, frequency: 30 minutes/bus) connecting Hoa Lac with Hanoi city, which cannot satisfy high demand for public transportation from workers and student. The bus is always full of people and thus the demand for additional public transportation is very urgent. Most of workers in Hoa Lac hi-tech park travel every day from Hanoi city to Hoa Lac by private or company rental bus. The management board proposed to establish 3 bus stops inside the hi-tech park, which can be located at places where there are many people and workers living around. Three bus stops were proposed as follows: (1) one near the building of management board, (2) one near Viettel building, and (3) one near residential houses. The BRT route should run through the main road of the hi-tech park and finally exit at National road no. 21. The management board requested that the project proponent would follow Vietnamese laws and regulations on environmental protection and construction, once the construction of the project facilities would be implemented inside the hi-tech park. In addition, the construction should avoid peak hours in the hi-tech park and the time when some conferences and trainings would be happening. Peak hours at the hi-tech park are about 7:30 in the morning and 17:30 in the afternoon. **Opinions from Women and Labor union of Hoa Lac hi-tech park:** Women and labor union of hi-tech park agreed with the proposal of BRT project which help to connect Hanoi city and Hoa Lac. The union suggested that the project proponent should not conduct construction during the time when there are a lot of people travelling on Thang Long expressway to avoid traffic accident. The design of the project should consider adopting properly exclusive lanes together with well notified separators, which would help drivers to recognize easily and minimize traffic accident. Exclusive lanes with clear notice board would reduce traffic accident, especially at interchanges, crossroads, and bus stops.	

END

Images of consultation meeting with Hoa Lac Hi- Tech Park
(May 27, 2016)

Picture 1: Consultation with Mr. Kim Giang Nam (Official of Division of Construction, Planning and Environment)

Picture 2: Consultation with Ms. Le Thi Mai Dung (Vice Chairwoman of Women Union and Labor Union)

MEMORANDUM OF DISCUSSION
FOR
DATA COLLECTION SURVEY ON BRT IN HANOI

1. Subject:	Consultation on the project and its environmental and social impacts
2. Venue:	Headquarter of Lieu Giai ward (26 Van Cao, Ba Dinh district, Hanoi city)
3. Date/Time for survey	May 16, 2016, 14:20–15:45
4. Prepared by	Tran Thanh Than
5. Date of Preparation	May 16, 2016

:

MEMORANDUM OF DISCUSSION

Date of Preparation: 2016/05/16

1. Name of Organization:	Lieu Giai ward (Ba Dinh district, Hanoi city)
2. Name of Attendants:	
(Lieu Giai ward) Nguyen Ngoc Tan / Chairman of Lieu Giai ward People's Committee Nguyen Hai Ha / Vice Chairman of Lieu Giai ward People's Committee Dinh Xuan Duc / Chairman of Fatherland Front of Lieu Giai ward Banh Thi Nhung / Chairwoman of Women Union of Lieu Giai ward (JICA Study team) Mr. Tran Thanh Than/ Local Consultant on Socio-economic Evaluation	
3. Date/ Time:	May 16, 2016 14:20–15:45
4. Agenda:	1) Introduction on project details 2) Discussion on the project content 3) Opinions on environmental and social impacts
5. Main opinions from Lieu Giai ward:	

Opinions from Lieu Giai ward people's committee:

People's Committee of Lieu Giai ward realized that the project documents on environment and social impacts and TOR for preparation of EIA have presented sufficiently positive and negative impacts to Lieu Giai ward. The committee totally agreed with the content of analyzed impacts and would be willing to cooperate with the project as necessary.

The committee requested that project facilities and exclusive lanes would be constructed on public land, land for transportation, such as center median, pavement, and so on in order to reduce as much as possible land acquired for the project, minimizing negative impacts from land acquisition of the project.

The committee proposed that the deport area would not be built in the ward, because available land in the ward is limited and density of people is very high. Nevertheless, if the project owner would require building a depot area in Lieu Giai ward after examining carefully socio-economic and environmental aspects, the committee would support the project plan.

The committee proposed that pedestrian bridges should be built at places in front of where public land or institutions are located. Pedestrian bridges should be avoided to be built in front of local people's shops and houses, thereby minimizing negative impacts to business, livelihood and walking activities of local people.

Opinions from Fatherland front of Lieu Giai ward:

Fatherland front of Lieu Giai ward also agreed with analysis of positive and negative impacts made by the study team and would be pleasure to cooperate and support project activities in the future.

