

Environmental Impact Assessment (Final)

Project Number: 51274-001
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THA: Bangkok Mass Rapid Transit (Yellow Line) (Part 4 of 6)

Prepared by The Mass Rapid Transit Authority of Thailand.

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Chapter 4

Environmental existing condition

The study of environmental existing condition around the project area is the study of the condition of the environmental resources of the project's development. It is used to be the essential information for an Environmental Impact Assessment which may occur during the construction and operation phase. And set up the prevention and mitigation measures including environmental monitoring and audit requirements. The study of environmental background is cover all 4 environmental aspects as well as physical environmental resources, biological environmental resources, human use values and quality of life value, as followed.

4.1 Physical Environmental Resources

4.1.1 Topography

1) Methodology

(1) Collect the geography's secondary data, the elevation of the area and the characteristics of the project and surrounding areas.

(2) Field surveys within and surrounding the project's areas, which are likely to hinder the operation of the project includes catchment area and soft ground etc.

(3) Impact Assessment of the landscape because of the project development. Including prescrib or recommend prevention and mitigation measures and environmental impact monitoring requirements.

2) Results

The area of the Yellow Line Mass project Transit (Lat Phrao - Samrong section) and adjoining areas within a radius of 500 meters. A distance of about 30 kilometers in the east of Bangkok, includes Chatuchak, Huay Khwang, Wang Thonglang, Bang Kapi, Suan Luang, Prawet and Bang Na and Samut Prakan province. The area south of the lower central plains. And slightly up to the northern Gulf of Thailand.

The geography of the city is mostly plain of the lower Central. The area has a maximum height of 1-3 meters above average sea level. Chao Praya river flows through the center of the city with no mountains, no forests; the soil is clay and sandy clay. The wettest in the rainy season. The area of more than 80 percent is suitable for in and off-season paddy field, crop farms, and orchards. Chao Phraya River is the only main rivers flows through the area.

The geography of Samut Prakan province; had Chao Praya River runs through the west and located at the far end of the river over the Gulf of Thailand. Most of the area are plain land and river plain. The area has a maximum height of 0.5-2 meters above average sea level, no mountains. The area of about 3 percent is forest, particularly mangrove forest. The soil is sandy clay. The wettest in the rainy season. The area is suitable for paddy field, crop farms, and salt-pond. At the southern coastal, the area is sea flood. In the dry season, the soil is extremely salty. Chao Phraya River is the only main rivers flows through the area.

The terrain along the project route shown in **Figure 4.1.1 - 1**, as detailed below.

(1) Project Route The area is the radius of 500 meters from the center of the route. In the east of Bangkok and Samut Prakan province. The details are as follows

- **Bangkok** comprises seven districts, including Chatuchak, Huay Khwang, Wang Thonglang, Bang Kapi, Suan Luang, Prawet and Bang Na.
- **Samut Prakan province** consists of two districts: Bang Phli and Muang Samut Prakan.

Geography along the entire route are lowland, at an altitude of about 0.5 to 3.0 meters above average sea level. Most of the area are the community, commercial district. There are some wilderness/empty areas. The route cuts through 19 waterways, including Bang Sue canal, Lat Phrao Canal, Saen Saeb canal, Hua Mak canal, Prawet Buri Rom canal, Old Phra Khanong canal, Samrong canal, etc. With 217 key sensitive areas on the environmental impact, such as Lat Phrao Hospital, Chularat 2 Hospital, Suan Luang church, Fut Hul Bari Mosque, Thanornpitvithaya School, Klongkratumratutid school, etc.

(2) The Depot. Located on approximately 112 rais of open space on the east of Srinagarindra Road. The surrounding area is plain. Nearby attractions include Sri Charoen Square Mall, Government/Enterprise (Samut Prakan Highway District and Highway information unit), Residential areas (VR Mansion, Premruethai Village (Udomsuk), etc.), gas station (BCP) and one sensitive area is Si lam Temple (300 meters away).

(3) Park and Ride buildings. Park and Ride buildings located on the Entrance-Exit of Buraphavithi highway and Bang Na - Trat Road by using space measuring 63,850 square meters (39.9 rais). The surrounding areas are plains with open space, consists of landmarks as well as Novotel Bangna Hotel, Maple Hotel, Empire Tower, Phairojkiija Building, Central Bangna Department Store, Big C, Bangna Complex, Supalai Condominium, Premruethai Technology, The Nation Building, Samut Prakan District Revenue Office, Premruethai Village. The three major sensitive areas are Si lam Temple, Thai-Nakharin Hospital, and International Community School.

4.1.2 Soil Resource

1) Methodology

(1) Collect and analyze data from the condition of the soil resource and soil properties, along the project route and adjoining areas such as soil type, properties and capability/potential of soil and problems of soil erosion and soil leaching, etc. By collection of the documents/reports, such as The survey report on the suitability of soil, Land Development Department (2519).

(2) Collect and review information related to resources such as Soil Series map scale 1: 50,000 and soil descriptions of Land Development Department

(3) Assessment of soil resources impacts from the development of the project. Suggested the prevention and mitigation measures and appropriated monitoring program to the project.

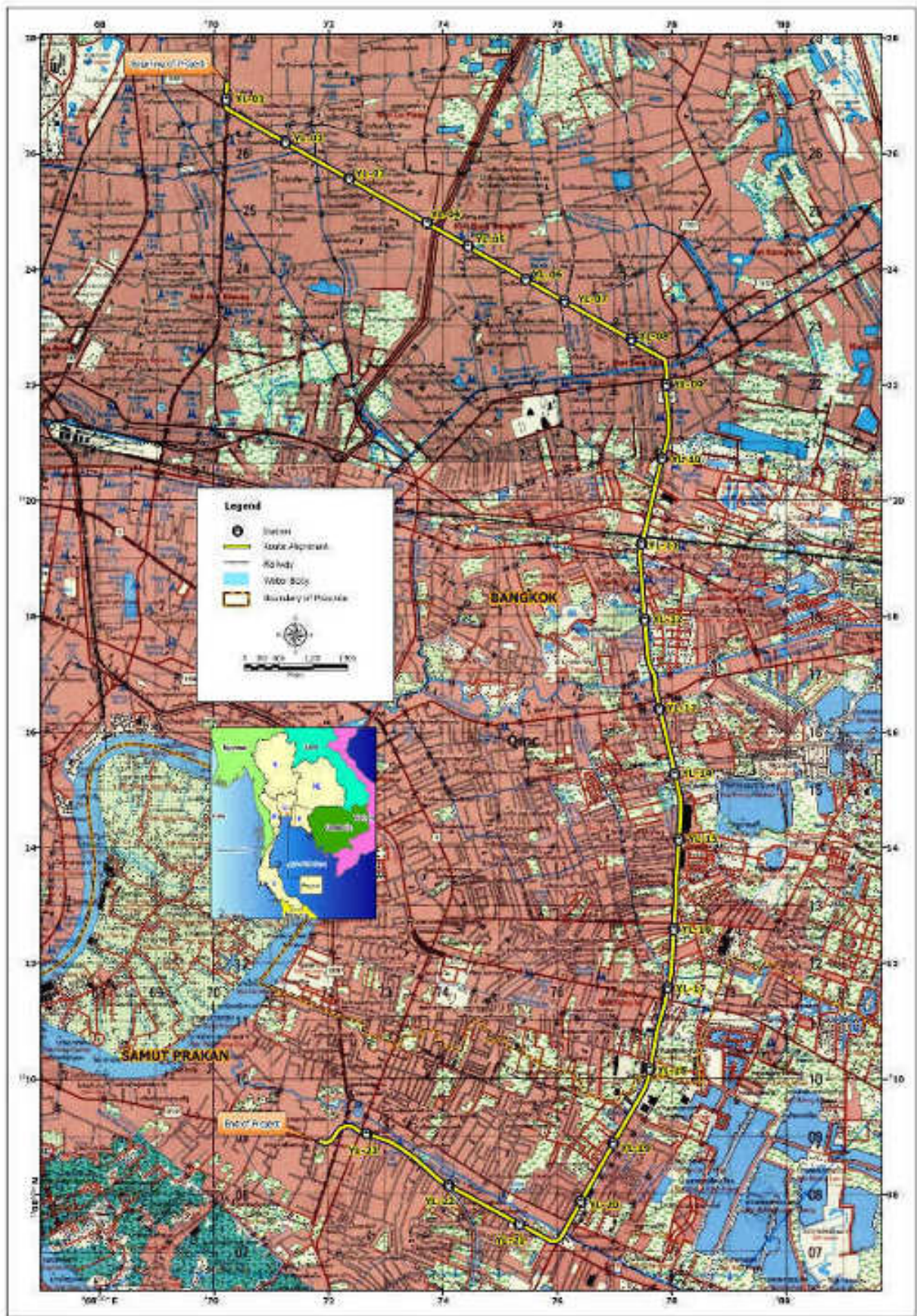


Figure 4.1.1 - 1 Topography condition along the project route

2) Results

Study results and analyze the status of soil and soil properties in a radius of 500 meters from the center of the project's route. The project area has geological morphology and soil type as below.

(1) Geomorphology

Geological morphology of the project area can be separated into 3 types according to the soil parent materials which being borne to deposit as below.

(1.1) Active Tidal Flats: Adjacent shore of the Gulf of Thailand. Tidal flats slightly above sea level, to about 1 meter. The soil is clay or silty clay with high salt content. Most areas will be sea flooded during the monsoon season. But the lower shore is sea flooded on a regular basis every day.

(1.2) Former Tidal Flats with recent marine and brackish water deposits: This area is up next to the tidal flat area. Mainly in the altitude of about three meters above sea level, the soil is clay or loamy clay with dark gray, deep down about 1 - 1.8 meter is a layer of clay with pale gray. The reaction is high and always found an unfroze manganese nodules on the top of the layer.

(1.3) Former Tidal Flats with older brackish water deposits: Found in both sides of Chao Phraya river. Lowland areas average height of 2 meters above sea level. The total areas are the rice field. The soil is clay with black color and deep. Soil pH is very acid.

(2) Properties and Type of Soil

According to the soil survey report 2006 of soil survey division, Land Development Department in a detailed reconnaissance scale 1: 100,000. Found that typical soil properties of Bangkok occur from three methods as the deposition of seawater sediment on the estuary, the deposition of brackish water or marine water sediments on the former tidal flats and the deposition of brackish water sediments deposited marine water sediment on the former tidal flats. Top and lower soil texture are clay or silty clay. The soil is very deep. The drainage is poor to very poor with medium fertile. Soil pH is very strongly acid to moderately alkaline. Strongly saline soils found in the active tidal flats. The strongly acid of soils due to the high accumulation of Jarosite. Soil properties in Bangkok. Most of the soil particles comply of clay, which is the top layer of soft soil thickness of 15 - 20 meters, divided into two parts.

- The top layer thickness of about 3-5 meters from the surface down. Occurred from the sedimentation of marine water in the Gulf of Thailand mixed with the sediment being swept from the north of the country.

- Subsoil depth of about 5-12 meters. Mostly occurred from the precipitation of sea water. The soil is in a soft to very soft condition, very ready to flow and collapse when there was an impact. Very high ratio of water content in the soil texture. The collapse did not happen all of a sudden. It collapsed after a Phase of years.

Soil type in Bangkok; Bangkok Clays will be found at the Delta alluvial plains of the Mae Klong River, and other branches of the river suitable for growing rice transplanted. If it is ditching will be suitable for vegetable gardens and orchards. This black clay area is a source of

massively rice fields as left for export. The ditches areas are orchard and vegetable garden in the Thonburi area, Nonthaburi and Samut Songkram province.

The soil series map data from the Land Developments Department (2006) found that the project's route cuts through 5 soil series, including Bangkok series, Bang Khen series, Thonburi series, Chachoengsao series and Samut Songkram series. Soil series map along project route as shown in **Figure 4.1.2 - 1**. Each soil series are detailing the properties of the soil.

Bangkok Series: Bk. Found on the plains, away from coastal and not flood. The area is almost flat, deep soil, poor drainage. The water holding capacity is high. The soil in all layers has low permeability. Topsoil layer of about 25 - 30 cm. depth. Soil texture is clay or silty clay. Soil background color is gray to gray-olive with a patch of russet or light brown-olives. Soil reaction is neutral to mildly alkaline. pH of about 7.0 to 7.5. In this soil type found black clumping of Manganese and Iron which soft to moderately rigid mixing scatters in the depths below 125-150 cm. The soil is liquidity soft with gray-dark green color. Cross section of soil series along project route as shown in **Figure 4.1.2 - 1**.

Bk is moderately high to high fertility, which is a top one for rice field. If there is enough water the second crop rice or dry crops as beans, corn, watermelons can be planted in the dry season. For dry crops will have a problem with drainage. Because the clay is poor drainage and high groundwater levels which are harmful to plant roots. Transplanted rice cultivation yield in Bk is 400 kg per rai if use fertilizer the yield is greater. This soil series sometimes are in the relatively high area, often lack water.

Bang Khen series: Bn. Found on the plains, away from the coast and rivers. Flooded only in rainy season. The area is flat, deep soil, poor drainage. Water holding capacity is high. The soil in all layers has low permeability. Soil depth of about 30 cm. with clay texture. Soil background color is very dark gray to black with a patch of dark brown or red-yellow. Soil reaction is slight to medium acid, pH of about 6.0 to 6.5. On top of this layer is found crystals of gypsum. The yellow patch of sulfur compounds (Cat Clay) was not identified, may be found at a depth of less than 100 cm. Cross section of soil series along project route as shown in **Figure 4.1.2 - 1**.

Bn is moderately high fertility, which is a good soil suitable for rice field. Cultivate, in the areas that close to the canals, can plant the second crop rice. This soil is not appropriate for dry crops due to often flooded and poor drainage. Besides, elevated ditching can be plant vegetable and crops.

Thon Buri series: Tb. Commonly found in the river plains. The area is flat, deep soil, poor drainage. Water holding capacity is high; permeability is low. Topsoil depth 40-70 cm. Soil texture is clay or silty clay. Soil background color is brown with a gray patch. Soil reaction is slightly to strongly acid with pH of about 5.5 to 6.5. The subsoil is clay or silty clay with the background color is gray to gray-olive. A patch of brown-yellow and light brown-olive. Soil reaction is moderate to strongly alkaline. pH of about 8.0 to 8.5. In this soil type found soft clumping of Manganese. Cross section of soil series along project route as shown in **Figure 4.1.2 - 1**.

Tb is moderately fertility but most suitable for orchards and vegetable gardens. In some areas do dry crops and growing rice between ditch. The problem of this soil series is in the very dry year, the river level is low, it will be flooded with saline water causing damages to the plantation.

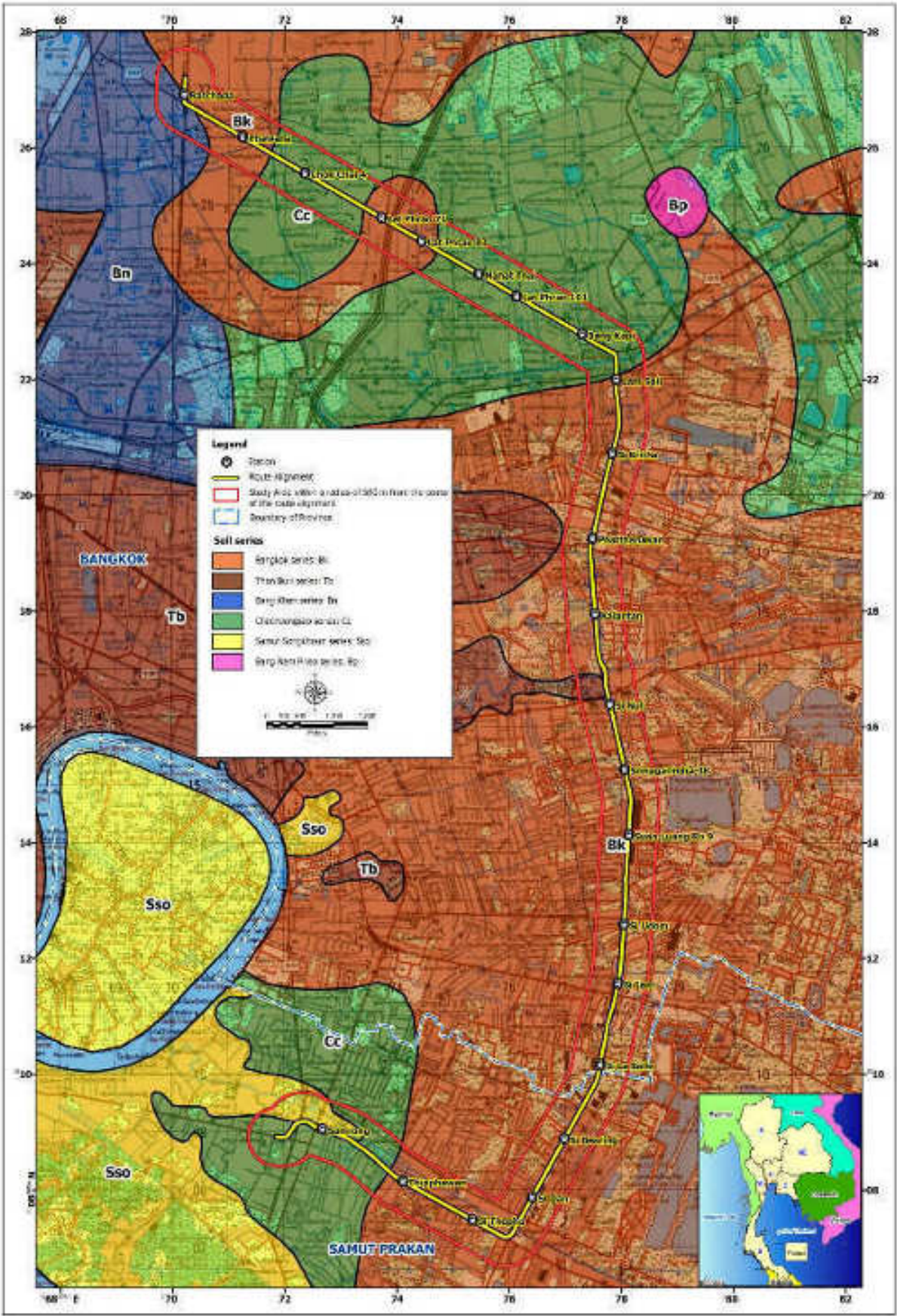


Figure 4.1.2 - 1 : Soil Series Map along the Project Route



Bk : Bangkok series



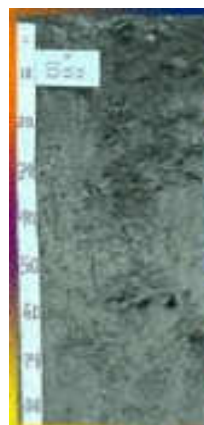
Bn : Bang Khen series)



Tb : Thon Buri series



Chachoengsao, Clay No.19



Samut Songkhram series, No.5

Source : Land Development Department, 1976.

Photo 4.1.2 - 1 : Soil Series Profile along the Project Route

Chachoengsao: Clay no.19. Found on the plains, away from coastal and not flood. The area is flat, deep soil, poor drainage. The water holding capacity is high. Soils have low permeability. Topsoil layer of about 20 cm. depth. Soil texture is clay. Soil background color is dark gray with a patch of brown or red-yellow. Soil reaction is strongly acid. pH of about 5.5. The subsoil is clay with the background color is brown-gray to gray. A patch of red and yellow-brown and few yellow patch in the depth are less than 100 cm. Soil Reaction is slightly acid. pH of about 6.5. Cross section of soil series along project route as shown in **Figure 4.1.2 - 1**.

Clay no.19 is moderately fertility, but the soil is not strongly acid, and the subsoil is slightly acid which is suitable for paddy field. Increasing the fertility of soil by adding the fertilizer to neutralize the top soil will increase the rice's production. Typically, this soil series use to cultivate transplanted rice but in some areas grow broadcasting rice.

Samut Songkhram series: no.5. Found in the coastal plains. The area is flat, deep soil, poor drainage. The water holding capacity is high. Soils have moderately high permeability due to having a lot of root plant and crab holes. Topsoil layer of about 30-50 cm. depth. Soil texture is clay. Soil background color is brown or dark brown with a few patch of gray. Soil reaction is moderately alkaline. pH of about 8.0. The subsoil is clay in the depth of 80 - 100 cm. The background color is brown-gray or gray-olive. At the depth, more than 100 cm is gray-dark green. Soil reaction is strong alkaline. pH of about 8.5. Cross section of soil series along project route as shown in **Figure 4.1.2 - 1**.

Found in the coastal plains. The area is flat, deep soil, poor drainage. The water holding capacity is high. Soils have moderately high permeability due to having a lot of root plant and crab holes. Topsoil layer of about 30-50 cm. depth. Soil texture is clay. Soil background color is brown or dark brown with a few patch of gray. Soil reaction is moderately alkaline. pH of about 8.0. The subsoil is clay in the depth of 80-100 cm. The background color is brown-gray or gray-olive. At the depth, more than 100 cm is gray-dark green. Soil reaction is strong alkaline. pH of about 8.5.

(3) Erosion

Erosion and stability of soil in the Bangkok Metropolitan Region data were collected and considered from landslide hazard map of the Land Regional Office 1 covers the lower central of the LDD 2001, and sinkhole data of the Department of Mineral Resources, 2007. Found that the areas along the route and adjoining areas within a radius of 500 meters are located in the Bangkok Metropolitan Region. It is an area with very low potential for landslides and were not in areas where there is potential for the sinkhole. The terrain is mostly flooded plain, height not exceeding 2 meters above mean sea level. The slope of no more than 2 percent. The average annual rainfall in the 30-year Phase (AD 1981-2010) of Donmuang Airport air monitoring Station No.s, Meteorological Department has a value of 1,376 mm. The soil form is mostly alluvial, which was sediments occurring from abundant of inland water. Soil texture is clay to clay loam. currently, these land utilization is a residential community, commercial/business areas and partially comprises with the wilderness areas etc.

4.1.3 Geology and Earthquake

1) Methodology

(1) Collect and analyze geological conditions data along project route and bordering areas in a radius of 500 meters from the various documents and reports.

- Thailand Geological Map scale 1:1,000,000 of the Department of Mineral Resources, 1999 and Plain Geological Map of Lower Central Plain scale 1:250,000 of the Department of Mineral Resources, 1976.

- Information on faults and earthquake risk in Thailand from the Active Faults Map of the Department of Mineral Resources, 2006.

- Information on earthquakes in Thailand since 1975 to present, record on earthquakes of the Meteorological Department, 2008 and map Thailand earthquakes risk-prone areas (2nd updated) of the Department of Mineral Resources, 2005.

(2) Earthquake Impact Assessment from the fault along the project route.

2) Results

(1) Geology

BTS route and bordering areas in a radius of 500 meters located on the lower Chao Phraya River plain or Chao Phraya basins (covering the areas ranging from the source of Chao Phraya River, Paknampho district, Nakhon Sawan province down south and out to the Gulf of Thailand in Samut Prakan province). It is a vast plain with a length of about 200 km. (from Chainat province to the mouth of Chao Phraya River) and a width of about 180 km. (from Nakhon Pathom province to Chaochaengsao province). Since the lower Chao Phraya River plain or Chao Phraya basins is deep, thus the thickness of the embedment occurring from sedimentation in Quaternary is about 300-2,000 meters. The thickness of sediment depended on the geology of bedrock at the bottom layer. This sediment had been divided into 2 major groups. The geology along the project route and adjoining areas within a radius of 500 meters, as shown in **Figure 4.1.3 - 1**.

(1.1) Sediment in Pleistocene Phase occurring from abundant of inland water consisting of gravel, sand, and claystone. A top layer is a stiff clay with gray to light brown color, but a patch of orange and red inserted in the sediment, mixed with iron and manganese granules and lime pellets. Some areas are the layer of lateritic soil that represents the top surface of the sediment in Pleistocene era. Reflecting the open space in the past which were the alluvial plains and had a depth of about 10-20 meters above mean sea level.

(1.2) Sediment in Holocene Phase occurring from changing in sea level in Holocene era. It is the process by which the lower central plain or, the lower Chao Phraya river plain was widely flat. The sediment accumulation was quick, especially in areas where the Chao Phraya river mixed with the sea water at estuaries. The flow speed of the Chao Phraya river decreases causing sedimentation at the river mouth and extended called "Chao Phraya Delta". According to geomorphology and occurring of the marine sediments which accumulated in the lower central plains. Mostly from the tidal process. The sea water flows in-out through the river/canal and many waterways in the lower central plain.

Geological foundation along the project route, mostly is soft to moderately hard of the clay layer. A thickness ranging from 13:00 to 20:00 meters down to the layer of hard clay with thicknesses ranging from 1.50 to 13.50 laid on the sand floor with a thickness of about

EXPLANATION

Sedimentary and Neotectonic

- Yellow line: Proposed Diversion Route (21st)
- Circle with dot: Station
- Black line: Road Alignment
- Blue line: River
- Red line: Boundary of 100-year flood plain
- Blue area: River Body
- Dashed line: Boundary of Province

BANGKOK

QMC

SAMUT PRAKAN

Start of Project

End of Project

YL-01, YL-02, YL-03, YL-04, YL-05, YL-06, YL-07, YL-08, YL-09, YL-10, YL-11, YL-12, YL-13, YL-14, YL-15, YL-16, YL-17, YL-18, YL-19, YL-20, YL-21

AEC/HC/D2A/WE/ENRICH/PSG

(2) Earthquake

Yellow Line Mass Transits Project (Lat Phrao - Samrong section) is located in the east of Bangkok area including Chatuchak, Huay Khwang, Wang Thonglang, Bang Kapi, Suan Luang, Prawet and Bang Na and Muang district, Samut Prakran province. This area is located on the Eurasian Plate, which is surrounded by other 2 plates were Indian Plate) or Indian - Australian Plate and Pacific Plate, which is relatively earthquake-free.

For the earthquake with seismic effected Thailand occurred in 2 areas that the earthquake have epicenter outside Thailand i.e. in Myanmar, the southern region of China, Lao PDR., Andaman Sea and earthquake which had center inside Thailand, mostly laying in the west i.e. Mae Tha Fault, Sri Sawat fault, and Ranong fault etc. The map of an active fault in Thailand, 2006 as shown in **Figure 4.1.3 - 2**.

The projects do not locate near any major faults; the nearest fault is in the west. A distance of 300 kilometers, including Three Pagoda fault, which lies across Thong Pha Phum district and Sangkhlaburi district, Kanchanaburi province in the northwest - southeast, length of about 60 kilometers.

From the collected data of Seismological Bureau, Thai Meteorological Department on the major earthquake that caused damage to the country found that there had no earthquake which had the center in the Bangkok Metropolitan Region. The importance of earthquake data in the country as shown in **Table 4.1.3 - 1**. And the heart of the quake which in Thailand and neighboring countries as shown in **Table 4.1.3 - 3**. However, the earthquake on 26 December 2004 with the center in North Sumatra, Indonesia, a magnitude of 9.3 Richter. Seismology can be felt even at Bangkok and the region, especially the buildings and constructions with a height more than three stories. No damage was reported in any of the buildings. The monitoring of Seismic Risk Map of Thailand of Department of Mineral Resources, 2nd edition, 2005 as shown in **Figure 4.1.3 - 4**. The project's route are in Bangkok and Samut Prakran province, which is located in zone 2 kor (intensity V-VIII mercully) is a risk of damage in the low to moderate levels, poorly designed buildings can be damaged.

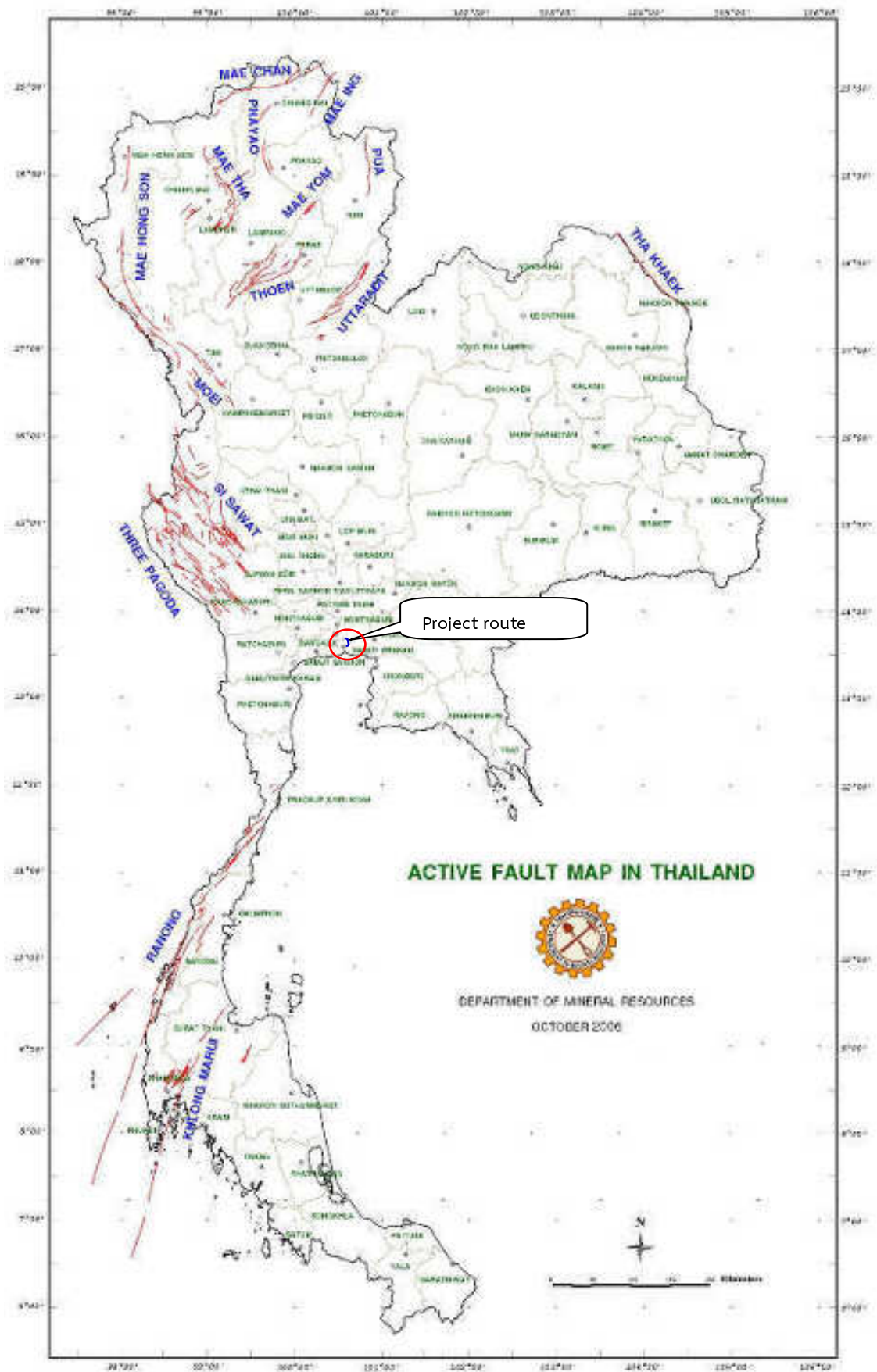
4.1.4 Surface Water Quality

1) Methodology

(1) Collect and review the secondary data of the waterways that the project's route will cut through, including the name, the cuts through location. Considered from the topographic map 1: 50,000 and field survey.

(2) Collect and review the secondary data on surface water quality from various related government agencies.

(3) Sampling the surface water in the river that the project's route cuts through on 1 July 2013 to clear assessment the impact of water pollution contaminated from the development of the project. And can be used as a reference for the future environmental impacts monitor program. The leaching of rain water will be the key factor to water pollution contamination problems, such as erosion of oil sediment into the waterway, etc.



Source : Department of Mineral Resources, 2006.

