

Study and Detailed Design of Phahon Yothin Center as a Transit-oriented Development Model Project



Office of Transport
and Traffic Policy and Planning

Executive Summary Report



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EXECUTIVE SUMMARY REPORT

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EXECUTIVE SUMMARY REPORT

1. INTRODUCTION

1.1 Project Background

On 6 February 2007, the Cabinet had resolved to acknowledge the results of public consultation to obtain comments, suggestions and requirements from the general public, and to approve the policy and implementation plan for Mass Rapid Transit Systems in Bangkok Metropolitan Region whereby two intermodal transport centers will be developed, namely Phahon Yothin Center (in Bang Sue) and Makkasan Center (in Makkasan). The two centers will provide interconnectivity between Bangkok and its vicinity and satellite towns by community train system. With shared use of railway tracks, long-distance trains from regional cities will link with mass rapid transit systems operating in Bangkok Metropolitan, resulting in travel convenience for commuters. On 16 October 2007, the Cabinet assigned the State Railway of Thailand (SRT) to implement the Mass Transit System Project in Bangkok (Red Line), Bang Sue-Rangsit Section, including Bang Sue Grand Station, with additional requirement for interconnection and integration of all rail routes and networks.

The Ministry of Transport assigned the Office of Transport and Traffic Policy and Planning (OTP) to carry out a study and preliminary design for the development of intermodal transport system at Phahon Yothin Center. This is aimed to support the development of 10 routes of mass rapid transit systems in accordance with the Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP). Bang Sue Grand Station, now under construction, will become a key intermodal transfer facility. Its construction is expected to be completed in 2018. The Grand Station, when completed, will provide travel convenience and promote modal shift to public transport, leading to greater efficiency in the development of mass rapid transit services.

1.2 Project Objectives

1) To carry out a study and detailed design for the development of intermodal linkage system between mass rapid transit (MRT) stations in Phahon Yothin Center so that the project construction can be undertaken and it can serve as a transit-oriented development model;

2) To carry out a study and detailed design of suitable feeder systems including Environmental Impact Assessment (EIA) so that feeder systems can be implemented to support passengers using major mass rapid transit systems and facilitate intermodal interconnections within Phahon Yothin Center; and

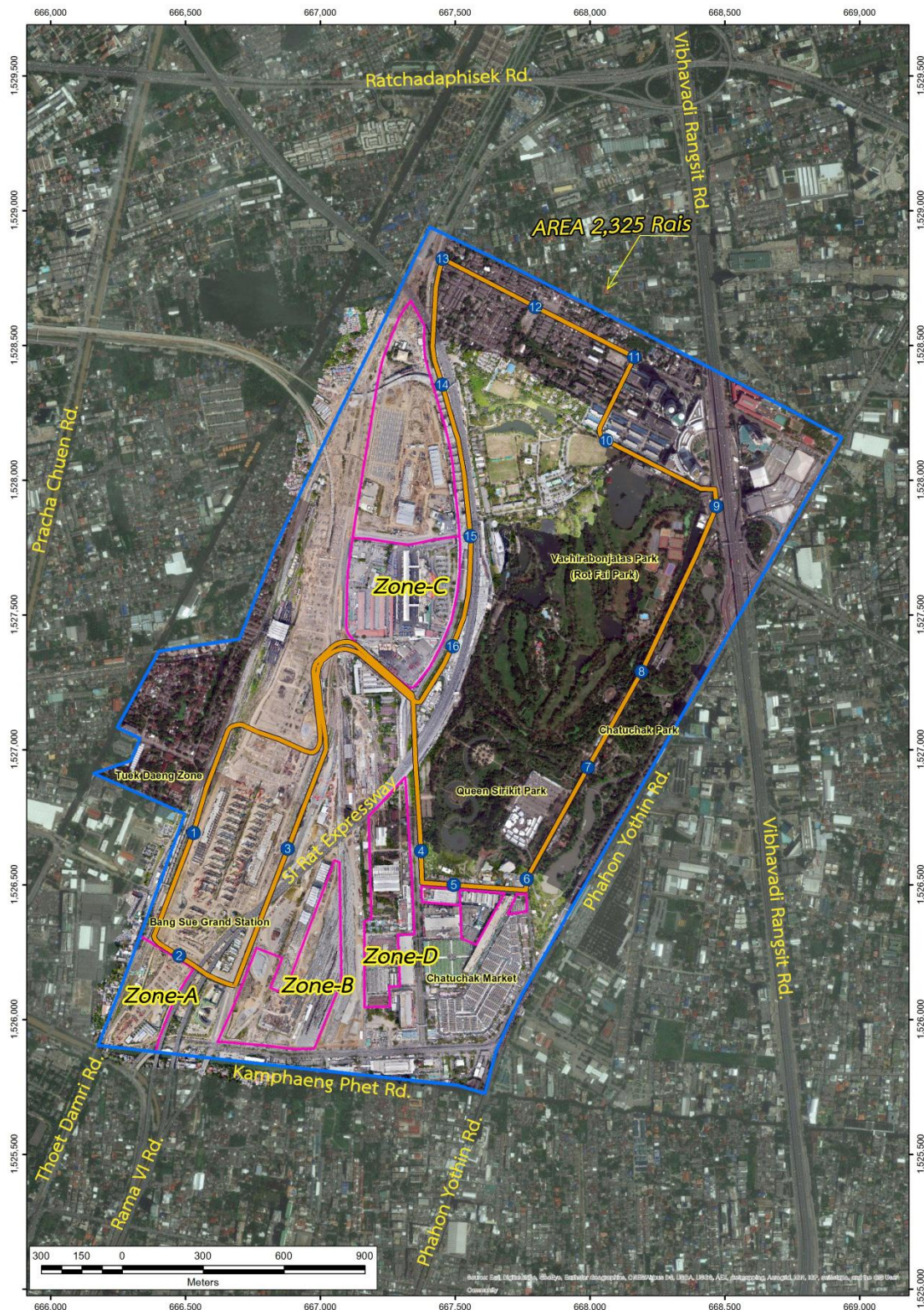
3) To study traffic management system in support of the development of Phahon Yothin Center.

1.3 Study Area

The study area of Phahon Yothin Center Project covers 2,325 rai, as described below.

- | | |
|--------|--|
| North: | It is bound by public ditch connecting Vibhavadi Rangsit Road and Kamphaeng Phet 2 Road, with mixed-use residential and commercial areas on the north of the public ditch; |
| South: | It is bordered by Khlong Bang Sue, which receives surface runoff from 3 main roads, i.e. Vibhavadi Rangsit Road, Phahon Yothin Road and Ratchadaphisek Road. Khlong Bang Sue connects to the east bank of the Chao Phraya River and meets with Khlong Lat Phrao. |
| East: | It is bound by Phahon Yothin Road and opposite the BTS building and depot of Bangkok Mass Transit System Public Company Limited. |
| West: | It is bordered by Thoet Damri Road and opposite the SCG office and Tuek Daeng Zone. |

The project study area is depicted in **Figure 1-1**.



Source: The Consultants, 2015

Figure 1-1: Study Area of Phahon Yothin Center Project

2. REVIEW OF PHAHON YOTHIN CENTER-RELATED POLICIES AND DEVELOPMENT PLANS

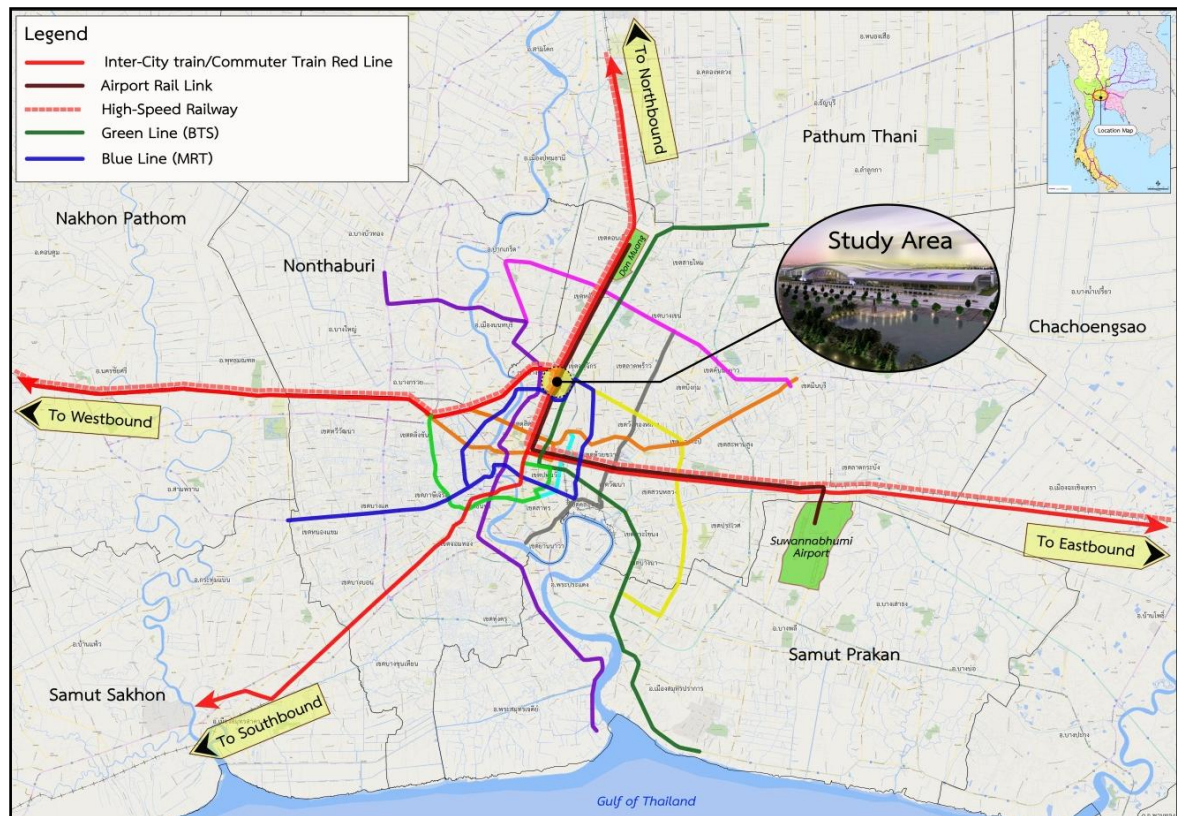
The Phahon Yothin Center is a large land area of the State Railway of Thailand, with the Bang Sue Grand Station to serve as the country's new transport hub of rail-based mass transit systems, including long-distance trains, commuter trains, Airport Rail Link, and high-speed trains.

2.1 Rail-Based Transport Network around Phahon Yothin Center

1) In the project area, there are totally five rail-based mass transit projects—currently completed and operational, and under construction. They are MRT Blue Line, BTS Green Line, MRT Purple Line, SRT Red Line, and SRT's Airport Rail Link.

(2) Bang Sue Grand Station will replace the existing Hua Lamphong Station to accommodate the rail-based transport system, including inter-city trains, Red Line commuter trains, high-speed railway, and Airport Rail Link.

Figure 2-1 and **Table 2-1** present the rail-based transport network linking to the study area.



Source: The Consultants, 2016

Figure 2-1: Complete Network of Mass Rapid Transit Systems
 Linking to the Study Area

Table 2-1: List of Mass Rapid Transit Projects Linking to the Study Area

No.	Route	Section	Opening Year	Note
1	Dark Red Line (SRT, OTP)	Rangsit-Thammasat	2018	Pending Consideration
		Bang Sue-Rangsit	2018	Under Construction
		Bang Sue-Hua Lamphong	2020	Pending Cabinet Approval
		Hua Lamphong-Bang Bon	2019	M-Map
		Bang Bon-Maha Chai	2029	M-Map
		Thammasat-Phachi Junction	2032	-
		Maha Chai-Pak Tho	2032	-
2	Light Red Line (SRT, OTP)	Bang Sue-Phaya Thai-Makkasan	2020	Pending Cabinet Approval
		Makkasan-Hua Mak	2020	Pending Cabinet Approval
		Taling Chan-Bang Sue	2018	Construction Completed, Pending Train Configuration
		Taling Chan-Salaya	2021	Pending Consideration
		Bang Bamru-Makkasan	2029	M-Map
		Siriraj-Taling Chan	2021	Pending Consideration
		Chachoengsao-Makkasan	2032	-
3	Airport Rail Link (SRT, OTP)	Phaya Thai-Makkasan-Suvarnabhumi	Currently Operational	In Operation
		Don Muang-Bang Sue	N/A	Pending Consideration
		Bang Sue-Phaya Thai	2022	Submitted to the Cabinet
4	Dark Green Line (MRTA, OTP)	Mo Chit-On Nut	Currently Operational	In Operation
		Mo Chit-Saphan Mai	2020	Under Construction
		Saphan Mai-Khu Khot	2020	Under Construction
		Khu Khot-Lam Luk Ka	2021	Design Revision, Pending Submission to the Cabinet
		On Nut-Bearing	Currently Operational	In Operation
		Bearing-Samut Prakan	2020	Under Construction
		Samut Prakan-Bang Pu	2021	Design Revision, Pending Submission to the Cabinet
5	Light Green Line (BMA, OTP)	National Stadium-Saphan Taksin	Currently Operational	In Operation
		Saphan Taksin-Thanon Taksin	Currently Operational	In Operation
		Thanon Taksin-Bang Wa	Currently Operational	In Operation
		Bang Wa-Taling Chan	2021	Pending Consideration
		National Stadium-Yot Se	2019	M-Map
6	Blue Line (MRTA)	Bang Sue-Hua Lamphong	Currently Operational	In Operation
		Bang Sue-Tha Phra	2020	Under Construction
		Hua Lamphong-Bang Khae	2020	Under Construction
		Bang Khae-Phutthamonthon Sai 4	2021	Pending Submission to the Cabinet
7	Purple Line (MRTA)	Bang Yai-Bang Sue	Currently Operational	In Operation
		Bang Sue-Rat Burana	2022	Pending Submission to the Cabinet
8	Orange Line (MRTA, OTP)	Taling Chan-Thailand Cultural Center	2023	Pending Consideration
		Thailand Cultural Center-Bang Kapi	2022	Approved by the Cabinet, Pending Bidding Process
		Bang Kapi-Min Buri	2022	Approved by the Cabinet, Pending Bidding Process
9	Pink Line (MRTA, OTP)	Khae Rai-Pak Kret	2020	Approved by the Cabinet, Pending Bidding Process
		Pak Kret-Lak Si Circle	2020	Approved by the Cabinet, Pending Bidding Process
		Lak Si Circle-East Outer Ring Road	2020	Approved by the Cabinet, Pending Bidding Process
		East Outer Ring Road-Min Buri	2020	Approved by the Cabinet, Pending Bidding Process
10	Yellow Line (MRTA, OTP)	Lat Phrao-Phatthanakan	2020	Approved by the Cabinet, Pending Bidding Process
		Phatthanakan-Samrong	2020	Approved by the Cabinet, Pending Bidding Process
11	Grey Line (BMA, OTP)	Watcharaphon-Thong Lo	2019	Pending EIA Consideration
		Thong Lo-Tha Phra	2029	-
12	Light Blue Line (BMA, OTP)	Din Daeng-Sathon	2029	M-Map
13	Gold Line (BMA)	Thon Buri-Khlong San	2020	Pending Consideration

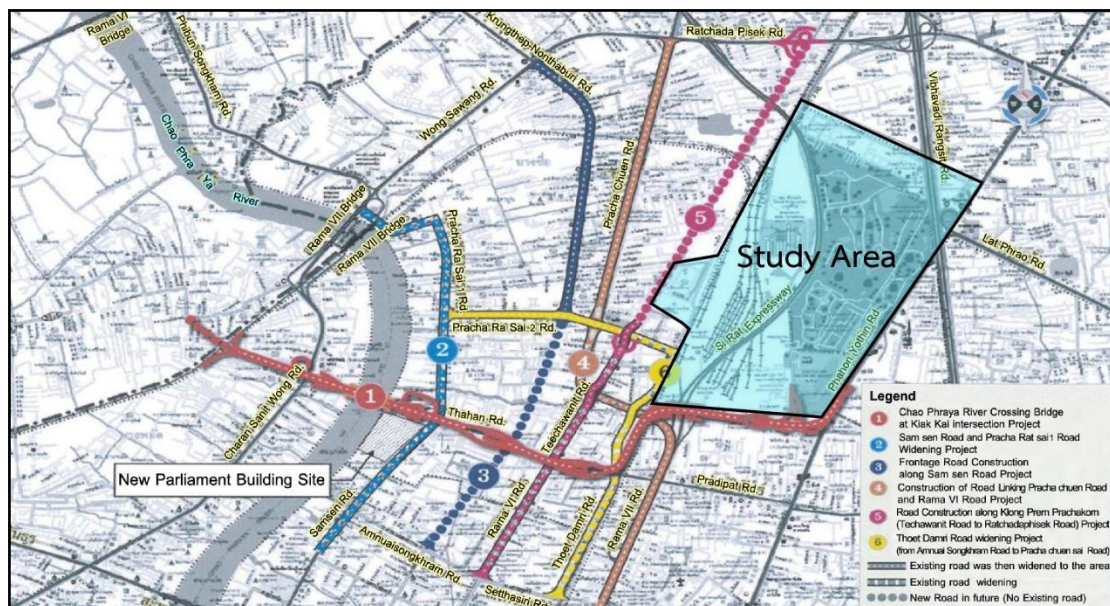
Source: The Consultants, 2016

2.2 Road and Expressway Networks around Phahon Yothin Center

Presently, the existing expressways around Phahon Yothin Center comprise Uttaraphimuk Elevated Tollway or Don Muang Tollway, Si Rat Expressway, and Si Rat–Outer Ring Road Expressway. The arterial roads around the project area are Vibhavadi Rangsit Road, Phahon Yothin Road, Ratchadaphisek Road, and Lat Phrao Road whereas the collector roads are Kamphaeng Phet Road, Rama VI Road, Thoet Damri Road, Kamphaeng Phet 5 Road, Pracha Rat Sai 2 Road, Pracha Chuen Road, and Kamphaeng Phet 6 Road. Local roads include Kamphaeng Phet 2 Road, Kamphaeng Phet 3 Road, and Kamphaeng Phet 4 Road.