The organization realized that the BRT project would bring positive impacts to the ward, rather than negative impacts. The project would provide a service to facilitate transportation of local people and thus reduce private vehicles and traffic congestion in peak hours at interchanges, like Lieu Giai-Van Cao- Doi Can interchange.

During construction and land acquisition, the project owner and contractors should avoid construction in peak hours, sleeping and relaxing time (such as at noon and night time), holidays and weekends.

The project proponent should consider supporting the ward to minimize negative impacts from the project activities, such as social security, sanitation and environment. There should be measures to

enhance management capacity, to supplement budget for security, to support on traffic safety, sanitation and environment, reducing traffic congestion during construction and operation stage.

Opinions from Women union of Lieu Giai ward:

Women union of Lieu Giai ward also agreed with analysis of positive and negative impacts made by the study team and would be pleasure to cooperate and support project activities in the future.

The project proponent should consider improving accessibility of BRT services to different groups of people. Design and operation of BRT should be examined to ensure elders, pregnant women, children, and disabled persons enable to use bus vehicles. In addition, bus fare could be reduced for special people, including poor and low-income people, student, and so on.

The project proponent should apply mitigation measures to minimize negative impacts to environment, livelihood and current traffic on existing roads. Impacts to grass and trees on Van Cao and Lieu Giai roads would be minimized as much as possible, because these greening areas are places where exercise and playing activities of local people of Lieu Giai ward, including elders, women and children, occur daily.

END

Images of consultation meeting with Lieu Giai ward
(May 16, 2016)

Picture 1: Introduction of the BRT project and its environmental and social impacts by Mr. Tran Thanh Than (Local Consultant on Socio-economic Evaluation)

Picture 2: Discussion on the project and its environmental and social impacts.

MEMORANDUM OF DISCUSSION
FOR
DATA COLLECTION SURVEY ON BRT IN HANOI

1. Subject:	Consultation on the project and its environmental and social impacts
2. Venue:	Headquarter of Me Tri ward (Nam Tu Liem district, Hanoi city)
3. Date/Time for survey	May 31, 2016, 10:00–11:15
4. Prepared by	Tran Thanh Than
5. Date of Preparation	May 31, 2016

:

MEMORANDUM OF DISCUSSION

Date of Preparation: 2016/05/31

1. Name of Organization:	Me Tri ward (Nam Tu Liem district, Hanoi city)
2. Name of Attendants:	
(Me Tri ward) Phan Vu Tuong Linh / Official of Me Tri ward People's Committee Nguyen Huu Quyet / Chairman of Fatherland Front of Me Tri ward Ngo Thi Mai Anh / Vice Chairwoman of Women Union of Me Tri ward (JICA Study team) Mr. Tran Thanh Than/ Local Consultant on Socio-economic Evaluation	
3. Date/ Time:	May 31, 2016 10:00–11:15
4. Agenda:	1) Introduction on project details 2) Discussion on the project content 3) Opinions on environmental and social impacts
5. Main opinions from Me Tri ward:	

Opinions from Me Tri ward people's committee:

People's Committee of Me Tri ward agreed with analysis of environmental and social impacts to Me Tri ward by the study team and totally agreed with the proposal of BRT project which may run through the ward.

The committee suggested establishing a depot at the area intended for construction of offices of central department and agencies, where is opposite Vietnam National Convention Center. The suggested area would have high demand for transportation in the future.

The committee requested that the project proponent would conduct essential mitigation measures to minimize negative impacts to current traffic and livelihood of people in Me Tri ward. Contractors must recover timely road surfaces and infrastructure without degradation of the quality after construction of project facilities.

If land acquisition would be implemented in the ward area, compensation price should be proposed appropriately.

Opinions from Fatherland front of Me Tri ward:

Fatherland front of Me Tri ward also agreed with the proposal of the BRT project which may pass through the ward. The organization had studied thoroughly the project document on analysis of environmental and social impacts and found that positive and negative impacts to Me Tri ward had been evaluated adequately and properly.

The organization requested that the project proponent would apply proposed mitigation measures to minimize negative environmental and social impacts to the ward and support and cooperate with the ward to protect environment, sanitation conditions, and to guarantee security at bus stops and depot (if any).

Opinions from Women union of Me Tri ward:

Women union of Me Tri ward agreed with the proposal of the BRT project passing through the ward. The union also agreed with analysis of environmental and social impacts from the project activities by the study team.

The union requested that the project proponent would support to affected people in getting job, especially for vulnerable and special people, including elders, women, children, disabled persons, poor people, and lonely old women.