Figure 4.1.3 - 2 Active fault zone in Thailand (2006)

Table 4.1.3 - 1 Importance Earthquake Statistics of Thailand

Date	Time (Local time)/ Magnitude/Intensity	Center/Region	Event record
17 Feb. 1975	10:38, 19:08/5.6	Thailand - Myanmar border region	Earthquake center at Tha Song Yang District, Tak Province, minor damaged in Northern and Central parts of Thailand and Bangkok
26 May 1978	06:22, 29:1/4.8	Phrao District, Chiang Mai Province	Felt the earthquake 15 second at Chiang Rai, Chiang Mai and Lampang Provinces, minor damaged in Phrao District, Chiang Mai Province
22 Apr. 1983	07:37, 10:21 /5.9, 5.2	Si Sawat District, Kanchanaburi Province	Felt the earthquake 2 times (07:37, 10:21) at Central and Northern parts of Thailand, many people felt panic, minor damaged in Bangkok
1 Oct. 1989	01:19, 23.3/5.3	Thailand - Myanmar border region	Felt the earthquake at Northern part of Thailand, many people felt panic, minor damaged in Chiang Mai and Chiang Rai Provinces
11 Sep. 1994	03:34 /5.1	Phan District, Chiang Rai Province	Felt the earthquake at Chiang Rai Province, some area damaged near earthquake center at Phan District e.g. hospital, temple and school
12 Jul. 1995	04:46/7.2	Myanmar	Felt the earthquake at high building in Bangkok and Northern part of Thailand, minor damaged in Chiang Rai Province
9 Dec. 1995	20: 26 /5.1	Rong Kwang District, Phrae Province	Felt the earthquake at Chiang Mai, Chiang Rai, Lamphun, Lampang, Phayao, Phrae, Uttaradit, Nan Provinces, minor damaged in Phrae Province
21 Dec. 1995	23:30 /5.2	Phrao District, Chiang Mai Province	Felt the earthquake at Chiang Mai Province, minor damaged near earthquake center at Phrao District
22 Dec. 1996	00:51 /5.5	Thailand - Laos border region	Felt the earthquake at Mueang Chiang Mai District, minor earthquake damaged at Mueang Chiang Rai District, Chiang Rai Province
20 Jan. 2000	03: 59 /5.9	Laos	Felt the earthquake at some area in Thailand, minor damaged at Nan and Phrae Provinces
2 Jul. 2002	10:54 /4.7	Chiang Saen District, Chiang Rai Province	Felt the earthquake and minor damaged at Chiang Saen and Chiang Khong Districts, Chiang Rai Province
22 Sep. 2003	01:16 /6.7	Myanmar	Felt the earthquake at some high building in Bangkok

Table 4.1.3 - 1 Importance Earthquake Statistics of Thailand (Cont'd)

Date	Time (Local time)/ Magnitude/Intensity	Center/Region	Event record
3 Feb. 2004	24:58 /1.9	San Sai District, Chiang Mai Province	Felt the earthquake at San Sai and Doi Saket Districts, Chiang Mai Province
27 Mar. 2004	11:05 /3.4	Mae Suai District, Chiang Rai Province	Felt the earthquake at Mae Suai District, Chiang Rai Province
6 Apr. 2004	11:49 /3.1	Mueang District, Chiang Rai Province	Felt the earthquake at Mueang District, Chiang Rai Province
30 May 2004	23:53 /2.0	San Sai District, Chiang Mai Province	Felt the earthquake at San Sai District Chiang Mai Province
11 Sep. 2004	08:30 /3.7	Samoeng District, Chiang Mai Province	Felt the earthquake at Samoeng, Hang Dong District and Mueang Chiang Mai District, Chiang Mai Province
17 Sep. 2004	18:25/5.8	Andaman sea	Felt the earthquake at high building in Bangkok
26 Dec. 2004	07:58 /9.0	Western Sumatra Island	Felt the earthquake at Southern part of Thailand including many high building in Bangkok. Tsunami surged at South-West area caused massive destruction and more than 10,000 people were killed.
26 Dec. 2004	08:30 /6.4	Myanmar	Felt the earthquake at Southern part of Thailand and high building in Bangkok
27 Dec. 2004	16:39 /6.6	Andaman sea	Felt the earthquake at Phuket Province
30 Dec. 2004	08:07, 08:13/ 5.4, 5.6	Myanmar	Felt the earthquake at Mueang Chiang Mai District, Chiang Mai Province
28 Mar. 2005	23:10/8.5	Western Sumatra Island	Felt the earthquake at Southern part of Thailand, warning people to evacuate at Phuket Province
19 May 2005	12:05/6.8	Western Sumatra Island	Felt the earthquake at Southern part of Thailand and some high building in Bangkok
5 Jul. 2005	22:42/6.8	Northern Sumatra Island	Felt the earthquake at Phuket Province
24 Jul. 2005	22:42/7.2	Nicobar Islands, India	Felt the earthquake at Phuket Province and warning people to evacuate
18 Sep. 2005	14:26/6.0	Myanmar-India border region	Felt the earthquake at high building in Chiang Mai Province
11 Oct. 2005	22:05/6.2	Northern Sumatra Island	Felt the earthquake at Phang Nga and Phuket Provinces
19 Nov. 2005	21:10/6.1	Northern Sumatra Island	Felt the earthquake at Phang Nga and Phuket Provinces
4 Dec. 2005	16:34/4.1	Chiang Mai Province	Felt the earthquake at high building in Chiang Mai and Lamphun Provinces

Table 4.1.3 - 1 Importance Earthquake Statistics of Thailand (Cont'd)

Date	Time (Local time)/ Magnitude/Intensity	Center/Region	Event record
7 Dec. 2005	16:02/3.9	Chiang Rai Province	Felt the earthquake at Mae Suai District, Chiang Rai Province
15 Dec. 2005	13:48/4.1	Chiang Rai Province	Felt the earthquake at Mueang Chiang Rai and Thoeng Districts, Chiang Rai Province
16 Dec. 2005	09:13, 09:14/ 3.8,3.9	Chiang Rai Province	Felt the earthquake at Pa Daet District, Chiang Rai Province
24 Jan. 2006	20:42/5.7	Shan state, Myanmar	Felt the earthquake at Chiang Mai, Chiang Rai and Mae Hong Son Provinces
16 Mar. 2006	20:34/3.0	Chiang Mai Province	Felt the earthquake at Chom Thong, Mae Wang, Mueang Chiang Mai District, Chiang-Mai Province
13 Jul. 2006	07:28/3.0	Chiang Mai Province	Felt the earthquake at Hang Dong District, Chiang Mai Province
6 Oct. 2006	12:15/3.4	Chiang Mai Province	Felt the earthquake at Chiang Dao District, Chiang Mai Province
27 Sep. 2006	21:30,23.15/4.8	Myanmar	Felt the earthquake at Prachuap Khiri Khan Province
28 Sep. 2006	00:35,01.45/4.6,5.0	Myanmar	Felt the earthquake at Prachuap Khiri Khan Province
8 Oct. 2006	04:17/5.6	Myanmar	Felt the earthquake at Phetchaburi, Ratchaburi, Prachuap Khiri Khan and Samut Songkhram Provinces, minor damaged in buildings at Prachuap Khiri Khan Province
21 Oct. 2006	08:59/4.5	Thailand-Laos border region	Felt the earthquake at Mae Sai and Mueang Chiang Rai Districts, Chiang Rai Province
17 Nov. 2006	01:39/4.4	Phan District, Chiang Rai Province	Felt the earthquake at Phan and Mueang Chiang Rai Districts, Chiang Rai Province
1 Dec. 2006	10:58/6.5	Eastern Sumatra Island	Felt the earthquake at Hat Yai District, Songkhla Province and Narathiwat Province
13 Dec. 2006	00:02/5.1	Mae Rim District, Chiang Mai Province	Felt the earthquake most area in Chiang Mai Province and high building in Chiang Rai Province
19 Dec. 2006	07:03/2.7	Mae Rim District, Chiang Mai Province	Felt the earthquake at Mae Rim District, Chiang Mai Province
23 Dec. 2006	15:51/3.6	Mae Rim District, Chiang Mai Province	Felt the earthquake at Mae Rim District, Chiang Mai Province
6 Jan. 2007	18:51/3.1	Mae Rim District, Chiang Mai Province	Felt the earthquake at Mueang Chiang Mai and Mae Rim Districts, Chiang Mai Province

Table 4.1.3 - 1 Importance Earthquake Statistics of Thailand (Cont'd)

Date	Time (Local time)/ Magnitude/Intensity	Center/Region	Event record
22 Apr. 2007	13:18/4.5	Wiang Pa Pao District, Chiang Rai Province	Felt the earthquake at Wiang Pa Pao District, Chiang Rai Province and Phayao Province
27 Apr. 2007	15:03/6.1	Northern Sumatra Island	Felt the earthquake at Phuket Province
15 May 2007	21:35/5.1	Laos- Myanmar border region	Felt the earthquake at Chiang Rai Province
16 May 2007	15:57/6.1	Laos - Myanmar border region	Felt the earthquake at Northern area of Thailand and high building in Bangkok
19 Jun. 2007	12:06/4.5	Mae Rim District, Chiang Mai Province	Felt the earthquake at Mae Rim District, Chiang Mai and Lamphun Province
23 Jun. 2007	15:17,15:27/5.5,5.2	Myanmar	Felt the earthquake at Chiang Saen District Chiang Rai Province and high building in Bangkok
12 Sep. 2007	18:10/8.4	Southern Sumatra Island	Felt the earthquake at high building in Bangkok
13 Sep. 2007	10:35/7.1	Southern Sumatra Island	Felt the earthquake at high building in Bangkok
16 Oct. 2007	13:47/5.0	Northern Laos	Felt the earthquake at Chiang Rai Province
2 Nov. 2007	02:05/5.7	Myanmar - Laos - China border region	Felt the earthquake at Chiang Rai Province
28 Dec. 2007	12:24/5.7	Northern Sumatra Island	Felt the earthquake at high building in Phuket and Pang Nga Provinces
20 Feb. 2008	15:05/7.5	Northern Sumatra Island	Felt the earthquake at high building in Bangkok and Phuket Province. There is a very small possibility of a local Tsunami.
22 Apr. 2008	02:31/3.9	Mae Rim District, Chiang Mai Province	Felt the earthquake at Mae Rim District, Chiang Mai Province
12 May 2008	13:27/7.8	Sichuan, China	Felt the earthquake at high building in Bangkok, around 20,000 people died in China
1 Jul. 2008	16:45/3.8	Phrao District, Chiang Mai Province	Felt the earthquake at Chiang Mai Province
21 Oct. 2008	19:24/5.7	Myanmar-China border region	Felt the earthquake at high building in Bangkok, many people were injured and one were killed in China.
22 Sep. 2008	20:30/5.2	South coast of Myanmar	Felt the earthquake at high building in Bangkok
23 Dec. 2008	13:38/4.1	Phrasaeng District, Surat Thani Province	Felt the earthquake at Phra Saeng District, Surat Thani Province
30 Sep. 2009	17:16/7.9	Central Sumatra Island	Felt the earthquake at Bangkok, around 1,000 people were killed in Indonesia.

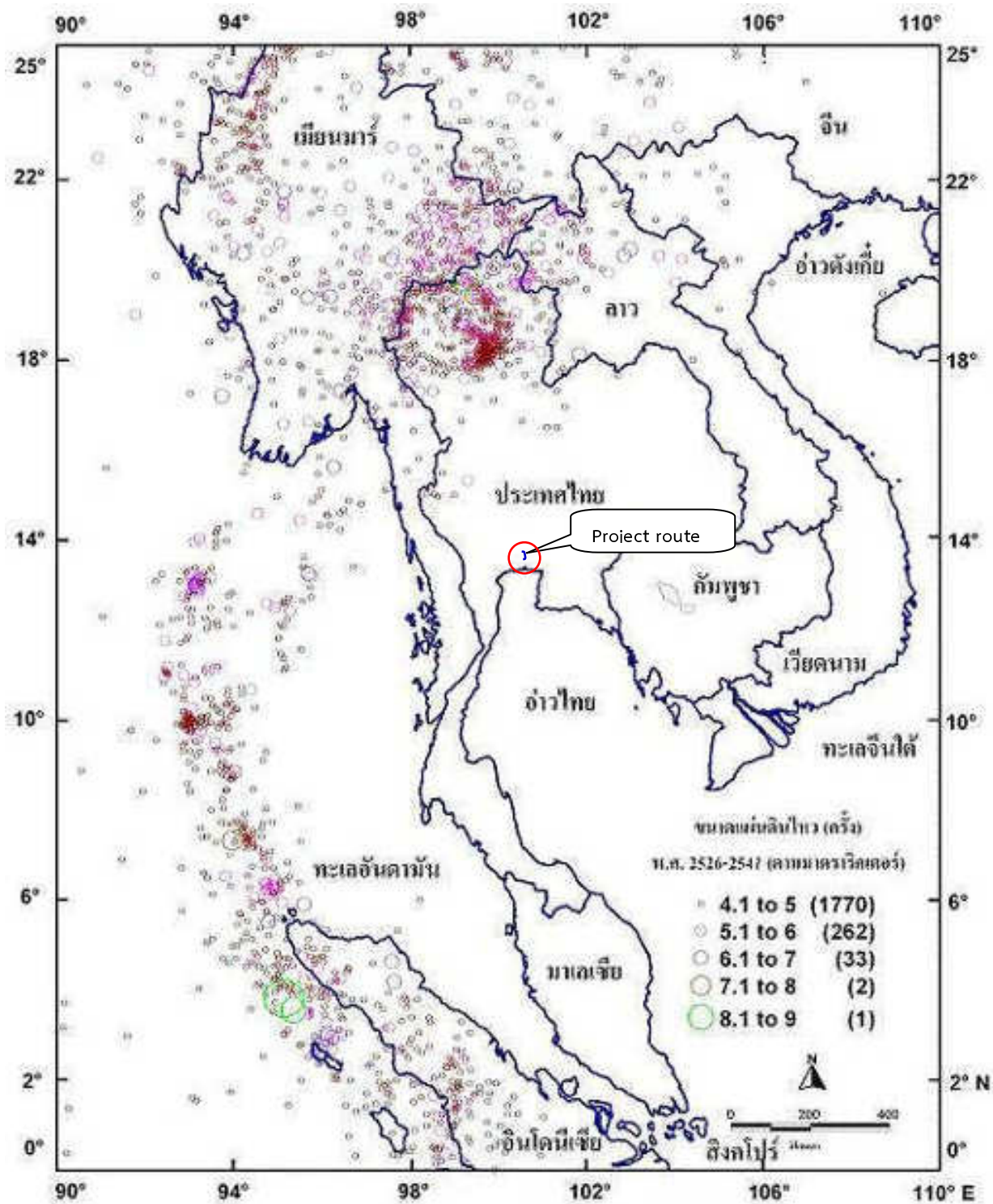
Table 4.1.3 - 1 Importance Earthquake Statistics of Thailand (Cont'd)

Date	Time (Local time)/ Magnitude/Intensity	Center/Region	Event record
20 Mar. 2010	02:53/5.0	Myanmar	Felt the earthquake at Chiang Rai Province
5 Apr. 2010	6:42/3.5	Wiang Chai District, Chiang Rai Province	Felt the earthquake at Mueang District, Chiang Rai Province
7 Apr. 2010	05:15/7.6	Northern Sumatra Island	Felt the earthquake at high buildings in Bangkok
9 May 2010	19:59/7.3	Northern Sumatra Island	Felt the earthquake at high building in Bangkok, Phuket, Pang Nga, Surat Thani and Songkhla Provinces
6 Jul. 2010	22:23/4.5	Myanmar	Felt the earthquake at Mae Sai, Mae Chan, Chiang Saen and Mae Fa Luang Districts, Chiang Rai Province
4 Feb. 2011	20:54/6.8	Myanmar-India border region	Felt the earthquake at high buildings in Bangkok
23 Feb. 2011	22:53/5.4	Laos	Felt the earthquake at Phrae, Nan, Udon Thani, Loei, Nong Khai, Nong Bua Lam Phu, Khon Kaen and Maha Sarakham Provinces
24 Mar. 2011	20:55/6.8	Myanmar	Felt the earthquake at Central and Northeastern parts of Thailand and high buildings in Bangkok, minor damaged in Mae Sai District, Chiang Rai Province and one people dead because of an accident
30 Apr. 2011	18:12/4.4	Andaman sea	Felt the earthquake at Phuket Province
10 May 2011	15:11/4.0	Myanmar	Felt the earthquake at Mae Sai District, Chiang Rai Province
24 Jun. 2011	23:42/3.5	Hat Samran District, Trang Province	Felt the earthquake at Kantang, Yan Ta Khao, Mueang Trang Districts, Trang Province
6 Sep. 2011	00:55/6.7	Northern Sumatra Island	Felt the earthquake at Mueang Phuket District, Phuket Province and Hat Yai District, Songkhla Province
20 Feb. 2012	03:48/2.7	Takua Pa District, Phang Nga Province	Felt the vibration at earthquake center and minor damaged.
5 Mar. 2012	13:54/5.2	Northern Sumatra Island	Felt the earthquake at Phuket Province
11 Apr. 2012	15:38/8.6	Western coast of Northern Sumatra Island	Felt the earthquake at Central, Southern and Northeastern parts of Thailand, Tsunami wave height is 80 cm. in Indonesia and 30 cm. at Miang Island, Pang Nga
16 Apr. 2012	16:44/4.3	Si Sunthon Sub-district, Thalang District, Phuket Province	Felt the earthquake at Phuket Province, some buildings damaged Thalang District, Phuket Province and more than 26 times of after shock

Table 4.1.3 - 1 Importance Earthquake Statistics of Thailand (Cont'd)

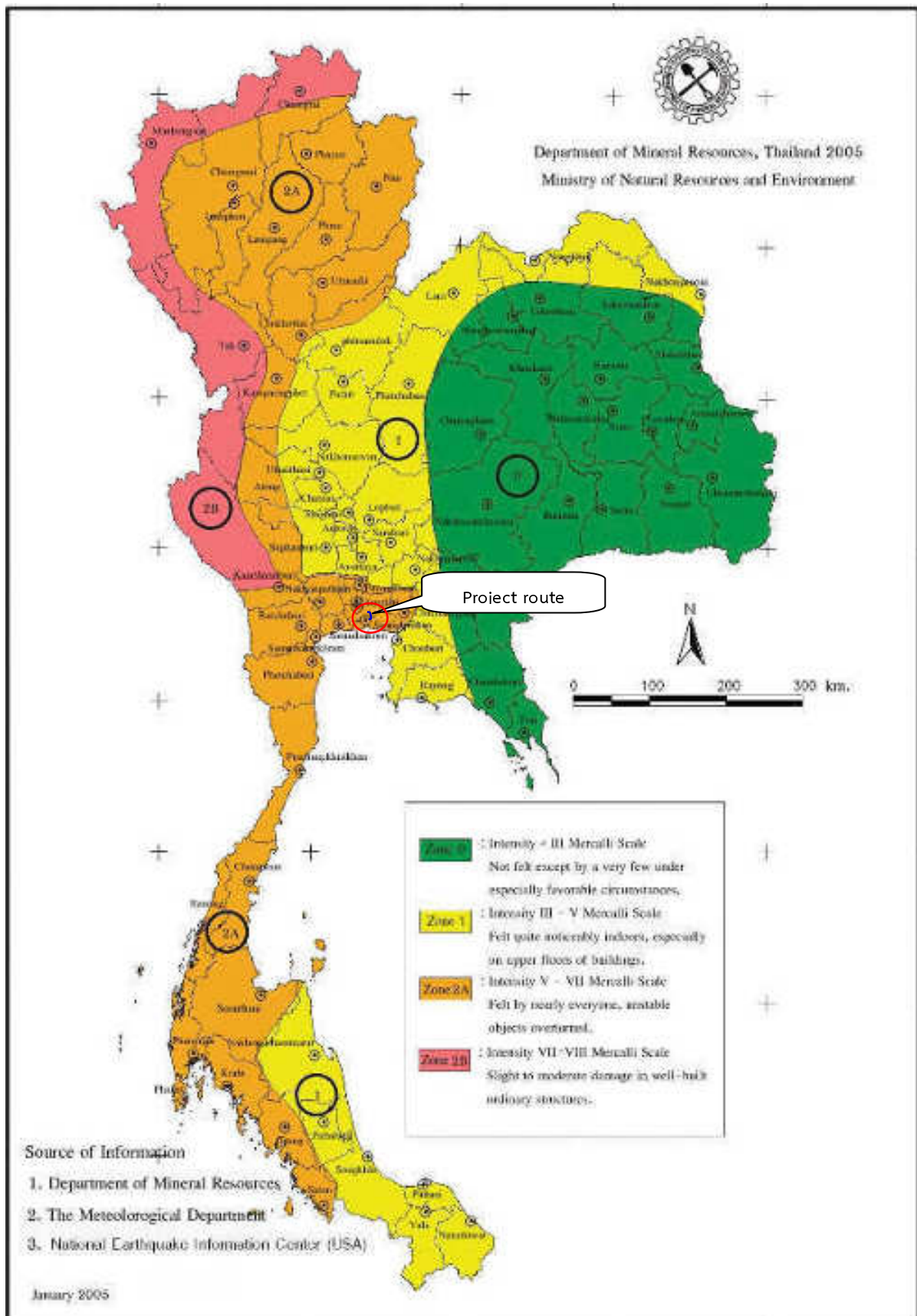
Date	Time (Local time)/ Magnitude/Intensity	Center/Region	Event record
4 Jun. 2012	12:49/4.0	Mueang Ranong District, Ranong Province	Felt the earthquake at Khao Niwet Sub- district, Bang Non Sub-district, Mueang Ranong District, Ranong Province
23 Jun. 2012	11:34/6.3	Northern Sumatra Island	Felt the earthquake at high building in Phuket and Songkhla Provinces
13 Sep. 2012	01:55/3.4	Chom Mok Kaeo Sub- district, Mae Lao District, Chiang Rai Province	Felt the earthquake at Phan District, Chiang Rai Province. The mirror and buildings are shaked.
11 Nov.2012	08:12/6.6	Myanmar	Felt the earthquake at Chiang Mai Province, Nonthaburi Province and Bangkok
11 Nov.2012	17:54/5.8	Myanmar	Felt the earthquake at Chiang Mai Province and high building in Bangkok
20 Dec. 2012	07:54/4.6	Myanmar	Felt the earthquake at Mae Sai District, Chiang Rai Province and high building in Chiang Mai Province
7 Feb. 2013	10:12/4.3	Myanmar	Felt the earthquake at Mae Sai District, Chiang Rai Province
2 Mar. 2013	20:35/3.4	Thung Fai Sub-district, Mueang Lampang District, Lampang Province	Heard loud sound, the buildings are shaken and felt the earthquake at Thung Fai Sub- district, Phichai Sub-district and Ton Thong Chai Sub-district, Mueang Lampang District,
5 Apr. 2013	23:20/2.9	Mae Win Sub-district, Mae Wang District, Chiang Mai Province	Felt the earthquake at Mae Wang District, Hang Dong District and Mueang Chiang Mai District, Chiang Mai Province
11 Apr. 2013	05:05/5.1	Myanmar	Felt the earthquake at Mae Hong Son Province
7 May 2013	03:17/5.4	Myanmar	Felt the earthquake at high building in Mae Sai and Mueang Chiang Rai Districts, Chiang Rai Province
7 Jun. 2013	00:01/3.1	Thung Pi Sub-district, Mae Wang District, Chiang Mai Province	Felt the earthquake at Mae Wang District, San Pa Tong District, Chiang Mai Province
2 Jul. 2013	14:37/6.0	Northern Sumatra Island, Indonesia	Felt the earthquake at high building in Bangkok, Phuket and Phang Nga Provinces

Source : Seismological Bureau, Thai Meteorological Department, 2013.



Source : Seismological Bureau, Thai Meteorological Department, 2005.

Figure 4.1.3 - 3 Epicenter of earthquake in Thailand and neighboring countries.



Source : Department of Mineral Resources, 2005.

Figure 4.1.3 - 4 Seismic Hazard Map of Thailand in 2005

Condition monitoring of the areas along project route to examine the water quality and aquatic ecology sampling points. Six stations were determined to be the representative of water quality and aquatic ecology monitoring stations as shown in **Figure 4.1.4 - 1**.

Sampling station	Location	Representative of surface water resources
Station 1 : Lat Phrao Canal	Lat Phrao road at Pibool Upphatham School	This canal is drainage from dense residential area and commercial area and close to Phawana Station (YL - 02)
Station 2 : Saen Saeb Canal	Srinagarindra road at Lam Sali intersection	This canal is drainage from dense residential area and commercial area and close to Lam Sali Station (YL - 09)
Station 3 : Hua Mak Canal	Bangkok-Chonburi Motorway (Highway No.7)	This canal is drainage from unoccupied area, low density resident, school, Islamic religious places and close to Phatthanakan Station (YL - 11)
Station 4 : Phra Khanong Canal	Srinagarindra road before intersection with On Nut road	This canal is drainage from dense residential area and close to Si Nut Station (YL - 13)
Station 5 : Bang Na Canal	Srinagarindra road after intersection with Thaparak road)	This canal is drainage from medium density resident, government and enterprise offices and close to Si La Salle Station (YL - 18)
Station 6 : Samrong Canal	Srinagarindra road before intersection with Thaparak road	This canal is drainage from medium density resident, government and enterprise offices and close to Si Dan Station (YL - 20)

Surface water sampling conducted using Water Sampler, collected water at the center of the river water resource and the center of the depth and the nearby areas that can be done. Water samples were analyzed using the Standard Method of AWWA, APHA and WPCF (1992) and the method that was accepted by The Office of Natural Resources and Environmental Policy. Analyzed some index parameters of the water quality that can be done immediately in the field. Send the samples to the registered laboratory with Department of Industrial Works to analyze the other index. The surface water quality index and analytical methods of the project were presented in **Table 4.1.4 - 1**.

The surface water quality analytical results of each Station No.s will be compared with the surface water quality standards as of the Notification of National Environmental Committee no.8 (B.E.2537) to assess the current conditions of the water quality and classify the type of surface water quality based on the utilization. For the consideration of the severity of the surface water quality impact from the project.

(4) Impact assessment of surface water quality from the development of the project. Both during construction and operation phase to set up the prevention and mitigation measures including the environmental impact monitoring requirements.

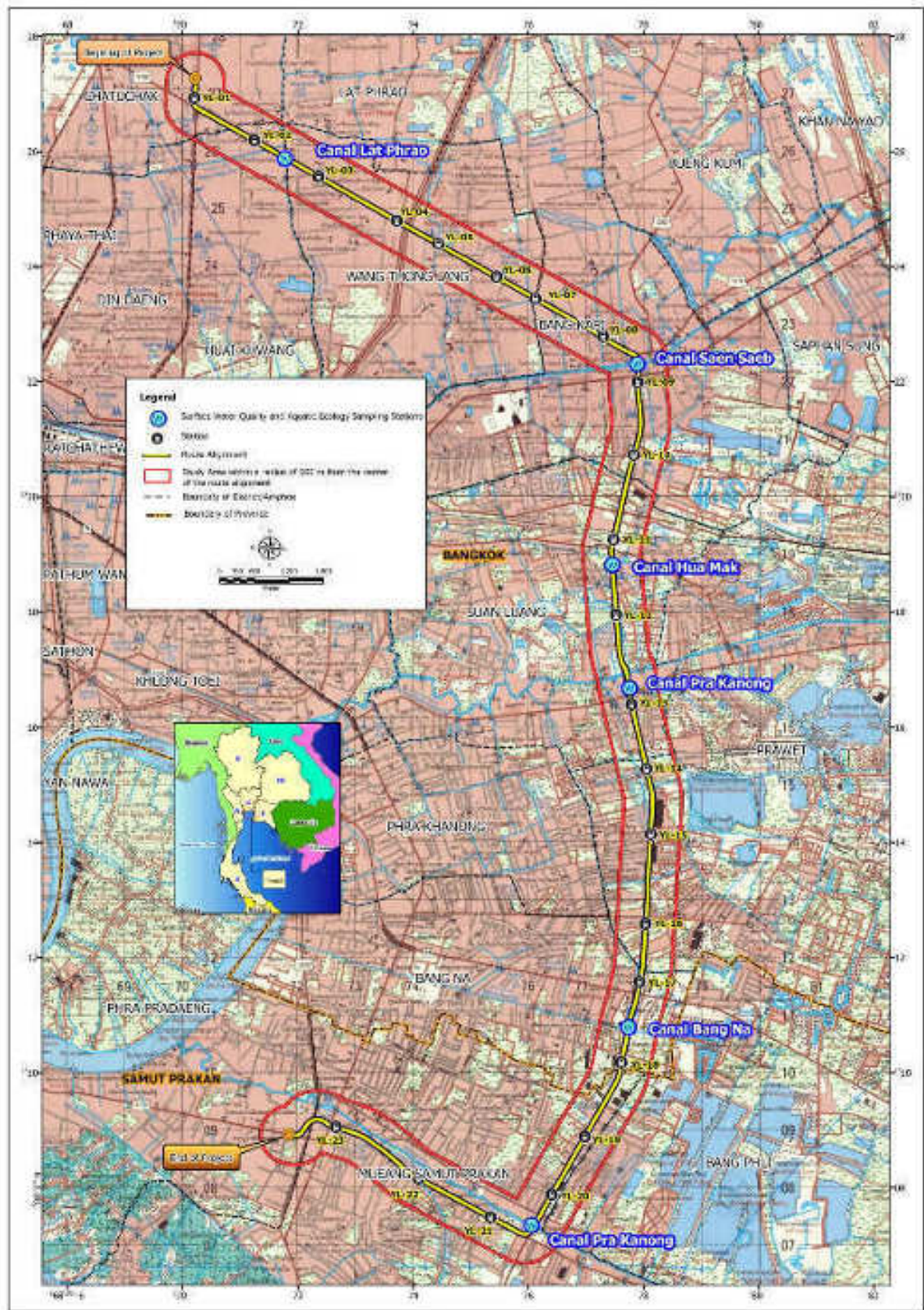


Figure 4.1.4 - 1 Surface water quality and aquatic ecology survey stations along the project route

Table 4.1.4 - 1 Surface water quality parameter and analysis method of project

Surface water quality parameter	Analysis method
1. Temperature	Certified Thermometer
2. pH	Electrometric Method (pH Meter)
3. Turbidity	Nephelometric Method
4. Dissolved Oxygen (DO)	Membrane Electrode Method
5. Biochemical Oxygen Demand (BOD)	5-Day BOD Test, Membrane Electrode Method
6. Total Suspended Solids	Dried at 103-105°C
7. Total Dissolved Solids	Dried at 103-105°C
8. Oil & Grease	Partition Gravimetric Method
9. Conductivity	Electrometric Method (Conductivity Meter)
10. Total Coliform Bacteria	Most Probable Number Method
11. Fecal Coliform Bacteria	Most Probable Number Method
12. Phosphorus - Phosphate	Ascorbic Acid Colorimetric Method
13. Nitrogen - Nitrate	Brucine Method
14. Nitrogen - Ammonia	Distillation and Titrimetric Method
15. Sulfate	Ascorbic Acid Colorimetric Method
16. Mercury	Atomic Absorption Spectrophotometry Method
17. Lead	Atomic Absorption Spectrophotometry Method

2) Results

(1) Secondary Data Collection

The results of the environmental impact assessment report of the Light and Dark Yellow Line Mass Transit Projects (Under the economic, environmental and preliminary design feasibility study of Yellow, Brown and Pink Line Mass Transit Projects) has taken the surface water samples in Lat Phrao Canal, Saen Saeb Canal, Hua Mak Canal, Phra Khanong Canal, Bang Na Canal and Samrong Canal in March (dry season) and May (rainy season), 2008. The analytical results of water quality of Lat Phrao Canal, Saen Saeb Canal, Hua Mak Canal, Phra Khanong Canal, Bang Na Canal and Samrong Canal was presented in **Table 4.1.4 - 2** and **Table 4.1.4 - 3**.

The water quality results of both seasons can be concluded that Klong Lat Phrao, Klong Saen Saeb, Klong Hua Mak, Klong Phra Khanong, Klong Bang Na and Klong Samrong the water quality were very deteriorated. That complied with Surface water quality class 5; wastewater receiving body from some activities and can be useful for transportation. This is due to receive the amount of wastewater from densely urban areas. The indications index of water quality degradation is an organic matters and microorganisms contamination in a high to very high level and a lack of dissolved oxygen.

(2) Field Survey

The sampling and analysis of water quality at 6 sampling Stations along project routed include Lat Phrao Canal, Saen Saeb Canal, Hua Mak Canal, Phra Khanong Canal, Bang Na Canal and Samrong Canal was the part of the project's activities taken on July 1, 2013, as shown in the **Photo 4.1.4 - 1**. Analytical results of surface water quality of Yellow Line Mass Transit System Project (Lat Phrao - Samrong section), on July 1, 2013, was presented in **Table 4.1.4 - 4** (detailed

on the water quality results as shown in **Appendix 4A**). Summary details of the monitoring and analysis of water quality at each station are below.

Table 4.1.4 - 2 Surface water quality of Lat Phrao Canal, Saen Saeb Canal and Hua Mak Canal in March and May, 2008.

Parameter	Unit	Lat Phrao Canal		Saen Saeb Canal		Hua Mak Canal	
		Mar. 2008	May 2008	Mar. 2008	May 2008	Mar. 2008	May 2008
Temperature	°C	28.7	31.0	28.9	30.5	29.0	31.5
Total Suspended Solids	mg/l	34.0	18.0	276.0	870	47.0	70.0
Conductivity	µs/cm	541.0	642.0	786.0	767.0	744.0	746.0
pH	-	7.30	6.28	7.45	6.90	7.61	6.89
DO	mg/l	3.7	0.5	1.2	1.8	5.1	1.2
BOD	mg/l	19.8	11.5	33.6	4.5	27.8	7.5
Phosphorus - Phosphate	mg/l	ND	0.88	1.33	0.88	0.44	1.33
Oil & Grease	mg/l	3.3	12.7	7.3	12.6	4.0	9.5
Fecal Coliform Bacteria	MPN/100 ml	≥16,000	5.0x10 ⁵	≥16,000	3.0x10 ⁵	≥16,000	5.0x10 ⁵
Total Coliform Bacteria	MPN/100 ml	≥16,000	2.2x10 ⁶	≥16,000	3.0x10 ⁵	≥16,000	5.0x10 ⁵

Source : Office of Transport and Traffic Policy and Planning, 2012. EIA report for Light Yellow Line Project (Feasibility Study and Preliminary Design of Yellow Line, Brown Line and Pink Line Mass Transit Projects)

Table 4.1.4 - 3 Surface water quality of Phra Khanong Canal, Bang Na Canal and Samrong Canal in March and May, 2008.

Parameter	Unit	Phra Khanong Canal		Bang Na Canal		Samrong Canal	
		Mar. 2008	May 2008	Mar. 2008	May 2008	Mar. 2008	May 2008
Temperature	°C	31.5	31.5	28.1	31.0	28.4	31.0
Total Suspended Solids	mg/l	43.0	24.0	38.0	30.0	69.0	2.0
Conductivity	µs/cm	705.0	700.0	564.0	904.0	390.0	109.1
pH	-	7.20	6.95	7.33	7.03	7.51	7.00
DO	mg/l	2.0	2.2	2.4	0.6	1.4	2.4
BOD	mg/l	10.7	7.0	32.7	7.7	33.6	12.0
Phosphorus - Phosphate	mg/l	ND	0.88	0.88	0.88	0.88	2.65
Oil & Grease	mg/l	8.7	10.6	2.0	11.3	3.3	11.0
Fecal Coliform Bacteria	MPN/100 ml	1,100,000	900,000	≥ 16,000	300,000	≥ 16,000	330,000
Total Coliform Bacteria	MPN/100 ml	1,700,000	900,000	≥ 16,000	300,000	≥ 16,000	330,000

Source : Office of Transport and Traffic Policy and Planning, 2012. EIA report for Dark Yellow Line Project (Feasibility Study and Preliminary Design of Yellow Line, Brown Line and Pink Line Mass Transit Projects)



Station 1 : Lat Phrao Canal



Station 2 : Saen Saeb Canal



Station 3 : Hua Mak Canal



Station 4 : Phra Khanong Canal



Station 5 : Bang Na Canal



Station 6 : Samrong Canal

Photo 4.1.4 - 1 Surface water quality sampling stations and activities along the project route (July 1, 2013)

Table 4.1.4 - 4 Surface water quality result of MRT Yellow Line Project Lat Phrao – Somrong Section on 1 July, 2013

Surface water quality parameter	Unit	Sampling station						Surface water quality standards ^{1/}	
		1	2	3	4	5	6	Class 3	Class 4
1. Temperature	°C	30.0	30.4	30.9	30.2	31.8	31.6	n'	n'
2. pH	-	7.29	7.60	7.74	7.69	7.50	7.66	5.0-9.0	5.0-9.0
3. DO ^{2/}	mg/l	<0.1	0.41	2.62	0.81	0.37	0.49	4.0	2.0
4. BOD	mg/l	80	16	20	17	81	22	2.0	4.0
5. Total coliform bacteria	MPN/100 ml	540,000	27,000	79,000	920,000	920,000	140,000	20,000	-
6. Fecal coliform bacteria	MPN/100 ml	33,000	6,800	4,500	14,000	17,000	17,000	4,000	-
7. Nitrate	mg/l	0.4	0.4	0.5	0.5	0.3	0.2	5.0	
8. Ammonia	mg/l	5.0	4.6	3.8	5.0	8.0	9.0	0.5	
9. Lead	mg/l	0.0049	0.0028	0.0073	0.0103	0.0066	0.0467	0.05	
10. Mercury	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.002	
11. Conductivity	µs/cm	650	470	640	870	650	570	-	
12. Turbidity	NTU	22	19	22	18	33	24	-	
13. Total dissolved solids	mg/l	510	490	500	660	570	500	-	
14. Total suspended solids	mg/l	14	14	23	15	9.2	13	-	
15. Oil & Grease	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	
16. Sulfate	mg/l	110	110	100	100	83	47	-	
17. Phosphate	mg/l	6.65	3.85	6.99	1.48	0.44	11.48	-	

Remark : ^{1/} Notification of the National Environmental Board, No. 8, B.E. 2537 (1994), issued under the Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (1992).

^{2/} DO (Dissolved Oxygen) value is lowest standard value.

n' naturally but changing not more than 3°C

Station 1 : Lat Phrao Canal (Lat Phrao road at Pibool Upphatham School)

Station 2 : Saen Saeb Canal (Srinagarindra road at Lam Sali intersection)

Station 3 : Hua Mak Canal (Bangkok-Chonburi Motorway (Highway No.7))

Station 4 : Phra Khanong Canal (Srinagarindra road before intersection with Onnut road)

Station 5 : Bang Na Canal (Srinagarindra road after intersection with Thaparak road)

Station 6 : Samrong Canal (Srinagarindra road before intersection with Thaparak road)

- Station No. 1 Lat Phrao Canal (Lat Phrao Road in the area of Phibun Uppatham School)

Surface water quality is deteriorated, with a temperature of 30°C, pH is 7.29, conductivity is 650 micro-cement/cm. Turbidity is 22 NTU, dissolved oxygen is less than 0.1 mg/dL. BOD or Biological Oxygen Demand is 80 mg/L. The total coliform is 540,000 MPN/100 ml. and the fecal coliform is 33,000 MPN/100 ml. Nitrogen (nitrate) is 0.4 mg/L. Nitrogen (Ammonia) is 5.0 mg/L. Lead is 0.0049 mg/L. Mercury is less than 0.0001 mg/L. Total dissolved solids equal to 510 mg/L. Total suspended solids equal to 14 mg/L. Fat and oil content is less than 0.5 mg/L. Sulfate is 110 mg/L and Phosphate-Phosphorus is 6.65 mg/L. Compared with the surface water quality standards as of the Notification of National Environmental Committee no.8 (B.E.2537) found that the water quality in this area is complied with a class 5, which has been a source of water effluent from some activities and can be useful for transportation.

- Station No. 2 Saen Saeb Canal (Srinagarindra Road at Lam Sali Intersection)

Surface water quality is deteriorated, with a temperature of 30.4°C, pH is 7.60, conductivity is 470 micro-cement/cm. Turbidity is 19 NTU, dissolved oxygen is 0.41 mg/L. BOD or Biological Oxygen Demand is 16 mg/L. The total coliform is 27,000 MPN/100 ml. and the fecal coliform is 6,800 MPN/100 ml. Nitrogen (nitrate) is 0.4 mg/L. Nitrogen (Ammonia) is 4.6 mg/L. Lead is 0.0028 mg/L. Mercury is less than 0.0001 mg/L. Total dissolved solids equal to 490 mg/L. Total suspended solids equal to 14 mg/L. Fat and oil content is less than 0.5 mg/L. Sulfate is 110 mg/L and Phosphate-Phosphorus is 3.85 mg/L. Compared with the surface water quality standards as of the Notification of National Environmental Committee no.8 (B.E.2537) found that the water quality in this area is complied with a class 5, which has been a source of water effluent from some activities and can be useful for transportation.

- Station No. 3 Hua Mak Canal (Motorway (Bangkok-Chonburi) or Highway No.7)

Surface water quality is deteriorated, with a temperature of 30.9°C, pH is 7.74, conductivity is 640 micro-cement/cm. Turbidity is 22 NTU, dissolved oxygen is 2.62 mg/L. BOD or Biological Oxygen Demand is 20 mg/L. The total coliform is 79,000 MPN/100 ml. and the fecal coliform is 4,500 MPN/100 ml. Nitrogen (nitrate) is 0.5 mg/L. Nitrogen (Ammonia) is 3.8 mg/L. Lead is 0.0073 mg/L. Mercury is less than 0.0001 mg/L. Total dissolved solids equal to 500 mg/L. Total suspended solids equal to 23 mg/L. Fat and oil content is less than 0.5 mg/L. Sulfate is 100 mg/L and Phosphate-Phosphorus is 6.99 mg/L. Compared with the surface water quality standards as of the Notification of National Environmental Committee no.8 (B.E.2537) found that the water quality in this area complies as a class 5, which has been a source of water effluent from some activities and can be useful for transportation.