1) Roads and Bridges under Planning and Construction

There are 6 public-sector road and bridge projects related to the Phahon Yothin Center: (1) Chao Phraya River Crossing Bridge at Kiak Kai Intersection (Kiak Kai Bridge) Project, 2) Sam Sen Road and Pracha Rat Sai 1 Road Widening Project, (3) Frontage Road Construction along Sam Sen Road Project, (4) Construction of Road Linking Pracha Chuen Road and Rama VI Road Project, (5) Road Construction along Khlong Prem Prachakon (from Techawanit Road to Ratchadaphisek Road) Project, and (6) Thoet Damri Road Widening Project (from Amnuai Songkhram Road to Pracha Rat Sai 2 Road) as depicted in **Figure 2-2**.



Source: Government Road Expansion Projects

Figure 2-2: Road and Bridge Projects with Positive Impacts on the Study Area

2) Expressways

The expressway projects in operation are as follows:

Uttaraphimuk Elevated Tollway (Don Muang Tollway) Project: The elevated tollway starts from Sam Liam Din Daeng and links to Si Rat Expressway Sector B. It goes north along Vibhavadi Rangsit Road, passing Don Mueang International Airport and the National Memorial to end at Phahon Yothin Road in Rangsit area, with a total length of 28.10 km.

Si Rat Expressway Project: It is included in the Second Stage Expressway System with a total length of 38.4 km, consisting of 4 sectors. *Sector A* starts from Ratchadaphisek Road passing Phaya Thai Interchange (Sam Sen Water Treatment Plant) to end at Rama IX Road. *Sector B linking to Sector A* begins from Phaya Thai Interchange (Sam Sen Water Treatment Plant), passing Si Ayutthaya Road to end in Bang Khlo area. *Sector C linking to Sector A* starts from Ratchadaphisek Road, passing Pracha Chuen Road, heading northward to end at Chaeng Watthana Road. This sector is included in the suburban network. *Sector D linking to Sector A* starts from Rama IX Road and goes eastwards to terminate at Srinagarindra Road. This sector is also included in the suburban network.

Si Rat-Outer Ring Road Expressway Project: This expressway, now in operation, connects between the Western Outer Ring Road (Kanchanaphisek Road) and Bangkok area.

The expressway project under planning is as follows:

DMT-Sirat Missing Link Project: The project will provide linkage between Uttaraphimuk Elevated Tollway (Don Muang Tollway) and Si Rat-Outer Ring Road Expressway with a major aim to alleviate traffic congestion problems in Bangkok area. The link will systematically connect with road and expressway networks, and also complement the transport network in response to the demand for convenient travel, and reduction of traffic congestion and density in urban areas.

2.3 Bus Services around Phahon Yothin Center

There are bus services covering the study area, with a total of 44 bus lines running on Vibhavadi-Rangsit, Lat Phrao, Phahon Yothin, Kamphaeng Phet, Rama VI,

Pracha Rat Sai 2, Siam Cement, and Techawanit roads. A terminal of Bangkok Mass Transit Authority (BMTA), covering 16 rai of land, is located in the midwestern part of the study area and adjacent to the bus terminal of The Transport Co., Ltd. (Mo Chit 2). When the Bang Sue Grand Station becomes operational, BMTA will move its bus terminal to a 9-rai parcel of land under the expressway on the south of the Grand Station, as illustrated in **Figure 2-3**.



Source: The Consultants, 2016

Figure 2-3: 44 BMTA Bus Routes in the Study Area

2.4 Operation Plan of The Transport Co., Ltd.

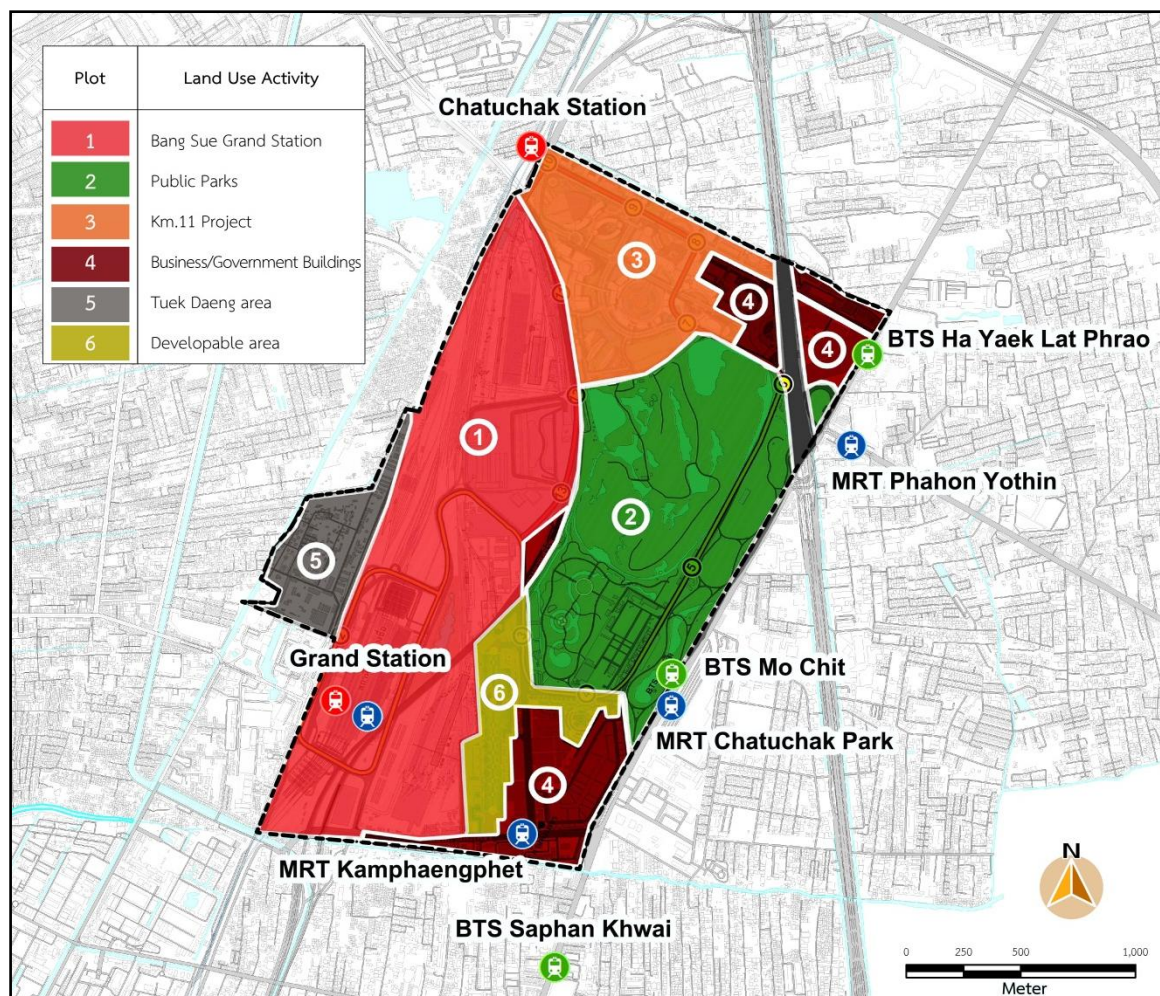
The Transport Co., Ltd., is presently situated in the midwestern part of the study area. It is called Mo Chit 2 bus terminal with an area of about 70 rai, serving about 90,000 passengers/day. The Transport Co., Ltd. will downsize its current terminal in the study area by relocating to the former BMTA bus terminal, with an approximate area of

16.43 rai. It is expected to accommodate approximately 60,000 passengers/day while another 30,000 passengers/day will use its Rangsit bus terminal which is located in 40 rai of land.

3. Land Size and Land Use Ratio

3.1 Study Area

The study area of Phahon Yothin Center Project covers 2,325 rai, consisting of Bang Sue Grand Station (No. 1), public parks (No. 2), the Km. 11 project area (No. 3), business/government buildings (No. 4), Tuek Daeng Zone (No. 5), and Plot 6, with an area of 127.5 rai, designated as commercial development area and intermodal transport hub, as presented in **Figure 3-1** and **Table 3-1**.



Source: State Railway of Thailand (SRT), 2015

Figure 3-1: Study Area of the Project

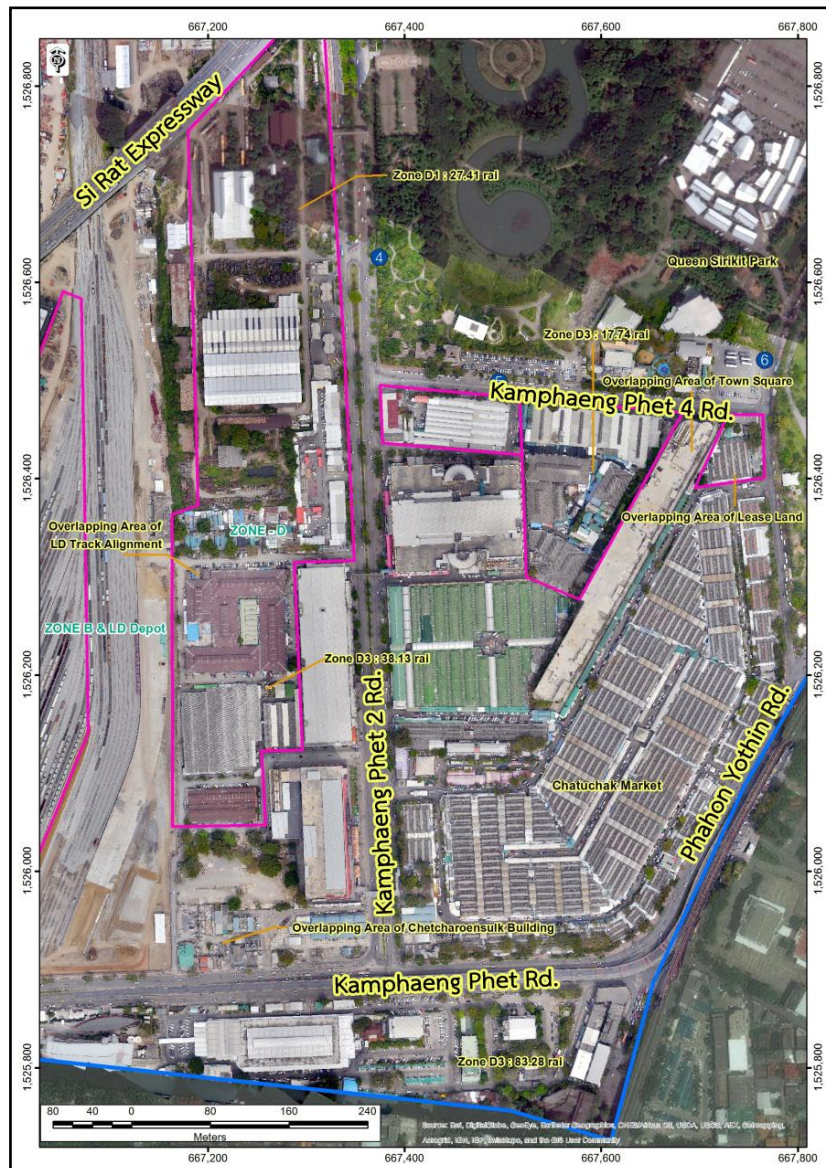
Table 3-1: Land Size and Land Use Ratio

Plot	Land Use Activity	Land Size (rai)	Land Use Ratio (%)
1	Bang Sue Grand Station	795	34
2	Public parks	765	33
3	Km. 11 Project	360	16
4	Business/government buildings	158.5	7
5	Tuek Daeng zone	119	5
6	Developable area	127.5	5
Total Area		2,325	100

Source: State Railway of Thailand (SRT), 2015

3.2 Commercial Development Area and Phahon Yothin Center (Zone D)

In the previous study, the survey results of the project area show that a part of the area is used for the development of the Red Line Project (fence of the construction area is now in place) and some parts are under contractual commitments or obligations, i.e. JJ Siam Development Project (Jet Jaroensuk), and Town Square Project. The developable area is therefore estimated to be only 80 rai, as outlined in pink in **Figure 3-2**.



Source: The Consultants, 2015

Figure 3-2: 80-Rai Reduced Development Area (Zone D)

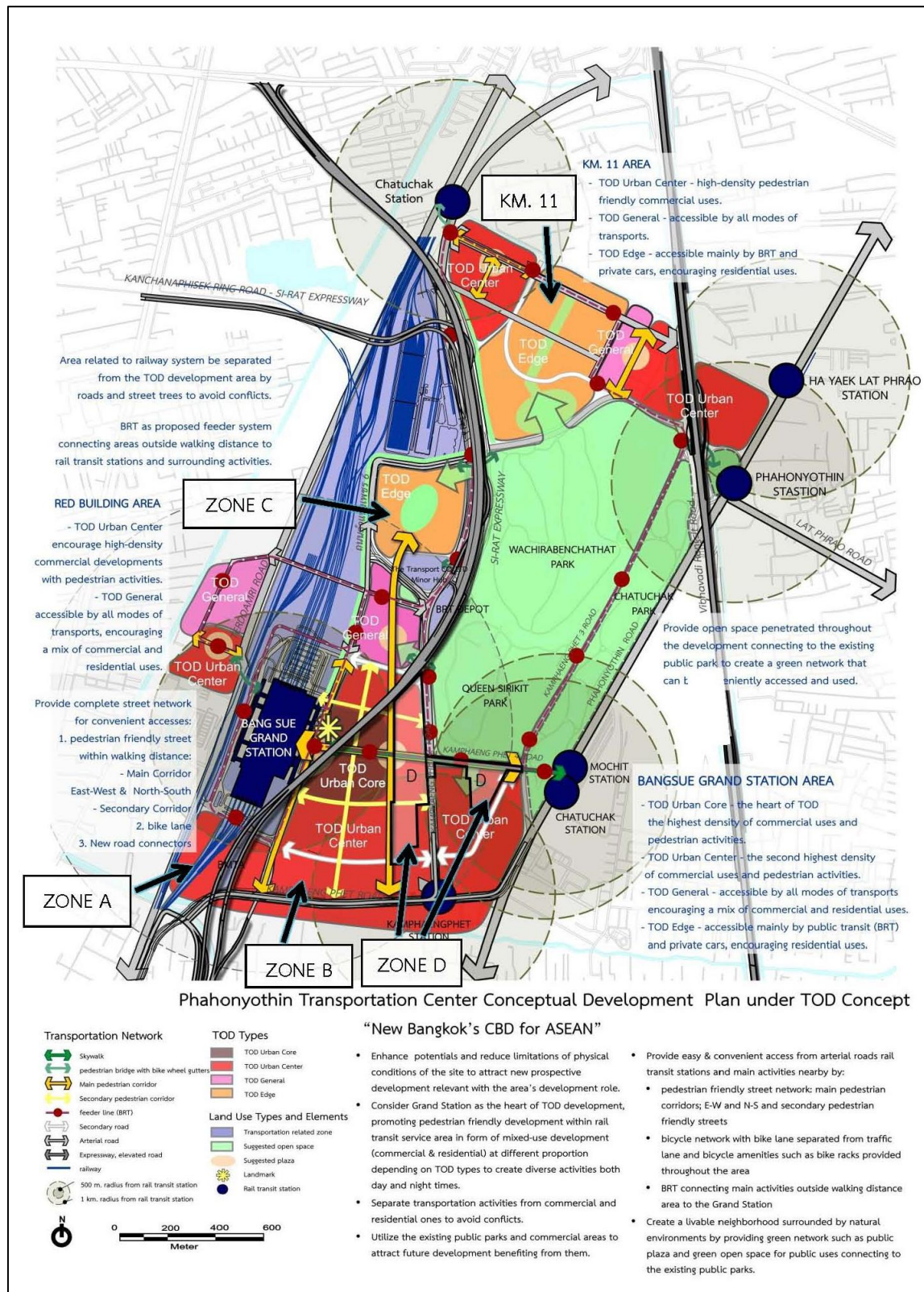
4. PRELIMINARY APPROACH TO PHAHON YOTHIN CENTER DEVELOPMENT

The approach to Phahon Yothin Center Development based on the TOD concept to realize the vision of “New Bangkok’s CBD for ASEAN” encompasses the following.

- Enhance potentials and reduces physical limitations of the site to attract the envisioned development activities

- Bang Sue Grand Station as the focal point of TOD development, promoting pedestrian friendly development within rail transit service area in the form of mixed-use development (commercial & residential) at different proportion depending on TOD types to create diverse activities during both day and night times.
- Provide easy and convenient access from arterial roads, rail transit stations and main activities nearby:
 - Pedestrian friendly street network: E-W and N-S main pedestrian corridors, and secondary pedestrian friendly streets
 - Bicycle network with bike lane separated from traffic lane including bike parking areas and amenities provided throughout the area
 - BRT connecting main activities outside walking distance area to the Grand Station
- Create a livable neighborhood surrounded by natural environments with green network, such as public plaza and green open space for public uses, connecting to the existing public parks.
- Utilize the existing public parks and commercial areas to promote and attract future development
- Separate transportation activities from commercial ones to avoid conflicts.

Figure 4-1 depicts Phahon Yothin Center Development Plan in 2,325 rai of land.