The project proponent and Hanoi city should conduct propagation and communication to young

people and teenagers on preventing social evils. Education, vocation training, and assisting in job searching toward low-level educated people in the ward would be considered.

END

Images of consultation meeting with Me Tri ward
(May 31, 2016)

Picture 1: Intruduction of the BRT project to representatives of Me Tri ward

Picture 2: Discussion on the project and its environmental and social impacts.

MEMORANDUM OF DISCUSSION
FOR
DATA COLLECTION SURVEY ON BRT IN HANOI

1. Subject:	Consultation on the project and its environmental and social impacts
2. Venue:	Headquarter of Thach Hoa commune (Thach That district, Hanoi city)
3. Date/Time for survey	May 27, 2016, 14:00–15:25
4. Prepared by	Tran Thanh Than
5. Date of Preparation	May 27, 2016

:

MEMORANDUM OF DISCUSSION

Date of Preparation: 2016/05/27

1. Name of Organization:	Thach Hoa commune (Thach That district, Hanoi city)
2. Name of Attendants:	
(Thach Hoa commune) Nguyen Van Tha/ Chairman of Thach Hoa commune People's Committee Tong Quang Thuy/ Vice Chairman of Thach Hoa commune People's Committee Nguyen Van Hung/ Vice Chairman of Thach Hoa commune People's Committee Nguyen Duc Hanh/ Chairman of Fatherland Front of Thach Hoa commune Nguyen Thi Nhan/ Chairwoman of Women Union of Thach Hoa commune Nguyen Van Dung/ Official of Thach Hoa commune People's Committee (JICA Study team) Mr. Bui Xuan Tung/ Expert of Environmental and Social Considerations Mr. Tran Thanh Than/ Local Consultant on Socio-economic Evaluation	
3. Date/ Time:	May 27, 2016 14:00–15:25
4. Agenda:	1) Introduction on project details 2) Discussion on the project content 3) Opinions on environmental and social impacts
5. Main opinions from Thach Hoa commune:	

Opinions from Thach Hoa commune people's committee:

People's Committee of Thach Hoa commune totally agreed with the proposal of BRT project which may run through the commune. The committee requested that the project shall be implemented in accordance with Vietnamese laws and regulations.

The committee suggested establishing a depot area next to Viettel sport center area, which is opposite Hanoi National University on Thang Long expressway. The selection of BRT route, construction of auxiliary facilities, and selection of bus vehicles would be considered carefully so that traffic congestion and traffic accident would be avoided and minimized and criminals and disorders would be limited.

The committee requested that the project would implement proposed environmental mitigation measures to prevent pollution. Environmental protection of soil, water, air, conservation of trees and plants, and waste collection in both construction and operation stages would be conducted properly in accordance with EIA report.

Once the BRT would be operated, connection between Thach Hoa and the surrounding areas with Hanoi city would be significantly enhanced. Beside positive impacts, the BRT would bring adverse effects to the commune, such as traffic safety, criminals, disorders, and social evils. The committee requested that the design and operation of the BRT route and a higher level of government would take care of above mentioned issues and support and cooperate with the commune to ensure social security, especially for bus stops. Security cameras could be installed at bus stops to enhance the safety of passengers and minimize criminals.

Regarding land acquisition, if the depot area would be established in the commune, negative impacts from the land acquisition would be not very large, because the area for land acquisition would be small (less than 2 ha). The committee requested that the project would follow Vietnamese laws, regulations and procedures with regards to land acquisition, compensation, and support. In addition, the project owner should negotiate directly with affected people and reach an agreement on compensation price and support to the people. Beside compensation and initial support for affected

people, the project owner should keep supporting in getting job and enhancing living standard of the affected people after the project would be operated.

Opinions from Fatherland front of Thach Hoa commune:

Fatherland front of Thach Hoa commune also agreed with the proposal of the BRT project which may pass through the commune. The organization requested that design and construction of bus stops should account for convenience and usability of passengers. For example, bus stops should be established in places where the demand would be highest and design of bus stops and bus vehicles would facilitate getting in and out for elders, women, children and disabled persons.

The organization also requested that higher level governments would cooperate and support the commune to ensure social security and traffic safety once the project would be operated.

During land acquisition, construction of facilities, and depot (if any), the project owner and contractors must implement mitigation measures to prevent from pollution of soil, water, air, and noise and to prevent sedimentation which might severely influence to drainage and irrigated channels in the commune area.