- Station No. 4 Phra Khanong Canal (Srinagarindra Road before intersects with On Nut Road)

Surface water quality is deteriorated, with a temperature of 30.2°C, pH is 7.69, conductivity is 870 micro-cement/cm. Turbidity is 18 NTU, dissolved oxygen is 0.81 mg/L. BOD or Biological Oxygen Demand is 17 mg/L. The total coliform is 920,000 MPN/100 ml. and the fecal coliform is 14,000 MPN/100 ml. Nitrogen (nitrate) is 0.5 mg/L. Nitrogen (Ammonia) is 5.0 mg/L. Lead is 0.0103 mg/L. Mercury is less than 0.0001 mg/L. Total dissolved solids equal to 660 mg/L. Total suspended solids equal to 15 mg/L. Fat and oil content is less than 0.5 mg/L. Sulfate is 100 mg/L

and Phosphate-Phosphorus is 1.48 mg/L. Compared with the surface water quality standards as of the Notification of National Environmental Committee no.8 (B.E.2537) found that the water quality in this area complies as a class 5, which has been a source of water effluent from some activities and can be useful for transportation.

- Station No. 5 Bang Na Canal (Srinagarindra Road after intersects with Thepharak Road)

Surface water quality is deteriorated, with a temperature of 31.8°C, pH is 7.50, conductivity is 650 micro-cement/cm. Turbidity is 33 NTU, dissolved oxygen is 0.37 mg/L. BOD or Biological Oxygen Demand is 81 mg/L. The total coliform is 920,000 MPN/100 ml. and the fecal coliform is 17,000 MPN/100 ml. Nitrogen (nitrate) is 0.38mg/L. Nitrogen (Ammonia) is 5.0 mg/L. Lead is 0.0066 mg/L. Mercury is less than 0.0001 mg/L. Total dissolved solids equal to 570 mg/L. Total suspended solids equal to 9.2 mg/L. Fat and oil content is less than 0.5 mg/L. Sulfate is 83 mg/L and Phosphate-Phosphorus is 0.44 mg/L. Compared with the surface water quality standards as of the Notification of National Environmental Committee no.8 (B.E.2537) found that the water quality in this area complies as a class 5, which has been a source of water effluent from some activities and can be useful for transportation.

- Station No. 6 Klong Samrong (Srinagarindra Road before intersects with Thepharak Road)

Surface water quality is deteriorated, with a temperature of 31.6°C, pH is 7.66, conductivity is 570 micro-cement/cm. Turbidity is 24 NTU, dissolved oxygen is 0.49 mg/L. BOD or Biological Oxygen Demand is 22 mg/L. The total coliform is 140,000 MPN/100 ml. and the fecal coliform is 17,000 MPN/100 ml. Nitrogen (nitrate) is 0.2 mg/L. Nitrogen (Ammonia) is 9.0 mg/L. Lead is 0.0467 mg/L. Mercury is less than 0.0001 mg/L. Total dissolved solids equal to 500 mg/L. Total suspended solids equal to 13 mg/L. Fat and oil content is less than 0.5 mg/L. Sulfate is 47 mg/L and Phosphate-Phosphorus is 11.48 mg/L. Compared with the surface water quality standards as of the Notification of National Environmental Committee no.8 (B.E.2537) found that the water quality in this area complies as a class 5, which has been a source of water effluent from some activities and can be useful for transportation.

4.1.5 Air Quality

1) Methodology

(1) Collect and review the secondary data from the approved EIA reports of Light and Dark Yellow Line Mass Transit System Project of the Office of Transport and Traffic Policy and Planning.

(2) Study and collect a changed of project's detailed as well as the plan and the construction process of the project for the information on the environmental impact assessment.

(3) Collect Meteorological data in 30 years Phase of air monitoring Station in Bangkok, 1981-2010, Thai Meteorological Department.

(4) Field survey of the existing environment by monitoring and sampling of air quality at 10 monitoring stations, each station continuously monitoring 24 hours a day for five days between June 14 to July 2, 2013, as shown in **Figure 4.1.5 - 1**. A diagram showing the sampling

and monitoring points as shown in **Appendix 4B**. The criteria for the selection of air quality monitoring station are as the following details.

Sampling Station	Location	Representative of surface water resources
Station 1 : Pibool Upphatham School	This location is about 5 meters distance from Lat Phrao road.	This school is near heavy traffic road in commercial area and dense residential area and close to Phawana station (YL - 02).
Station 2 : Wat Mae Phra Kularb Tip (Maria Rosa Mystica Church)	This location is about 10 meters distance from Lat Phrao road.	This church of Christ is near heavy traffic road in commercial area and dense residential area and close to Mahat Thai station (YL - 06).
Station 3 : Vejthani Hospital	This location is about 20 meters distance from Lat Phrao road.	This hospital is near heavy traffic road in commercial area and dense residential area along the project route.
Station 4 : Mae Phra Ong Uppatham Catholic Church (Church of Christ)	This location is about 100 meters distance from Srinagarindra road.	This church of Christ is near heavy traffic road in commercial area and dense residential area and close to Si Kritha station (YL - 10).
Station 5 : Klongkalantan School	This location is about 50 meters distance from Srinagarindra road.	This school is near heavy traffic road in residential area and close to Phatthanakan station (YL - 11).
Station 6 : Khajonsiri Temple	This location is about 200 meters distance from Srinagarindra road.	This temple of Buddhist is near heavy traffic road in dense residential area and close to Si Nut station (YL - 13).
Station 7 : Darul Amin Mosque	This location is about 5 meters distance from Srinagarindra road.	This mosque of Islam is near heavy traffic road in commercial area and dense residential area along the project route.
Station 8 : Sri lam Temple	This location is about 100 meters distance from Srinagarindra road.	This temple of Buddhist is near heavy traffic road in dense residential area and close to Si lam station (YL - 17) and Depot.
Station 9 : Siriwutti Wittaya School	This location is about 100 meters distance from Thepharak road.	This school is near heavy traffic road in residential area and close to Thipphawan station (YL - 22).
Station 10 : Chulavej Hospital	This location is about 5 meters distance from Thepharak road.	This hospital is near heavy traffic road in commercial area and dense residential area and close to Samrong station (YL - 23).

The air quality parameter, as well as the methods of collecting and analyzing samples of air quality shall comply with the requirements of the ONEP or US-Environmental Protection Agency or the Methods of Air Sampling and Analysis: 3rd Edition, AWMA, ACS, AICHE, APWA ASME, AOAC, HPS, and ISA. Are summarized below.

Air quality Parameter	Method	Analysis method*
1. Total Suspended Particulate (TSP)	High-Volume Air Sampler	Gravimetric
2. Particulate Matter less than 10 microns (PM-10)	High-Volume Air Sampler	Gravimetric
3. Particulate Matter less than 2.5 microns (PM-2.5)	High-Volume Air Sampler	Gravimetric
4. Nitrogen dioxide (NO ₂)	NO ₂ Analyzer	Chemiluminescence
5. Carbon monoxide (CO)	CO Analyzer	Non-dispersive Infrared Detection
6. Total Hydrocarbon (THC)	Sampling Bag	Ionization Detection
7. Non-methane hydrocarbon (NMHCs)	Sampling Bag	Ionization Detection
8. Wind speed and direction	Anemometer	Anemometer

Remark : * Use US.EPA analysis method and ISO analysis method for wind speed and direction

(5) Assess the air quality impacts in the changed of the project details, considering the long-term impact of the construction and operation phase.

(6) Recommended the air quality prevention and mitigation measures and auditing requirements that appropriated to the project.

2) Study Results

(1) Climate and Meteorology

The climate within the Bangkok Metropolitan Region along project route includes Chatuchak, Huay Khwang, Wang Thonglang, Bang Kapi, Suan Luang, Prawet, Bang Na and Muang district, Samut Prakan province classified as Tropical influenced by 2 types of wind, Southwest, and Northeast wind. The project area was impacted occurring 2 seasons; the rainy season is from mid-May to October the southwest wind blow moisture from the Indian Ocean into the project area. This is the caused of wet and flooded in some areas. Winter starts from November - mid-February. With the northeast wind blow the cold from China, covering the project area, causing cold and dry. The dry season runs from mid-February - mid-May, when the weather is dry and hot, especially during the mid-March to April.

Considering the statistics of climate/meteorological from Don Muang monitoring Station No. (latitude 13°55'N longitude 100°36'E) in 30 years Phase (1976-2006) as shown in **Table 4.1.5 - 1** can be summarized as follows.

- Temperature: The mean maximum temperature was 33.3°C, the mean minimum temperature was 24.9°C and the average annual temperature was 28.6°C.
- Relative Humidity; The mean maximum was 88%, the mean minimum was 54% and an average annual was 73%.
- Rainfall: The annual average rainfall volume was 1,376 mm. total 112 days of rain and the highest volume on a rainy day was 284.9 mm. in September. The average lowest volume was in December which 6.5 mm.
- Pressure: The highest air pressure was in March which 1,024.9 Hector Pascal and the annual average air pressure was 1,009.5 Hector Pascal.
- Wind: The local wind has 2 directions as below.

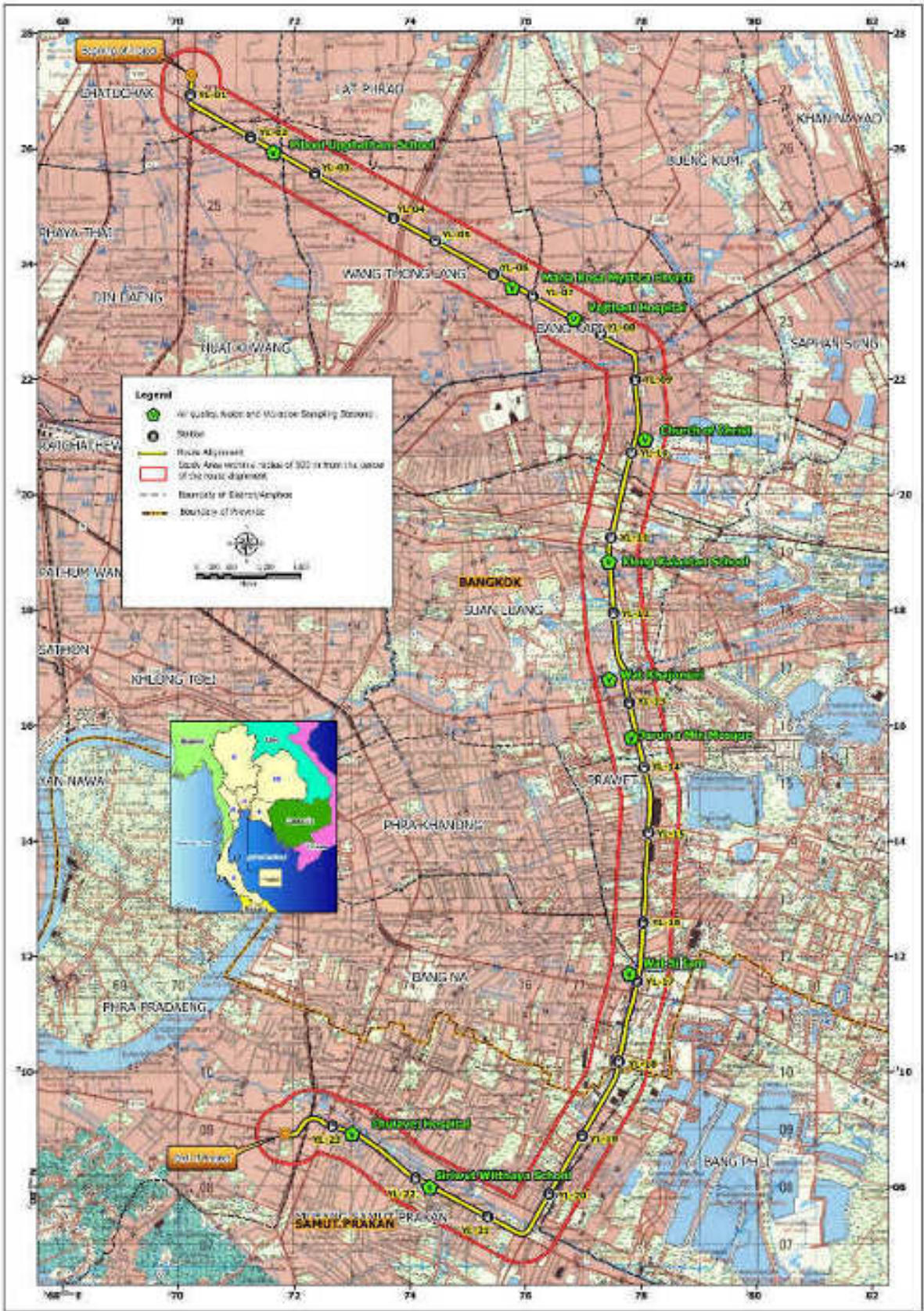


Figure 4.1.5 - 1 Location of Ambient Air Quality, Noise and Vibration sampling stations along the Project Route

Table 4.1.5 - 1 Meteorological data from Don Muang Station in 30 years Phase (1976-2006)

Station	Donmuang Airport	Elevation of station above MSL	4	Meters
Index Station	48456	Height of barometer above MSL	12	Meters
Latitude	13 55 N	Height of thermometer above ground	8.75	Meters
Longitude	100 36 E	Height of wind vane above ground	5.00	Meters
		Height of rain gauge	2.50	Meters

Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Pressure (Hectopascal)													
Mean	1012.6	1011.4	1010.0	1008.6	1007.4	1006.8	1007.0	1007.1	1008.3	1010.1	1011.7	1013.2	1009.5
Ext. max.	1023.7	1021.3	1024.9	1017.3	1018.3	1013.3	1013.6	1013.2	1015.6	1019.8	1021.0	1023.4	1024.9
Ext. min.	1009.1	1009.1	1006.4	1006.1	1003.4	1010.0	1003.7	1010.0	1003.9	1007.9	1008.5	1010.5	1003.4
Mean daily range	4.9	4.9	4.8	4.8	4.5	3.7	3.8	4.0	4.6	4.6	4.5	4.7	4.5
Temperature (° Celsius)													
Mean	27	28.3	29.5	30.4	29.8	29.4	29.0	28.8	28.4	28.2	27.7	26.4	28.6
Mean max.	32.2	33.6	34.8	35.7	34.7	33.8	33.4	33.1	32.9	32.3	31.8	31.2	33.3
Mean min.	22.4	23.9	25.2	26.3	26.3	26.2	25.9	25.8	25.3	25.2	24.1	22.0	24.9
Ext. max.	36.6	38.5	40.0	39.9	40.8	40.0	39.3	38.1	39.4	37.2	36.9	36.7	40.8
Ext. min.	21.3	24.4	23.9	26.0	26.0	25.3	26.3	24.9	25.0	24.6	24.2	21.9	21.3
Relative Humidity (%)													
Mean	67	70	71	72	75	75	75	76	79	78	71	65	73
Mean max.	87	90	89	89	89	88	88	88	91	91	86	83	88
Mean min.	46	47	48	51	56	58	58	59	61	61	53	47	54
Evaporation (mm.)													
Mean-pan	-	-	-	-	-	-	-	-	-	-	-	-	-
Wind (Knots)													
Mean wind speed	4.1	5.4	6.1	6.1	5.9	6.5	6.6	6.2	4.9	4.0	4.0	4.0	-
Prevailing wind	E	S	S	S	S	S	SW	SW	S	N	N	N	-
Max. wind speed	34	41	45	56	53	44	48	43	47	40	32	32	56
Rainfall (mm)													
Mean	11.8	9.3	40.4	88.5	207.6	168.1	159.1	170.9	284.9	191.9	37	6.5	1376
Mean rainy day	1	1	3	7	14	15	15	17	19	15	4	1	112
Daily maximum	69.3	41.5	77.0	121.1	210.7	106.7	99.4	124.0	144.6	207.7	60.2	34.6	210.7
Visibility (km.)													
0700 L.S.T.	4	5	6	7	9	9	9	9	9	7	7	6	7

Remark: E = East

S = South

SW = South-west

N = North

Source: Meteorological Department, 2011

South wind will be formed February to September. The total Phase was eight months, with the average maximum wind speed in June, was 6.5 knots.

Northeast wind will be formed October to December. The entire Phase was three months, with the average maximum wind speed was 4 knots.

(2) Air Quality

(2.1) Secondary Data Reviewed

The review of secondary data from both previous Final EIA reports of TOP (Light and Dark Yellow Line Mass Transit Projects, June 2012) found that the air monitoring index were 24 hours Total Suspended Particle (TSP), 10 Micron Particle (PM-10), carbon monoxide (CO), nitrogen dioxide (NO₂), total hydrocarbons (THC), methane-hydrocarbons (MHC) and non- methane hydrocarbons (NMHC). The results of air quality monitoring along project route during 2008-2009, as shown in **Table 4.1.5 - 2**.

From monitoring results, it was found that the air quality in the project route complied with Standard of general ambient air quality according to Notification of National Environmental Committee no.24 (B.E. 2004) and No.36 (BE. 2553).

(2.2) Field Survey

Monitoring and sampling on air quality in the sensitive areas at 10 stations (detailed results of air quality monitoring as shown in **Appendix 4C**), The diagram of air quality monitoring station along the project route as shown in **Photo 4.1.5 - 1**. Each site was continuously monitoring 24 hours a day for five days between June 14 until July 2, 2013. Found that all parameter of the air quality along the project route complied with Standard. Results of air quality monitoring along the project route between 14 June and 2 July 2013, as shown in **Table 4.1.5 - 3**, details are as follows.

- Station No. 1 : Pibool Upphatham School, Sam Saen Nok, Huay Khwang, Bangkok

The air quality monitoring found that TSP from 0.036 to 0.090 mg/m³ which was about 10.90 to 27.27 percent of the standard (standard average TSP is 0.33 mg/m³). PM10 ranged from 0.036 to 0.046 mg/m³ which was about 30.00 to 38.33 percent of the standard (standard PM10 is 0.12 mg/m³), PM2.5 ranged from 0.013 to 0.022 mg/m³ which was about 26.0 to 44.0 percent of the standard. (standard PM2.5 is 0.05 mg/m³).

The average one-hour maximum concentration of NO₂ ranged from 0.0185 to 0.0316 ppm. which was about 10.88 to 18.58 percent of the standard (standard NO₂ is 0.17 ppm). The average one-hour maximum concentration of CO ranged from 0.8 to 1.7 ppm. which was about 2.6 to 11.0 percent of the standard (Standard CO is 30 ppm). The concentration of THC ranged 2.12 to 2.42 ppm. Thailand has still not determined the air quality standard for this parameter. NMHC ranged 0.32 to 0.57 ppm. Thailand has still not determined the air quality standard for this parameter.

Table 4.1.5 - 2 Results of Air Quality from Sampling Station along the Project Route between 2008 – 2009

No.	Station	Date	Result of Air Quality						
			TSP 24 hrs. (mg/m ³)	PM-10 24 hrs. (mg/m ³)	CO 1 hr. (ppm)	NO ₂ 1 hr. (ppm)	THC (ppm)	CH ₄ (ppm)	NMHC (ppm)
1	Pibool Upphatham ^{/1} School 1 st Time	12-13 March, 2008	0.065	0.047	0.63	0.0093	2.68	2.09	0.59
		13-14 March, 2008	0.062	0.040	0.78	0.0060	2.51	2.07	0.44
		14-15 March, 2008	0.065	0.045	0.58	0.0084	2.38	1.99	0.39
		15-16 March, 2008	0.069	0.040	0.57	0.0063	2.39	2.03	0.36
		16-17 March, 2008	0.064	0.044	0.57	0.0054	2.78	2.08	0.70
	2 nd Time	30 April-1 May, 2008	0.051	0.032	0.93	0.0454	2.29	2.03	0.26
		1-2 May, 2008	0.049	0.029	1.01	0.0801	2.42	2.15	0.27
		2-3 May, 2008	0.049	0.033	0.70	0.0551	2.15	1.97	0.18
		3-4 May, 2008	0.054	0.030	0.99	0.0222	2.24	2.06	0.17
		4-5 May, 2008	0.072	0.022	0.91	0.0179	2.18	2.01	0.17
2	Maria Rosa ^{/1} Church 1 st Time	19-20 March, 2008	0.055	0.034	0.76	0.0059	2.79	2.09	0.70
		20-21 March, 2008	0.047	0.030	0.87	0.0106	2.33	1.98	0.35
		21-22 March, 2008	0.063	0.030	0.58	0.0063	2.40	2.00	0.40
		22-23 March, 2008	0.049	0.025	0.86	0.0062	2.28	1.99	0.29
		23-24 March, 2008	0.082	0.044	0.88	0.0067	2.32	1.98	0.34
	2 nd Time	16-17 May, 2008	0.060	0.042	0.98	0.0117	4.20	3.05	1.15
		17-18 May, 2008	0.069	0.038	0.96	0.0176	8.12	3.25	4.87
		18-19 May, 2008	0.085	0.049	0.70	0.0157	6.51	3.14	3.37
		19-20 May, 2008	0.045	0.031	1.00	0.0207	4.10	2.97	1.13
		20-21 May, 2008	0.070	0.041	1.10	0.0251	3.72	2.82	0.90
3	Vejthani Hospital ^{/1}	22-23 April, 2009	0.094	0.034	0.99	0.0248	2.97	2.10	0.87
		23-24 April, 2009	0.068	0.062	0.87	0.0199	2.74	2.16	0.58
		24-25 April, 2009	0.075	0.045	0.95	0.0201	2.86	2.08	0.78
		25-26 April, 2009	0.082	0.057	0.78	0.0215	2.93	2.32	0.61
		26-27 April, 2009	0.098	0.068	0.86	0.0189	2.68	2.14	0.54
4	Mae Phra Ong Uppatham Catholic Church ^{/1}	22-23 April, 2009	0.124	0.063	0.78	0.0178	2.75	2.18	0.57
		23-24 April, 2009	0.109	0.054	0.85	0.0189	2.79	2.04	0.75
		24-25 April, 2009	0.133	0.061	0.68	0.0205	2.82	2.16	0.66
		25-26 April, 2009	0.115	0.045	0.97	0.0192	2.81	2.13	0.68
		26-27 April, 2009	0.099	0.059	0.85	0.0184	2.69	2.05	0.64
5	Klongkalantan School ^{/2} 1 st Time	19-20 March, 2008	0.076	0.051	1.16	0.0284	2.29	1.98	0.31
		20-21 March, 2008	0.073	0.045	0.84	0.0276	2.31	2.06	0.25
		21-22 March, 2008	0.064	0.041	0.75	0.0208	2.28	1.99	0.29
		22-23 March, 2008	0.057	0.032	0.96	0.0162	2.30	2.04	0.26
		23-24 March, 2008	0.095	0.062	0.84	0.0226	2.26	1.99	0.27
	2 nd Time	30 April – 1 May, 2008	0.066	0.023	1.62	0.0130	2.29	2.03	0.26
		1-2 May, 2008	0.053	0.023	2.61	0.0139	2.24	1.99	0.25
		2-3 May, 2008	0.068	0.023	1.61	0.0223	2.17	1.89	0.28
		3-4 May, 2008	0.056	0.023	1.95	0.0190	2.18	1.95	0.23
		4-5 May, 2008	0.072	0.031	1.69	0.0179	2.24	1.96	0.28
6	Khajonsiri Temple ^{/2}	22-23 April, 2009	0.120	0.042	0.55	0.0259	2.39	2.20	0.19
		23-24 April, 2009	0.098	0.025	0.73	0.0205	2.07	1.75	0.32
		24-25 April, 2009	0.049	0.015	1.09	0.0196	2.05	1.76	0.29
		25-26 April, 2009	0.052	0.012	0.82	0.0108	2.24	2.01	0.23
		26-27 April, 2009	0.109	0.009	1.09	0.0062	2.48	2.10	0.38

Table 4.1.5 - 2 Results of Air Quality from Sampling Station along the Project Route between
2008 – 2009 (Cont'd.)

No.	Station	Date	Result of Air Quality						
			TSP 24 hrs. (mg/m ³)	PM-10 24 hrs. (mg/m ³)	CO 1 hr. (ppm)	NO ₂ 1 hr. (ppm)	THC (ppm)	CH ₄ (ppm)	NMHC (ppm)
7	Derin & Min Mosque	22-23 April, 2009	0.139	0.093	1.87	0.0260	3.25	2.15	1.03
		23-24 April, 2009	0.206	0.012	1.53	0.0335	3.73	2.24	1.19
		24-25 April, 2009	0.068	0.042	1.74	0.0240	3.54	2.16	1.38
		25-26 April, 2009	0.017	0.008	1.55	0.0355	3.30	2.50	1.20
		26-27 April, 2009	0.012	0.012	1.43	0.0577	3.45	2.20	1.25
8	Si Anan School 1 st Time	20-21 March, 2008	0.098	0.048	1.13	0.0171	2.30	2.03	0.29
		21-22 March, 2008	0.121	0.040	1.09	0.0182	2.26	1.99	0.27
		22-23 March, 2008	0.101	0.039	1.05	0.0143	2.29	2.03	0.25
		23-24 March, 2008	0.121	0.035	1.30	0.0131	2.23	1.90	0.27
	2 nd Time	7-8 May, 2008	0.306	0.096	2.35	0.0571	2.75	2.05	0.28
		8-9 May, 2008	0.278	0.091	1.70	0.0222	2.28	2.07	0.21
		9-10 May, 2008	0.348	0.050	1.89	0.0240	2.31	2.14	0.17
		10-11 May, 2008	0.233	0.063	1.59	0.0230	2.40	2.17	0.23
		11-12 May, 2008	0.184	0.061	1.92	0.0347	2.35	2.08	0.29
9	Siriwat Witthaya School	22-23 April, 2009	0.122	0.051	1.85	0.0317	2.36	2.16	0.20
		23-24 April, 2009	0.037	0.031	1.47	0.0310	2.40	2.15	0.25
		24-25 April, 2009	0.110	0.028	1.61	0.0120	2.66	2.21	0.45
		25-26 April, 2009	0.026	0.031	1.70	0.0186	2.38	2.16	0.22
		26-27 April, 2009	0.075	0.040	1.74	0.0130	2.40	2.13	0.27
10	Chulalongkorn Hospital	22-23 April, 2009	0.078	0.032	1.53	0.0254	2.29	2.11	1.18
		23-24 April, 2009	0.095	0.044	0.70	0.0389	3.26	2.03	0.23
		24-25 April, 2009	0.111	0.028	0.49	0.0140	3.85	2.10	1.75
		25-26 April, 2009	0.090	0.090	0.55	0.0310	3.36	2.11	1.25
		26-27 April, 2009	0.125	0.062	1.50	0.0255	3.37	2.15	1.22
Standard			0.330*	0.120*	30*	0.17**			

Remark: * Ambient air standard according to Notification of National Environmental Board No. 24, B.E. 2547 (2004)

** Ambient air standard according to Notification of National Environmental Board No. 36, B.E. 2553 (2010)

Source: Office of Transportation and Traffic Policy and Planning (OTTP, 2012), The EA Report on the M4 - Dark Yellow Line Project, Office of Transportation and Traffic Policy and Planning (OTTP, 2012), The EA Report on the MRT Yellow Line Project.



Station 1 : Phoo, Upphatham School



Station 2 : Maria Rosa Mystina Church



Station 3 : Vejthani Hospital



Station 4 : Mae Phra Ong Uppatham
Catholic Church



Station 5 : Klongkalantan School



Station 6 : Khajonsiri Temple



Station 7 : Darul Amin Mosque



Station 8 : Si lam Temple



Station 9 : Siriwutti Wittaya School



Station 10 : Chulavej Hospital

Photo 4.1.5 - 1 Sampling Stations of Air Quality along the Project Route

Table 4.1.5-3 Results of Air Quality from Sampling Station along the Project Route between June 14 to July 2, 2013.

No.	Station	Date	Existing of Air Quality						
			TSP 24 hrs. (mg/m ³)	PM-10 24 hrs. (mg/m ³)	PM-2.5 24 hr. (mg/m ³)	CO 1 hr. (ppm)	NO ₂ 1 hr. (ppm)	THC (ppm)	NMHC (ppm)
1	Pibool Uppatham	20-21 June, 2013	0.044	0.025	0.015	1.3	0.0305	2.36	0.46
		21-22 June, 2013	0.090	0.046	0.022	1.7	0.0316	2.60	0.57
		22-23 June, 2013	0.042	0.023	0.014	0.8	0.0228	2.17	0.32
		23-24 June, 2013	0.036	0.020	0.013	1.2	0.0242	2.42	0.50
		24-25 June, 2013	0.039	0.022	0.015	1.0	0.0185	2.12	0.33
2	Maria Rosa Church	20-21 June, 2013	0.036	0.021	0.013	1.3	0.0237	2.62	0.62
		21-22 June, 2013	0.045	0.025	0.015	1.8	0.0249	2.62	0.48
		22-23 June, 2013	0.041	0.023	0.015	1.5	0.0271	2.06	0.28
		23-24 June, 2013	0.042	0.021	0.014	2.0	0.0267	1.98	0.22
		24-25 June, 2013	0.046	0.024	0.016	1.2	0.0213	2.56	0.62
3	Vejthani Hospital	26-27 June, 2013	0.057	0.027	0.017	1.6	0.0653	2.68	0.96
		27-28 June, 2013	0.079	0.038	0.020	2.3	0.0620	2.84	1.10
		28-29 June, 2013	0.059	0.029	0.017	1.4	0.0604	2.80	0.95
		29-30 June, 2013	0.071	0.032	0.021	1.3	0.0492	2.39	1.49
		30 June -1 July, 2013	0.048	0.026	0.016	1.5	0.0428	2.52	0.58
4	Mae Phra Ong Uppatham Catholic	27-28 June, 2013	0.075	0.036	0.016	1.5	0.0382	2.70	0.95
		28-29 June, 2013	0.063	0.031	0.013	1.2	0.0278	2.32	0.60
		29-30 June, 2013	0.050	0.023	0.011	1.0	0.0243	2.10	0.31
		30 June-1 July, 2013	0.065	0.028	0.014	1.2	0.0264	2.09	0.32
		1-2 July, 2013	0.061	0.031	0.016	1.2	0.0269	2.36	0.49
5	Klongkalan School	14-15 June, 2013	0.114	0.049	0.024	1.5	0.0455	2.32	0.45
		15-16 June, 2013	0.146	0.060	0.028	1.4	0.0694	2.30	0.41
		16-17 June, 2013	0.180	0.059	0.027	1.5	0.0797	2.24	0.42
		17-18 June, 2013	0.141	0.050	0.026	2.7	0.0540	2.37	0.50
		18-19 June, 2013	0.161	0.047	0.023	1.5	0.0525	3.20	0.96
6	Khajonsiri Temple	14-15 June, 2013	0.115	0.040	0.017	1.2	0.0249	2.41	0.54
		15-16 June, 2013	0.134	0.051	0.019	0.9	0.0259	2.21	0.35
		16-17 June, 2013	0.081	0.032	0.016	0.8	0.0182	2.62	0.72
		17-18 June, 2013	0.089	0.038	0.020	1.2	0.0348	2.63	0.75
		18-19 June, 2013	0.086	0.036	0.015	1.0	0.0206	2.31	0.77
7	Darun a Min Mosque	14-15 June, 2013	0.065	0.034	0.013	1.3	0.0190	2.40	0.53
		15-16 June, 2013	0.119	0.061	0.020	1.1	0.0264	2.25	0.35
		16-17 June, 2013	0.076	0.036	0.017	1.1	0.0198	2.22	0.42
		17-18 June, 2013	0.070	0.032	0.015	1.8	0.0337	2.37	0.50
		18-19 June, 2013	0.061	0.028	0.014	1.1	0.0214	2.33	0.77
8	Si lam Temple	20-21 June, 2013	0.139	0.052	0.027	2.7	0.0443	2.21	0.39
		21-22 June, 2013	0.114	0.047	0.023	1.4	0.0341	2.77	0.79
		22-23 June, 2013	0.118	0.044	0.021	2.1	0.0303	1.96	0.19
		23-24 June, 2013	0.105	0.036	0.020	1.3	0.0285	2.02	0.23
		24-25 June, 2013	0.123	0.042	0.022	1.1	0.0293	2.40	0.62
9	Siriwut Witthaya School	27-28 June, 2013	0.128	0.057	0.023	1.1	0.0327	2.28	0.46
		28-29 June, 2013	0.100	0.049	0.021	1.2	0.0358	2.16	0.45
		29-30 June, 2013	0.082	0.030	0.016	0.8	0.0307	2.01	0.30
		30 June -1 July, 2013	0.086	0.038	0.017	1.6	0.0422	2.30	0.51
		1-2 July, 2013	0.059	0.031	0.017	1.0	0.0317	2.48	0.59

Table 4.1.5-3 Results of Air Quality from Sampling Station along the Project Route between June 14 to July 2, 2013 (Cont'd.)

No.	Station	Date	Existing of Air Quality						
			TSP 24 hrs. (mg/m ³)	PM-10 24 hrs. (mg/m ³)	PM-2.5 24 hr. (mg/m ³)	CO 1 hr. (ppm)	NO ₂ 1 hr. (ppm)	THC (ppm)	NMHC (ppm)
10	Chulavej Hospital	27-28 June, 2013	0.156	0.073	0.025	3.6	0.0281	2.16	0.29
		28-29 June, 2013	0.215	0.101	0.030	2.1	0.0537	2.42	0.51
		29-30 June, 2013	0.186	0.073	0.031	2.9	0.1001	2.55	0.62
		30 June-1 July, 2013	0.200	0.099	0.033	3.9	0.0647	2.17	0.34
		1-2 July, 2013	0.170	0.107	0.030	4.1	0.0528	2.20	0.28
Standard			0.330*	0.120*	0.05**	30*	0.17**	-	-

Remark: * Ambient air standard according to Notification of National Environmental Board No. 24, B.E. 2547 (2004)

** Ambient air standard according to Notification of National Environmental Board No. 10 , B.E 2538 (1995)

*** Ambient air standard according to Notification of National Environmental Board No. 36 , B.E 2553 (2010)

- Station No. 2: Maria Rosa Mystica Church, Wang Thonglang, Wang Thonglang, Bangkok

The air quality monitoring found that TSP from 0.036 to 0.046 mg/m³ which was about 10.90 to 13.93 percent of the standard (standard average TSP is 0.33 mg/m³). PM10 ranged from 0.021 to 0.025 mg/m³ which was about 17.5 to 20.83 percent of the standard (standard PM10 is 0.12 mg/m³), PM2.5 ranged from 0.013 to 0.015 mg/m³ which was about 26.0 to 30.0 percent of the standard (standard PM2.5 is 0.05 mg/m³).

The average one-hour maximum concentration of NO₂ ranged from 0.0213 to 0.0271 ppm. which was about 12.52 to 15.94 percent of the standard (standard NO₂ is 0.17 ppm). The average one-hour maximum concentration of CO ranged from 1.3 to 2.0 ppm. which was about 4.3 to 6.6 percent of the standard (Standard CO is 30 ppm). The concentration of THC ranged 1.98 to 2.62 ppm. Thailand has still not determined the air quality standard for this parameter. NMHC ranged 0.22 to 0.62 ppm. Thailand has still not determined the air quality standard for this parameter.

- Station No. 3: Vejthani Hospital, Klong-Chan, Bang Kapi, Bangkok

The air quality monitoring found that TSP from 0.048 to 0.079 mg/m³ which was about 14.54 to 23.93 percent of the standard (standard average TSP is 0.33 mg/m³). PM10 ranged from 0.026 to 0.038 mg/m³ which was about 21.66 to 31.66 percent of the standard (standard PM10 is 0.12 mg/m³), PM2.5 ranged from 0.016 to 0.021 mg/m³ which was about 32.0 to 42.0 percent of the standard (standard PM2.5 is 0.05 mg/m³).

The average one-hour maximum concentration of NO₂ ranged from 0.0428 to 0.0653 ppm. which was about 25.17 to 38.4 percent of the standard (standard NO₂ is 0.17 ppm). The average one-hour maximum concentration of CO ranged from 1.3 to 2.3 ppm. which was about 4.3 to 7.6 percent of the standard (Standard CO is 30 ppm). The concentration of THC ranged 2.39 to 2.84 ppm. Thailand has still not determined the air quality standard for this parameter. NMHC ranged 0.58 to 1.49 ppm. Thailand has still not determined the air quality standard for this parameter.

- Station No. 4: Mae Phra Ong Uppatham Catholic Church, Hua Mak, Bang Kapi, Bangkok

The air quality monitoring found that TSP from 0.050 to 0.075 mg/m³ which was about 15.15 to 22.72 percent of the standard (standard average TSP is 0.33 mg/m³). PM10 ranged from 0.023 to 0.036 mg/m³ which was about 19.16 to 30.00 percent of the standard (standard PM10 is 0.12 mg/m³), PM2.5 ranged from 0.011 to 0.016 mg/m³ which was about 22.0 to 30.0 percent of the standard (standard PM2.5 is 0.05 mg/m³).

The average one-hour maximum concentration of NO₂ ranged from 0.0243 to 0.0382 ppm. which was about 14.29 to 22.47 percent of the standard (standard NO₂ is 0.17 ppm). The average one-hour maximum concentration of CO ranged from 1.0 to 1.5 ppm. which was about 3.3 to 5.0 percent of the standard (Standard CO is 30 ppm). The concentration of THC ranged 2.09 to 2.70 ppm. Thailand has still not determined the air quality standard for this parameter. NMHC ranged 0.31 to 0.95 ppm. Thailand has still not determined the air quality standard for this parameter.