Source: The Consultants, 2016

Figure 4-1: Phahon Yothin Center Development Plan in 2,325 Rai of Land

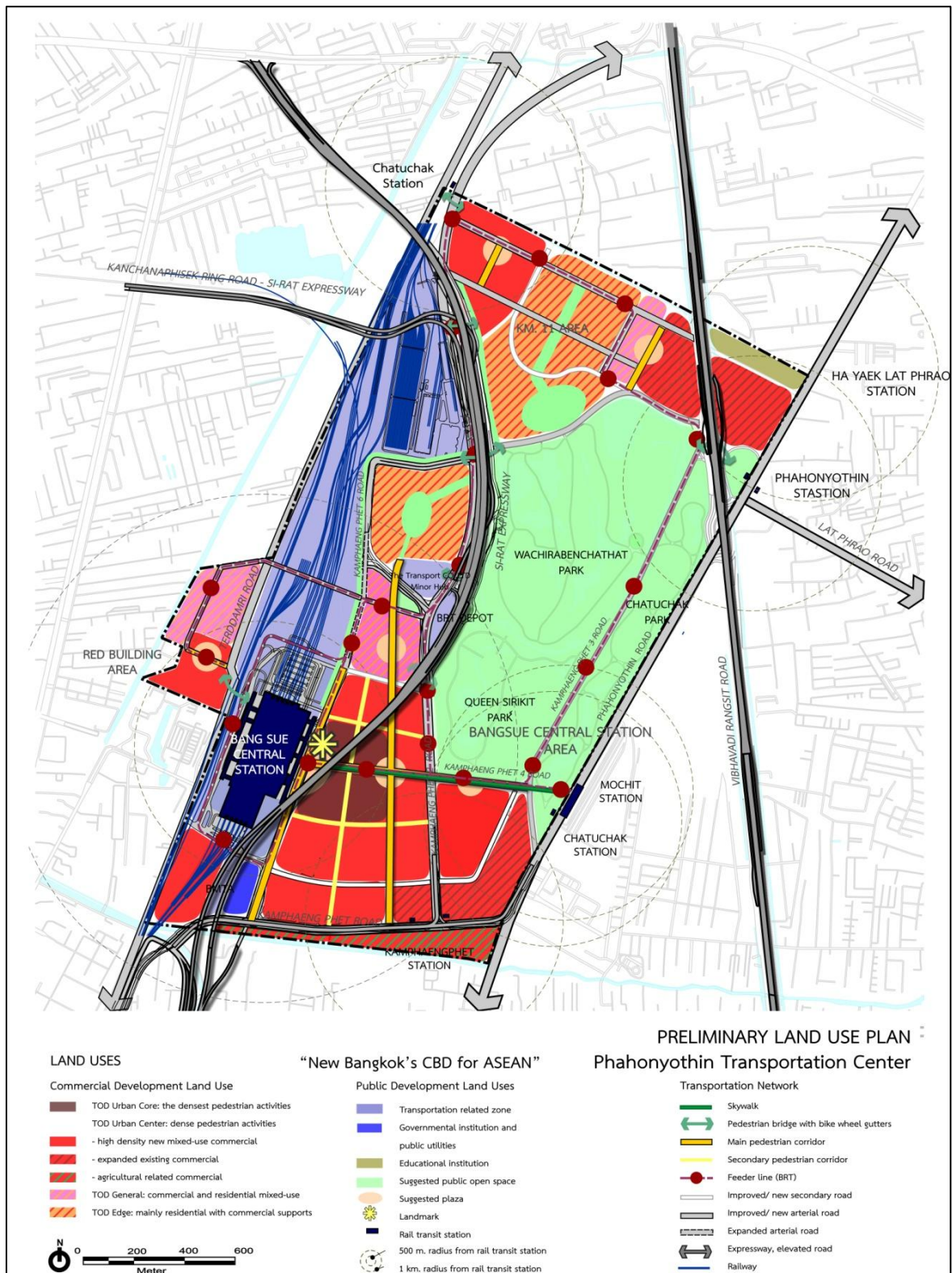
4.1 Land Utilization for Commercial Use

There are 4 major zones as follows:

- (1) TOD Urban Core–Major Activity and Development Center: Use of private cars is discouraged in this zone while access by Bus Rapid Transit (BRT) system is promoted, with highest density of pedestrians and commercial and residential activities (80:20). It is located east of the area, within 500 meters from Bang Sue Grand Station, towards BTS Mo Chit Station and MRT Chatuchak Park Station.
- (2) TOD Urban Core–Mixed use and commercial area development with high density of pedestrians: Emphasis is given to commercial activities rather than housing development (60-70:40-30). This zone can be accessed by every travel mode; however, greater importance is still given to walkways, bike lanes, and BRT system. There are 3 main areas in this zone.
 - Area further from the TOD Urban Core of Bang Sue Grand Station Zone, linking to BTS Mo Chit Station, and MRT Chatuchak Park Station and Kamphaeng Phet Station as well as the area south of the Grand Station;
 - Area within 500 meters from Bang Sue Grand Station and located in Tuek Daeng Zone;
 - Areas within 500 meters from Red Line Chatuchak Station, BTS Extension Line Ha Yaek Lat Phrao Station, and MRT Phahon Yothin Station in the KM. 11 Zone
- (3) TOD General–Located further from TOD Urban Center within 700-100 meters from Bang Sue Grand Station, with lower density of development: Commercial and residential development is in equal proportions (50:50). As a result, there are less pedestrian-oriented activities while emphasis is given to equal access for every travel mode: private cars, bikes, and BRT. This zone consists of 3 main areas.

- Area just next to the TOD Urban Center and north of Bang Sue Grand Station Zone to connect to Bus Terminal of The Transport Co., Ltd.;
 - Area located further from the TOD Urban Center and in Tuek Daeng Zone;
 - Area further from the TOD Urban Center and from BTS Ha Yaek Lat Phrao Station and MRT Phahon Yothin Station in the KM. 11 Zone.
- (4) TOD Edge—This area lies about 1,000 m away from Bang Sue Grand Station. Residential development has higher proportion than commercial activities (70:30), with emphasis on access by private cars and feeder system to achieve interconnectivity with major transit systems in the vicinity and to link with nearby public parks for maximum use.

Figure 4-2 illustrates the proposed land use plan for the project.



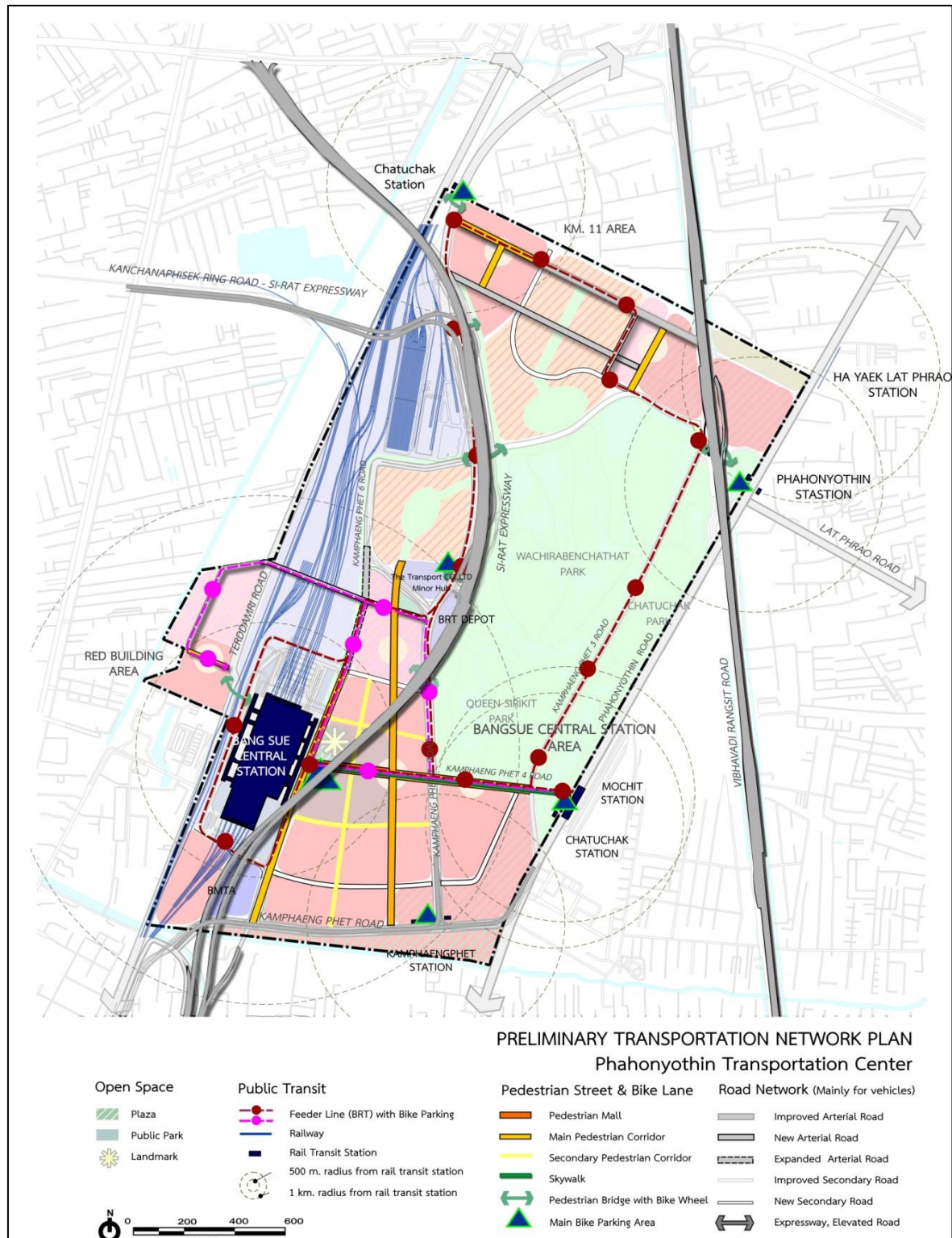
Source: The Consultants, 2016

Figure 4-2: Proposed Land Use Plan for Phahon Yothin Center

4.2 Transport Network

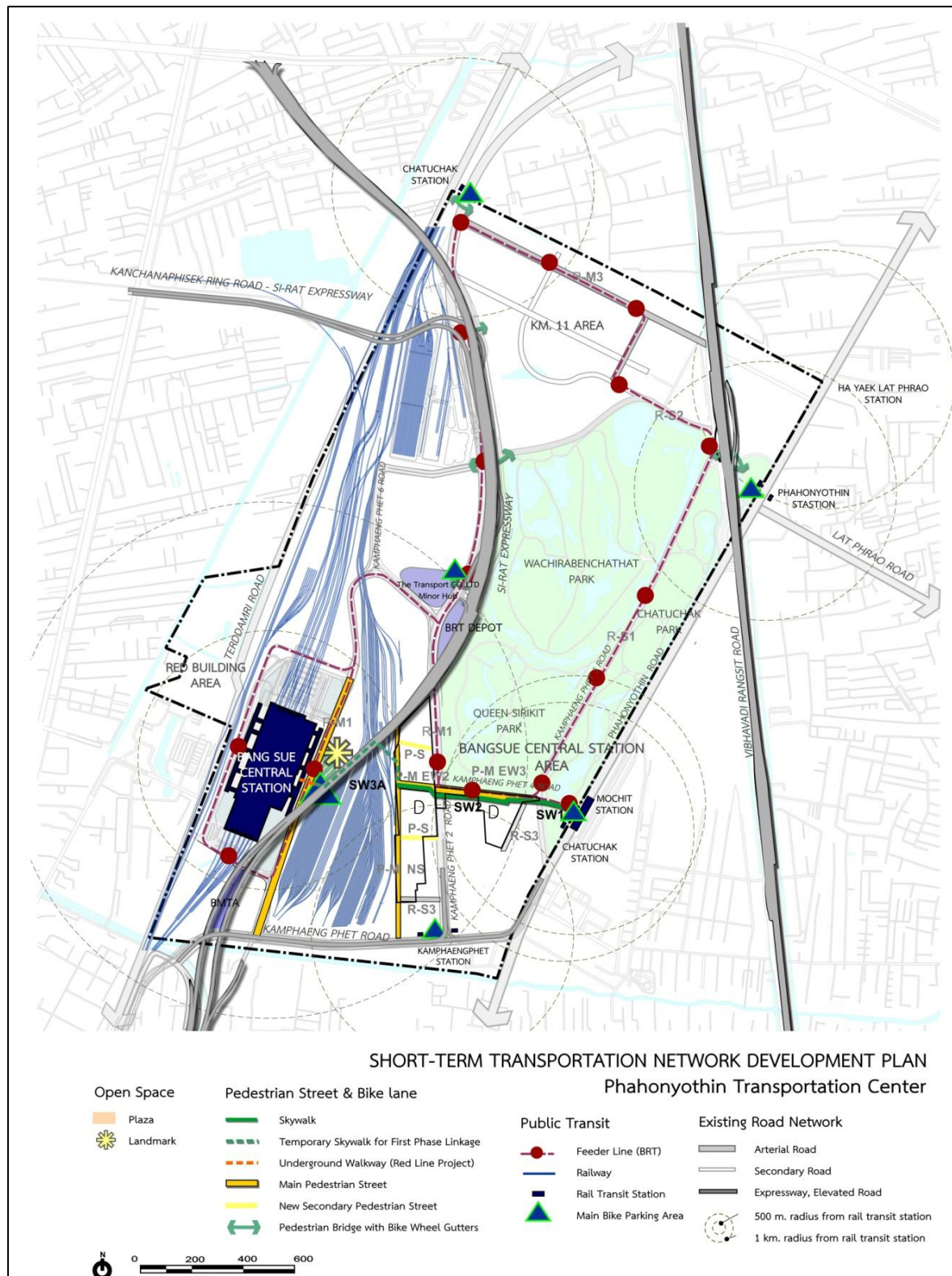
To provide convenient access to Bang Sue Grand Station and its vicinity, transport network interconnection will be developed, particularly in an environmentally friendly and less car-dependent manner. The transport network will consist of the following:

- (1) North-South and East-West pedestrian-oriented road corridors, both at grade walkways and skywalks, in Bang Sue Grand Station Zone, Km. 11 Zone, and Tuek Daeng Zone as well as secondary pedestrian-oriented roads. This is aimed to encourage walking and biking within the walking distance from transit stations. Wide sidewalks and bike lanes will be exclusively provided, creating walking streets with greenery, aesthetic appeal and uniqueness.
- (2) Exclusive bike lanes for every road to facilitate cyclists and promote actual use, with facilities provided, such as bike stairs equipped with wheeling ramps where bike lanes intersect with main roads with high density traffic, bike parking areas of various sizes, e.g. a main bike parking area at every transit station, small bike parking areas at every BRT station. In addition, there are recommended bike parking spaces in privately-developed land spatially located throughout the TOD area.
- (3) BRT system for convenience and linkage between areas beyond walkable distance and main mass rapid transit systems as well as other activities in the vicinity, i.e. Bang Sue Grand Station to connect to BTS Mo Chit Station, MRT Chatuchak Park Station, BTS Extension Line Ha Yaek Lat Phrao Station, and MRT Phahon Yothin Station as well as Km. 11 Zone, Red Line Chatuchak Station and Tuek Daeng Zone.
- (4) Main roads for automobiles: Road improvement will be carried out to accommodate BRT system, bikeways and related facilities. In addition, new roads will be built to provide convenient access to the TOD, as depicted in **Figures 4-3 and 4-4**.



Source: The Consultants, 2016

Figure 4-3: Preliminary Transport Network Plan for Phahon Yothin Center



Source: The Consultants, 2016

Figure 4-4: Transport Network Plan, First Phase

4.3 Open Space Network

To create quality urban environment, open spaces will be provided in various forms to connect to the existing large green area in order to form a large green network that is usable with easy access.

- (1) Open Areas, both public open area, i.e. multipurpose open yard in front of Bang Sue Grand Station, and recommended open plazas in the privately-developed areas;
- (2) Open Green Areas, both the public open green area and the recommended green areas to be integrated in each parcel of privately-developed land. Buffer zones are also designated to separate transit-related areas or main roads from the land development zones, especially housing development zones.

Zone D is located within a TOD Urban Center—an important zone—even though it is not in the TOD Urban Core which is the center of the area development. The TOD Urban Center lies adjacent to the TOD Urban Core and is designated as a mixed-use and high-density commercial and residential zone where various development activities can take place. There are 3 TOD Urban Centers that can have similar development patterns; however, Zone D which is located within Bang Sue Grand Station Zone has greater advantages, compared to the other two urban centers (Km. 11 Zone, and Tuek Daeng Zone). Zone D is within walkable distance of 4 transit stations, namely Bang Sue Grand Station, BTS Mo Chit Station, MRT Chatuchak Station, and MRT Kamphaeng Phet Station. Kamphaeng Phet 2 road is the main road passing right in front of the zone. Moreover, this zone is at the intersection of east-west and north-south walkways where high-density pedestrian traffic will be promoted. Consequently, Zone D has high potential and opportunity for commercial development that will benefit from the high-density pedestrian flow and easy access from transit systems and the existing main road.

5. TRAFFIC STUDY

5.1 Study of Transport Network and Traffic Volume at Phahon Yothin Center and Vicinity

1) Travel Demand Forecast for Each Zone

Travel demand forecast shows the projections for the preliminary opening year of each zone, with details described as follows:

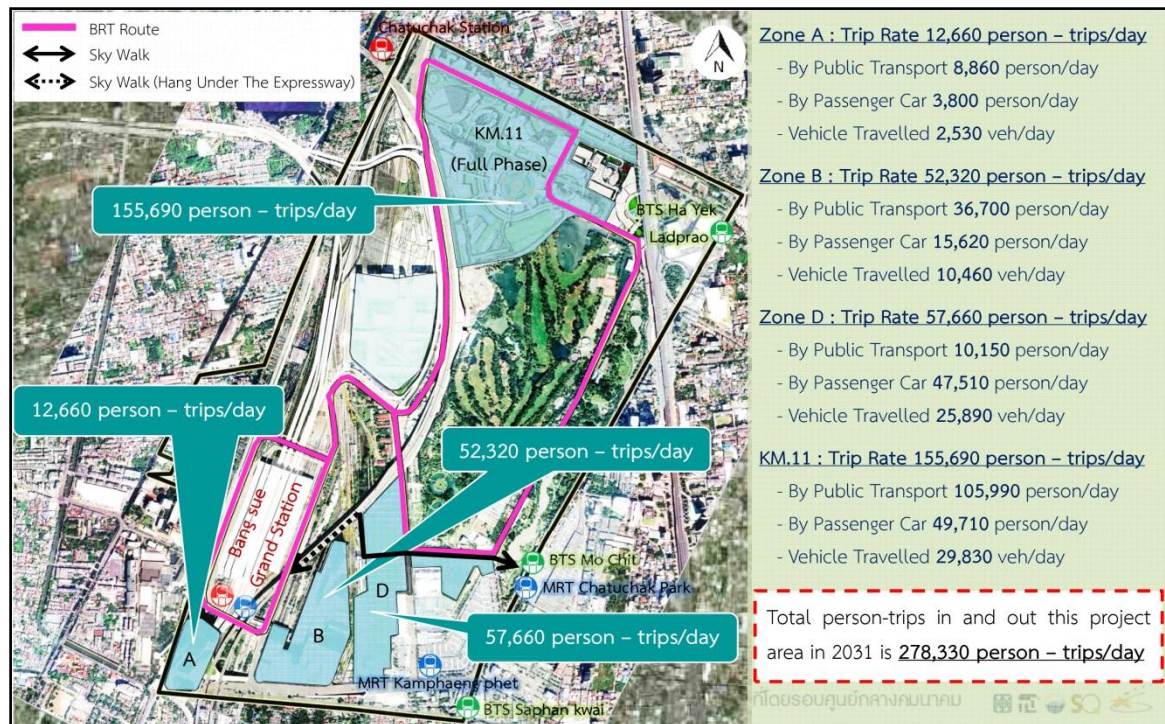
■ In 2022, Opening of Zones A, D and Km. 11 Development Zone, Phases 1 and 2: There will be 8,440 person-trips/day for Zone A, 38,440 person-trips/day for Zone D, and 77,500 person-trips/day for Km. 11 Development Zone, as shown in Figure 5-1.