Regarding land acquisition and compensation for agricultural land (if any), the project owner and Hanoi city should propose and adopt a compensation plan which would compensate and bring highest benefits to affected people. If service land would be provided for affected people as compensation, service land should have suitable location and adequate infrastructure to facilitate production, business, and life of people.

Opinions from Women union of Thach Hoa commune:

Women union of Thach Hoa commune realized that the BRT project would bring positive environmental and social impacts, which would be higher than negative impacts. Women union agreed with the proposal of the BRT project.

The union requested that the project owner and Hanoi city would support the commune in training, vocational training and getting job for affected women. Special care and support must be paid on women whose working age is ending. Lonely and disabled people in family whose land would be acquired should be supported adequately as well.

It is noted that most of women in the commune are working in agricultural field and not well educated. Once land is acquired, middle-age women would meet a lot of difficulties to get job, because they are too old to be vocationally trained and worked in a factory. Most of middle-age women would join for cleaning in companies or freelance jobs.

Although young women can be vocationally trained and worked for factories and companies in the area, the project owner would have policies to give a priority to affected women in recruitment. Recruitment of affected people/women for unskilled or low-skilled jobs, such as waitress, sanitation, and other side jobs in bus stops, depot would be considered.

END

Images of consultation meeting with Thach Hoa commune
(May 27, 2016)

Picture 1: Comments and opinions from Mr. Tong Quang Thuy (Vice Chairman of Thach Hoa commune People's Committee)

Picture 2: Discussion on the project content and its environmental and social impact

Appendix C: Attendant Lists for Consultation Meetings with the Hanoi EPA, Hoa Lac High Tech Park, Lieu Giai Ward, Me Tri Ward, and Thach Hoa Commune in May, 2016

DANH SÁCH CÁN BỘ TRẢ LỜI NỘI DUNG
THAM VẤN TÁC ĐỘNG MÔI TRƯỜNG, XÃ HỘI CỦA DỰ ÁN BRT

List of participants for Consultation on environmental and socio-economic impacts of the BRT project

Nội dung: ....Tham vấn ý kiến của Sở Bảo vệ môi trường Hà Nội.....

Content: .consultation meeting with representatives of Hanoi Environment

Địa điểm: Tầng 9, Cung Trí Thức 22 Tôn Thất Thuyết, Protection Agency....

Address: .9th floor, Cung Tri Thuc Tower, 22 Ton That Thuyet Street, Cau Giay, Ha

Thời gian: ..14h.20'.....16h.45'.....ngày 17/5/2016.....

Time: 14h20.....16h45'.....May 17, 2016.....

Danh sách tham dự

List of participants

No.	Họ và Tên Name	Chức vụ Possition	Liên hệ Contact	Chữ ký Signature
1	Tạ Ngọc Sơn	P. Trưởng phòng QLDA và TT CC BV MT	0982685858	
2	Lý. T. T. T. Nhung	P. T.P. Thẩm định và ĐM	0913977668	
3	Trần Thanh Thản	Dự án BRT Hà Nội	0911541869	
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DANH SÁCH THAM DỰ CUỘC HỌP
THAM VẤN TÁC ĐỘNG MÔI TRƯỜNG, XÃ HỘI CỦA DỰ ÁN BRT

List of participants for Consultation on environmental and socio-economic impacts of the BRT project

Nội dung: Tham vấn Khu Công nghệ cao Hòa Lạc
Content: Consultation meeting with delegates of Hoa Lac Hi-Tech Park
Địa điểm: Khu Công nghệ cao Hòa Lạc, huyện Thạch Thất, Hà Nội
Address: Office of Hoa Lac Hi-Tech Park, Km29, Thang Long Expressway, Thach That district Ha Noi city
Thời gian: 09h30 – 11h10 ngày 27/5/2016
Time: May 27, 2016 from 09h30 to 11h10

Danh sách tham dự
List of participants

No.	Họ và Tên Name	Chức vụ Possition	Liên hệ Contact	Chữ ký Signature
1	Kim Cương Nam	CV Ban QLDA XD KT	0903698666	
2	Lê Thị Mai Dung	Phó Chủ tịch Công đoàn Cơ sở kiêm Trưởng phòng Phòng CNC HL	0979182479	
3	Bùi Xuân Tùng	Chuyên gia Môi trường & Xã hội	0984135336	
4	Trần Thanh Thản	Chuyên gia dự án BRT Hà Nội	0912541969	
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DANH SÁCH THAM DỰ CUỘC HỌP
THAM VẤN TÁC ĐỘNG MÔI TRƯỜNG, XÃ HỘI CỦA DỰ ÁN BRT