- Station No. 5: Khlong Kalantan School, Suan Luang, Suan Luang, Bangkok

The air quality monitoring found that TSP from 0.114 to 0.180 mg/m³ which was about 34.54 to 54.54 percent of the standard (standard average TSP is 0.33 mg/m³). PM10 ranged from 0.049 to 0.060 mg/m³ which was about 40.83 to 50.00 percent of the standard (standard PM10 is 0.12 mg/m³), PM2.5 ranged from 0.023 to 0.028 mg/m³ which was about 46.0 to 56.0 percent of the standard (standard PM2.5 is 0.05 mg/m³).

The average one-hour maximum concentration of NO₂ ranged from 0.0455 to 0.0797 ppm. which was about 26.76 to 46.88 percent of the standard (standard NO₂ is 0.17 ppm). The average one-hour maximum concentration of CO ranged from 1.4 to 2.7 ppm. which was about 4.6 to 9.0 percent of the standard (Standard CO is 30 ppm). The concentration of THC ranged 2.24 to 3.20 ppm. Thailand has still not determined the air quality standard for this parameter. NMHC ranged 0.41 to 0.96 ppm. Thailand has still not determined the air quality standard for this parameter.

- Station No. 6 : Khachon Siri Temple, Suan Luang, Suan Luang, Bangkok

The air quality monitoring found that TSP from 0.081 to 0.134 mg/m³ which was about 24.54 to 40.60 percent of the standard (standard average TSP is 0.33 mg/m³). PM10 ranged from 0.032 to 0.051 mg/m³ which was about 26.66 to 42.5 percent of the standard (standard PM10 is 0.12 mg/m³), PM2.5 ranged from 0.015 to 0.020 mg/m³ which was about 30.0 to 40.0 percent of the standard (standard PM2.5 is 0.05 mg/m³).

The average one-hour maximum concentration of NO₂ ranged from 0.0182 to 0.0348 ppm. which was about 10.70 to 20.47 percent of the standard (standard NO₂ is 0.17 ppm). The average one-hour maximum concentration of CO ranged from 0.8 to 1.2 ppm. which was about 2.6 to 4.0 percent of the standard (Standard CO is 30 ppm). The concentration of THC ranged 2.21 to 2.63 ppm. Thailand has still not determined the air quality standard for this parameter. NMHC ranged 0.35 to 0.77 ppm. Thailand has still not determined the air quality standard for this parameter.

- Station No. 7: Darulamin Mosque, Suan Luang, Suan Luang, Bangkok

The air quality monitoring found that TSP from 0.061 to 0.119 mg/m³ which was about 18.48 to 36.06 percent of the standard (standard average TSP is 0.33 mg/m³). PM10 ranged from 0.028 to 0.061 mg/m³ which was about 23.33 to 50.83 percent of the standard (standard PM10 is 0.12 mg/m³), PM2.5 ranged from 0.013 to 0.020 mg/m³ which was about 26.0 to 40.0 percent of the standard (standard PM2.5 is 0.05 mg/m³).

The average one-hour maximum concentration of NO₂ ranged from 0.0190 to 0.0337 ppm. which was about 11.17 to 19.82 percent of the standard (standard NO₂ is 0.17 ppm). The average one-hour maximum concentration of CO ranged from 1.0 to 1.8 ppm. which was about 3.3 to 6.0 percent of the standard (Standard CO is 30 ppm). The concentration of THC ranged 2.22 to 2.40 ppm. Thailand has still not determined the air quality standard for this parameter. NMHC ranged 0.35 to 0.77 ppm. Thailand has still not determined the air quality standard for this parameter.

- Station No. 8: Si lam Temple, Bang Na, Bang Na, Bangkok

The air quality monitoring found that TSP from 0.105 to 0.139 mg/m³ which was about 31.81 to 42.12 percent of the standard (standard average TSP is 0.33 mg/m³). PM10 ranged from 0.036 to 0.052 mg/m³ which was about 30.00 to 43.33 percent of the standard (standard PM10 is 0.12 mg/m³), PM2.5 ranged from 0.020 to 0.027 mg/m³ which was about 40.0 to 54.0 percent of the standard (standard PM2.5 is 0.05 mg/m³).

The average one-hour maximum concentration of NO₂ ranged from 0.0285 to 0.0443 ppm. which was about 16.76 to 26.05 percent of the standard (standard NO₂ is 0.17 ppm). The average one-hour maximum concentration of CO ranged from 1.1 to 2.7 ppm. which was about 3.6 to 9.0 percent of the standard (Standard CO is 30 ppm). The concentration of THC ranged 1.96 to 2.77 ppm. Thailand has still not determined the air quality standard for this parameter. NMHC ranged 0.19 to 0.62 ppm. Thailand has still not determined the air quality standard for this parameter.

**- Station No. 9: Siriwut Witthaya School, Thepharak, Muang Samut
Prakran, Samut Prakran province**

The air quality monitoring found that TSP from 0.059 to 0.128 mg/m³ which was about 17.87 to 38.73 percent of the standard (standard average TSP is 0.33 mg/m³). PM10 ranged from 0.030 to 0.057 mg/m³ which was about 25.00 to 47.5 percent of the standard (standard PM10 is 0.12 mg/m³), PM2.5 ranged from 0.016 to 0.023 mg/m³ which was about 32.0 to 46.0 percent of the standard (standard PM2.5 is 0.05 mg/m³).

The average one-hour maximum concentration of NO₂ ranged from 0.0307 to 0.0422 ppm. which was about 18.05 to 24.82 percent of the standard (standard NO₂ is 0.17 ppm). The average one-hour maximum concentration of CO ranged from 0.8 to 1.6 ppm. which was about 2.6 to 5.3 percent of the standard (Standard CO is 30 ppm). The concentration of THC ranged 2.01 to 2.48 ppm. Thailand has still not determined the air quality standard for this parameter. NMHC ranged 0.30 to 0.59 ppm. Thailand has still not determined the air quality standard for this parameter.

**- Station No. 10: Chulavej Hospital, Thepharak, Muang Samut Prakran,
Samut Prakran province**

The air quality monitoring found that TSP from 0.156 to 0.215 mg/m³ which was about 47.27 to 65.15 percent of the standard (standard average TSP is 0.33 mg/m³). PM10 ranged from 0.073 to 0.101 mg/m³ which was about 60.83 to 84.16 percent of the standard (standard PM10 is 0.12 mg/m³), PM2.5 ranged from 0.025 to 0.033 mg/m³ which was about 50.0 to 66.0 percent of the standard (standard PM2.5 is 0.05 mg/m³).

The average one-hour maximum concentration of NO₂ ranged from 0.0281 to 0.1001 ppm. which was about 16.52 to 58.88 percent of the standard (standard NO₂ is 0.17 ppm). The average one-hour maximum concentration of CO ranged from 2.1 to 4.1 ppm. which was about 7 to 13.6 percent of the standard (Standard CO is 30 ppm). The concentration of THC ranged 2.16 to 2.55 ppm. Thailand has still not determined the air quality standard for this parameter. NMHC ranged 0.28 to 0.62 ppm. Thailand has still not determined the air quality standard for this parameter.

4.1.6 Noise Level

1) Methodology

(1) Collect the secondary data from the approved EIA reports of Light and Dark Yellow Line Mass Transit System Project of the Office of Transport and Traffic Policy and Planning.

(2) Study and collect a changed of project's detailed as well as the plan and the construction process of the project for the information on the environmental impact assessment.

(3) Monitor on the noise level in the sensitive areas nearby the project route as well as school, hospital, religious place, big community etc. as the primary data. By monitoring average noise level of 24 hours (Leq₂₄), the maximum noise level (L_{max}), day – night noise level (L_{dn}) and 90 percentile noise level (L₉₀) at 10 monitoring stations. Each station was continuously monitoring 24 hours a day for five days between June 14 until July 2, 2013. The monitoring station along project routed was presented in **Figure 4.1.5 - 1**. The diagram of monitoring and sampling points the shown in **Appendix 4B**. The criteria and guideline for selection of the noise level monitoring station were the same as the air quality.

(4) Assess the noise level impacts in the changed of the project details, considering the long-term impact of the construction and operation phase.

(5) Recommend the noise level prevention and mitigation measures and auditing requirements that appropriated to the project.

2) Study Results

(1) Secondary Data Reviewed

The review of secondary data from both previous Final EIA reports of TOP (Light and Dark Yellow Line Mass Transit Projects, June 2012) found that the noise level monitoring index was Leq₂₄, L_{max}, L_{dn} and L₉₀. The results of noise level monitoring along project routed during 2008-2009, as shown in **Table 4.1.6 - 1**.

From monitoring results of both previous Final EIA reports of TOP (Light and Dark Yellow Line Mass Transit Projects, June 2012), it was found that most of the results complied with

**Table 4.1.6 - 1 Results of Noise Level from Sampling Station along the Project Route between
2008 - 2009**

No.	Station	Date	Noise Level (dB(A),)			
			Leq ₂₄	L _{max}	L _{dn}	L ₉₀
1	Pibool Upphatham School 1 st Time	12-13 March, 2008	60.92	85.60	66.76	53.1-59.2
		13-14 March, 2008	61.20	86.60	67.09	52.8-59.1
		14-15 March, 2008	61.16	84.10	67.21	53.5-59.0
		15-16 March, 2008	61.02	84.70	66.78	53.3-58.5
		16-17 March, 2008	63.25	87.40	68.34	57.8-69.5
	2 nd Time	30 April-1 May, 2008	63.01	83.00	68.39	56.0-60.7
		1-2 May, 2008	62.95	84.50	69.38	55.5-60.9
		2-3 May, 2008	65.83	97.50	69.52	55.6-61.1
		3-4 May, 2008	64.43	90.40	69.03	54.8-61.3
		4-5 May, 2008	62.71	86.60	68.64	53.6-60.2
		Min. – Max.	60.92-65.83	83.00-97.50	66.76-69.52	52.8-69.5
2	Maria Rosa Church ^{/1} 1 st Time	19-20 March, 2008	61.27	96.50	65.86	46.6-55.0
		20-21 March, 2008	61.03	89.80	65.94	46.9-56.0
		21-22 March, 2008	61.14	93.80	65.90	47.8-56.8
		22-23 March, 2008	61.07	92.40	65.29	47.7-56.8
		23-24 March, 2008	61.99	94.20	66.85	47.0-59.0
	2 nd Time	16-17 May, 2008	67.12	93.30	73.52	53.0-59.7
		17-18 May, 2008	70.92	93.50	77.09	55.1-71.4
		18-19 May, 2008	72.32	103.30	78.64	54.7-72.7
		19-20 May, 2008	71.39	91.30	77.70	53.6-71.3
		20-21 May, 2008	72.29	93.60	78.21	56.3-72.3
		Min. – Max.	61.03-72.39	89.80-103.30	65.29-78.64	46.6-72.7
3	Vejthani Hospital	22-23 April, 2009	69.50	93.40	75.20	60.6-67.2
		23-24 April, 2009	68.70	90.45	74.36	60.4-66.9
		24-25 April, 2009	67.52	89.85	74.25	60.3-66.7
		25-26 April, 2009	68.38	90.20	75.32	61.3-66.8
		26-27 April, 2009	67.06	89.30	75.20	60.2-67.1
		Min. – Max.	67.06-69.50	89.30-93.40	74.25-75.32	60.2-67.2
4	Mae Phra Ong Uppatham Catholic Church	22-23 April, 2009	71.20	94.80	76.90	66.5-69.4
		23-24 April, 2009	70.82	93.24	75.34	66.3-68.2
		24-25 April, 2009	69.98	94.58	74.69	66.2-68.1
		25-26 April, 2009	67.49	93.36	72.51	66.0-67.8
		26-27 April, 2009	68.24	93.27	73.84	66.2-68.3
		Min. – Max.	67.49-71.20	93.24-94.8	72.51-76.90	66.0-69.4
5	Klongkalantan School 1 st Time	19-20 March, 2008	67.49	96.20	74.92	55.2-71.8
		20-21 March, 2008	65.47	89.80	72.46	60.2-61.5
		21-22 March, 2008	66.31	101.00	70.34	55.7-60.9
		22-23 March, 2008	62.55	92.00	68.34	55.0-60.7
		23-24 March, 2008	63.34	99.80	69.15	54.2-60.7
	2 nd Time	30 April – 1 May, 2008	72.12	95.20	74.42	55.1-65.0
		1-2 May, 2008	74.02	96.70	74.54	53.5-64.0
		2-3 May, 2008	66.33	92.90	72.75	54.5-60.3
		3-4 May, 2008	64.48	92.70	70.94	53.8-59.6
		4-5 May, 2008	63.42	93.30	69.65	53.2-59.6
		Min. – Max.	62.55-74.02	89.80-101.00	68.34-74.92	53.2-71.8

**Table 4.1.6 - 1 Results of Noise Level from Sampling Station along the Project Route between
2008 – 2009 (Cont'd.)**

No.	Station	Date	Noise Level (dB(A),)			
			Leq ₂₄	L _{max}	L _{dn}	L ₉₀
6	Khajonsiri Temple	22-23 April, 2009	62.13	95.80	69.06	55.0-69.0
		23-24 April, 2009	65.14	96.30	66.30	54.6-70.1
		24-25 April, 2009	58.90	94.00	65.00	47.1-51.4
		25-26 April, 2009	66.30	94.70	69.88	52.4-69.9
		26-27 April, 2009	69.07	98.70	69.98	54.6-69.2
		Min. – Max.	58.90-69.07	94.00-98.70	65.00-69.98	47.1-70.1
7	Darun a Min Mosque	22-23 April, 2009	66.07	92.30	71.35	54.6-65.3
		23-24 April, 2009	64.18	93.60	72.30	51.1-65.6
		24-25 April, 2009	66.00	93.00	71.40	52.7-63.4
		25-26 April, 2009	67.07	92.70	75.63	66.3-72.8
		26-27 April, 2009	69.12	93.30	75.86	62.3-75.3
		Min. – Max.	64.18-69.12	92.30-93.60	71.35-75.86	51.1-75.3
8	Wat Si lam 1 st Time	19-20 March, 2008	65.55	100.3	71.06	58.2-65.4
		20-21 March, 2008	65.30	100.8	71.93	61.8-64.9
		21-22 March, 2008	66.20	104.0	72.58	59.7-63.8
		22-23 March, 2008	65.25	88.0	71.68	60.0-63.5
		23-24 March, 2008	66.49	81.5	71.55	59.5-63.5
	2 nd Time	30 April-1 May, 2008	76.62	93.60	82.81	61.0-63.1
		1-2 May, 2008	72.40	94.40	75.14	58.4-64.8
		2-3 May, 2008	70.45	94.50	71.70	58.4-63.1
		3-4 May, 2008	76.53	93.20	81.74	58.6-62.3
		4-5 May, 2008	72.32	92.70	78.68	59.4-63.3
		Min. – Max.	72.32-76.62	92.70-94.50	71.70-82.81	58.4-64.8
9	Siriwut Witthaya School	22-23 April, 2009	59.31	91.70	88.10	54.5-59.6
		23-24 April, 2009	61.35	88.90	78.69	55.2-63.5
		24-25 April, 2009	62.13	92.30	77.11	54.8-65.7
		25-26 April, 2009	66.30	91.40	72.30	58.8-64.1
		26-27 April, 2009	69.12	85.40	77.26	54.6-65.3
		Min. – Max.	59.31-69.12	85.40-92.30	72.30-88.10	54.5-65.7
10	Chulavej Hospital	22-23 April 2009	68.82	88.10	76.77	63.3-69.9
		23-24 April 2009	69.07	91.70	76.64	63.1-68.7
		24-25 April 2009	67.78	92.70	78.09	63.2-69.2
		25-26 April 2009	65.06	98.70	79.40	64.1-71.8
		26-27 April 2009	66.15	93.30	78.47	64.9-71.6
		Min. – Max.	65.06-69.07	88.10-98.70	76.77-79.40	63.1-71.8
Standard*			70	115	-	-

Source: Office of Transportation and Traffic Policy and Planning (OTP, 2012), The EIA Report on the MRT Yellow Line and Dark Yellow Line Project.

Standard. Except Leq_{24} at Maria Rosa Mystica Church (second time), Futhulbari Mosque, Khlong Ka Lan Tan School (second time) and Si lam Temple (second time) exceeding 70 dB(A), which is the standard of the Ministry of Natural Resources and Environment.

(2) Field Survey Result

The noise level is measured in the area along project route. The monitoring index was Leq_{24} , L_{max} , L_{dn} and L_{90} with Precision Integrating Sound Level at about 1.5 meters high from the ground level. Between June 14 and July 2, 2013, in the sensitive areas at 10 stations, each station monitor for the 24 consecutive hours for 5 days (detailed results of noise level monitoring as shown in **Appendix 4D**). The diagram of noise level monitoring station along project route as illustrated in **Photo 4.1.6 - 1**. Results of noise level monitoring along project routed between 14 June and 2 July 2013, as shown in **Table 4.1.6 - 2**.

- Station No. 1 Phibun Uppatham School, Sam Sen Nok, Huay Khwang, Bangkok

The monitoring noise level between 20 to 25 June 2013 showed that Leq_{24} ranged between 55.1 to 67.1 dB(A) was complied with Standard of general noise level not exceed 70 dB(A) of the Ministry of Natural Resources and Environment. L_{max} ranged from 85.4 to 110.6 dB(A) was complied with L_{max} Standard not exceed 115 dB(A). L_{dn} ranged 57.4 to 67.2 dB(A) and L_{90} ranged 51.0 to 55.0 dB(A).

- Station No. 2 Maria Rosa Mystica Church, Wang Thonglang, Wang Thonglang, Bangkok

The monitoring noise level between 20 to 25 June 2013 showed that Leq_{24} ranged between 60.6 to 61.3 dB(A) was complied with Standard of general noise level not exceed 70 dB(A) of the Ministry of Natural Resources and Environment. L_{max} ranged from 89.2 to 101.3 dB(A) was complied with L_{max} Standard not exceed 115 dB(A). L_{dn} ranged 65.2 to 66.6 dB(A) and L_{90} ranged 52.2 to 53.3 dB(A).

- Station No. 3 Vejthani Hospital, Klong-Chan, Bang Kapi, Bangkok

The monitoring noise level between 26 June to 1 July 2013 showed that Leq_{24} ranged between 69.4 to 70.6 dB(A) was complied with Standard of general noise level not exceed 70 dB(A) of the Ministry of Natural Resources and Environment. L_{max} ranged from 97.3 to 106.3 dB(A) was complied with L_{max} Standard not exceed 115 dB(A). L_{dn} ranged 75.8 to 76.5 dB(A) and L_{90} ranged 64.4 to 65.3 dB(A).

- Station No. 4 Mae Phra Ong Uppatham Catholic Church, Hua Mak, Bang Kapi, Bangkok

The monitoring noise level between 27 June to 2 July 2013 showed that Leq_{24} ranged between 55.6 to 56.1 dB(A) was complied with Standard of general noise level not exceed 70 dB(A) of the Ministry of Natural Resources and Environment. L_{max} ranged from 79.7 to 97.6 dB(A) was complied with L_{max} Standard not exceed 115 dB(A). L_{dn} ranged 79.7 to 97.6 dB(A) and L_{90} ranged 52.2 to 53.0 dB(A).

- Station No. 5 Klongkalantan School, Suan Luang, Suan Luang, Bangkok

The monitoring noise level between 14 to 19 June 2013 showed that Leq_{24} ranged between 59.1 to 65.1 dB(A) was complied with Standard of general noise level not exceed 70 dB(A) of the Ministry of Natural Resources and Environment. L_{max} ranged from 87.9 to 95.8 dB(A)

was complied with $L_{\max}$ Standard not exceed 115 dB(A). L_{dn} ranged 64.3 to 69.1 dB(A) and L_{90} ranged 54.2 to 57.9 dB(A).

- Station No. 6 Khachon Siri Temple, Suan Luang Suan Luang, Bangkok

The monitoring noise level between 14 to 19 June 2013 showed that Leq_{24} ranged between 60.4 to 63.5 dB(A) was complied with Standard of general noise level not exceed 70 dB(A) of the Ministry of Natural Resources and Environment. $L_{\max}$ ranged from 92.8 to 99.9 dB(A) was complied with $L_{\max}$ Standard not exceed 115 dB(A). L_{dn} ranged 65.0 to 68.4 dB(A) and L_{90} ranged 46.9 to 50.0 dB(A).

- Station No. 7 Darulamin Mosque, Suan Luang Suan Luang Bangkok

The monitoring noise level between 14 to 19 June 2013 showed that Leq_{24} ranged between 56.8 to 61.3 dB(A) was complied with Standard of general noise level not exceed 70 dB(A) of the Ministry of Natural Resources and Environment. $L_{\max}$ ranged from 85.0 to 98.0 dB(A) was complied with $L_{\max}$ Standard not exceed 115 dB(A). L_{dn} ranged 60.4 to 64.7 dB(A) and L_{90} ranged 45.2 to 51.1 dB(A).

- Station No. 8 Si lam Temple, Bang Na, Bang Na, Bangkok

The monitoring noise level between 20 to 25 June 2013 showed that Leq_{24} ranged between 68.4 to 69.3 dB(A) was complied with Standard of general noise level not exceed 70 dB(A) of the Ministry of Natural Resources and Environment. $L_{\max}$ ranged from 87.7 to 101.5 dB(A) was complied with $L_{\max}$ Standard not exceed 115 dB(A). L_{dn} ranged 73.2 to 74.1 dB(A) and L_{90} ranged 65.5 to 66.7 dB(A).

- Station No. 9 Siriwit Witthaya School, Thepharak, Muang Samut Prakran, Samut Prakran province

The monitoring noise level between 27 June to 2 July 2013 showed that Leq_{24} ranged between 60.8 to 63.9 dB(A) was complied with Standard of general noise level not exceed 70 dB(A) of the Ministry of Natural Resources and Environment. $L_{\max}$ ranged from 90.8 to 96.6 dB(A) was complied with $L_{\max}$ Standard not exceed 115 dB(A). L_{dn} ranged 62.7 to 68.1 dB(A) and L_{90} ranged 54.3 to 56.6 dB(A).

- Station No. 10 Chulavej Hospital, Thepharak, Muang Samut Prakran, Samut Prakran province

The monitoring noise level between 27 June to 2 July 2013 showed that Leq_{24} ranged between 73.1 to 73.7 dB(A) was not complied with Standard of general noise level not exceed 70 dB(A) of the Ministry of Natural Resources and Environment. $L_{\max}$ ranged from 98.3 to 103.4 dB(A) was complied with $L_{\max}$ Standard not exceed 115 dB(A). L_{dn} ranged 79.6 to 80.1 dB(A) and L_{90} ranged 67.7 to 68.3 dB(A).



Station 1 : Pibool Uppatham School



Station 2 : Maria Rosa Mystica Church



Station 3 : Vejthani Hospital



Station 4 : Mae Phra Ong Uppatham Catholic Church



Station 5 : Klongkalantan School



Station 6 : Khajonsiri Temple



Station 7 : Darul Amin Mosque



Station 8 : Si lam Temple



Station 9 : Siriwutti Wittaya School



Station 10 : Chulavej Hospital

Photo 4.1.6 - 1 The Noise Sampling Station along Project Route

**Table 4.1.6 - 2 Results of Noise from Sampling Station along the Route Project between
June 14 to July 2, 2013**

No.	Station	Date	Noise Level (dB(A),)			
			Leq ₂₄	L _{max}	L _{dn}	L ₉₀
1	Pibool Upphatham	20-21 June, 2013	64.9	110.6	66.1	55.0
		21-22 June, 2013	58.9	98.0	61.4	52.2
		22-23 June, 2013	55.1	90.7	57.4	51.0
		23-24 June, 2013	55.2	85.4	59.1	51.0
		24-25 June, 2013	67.1	102.9	67.2	54.9
		Min. – Max.	55.1-67.1	85.4-110.6	57.4-67.2	51.0-55.0
2	Maria Rosa Church	20-21 June, 2013	61.3	95.1	66.6	52.2
		21-22 June, 2013	61.0	89.2	65.2	53.0
		22-23 June, 2013	60.6	101.3	65.2	53.3
		23-24 June, 2013	60.9	97.3	65.8	52.4
		24-25 June, 2013	60.7	91.5	65.6	52.4
		Min. – Max.	60.6-61.3	89.2-101.3	65.2-66.6	52.2-53.3
3	Vejthani Hospital	26-27 June, 2013	70.6	106.3	76.5	65.3
		27-28 June, 2013	69.5	97.9	75.8	64.5
		28-29 June, 2013	69.7	101.3	76.2	64.5
		29-30 June, 2013	69.4	97.4	76.0	64.4
		30 June-1 July, 2013	70.1	97.3	76.1	65.1
		Min. – Max.	69.4-70.6	97.3-106.3	75.8-76.5	64.4-65.3
4	Mae Phra Ong Uppatham Catholic Church	27-28 June, 2013	55.6	88.3	61.0	52.8
		28-29 June, 2013	55.7	97.6	61.7	53.0
		29-30 June, 2013	56.0	79.7	61.3	52.5
		30 June-1 July, 2013	56.1	97.3	61.6	53.0
		1-2 July, 2013	55.9	88.1	61.3	52.2
		Min. – Max.	55.6-56.1	79.7-97.6	61.0-61.7	52.2-53.0
5	Khajonsiri Temple	14-15 June, 2013	63.5	99.6	68.4	50.0
		15-16 June, 2013	61.5	92.8	67.7	49.5
		16-17 June, 2013	60.4	93.8	65.0	46.9
		17-18 June, 2013	60.4	93.7	67.5	47.2
		18-19 June, 2013	61.5	99.9	67.5	49.4
		Min. – Max.	60.4-63.5	92.8-99.9	65.0-68.4	46.9-50.0
6	Darul Amin Mosque	14-15 June, 2013	61.3	91.7	62.9	51.1
		15-16 June, 2013	59.9	98.0	64.7	45.2
		16-17 June, 2013	58.5	95.2	61.7	52.6
		17-18 June, 2013	57.1	85.0	61.2	50.8
		18-19 June, 2013	56.8	85.1	60.4	50.7
		Min. – Max.	56.8-61.3	85.0-98.0	60.4-64.7	45.2-51.1
7	Klongkalantan School	14-15 June, 2013	62.2	90.5	66.4	56.0
		15-16 June, 2013	59.1	95.1	64.3	54.2
		16-17 June, 2013	61.1	88.2	65.6	55.8
		17-18 June, 2013	64.2	87.9	69.0	57.9
		18-19 June, 2013	65.1	95.8	69.1	57.9
		Min. – Max.	59.1-65.1	87.9-95.8	64.3-69.1	54.2-57.9
8	Si lam Temple	20-21 June, 2013	68.4	87.7	73.2	65.6
		21-22 June, 2013	68.5	101.5	73.5	65.5
		22-23 June, 2013	68.7	89.4	73.5	65.9
		23-24 June, 2013	69.3	92.2	73.9	66.4
		24-25 June, 2013	69.2	88.8	74.1	66.7
		Min. – Max.	68.4-69.3	87.7-101.5	73.2-74.1	65.5-66.7

Table 4.1.6 - 2 Results of Noise from Sampling Station along the Route Project between June 14 to July 2, 2013 (Cont'd.)

No.	Station	Date	Noise Level (dB(A),)			
			Leq ₂₄	Leq ₂₄	Leq ₂₄	Leq ₂₄
9	Siriwutti Wittaya School	27-28 June, 2013	63.7	91.9	66.9	56.6
		28-29 June, 2013	61.7	90.8	63.8	55.0
		29-30 June, 2013	63.9	99.0	68.1	56.5
		30 June -1 July, 2013	60.8	93.0	62.7	54.3
		1-2 July, 2013	63.8	96.6	66.6	56.4
		Min. – Max.	60.8-63.9	90.8-96.6	62.7-68.1	54.3-56.6
10	Chulavej Hospital	27-28 June, 2013	73.7	102.7	79.7	68.0
		28-29 June, 2013	73.6	103.4	79.8	68.1
		29-30 June, 2013	73.1	102.2	80.1	67.7
		30 June.-1 July, 2013	73.5	98.3	79.6	68.3
		1-2 July, 2013	73.4	102.2	79.7	68.0
		Min. – Max.	73.1-73.7	98.3-103.4	79.6-80.1	67.7-68.3
ค่ามาตรฐาน*			70	115	-	-

Remark: * Ambient noise standard according to Notification of National Environmental Board No. 15, B.E. 2540 (1997)

Source : Field survey by ENRICH Consultant Co., Ltd. 2013.

4.1.7 Vibration

1) Methodology

(1) Collect the secondary data from the approved EIA reports of Light and Dark Yellow Line Mass Transit System Project of the Office of Transport and Traffic Policy and Planning.

(2) Study and collect a changed of project's detailed as well as the plan and the construction process of the project for the information on the environmental impact assessment.

(3) Existing environment survey by monitoring on vibration level in the sensitive areas nearby the project route. Each station was continuously monitoring 24 hours a day for five days between June 14 until July 2, 2013. The monitoring station along project route was presented in **Figure 4.1.5 - 1**. The diagram of monitoring and sampling points are shown in **Appendix 4B**. The criteria and guideline for the selection of the vibration level monitoring stations were the same as the air quality monitoring station.

(4) Assess the vibration level impacts in the changed of the project details, considering the long-term impact of the construction and operation phase.

(5) Recommend the vibration level prevention and mitigation measures and auditing requirements that appropriated to the project.

2) Study Results

(1) Secondary Data Review

The review of secondary data from both previous Final EIA reports of TOP (Light and Dark Yellow Line Mass Transit System Projects, June 2012) found that the vibration level monitoring index was Peak Particle Velocity, PPV (millimeter/second) and Frequency (Hz). The results of vibration level monitoring along project route during 2008 - 2009, as shown in **Table 4.1.7 - 1**.

From monitoring results of both previous Final EIA reports of TOP (Light and Dark Yellow Line Mass Transit System Projects, June 2012), it was found that the vibration level ranged 0.020 to 2.410 mm./sec. At Station No. 1 Phibun Uppatham School, Lat Phrao Road (5 meters away from the project route) has the maximum vibration level of 2.410 mm/sec (11:00 to 12:00 hrs. On May 4, 2008). These because of the monitoring station closed to Lat Phrao Road with the high traffic volume and the vehicle size 6, 10, 18 wheels take the road at all times. When compared with the standard that impact to human feelings of Reiher & Meister, can be concluded that more than 98% PPV at every station were lower than level 3 as a vibration that humans can recognize easily (<0.30 mm/sec) And no impacts to old buildings when comparing with Vibration Standard of DIN 4150 (<2.00 mm/sec).

(2) Field Survey Result

The vibration level was measured in the area along project route. The monitoring index was PPV and Frequency. Between June 14 and July 2, 2013, as shown in **Table 4.1.7-2**, in the sensitive areas at 10 stations, each station monitor for the 24 consecutive hours for 5 days (detailed results of vibration level monitoring as shown in **Appendix 4E**). The diagram of vibration level monitoring stations along project route as illustrated in **Photo 4.1.7 - 1**. The results as below.

- Station No. 1 Phibun Uppatham School, Sam Sen Nok, Huay Khwang, Bangkok

Results of existing vibration monitoring between 20 to 25 June 2013 showed that PPV was in the range of 1.14 to 3.00 mm./sec. The maximum level within 24 hours of five consecutive days was 3.00 mm/sec. The frequency less than 100 Hz when compared with the vibration standard for building type 2 impact prevention (residential buildings, common housing building, row-room building, row-house brick building, row-house building, duplex house), according to the Notification of National Environment Committee No. 37 (B.E. 2553) found that the maximum value was lower than the standard limit.

- Station No. 2 Maria Rosa Mystica Church, Wang Thonglang, Wang Thonglang, Bangkok

Results of existing vibration monitoring between 20 to 25 June 2013 showed that PPV was in the range of 0.891 to 2.17 mm./sec. The maximum level within 24 hours of five consecutive days was 2.17 mm/sec. The frequency was 3.2 Hz when compared with the vibration standard for building type 2 impact prevention (residential buildings, common housing building, row-room building, row-house brick building, row-house building, duplex house), according to the Notification of National Environment Committee No. 37 (B.E. 2553) found that the maximum value was lower than the standard limit.

- Station No. 3 Vejthani Hospital, Klong-Chan, Bang Kapi, Bangkok

Results of existing vibration monitoring between 26 June to 1 July 2013 showed that PPV was in the range of 0.946 to 1.53 mm/sec. The maximum level within 24 hours of five consecutive days was 1.53 mm/sec. The frequency was 4.3 Hz when compared with the vibration standard for building type 2 impact prevention (residential buildings, common housing building, row-room building, row-house brick building, row-house building, duplex house), according to the Notification of National Environment Committee No. 37 (B.E. 2553) found that the maximum value was lower than the standard limit.