Source: The Consultants, 2016

Figure 5-1: Travel Demand Forecast Results for Each Zone in 2022

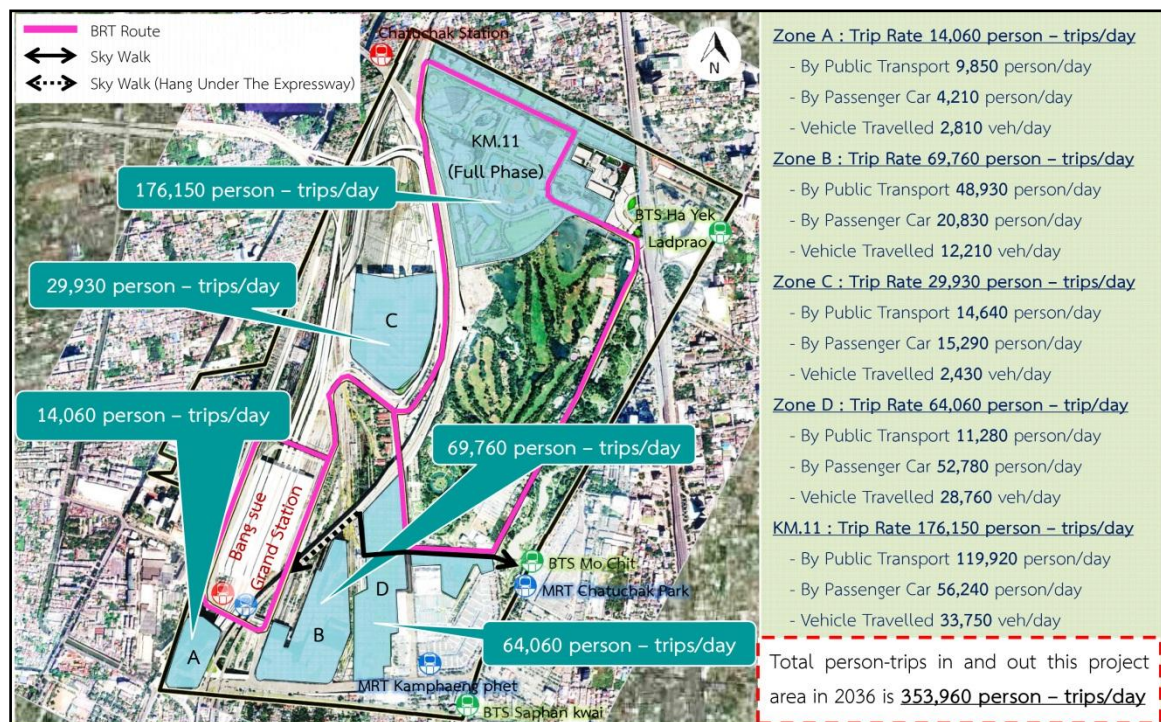
■ In 2032, Opening of Zones A, B, D and Km. 11 Development Zone (Full Phase): There will be 12,660 person-trips/day for Zone A, 52,320 person-trips/day for Zone B, 57,660 person-trips/day for Zone D, and 155,690 person-trips/day for Km. 11 Development Zone (Full Phase), as presented in Figure 5-2.



Source: The Consultants, 2016

Figure 5-2: Travel Demand Forecast Results for Each Zone in 2032

■ In 2037, Opening of Zones A, B, C, D and Km. 11 Development Area (Full Phase): There will be 14,060 person-trips/day for Zone A, 69,760 person-trips/day for Zone B, 29,930 person-trips/day for Zone C, 64,060 person-trips/day for Zone D, and 176,150 person-trips/day for Km. 11 Development Zone (Full Phase), as illustrated in Figure 5-3.

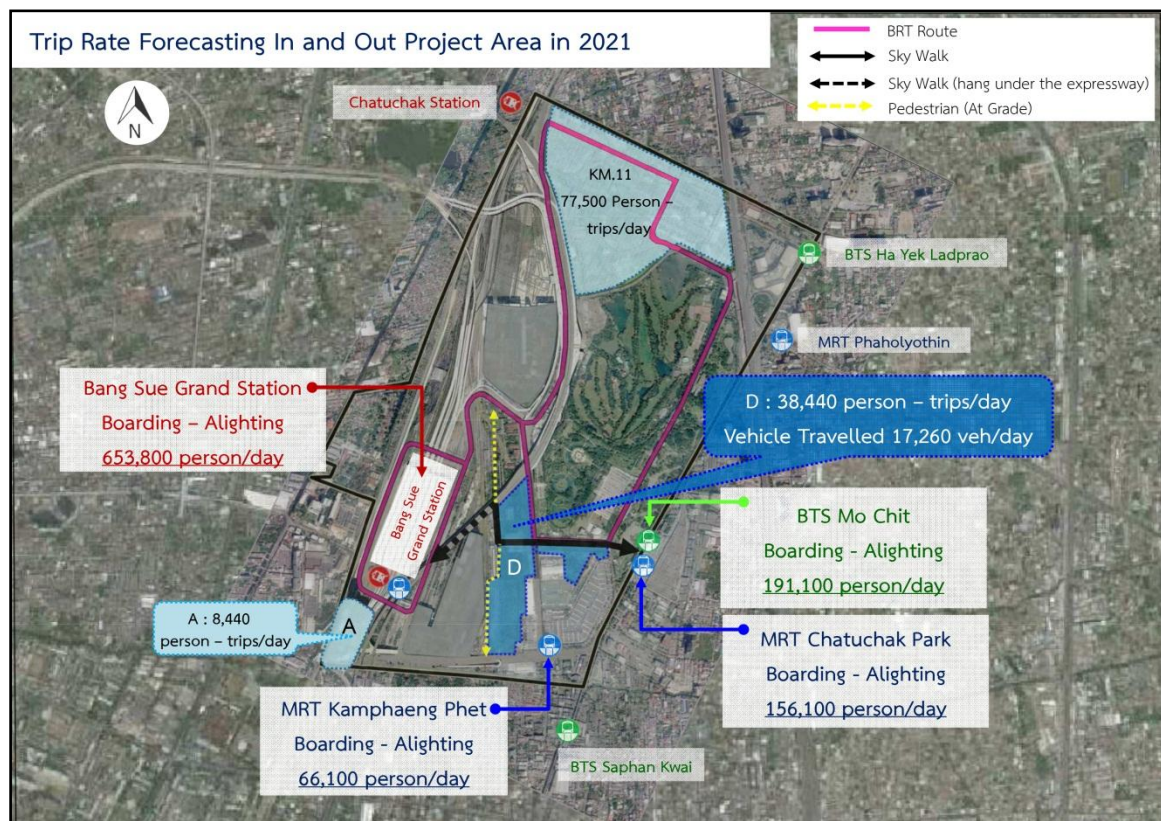


Source: The Consultants, 2016

Figure 5-3: Travel Demand Forecast Results for Each Zone in 2037

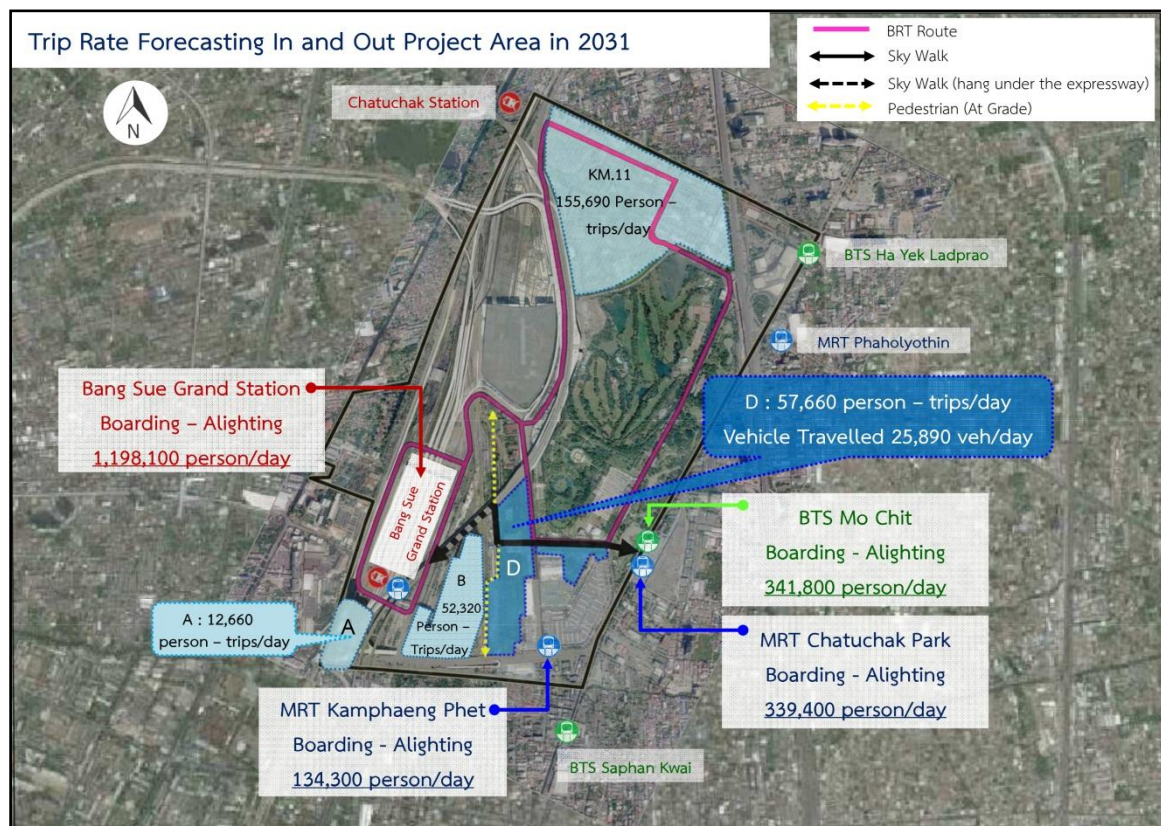
2) Ridership Forecast

The forecast boardings and alightings at railway and mass rapid transit stations in the project area, i.e. Bang Sue Grand Station, MRT Kamphaeng Phet Station, MRT Chatuchak Station, and BTS Mo Chit Station, are based on the opening years of development zones, as shown in Figures 5-4 to 5-6.



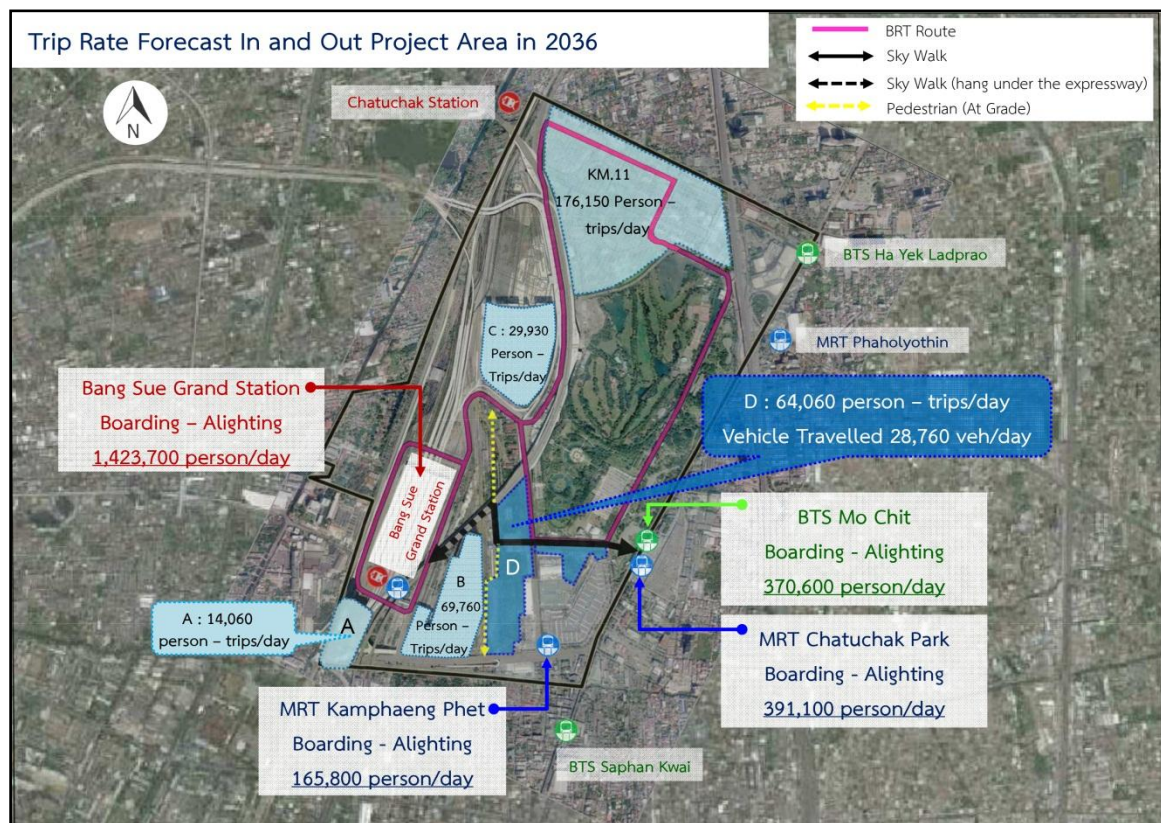
Source: The Consultants, 2016

Figure 5-4: Ridership Forecast Results in the Project Area, 2022



Source: The Consultants, 2016

Figure 5-5: Ridership Forecast Results in the Project Area, 2032

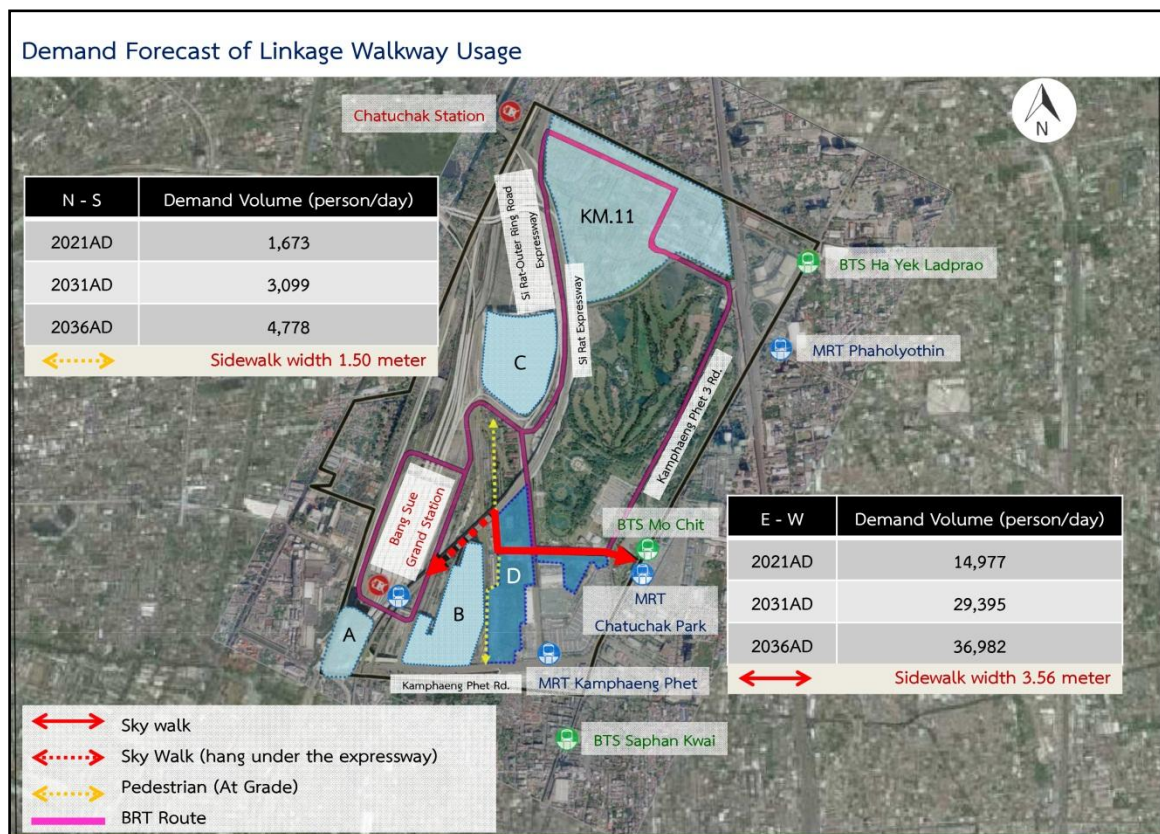


Source: The Consultants, 2016

Figure 5-6: Ridership Forecast Results in the Project Area, 2037

3) Forecast Volume of Walkway Users

It is forecast that pedestrians using the East-West skywalk within Phahon Yothin Center will walk from BTS Mo Chit Station, passing Zone D, to reach Bang Sue Grand Station. The North-South at-grade walkway begins from Kamphaeng Phet Road, passing Zone D to the north. The number of walkway users was projected for 2022, 2032 and 2037 based on the SRT's development phasing, with details shown in **Figure 5-7**.



Source: The Consultants, 2016

Figure 5-7: Projected Pedestrian Use of Walkway

4) Ridership Forecast for Feeder System (BRT)

Ridership forecast for feeder system (BRT) in 2022, 2032 and 2037 was based on the SRT's development phasing. The feeder system (BRT) will be operational in 2022, with a flat fare of 15 baht (referring to the fare rates of the Department of Land Transport, B.E. 2551 (2008)). The forecast results are summarized in **Table 5-1**.