List of participants for Consultation on environmental and socio-economic impacts of the BRT project

Nội dung: Tham vấn đại diện các cơ quan, đoàn thể phường Liễu Giai, Ba Đình Hà Nội
Content: Consultation meeting with representatives of community and administrative
Địa điểm: Số 22 Hoàng Cao, Ba Đình, thành phố Hà Nội ..... *institutions of Lieu Giai ward*
Address: No 22 Hoang Cao street, Ba Dinh district, Hanoi city
Thời gian: ..14h30'..15h45'.....ngày..16..tháng..5,...năm..2016
Time: ...14h30'...15h45'.....May...16,...2016

Danh sách tham dự
List of participants

No.	Họ và Tên Name	Chức vụ Possition	Liên hệ Contact	Chữ ký Signature
1	Nguyễn Ngọc Tân	Bí thư Đảng - CT UBND Phường	0904112772	
2	Nguyễn Hải Hà	Phó chủ tịch UBND Phường	0983873369	
3	Bành Thị Nhung	ĐUV - CT HĐ LHPN Phường	0904000659	
4	Trần Văn Sức	UV TVTV - Chủ tịch HĐ MTTQ	0948986969	
5	Trần Thanh Thản	Dự án BRT Hà Nội	0912548869	
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DANH SÁCH CÁN BỘ TRẢ LỜI
THAM VẤN TÁC ĐỘNG MÔI TRƯỜNG, XÃ HỘI CỦA DỰ ÁN BRT

List of Delegates for Consultation on environmental and socio-economic impacts of the BRT project

Nội dung: Tham vấn tác động môi trường, xã hội từ dự án BRT với phường Mễ Trì

Content: Consultation on environmental and socio-economic impacts of the BRT project with Me Tri ward

Địa điểm: Trụ sở Ủy ban Nhân dân, Ủy ban Mặt trận Tổ quốc và Hội Liên hiệp Phụ nữ phường Mễ Trì, quận Nam Từ Liêm, thành phố Hà Nội

Address: Office of People's Committee of Me Tri ward, Vietnam Fatherland Front of Me Tri ward, and Vietnam Women Union of Me Tri ward

Thời gian: ...10h00 - 11h15 ngày 31/5/2016.....

Time: .....May 31, 2016 from 10h00 to 11h15.....

Danh sách tham dự

List of participants

No.	Họ và Tên Name	Chức vụ Possition	Liên hệ Contact	Chữ ký Signature
1	Phan Vũ Tường Linh	Cán bộ địa chính - xây dựng	0982266688	
2	Nguyễn Hữu Quyết	CT UBMTTQ phường	0912060082	
3	Ngô Thị Mai Anh	phó chủ tịch Hội phụ nữ	0975677928	
4				
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6				

DANH SÁCH THAM DỰ CUỘC HỌP
THAM VẤN TÁC ĐỘNG MÔI TRƯỜNG, XÃ HỘI CỦA DỰ ÁN BRT

List of participants for Consultation on environmental and socio-economic impacts of the BRT project

Nội dung: Tham vấn xã Thạch Hòa, huyện Thạch Thất, Hà Nội
Content: Consultation meeting with delegates of Thach Hoa commune
Địa điểm: Xóm 6, xã Thạch Hòa, huyện Thạch Thất, Hà Nội
Address: Hamlet 6, Thach Hoa commune, Thach That district, Hanoi City
Thời gian: 14h.00' - 15h.25' ngày 27/5/2016
Time: May 27, 2016, from 14h.00' to 15h.25'

Danh sách tham dự
List of participants

No.	Họ và Tên Name	Chức vụ Possition	Liên hệ Contact	Chữ ký Signature
1	Tống Quang Thủy	phó CT UBND xã	0973168168	
2	Nguyễn Đức Kạnh	CT. MTTQ xã	01639027888	
3	Nguyễn Thị Nhàn	CT. Hội LHPN xã	0987212246	
4	Nguyễn Văn Dũng	Văn phòng UBND	0982683484	
5	Nguyễn Văn Thá	Chủ tịch UBND	0989291973	Thá
6	Nguyễn Văn Hùng	phó CT UBND xã	0966538598	Hùng
7	Bùi Xuân Tùng	Chuyên gia môi trường xã hội	0984935336	
8	Trần Thanh Thản	Dự án BRT Hà Nội	0912548969	
9				