**Table 4.1.7 - 1 Results of Vibration from Sampling Station along the Project Route between
2008 – 2009**

No.	Station	Date	Peak Particle Velocity (mm./sec.)	Frequency (Hz)	Axial vibration measurements
1	Pibool Upphatham School 1 st Time	12-13 March, 2008	1.075	50	Transverse
		13-14 March, 2008	0.950	42	Transverse
		14-15 March, 2008	0.850	42	Transverse
		15-16 March, 2008	0.700	50	Transverse
		16-17 March, 2008	0.600	50	Transverse
	2 nd Time	30 April-1 May, 2008	0.968	73	Longitudinal
		1-2 May, 2008	1.620	>100	Longitudinal
		2-3 May, 2008	2.080	>100	Longitudinal
		3-4 May, 2008	2.410	>100	Transverse
		4-5 May, 2008	0.730	>100	Vertical
		Min - Max	0.600-1.620	42->100	-
2	Maria Rosa Mystica Church 1 st Time	19-20 March, 2008	0.725	50	Vertical
		20-21 March, 2008	0.975	42	Transverse
		21-22 March, 2008	0.825	42	Transverse
		22-23 March, 2008	1.575	28	Vertical
		23-24 March, 2008	1.575	42	Transverse
	2 nd Time	16-17 May, 2008	0.778	64	Transverse
		17-18 May, 2008	1.400	>100	Transverse
		18-19 May, 2008	1.510	85	Transverse
		19-20 May, 2008	0.429	43	Vertical
		20-21 May, 2008	0.571	47	Vertical
		Min - Max	0.429-1.575	28->100	-
3	Vejthani Hospital	22-23 April, 2009	1.986	50	Longitudinal
		23-24 April, 2009	1.112	31	Vertical
		24-25 April, 2009	1.520	36	Transverse
		25-26 April, 2009	0.788	58	Vertical
		26-27 April, 2009	0.825	43	Vertical
		Min - Max	0.788-1.986	31-50	-
4	Darul Amin Mosque	22-23 April, 2009	1.922	>100	Longitudinal
		23-24 April, 2009	0.988	62	Transverse
		24-25 April, 2009	1.356	>100	Longitudinal
		25-26 April, 2009	2.115	73	Transverse
		26-27 April, 2009	1.445	>100	Transverse
		Min - Max	0.988-2.115	62->100	-
5	Klongkalantan School 1 st Time	19-20 March, 2008	0.889	5	Vertical
		20-21 March, 2008	0.937	4	Vertical
		21-22 March, 2008	0.857	4	Vertical
		22-23 March, 2008	0.952	6	Longitudinal
		23-24 March, 2008	1.400	5	Vertical
	2 nd Time	30 April -1 May, 2008	0.841	85	Transverse
		1-2 May, 2008	1.030	3	Vertical
		2-3 May, 2008	1.020	4	Vertical
		3-4 May, 2008	0.921	4	Vertical
		4-5 May, 2008	1.980	73	Vertical
		Min - Max	0.857-1.980	3-85	-

**Table 4.1.7 - 1 Results of Vibration from Sampling Station along the Project Route between
2008 – 2009 (Cont'd.)**

No.	Station	Date	Peak Particle Velocity (mm./sec.)	Frequency (Hz)	Axial vibration measurements
6	Khajonsiri Temple	22-23 April, 2009	1.190	3	Vertical
		23-24 April, 2009	1.270	8	Vertical
		24-25 April, 2009	1.370	17	Vertical
		25-26 April, 2009	1.860	19	Vertical
		26-27 April, 2009	1.100	20	Vertical
		Min - Max	1.100-1.860	3-20	-
7	Darul Amin Mosque	22-23 April, 2009	1.890	8	Transverse
		23-24 April, 2009	0.750	53	Longitudinal
		24-25 April, 2009	0.675	47	Longitudinal
		25-26 April, 2009	0.800	20	Transverse
		26-27 April, 2009	1.550	50	Transverse
		Min - Max	0.675-1.890	8-53	-
8	Si lam Temple 1 st Time	19-20 March, 2008	1.110	7	Vertical
		20-21 March, 2008	1.140	5	Vertical
		21-22 March, 2008	1.190	4	Vertical
		22-23 March, 2008	1.190	85	Longitudinal
		23-24 March, 2008	1.650	8	Longitudinal
	2 nd Time	30 April-1 May, 2008	1.140	9	Vertical
		1-2 May, 2008	1.400	20	Vertical
		2-3 May, 2008	1.140	4	Vertical
		3-4 May, 2008	1.540	85	Vertical
		4-5 May, 2008	1.670	85	Vertical
		Min - Max	1.110-1.670	4-85	-
9	Siriwutti Wittaya School	22-23 April, 2009	1.986	5	Longitudinal
		23-24 April, 2009	0.984	56	Longitudinal
		24-25 April, 2009	0.950	11	Vertical
		25-26 April, 2009	1.270	43	Vertical
		26-27 April, 2009	0.983	10	Vertical
		Min - Max	0.950-1.986	5-56	-
10	Chulavej Hospital	22-23 April, 2009	1.800	56	Transverse
		23-24 April, 2009	1.670	4	Vertical
		24-25 April, 2009	1.751	6	Transverse
		25-26 April, 2009	1.192	64	Vertical
		26-27 April, 2009	1.563	13	Vertical
		Min - Max	1.192-1.800	4-56	-

Remark : Transverse = Transverse Geophone
 Vertical = Vertical Geophone
 Longitudinal = Longitudinal Geophone
 N/A = Not Available
 * = Standard value according to Notification of Environmental Board B.E. 2553 (2010), Standard for building impact prevention

**Table 4.1.7 - 2 Results of Vibration from Sampling Station along the Project Route between
June 14 to July 2, 2013**

No.	Station	Date	Time of Peak Particle Velocity	Peak Particle Velocity (mm./sec.)	Frequency (Hz)	Standard* (mm./sec.)
1	Pibool Upphatham School	20-21 June, 2013	6:19:48 pm.	1.14 (Vert)	>100	20
		21-22 June, 2013	9:29:14 am.	1.40 (Vert)	>100	20
		22-23 June, 2013	10:33:09 am.	1.34 (Vert)	85	18.5
		23-24 June, 2013	5:56:02 am.	2.00 (Vert)	73	17.3
		24-25 June, 2013	12:41:09 pm.	3.00 (Vert)	>100	20
		Min - Max		1.14-3.00	73->100	
2	Maria Rosa Mystica Church	20-21 June, 2013	9:02:59 am.	0.891 (Vert)	9.8	5
		21-22 June, 2013	5:00:54 pm.	2.17 (Vert)	3.2	5
		22-23 June, 2013	12:06:30 pm.	0.717 (Vert)	11	5.25
		23-24 June, 2013	11:37:20 am.	1.14 (Vert)	5.7	5
		24-25 June, 2013	10:18:52 am.	1.15 (Vert)	8.5	5
		Min - Max		0.891-2.17	3.2-11	
3	Vejthani Hospital	26-27 June, 2013	08:14:35 am.	0.946 (Vert)	3.5	5
		27-28 June, 2013	3:42:50 pm.	1.11 (Vert)	3.4	5
		28-29 June, 2013	4:27:59 am.	1.14 (Vert)	3.7	5
		29-30 June, 2013	9:31:26 pm.	1.53 (Vert)	4.3	5
		30 June-1 July, 2013	5:04:34 am.	1.28 (Vert)	3.5	5
		Min - Max		0.946-1.53	3.4-4.3	
4	Mae Phra Ong Uppatham Catholic Church	27-28 June, 2013	11:43:37 am.	0.905 (Vert)	9.8	5
		28-29 June, 2013	4:50:57 pm.	0.714 (Vert)	2.5	5
		29-30 June, 2013	12:08:26 am.	0.730 (Vert)	3.4	5
		30 June -1 July, 2013	2:56:24 am.	0.810 (Vert)	2.7	5
		1-2 July 2013	12:08:53 am.	0.619 (Vert)	2.6	5
		Min - Max		0.619-0.905	2.5-9.8	
5	Klongkalantan School	14-15 June, 2013	10:40:14 am.	1.08 (Vert)	73	17.3
		15-16 June, 2013	3:12:02 pm.	1.40 (Vert)	64	16.4
		16-17 June, 2013	12:04:56 pm.	1.30 (Vert)	3.0	5
		17-18 June, 2013	9:05:50 pm.	1.41 (Vert)	3.0	5
		18-19 June, 2013	3:46:52 am.	1.19 (Vert)	3.5	5
		Min - Max		1.08-1.41	3.0-73	
6	Khajonsiri Temple	14-15 June, 2013	8:07:58 am.	0.524 (Vert)	23	8.25
		15-16 June, 2013	1:00:12 pm.	0.429 (Vert)	13	5.75
		16-17 June, 2013	12:00:05 pm.	0.556 (Tran)	2.2	5
		17-18 June, 2013	5:05:43 am.	1.33 (Tran)	1.7	5
		18-19 June, 2013	7:07:22 am.	1.22 (Tran)	73	17.3
		Min - Max		0.429-1.33	1.7-73	

**Table 4.1.7 - 2 Results of Vibration from Sampling Station along the Project Route between
June 14 to July 2, 2013 (Cont'd.)**

No.	Station	Date	Time of Peak Particle Velocity	Peak Particle Velocity (mm./sec.)	Frequency (Hz)	Standard* (mm./sec.)
7	Darul Amin Mosque	14-15 June, 2013	-	<0.300	N/A	5
		15-16 June, 2013	-	<0.300	N/A	5
		16-17 June, 2013	-	<0.300	N/A	5
		17-18 June, 2013	-	<0.300	N/A	5
		18-19 June, 2013	-	<0.300	N/A	5
		Min - Max		-	-	
8	Si lam Temple	20-21 June, 2013	11:23:41 pm.	1.11 (Vert)	3.8	5
		21-22 June, 2013	12:53:06 pm.	1.09 (Vert)	2.8	5
		22-23 June, 2013	2:57:23 pm.	1.74 (Vert)	3.2	5
		23-24 June, 2013	9:37:00 pm.	1.30 (Vert)	3.0	5
		24-25 June, 2013	6:49:57 pm.	0.930 (Vert)	2.7	5
		Min - Max		0.930-1.74	2.7-3.8	
9	Siriwutti Wittaya School	27-28 June, 2013	2:54:41 pm.	1.21 (Vert)	3.6	5
		28-29 June, 2013	6:56:44 am.	1.05 (Vert)	3.2	5
		29-30 June, 2013	6:13:36 pm.	4.52 (Tran)	47	14.25
		30 June -1 July, 2013	4:19:30 am.	1.23 (Vert)	3.3	5
		1-2 July, 2013	10:35:49 am.	1.02 (Vert)	3.2	5
		Min - Max		1.02-4.25	3.2-47	
10	Chulavej Hospital	27-28 June, 2013	9:55:47 pm.	2.06 (Vert)	10	5
		28-29 June, 2013	1:54:40 pm.	2.25 (Vert)	4.8	5
		29-30 June, 2013	12:20:42 pm.	2.59 (Vert)	3.5	5
		30 June -1 July, 2013	5:07:38 am.	2.20 (Vert)	11	5.25
		1-2 July, 2013	7:11:11 pm.	2.51 (Vert)	11	5.25
		Min - Max		2.06-2.59	3.5-11	

หมายเหตุ: Tran = Transverse Geophone
 Vert = Vertical Geophone
 Long = Longitudinal Geophone
 N/A = Not Available
 * = Standard value according to Notification of Environmental Board B.E. 2553 (2010), Standard for building impact prevention



Station 1 : Pibool Upphatham School



Station 2 : Maria Rosa Mystica Church



Station 3 : Vejthani Hospital



Station 4 : Mae Phra Ong Uppatham Catholic Church



Station 5 : Klongkalantan School



Station 6 : Khajonsiri Temple



Station 7 : Darul Amin Mosque



Station 8 : Si lam Temple



Station 9 : Siriwutti Wittaya School



Station 10 : Chulavej Hospital

Photo 4.1.7 - 1 The Vibration Sampling Station along Project Routed

- Station No. 4 Mae Phra Ong Uppatham Catholic Church, Hua Mak, Bang Kapi Bangkok

Results of existing vibration monitoring between 27 June to 2 July 2013 showed that PPV was in the range of 0.619 to 0.905 mm/sec. The maximum level within 24 hours of five consecutive days was 0.905 mm/sec. The frequency was 9.8 Hz when compared with the vibration standard for building type 2 impact prevention (residential buildings, common housing building, row-room building, row-house brick building, row-house building, duplex house), according to the Notification of National Environment Committee No. 37 (B.E. 2553) found that the maximum value was lower than the standard limit.

- Station No.5 Klongkalantan School (Meesuwan Anusorn) Suan Luang, Suan Luang, Bangkok

Results of existing vibration monitoring between 14 to 19 June 2013 showed that PPV was in the range of 1.08 to 1.41 mm/sec. The maximum level within 24 hours of five consecutive days was 1.41 mm/sec. The frequency was 3.0 Hz when compared with the vibration standard for building type 2 impact prevention (residential buildings, common housing building, row-room building, row-house brick building, row-house building, duplex house), according to the Notification of National Environment Committee No. 37 (B.E. 2553) found that the maximum value was lower than the standard limit.

- Station No. 6 Khachon Siri Temple, Suan Luang, Suan Luang Bangkok

Results of existing vibration monitoring between 14 to 19 June 2013 showed that PPV was in the range of 0.429 to 1.33 mm/sec. The maximum level within 24 hours of five consecutive days was 1.33 mm/sec. The frequency was 1.7 Hz when compared with the vibration standard for building type 2 impact prevention (residential buildings, common housing building, row-room building, row-house brick building, row-house building, duplex house), according to the Notification of National Environment Committee No. 37 (B.E. 2553) found that the maximum value was lower than the standard limit.

- Station No. 7 Darulamin Mosque, Suan Luang, Suan Luang, Bangkok

Results of existing vibration monitoring between 14 to 19 June 2013 showed that PPV was less than 0.300 mm/sec. Detection of frequency could not be conducted. When compared with the vibration standard for building type 2 impact prevention (residential buildings, common housing building, row-room building, row-house brick building, row-house building, duplex house), according to the Notification of National Environment Committee No. 37 (B.E. 2553) found that the maximum value was lower than the standard limit.

- Station No. 8 Si Iam Temple, Bang Na, Bang Na, Bangkok

Results of existing vibration monitoring between 20 to 25 June 2013 showed that PPV was in the range of 0.930 to 1.74 mm/sec. The maximum level within 24 hours of five consecutive days was 1.74 mm/sec. The frequency was 3.2 Hz when compared with the vibration standard for building type 2 impact prevention (residential buildings, common housing building, row-room building, row-house brick building, row-house building, duplex house), according to the Notification of National Environment Committee No. 37 (B.E. 2553) found that the maximum value was lower than the standard limit.

- Station No. 9 Siriwut Witthaya School, Thepharak, Muang Samut Prakran, Samut Prakran province

Results of existing vibration monitoring between 27 June to 2 July 2013 showed that PPV was in the range of 1.02 to 4.25 mm/sec. The maximum level within 24 hours of five consecutive days was 4.25 mm/sec. The frequency was 47 Hz when compared with the vibration standard for building type 2 impact prevention (residential buildings, common housing building, row-room building, row-house brick building, row-house building, duplex house), according to the Notification of National Environment Committee No. 37 (B.E. 2553) found that the maximum value was above the standard limit.

- Station No. 10 Chulavej Hospital, Thepharak, Muang Samut Prakran, Samut Prakran province

Results of existing vibration monitoring between 27 June to 2 July 2013 showed that PPV was in the range of 2.06 to 2.59 mm/sec. The maximum level within 24 hours of five consecutive days was 2.59 mm/sec. The frequency was 3.5 Hz when compared with the vibration standard for building type 2 impact prevention (residential buildings, common housing building, row-room building, row-house brick building, row-house building, duplex house), according to the Notification of National Environment Committee No. 37 (B.E. 2553) found that the maximum value was lower than the standard limit.

4.2 Biological Environmental Resources

4.2.1 Aquatic Ecology

1) Methodology

(1) Secondary data collect from various related documents or reports.

(2) Sampling Phytoplankton, Zooplankton, and Benthos at 6 sampling stations where project routed were cut through, including Lat Phrao Canal, Saen Saeb Canal, Hua Mak Canal, Phra Khanong Canal, Bang Na Canal and Samrong Canal, which is the same station as the surface water quality station.

(3) Sampling and monitoring were conducted on 1 July 2013 which the detailed below.

(3.1) A sampling of phytoplankton and Zooplankton. Use plankton bag 30 microns in size to filter 80 liters of water samples. Conducted the sampling at 6 stations by filtered through plankton bag at about 0.6 meters depth below the water surface. Plankton samples pending in the bag was collected and kept with Formalin solution concentrations of 5 to 7 percent. Then identification and analysis at the laboratories. The density of aquatic organisms was calculated in units of cells per cubic meter. After analyzing the type and density of plankton then calculated for Species Diversity Index from the equation of Shannon - Wiener Index (Shannon and Wiener, 1963) as follows.

$$\begin{array}{rcl}
 H' & = & \sum P_i (\ln P_i) \\
 \text{When } H' & = & \text{Species Diversity Index} \\
 P_i & = & n_i / N
 \end{array}$$

N	=	Total plankton
n_i	=	no. of each plankton

Biodiversity is an indicator of water quality (Wilhm and Dorrix, 1968) as follows.

H'	< 1.0	poor water quality
H'	= 1.0 - 3.0	moderate water quality
H'	> 3.0	good to very good water quality

(3.2) Benthos sampling, The samples were collected in the same sites of phytoplankton and Zooplankton. Soil samples were collected using an Ekman Grab to dig water bed. Benthos Identification by filtered through the various sieve sizes and recording characteristics of sediment, sorting and storage of the sample solution with Formalin at a concentration of 5 to 7 percentage which to is identified and analyzed in the laboratories.

3) Study Results

(1) Secondary Data Collection

The survey and sampling of Aquatic Ecology from Light and Dark Yellow Line Mass Transit Projects EIA reports (Under the economic, environmental and preliminary design feasibility study of Yellow, Brown and Pink Line Mass Transit Project). By collected Aquatic Ecology samples in Lat Phrao Canal, Saen Saeb Canal, Hua Mak Canal, Phra Khanong Canal, Bang Na Canal and Samrong Canal during the dry season (18 to 20 March 2008) and the beginning of the rainy season (20 to 22 May 2008). Summarize of type and quantity of phytoplankton, Zooplankton and Benthos in Lat Phrao Canal, Saen Saeb Canal, and Hua Mak Canal in March and May 2008, as shown in **Table 4.2.1 - 1**. A summary of type and amount of phytoplankton, Zooplankton and Benthos in Phra Khanong Canal, Bang Na Canal, and Samrong Canal in March and May 2008, as shown in **Table 4.2.1 - 2**. The results of the 2 seasons sampling are summarized below.

Considering the Species Diversity Index, H' of phytoplankton, Zooplankton and Benthos using Shannon - Weiner Diversity Index (1963) found that the species diversity index of phytoplankton ranged from 0.90 to 2.53 (the rainy season was higher than the drought. Except Phra Khanong Canal the dry season was higher than the wet season). Shows that the water quality of surface water sources was moderate ($H' > 1.0$), especially during the rainy season was at moderately high levels ($H' = 1.83$ to 2.53) and the dry season, water quality and lowered which the threshold was low to moderately medium ($H' = 0.90$ to 2.37). The species diversity index of Zooplankton and Benthos were similar ($H' =$ none to 1.53), so it is a testament to the decline of water bed in surface water sources.

(2) Field Survey and Samples Collection

Conducted a survey and sampling in the field at six stations along the routed include Lat Phrao Canal, Saen Saeb Canal, Hua Mak Canal, Phra Khanong Canal, Bang Na Canal and Samrong Canal. A sampling of phytoplankton, Zooplankton, and Benthos on July 1, 2013, as shown in **Photo 4.2.1 - 1** (detailed measurements of Aquatic Ecology, as shown in **Appendix 4F**). The summary results of the survey are as follows.

Table 4.2.1 - 1 Summary of Type and Quantity of Phytoplankton, Zooplankton, and Benthos included Lat Phrao Canal, Saen Saeb Canal, and Hua Mak Canal between March to May, 2008

Type and quantity of Phytoplankton, Zooplankton, and Benthos	Klong Lat Phrao		Klong Saen Saeb		Klong Hua Mak	
	March, 2008	May, 2008	March, 2008	May, 2008	March, 2008	May, 2008
Total of Phytoplankton (cell/m ³)	507,900,000	5,320,000	31,600,000	5,312,000	303,500,000	3,636,000
Total of Zooplankton (cell/m ³)	11,700,000	5,000	44,000	12,800	-	7,200
Total of Plankton (cell/m ³)	519,600,000	5,325,000	31,644,000	5,324,800	303,500,000	3,643,200
Percentage of Phytoplankton	97.7	99.9	99.8	99.7	100	99.8
Percentage of Zooplankton	2.3	0.1	0.2	0.3	0	0.2
Species Diversity Index (H) of Phytoplankton	1.96	2.32	1.79	1.99	1.77	2.11
Quantity of Phytoplankton	22	16	17	16	16	12
Species Diversity Index (H) of Zooplankton	0.35	0.95	1.03	0.56	-	0.97
Quantity of Zooplankton	4	3	4	2	-	3
Total of Benthos (Number per m ²)	22	66	22	22	0	0
Species Diversity Index (H) of Benthos	0	0.63	0	0	-	-
Quantity of Benthos	1	2	1	1	-	0

Source: Office of Transportation and Traffic Policy and Planning (OTP, 2012), The EIA Report on the MRT Yellow Line Project.

Table 4.2.1 – 2 Summary of Type and Quantity of Phytoplankton, Zooplankton, and Benthos included Phra Khanong Canal, Bang Na Canal, and Samrong Canal between March to May, 2008

Type and quantity of Phytoplankton, Zooplankton, and Benthos	Klong Phra Khanong		Klong Bang Na		Klong Samrong	
	March, 2008	May, 2008	March, 2008	May, 2008	March, 2008	May, 2008
Total of Phytoplankton (cell/m ³)	177,216,000	10,605,000	3,457,800	3,636,000	80,025,000	4,408,200
Total of Zooplankton (cell/m ³)	411,840	12,000	48,960	900	640,200	431,520
Total of Plankton (cell/m ³)	177,627,840	10,617,000	3,506,760	3,636,900	80,665,200	4,839,720
Percentage of Phytoplankton	99.7	99.9	98.6	99.9	99.2	99.1
Percentage of Zooplankton	0.3	0.1	1.4	0.1	0.8	8.9
Species Diversity Index (H) of Phytoplankton	2.37	1.93	0.90	1.83	1.77	2.53
Quantity of Phytoplankton	21	22	7	15	16	16
Species Diversity Index (H) of Zooplankton	1.29	0.56	0.97	0.00	1.53	1.08
Quantity of Zooplankton	6	2	3	1	7	4
Total of Benthos (Number per m ²)	22	66	22	0	0	0
Species Diversity Index (H) of Benthos	0.00	0.00	0.82	0.63	-	0.80
Quantity of Benthos	1	1	1	0	0	0

Source: Office of Transportation and Traffic Policy and Planning (OTP, 2012), The EIA Report on the MRT Dark Yellow Line Project.



Station 1 : Lat Phrao Canal



Station 2 : Saen Saeb Canal



Station 3 : Hua Mak Canal



Station 4 : Phra Khanong Canal



Station 5 : Bang Na Canal



Station 6 : Samrong Canal

Photo 4.2.1 - 1 Aquatic Ecology Sampling Activities along the Project Route on 1 July, 2013.

(2.1) Station No. 1 Lat Phrao Canal

(a) Phytoplankton and Zooplankton

● Phytoplankton

The results of the survey and sampling found 15 groups of phytoplankton. The most common type was Cyanophyta (blue-green algae) species *Oscillatoria* sp. 525 units per liter, following by Bacillariophyta (diatom) species *Cyclotella* sp. 186 units per liter. The least found groups were Cyanophyta species *Spirulina platensis* (Nordstedt) Geitler, Chlorophyta (green algae) species *Crucigenia* sp. and *Pandorina morum* (Muller) Boy, Euglenophyta (euglenoids) species *Euglena* spp. and Bacillariophyta species *Aulacoseira granulate* (Ehrenberg) Simonse, with the same amount of 6 units per liter, a survey of the type and quantity of Phytoplankton along the routed, on July 1, 2013, as shown in **Table 4.2.1 - 3**.

● Zooplankton

The results of the survey and sampling found 2 groups of Zooplankton which were *Vorticella* sp. and protozoa with cilia found 6 Zooplankton per liter, a survey of the amount of Zooplankton along the project route on July 1, 2013, as shown in **Table 4.2.1 - 4**.

The species diversity index of plankton at Station No. 1 Klong Lat Phrao was 1.59 indicated that the water quality was at the moderate level. The conclusion of type, quantity and diversity of plankton along the project route as shown in **Table 4.2.1 - 5**.

(b) Benthos

From the sampling found one group of Benthos as *Indoplanorbis exustus* of 15 Benthos per square meter. The survey of type and quantity of Benthos along the project route as shown in **Table 4.2.1 - 6**.

(2.2) Station No. 2 Saen Saeb Canal

(a) Phytoplankton and Zooplankton

● Phytoplankton

The results of the survey and sampling found 41 groups of Phytoplankton. The most common type was Cyanophyta species *Oscillatoria* sp. 3,500 units per liter, following by Bacillariophyta species *Cyclotella* sp. 1,050 units per liter. The least found groups were Cyanophyta species *Merismopedia minima* Beck, Chlorophyta species *Actinastrum gracillimum* Smith, *Eudorina elegans* Ehrenberg, *Monoraphidium caribeum* Hindak, *Pandorina morum* (Muller) Bory, *Scenedesmus quadricuada* (Turpin) Brebisson, *Tetraedron regulare* (Kuetzing) and *Tetraedron trigonum* (Naegeli) Hansgirg, Euglenophyta species *Phacus acuminatus* Strokes, *Phacus longicuada* (Ehrenberg) Dujardin, *Phacus pseudonordstedtii* Pochmann and *Phacus tortus* (Lemmermann) Skvortzow and Bacillariophyta species *Aulacoseira granulate* (Ehrenberg) Simonse, with the same amount of 7 units per liter, a survey of the type and quantity of Phytoplankton along the routed, on July 1, 2013, as shown in **Table 4.2.1 - 3**.

● Zooplankton

The results of the survey and sampling found 5 groups of Zooplankton. The most found group was *Vorticella* sp. of 21 Zooplankton per liter while the least found group was *Euplotes* sp., *Ascomorpha* sp., *Filinia longiseta* (Ehrenberg) and *Lecane* sp., with the

same amount of 7 Zooplankton per liter, a survey of the amount of Zooplankton along the project route on July 1, 2013, as shown **Table 4.2.1 - 4**.

The species diversity index of plankton at Station No. 2 Saen Saeb Canal was 1.88 indicated that the water quality was at the moderate level. The conclusion of type, quantity and diversity of plankton along the project route as shown in **Table 4.2.1 - 5**.

(b) Benthos

From the sampling found 3 groups of Benthos. The most found group was *Tubifex tubifex* of 356 Benthos per square meter which the species diversity index of Benthos was 0.72. The survey of type and quantity of Benthos along the project routed. As shown in **Table 4.2.1 - 6**.

(2.3) Station No. 3 Klong Hua Mak

(a) Phytoplankton and Zooplankton

● **Phytoplankton**

The results of the survey and sampling found 40 groups of phytoplankton. The most common type was Cyanophyta species *Oscillatoria* sp. 9,750 units per liter, following by Euglenophyta species *Euglena acus* Ehrenberg 2,400 units per liter. The least found groups was Cyanophyta species *Microcystis aeruginosa* Kutzing, Chlorophyta species *Coelastrum microsporum* Naegeli, *Diclostera* sp., *Oocystis* sp., *Radiococcus* sp., *Selenastrum* sp. and *Tetraedron gracile* (Riensch) Hansgirg, Euglenophyta species *Lepocinclis fusiformis* (Carter) Lemmermann, *Lepocinclis pseudo-ovum* Conrad *Phacus* sp. and *Strombomonas* sp, with the same amount of 6 units per liter, a survey of the type and quantity of Phytoplankton along the routed, on July 1, 2013, as shown in **Table 4.2.1 - 3**.

● **Zooplankton**

The results of the survey and sampling found Zooplankton group protozua with cilia of 18 Zooplankton per liter, a survey of the amount of Zooplankton along the project routed on July 1, 2013, was shown **Table 4.2.1 - 4**.

The species diversity index of plankton at Station No. 3 Klong Hua Mak was 2.01 indicated that the water quality was at the moderate level. The conclusion of type, quantity and diversity of plankton along the project routed. As shown in **Table 4.2.1 - 5**.

(b) Benthos

From the sampling found 3 groups of Benthos. The most found group was *Tubifex tubifex* of 444 Benthos per square meter which the species diversity index of Benthos was 0.66. The survey of type and quantity of Benthos along the project routed. As shown in **Table 4.2.1 - 6**.

(2.4) Station No. 4 Klong Pra Kanong

(a) Phytoplankton and Zooplankton

● **Phytoplankton**

The results of the survey and sampling found 61 groups of phytoplankton. The most common type was Bacillariophyta species *Cyclotella* sp. 7,950 units per liter, following by Cyanophyta species *Oscillatoria* sp. 5,250 units per liter. The least found groups was Cyanophyta species *Anabaena* sp., Chlorophyta species *Actinastrum gracillimum* Smith,

Closterium acerosum (Schrank) Ehrenberg, *Closterium gracile* Brebisson, *Pediastrum simplex* Meyen, *Pediastrum* sp., *Scenedesmus javanensis* Chodat, *Selenastrum* sp. and *Tetraedron regulare* (Kuetzing), Euglenophyta species *Phacus hamatus* Pochmann, with the same amount of 6 units per liter, a survey of the type and quantity of Phytoplankton along the project route, on July 1, 2013, as shown in **Table 4.2.1 - 3**.

- **Zooplankton**

The results of the survey and sampling found 15 groups of Zooplankton. The most found group was *Vorticella* sp. of 225 Zooplankton per liter while the least found group was *Coleps* sp., *Euplotes* sp., *Anuraeopsis* sp., *Brachionus angularis* Gosse, *Brachionus* sp. and Copepod nauplii with the same amount of 6 Zooplankton per liter, a survey of the amount of Zooplankton along the project route on July 1, 2013, was shown **Table 4.2.1 - 4**.

The species diversity index of plankton at Station No. 4 Phra Khanong Canal was 2.44 indicated that the water quality was at the moderate level. The conclusion of type, quantity and diversity of plankton along the project route as shown in **Table 4.2.1 - 5**.

(b) Benthos

From the sampling found 2 groups of Benthos. The most found group was *Notonecta* sp. of 104 Benthos per square meter which the species diversity index of Benthos was 0.69. The survey of type and quantity of Benthos along the project route as shown in **Table 4.2.1 - 6**.

(2.5) Station No. 5 Bang Na Canal

(a) Phytoplankton and Zooplankton

- **Phytoplankton**

The results of the survey and sampling found 26 groups of Phytoplankton. The most common type was Cyanophyta species *Oscillatoria* sp. 1,340 unit per liter, followed by Bacillariophyta species *Cyclotella* sp. 860 units per liter. The least found groups was Cyanophyta species *Anacystis* sp., *Pseudo-anabaena* sp., Chlorophyta species *Coelastrum microsporum* Naegeli, *Dictyosphaerium* spp., *Monoraphidium caribeum* Hindak, *Monoraphidium irregular* (Smith) Komarkova-Legnerova, *Pediastrum duplex* Meyen and *Pediastrum tetras* (Ehrenberg) Ralfs, Euglenophyta species *Euglena acus* Ehrenberg, *Phacus hamatus* Pochmann and *Trachelomonas* sp., with the same amount of 8 units per liter, a survey of the type and quantity of Phytoplankton along the routed, on July 1, 2013, as shown in **Table 4.2.1 - 3**.

- **Zooplankton**

The results of the survey and sampling found 3 groups of Zooplankton. The most found group was *Brachionus angularis* Gosse of 40 Zooplankton per liter, a survey of the amount of Zooplankton along the project route on July 1, 2013, was shown **Table 4.2.1 - 4**.

The species diversity index of plankton at Station No. 5 Bang Na Canal was 1.75 indicated that the water quality was at the moderate level. The conclusion of type, quantity and diversity of plankton along the project route as shown in **Table 4.2.1 - 5**.

Table 4.2.1 - 3 Species and Density of Plankton along the Project Route on July 1, 2013.

Phytoplankton	Unit	Sampling Station					
		1	2	3	4	5	6
Division Cyanophyta							
Class Cyanophyceae							
<i>Anabaena</i> sp.	Units/L	0	14	0	6	0	0
<i>Anacystis</i> sp.	Units/L	0	21	18	30	8	0
<i>Merismopedia minima</i> Beck	Units/L	0	7	180	180	16	0
<i>Merismopedia</i> sp.	Units/L	18	105	375	450	24	0
<i>Microcystis aeruginosa</i> Kutzing	Units/L	0	0	6	12	0	0
<i>Oscillatoria</i> sp.	Units/L	525	3,500	9,750	5,250	1,340	375
<i>Pseudo-anabaena</i> sp.	Units/L	0	70	0	105	8	0
<i>Spirulina platensis</i> (Nordstedt) Geitler	Units/L	6	0	78	1,200	0	0
Division Chlorophyta							
Class Chlorophyceae							
<i>Actinastrum gracillimum</i> Smith	Units/L	0	7	0	6	0	0
<i>Actinastrum hantzschii</i> Lagerheim	Units/L	0	0	375	450	0	0
<i>Actinastrum raphidioides</i> (Reinsch) Brunnthal	Units/L	0	123	375	600	0	0
<i>Ankistrodesmus falcatus</i> (Corda) Ralfs	Units/L	30	21	600	975	260	6
<i>Chlamydomonas</i> sp.	Units/L	48	0	0	0	0	0
<i>Closteriopsis</i> sp.	Units/L	0	0	18	24	0	0
<i>Closterium acerosum</i> (Schrank) Ehrenberg	Units/L	0	0	0	6	0	0
<i>Closterium gracile</i> Brebisson	Units/L	0	0	12	6	0	0
<i>Closterium</i> sp.	Units/L	0	14	0	0	0	0
<i>Coelastrum asteroideum</i> De Notaris	Units/L	0	0	0	36	0	0
<i>Coelastrum cambricum</i> Ascher	Units/L	0	0	0	24	0	0
<i>Coelastrum microsporum</i> Naegeli	Units/L	0	0	6	18	8	0
<i>Coenochloris</i> sp.	Units/L	0	0	750	0	0	0
<i>Crucigenia</i> sp.	Units/L	6	35	108	420	24	0
<i>Dicloster</i> sp.	Units/L	0	0	6	0	0	0
<i>Dictyosphaerium</i> spp.	Units/L	0	28	375	1,200	8	0
<i>Didymocystis</i> sp.	Units/L	0	0	0	36	0	0
<i>Eudorina elegans</i> Ehrenberg	Units/L	0	7	12	270	24	0
<i>Kirchneriella lunaris</i> (Kirchner) Moebius	Units/L	0	0	0	18	0	0
<i>Micractinium quadrisetum</i> (Lemmermann) Smith	Units/L	0	14	0	36	0	0
<i>Micractinium pusillum</i> Fresenius	Units/L	0	105	54	300	16	12
<i>Monoraphidium caribeum</i> Hindak	Units/L	0	7	255	198	8	0

**Table 4.2.1 - 3 Species and Density of Plankton along the Project Route on July 1, 2013
(Cont'd).**

Phytoplankton	Unit	Sampling Station					
		1	2	3	4	5	6
Division Chlorophyta							
Class Chlorophyceae							
<i>Monoraphidium irregulare</i> (Smith) Komarkova-Legnerova	Units/L	0	28	0	210	8	0
<i>Oocystis</i> sp.	Units/L	0	0	6	48	16	0
<i>Pandorina morum</i> (Muller) Bory	Units/L	6	7	0	42	0	0
<i>Pediastrum duplex</i> Meyen	Units/L	0	0	0	18	8	6
<i>Pediastrum simplex</i> Meyen	Units/L	0	0	0	6	0	0
<i>Pediastrum tetras</i> (Ehrenberg) Ralfs	Units/L	0	0	0	12	8	0
<i>Pediastrum</i> sp.	Units/L	0	0	0	6	0	0
<i>Radiococcus</i> sp.	Units/L	0	0	6	12	0	6
<i>Scenedesmus acuminatus</i> (Lagerheim) Chodat	Units/L	12	35	1,650	150	0	0
<i>Scenedesmus disciformis</i> (Chodat) Fott & Komarek	Units/L	0	0	36	72	0	0
<i>Scenedesmus javanensis</i> Chodat	Units/L	0	0	0	6	0	0
<i>Scenedesmus protuberans</i> Fristch&Rich	Units/L	0	0	0	12	0	0
<i>Scenedesmus quadricuada</i> (Turpin) Brebisson	Units/L	0	7	72	600	16	0
<i>Selenastrum</i> sp.	Units/L	0	0	6	6	0	0
<i>Spondylomorom quaternarium</i> Ehrenberg	Units/L	12	14	0	72	0	66
<i>Tetrastrum</i> sp.	Units/L	0	0	0	12	0	0
<i>Tetraedron gracile</i> (Riensch) Hansgirg	Units/L	0	0	6	0	0	0
<i>Tetraedron regulare</i> (Kuetzing)	Units/L	0	7	0	6	0	0
<i>Tetraedron trigonum</i> (Naegeli) Hansgirg	Units/L	0	7	36	54	0	0
<i>Volvox</i> sp.	Units/L	0	0	0	12	0	0
Division Chlorophyta							
Class Euglenophyceae							
<i>Euglena acus</i> Ehrenberg	Units/L	0	21	2,400	60	8	600
<i>Euglena oxyuris</i> Schmarda	Units/L	0	14	0	0	0	6
<i>Euglena</i> spp.	Units/L	6	105	195	105	32	825
<i>Lepocinclis fusiformis</i> (Carter) Lemmermann	Units/L	0	0	6	60	16	12
<i>Lepocinclis ovum</i> (Ehrenberg) Lemmermann	Units/L	12	350	30	450	32	300
<i>Lepocinclis pseudo-ovum</i> Conrad	Units/L	0	42	6	42	0	72
<i>Phacus acuminatus</i> Strokes	Units/L	0	7	0	24	0	96

**Table 4.2.1 - 3 Species and Density of Plankton along the Project Route on July 1, 2013
(Cont'd).**

Phytoplankton	Unit	Sampling Station					
		1	2	3	4	5	6
Division Chlorophyta							
Class Euglenophyceae							
<i>Phacus hamatus</i> Pochmann	Units/L	0	35	0	6	8	0
<i>Phacus longicuada</i> (Ehrenberg) Dujardin	Units/L	0	7	0	0	0	0
<i>Phacus pseudonordstedtii</i> Pochmann	Units/L	0	7	24	0	0	0
<i>Phacus tortus</i> (Lemmermann) Skvortzow	Units/L	0	7	0	0	0	6
<i>Phacus</i> sp.	Units/L	0	0	6	18	0	0
<i>Strombomonas fluvialis</i> (Lemmermann) Deflandre	Units/L	0	35	18	42	0	0
<i>Strombomonas gibberosa</i> (Playfair) Deflandre	Units/L	0	14	12	48	0	0
<i>Strombomonas</i> sp.	Units/L	0	0	6	0	0	0
<i>Trachelomonas crebea</i> Kellicott	Units/L	0	14	0	0	0	0
<i>Trachelomona hispida</i> (Perty) Stein	Units/L	0	0	0	18	0	6
<i>Trachelomonas volvocina</i> Ehrenberg	Units/L	0	228	135	84	0	0
<i>Trachelomonas</i> sp.	Units/L	0	0	0	0	8	0
Division Chromophyta							
Class Bacillariophyceae							
<i>Aulacoseira granulata</i> (Ehrenberg) Simonsen	Units/L	6	7	0	36	0	0
<i>Cyclotella</i> sp.	Units/L	186	1,050	1,650	7,950	860	30
<i>Navicula</i> sp.	Units/L	24	21	0	0	16	18
<i>Nitzschia</i> spp.	Units/L	36	350	750	300	200	24
Class Chrysophyceae							
<i>Mallomonas</i> sp.	Units/L	0	0	0	42	0	0

Remark : Station 1 : Lat Phrao Canal Station 4 : Phra Khanong Canal
 Station 2 : Saen Saeb Canal Station 5 : Bang Na Canal
 Station 3 : Hua Mak Canal Station 6 : Samrong Canal

Source : Field survey by ENRICH Consultant Co., Ltd. 2013.

Table 4.2.1 - 4 Species and Density of Zooplankton along the Project Route on 1 July, 2013.