Table 5-1: Ridership Forecast for Feeder System (BRT): 15-Baht Flat Fare

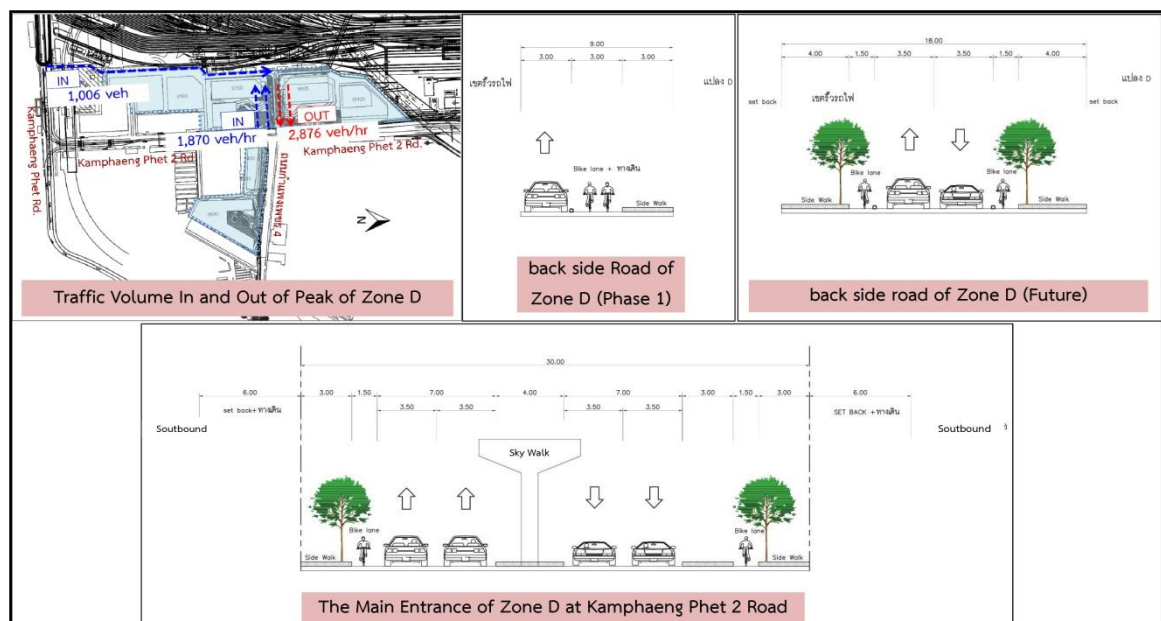
Year	Boarding (passengers/day)	Max line load (passengers/hr)
2022	33,400	992
2032	63,600	2,693
2037	105,700	4,258

Source: The Consultants' Forecast, 2016

5.2 Traffic Management Concept for the Project Area

1) Traffic Management in Commercial Zones and Interconnected Walkways

Zone D, with an area of 80 rai, is a large parcel of land and will be developed into commercial zone. Therefore, internal road system should be planned for connectivity of all subzones. Zone D can be accessed in two ways. One is the main entrance-exit on the two-way Kamphaeng Phet 2 Road. The other access is via one-way entrance from Kamphaeng Phet 1 Road. After the relocation of stabling yard under the long-term plan, the entrance road from Kamphaeng Phet 1 Road can be improved to serve two-way traffic. **Figure 5-8** exhibits traffic management approach and incoming–outgoing traffic volumes of Zone D.



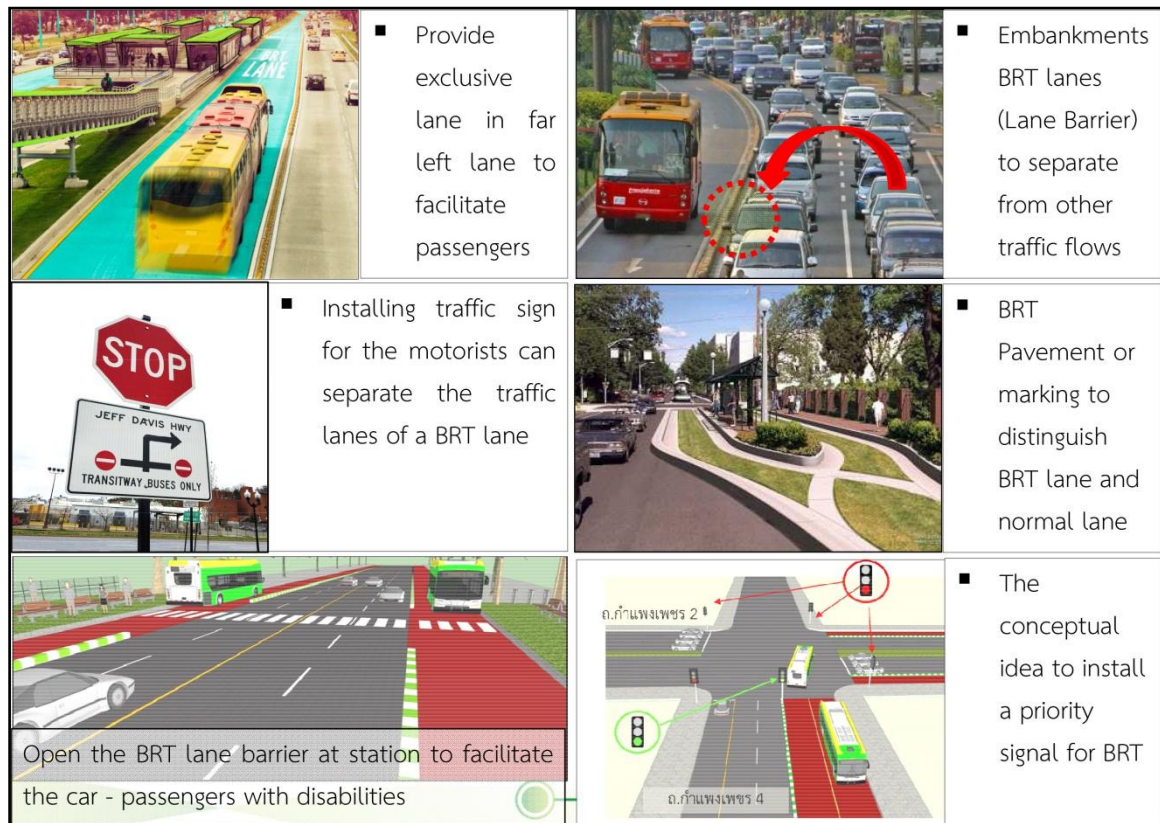
Source: The Consultants, 2016

Figure 5-8: Traffic Management in Commercial Zones and Connected Walkways

2) Feeder System (BRT) Management

Feeder system operation aims to provide fast and efficient service to commuters. BRT exclusive lane is required on each road within the feeder system service area. In some cases, the system may have to intersect with other traffic flows, such as intersections. Consequently, special BRT traffic signals, with BRT signal priority

concept, are required to be installed. Traffic signs will be installed and pavement markings painted to enable drivers to clearly see the BRT exclusive lanes. **Figure 5-9** presents examples of BRT traffic management concept.



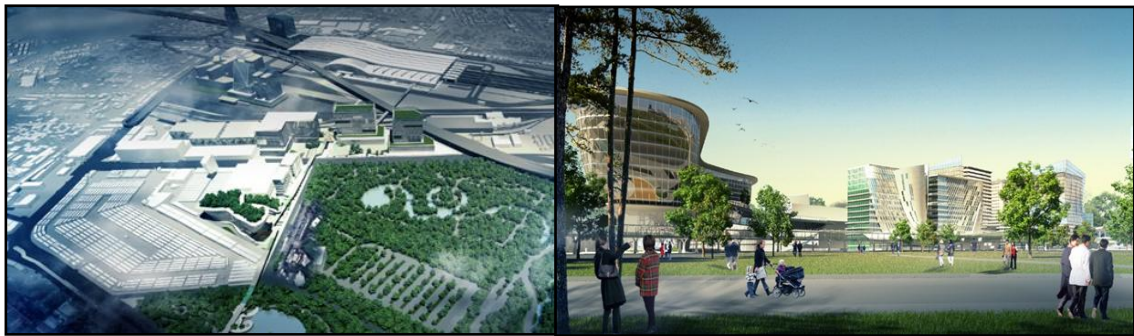
Source: The Consultants, 2016

Figure 5-9: BRT Traffic Management

6. MARKETING FEASIBILITY STUDY

Zone D is incorporated into the Phahon Yothin Center which is the Transit-Oriented Development (TOD) model with the master concept to become “**the New Business Hub of ASEAN.**” Nevertheless, there are several zones in the Phahon Yothin Center pending commercial development, e.g. Zones A, B and C, Nikhom Rotfai, Km. 11 Zone, and Tuek Daeng Zone. Each zone has its prominence and advantageous location for determining its zone concept which will be consistent and clearly non-overlapping.

Zone D is at the location with convenient linkage with Kamphaeng Phet station, BTS Mo Chit/MRT Chatuchak stations, and Bang Sue Grand Station. Hence it will be developed as **“the World Renowned Interchange Plaza”** by creating both at-grade walkways and skywalk which connect Bang Sue Grand Station with BTS Mo Chit/MRT Chatuchak stations. This Zone will serve daytime population or office staff and tourists traveling from Chatuchak Market and in the evening and night time will also accommodate people residing around here so as to create a lively and vibrant environment and attract people to the area. According to the market sounding seminar among investors, they are interested in the project and have agreed with the development concept proposed by the Consultants.



Source: The Consultants, 2016

Figure 6-1: Visual Perspective of Commercial Development in Zone D

With the suitable business option and development concept which are in harmony with the potential of Zone D and the overall development, the marketing mix has been determined by taking into account the conditions and important factors of each sub-zone.

- 1) Zone D1: Zone D will be completed and opened in the same period as Bang Sue Grand Station to ensure transport linkages and will be implemented in parallel with the development of Zone A which is in the south and close to Bang Sue Grand Station. Initially, Zone A will be developed to serve office, hotel, and retail businesses. Therefore, completion of Zones A and D in the same period will lead to oversupply of commercial areas. Zone D1 is mainly designed for daytime businesses, i.e.

office and retail businesses and show rooms which will be built for lessees in the project area. Open plaza area will be provided for organizing events.

- 2) Zone D2 consists of two areas:
 - The area behind the existing commercial buildings and shopping malls, e.g. In-square and JJ Square, is suitable for development of service and parking buildings.
 - The area next to Kamphaeng Phet 2 Road is suitable for development of office-for-rent buildings, fitness, food & beverage, and retail businesses.
- 3) Zone D3: The area next to Kamphaeng Phet 2 Road which is the main road can be fully developed (whereas the area near the 4-lane Kamphaeng Phet 4 Road is not large enough for construction of large buildings). This zone is designated for retail & entertainment businesses including food & beverage, dinner and cultural show center for tourists, sport arena, hotels for new generation tourists, small offices, condominiums (Leasehold) and serviced apartments.
- 4) Development of Transport Connectivity System: Some parts of Zones D3 and D2 are allocated for roadways and a skywalk to enable linkage of BTS Mo Chit Station and MRT Chatuchak Station to Bang Sue Grand Station .



Source: The Consultants, 2016

Figure 6-2: Suitable Business Groups for Zone D

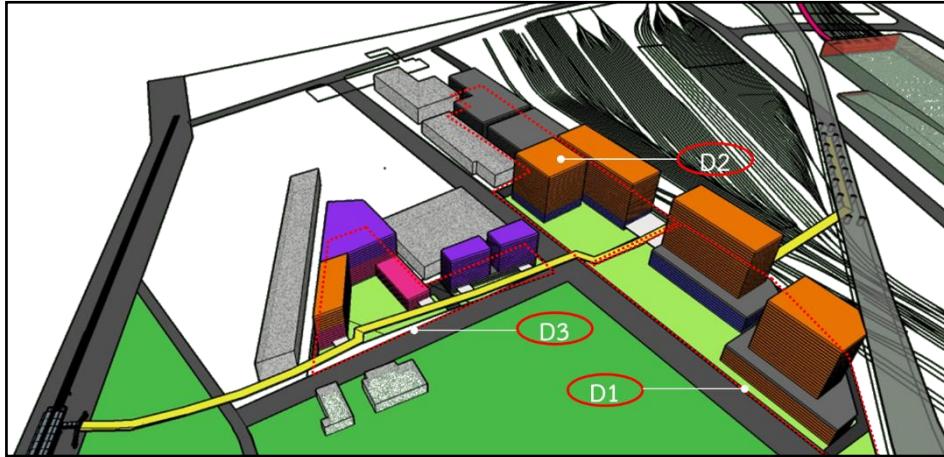
7. STUDY, DESIGN AND CONSTRUCTION COST ESTIMATION FOR THE DEVELOPMENT OF INTERMODAL TRANSFER FACILITY AND INTERCONNECTED PEDESTRIAN CORRIDOR

1) Preliminary Design of Commercial Area (Zone D) and Interconnected Pedestrian Corridor Development

The Transit-Oriented Development (TOD) concept was applied to the market feasibility study as well as traffic management study for Zone D and interconnected walkway in Phahon Yothin Center. This has led to architectural and engineering designs which were subsequently used as the basis for the estimation of capital cost and expenses for further analysis of the project feasibility.

For the project design, the project area was considered and recommended to be developed into a transportation and business hub in line with the

Transit-Oriented Development (TOD) concept. Zone D has an area of about 80 rai and is divided into 3 subzones as follows:



Source: The Consultants, 2016

Figure 7-1: Subzone Layout of Phahon Yothin Center Project Area

For the maximization of floor area utilization with reference to the land use types under the Bangkok Comprehensive Plan B.E. 2556 (2013), the development of floor areas is as follows:

Table 7-1: Optimization of Zone D Development

No.	Land Lots	Total Area (rai)	Total Area (sq.m.)	Total Floor Area (sq.m.) (FAR 8:1)	Total Open Space (sq.m.) (OSR 4%)	Total Building Coverage BCR (sq.m.)
Zone D		80.86	129,375			
1	Zone D1	25.04	40,075	350,800	14,032	29,818
2	Zone D2	40.49	64,795	488,000	19,520	41,480
3	Zone D3	15.31	24,505	227,120	9,085	19,305

Source: The Consultants, 2016

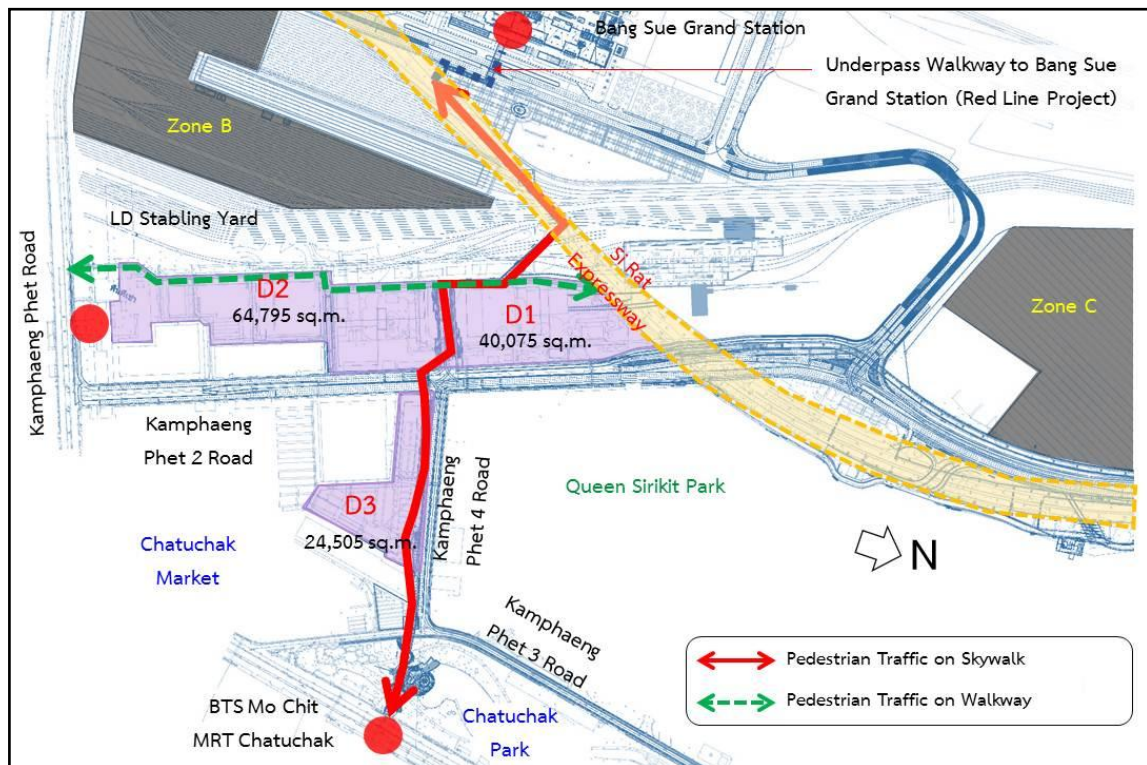
In the study and computation of building volumes, the Consultants aimed to derive suitable floor areas consistent with the market feasibility study so as to maximize the use of floor areas, as presented in **Table 7-2**.

Table 7-2: Optimum Land Development According to Relevant Laws

Total Area FAR for Zone D	Ratio	Total Area Required by Law (sq.m.)		Actual Construction Area
		(sq.m.)	(rai)	(sq.m.)
Land size		129,375	80.86	129,375
OSR by land lot	4%	41,400	26	71,207
BCR by land lot	-	-	-	58,168
FAR by land lot	8 : 1	1,035,000	-	998,006

Source: The Consultants, 2016

The alignment of the east-west skywalk corridor is depicted as follows:



Source: The Consultants, 2016

Figure 7-2: Walkway and Skywalk Corridor Alignments

Table 7-3: Summary of Skywalk Areas

No.	Skywalk	Width (m)	Length (m)	Area (sq.m.)
1	Chatuchak Station (BTS) – Zone D3	6	279	1,674
2	Zone D3 – Large land lot (D1+D2)	6	44	264
3	Zone D – Bang Sue Grand Station	6	415	2,490
	Total	-	738	4,428
	Skywalk area within Zones D1, D2 and D3	6	532	3,192
	Total skywalk area	1,270		7,620

Source: The Consultants, 2016



Source: The Consultants, 2016

Figure 7-3: Perspective View of Skywalk



Source: The Consultants, 2016

**Figure 7-4: Perspective View of Skywalk and Commercial Areas from
Kamphaeng Phet 4 Road**



Source: The Consultants, 2016

**Figure 7-5: Perspective View of Skywalk and Commercial Areas
from Kamphaeng Phet 2 Road**

2) Construction Cost Estimation

The project costs consist of two main parts, i.e. capital cost of commercial area development, and capital cost of skywalk. These costs include demolition and relocation cost, construction cost, architectural cost, public utilities cost, and cost of electrical and lighting system, as presented in **Table 7-4**, which are constant 2016 prices.