Zooplankton	Unit	Sampling Station					
		1	2	3	4	5	6
Phylum Sarcomastigophora							
<i>Actinophrys sol</i> Ehrenberg	Ind./L	0	0	0	30	0	0
Phylum Ciliophora							
<i>Coleps</i> sp.	Ind./L	0	0	0	6	8	0
<i>Colpoda</i> sp.	Ind./L	0	0	0	0	0	6
<i>Euplotes</i> sp.	Ind./L	0	7	0	6	0	6
<i>Paramecium</i> sp.	Ind./L	0	0	0	18	0	6
<i>Vorticella</i> sp.	Ind./L	6	21	0	225	8	6
<i>Tintinnopsis</i> sp.	Ind./L	0	0	0	18	0	0
Unidentified ciliate protozoan	Ind./L	6	0	18	12	0	18
Phylum Rotifera							
<i>Anuraeopsis</i> sp.	Ind./L	0	0	0	6	0	0
<i>Ascomorpha</i> sp.	Ind./L	0	7	0	0	0	0
<i>Brachionus angularis</i> Gosse	Ind./L	0	0	0	6	40	0
<i>Brachionus</i> sp.	Ind./L	0	0	0	6	0	0
<i>Filinia longiseta</i> (Ehrenbeg)	Ind./L	0	7	0	30	0	0
<i>Lecane</i> sp.	Ind./L	0	7	0	0	0	0
<i>Polyarthra</i> sp.	Ind./L	0	0	0	12	0	0
<i>Rotaria</i> sp.	Ind./L	0	0	0	12	0	0
Unidentified rotifers	Ind./L	0	0	0	24	0	0
Phylum Arthropoda							
Subphylum Crustacea							
Class Maxillopoda							
Subclass Copepoda							
Copepod nauplii	Ind./L	0	0	0	6	0	0

Remark : Station 1 : Lat Phrao Canal Station 4 : Phra Khanong Canal
 Station 2 : Saen Saeb Canal Station 5 : Bang Na Canal
 Station 3 : Hua Mak Canal Station 6 : Samrong Canal

Source : Field survey by ENRICH Consultant Co., Ltd. 2013.

Table 4.2.1 - 5 Summary Density, Species and Diversity of Plankton along the Project Route

Item	Khlong Lat Phrao	Khlong Saen Saeb	Khlong Hua Mak	Khlong Phra Khanong	Khlong Bang Na	Khlong Samrong
Density of plankton						
Phytoplankton (Unit/L)	933	6,497	20,409	22,497	2,980	2,466
Zooplankton (Ind./L)	12	35	18	917	56	42
Total	945	6,532	20,427	23,414	3,036	2,508
Number of plankton species						
Phytoplankton (species)	15	41	40	61	26	18
Zooplankton (species)	2	5	1	15	3	4
Total	17	46	41	76	29	22
Species diversity index	1.59	1.88	2.01	2.44	1.75	1.93

Table 4.2.1 - 6 Species and Density of Benthos along the Project Route on 1 July, 2013.

Benthos	Unit	Sampling Station					
		1	2	3	4	5	6
Phylum Annelida							
Class Oligocheata							
Order Opisthopora							
Family Tubificidae							
<i>Branchiura</i> sp.	Ind./m ²	0	74	59	0	0	0
<i>Tubifex tubifex</i>	Ind./m ²	0	356	444	0	0	0
Phylum Arthropoda							
Class Insecta							
Order Ephemeroptera							
Family Baetidae							
<i>Baetis</i> sp.	Ind./m ²	0	0	0	0	0	30
Family Caenidae							
<i>Caenis</i> sp.	Ind./m ²	0	0	0	0	0	30
Order Odonata							
Family Lestidae							
<i>Archilestes</i> sp.	Ind./m ²	0	0	0	0	0	30
Order Hemiptera							
Family Naucoridae							
<i>Aphelocheirus</i> sp.	Ind./m ²	0	0	0	15	0	0
Family Notonectidae							
<i>Notonecta</i> sp.	Ind./m ²	0	0	0	104	0	44
Family Belostomatidae							
<i>Belostoma</i> sp.	Ind./m ²	0	0	0	0	0	44
Order Diptera							
Family Chironomidae							
<i>Chironomus</i> sp.	Ind./m ²	0	44	59	0	0	0
Order Basomatophora							
Family Lymnaeidae							
<i>Lymnaea auricularis swinnoei</i>	Ind./m ²	0	0	0	0	0	44
Family Planorbidae							
<i>Indoplanorbis exutus</i>	Ind./m ²	15	0	0	15	0	0
Phylum Mollusca							
Class Gastropoda							
Order Mesogastropoda							
Family Ampullariidae							
<i>Pomacea insularis</i>	Ind./m ²	0	0	0	0	44	0
Total of species		1	3	3	3	1	6
Total of density		15	474	562	134	44	222
Species diversity index		0.00	0.72	0.66	0.69	0.00	1.77

Remark : Station 1 : Lat Phrao Canal Station 4 : Phra Khanong Canal
 Station 2 : Saen Saeb Canal Station 5 : Bang Na Canal
 Station 3 : Hua Mak Canal Station 6 : Samrong Canal

Source : Field survey by ENRICH Consultant Co., Ltd. 2013.

(b) Benthos

From the sampling found one group of Benthos was *Pomacea insularis* of 44 Benthos per square meter. The survey of type and quantity of Benthos along the project route as shown in **Table 4.2.1 - 6**.

(2.6) Station No. 6 Samrong Canal

(a) Phytoplankton and Zooplankton

● **Phytoplankton**

The results of the survey and sampling found 18 groups of phytoplankton. The most common type was Euglenophyta species *Euglena* spp. 825 unit per liter, followed by *Euglena acus* Ehrenberg 600 unit per liter. The least found groups was Chlorophyta species *Ankistrodesmus falcatus* (Corda) Ralfs, *Pediastrum duplex* Meyen and *Radiococcus* sp., Euglenophyta species *Euglena oxyuris* Schmarida, *Phacus tortus* (Lemmermann) Skvortzow and *Trachelomona hispida* (Perty) Stein, with the same amount of 6 units per liter, a survey of the type and quantity of Phytoplankton along the routed, on July 1, 2013, as shown in **Table 4.2.1 - 3**.

● **Zooplankton**

The results of the survey and sampling found 5 groups of Zooplankton. The most found a group was protozoa with cilia (unidentified) of 18 Zooplankton per liter, a survey of the amount of Zooplankton along the project route on July 1, 2013, as shown **Table 4.2.1 - 4**.

The species diversity index of plankton at Station No. 6 Samrong Canal was 1.93 indicated that the water quality was at the moderate level. The conclusion of type, quantity and diversity of plankton along the project route as shown in **Table 4.2.1 - 5**.

(b) Benthos

From the sampling found 6 groups of Benthos. The most found a group was *Notonecta* sp., *Belostoma* sp. and *Lymnaea auricularis swinnoei* of 44 Benthos per square meter which the species diversity index of Benthos was 1.77. The survey of type and quantity of Benthos along the project route as shown in **Table 4.2.1 - 6**.

4.2.2 Terrestrial Resources

4.2.2.1 Forest resources

1) Methodology

The Yellow Line Mass Transit Construction Project (Lat-Phrao - Samrong section) conducted in large urban areas. (Non-conserved-protected forest by law). The study and analyze of the forest had considered exploring trees/tree species found in the project construction areas. The distance was about 30 kilometers included 23 Sky train stations, one Depot and one Park and Ride.

The study covered the existing plant communities or plants of both sides which not exceed 20 meters from each side of project route, which expected to be affected by the project operation. This was because, the routed construction will be on the 3 main roads, Lat Phrao Road, Srinagarindra Road and Thepharak Road. The study areas covered both sides of the area along the

routed and traffic island and nearby started from Ratchada Station (YL - 01), Phawana Station (YL - 02), Chok Chai 4 Station (YL - 03), Lat Phrao 71 Station (YL - 04), Lat Phrao 83 Station (YL - 05), Mahat Thai Stations (YL - 06), Lat Phrao 101 Station (YL - 07), Bang Kapi Station (YL - 08), Lamsali Station (YL - 09), Si Kritha Station (YL - 10), Phatthanakan Station (YL - 11), Kalatan Station (YL - 12), Si Nut Station (YL - 13), Srinagarindra 38 Station (YL - 14), Suan Luang Ro 9 Station (YL - 15), Si Udom Station (YL - 16), Si lam Station (YL - 17), Si La Salle Station (YL - 18), Si Bearing Station (YL - 19), Si Dan Station (YL - 20), Si Thepha Station (YL - 21), Tippawan Station (YL - 22.), and Samrong Station (YL - 23), including a depot and park and ride, as shown in **Figure 4.2.2 - 1**.

Detailed of survey and study methodology on forest resources as below.

(1) Study and collect secondary data from related reports. The existing maps include topographic maps, project detailed map, Land Use Map and other information in the project areas and vicinity.

(2) Field data survey: collect information of plant social in the project areas. The methodology as.

- Determine the extent and duration of the study area to cover the project area.
- Survey method by the enumeration of trees in the project area and vicinity.
Along the BTS routed, sky train stations, Depot and park and ride.

(3) Analysis and processing: analyze the field survey collected for species found in the project area and vicinity.

(4) EIA of forest resources due to project development during the construction and operation phase.

(5) Recommendations for the appropriation prevention and mitigation measures for the project.

2) Study Results

Mainly land utilization in the project construction areas was the construction of the railway across the traffic island of the main roads of Bangkok and vicinity include Lat Phrao Road, Srinagarindra Road, and Thepharak Road. The routed passed through the downtown area/suburb which was an urban community and there was no remaining of the forest. Therefore, this study of plant social was the study of the plant species in the project area and nearby which were the traffic island and on both sides of the main road above. There was similar species of plants in every study area which were trees planted along the length of the traffic island and perennial trees planted along the sidewalk with a little bit mixing of human and naturally grow. While the shrubs, annual plants, and grass mostly grew naturally and ornamental plants around housing, the garden at the traffic island. The study results and survey on forest resources in the project's study divided into 3 sections as Lat Phrao Road, Srinagarindra Road and Thepharak Road, including the Depot and park and ride construction areas. Study results detailed as follows.

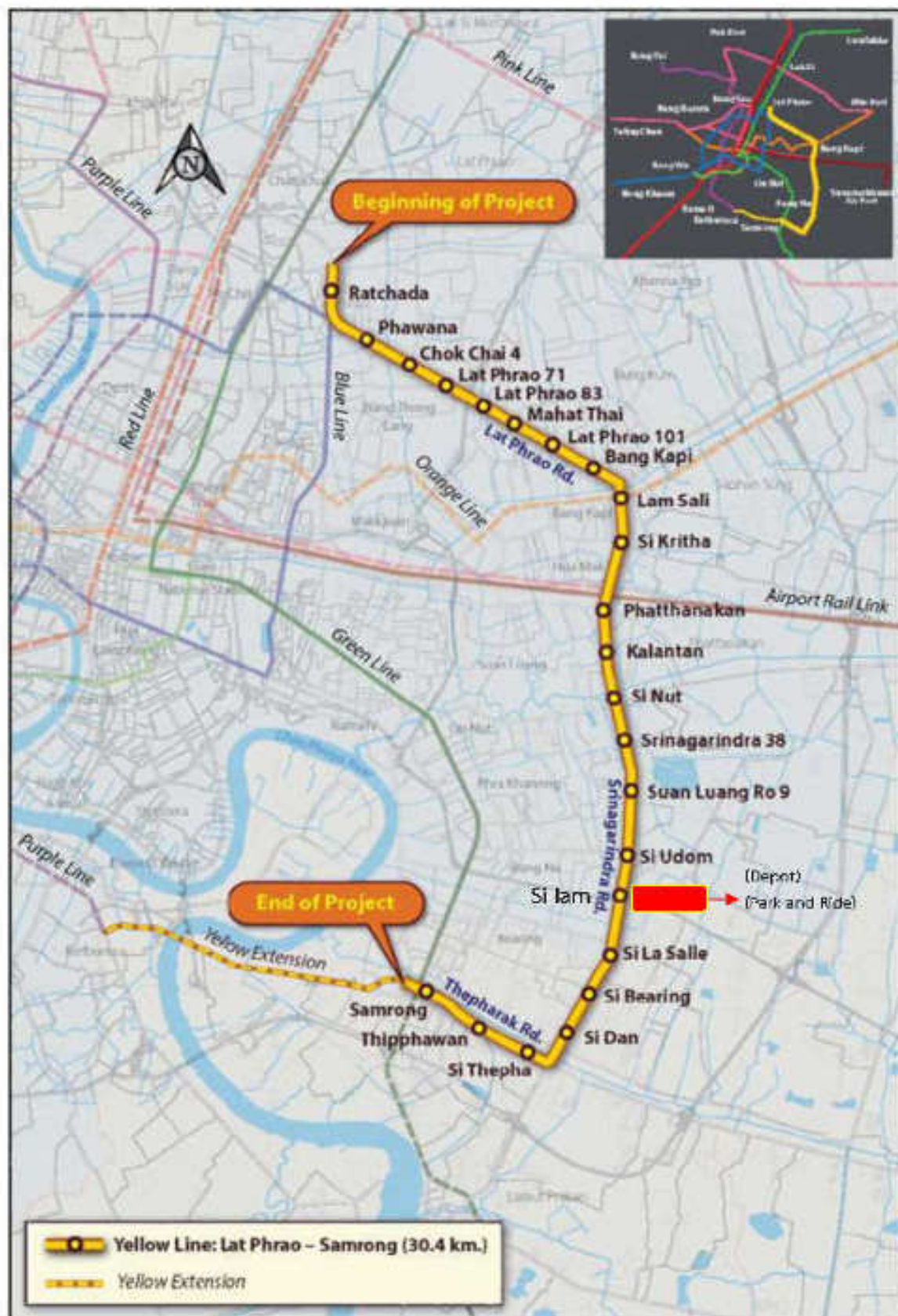


Figure 4.2.2 - 1 Terrestrial ecology study area

1. Sky train routed and stations

1.1 Lat Phrao Road (Ratchada Station to Bang Kapi Station)

The project study area lied across certain areas of Bangkok as Chatuchak, Huay Khwang, Wang Thonglang and Bang Kapi, which has the land utilization of the surrounding areas as the densely urban communities consisted of residential buildings, commercial buildings, office buildings and infrastructure such as electricity avenue and the park and ride building of Bangkok MRT Chaloom Ratchamongkhon project of the Mass Rapid Transit Authority of Thailand (MRTA). The ecosystem around the project was an urban ecology. Most of the plants in the areas were humanly grow both in the traffic island area and either side of the sidewalks, with the study results as followed.

- Ratchada Station (YL - 01) to Phawana Station (YL - 02) distance 1,314 meters start from the bridge of Blue Line Mass Transit System at the park and ride building. There were some of the routed lied across communities and landmarks. From the survey found plants along both sidewalks of Lat Phrao Road for about 11 species, such as *Lagerstroemia speciosa* var. *speciosa* and *Lagerstroemia* sp.etc. The dominant species was *Lagerstroemia speciosa* var. *speciosa* (60 trees). At the traffic island of Lat Phrao Road found only 3 species of *Pterocarpus indicus* Willd (4 trees), *Alstonia scholaris* var. *scholaris* (16 trees) and *Mimusops elengi* L. (2 trees), the ground was covered with ornamental plants as *Carmonretusa* (Vahl) Masam. all the areas.

- Phawana Station (YL - 02) to Chok Chai 4 Station (YL - 03) distance 1,292 meters start from Soi Ladphrao 44 to Chok Chai 4 Department Store (Soi Ladphrao 53). From the survey found 12 species plants of along both sidewalks of Lat Phrao Road, such as *Pterocarpus indicus* Willd, *Lagerstroemia speciosa* var. *speciosa*, *Mimusops elengi* L. and *Tabebuia rosea* (Bertol.) DC. etc. The dominant species were *Pterocarpus indicus* Willd (40 trees) and *Lagerstroemia speciosa* var. *speciosa* (3 trees). The ground was covered with ornamental plants as *Murraya paniculata*, *Ixora chinensis* Lamk., *Crinum asiaticum* and *Carmonretusa* (Vahl) Masam.

- Chok Chai 4 Station (YL - 03), Lat Phrao 71 Station (YL - 04) to Lat Phrao 83 Station (YL - 05) distance 2,400 meters start from Soi Lat Phrao 53 between Soi Lat Phrao 83 and Soi Lat Phrao 85 opposite of Soi Lat Phrao 80/3 to Big C Deapartment Store (Lat Phrao). From the survey found 19 species plants of along both sidewalks of Lat Phrao Road, such as *Pterocarpus indicus* Willd, *Areca catechu* Linn., *Tabebuia rosea* DC.etc. The dominant species was *Pterocarpus indicus* Willd (19 trees) and *Areca catechu* Linn. (24 trees), the ground was covered with ornamental plants as *Murraya paniculata*, *Ixora chinensis* Lamk., *Crinum asiaticum* and *Carmonretusa* (Vahl) Masam.

- Lat Phrao 83 Station (YL - 05) to Mahat Thai Station (YL - 06) distance 1,112 meters start from Big C Deapartment Store (Lat Phrao) to Soi Lat Phrao 118 which located near Lat Phrao Hospital and Foodland Supermarket Co.,Ltd. From the survey found 11 species of plants, such as *Pterocarpus indicus* Willd, *Mimusops elengi* L., *Streblus asper* Lour., *Ficus altissima* etc. The dominant species was *Pterocarpus indicus* Willd (100 trees) and *Mimusops elengi* L. (45 trees).

- Mahat Thai Station (YL - 06) to Lat Phrao 101 Station (YL - 07) distance 904 meters start from Soi Lat Phrao 114 to Soi Lat Phrao 128/1 (right side). From the survey found plants along both sidewalks for about 14 species, such as *Pterocarpus indicus* Willd, *Wrightia pubescens* R. Br., *Mimusops elengi* L., *Tabebuia rosea* DC.etc. The dominant species was *Pterocarpus indicus* Willd (85 trees) and *Wrightia pubescens* R. Br. (60 trees). At the traffic island of Lat Phrao Road found only *Mimusops elengi* L. (90 trees) and *Tabebuia rosea* DC.(1 tree).

- Lat Phrao 101 Station (YL - 07) to Bang Kapi Station (YL - 08) distance 1,240 meters start from Soi Lat Phrao 128/1 to The Mall Bang Kapi Department Store. From the survey found 13 species of plants along both sidewalks, such as *Pterocarpus indicus* Willd, *Lagerstroemia loudonii* Teijsm.&Binn. etc. The dominant species was *Pterocarpus indicus* Willd (86 trees). At the traffic island of Lat Phrao Road found only *Mimusops elengi* L. (15 trees).

- Bang Kapi Station (YL - 08) to Lam Sali Station (YL - 09) distance 1,449 meters start from The Mall Bang Kapi Department Store until Lam Sali Intersection. From the survey found 8 species of plants along both sidewalks, such as *Wrightia religiosa* Benth., *Pterocarpus indicus* Willd, *Tabebuia rosea* DC.etc. The dominant species was *Wrightia pubescens* R. Br. (18 trees). At the traffic island of Srinagarindra Road found only *Polyalthia longifolia* Benth Hook.f. var. *Pandurata* (36 trees).

1.2 Srinagarindra Road (Lam Sali Station to Si Dan Station)

The project study area across certain areas of Bangkok in Bang Kapi, Suan Luang, Prawet and Bang Na and cross over to the Muang Samut Prakan district, Samut Prakan province. The land utilization of the surrounding areas as the densely urban communities consisted of residential buildings, commercial buildings, office buildings and shopping malls, the ecosystem surrounding the project is classified as Urban Ecology. Most of the plants in the areas were humanly grow both in the traffic island areas and another side of the sidewalks, with the study results as followed.

- Lam Sali Station (YL - 09) to Si Kritha Station (YL - 10) distance 1,299 meters start from Lam Sali Intersection to Krung Thep Kritha Intersection. From the survey found 25 species of plants along both sidewalks, such as *Palmae*, *Pterocarpus indicus* Willd, *Cassia fistula* etc. The dominant species was *Palmae* (43 trees). At the traffic island of Srinagarindra Road found only 2 species were *Mimusops elengi* L. (103 trees) and *Alstonia scholaris* var. *scholaris* (1 tree).

- Si Kritha Station (YL - 10) to Phatthanakan Station (YL - 11) distance 1,547 meters start from Krung Thep Kritha Intersection to Phatthanakan Intersection that intersects with Motorway (Bangkok-Chonburi). From the survey found 15 species of plants along both sidewalks, such as *Areca catechu* Linn., Conifers and *Erythrina variegata* L. etc. The dominant species was *Areca catechu* Linn (103 trees), *Erythrina variegata* L. (102 trees) and Conifers (103 trees).

- Phatthanakan Station (YL - 11) Kalantan Station (YL - 12) to Si Nut Station (YL - 13) distance 2,867 meters. From the survey found 25 species of plants along both sidewalks, such as *Codiaeum variegatum* (L.) Blume, *Streblus asper* Lour., *Cassia fistula*, *Phyllanthus acidus* (L.) Skeels, *Mimusops elengi* L., *Caryota mitis* Lour. etc. The dominant species was *Palmae* (43 trees). At the

traffic island of Srinagarindra Road found only 2 species were *Mimusops elengi* L. (103 trees) and *Alstonia scholaris* var. *scholaris* (1 tree).

- Si Nut Station (YL - 13) Srinagarindra 38 Station (YL - 14) to Suan Luang Ro 9 Station (YL - 15) distance 2,287 meters start from On Nut Intersection to Seacon Square. From the survey found plants along both sidewalks of Srinagarindra Road for about 15 species, such as *Cassia fistula*, *Alstonia scholaris* var. *scholaris*, *Tabebuia rosea* (Bertol.) DC., *Samanea saman* (Jacq.) Merr. etc. The dominant species were *Areca catechu*, Linn. (128 trees) and Conifers (103 trees).

- Suan Luang Ro 9 Station (YL - 15) to Si Udom Station (YL - 16) distance 1,571 meters start from Seacon Square to Udomsuk Intersection. From the survey found 14 species of plants along both sidewalks, such as *Alstonia scholaris* var. *scholaris*, *Pterocarpus indicus* Willd, *Artocarpus heterophyllus* Lam. etc. The dominant species were *Cassia fistula* (100 trees) and *Polyalthia longifolia* Benth Hook.f. var. *Pandurata* (30 trees).

- Si Udom Station (YL - 16) to Si lam Station (YL - 17) distance 1,003 meters start from Udomsuk Intersection to Samut Prakan Highway District. From the survey found no different other plants that seen along both sidewalks of Srinagarindra Road as *Pterocarpus indicus* Willd (55 trees) and *Cassia fistula* (20 trees).

- Si lam Station (YL - 17) to Si La salle Station (YL - 18) distance 1,436 meters start from Samut Prakan Highway District to La Salle Intersection (Soi Sukhumvit 105). A lot of trees were planted in the areas of Samut Prakan Highway District which seem to be an old public park, currently no maintainace. From the survey found 9 species of plants along both sidewalks, such as *Cassia fistula* L., *Pterocarpus indicus* Willd, *Tabebuia rosea* (Bertol.) DC., *Palmae* etc. The dominant species were *Pterocarpus indicus* Willd (182 trees) and *Polyalthia longifolia* Benth Hook.f. var. *Pandurata* (36 trees).

- Si La Salle Station (YL - 18) to Si Bearing Station (YL - 19) distance 1,440 meters start from La salle Intersection (Soi Sukhumvit 105) to Soi Bearing (Sukhumvit 107). From the survey found 12 species of plants along both sidewalks, such as *Leucaena leucocephala* (Lam.) de Wit, *Pterocarpus indicus* Willd and *Alstonia scholaris* var. *scholaris* etc. The dominant species was *Pterocarpus indicus* Willd (24 trees).

- Si Bearings Station (YL - 19) to Si Dan Station (YL - 20) distance 1,359 meters start from Soi Bearing (Sukhumvit 107) to Nam Daeng Road Intersection. From the survey found grewed plants along both sidewalks for about 17 species, such as *Leucaena leucocephala* (Lam.) de Wit, *Senna siamea* (Lam.) Irwin & Barneby, *Alstonia scholaris* var. *scholaris* etc. The dominant species was *Tabebuia arentea* Britt. (241 trees).

- Si Dan Station (YL - 20) to Si Thepha Station (YL - 21) distance 1,111 meters start from Nam Daeng Road Intersection to Si Thepha Market. The road was elevated overpass. From the survey found grewed 17 species of plants along both sidewalks, such as *Pterocarpus indicus* Willd, *Acacia auriculiformis* A. Cunn. ex Benth. and *Bauhinia purpurea* L. etc. The dominant species was *Pterocarpus indicus* Willd (107 trees). At the traffic island of Srinagarindra Road found 7 species were

Streblus asper Lour., *Acacia mangium* Wild. and *Cassia fistula* etc. The dominant species was *Tabebuia arentea* Britt. (113 trees).

1.3 Thepharak Road (Si Thepha Station to Samrong Station)

The project study area across certain areas of Muang Samut Prakan district, Samut Prakan province, which has the land utilization of the surrounding areas as the densely urban communities consisted of residential buildings, commercial buildings, factories etc., the ecosystem surrounding the project is classified as Urban Ecology. Most of the plants in the areas were humanly grow both in the traffic island areas and either side of the sidewalks, with the study results as followed.

- Si Thepha station (YL - 21) to Thippawan station (YL - 22) distance 1,620 meters start from Si Thepha Market to Chularat 2 Hospital. This area was a dense residential community located in Samut Prakan province with Si Thepha fresh market. From the survey found plants along both sidewalks for about 12 species, such as *Pterocarpus indicus* Willd, *Bauhinia purpurea* L., *Tabebuia rosea* DC. and *Alstonia scholaris* var. *scholaris*. etc. The dominant species were *Pterocarpus indicus* Willd (75 trees) and *Casuarina junghuhniana* Miq. (34 trees). At the traffic island found 9 species, the dominant species was *Tabebuia arentea* Britt. (171 trees).

- Thippawan station (YL - 22) to Samrong Station (YL - 23) distance 1,740 meters start from Chularat 2 Hospital to Sukhumvit Road Junction (Sukhumvit-Thepharak Intersection) with was the like to Green Line Mass Transit Project (Bearing-Samut Prakan Section). This area was a dense residential community located in Samut Prakan province with big fresh market and Imperial World Department Store. From the survey found plants along both sidewalks for about 12 species. The dominant species were *Tabebuia rosea* DC. (9 trees) and *Terminalia catappa* L. (3 trees). At the traffic island found 9 species, the dominant species was *Tabebuia arentea* Britt. (171 trees).

2. Park and Ride and Depot Construction area

The construction areas of park and ride building was of 40 rais and depot of 122 rais located in the area near the intersection of Srinagarindra Road and Bangna - Trad Road, slanting to the back. North side close to the empty space and and Cha-Um Niwat Housing and Park Avenue Village. Southern part adjacent to Khlet Canal, Maple Hotel and Suan Parklands Village. While the west and to the east adjacent to Srinagarindra Road and Bang Na Canal, respectively. Current conditions was a big waste land, no property and any building in the area. Found the trees in that open space of about 6 species of *Acacia auriculiformis* A. Cunn. Ex Benth., *Sesbania grandiflora* (L.) Desv., *Annona squamosa* L., *Millingtonia hortensis* L.f. and *Tamarindus indica* L. etc., with *Phyllanthus emblica* L. (10 trees) as a dominant species in this area.

Overview of the plants found either side of the pedestrian along the project route, depot and park and ride building and Rama Nine Interchange. Found more than 95% of the trees are planted by humans, such as *Pterocarpus indicus* Willd., *Tabebuia rosea* DC., *Peltophorum pterocarpum* (DC.). Backer ex K. Heyne., *Lagerstroemia* sp., *Alstonia scholaris* var. *scholaris*, *Mimusops elengi* L., *Lagerstroemia speciosa* var. *speciosa*, mahogany (*Swietenia mahagoni* (L.) Jacq.), *Millingtonia hortensis* Lf, *Delonix regia* (Bojer ex Hook.) Rafin. and the trees that grow naturally found only 3 species were *Samanea saman* (Jacq.) Merr., *Tamarindus indica* L. and

Pithecellobium dulce (Roxb.) Benth. When considering the results of the survey and count trees along the transit trail and vicinity can be concluded that the area has a total of 60 species of 5,325 trees which classified as follows.

The details of the survey on terrestrial ecology and existing environment along the project route as shown in **Appendix 4G**.

4.3 Human Use Values

4.3.1 Land Use

1) Methodology

(1) Study and analyze of existing land use along the project route and adjoining areas by reviewed the papers/reports and collected information from various entities, including topographic maps, satellite imagery, Bangkok City Plan, etc.

(2) Field survey the existing land use along the project route and vicinity to present form of land use in the most current.

(3) Analyze and estimate in changing of land use along the project route and adjoining areas when developing a project. Provide an appropriate prevention and mitigation measures.

2) Study Results

(1) Land use in the areas of project route

Land use in the year 2013 along the project route and adjoining areas within 500 meters of the radius, showed 16 patterns of land use. Most of the areas about 39.02% of the project area were single house communities 7,475.11 rais. Followed by empty space/wastelands with the area of 3,259.97 rais or 17.03% of the project areas. Also, a shop/commercial building (16.97%), infrastructure and utilities (6.62%), industrial and warehouse (5.8%), common housing building (4.94%), water sources (2.02%), department stores (1.86%), slum (1.58%). A land use patterns within 500 meters of radius as shown in **Figure 4.3.1 - 1** and **Table 4.3.1 - 1**.

In addition, the dividing of land use on the road along the project route consists of Lat Phrao Road, Srinagarindra Road and Thepharak Road detailed as follows.

- **Lat Phrao Road (Ratchadapisek Station - Bang Kapi Station)** land use within 500 meters of the radius. Found that it was used as single house community the most of 3,154.94 rais, accounting for 50.57% of the project area. Followed by shops/commercial building with the area of 1,332.44 rais, accounting for 21.36% of the project area. Also, an empty space/wastelands (7.39%), common housing building (5.30%) infrastructure and utilities (4.94%), department stores (3.34%), government offices (2.16%), water resources (1.04%) etc., as shown in **Table 4.3.1 - 2**.

- **Srinagarindra Road (Srinagarindra Station - Si Dan Station)** land use within 500 meters of the radius. Found that it was used as single house community the most of 3,566.29 rais, accounting for 36.78% of the project area. Followed by empty space/wastelands with the area of 2,302.24 rais, accounting for 23.74% of the project area. In addition, a shops/commercial building (13.59%), infrastructure and utilities (7.98%), common housing building (4.64%) industrials and warehouses (4.21%), water resources (1.93%) etc., as shown in **Table 4.3.1 - 3**.

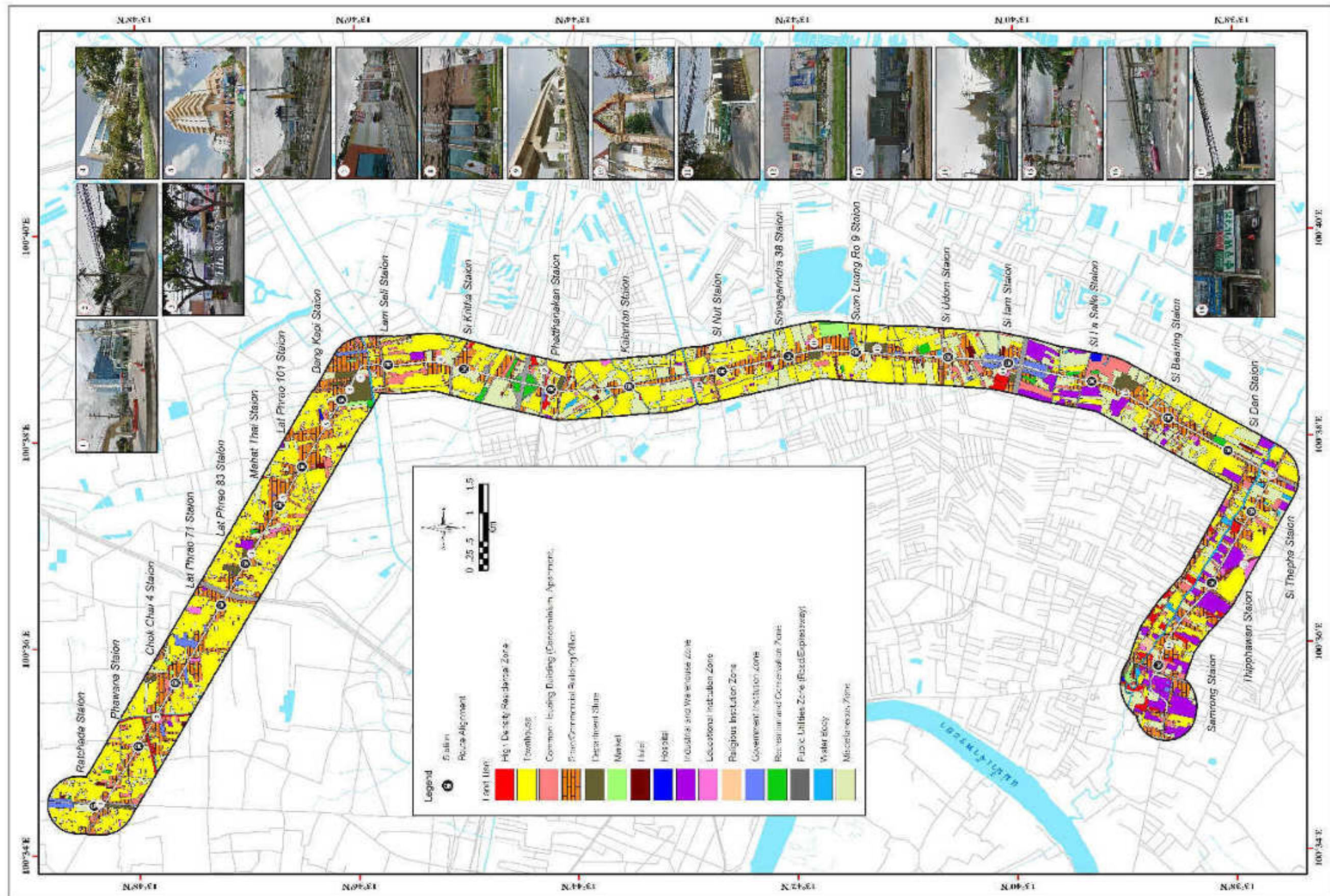


Figure 4.3.1 – 1 Land use pattern along the project route (radius 500 meters from center line of project)

Table 4.3.1 - 1 Existing land use pattern along the project route (radius 500 meters from center line of project)

No.	Land use pattern	Area	
		Rai	%
1	Dense residential zone (crowded community)	303.12	1.58
2	Residential area, village, townhouse	7,475.11	39.02
3	Residential buildings (condominium/flat/apartment)	946.72	4.94
4	Stores, commercial building, offices, entertainment buildings	3,250.89	16.97
5	Department store	356.12	1.86
6	Market	126.77	0.66
7	Hotel	84.26	0.44
8	Hospital and health care	31.34	0.17
9	Industrial and warehouse zone	1,030.81	5.38
10	Institution zone (school/college/university)	138.33	0.72
11	Religious place zone (temple/mosque/church)	65.86	0.34
12	Government institution zone	267.91	1.40
13	Recreation and environmental conservation area (park)	163.30	0.85
14	Infrastructure (road/expressway)	1,268.68	6.62
15	Water resources (river/canal/pond)	386.63	2.02
16	Miscellaneous land	3,259.97	17.03
Total		19,155.81	100.00

Table 4.3.1 - 2 Existing land use pattern at Lat Phrao road along the project route (radius 500 meters from center line of project)

No.	Land use pattern	Area	
		Rai	%
1	Dense residential zone (crowded community)	44.93	0.72
2	Residential area, village, townhouse	3,154.94	50.57
3	Residential buildings (condominium/flat/apartment)	330.56	5.30
4	Store, commercial building, office, entertainment building	1,332.44	21.36
5	Department store	208.49	3.34
6	Market	36.21	0.58
7	Hotel	25.67	0.42
8	Hospital and health care	11.50	0.18
9	Industrial and warehouse zone	41.22	0.66
10	Institution zone (school/college/university)	59.67	0.96
11	Religious place zone (temple/mosque/church)	5.30	0.08

Table 4.3.1 - 2 Existing land use pattern at Lat Phrao road along the project route (radius 500 meters from center line of project) (Cont' d).

No.	Land use pattern	Area	
		Rai	%
12	Government institution zone	134.57	2.16
13	Recreation and environmental conservation area (park)	19.03	0.30
14	Infrastructure (road/expressway)	308.23	4.94
15	Water resources (river/canal/pond)	65.07	1.04
16	Miscellaneous land	461.29	7.39
Total			100.00

Table 4.3.1 - 3 Existing land use pattern at Srinagarindra road along the project route (radius 500 meters from center line of project)

No.	Land use pattern	Area	
		Rai	%
1	Dense residential zone (crowded community)	95.79	0.99
2	Residential area, village, townhouse	3,566.29	36.78
3	Residential buildings (condominium/flat/apartment)	450.02	4.64
4	Store, commercial building, office, entertainment building	1,317.41	13.59
5	Department store	138.58	1.43
6	Market	72.44	0.75
7	Hotel	47.52	0.49
8	Hospital and health care	17.16	0.18
9	Industrial and warehouse zone	408.03	4.21
10	Institution zone (school/college/university)	34.51	0.36
11	Religious place zone (temple/mosque/church)	26.24	0.27
12	Government institution zone	114.87	1.18
13	Recreation and environmental conservation area (park)	144.27	1.48
14	Infrastructure (road/expressway)	773.80	7.98
15	Water resources (river/canal/pond)	187.01	1.93
16	Miscellaneous land	2,302.24	23.74
Total			100.00

● **Thepharak Road (Thepharak Station - Samrong Station)** land use within 500 meters of the radius. Found that it was used as single house community the most of 753.94 rais, accounting for 23.41% of the project area. Followed by shops/commercial building with the area of 601.03 rais, accounting for 18.66% of the project area. In addition, industrials and warehouses (18.06%), an empty space/wastelands (15.41%), infrastructure and utilities (5.80%),

common housing building (5.16%), slums (5.04%), water sources (4.18%) etc., as shown in **Table 4.3.1 - 4**.