Table 7-4: Project Cost Estimates

No.	Description	Cost (million baht)
1	Commercial Area (Zone D)	
	- Demolition and relocation works	447.53
	- Structural works and building utilities	18,971.80
	- Architectural works	35.22
	- Roadworks in Zone D	40.37
	- Public utilities system	48.99
	- Street electrical and lighting system	4.84
Sub-total 1		19,548.77
2	Skywalk	
	- Structural works	308.85
	- Architectural works	140.68
	- Mechanical works	87.07
	- Electrical and lighting works	41.37
	- Public utilities works	67.09
Sub-total 2		645.05
Total 1+2		20,193.82
Physical contingency 15%		3,029.07
VAT 7%		1,625.60
Design and construction supervision cost: 9%		2,090.06
Loan interest (4-year construction phase)		2,745.14
Grand Total		29,683.69

Source: The Consultants, 2016

In addition, physical contingency is estimated at 15% of the capital cost while VAT is 7%, and design and construction supervision cost is 9%. Loan interest for the project development during the 4-year construction phase will be 2,745.14 million baht; consequently, the total construction cost including the loan interest amounts to 29,683.69 million baht.

8. STUDY, DESIGN AND CONSTRUCTION COST ESTIMATION OF FEEDER SYSTEM (BRT)

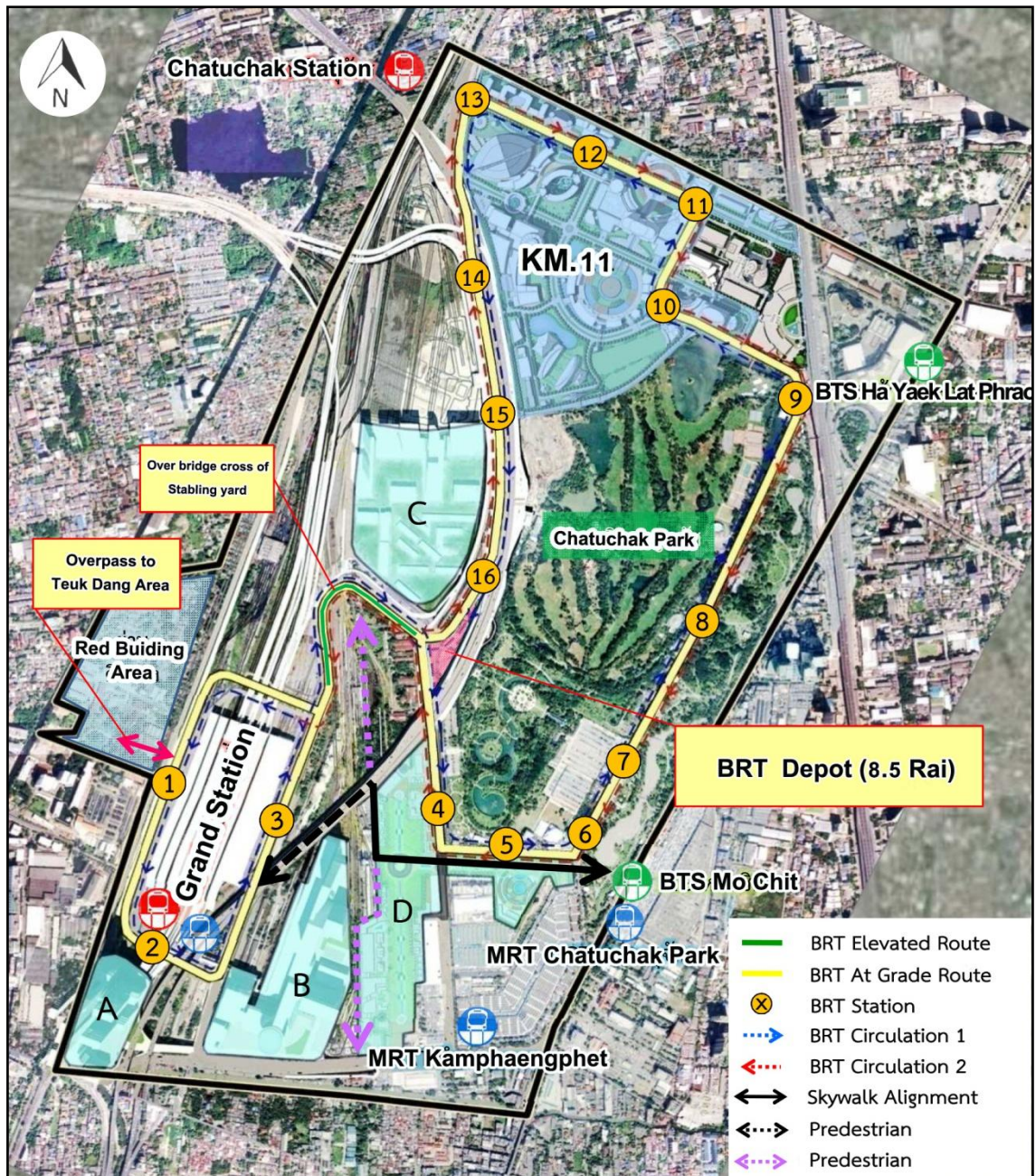
In addition to the main public transport system providing connections with travel from other areas, the Office of Transport and Traffic Policy and Planning (OTP) has studied the feeder system (BRT) that is suitable for the project area to facilitate passengers coming to trunk-line stations. The study also includes interconnected walkways to inner areas of the Project or areas beyond walking distance. The BRT circular route alignment will connect building clusters, i.e. passenger building of Bang Sue Grand Station, commercial zones: A, B, and C, Phahon Yothin Center (Zone D), Km. 11 development zone, Chatuchak Plaza, and public park. It will also link with major transit stations outside Phahon Yothin Center, i.e. Mo Chit Station and Chatuchak Park MRT Station.

8.1 Feeder System (BRT) Design

1) Design of Route Alignment

The feeder system (BRT) with a total 16 stations will begin services in 2022. The designated BRT routes are as follows: Station 1 is located in front of Bang Sue Grand Station on Thoet Damri Road (west of Bang Sue Grand Station). BRT buses turn left to Station 2 on the south of Bang Sue Grand Station where BMTA's 45-bus parking area will be situated. Then they make another left turn to go to Station 3 on the road in front of and on the east side of Bang Sue Grand Station. This route will be at-grade lane. After this, the BRT line will run on an elevated roadway to cross over the stabling yard and Kamphaeng Phet 6 Road before turning right onto Kamphaeng Phet 2 Road to run at grade again to reach Station 4 in front of Zone D. Then the line turns left onto Kamphaeng Phet 4 Road reaching Station 5 in front of the Children's Discovery Museum. Another left turn onto Kamphaeng Phet 3 Road leads to Station 6 in front of JJ Green parking lot, Station 7 in front of JJ Green Project, Station 8 in front of the Railway Hall of Fame, and Station 9 in front of PTT Head Office. The BRT line once again turns left to Km. 11 zone to arrive at Station 10 at Buddhadasa Indapanno Archives, Stations 11 and 12 within SRT's Km. 11 development zone, and Station 13 in front of Chatuchak Station. The line then takes another left turn onto Kamphaeng Phet 2 Road to go towards

Station 14 at the commuter train depot, Station 15 at the Railways Technical School, and Station 16 at SRT's Zone C. Finally, BRT buses will continue towards Station 1. To facilitate BRT users, the BRT will provide two-way services on Kamphaeng Phet 6 Road, Kamphaeng Phet 2 Road, Kamphaeng Phet 3 Road and service road within the Km. 11 zone. One-way services will be provided on the road around Bang Sue Grand Station, as exhibited in **Figure 8-1**.



Source: The Consultants, 2016

Figure 8-1: BRT Route Alignment and Station Locations

2) BRT Stations

The design of Bus Rapid Transit (BRT) stations covers conceptual station area sizing, layout of station facilities, route alignment, accessibility, and boarding-alighting, with uniformity of all buildings of the project. The design took into consideration the station utilization by children, senior people and the disabled in accordance with the Universal Design concept, and stations in sizes S and M are provided, as depicted in **Figures 8-2 and 8-3**.



Source: The Consultants, 2016

Figure 8-2: Perspective of Bus Rapid Transit (BRT) Station, Size S



Source: The Consultants, 2016

Figure 8-3: Perspective of Bus Rapid Transit (BRT) Station, Size M

3) BRT Depot

A flat land of approx. 8.5 rai will be developed into BRT depot. Currently, it is the location of a PTT gas station. The depot consists of the following elements.

1. Maintenance and support service zones

- An open concrete parking area for 20 buses
- Maintenance preparation zone for 2 buses in front of the depot
- Rubber tire spare room with access for delivery trucks
- Parts and engine repair room (air conditioning system)
- a separate zone for under vehicle pressure washing
- 2 parking bays for auto body painting and repair
- Underground bays equipped with waste oil disposal device and pressure lubrication device
- Refueling zone in front of the project's road access with a safety distance of 10.00 m away from buildings in the project area.

- Bus washing zone equipped with bus exterior washer
- 2. Office and staff service zones
 - Staff amenities, i.e. rest areas and toilets
 - Workroom, canteen and a rest area for maintenance and engineering staff
 - Administrative office



Source: The Consultants, 2016

Figure 8-4: BRT Depot Layout

8.2 Construction Cost Estimates

Construction costs were estimated for the BRT opening year in 2022 for full phase services (16 stations), with details given in **Table 8-1**.

Table 8-1: Investment Cost of Feeder System (BRT) Infrastructure

Description	Phase I	Phase II
Opening Year	2022	2037
Construction Year	2020-2021	2036
Investment Cost		
1) General works and site facilities	9.44	-
2) Road improvement for BRT system	184.82	-
3) Construction of BRT stations	163.25	-
4) Construction of BRT depot	61.93	-
5) Demolition and relocation works (built structures)	223.26	-
Total 1-5	642.69	0.00
6) Bus procurement cost (million baht)		
- 42 buses (throughout 30 years)	18 buses	24 buses
- Total bus cost	288.90	385.20
7) Operation control system cost (million baht)	106.40	
8) Ticketing system and common ticketing system costs (million baht)	21.40	
Grand Total	1,059.39	385.20

Source: The Consultants, 2016

9. ECONOMIC, FINANCIAL AND INVESTMENT FEASIBILITY STUDY

9.1 Commercial Area (Zone D) and Interconnected Pedestrian Corridor Development

9.1.1 Economic Feasibility Study

The development of commercial areas generally generates economic benefits from resource use for investment. Benefits from the commercial area development at Phahon Yothin Center include the following.

(1) Benefit of Supporting the Central Business District (CBD) Growth

Bangkok is a metropolitan economy principally driven by commercial and service sectors. Development of Phahon Yothin Center into a Central Business District (CBD) will bring about enhanced efficiency of Phahon Yothin Center as a new CBD in

propelling the economy, particularly the commercial and service sectors, since CBD is a high-density business and commercial zone characterized by a high concentration of offices and high density of economic activities, with travel convenience.

(2) Economic Multiplier Effects

Large-scale investment will be undertaken in this development project which will have consequential impacts on the overall economy, benefiting related economic sectors: manufacturing and service sectors. It will be a significant source of income for both entrepreneurs and workers. These economic benefits can be explained in terms of economic multipliers, with the analysis results given in **Table 9-1**.

Table 9-1: Economic Multiplier Effects from the Development of Phahon Yothin Center, Zone D and Connected Pedestrian Corridor

Unit: million baht

Description	Capital Cost	Multiplier Effect			
		Output Effect	Wages & Salaries Effect	Operating Surplus Effect	Income Effect
Zone D and Connected Pedestrian Corridor	26,938.6	69,771.0	8,081.6	12,391.8	20,473.3

Source: The Consultants, 2016

9.1.2 Financial and Investment Feasibility Study

The project's financial feasibility study in base case was carried out, using the marketing study results, capital cost estimates of the project development and operating cost estimates. The project life is 30 years (excluding the construction period). The project revenue will come from 6 major businesses, namely office for rent, commercial space for rent, hotel business, car parking service, long-term leasehold condominium, and serviced apartments. The project developer will be solely responsible for construction of all walkways.

In addition, the impacts of other cases were also assessed, such as in case SRT undertakes the skywalk construction works (in case the skywalk construction cost is

excluded from the overall construction cost of the project), extension of project period to 50 years, and adjustment of assumptions for more aggressive financial projections¹. It was aimed to assess the business potential of the project, with the analysis results given in **Table 9-2**, with a summary presented herein.

1) Base case: The project NPV is 7,166 million baht and the project FIRR is 7.84%. As the landowner, SRT will have minimum revenue of not less than 3,598 million baht from 30-year land lease for the project development (referring to the regulation and resolution of the SRT Committee No. 1/2554 dated 26 January 2011).

2) Base case: In case the walkway construction cost is excluded from the project's overall construction cost (in case the skywalk is constructed by SRT), the project NPV will increase by about 847 million baht (from the original value of 7,166 million baht) to 8,013 million baht. The project FIRR will rise by 0.23% (from 7.84%) to be 8.07%.

3) Base case :In case of extension of project period to 50 years, the project NPV will soar by 10,700 million baht (from the original value of 7,166 million baht) to 17,866 million baht. The project FIRR will increase to 8.84%—a rise by 1.00% (from 7.84%).

4) Base case without the skywalk construction cost :In case the project period is extended to 50 years, the project NPV will go up by 11,562 million baht (from the original value of 7,166 million baht) to 18,728 million baht. The project FIRR will rise by 1.18% (from 7.84%) to 9.02%.

5) Other cases such as more aggressive financial projections than those in the base case so as to assess the project's business potential. The project NPV and FIRR (including Return on Equity (ROE)) will increase progressively. In case other assumptions remain unchanged but with an extension of project period to 50 years, the project NPV will rise by 10,700-16,270 million baht. The project FIRR will also increase by about 0.60-1.00%, compared to the case without the extension of project period.

¹ The case of more aggressive financial projections means assumption of higher revenue than the base case, i.e. 1) additional 500 sq.m. of commercial area in the Reception Hall of D1 Building, 2) increase in sale prices for long-term residential buildings from 55,000 baht/sq.m. to 65,000 baht/sq.m., and 3) change the use of 30,000 sq.m. in D2/4 building from office space to commercial space.

6) In case of project period extension from 30 years to 50 years, SRT—the landowner—should receive a higher minimum revenue from land use fees, from 3,598 million baht (in case of 30-year period) to 5,996 million baht (in case of 50-year period) or an increase of about 2,398 million baht (according to the approach proposed by the Consultants in the Feasibility Study Report)

7) From the aforementioned analysis, it can be concluded that the extension of project period to 50 years (excluding the construction time) will result in a rise in the overall project benefit by about 0.60-1.00%. Additionally, SRT as the landowner will obtain higher minimum benefit of about 2,398 million baht from the land use fees, compared to the 30-year project period.

**Table 9-2: Summary of Financial and Investment Feasibility Study Results
in Different Cases**

Unit: million baht	Base Case	Without Skywalk Case	Increase in Price and OCR Case	Aggressive Case	More Aggressive Case	Most Aggressive Case
30-year Case: NPV	7,166	8,013	11,186	14,125	18,999	20,040
: FIRR	7.84%	8.07%	8.63%	9.19%	10.07%	10.24%
: ROE	9.03%	9.41%	10.21%	11.07%	12.38%	12.65%
30-year Case: NPV	8,013	8,013	12,062	15,023	19,904	20,945
Without Skywalk: FIRR	8.07%	8.07%	8.86%	9.44%	10.32%	10.50%
: ROE	9.41%	9.41%	10.57%	11.45%	12.77%	13.05%
50-year Case: NPV	17,866	18,728	23,743	27,685	34,790	36,284
: FIRR	8.84%	9.02%	9.51%	9.98%	10.74%	10.89%
: ROE	10.06%	10.34%	11.03%	11.74%	12.85%	13.09%
50-year Case: NPV	18,728	18,728	24,639	28,604	35,721	37,215
Without Skywalk: FIRR	9.02%	9.02%	9.70%	10.18%	10.95%	11.10%
: ROE	10.34%	10.34%	11.32%	12.04%	13.18%	13.42%

Source: The Consultants, 2016

9.2 Feeder System (BRT)

9.2.1 Economic Feasibility Study

The economic analysis results reveal that investment in feeder system development project in the form of BRT system is viable as NPV is equal to 2,692.68 million baht and B/C ratio is 1.84. Additionally, EIRR is 17.74%. All these indicators are higher than the set criteria, showing that the project will yield positive benefits and economic returns which will outweigh its costs.

9.2.2 Financial and Investment Feasibility Study

Financial feasibility analysis was carried out for the development of BRT system in 3 scenarios of different fare rates (base rate as of 2016), i.e. fare rate (base rate) at 10 baht, 15 baht and 20 baht per trip respectively. Rate will be escalated by 10% every 5 years from the opening year in 2022. The estimated ridership and fare revenue of each scenario are shown in **Table 9-3**.

Table 9-3: Estimation of Ridership and Fare Revenue

Base Fare=10 Baht	2022	2027	2032	2037	2042	2047	2051
Ridership Boarding (persons/day)	37,700	54,750	71,800	119,400	131,827	145,548	157,546
Fare Revenue (million Baht/year)	124.41	198.74	284.33	512.23	609.04	720.46	779.85
Base Fare=15 Baht	2022	2027	2032	2037	2042	2047	2051
Ridership Boarding (persons/day)	33,400	48,500	63,600	105,700	116,701	128,848	139,469
Fare Revenue (million Baht/year)	165.33	272.09	398.77	732.50	885.76	1,062.99	1,150.62
Base Fare=20 Baht	2022	2027	2032	2037	2042	2047	2051
Ridership Boarding (persons/day)	29,000	42,150	55,300	92,000	101,575	112,147	121,392
Fare Revenue (million Baht/year)	191.40	306.01	437.98	789.36	972.08	1,184.28	1,281.90

Source: The Consultants, 2016

The financial feasibility was analyzed for the BRT development, taking into account various indicators, namely net present value, internal rate of return, and benefit cost ratio, with the results summarized herein.

1) With Infrastructure Case

The project FIRR analysis shows that the project is worth investing as the project FIRR in the 3 cases is higher than the average financial cost of 3.43% and the project NPV is positive in all cases. In the event that the fare rate (base case) is 10 baht/trip, the project's return on investment is not high, when compared to investment by bank loans or private investment where the loan interest rate and the return on investment is normally in the range of 6-10% per year.

When considering the investment risk from the private investor perspective, ridership risk (directly relating to the commercial area development plan in Phahon Yothin Center and future mass transit development projects) is the most significant project risk and will have direct impacts on the estimated ridership and return on investment of the project. It is evident that a decrease in ridership will result in a decline in the project revenue and returns and may render the project unworthy of investment from the private investor perspective. This is quite clear from the market sounding results, with potential private investors showing little interest in the BRT investment.

Table 9-4: Project Financial Returns (with Infrastructure Case)

Fare Rate (Base Rate)	10 Baht/Trip	15 Baht/Trip	20 Baht/Trip
Financial Internal Rate of Return (FIRR)	9.81%	14.80%	16.60%
Net Present Value (NPV) at 5% Discount Rate- million baht	1,099	2,842	3,475
Benefit Cost Ratio (B/C)	1.38	1.95	2.16

Source: The Consultants, 2016

2) Without Infrastructure Case

SRT (the landowner) or other relevant government agencies (Office of Transport and Traffic Policy and Planning (OTP) or other agencies under the Ministry of

Transport) may wish to provide BRT system in Phahon Yothin Center in order to achieve interconnectivity within the Center (especially when the commercial area development project is not yet fully implemented), to promote commercial area development projects in the Center, and to support passenger volumes that will grow after the opening of Bang Sue Grand Station. SRT (the landowner) or other relevant government agencies may consider investment in BRT infrastructure themselves and the project developer (by private investment) will invest only in bus procurement, operation control system, ticketing system, and operation and maintenance costs. In this case, the project capital cost will decline by about 642.69 million baht (base price as of 2016) and the project FIRR will increase, compared to the with infrastructure case, as given in **Table 9-5**.

Table 9-5: Comparison of the Project Financial Returns in Case of With and Without Infrastructure

Fare Rate (Base Rate)	10 Baht/Trip		15 Baht/Trip		20 Baht/Trip	
Case	With Infrastructure	Without Infrastructure	With Infrastructure	Without Infrastructure	With Infrastructure	Without Infrastructure
Financial Internal Rate of Return: FIRR	9.81%	17.76%	14.80%	25.81%	16.60%	29.50%
Net Present Value at 5% Discount Rate: NPV	1,099	1,675	2,842	3,419	3,475	4,052
Benefit Cost Ratio: B/C Ratio	1.38	1.69	1.95	2.40	2.16	2.66

Source: The Consultants, 2016

However, in case SRT or other government agency (as the project owner) is designated to be responsible for BRT infrastructure investment, appropriate ratio of fare revenue sharing (and other operating incomes, if any) should be determined between SRT or government agency (as the project owner) which invests in the BRT infrastructure development, and the operating unit (which may be the private sector) which will invest in bus procurement and be responsible for operating costs. This will ensure that the operating unit will receive suitable returns and the project owner will be able to recover its infrastructure investment costs.

The study shows that in case the operating unit (which may be the private sector) will earn a return between 12.00% and 15.00% in the without infrastructure scenario, the ratio of fare revenue sharing with the project owning agency (which may be SRT or other government agency) is derived as given in **Table 9-6**.

Table 9-6: Analysis Results of Fare Revenue Sharing Ratio

(Base) Fare Rate	Operator's Return Rate (Project FIRR in case of Without Infrastructure)	Revenue Sharing Ratio by Operator (% of Fare Revenue)	Revenue Sharing Ratio by Project Owner (% of Fare Revenue)	Project Owner's FIRR on Infrastructure Investment (%)	Payback Period of Project Owner on Investment in Infrastructure (Years)
10 Baht/Trip	1) Target Return at 12% (Actual Return 13.18)	Approx. = 75	Approx = 25	Approx. = 9.77	13
	2) Target Return 15% (Actual Return 15.52%)	Approx. = 85	Approx. = 15	Approx. = 6.01	17
15 Baht/Trip	1) Target Return at 12% (Actual Return 12.66%)	Approx.= 60	Approx. = 40	Approx. = 15.70	9
	2) Target Return 15 % (Actual Return 14.81%)	Approx.= 65	Approx. = 35	Approx. = 14.47	9
20 Baht/Trip	1) Target Return at 12% (Actual Return 11.47%)	Approx. = 50	Approx. = 50	Approx. = 19.86	7
	2) Target Return at 15% (Actual Return at 15.58%)	Approx. = 58	Approx. = 42	Approx. = 18.00	7

Source: The Consultants, 2016

From the aforementioned BRT financial projections, it can be concluded that the project infrastructure investment may be undertaken by SRT or other relevant government agency (collectively called the project owning agency). The BRT operating unit (which may be private sector) will be responsible for bus procurement, control system, ticket system, and operation and maintenance costs. This would make the project more attractive for investment from the perspective of private investors who may bid for the project operation, particularly ridership risk which is related to the plan for commercial area development projects in Phahon Yothin Center.

10. STUDY OF THE MOST SUITABLE AND BENEFICIAL MANAGEMENT AND INVESTMENT OPTION

10.1 Development of Commercial Area (Zone D) and Connected Walkways

The optimal management and investment option for Zone D is that SRT grants the long-term land development right to the private entity that has expertise, experience, flexibility, and financial resources. SRT will benefit from the project in the form of annual financial returns at the pre-determined rate and the returns which vary according to the project revenue. And this will not significantly cause SRT (the public sector) to have more financial burden.

In preparation for the request for PPP approval, draft invitation to tender, draft Request for Proposal documents, draft long-term land development right contract, etc., the conditions contained therein should be clearly stipulated, for example, private investor selection, business patterns which should be included in the project (and support the operation of Bang Sue Grand Station), the benefits in various forms that the private entity shall give to SRT, and suitable land development right period. In the initial stage, the Consultants consider the period of 30 years (excluding construction period) should be sufficient for investors to gain benefits which are viable for investment. Renewal of the contract shall not be allowed to the private entity.

In tandem with preparation for the request for PPP approval, etc., the Consultants consider that SRT should set up a Project Task Force which is a cross-functional team for project development without changing SRT's overall management structure. A Working Committee should be also established to follow up and push forward the project progress and to coordinate with related organizations during all phases: before submission of project for approval, follow-up of project progress, project construction, follow-up and assessment of business operation results, and contract compliance until the end of the project.

Regarding the development of connected walkways which are a kind of infrastructure facilities, they can be divided into two main groups with the details described below.

1) The connected walkways which stretch between buildings in the project area or its surroundings will directly benefit the project's commercial businesses as they will provide convenient access to buildings or become parts of the buildings, etc. (hereinafter called "the Connected Walkways Group A"). SRT, as the landowner, shall stipulate in the contract conditions that the selected private entity for each zone must be responsible for investment in walkway construction and the operating costs thereof. Moreover, SRT shall provide convenience and support to investors and shall ensure that the development and construction plans of the Connected Walkways Group A are in compliance with those of the Connected Walkways Group B, and overall commercial area of the Phahon Yothin Center.

2) The connected walkways which link between public roads and stations within and around the Phahon Yothin Center and do not consist of any components of the Connected Walkways Group A will be hereinafter called "the Connected Walkways Group B." During the initial period, SRT as the landowner shall be "the host agency" in terms of project investment, construction, and operation. SRT may solely invest in connected walkway construction, or determine that the investors should be also responsible for the connected walkways near their zones. However, this should be clearly included as the conditions since the step of selecting investor of each zone. In case of no investor in any sections of Connected Walkways Group B, SRT shall be responsible for construction of such sections to ensure all walkways will be completely linked throughout the Phahon Yothin Center, resulting in convenience of service users. This will in turn increase the number of service users of the Phahon Yothin Center and SRT will gain more returns from higher land price, long-term land usage fees, and profit sharing from commercial development.

From the financial feasibility and investment analysis of the connected walkways for Zone D, it may be concluded that the overall construction cost, either in the with infrastructure case or without infrastructure case, will not have any significant impact on the project returns. SRT, as the landowner and project owning agency, may clearly stipulate as a condition of private investor selection that the private investor shall be responsible for construction of walkways connecting BTS Station to Bang Sue Grand Station, which will pass nearly all the Zone D area.

Moreover, SRT shall provide convenience and support to private investors and shall ensure that the development and construction plans of the connected walkways are in compliance with those of the overall commercial areas in Phahon Yothin Center to achieve complete interconnection of all walkways.

10.2 Bus Rapid Transit (BRT) System

The optimal management and investment choice for the BRT system in the Phahon Yothin Center is that SRT should act as the owner because the BRT system will be mostly available in SRT's area and SRT will most benefit from the project operation. Besides, the BRT system will enhance connectivity of rail-based systems in the Phahon Yothin Center with Bang Sue Grand Station (under SRT's supervision) as the key interchange station. It will also support commercial area development projects in which SRT will select private entities to participate. As a result, this will directly and indirectly benefit SRT which owns most area of the Phahon Yothin Center (for example, increase in ridership at Bang Sue Grand Station, greater convenience of passengers passing by and/or using services in the project area, higher revenue sharing from commercial area development projects, and hike in the overall land price.

As for investment option, SRT, as the landowner, will prepare the commercial area development plan in the project area and will provide the BRT system. During the initial period when commercial areas are not much developed (the number of passengers is not high), SRT (as the landowner) or relevant government agency (OTP) or other agencies under the Ministry of Transport) may provide other feeder transport services which are not full BRT system. That is, basic busways may be initially provided and then gradually changed to full BRT system when commercial areas are more developed and there is enough ridership. The operating unit shall be responsible for procuring buses.

In case SRT (as the landowner) or relevant government agency (Office of Transport and Traffic Policy and Planning (OTP) or other agencies under the Ministry of Transport), intends to provide full BRT system in Phahon Yothin Center to create interconnectivity within the Center (particularly during the period when commercial areas are not yet fully developed; to promote commercial area development projects in

the Center; and to accommodate passenger volumes that will grow after the opening of Bang Sue Grand Station. SRT (as the landowner) or other relevant government agencies may consider investing in BRT infrastructure themselves and the project developer (by private investment) will invest only in bus procurement, operation control system, ticketing system, and operation and maintenance costs. In such case, SRT (as the landowner) or other relevant government agencies may request financial support from the government for infrastructure investment.

In addition, in case SRT or other government agency (as the landowner) is designated to be responsible for BRT infrastructure investment, appropriate ratio of fare revenue sharing (and other operating incomes, if any) should be determined between SRT or government agency investing in the BRT infrastructure development, and the operating unit (which may be the private sector) which will invest in bus procurement and be responsible for operating costs. This will ensure that the operating unit will receive suitable returns and the project owning agency will be able to recover its infrastructure investment costs. In the selection of operating unit (which may be private sector), the selection criteria may include requirement for the operating unit to propose a ratio of fare revenue sharing to be provided in each year to the project owning agency.

11. ENVIRONMENTAL STUDY

11.1 Initial Environmental Examination (IEE) of Zone D and Connected Walkways

IEE covers four main environmental components: physical resource, biological resource, human use value, and quality of life value. Impacts on the environmental components are described below.

1) Impacts on Physical Resources

During the construction period, development of commercial areas and connected walkways in Zone D of the Phahon Yothin Center will mainly cause impacts on air quality and noise level from transportation of construction materials and construction processes, followed by impacts on surface water quality in nearby water bodies due to discharge of wastewater from construction activities and consumption of construction workers.

During the operation period, the project will mainly cause impacts on air quality and noise level due to traffic, followed by impacts on surface water quality in nearby water bodies due to discharge of wastewater in Zone D.

2) Impacts on Biological Resources

The project area is generally composed of flat terrains with high density of communities. Most land is used for commercial and residential purposes. Commercial area is rented out by SRT. Kamphaeng Phet 2 and Kamphaeng Phet 4 roads are aligned in this Zone serving as the secondary roads in Chatuchak area. No forest area or conservation area is found. There is no rare plant or wild animal in the project area. Consequently, the project development during the construction and operation periods will not cause any impact on biological resources.

3) Impacts on Human Use Values

The project development during the construction and operation periods will increase the demand for water, electricity, solid waste management, drainage system, and transportation routes. Without planning, design and determination of suitable impact prevention measures, there will be impacts on construction workers, nearby communities, and those who will use services in the project area.

The initial discussion with related agencies shows that the Metropolitan Waterworks Authority, the Metropolitan Electricity Authority, and Chatuchak District Office have sufficient capacity to provide water, electricity, and solid waste management services. As for drainage of water from the project area, the SRT Red Line's drains, currently under construction, were designed to adequately accommodate storm water in the project area. The traffic system in the project area must be appropriately designed to prevent the probable impacts during the operation period. As a result, the impacts in this aspect will be at low level.

4) Impacts on Quality of Life Values

The project development during the construction period will probably impact on socio-economic conditions, aesthetics, public health, occupational safety and health of workers and people in nearby areas. The construction processes consist of activities like other projects in general. If suitable and comprehensive environmental impact prevention and rectification measures are determined, the project impacts will be controlled to be at acceptable and low level.

During the operation period, the project will have positive impacts on socio-economic conditions and aesthetics in the project area. This is because the commercial area development will create jobs and increase people's income, as well as enhance the landscape of the project area.

The initial environmental impacts from development of commercial areas in the Phahon Yothin Center and connected walkways in Zone D during the construction and operation periods are presented in **Table 11-1**.

Table 11-1: Summary of Initial Environmental Impacts for Zone D and Connected Walkways

Environmental Parameters	Probable Impacts							
	Construction Period				Operation Period			
	High	Medium	Low	None	High	Medium	Low	None
1. Physical Resources								
-Topography			✓				✓	
-Soil Resource			✓					✓
-Geological Conditions and Earthquake								
+ Geological Conditions			✓					✓
+ Earthquake				✓				✓
-Meteorology and Air Quality			✓				✓	
-Noise Level			✓				✓	
-Hydrology and Surface Water Quality								
+ Hydrology				✓				✓
+ Surface Water Quality			✓				✓	
-Hydrogeology and Groundwater Quality				✓				✓
2. Biological Resources								
-Terrestrial Ecology								
+ Forest Resources			✓					✓
+ Wildlife Resources			✓					✓
-Aquatic Ecology			✓				✓	
3. Human Use Values								
-Land Use			✓					✓
-Water Consumption			✓				✓	
-Wastewater and Sewage Management			✓				✓	
-Drainage and Flood Control			✓				✓	
-Solid Waste Management			✓				✓	
-Transportation			✓				✓	
-Energy and Electricity			✓				✓	
4. Quality of Life Values								
-Socio-economic Conditions			✓				✓	
-Aesthetics and Scenery			✓					✓
-Public Health and Occupational Health			✓					✓
-Fire Prevention and Safety			✓				✓	

Source: The Consultants, 2016

Therefore, to prevent and mitigate environmental impacts to be at acceptable level, and to monitor environmental impacts from the project implementation during the construction and operation periods, the appropriate and comprehensive environmental impact prevention and mitigation measures must be determined.

11.2 Environmental Impact Assessment (EIA) of the Bus Rapid Transit (BRT) System

EIA covers four major environmental components: physical resource, biological resource, human use value, and quality of life value. Impacts on the environmental components are described below.

1) Impacts on Physical Resources

During the construction and operation periods, the BRT system will mainly cause impacts on air quality and noise level from transportation of construction materials and construction processes, followed by impacts on surface water quality in nearby water bodies due to discharge of wastewater from construction activities and consumption of construction workers. However, the impacts will be at low level.

2) Impacts on Biological Resources

No forest area or conservation area is found along the existing roads (Kamphaeng Phet 2, Kamphaeng Phet 3, Kamphaeng Phet 4, Nikhom Rotfai Sai 1, and Vibhavadi Rangsit 11 roads) where the BRT system will be aligned. There is no rare plant or wild animal in the project area. Consequently, the project development during the construction and operation periods will not cause any impact on biological resources.

3) Impacts on Human Use Values

The project development during the construction and operation periods will increase the demand for water, electricity, solid waste management, and drainage system. Without planning, design and determination of suitable impact prevention measures, there will be impacts on construction workers, nearby communities, and those who will use services in the project area. After initial discussion with related agencies, the Metropolitan Waterworks Authority, the Metropolitan Electricity Authority, and Chatuchak District Office have sufficient capacity to provide water, electricity, and solid waste management services. As for drainage of water from the project area, the SRT Red Line's

drains, currently under construction, were designed to adequately accommodate storm water in the project area. The traffic system in the project area must be appropriately designed to prevent the probable impacts during the operation period. As a result, the impacts in this aspect will be at low level.

4) Impacts on Quality of Life Values

The project development during the construction period will probably impact on socio-economic conditions, aesthetics, public health, occupational safety and health of workers and people in nearby areas. The construction processes consist of activities like other projects in general. If suitable and comprehensive environmental impact prevention and mitigation measures are determined, the project impacts will be controlled to be at acceptable and low level.

The project impacts during the operation period will be at low level and will occur in the project area only.

The initial environmental impacts from development of the BRT system during the construction and operation periods are presented in **Table 11-2**.