Table 4.3.1 - 4 Existing Land Use Pattern at Thepharak Road along the Project Route (radius 500 meters from center line of project)

No.	Land use pattern	Area	
		Rai	%
1	Dense residential zone (crowded community)	162.39	5.04
2	Residential area, village, townhouse	753.94	23.41
3	Residential buildings (condominium/flat/apartment)	166.14	5.16
4	Store, commercial building, office, entertainment building	601.03	18.66
5	Department store	9.05	0.28
6	Market	18.12	0.57
7	Hotel	11.07	0.34
8	Hospital and health care	2.69	0.08
9	Industrial and warehouse zone	581.56	18.06
10	Institution zone (school/college/university)	44.15	1.37
11	Religious place zone (temple/mosque/church)	34.32	1.07
12	Government institution zone	18.47	0.57
14	Recreation and environmental conservation area (park)	186.65	5.80
15	Infrastructure (road/expressway)	134.55	4.18
16	Water body (river/canal/pond)	496.44	15.41
Total		3,220.57	100.00

(2) Land Use in Depot Area

The surrounding area within 1 kilometer radius from the depot was about 3.14 square kilometers, as shown in **Table 4.3.1 - 5** and **Figure 4.3.1 - 2**. Details are as follows.

- North: neighboring with empty area and villages,
- South: neighboring with Khlet Canal, Suan Park Land Village, and International Community School,
- West: neighboring with Srinagarindra Road and Si lam Temple,
- East: neighboring with the empty area and Bang Na Canal.

Land utilization in the depot and were mainly residential area, 644.85 rais, accounting for 32.86% of the project area. Followed by an empty space 394.40 rais, representing 20.10% of the project area and 290.52 rais was an agricultural area, 14.80% of the project area.

(3) Land Use according to Town and City Planning Ministerial Regulation

Study the land uses according to Town and City Planning Ministerial Regulation within a radius of 500 meters. Found that the area along the route of the Bangkok Mass Transit

Yellow Line Project : Lat Phrao-Samrong Section was in Bangkok Master planning, 2013 and Samut Prakan Master planning. The land use details as shown in **Figure 4.3.1 - 2**.

Bangkok Master Planning, 2013

Land use along the project route can be classified as 4 types belows.

- Brown zone is a densely residential area such as the project route that crosses Chatuchak and Huay Khwang.
- Orange zone is moderately dense residential area such as the project route that cross Wang Thonglang, Bang Kapi, Suan Luang, Prawet and Bang Na.
- Yellow zone is a less dense residential area such as the project routed that cross Wang Thonglang, Bang Kapi, and Bang Na.
- Red zone is the commercial area such as certain areas of Wang Thonglang, Bang Kapi, and Bang Na.

Samut Prakan Master Planning

Curently the Samut Prakan Master planning was under editing, in the process of law No. 17: Department of Public Works and Town and Country Planning printed maps and plan. And also prepare for land use drafted of Samut Prakran master planning (not promulgate) as shown in **Figure 4.3.1 - 3**, with the details of land use.

- Orange zone is moderately dense residential area as the project route that cross most of Muang Samut Prakarn district,
- The red zone is the commercial and densely residential area as the project route that crosses Samrong Nua Municipality.

Table 4.3.1 - 5 Existing Land Use pattern at Depot and its vicinity (radius 1 kilometer from center of Depot)

Land use pattern	Study area (radius 1 kilometer from center of Depot)		
	Square meter	Rai	%
1. Residential zone	1,031,755.15	644.85	32.86
2. Residential and commercial zone	65,335.14	40.83	2.08
3. Commercial zone	235,693.33	147.31	7.51
4. Industrial zone	30,068.69	18.79	0.96
5. Warehouse zone	21,446.17	13.40	0.68
6. Institution zone	6,600.50	4.13	0.21
7. Government place zone	5,912.67	3.70	0.19
8. Religious place zone	13,447.87	8.40	0.43
9. Infrastructure	76.83	0.05	0.00
10. Recreation area	67.67	0.04	0.00
11. Agriculture area	464,838.99	290.52	14.80
12. Green area	631,042.97	394.40	20.10
13. Abandoned area	46,331.64	28.96	1.48
14. Water resources	72,214.54	45.13	2.30
15. Road	515,167.83	321.98	16.41
Total	3,140,000.00	1,962.50	100.00

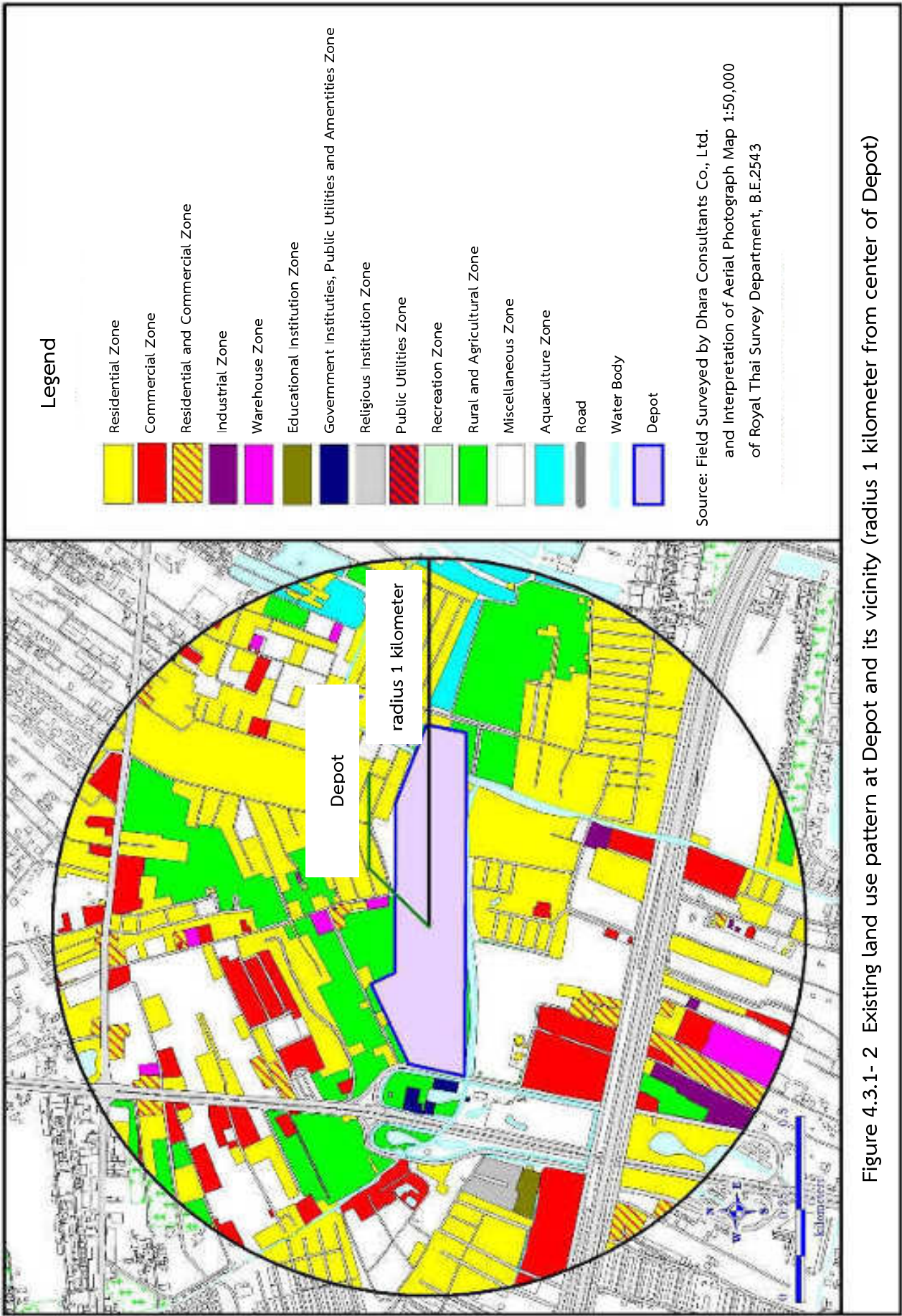


Figure 4.3.1- 2 Existing land use pattern at Depot and its vicinity (radius 1 kilometer from center of Depot)

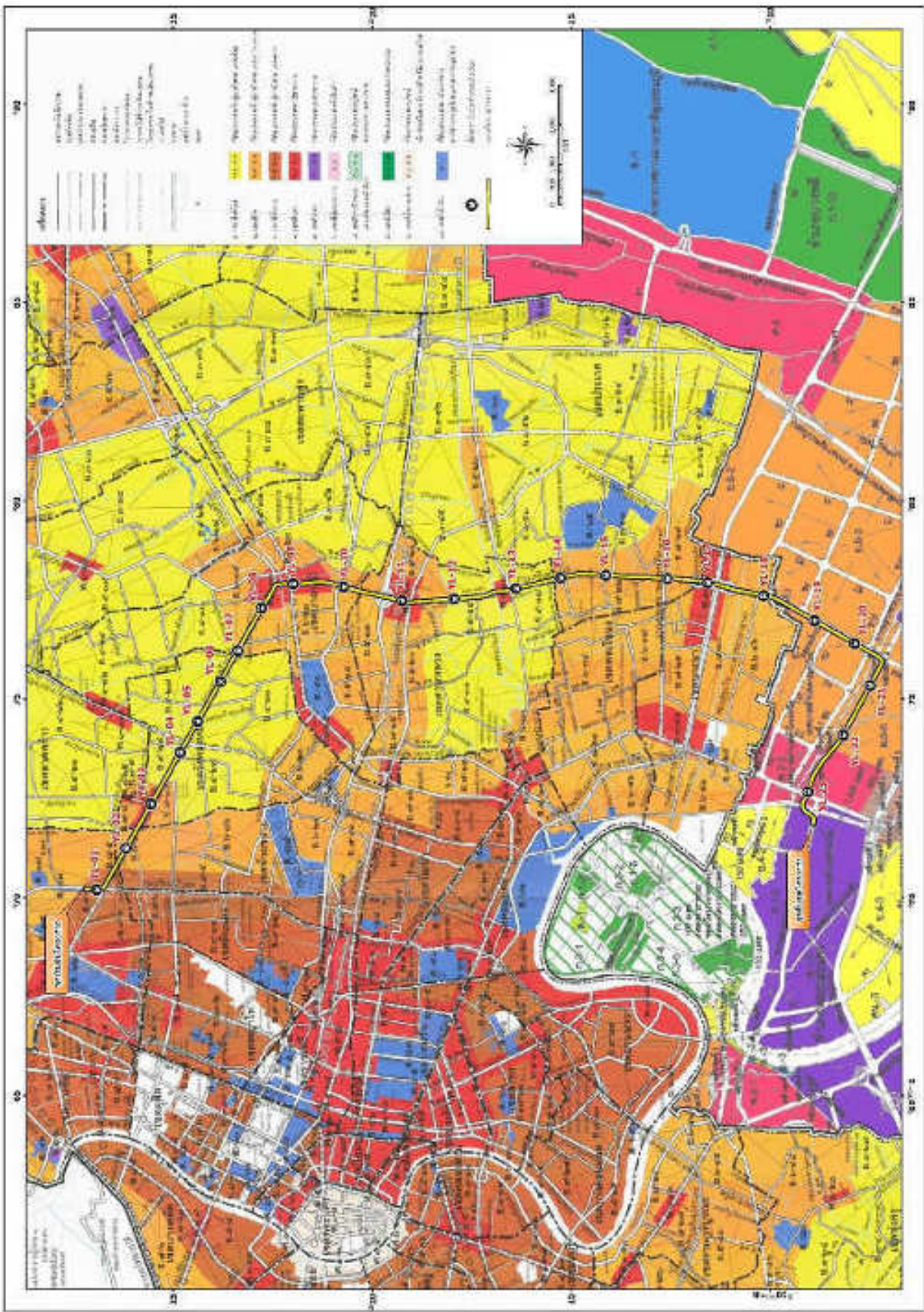


Figure 4.3.1 – 3 Land use zoning plan in Bangkok Comprehensive Plan, 2013 and Samut Prakan Comprehensive Plan (Draft)

4.3.2 Transportation

1) Methodology

(1) Collect and analyze transportation data along the project route and vicinity as road network linked to the train project, traffic volume data on the main/secondary road and transportation system development plan that related and connected with the project area etc. By collecting the secondary data from related documents/reports as traffic volume 2012 - 2013 of Bangkok Metropolitan Traffic and Transportation Department etc.

(2) Analyze and estimate the transportation impacts from the development of the project both construction and operation phase.

(3) Provide an appropriate prevention and mitigation measures and auditing requirements.

2) Study Results

Reviewed both previous EIA report (Light and Dark Yellow Line Mass Transit Project, OTP) 2012 detailed below.

(1) Transportation Network Linked with Yellow Line Mass Transit Project

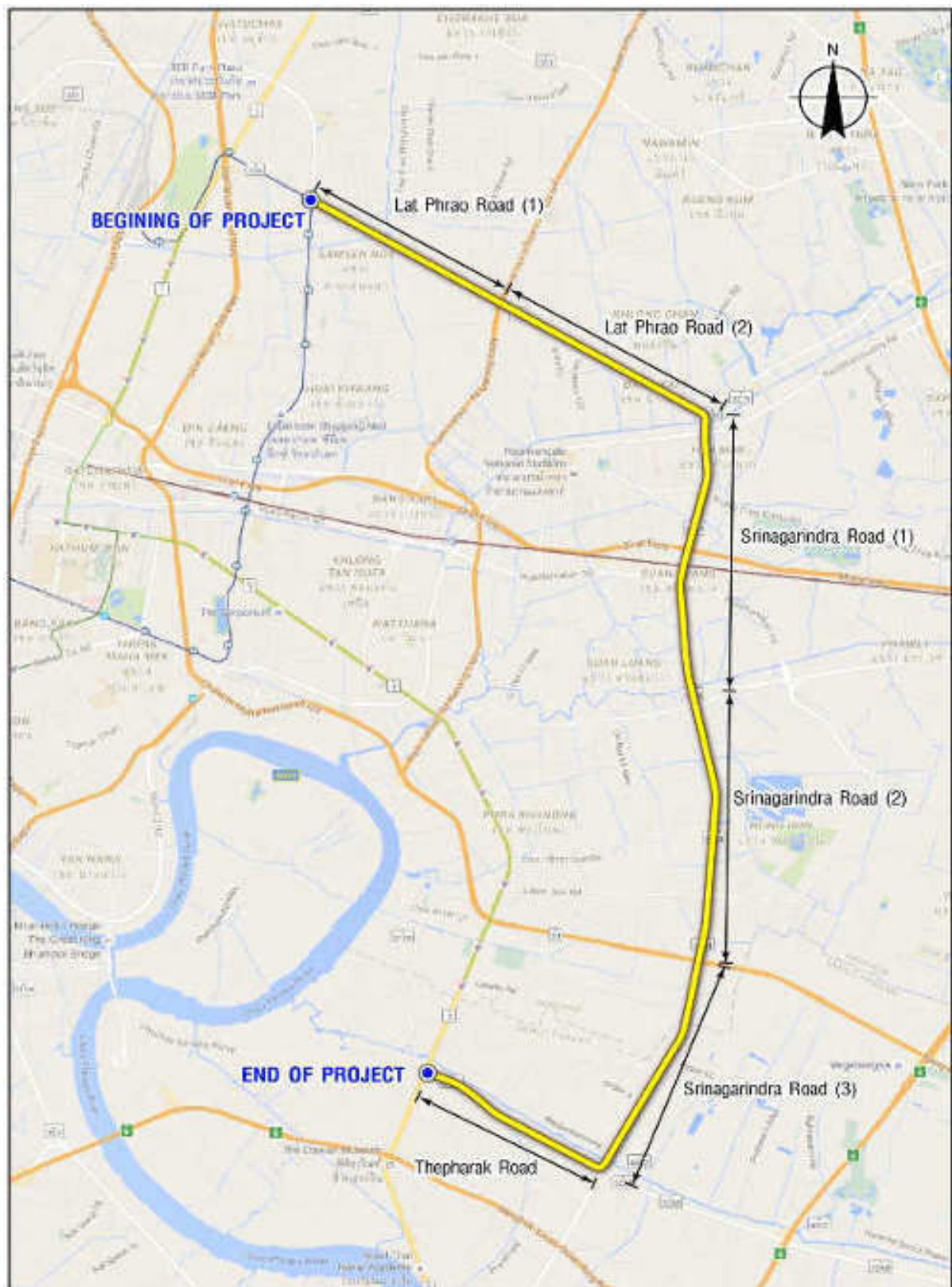
Bangkok Mass Transit Yellow Line Project : Lat Phrao-Samrong start from the link of Blue Line Mass Transit Project (Bang Sue - Hua Lampong section) at Ratchada - Lat Phrao intersection and ends at Samrong junction. Which connects to the Green Line Mass Transit Project, the project route start from Ratchada - Lat Phrao intersection along Lat Phrao road to the west until Bang Kapi intersection (Lat Phrao - Srinagarindra) and headed south along Srinagarindra road to Thepharak intersections (Srinagarindra - Thepharak) and turn right to Thepharak Road which ended at Samrong intersection (Thepharak - Sukhumvit). The study was divided into six sub-areas along the project route. The main road network along the route of Yellow Line Mass Transit Project (Lat Phrao – Samrong section), as shown in **Figure 4.3.2 - 1**, as detailed below.

(1.1) Lat Phrao Road (Ratchada - Lat Phrao Intersection ended at Lat Phrao 86 junction)

This section was approximately 4 km. These section of Lat Phrao road is the responsibility of the Department of Highways. The road is six lanes (back - forth) with a traffic island and sidewalks on both sides with the right of way width of 30 meters with many networks of major/minor roads as Ratchadaphisek road, Praditmanutham road, Chok Chai 4 road and Soi Lat Phrao 64. As along Lat Phrao road at Ratchada - Lat Phrao intersection ended at Lat Phrao 86 junction has 6 major junctions. The project area of Lat Phrao road (Ratchada - Lat Phrao intersection) to Praditmanutham road junction, as shown in **Figure 4.3.2 - 2** below.

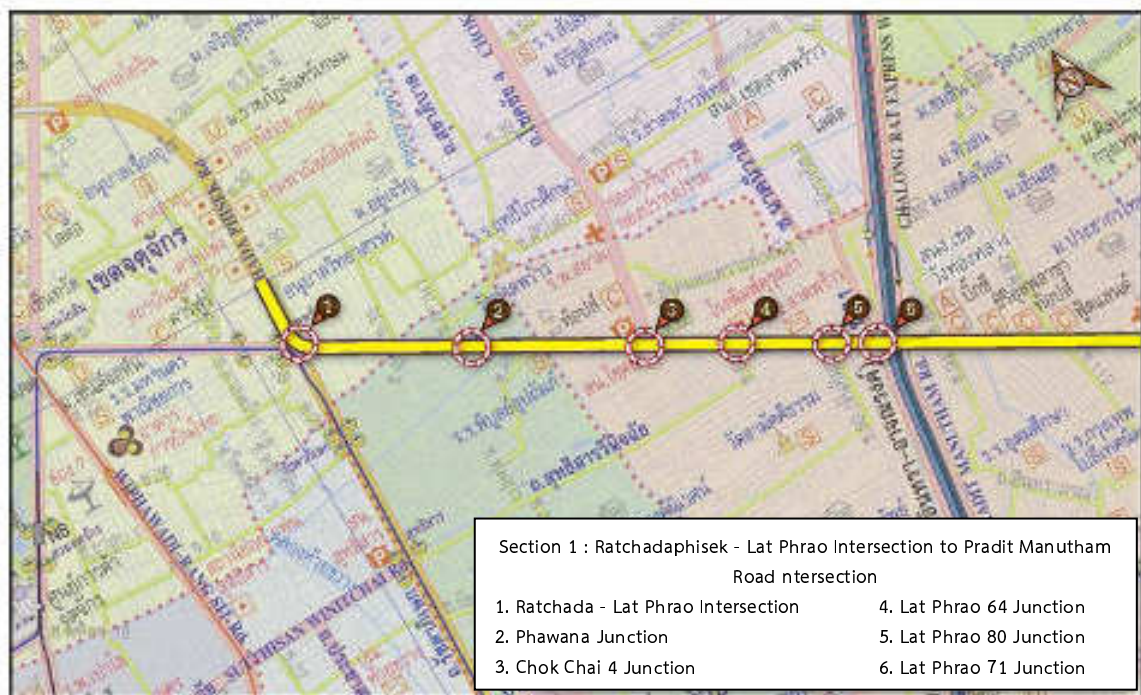
- **Ratchada - Lat Phrao Intersection** is an intersection between Lat Phrao road and Ratchadaphisek Road. Currently has a four-lanes overpass (back - forth) in the line of Ratchadaphisek Road. The traffic control at the ground level junction was with traffic lights and allow to move in any direction.

- **Phawana Junction** is a junction linked between Lat Phrao road with Soi Lat Phrao 41 or Soi Phawana. The linked between Soi Lat Phrao 41 and Lat Phrao road is skew. The traffic control at the junction was with traffic lights and allow to move in any direction.



Source : Office of Transport and Traffic Policy and Planning, 2012.

Figure 4.3.2 - 1 Transportation Network along the Project Route



Source : Office of Transport and Traffic Policy and planning, 2012.

Figure 4.3.2 - 2 Study Area at Lat Phrao Road from Ratchadaphisek - Lat Phrao Intersection to Pradit Manutham Road Intersection

- **Chok Chai 4 Junction** is a junction linked between Lat Phrao road with Chok Chai 4 road (4 traffic lanes). The angle connected between Chok Chai 4 and Lat Phrao road is skew. The traffic control at the junction was with traffic lights and allow to move in any direction.

- **Lat Phrao 64 Junction** is a junction linked between Lat Phrao road with Soi Lat Phrao 64. The traffic control at the junction was with traffic lights and allow to move in any direction.

- **Lat Phrao 80 Junction** is a junction linked between Lat Phrao road with Soi Lat Phrao 80. The traffic control at the junction was with traffic lights and force all vehicles coming from Soi Lat Phrao 80 to turn left into Lat Phrao road as of the light and do not make a u-turn at the junction in the inbound direction of Lat Phrao (Bang Kapi - Ratchada).

- **Lat Phrao 71 and Pradit Manutham Junction** is a junction linked between Lat Phrao road with Soi Lat Phrao 71 and intersect of Lat Phrao and Pradit Manutham road. The traffic control at the junction was with stop and go signs and forced all the vehicles from Soi Lat Phrao 71 to turn left into Lat Phrao road, while the vehicles on Lat Phrao road that came from Bang Kapi can turn right into Soi Lat Phrao 71 on schedule. At Praditmanutham Junction, all vehicles will be forced to turn left through the Junction.

(1.2) Lat Phrao Road (Lat Phrao 86 to Lam Sali Intersection)

The road network at Lat Phrao 86 to Lam Sali Intersection was approximately 5 km (Figure 4.3.2 - 1). These section of Lat Phrao road is the responsibility of the Department of Highways. The road is six traffic lanes (back - forth) with a traffic island and sidewalks on both sides

with the right of way width of 30 meters with many networks of major/minor roads as Srinagarindra Road, Ramkhamhaeng Road and Lat Phrao 101 Road. As along Lat Phrao road at Lat Phrao 86 junction ended at Lam Sali Intersection has 6 major junctions. The project area of Lat Phrao road (Lat Phrao 86 to Lam Sali Intersection), as shown in **Figure 4.3.2 - 3** below.

- **Lat Phrao 112 Junction** is a junction linked between Lat Phrao road with Soi Lat Phrao 112. The angle connected between Lat Phrao road and Soi Lat Phrao 112 is skew causing a difficult to large vehicles that want to turn left into Soi Lat Phrao 112. The traffic control at the junction was with traffic lights and force all vehicles coming from Soi Lat Phrao 112 to turn left into Lat Phrao road as the signal interval.

- **Lat Phrao 122 Junction** is a junction linked between Lat Phrao road with Soi Lat Phrao 122 the connected with Ramkhamhaeng Road. The traffic control at the junction was with traffic lights and force all vehicles coming from Soi Lat Phrao 122 to turn left into Lat Phrao road as the signal interval.

- **Lat Phrao 101 Junction** is a junction linked between Lat Phrao road with Soi Lat Phrao 101 can be connected with Nawamin Road. The traffic control at the junction was with traffic lights and allow to move in any directions. Except no u-turn on the inbound direction of Lat Phrao (Bang Kapi - Ratchada).

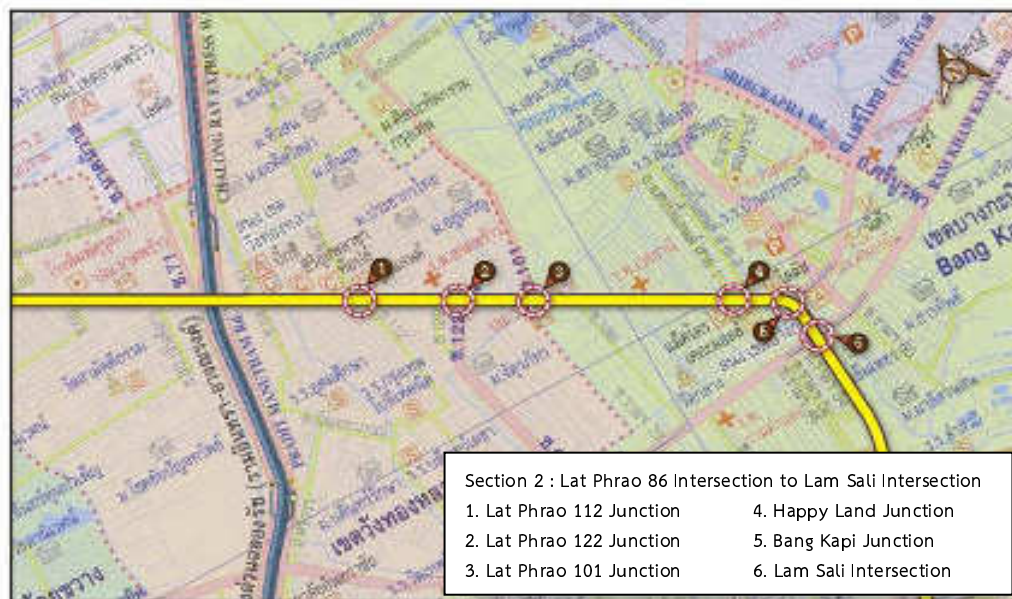
- **Happy Land Junction** is a junction linked between Lat Phrao and Happy Land road as an exit of The Mall Bang Kapi Department Store which has a four-lanes overpass (back - forth) in the line of Lat Phrao Road. The traffic control at the junction was with traffic lights and allow to move in any directions.

- **Bang Kapi Junction** is a junction linked between Lat Phrao and Srinagarindra Road which has a four-lanes overpass (back - forth) in the line of Lat Phrao Road extended from Happy Land. The traffic control at the junction was with traffic lights and allow to move in any directions. Also, let the vehicles on Lat Phrao Road heading east in the far left lane can go through the junction without waiting for a signal light.

- **Lam Sali Intersection** is an intersection of Srinagarindra and Ramkhamhaeng Road which has a four-lanes overpass (back - forth) in the line of Ramkhamhaeng Road. The traffic control at the junction was with traffic lights and allow u-turn on Ramkhamhaeng Road under the overpass.

(1.3) Srinagarindra Road (Lam Sali Intersection to Phatthanakan Intersection)

Srinagarindra Road (Lam Sali Intersection to Phatthanakan Intersection) was approximately 3 km (**Figure 4.3.2 - 1**). Srinagarindra Road is the main road that lies in the north – south direction and linked between Lat Phrao Road and Phatthanakan Road. The road is six traffic lanes (3 traffic lanes per direction) with a traffic island to separate the path with many networks of major/minor roads as Krung Thep Kritha Road, Rama 9 Road, Bangkok - Chonburi Road (Motorway no. 7), Phatthanakan Road and Soi Ramkhamhaeng 24. As along Srinagarindra Road (Lam Sali to Phatthanakan Intersection) has 2 major junctions. The project area of Lam Sali Intersection to Phatthanakan Intersection, as shown in **Figure 4.3.2 - 4** below.



Source : Office of Transport and Traffic Policy and Planning, 2012.

Figure 4.3.2 - 3 Study Area at Lat Phrao Road from Lat Phrao 86 Intersection to Lam Sali Intersection



Source : Office of Transport and Traffic Policy and planning, 2012.

Figure 4.3.2 - 4 Study Area from Lam Sali Intersection to Phatthanakan Intersection

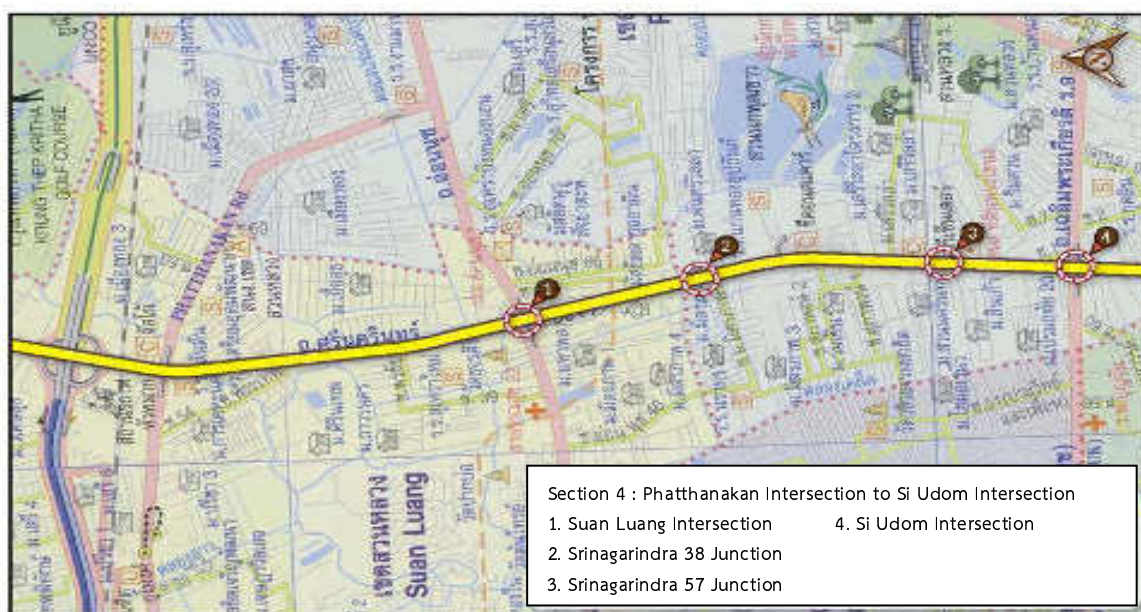
- **Krung Thep Kritha Intersection** is an intersection of Srinagarindra Road and Krung Thep Kritha Road and New Krung Thep Kritha Road (Soi Ramkhamhaeng 24). Currently, the traffic control at the junction was with traffic lights and allow to move all directions. Except vehicles on Srinagarindra Road heading south (to On Nut) that want to turn right into New Krung Thep Kritha Road must pass the intersection and then u-turn on Srinagarindra Road. High

traffic volume during rush hour (morning and evening Phase) due to the high traffic volume into an intersection.

- **Phatthanakan Intersection** is an intersection of Srinagarindra Road and Phatthanakan Road, which has a two-lanes overpass (back - forth) in the line of Phatthanakan Road. It is a change to the width and shape of city streets to suburban streets. Traffic jams during rush hour(morning and evening Phase). The traffic control at the junction was with traffic lights. All vehicles on Phatthanakan road required to pass the junction in the line of Phatthanakan road must use overpass. The vehicles that pass the ground junction on Phatthanakan road force to turn left or right into Srinagarindra Road only do not go straight. The vehicles Srinagarindra Road can move in any direction.

(1.4) Srinagarindra Road (Phatthanakan Intersection to Si Udom Junction)

Srinagarindra Road (Phatthanakan Intersection to Si Udom Junction) was approximately 7 km (**Figure 4.3.2 – 1**) with many networks of major/minor roads as Chaloe Phrakiat Ratchakan Thi 9 Road, Udomsuk Road and Soi Sukhumvit 77. As along Srinagarindra road (Phatthanakan to Si Udom Junction) has 4 major junctions. The project area of Phatthanakan Intersection to Si Udom Intersection, as shown in **Figure 4.3.2 - 5** below.



Source : Office of Transport and Traffic Policy and Planning, 2012.

Figure 4.3.2 - 5 Study Area from Phatthanakan Intersection to Si Udom Intersection

- **Suan Luang Intersection** is an intersection of Srinagarindra Road and On Nut Road which has a two-lanes overpass (back - forth) of On Nut Road. While in the area of Srinagarindra Road was 8 traffic lanes. The traffic control at the junction was with traffic lights. All vehicles on On Nut Road required to pass the junction in the line of On Nut road must use overpass. The vehicles that pass the ground junction on On Nut Road headed west (to Sukhumvit) force to turn left or right into Srinagarindra Road only, do not go straight. While the vehicles on On Nut road headed east (to Lat Krabang) must turn left, if the vehicles required to use Srinagarindra

Road headed south (to Bang Na – Trat) must use the u-turn under Phra Khanong Canal bridge 400 meters away from the junction. can move in any direction. Traffic jams during rush hour.

- **Srinagarindra 38 Junction** (new) is a junction linked between Srinagarindra Road and Soi Srinagarindra 38 (2 traffic lanes (back - forth)) with no traffic control at the junction.

- **Srinagarindra 57 Junction** is a junction linked between Srinagarindra Road and Soi Srinagarindra 57 (4 traffic lanes (back - forth)). The traffic control at the junction was with traffic lights allow all vehicles to move in any direction.

- **Si Udom Intersection** is an intersection of Srinagarindra Road, Udom Suk Road and Chaloem Phrakiat Rama 9 Road which has a two-lanes overpass (back - forth) in the line of Udomsuk Road and Chaloem Phrakiat Rama 9 Road. While in the area of Srinagarindra road was 8 traffic lanes. The traffic control at the junction was with traffic lights. All vehicles on Udomsuk Road and Chaloem Phrakiat Rama 9 Road required to pass the junction in the line of Udom Suk Road and Chaloem Phrakiat Rama 9 Road must use overpass. The vehicles that pass the ground junction on Udomsuk Road and Chaloem Phrakiat Rama 9 Road force to turn left or right into Srinagarindra Road only do not go straight, while the vehicles on Srinagarindra Road can move in any direction.

(1.5) Srinagarindra Road (Si Udom Intersection to Thepharak Junction)

Srinagarindra Road (Si Udom Intersection to Thepharak Intersection) was approximately 7 km (**Figure 4.3.2 – 1**) with many networks of major/minor roads as Bang Na - Trat Frontage Road, Thepharak Road, La Salle Raod (Sukhumvit 105), Bearing Road (Sukhumvit 107). As along Srinagarindra Road (Si Udom to Thepharak Junction) has 2 major junctions. The project area of Lat Phrao Raod (Si Udom to Thepharak Junction), as shown in **Figure 4.3.2 - 6** below.



Source : Office of Transport and Traffic Policy and planning, 2012.

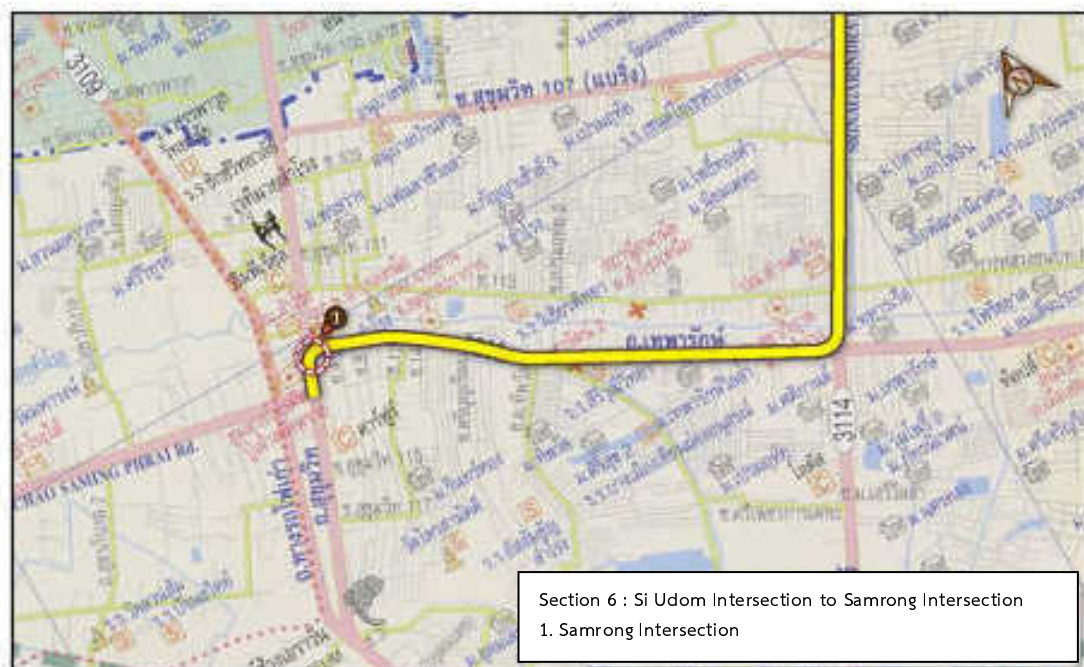
Figure 4.3.2 - 6 Study Area at Srinagarindra Road from Si Udom Intersection to Si Thepha Intersection

- **La Salle Intersection (new)** is an intersection of Srinagarindra Road and Sukhumvit 105 Road (4 traffic lanes (back - forth). Currently has a 4 lanes overpass (back - forth) in the line of Srinagarindra Road with space between the bridge in both directions. The traffic control at the ground junction was with traffic lights allow all vehicles to move in any directions. And has a lane for the vehicle to exit and entrance to Srinagarindra Road and Sukhumvit 105 Road.