Table 11-2: Summary of Initial Environmental Impacts for the BRT System

Environmental Parameters	Probable Impacts							
	Construction Period				Operation Period			
	High	Medium	Low	None	High	Medium	Low	None
1. Physical Resources								
-Topography			✓				✓	
-Geological Conditions and Earthquake								
+ Geological Conditions			✓					✓
+ Earthquake				✓				✓
-Soil Resource			✓					✓
-Meteorology and Air Quality			✓				✓	
-Noise Level			✓				✓	
-Vibration			✓				✓	
-Hydrology and Surface Water Quality								
+ Hydrology				✓				✓
+ Surface Water Quality			✓				✓	
-Hydrogeology and Groundwater Quality				✓				✓
2. Biological Resources								
-Terrestrial Ecology								
+ Forest Resources			✓					✓
+ Wildlife Resources			✓					✓
-Aquatic Ecology			✓				✓	
3. Human Use Values								
-Land Use			✓					✓
-Water Consumption			✓				✓	
-Wastewater and Sewage Management			✓				✓	
-Drainage and Flood Control			✓				✓	
-Solid Waste Management			✓				✓	
-Transportation			✓				✓	
4. Quality of Life Values								
-Socio-economic Conditions			✓				✓	
-Aesthetics and Scenery			✓					✓
-Public Health and Occupational Health		✓					✓	
-Fire Prevention and Safety			✓				✓	

Source: The Consultants, 2016

Therefore, to prevent and mitigate environmental impacts to be at acceptable level, and to monitor environmental impacts from the project implementation during the construction and operation periods, the appropriate and comprehensive environmental impact prevention and mitigation measures must be determined.

12. PROJECT MASTER PLAN

12.1 Commercial Area Development Master Plan

The draft master schedule has been prepared based on the following:

- Development Phasing
- Private Investments in State Undertakings Act B.E. 2556 (2013)
- Notification of the State Enterprise Policy Office regarding Details of Invitation to Tender, Request for Proposal Documents, Invitation Method, Selection Method of the Selection Committee, Determination of Tender Security and Performance Security

Based on the development phasing, the timeframe for development of Zone D during 2016-2022 is as follows.

- | | |
|---|-----------|
| 1) SRT submits the project to the Ministry of Transport/PPP Committee/the Cabinet for approval. | 2016 |
| 2) SRT or its affiliate selects the private entity to invest in the project. | 2017 |
| 3) The private entity prepares the project plans. | 2018 |
| 4) The private entity prepares traffic report/EIA report/request for approval of construction. | 2019 |
| 5) The private entity starts construction. | 2020-2022 |

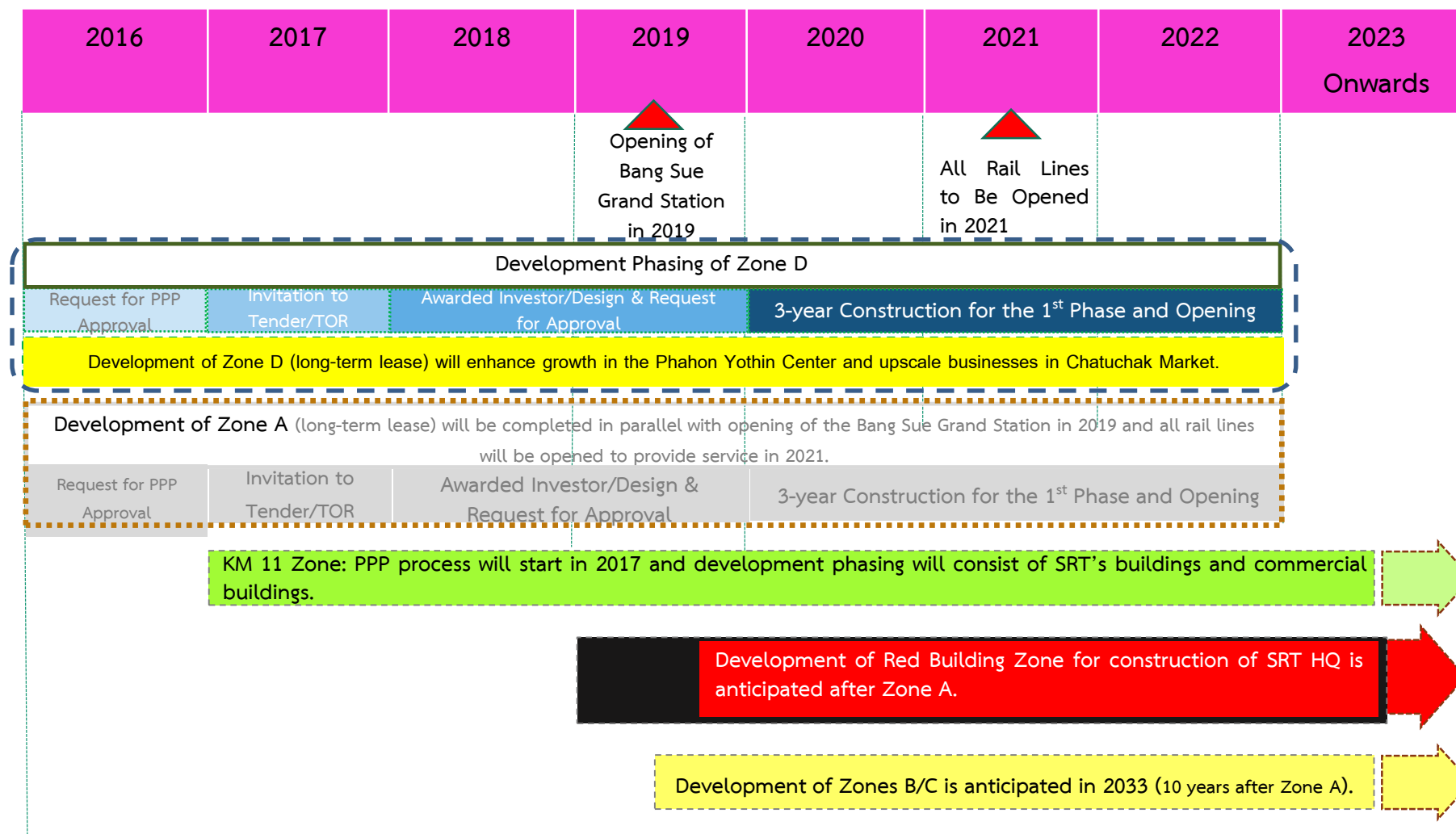


Figure 12-1: Development Phasing for Commercial Areas in Phahon Yothin Center and Zone D

12.2 BRT Implementation Plan

The BRT system consists of 16 stations, starting from Station No. 1 in the west of the Bang Sue Grand Station to the Stations No. 2-16 and then returning to Station No. 1. The two-way traffic was designed for the BRT route except for the area around the Bang Sue Grand Station where the traffic is one-way. The full BRT service will be available in 2022 and will be implemented under the PPP Net Cost scheme. Upon completion of study and the Cabinet's approval, the construction of the BRT system will start in November 2019 and will take about 2 years. The BRT system will be ready to provide service in February 2022. The BRT implementation plan is presented in **Table 12-1**.

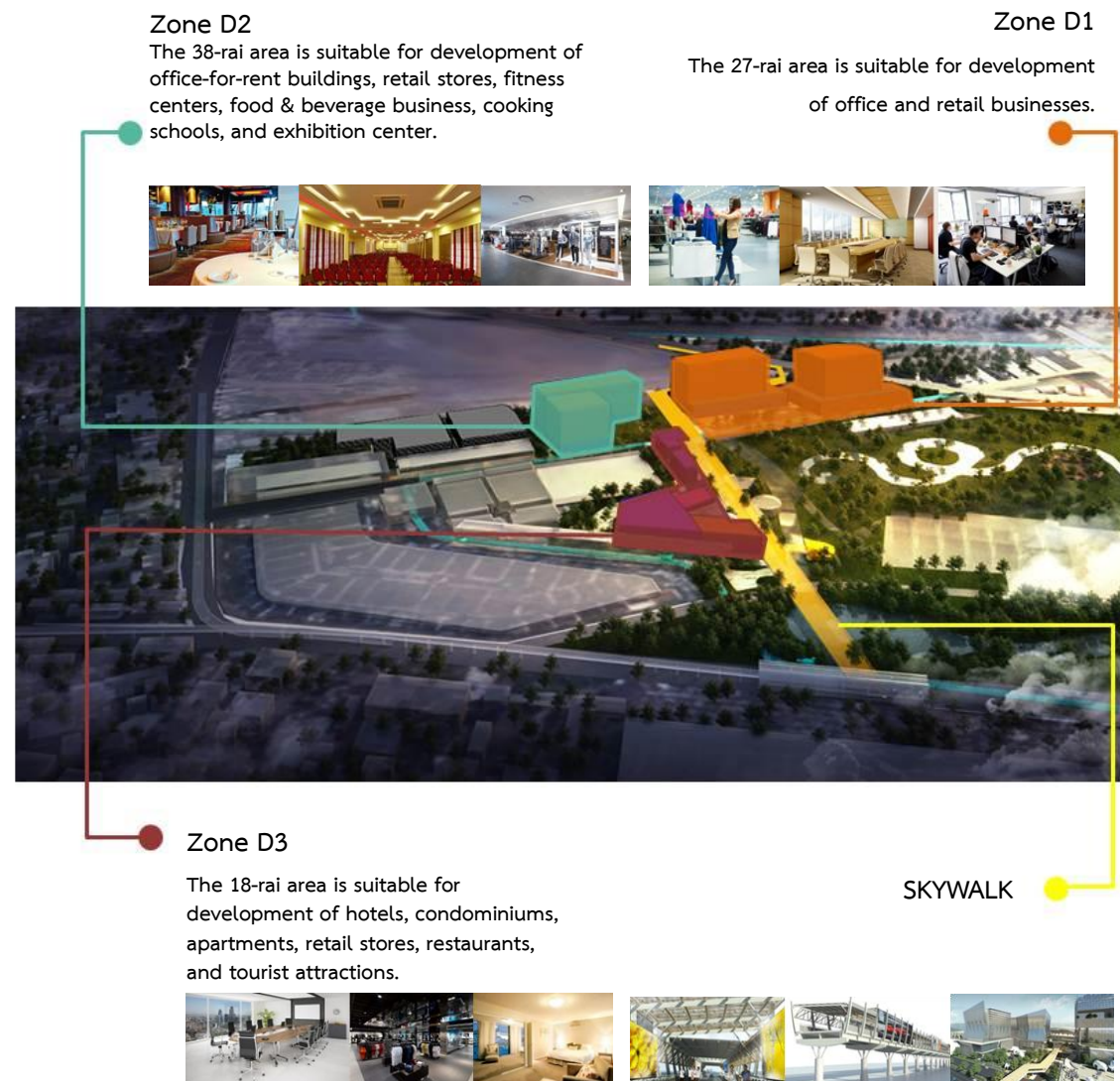
Table 12-1: BRT Implementation Plan under PPP Net Cost Scheme

No.	Works	Year												Period (Months)												Period (Months)	Responsible Agency														
		Month																																							
1	Project Study in Compliance with the Private Investments in State Undertakings Act B.E. 2556 (2013) (PPP Case)																																								
	1.1 Project Study in Compliance with the Private Investments in State Undertakings Act B.E. 2556 (2013)																											7.5	Consultants/OTP												
	1.2 Implementation by SRT																											18	SRT												
	1.3 Submission of Study Report to Ministry of Transport/SEPO/PPP Committee/Cabinet for Consideration of Investment Option																																							8.5	SRT/SRT Board of Directors/Ministry of Transport/SEPO/PPP Committee/Cabinet
2	Land Acquisition																																								
	2.1 Engagement of Property Surveyor																																							2	SRT
	2.2 Property Survey/Land Acquisition/Site Handover																																							10	SRT
3	Civil Works																																								
	3.1 Selection of Contractors																																							6	SRT
	3.2 Removal of Public Utilities and Civil Works																																							12	SRT
4	Procurement, Installation, and Operation Works																																								
	4.1 Appointment of Selection Committee (under Section 35)																																							0.5	SRT/SRT's Board of Directors
	4.2 Preparation of Draft Invitation to Tender, Draft TOR, and Draft Contract by the Consultants																																							4	Consultants/SRT
	4.3 The Selection Committee (under Section 35) considers Draft Invitation to Tender, TOR, and Draft Contract.																																							1	Selection Committee (Section 35)
	4.4 Invitation to Tender/Selection of Private Entity																																							7.5	Selection Committee (Section 35)
	4.5 The Selection Committee (under Section 35) proposes the selection result to SEPO and submits Draft Contract to AGO for examination. The Ministry of Transport proposes the project for the Cabinet's approval. Contract signing																																							4	Selection Committee (Section 35)/SEPO/Ministry of Transport/Cabinet/AGO
	4.6 Procurement and Installation Works																																							12	Private Investor
	4.7 BRT Installation Works																																							12/3	Private Investor

Note: Implementation Plan under PPP Net Cost Scheme (30-year Concession Period)

Source: The Consultants, 2016

Summary of Commercial Development in Zone D



Area of Zone D	80.86	rai		
Land Price (312,300 baht/sq.wah)	9,994	MB		
Maximum Development Area Pursuant to Laws (FAR: 8:1)	1,035,000	sq.m.		
Estimated Development Area	998,006	sq.m.		
Opening Year	2022			
Estimated Cost for Commercial Area (Zone D) ^{1,2}	19,549	MB		
Estimated Cost for Skywalk ^{1,2}	645	MB		
Total	20,194	MB		
Total Capital Cost ³	29,684	MB		
Project Benefits in Different Cases ⁴	30-year Case (Base Case)	30-year Case (Without Skywalk)	50-year Case	50-year Case (Without Skywalk)
Project NPV (MB)	7,166	8,013	17,866	18,728
Project Rate of Return (vs. WACC = 6.20%)	7.84%	8.07%	8.84%	9.02%
Rate of Return to Private Investor (Vs Ke=7.70%)	9.03%	9.41%	10.06%	10.34%
Minimum Return to SRT from Long-term Land Development Right (not Less Than x MB) consisting of:	> 3,598	> 3,598	> 5,996	> 5,996
	Not Less Than 36% of Land Price		Not Less Than 60% of Land Price	
1) Land Use Fee ⁵ (MB)	> 1,079	> 1,079	> 1,799	> 1,799
2) NPV of the Remaining Benefit ⁶ (MB)	2,518	2,518	4,197	4,197

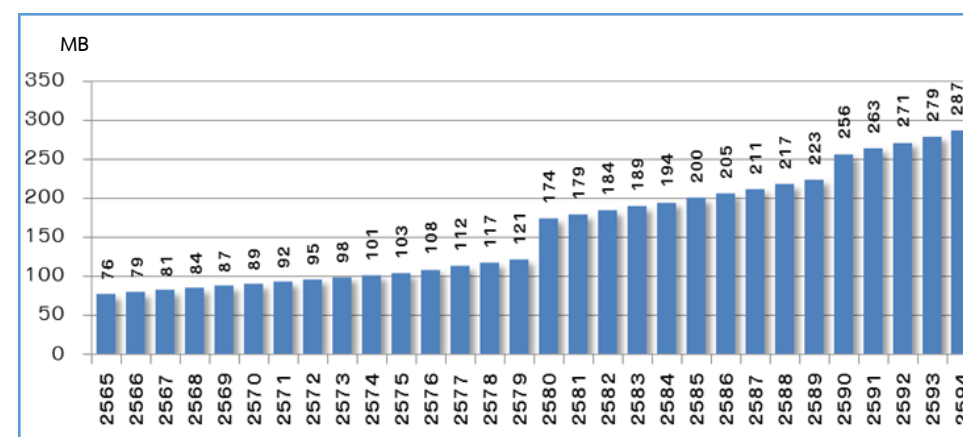
Notes

- 1) Excluding contingency, VAT, construction supervision cost, and loan interest during the construction period
- 2) 2016 prices
- 3) Including contingency (15%), VAT (7%), and loan interest (6.50% p.a.) during the construction period (D/E =1.5:1)
- 4) Project revenue will come from major businesses, e.g. hotel, office-for-rent building, shopping center, condominium, serviced apartment, and car parking building, excluding additional income from PR and advertising services for commercial buildings and connected walkways.
- 5) Payment required on the contract signing date
- 6) Payment by instalments throughout the project period

Summary of Feeder System (BRT) Development



Estimated Operation & Maintenance Cost of Feeder System (BRT) (MB)



Source: The Consultants, 2016

	Phase 1	Phase 2				
Opening Year	2022	2037				
Number of Stations	16	-				
Estimated Distance per Trip (km)	9.15	-				
Infrastructure Cost ^{1,2} (MB)	643	-				
Operation Control System Cost ^{1,2} (MB)	106	-				
Ticketing System Cost ^{1,2} (MB)	21	-				
Bus Procurement Cost ^{1,2} (MB)	289.00	385.00				
Number of Buses (Bus)	18	24				
Ridership Forecast	10 Baht/Trip		15 Baht/Trip		20 Baht/Trip	
2022	37,700		33,400		29,000	
2037	119,400		105,700		92,000	
2047	145,548		128,848		112,147	
Project Financial Returns ³	With Infrastructure	Without Infrastructure ⁴	With Infrastructure	Without Infrastructure ⁴	With Infrastructure	Without Infrastructure ⁴
FIRR	9.81%	17.76%	14.80%	25.81%	16.60%	29.50%
NPV (at 5.00% Discount Rate)	1,099	1,675	2,842	3,419	3,475	4,052
B/C Ratio	1.38	1.69	1.95	2.40	2.16	2.66
Fare-Revenue Sharing for Project Owner ⁵ (% of Fare Revenue)	N/A	15% - 25%	N/A	35% - 40%	N/A	42% - 50%
Payback Period for Investment in Infrastructure ⁶	N/A	13 - 17 Years	N/A	Approx. 9 Years	N/A	Approx. 7 Years

Notes

- 1) Excluding loan interest during the construction period
- 2) 2016 prices
- 3) The project financial returns were estimated based on the fare revenue only. The project's operation cost will be 76 million baht in the first year of service and will gradually increase to reach 287 million baht in the 30th year. The operation cost covers salary, fuel price, general maintenance cost, administrative cost as presented in the following figure. There is also maintenance cost at 7-year service interval of about 126 million baht/time (2016 price).
- 4) The without-infrastructure case means the government agency is responsible for investment in infrastructure and the private entity for procurement and operation of buses, control system and ticketing system.
- 5) It means the fare-revenue sharing provided to the project owner⁴ to ensure the private operator will receive the investment returns of about 12-15% (% of fare revenue).
- 6) Calculation is based on fare-revenue sharing compared to infrastructure investment cost.