- **Si Thepha Intersection** is an intersection of Srinagarindra Road and Thepharak Road. Currently has a 4 lanes overpass (back - forth) in the line of Srinagarindra Road with space between the bridge in both directions. The traffic control at the ground junction was with traffic lights allow all vehicles to move in any directions. And has the right turn lane on Srinagarindra Road in the space between pier of the overpass as Sikarin Junction.

(1.6) Thepharak Road (Si Udom Intersection to Samrong Junction)

Thepharak Road (Si Udom Intersection to Samrong Junction) was approximately 4 km (**Figure 4.3.2 - 1**). By Thepharak Road or Highway 3268 (Samrong) converging with Highway 3317 (Bangbo) is a local road in Samut Prakran province posing in east - west direction. The road is 8 traffic lanes (4 traffic lanes per direction) with a traffic island to separate the direction, intersected with Srinagarindra Road at Si Thepha junction. The primary road network is Sukhumvit 107 Road. Samrong junction is a major junction (The project area of Si Udom to Samrong Junction, as shown in **Figure 4.3.2 - 7**). It is a junction linked between Thepharak Road and Sukhumvit Road. The traffic control at the junction was with traffic lights which do not allow the vehicles from Sukhumvit Road turn right into Thepharak Road, have to go straight and make a u-turn under Samrong Canal overpass with 290 meters away from the junction.



Source : Office of Transport and Traffic Policy and Planning, 2012.

Figure 4.3.2 - 7 Study Area from Si Udom Intersection to Samrong Intersection

(2) Traffic Volume On Transportation Network linked with the Bangkok Mass Transit Yellow Line Project : Lat Phrao-Samrong Section

The traffic volume data 2013 of the Bangkok Traffic and Transport Department in the main junction was summarized as follows.

(2.1) Lat Phrao Road (Ratchada – Lat Phrao Junction ended at Lat Phrao 86 Junction)

- **Ratchada - Lat Phrao Junction** The traffic volume into the junction was about 16,743 PCU/hr. Separated into morning rush hour about 9,051 PCU/hr. and evening rush hour about 7,692 PCU/hr.
- **Phawana Junction** The traffic volume into the junction was about 9,112 PCU/hr. Separated into morning rush hour about 4,324 PCU/hr. and evening rush hour about 4,788 PCU/hr.
- **Chok Chai 4 Junction** The traffic volume into the junction was about 9,162 PCU/hr. Separated into morning rush hour about 5,368 PCU/hr. and evening rush hour about 3,794 PCU/hr.

(2.2) Lat Phrao Road (Lat Phrao 86 to Lam Sali Intersection)

- **Lat Phrao 112 Junction** The traffic volume into the junction was about 9,304 PCU/hr. Separated into morning rush hour about 4,582 PCU/hr. and evening rush hour about 4,722 PCU/hr.
- **Lat Phrao 101 Junction** The traffic volume into the junction was about 9,101 PCU/hr. Separated into morning rush hour about 4,179 PCU/hr. and evening rush hour about 4,922 PCU/hr.
- **Happy Land Junction** The traffic volume into the junction was about 10,864 PCU/hr. Separated into morning rush hour about 5,739 PCU/hr. and evening rush hour about 5,125 PCU/hr.
- **Lam Sali Intersection.** The traffic volume into the junction was about 7,310 PCU/hr. Separated into morning rush hour about 3,314 PCU/hr. and evening rush hour about 3,996 PCU/hr.

(2.3) Srinagarindra Road (Lam Sali Intersection to Phatthanakan Intersection)

- **Krung Thep Kritha Intersection** The traffic volume into the junction was about 13,522 PCU/hr. Separated into morning rush hour about 7,759 PCU/hr. and evening rush hour about 5,763 PCU/hr.
- **Phatthanakan Junction.** The traffic volume into the junction was about 13,157 PCU/hr. Separated into morning rush hour about 6,801 PCU/hr. and evening rush hour about 6,356 PCU/hr.

(2.4) Srinagarindra Road (Phatthanakan Intersection to Chalem Prakiet Intersection)

- **Srinagarindra 57 Junction (Suphamong Junction)** The traffic volume into the junction was about 9,816 PCU/hr. Separated into morning rush hour about 6,992 PCU/hr. and evening rush hour about 2,824 PCU/hr.

(3) Analysis of Traffic Problem at the Transportation Network linked with Bangkok Mass Transit Yellow Line Project : Lat Phrao-Samrong

The reviewed and analysis of traffic problem at the transportation network linked Bangkok Mass Transit Yellow Line Project : Lat Phrao-Samrong Section as shown in **Table 4.3.2 - 1**.

(3.1) Traffic Condition on Lat Phrao Road

- The traffic volume on the entire route of Lat Phrao Road in the morning rush hour was approximately 500 to 800 PCU/lane/day, these number of vehicle was a result of a traffic controlling by the police. Whether it was the controlling at the junction or the median opening, when combined the traffic volume passed the junction for the critical direction was about 1,000 to 1,150 PCU/lane during rush hours. These circumstances shows that the flow of traffic volume at the critical junction was relatively low. If improve the traffic control method to meet an international standard, the flow of traffic volume at the critical direction passed the junction will high about 1,400 to 1,500 PCU/lane on the critical direction.

- The current implementation of traffic control officers caused the delays at each junction average about 10 to 20 minutes/vehicle, depending on the desired to pass the junction, such as junction with high passing demand (neither large or small junction or just median opening). Besides, waiting time also very vary such as the vehicle that arrives and is the last group passed the junction do not waste any time at the junction while the first vehicle at the red light will waste about 10 to 30 minutes. Depending on the light controlling at the junction by officials.

- The vehicles on the road that intersected with Lat Phrao Road either the main road such as Ratchadaphisek Road or minor roads or soi the flowing rate was lower, for example, Ratchada/Lat Phrao junction. The traffic volume at Ratchadapisek road around the junction (not flyover) the flow rate was approximately 350 to 650 vehicle/lane/hour which much lower than Lat Phrao Road. This may be due to low demand on passed at the junction or the controlling method of the officer making a traffic via junction very less. As well as the average delay of each vehicle, was relatively high with close to or more than on the Lat Phrao Road.

- Considering the traveling speed found that an average on each road section from all type of vehicle (including bus) was about 8 to 12 km/hr. (Including delays at the junction), which is relatively low. In spite of moving speed on the road was at a moderate speed, long wasted time at Junction. Also, the change of travel time (travel speed) was very high, as if the first car passes the junction the travel speeds were excess 20 km/hr. If jam at the junction (which most vehicles have jammed at least one junction) the entire travel speeds will decrease over 50% immediately.

- Summarize the current critical junction (all roads) was concluded on traffic conditions as a result of current traffic control only. This situation may not be the real desired of travelers. This is because the controlling method of the authorities, such as vehicular traffic must u-turn back at the median opening (instead of improving junction in front of major alley). This may result in the driver to find or change the route to avoid traffic jams.

Table 4.3.2 - 1 Result of Traffic Analysis at each Intersection on Transportation Study Network

Section	Road name	Average speed	Critical intersection and continuous intersection	Average delay at intersection	LOS
1	Lat Phrao 1 between Ratchadaphisek - Lat Phrao intersection to Ratchadaphisek -Pradit Manutham road intersection	WB: 8 km/hr EB: 12 km/hr	(Critical Intersection) Ratchadaphisek - Lat Phrao intersection	18 minute	F
			Chock Chai 4 intersection	11 minute	F
2	Lat Phrao 2 between Ratchadaphisek - Lat Phrao intersection to Ratchadaphisek -Pradit Manutham road intersection	WB: 8 km/hr EB: 12 km/hr	Lat Phrao intersection / Pradit Manutham intersection	6 minute	F
			(Critical Intersection) Lat Phrao 122 intersection (Mahat Thai road)	12 minute	F
			Lat Phrao 101 intersection	9 minute	F
3	Srinagarindra 1 between Lam Sali intersection to Srinagarindra - Phatthanakan intersection	SB: 18 km/hr NB: 12 km/hr	(Critical Intersection) Lam Sali intersection	17 minute	F
			Srinagarindra intersection/ Krung Thep Kritha intersection	6 minute	F
4	Srinagarindra 2 between Phatthanakan intersection to Si Udom intersection	SB: 13 km/hr NB: 17 km/hr	Srinagarindra intersection/ Phatthanakan intersection	8 minute	F
			(Critical Intersection) Suan Luang intersection (Cross to On Nut road)	14 minute	F
5	Srinagarindra 3 between Si Udom intersection to Thepha Rak intersection	SB: 18 km/hr NB: 12 km/hr	Si Udom intersection	7 minute	F
6	Thepha Rak road	WB: 9 Km/hr EB: 15 Km/hr	(Critical Intersection) Samrong intersection (Thepha Rak/Sukhumvit road)	15 minute	F

Source : Traffic study result from Asian Engineering Consultants Corporation Limited, 2013.

- The survey found that the traffic jams on Lat Phrao Road start very early in the morning from about 6:30 am. until 9:00 am. or beyond. These circumstance showed that the traffic demand on Lat Phrao Road will be longer than normal to about one and a half hours. Therefore, it is difficult to measure the demand or actual demand on Lat Phrao Road. Also during the evening rush hour, the traffic jam on the road start from approximately 4:30 pm. until dusk to about 8:30. pm., which has been shown increasing on the activities, then evening demand or traveling desires on Lat Phrao Road will be even more than in the morning.

(3.2) Traffic Condition on Srinagarindra Road

- Traffic condition generally on Srinagarindra Road was much better than the Lat Phrao Road. Traffic volume on Srinagarindra Road in each lane at junctions in rush hour was about 450 to 550 vehicle/lane. While the traffic volume on an intersected roads was based on

each junction, also about 450 to 550 vehicle/lane/hour. When combined the highest traffic volume in each direction to be the traffic volume/hour/lane at the junction was around 900 to 1,100 vehicle/lane/hour. This situation shows that the flow at junction/lane of the critical direction was very low. Resulted in an average delay at the junction was quite high. As same as the situation on Lat Phrao Road, about 15 to 20 minutes/vehicle. On Nut junction was a critical junction.

- Travel speeds on Srinagarindra Road were between 12 to 18 km./hr. depending on the traffic direction. The direction heading into On Nut Junction has more traffic jams than heading out.

(3.3) Traffic Condition on Thepharak Road

- Traffic condition generally on Thepharak Road was similar with Lat Phrao Road more than Srinagarindra Road. These may be due to the similarity of land use on Thepharak Road and Lat Phrao Road. The traffic volumes on Thepharak Road in each lane at junctions in rush hour, about 500 to 650 vehicle/lane. While the traffic volume on an intersected roads was based on each junction, also about 400 to 650 vehicle/lane/hour. When combined the highest traffic volume in each direction to be the traffic volume/hour/lane at the junction was around 1,100 to 1,200 vehicle/lane/hour.

- Travel speeds on Srinagarindra Road were between 12 to 18 km./hr. depending on the traffic direction. The direction heading into Samrong Junction has more traffic jams than heading out due to this junction is a critical junction.

(4) Traffic Management During Project Construction Phase

(4.1) Using labels and traffic signs around the construction area

To control, alerts and recommended the traffic routes that will be the lane closed to suit with the traffic condition of travelers. The goal is to introduce the route, caution in lane use, including control in lanes use and speed lead. Therefore, the consultants have offered a sample of closed lanes on Lat Phrao Road (by labels and traffic signs which can be applied to Thepharak Road with similar size) and Srinagarindra Road. A sample of closed lanes on Lat Phrao Road, as shown in **Figure 4.3.2 - 8** and sample of the closed lane on Srinagarindra Road, as shown in **Figure 4.3.2 - 9**, respectively.

(4.2) Recommendation of shortcut in the area

Shortcut on Lat Phrao Road, as shown in **Table 4.3.2 - 2** will help spread the traffic volume in terms of the personal car off Lat Phrao Road area more quickly. Which direct impact on traffic jams of Lat Phrao Road to decline.

(4.3) Traffic Control and Management

- The traffic condition on Lat Phrao Road has high volume of u-turn vehicles especially in the morning rush hour. Lot of vehicle were going inbound (heading west) (it also has the vehicles that desired to turn in the opposite direction). Besides, these both traffic volume take a lot more time than a normal turn right at junction, unnecessary increase the amount of vehicles on both directions of the road, either. As a result, a large number of vehicles



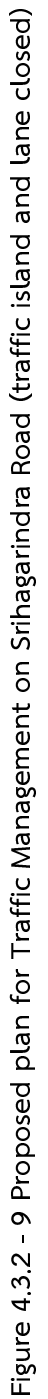


Table 4.3.2 - 2 Shortcut road around Lat Phrao road

No.	Southern	Northern
1	Lat Phrao 48 - Ratchadapisek Road	Lat Phrao 35 – Chok Chai 4 Road
2	Lat Phrao 64 - Ratchadapisek Road	Phawana Road - Chok Chai 4 Road
3	Lat Phrao 80 - Ratchadapisek Road	Lat Phrao 55 - Nak Niwat Road
4	Pradit Manuthum road - Pracha Uthit Road	Pradit Manuthum road - Lat Phrao 101
5	Lat Phrao 94 - Pradit Manuthum Road	Lat Phrao 81 - Lat Phrao 101
6	Lat Phrao 112 - Pradit Manuthum Road	Lat Phrao 87 - Lat Phrao 101
7	Lat Phrao 122 - Ramkhamhaeng Road	Lat Phrao 93 - Lat Phrao 101
8	Lat Phrao 130 - Ramkhamhaeng Road	Lat Phrao 107 - Nawamin Road
9	The Mall Bang Kapi entrance - Ramkhamhaeng Road	Happy Land - Nawamin Road

using Lat Phrao Road on both sides. The way to solve this problem is to allow the vehicles exit from the alley to turn right or construct moer junctions on Lat Phrao Road.

- Increasing the junctions into the network seem to increase more intersects in to the network which may increase an average delay. But in fact, only distribute the previously median opening for u-turn to occur simultaneously at many junctions. It cause 2 advantages.

- To turn right take a lot less time at the junction than make a u-turn.
- To distribute the turn right to many junctions enabling simultaneous

multiple cars.

- Provide the traffic signal coordination concept with Queue Management. Parameters for traffic signal coordination as shown in **Table 4.3.2 – 3**. Initially, it was a traffic signal coordination model for Lat Phrao Road Junction Road from Seri Thai/Nawamin junction to Bang Kapi. The longest green light interval at the junction was not more than 60 seconds (because this is the time for maximun flowing rate out of the junction per second. If the green light interval was longer. The flow rate of the vehicle out of the junction will decrease). The red light interval will be equal to the the traffic demand on the other side of the junction.

- This time control will be only used during rush hours, which is the phase and signal interval must stabilize. Because of the high traffic demand to pass the junction and the traffic light have to work for a maximum capacity of the junction. In other words is maximum releasing the car out of the junction.

(4.4) Public transport system

Improvement of bus services on Lat Phrao Road have to conduct in 2 ways, simultaneously.

- Reduce the number of bus routes on Lat Phrao Road to the minimum requirement for the decresing of route duplication.

- Improve bus scheduled starting from terminal (port) or improvements at various points on Lat Phrao Road especially the entrance - exit area. This improvement is a very

simple and can be expanded to a full path if appropriate. The same case must be made for Srinagarindra Road and Thepharak Road as well.

Table 4.3.2 - 3 Traffic Light Parameters for Coordination Work

Intersection	Around traffic light time (minute)	Traffic light time on critical direction	Traffic light time	Overlap traffic light time
Bang Kapi Intersection	140	60/80	4	0
Bang Kapi T – Intersection	140	60/80	3	40
Happy Land Intersection	140	60/80	3	100
Lat Phrao 140	140	60/80	3	10
Lat Phrao 132	140	60/80	3	60
Lat Phrao 130	140	60/80	3	0
Lat Phrao 101	140	60/80	3	50
Lat Phrao 124	140	60/80	3	120
Lat Phrao 122	140	60/80	3	0
Lat Phrao 112	140	60/80	3	10
Lat Phrao 102	140	60/80	3	40
Lat Phrao 94	140	60/80	3	30
Lat Phrao 86	140	60/80	3	90

Remark : All parameters is preliminary design values.

4.3.3 Public Utilities

1) Methodology

(1) study, collect and analyze the struc and utilities data along the project route and vicinity includes water supply system, electrical system, a telecommunications system that related and linked to the project area. Collected the related documents/reports from infrastructure system providers in the project area, including the Metropolitan Waterworks Authority (MWA), Metropolitan Electricity Authority (MEA), The Electricity Generating Authority of Thailand (EGAT), CAT Telecom Public Company Limited, TOT Public Company Limited, True Corperation Public Company Limited, PTT Public Company Limited and Water Pipeline Transport Company Limited.

(2) Field survey and inspection in the project area to use the data in the study and analysis of the impact of struc and utility system relocation due to project development.

(3) Assessment the Impacts from the project construction based on a detailed study and route structure design and composition of the project which expected to affect the struc and utility system relocation.

(4) Recommend the prevention and mitigation measures on infrastruc and utilities that are expected to arise from the project both during the construction and operation phase.

2) Study Results

4.3.3.1 Water Supply System

Data collection on water supply system along the project route within a radius of 500 meters and adjoining areas of the Metropolitan Waterworks Authority (MWA) together with the field survey and monitoring, can be concluded as follows:

1) Waterworks office under the Metropolitan Waterworks Authority (MWA) with the service areas cover along the project route and adjoining areas. A total of 5 offices, including.

1.1 Payathai Waterworks is located at Vibhavadi-Rangsit Road, Bangkok responsible for water supply distribution of 55.40 sq.km with total of 84,090 water users, water distribution of 87.17 million cubic meters/year and 29.29% water loss rate (Metropolitan Waterworks Authority, 2011).

1.2 Lat Phrao Waterworks is located at along Pracha Uthid Road, Bangkok responsible for water supply distribution of 99.07 sq.km with total of 137,651 water users, water distribution of 83.31 million cubic meters/year and 21.29% water loss rate (Metropolitan Waterworks Authority, 2011).

1.3 Sukhumvit Waterworks is located at Sukhumvit Road responsible for water supply distribution of 87.06 sq.km with total of 105,204 water users, water distribution of 107.23 million cubic meters/year and 29.30% water loss rate (Metropolitan Waterworks Authority, 2011).

1.4 Prakanong Waterworks is located at Sukhumvit Road, Bangkok responsible for water supply distribution of 270.23 sq.km with total of 131,191 water users, water distribution of 103.44 million cubic meters/year and 30.16% water loss rate

1.5 Samut Prakarn Waterworks is located between Soi Wichit Neramit and Soi Boonsiri 4, Samut Prakarn province responsible for water supply distribution of 597.46 sq.km with total of 142,531 water users, water distribution of 116.18 million cubic meters/year and 26.39% water loss rate (Metropolitan Waterworks Authority, 2011).

2) Summarization of water supply system survey along the project route as follow.

2.1 Lat Phrao Road, starting from Ratchada Station / Lat Phrao until Bang Kapi is the main water supply pipeline with diameter of 1,500 mm., lied under the traffic island at a depth of about one meter and the water supply pipeline pipe with diameter of 300 mm., lied under the footpath at a depth of one meter.

2.2 Srinagarindra Road, starting from the intersect of Lat Phro Road until the intersect of Rama 9 Road is the main water supply pipeline with diameter of 1,000 mm. and the water supply pipeline pipe with diameter of 300 mm., lied under the footpath at a depth of one meter.

2.3 Srinagarindra Road, starting from Bang Na – Trat Road until Si Thepha junction is the main water supply pipeline with diameter of 800 mm. and the water supply pipeline pipe with diameter of 300 mm., lied under the footpath at a depth of one meter in the out bound direction.

2.4 Thepharak Road, starting from Si Thepha junction to Samrong and Pu Chao Saming Phrai junction is the main water supply pipeline with diameter of 1,200 mm. and the water supply pipeline pipe with diameter of 300 mm., lied under the footpath at a depth of one meter in the out bound direction.

4.3.3.2 Electrical System

Data collection of the electrical system along the project route within a radius of 500 meters and vicinity of the Metropolitan Electricity Authority (MEA). Together with the field survey and monitoring concluded as follows:

1) The MEA Lat Phrao is located on Ramkhamhaeng Road with responsible for electricity distribution of 167 sq.km with total of 251,765 users, electricity unit distribution of 2,679,707,110 kW-hr. (data from January - December 2008). The distribution transmission control along the project route of 2 subtrasmissions.

1.1 Klongchan Substation received electricity from the transmission line 69 kV from Bang Kapi Terminal Station. By changing the voltage from 69 kV to 24 kV via transformer 1x40 + 2x60 MVA, distribute 16 Feeder electricity.

1.2 Wang Thonglang Substation received electricity from the transmission line 69 kV from Ratchadapisek Terminal Station. By changing the voltage from 69 kV to 24 kV via transformer 3x60 MVA, distribute 16 Feeder electricity.

2) MEA Bang Kapi is located on Ramkhamhaeng Road, Suan Luang, Suan Luang, Bangkok with responsible for electricity distribution of 167 sq.km with total of 197,456 users, electricity unit distribution of 3,145,472,713 kW-hr. (data of January – December, 2009). The distribution transmission control along the project route of one subtrasmission is Phatthanakan Substation (PTN). Received electricity from the transmission line 115 kV from On Nut Terminal Station. By changing the voltage from 115 kV to 24 kV via transformer 2x60 MVA, distribute 4 Feeder electricity.

3) MEA Prawet is located on King Kaew Road, Rachathewa Subdistrict, Bangphli District, Samut Prakran province with responsible for electricity distribution of 127 sq.km with total of 134,482 users, electricity unit distribution of 1,843,908,463 kW-hr. (data of January – December, 2009). The distribution transmission control along the project route of one subtrasmission is Suan Luang Substation (SG). Received electricity from the transmission line 69 kV from On Nut Terminal Station. By changing the voltage from 69 kV to 24 kV via transformer 3x60 MVA, distribute 19 Feeder electricity.

4) MEA Samut Prakarn is located on Sukhumvit Road, Pak Num Subdistrict, Muang District, Samut Prakran province with responsible for electricity distribution of 124 sq.km with total of 165,645 users, electricity unit distribution of 4,384,590,876 kW-hr. (data of January – December, 2009). The distribution transmission control along the project route of 2 subtrasmissions.

4.1 Samrong Substation (SRS) received electricity from the transmission line 69 kV from Thepharak Terminal Station. By changing the voltage from 69 kV to 24 kV via transformer 3x60 MVA, distribute 14 Feeder electricity.

4.2 Bang Muang Substation (BMU) received electricity from the transmission line 69 kV from Thepharak Terminal Station. By changing the voltage from 69 kV to 24 kV via transformer 3x60 MVA, distribute 16 Feeder electricity.

5) The conclusion of electrical system survey along the project route and vicinity is as follows:

5.1 Lat Phrao Road starts from Ratchada/Lat Phrao Station at Ratchada - Lat Phrao intersection passed Lat Phrao Road until the confluence with Srinagarindra Road as follows.

a) North: A transmission line 69 kV laid elevated along Lat Phrao Road to Wang Thonglang substation and laid elevated from substation Wang Thonglang to At Narong – Ram Inthra Expressway before laid underground through Lat Phrao Road and elevated again along Lat Phrao Road before sifting down underground to Klongchan Substation.

b) South: A transmission line 69 kV laid elevated from Klongchan substation along Lat Phrao Road until the confluence with Srinagarindra Road.

5.2 Srinagarindra Road strat from the confluence with Lat Phrao Road until Rama 9 Interchange and Bangkok-Chonburi Motorway as follow.

a) East: A transmission line 115 kV laid elevated along Srinagarindra Road until and shifted underground at Ramkhamhaeng Road.

b) West: A transmission line 115 kV laid elevated from Klongchan substation along Lat Phrao Road until Rama 9 Interchange before difted underground and elevated to Bangkok-Chonburi Motorway.

5.3 Srinagarindra Road from Phatthanakan station passed Srinagarindra Road until confluence with Thepharak Road as follows:

a) North: A transmission line 115 kV laid elevated across Srinagarindra Road to Bang Na-Trat Road.

b) South: A transmission line 115 kV laid elevated along Srinagarindra Road. At the far end of Srinagarindra Road has the underground line connected with the transmission line 115 kV at Bang Na - Trat Road in the North.

6) The survey of high voltage lines along the mass transit system rails and adjoining areas have concluded that the area of Phatthanakan Road-Srinagarindra junction has a high voltage transmission line of EGAT - Thailand cut across Srinagarindra Road with 20 meters height above the surface of Srinagarindra Road.

4.3.3.3 Telecommunication system

Data collection of telecommunications system along the project route within a radius of 500 meters and vicinity such as TOT Public Company Limited, CAT Telecommunications Co., Ltd., Total Access Communication Public Company Limited, True Corperation Public Company Limited and Advanced Info service Public Company Limited etc. Together with the field survey and monitoring concluded as follows:

1) Public switched and mobile telephone systems in Bangkok and vicinity area from the report of the Public switched and mobile telephone and internet market 2008 (Office of Policy and Rules, the National Telecommunications Commission, 2009), considering only

current 2 public switch telephone service providers, namely TOT Co., Ltd. and True Corporation Public Company Limited. The public switched telephone number (end of 2008) with a total of 3,535,364 subscribers (49.83% of public switched telephone number all the country).

2) Telecommunication system survey along the project route and nearby areas as follow:

2.1 Networks system of TOT Public Company Limited is a Communication - Antenna Line size 9-D4 ", 12-D4", 16-D4 " elevated and lied with electrical poles of the MEA along both side of the sidewalks of Lat Phrao Road, Srinagarindra Road and Thepharak Road.

2.2 Networks system of CAT Telecommunications Co., Ltd. has 2 types.

a) Fiber Optic Communication System is underground conduits and fiber optic communication system size OFC 48C AERIAL, OFC 2-24C AERIAL, OFC 24C AERIAL, DROP OFC 8C, OFC 24C DUCT, placed underneath the ground at a depth of 60 centimeters along the sidewalks on both sides of Lat Phrao Road and Srinagarindra Road.

b) Copper Cable Communication System is an underground conduits and copper cable size 100 - 0.65 AP(8), placed underneath the ground at a depth not exceed 60 centimeters along the sidewalks on both sides of Lat Phrao Road and Srinagarindra Road.

2.3 Networks system of DTAC is an underground conduits and copper cable size 12C, 36C, 48C, 72C, 72C(A), 72C(C) and 120C, placed underneath the ground at a depth not exceed 60 centimeters along the sidewalks on both sides of Srinagarindra Road and Thepharak Road.

2.4 Networks system of True Corporation Public Company Limited has 2 types.

a) Fiber Optic Communication System is an underground conduits and fiber optic cable size OFB-S(12), OFB-S(24), OFB-S(36), OFB-S(48), OFB-S(60), OFB -S(80), OFB - S(140), placed underneath the ground at a depth of 60 centimeters along the sidewalks on both sides of Srinagarindra Road and Thepharak Road.

b) Copper Cable Communication System is an underground conduits and copper cable size 100-.4AP-FSF, 200-.4AP-FSF, 300-.4AP-FSF, 400-4AP-FSF, 600-.4AP-FSF, 900-.4AP-FSF, 1200-.4AP-FSF, 1500-.4AP-FSF, 1800-.4AP-FSF, PVC 6-04", PVC 9-04", PVC 12-04", placed underneath the ground at a depth not exceed 60 centimeters along the sidewalks on both sides of Srinagarindra Road and Thepharak Road.

4.3.3.4 Fuel and Gas Pipeline System

Data collection of fuel and gas pipelines along the project and adjoining areas within a radius of 500 meters and vicinity such as Fuel Pipeline Transportation Limited (FPT) and PTT Public Company Limited, together with the field survey and monitoring. Found that Bangkok has plans to construct a Phatthanakan Intersection Underpass. It was a cooperation between The Railway Transit Authority of Thailand (MRTA) and Bangkok to construct a Phatthanakan Intersection Underpass with The Bangkok Mass Transit Yellow Line Project : Lat Phrao-Samrong due to it may affect the fuel pipeline diameter 14" of FPT and pipeline size 12" of PTT that placed parallel with the Eastern Railroad of State Railway of Thailand (SRT) on Srinagarindra Road, which has a depth of fuel and gas pipelines near the intersection of

Srinagarindra Road at the same depth of the tunnel underpass at a depth of -7.00 m, approximately. These fuel pipeline delivers fuel to the aircraft at Suvarnabhumi airport. The average fuel deliver rate of 3 to 4 million liters per day. While the gas pipeline of PTT has not supply gas to any organizations. But in the current conditions, Nitrogen gas already compressed into a 12" diameter pipeline.

The meeting coordination with related organizations detailed in **Appendix 4H**.

4.3.4 Flood Control and Drainage

1) Methodology

- (1) Data collection of water drainage from various documents and reports.
 - Topographic Map (covering Bangkok and vicinity), scale 1: 50,000 (L7018) of the Royal Thai Survey Department (1999).
 - Flooding prevention and troubleshooting action plan of Bangkok, 2008 in the responsibilities of Department of Drainage and Sewerage, Bangkok 2009.
 - Bangkok full map (district and subdistrict), scale 1: 70,000 of Bangkok Guide Ltd., Part., 2005.
 - Report on Chao Phraya River basin flood forecast and warning system. Chao Phraya River basin study and installation fo telemetering system for flood forecast and warning submitted to Royal Irrigation Department. Prepared by Water Development Consultant Co.,Ltd., Thai Engineering Consultant Co.,Ltd. and A.M.R Asis Co., Ltd., 2008.
 - A full report of Hydrodynamic Flow Measurement Project conducted by Assoc. Prof. Chukiat Supphaisal et. al., 2004.
- (2) Analysis and assessment of the project development including proposed prevention and mitigation measures and auditing requiriements.

2) Study Results

(1) Surface water sources along the project route

Reviewed and survey the surface water sources system along the project route and nearby areas within a radius of 500 meters found 19 natureral and man-made water sources as follows.

(1.1) Num Kaew Canal (Km.1+100): Concrete lined canal is a branch separated from Lat Phrao Canal a width of 7 to 10 m. used for water drainage and sewerage from the community. Residential is moderate density (ie Phawana community, Prayun Village, Thip Thani Village and Porn Pailin Village etc.) and the commercial/trade areas. Water flow in the canal is relatively slow to very slow with flowing direction into Klong Huay Khwang. Water was turbided. The sediment is blankish brown mud and sand and stinks.

(1.2) Bang Sue Canal (Km.1+830): Dirt canal is a branch separated from Lat Phrao Canal a width of 10 to 15 m. used for water drainage and sewerage from the densely residential community (ie Jittrapa Place Village and Lat Phrao Villa Village etc.) and the commercial/trade areas. Water current quite fast with flowing direction to the west. Water is high turbidity. The sediment is dark blank mud and sand and slightly odor.

(1.3) Lat Phrao Canal (Km.2+150): It is a dirt alternate with concrete lining connected to Klong Saen Saeb a width of 20 to 25 meters, used for water drainage and sewerage area from densely residential communities (such as Yu Charoen village, Jittrapa Place Village etc.) and densely commercial areas. Water current in the canal is slow with flowing direction from north to south. Water is high turbidity. The sediment is blank fine soil and moderately odor.

(1.4) Wat Tuek Canal (Km.4+430): It is a soil canal (under construction the water drainage system), width 3 to 5 meters, used for water drainage and sewerage area from densely residential communities (such as Taweek Suk Niwet village, Nakornphan Town House etc.) and densely commercial areas. Water current in the canal is almost still with flowing direction from north to south. Water is high turbidity. The sediment is dark black fine soil and slightly odor.

(1.5) Chaokhun Sing Canal (Km.5+175): It is a concrete lined canal with 5 to 7 m. in width, used for water drainage and sewerage area from commercial/trade (such as Big C Lat Phrao Department Store, Krung Sri Ayuttaya Bank, Krung Thai Bank etc.), densely residential communities (ie Si Siam Mit Village, Orchid Villa Village and Chokchai 2 Village first phase etc.) Water current is slightly slow with flowing direction from northwest to southeast. Water was turbid. The sediment is dark black mud and sand and relatively strong odor.

(1.6) Chan Canal (Km.7+000): It is a soil alternate with concrete lining canal connected to Klong Ai Sua, Klong Rotbung, and Klong Lam Phang Phuai before drained into Klong Saen Saeb with 10 meters in width, used for water drainage and sewerage area from densely residential communities (such as Yu Charoen village, Prathum Thong Village and Ratchaphong Village etc.) Water current in the canal is slightly slow with flowing direction from north to south. Water is turbid. The sediment is dark black mud and slightly odor.

(1.7) Yai Phuan Canal (Km.8+400): It is a small concrete lined canal receiving water from Klong Ta Nang with 10 m. in width, used for water drainage and sewerage area from residential communities (such as Pin Charoen Village, Chunsuk Village etc.) and important places such as Vejthani Hospital, Phattharabut Kindergarten School etc. Water current is almost still with flowing direction from northwest to southeast. Water was turbid. The sediment is dark black mud and strong odor.

(1.8) Ta Nang Canal (Km.8+900): It is a small concrete lined canal which is a subcanal separated from Klong Lam Phang Phuai with 7 m. in width, used as water drainage and sewerage area from commercial/trade (ie The Mall Bang Kapi Department Store, Tesco Lotus Bang Kapi Department Store etc.) Water current is slightly slow with flowing direction from north to south. Water is high turbidity. The sediment is dark black sand mud and severe odor.

(1.9) Saen Saeb Canal (Km.9+250): It is a main concrete lined canal in draining water into Chao Phraya River with 30 to 40 m. in width, used for water drainage and sewerage area from subcanal (ie Klong Ta Nang, Klong Chan, Klong Yai Phun etc.) and densely commercial/trade and residential communities (ie Preampre Intercondominium Village and Kanya House Village etc.) and important places such as Bang Kapi market, The Mall Bang Kapi Department Store, Bang Kapi Office, Wang Thonglang Clinic and Lat Phrao Police Station etc. Water current is relatively fast with flowing direction from northeast to southwest. Water is high turbidity. The sediment is dark blackish brown mud and not severe odor.

(1.10) Kacha Canal (Km.11+330): It is a concrete lined canal separated from Klong Hua Mak with 10 m. in width, used for water drainage and sewerage area from relatively dense residential communities (ie Wisetsuk Nakorn Village, Seri 3-4 Village, Srinagarindra Mansion, Sirithep Townhouse Village Phase 6 and Skyplace etc.) and important places such as Samitivej Hospital and Chutima Kindergarten School etc. Water current is relatively slow with flowing direction from northwest to southeast. Water is high turbidity. The sediment is dark green mud and slightly odor.

(1.11) Hua Mak Canal (Km.12+100): It is a soil subcanal in draining water into Klong Saen Saeb with 10 to 15 meters in width, used for water drainage and sewerage area from various subcanals (ie Klong Chek, Klong Bung etc.) and moderately dense residential communities (such as Ueasuk Village, The Mansion, Muang Thong Village phase 3, Arunsawad Apartment and Flora Vill Condo etc.) and important places such as Vipa-Ram Hospital, Kor Klang Wellness Center, Hua Mak Train Station, Masjid Darissalam, Dal Islam School and Thetsaban Hua Mak School etc. Water current in the canal is relatively slow with flowing direction from south to north. Water is moderately turbidity. The sediment is brown mud and no odor.

(1.12) Ban Ma Canal (Km.13+800): It is a branch canal of Klong Saen Saeb, used for water drainage. The width is approximately 5-10 meters. Water in the canal is quite dark. It is a sewerage body from the public houses on either side. Water flow is relatively slow. Water is turbidity. The sediment is dark black mud and strongly odor.

(1.13) Prawet Burirom Canal (Km.14+750): A main drainage canala which draining water from east into Chao Phraya River. A length of about 10 km. The width at the passed section is 18 to 20 m. It is the receiving body from subbranch canal and the houses on either side. Water flow is relatively slow. Water is turbidity. The sediment is dark black mud and strongly odor.

(1.14) Pra Kanong Canal (Km.14+950): It is a branch canal of Klong Prawet Burirom with 10 to 15 m. width. The water is quite dark due to receiving wastewater from the houses on either side. Water flow is relatively slow. Water is turbidity. The sediment is dark black mud and strongly odor.

(1.15) Ta Sad Canal (Km.16+270): It is a branch canal connected between Klong Khlet and Klong Nong Bon with 5 to 8 m. width. It is the drainage canal for flooding prevention. Water is quite dark due to receiving wastewater from household. Water flow is relatively slow. Water is turbidity. The sediment is dark black mud and strongly odor.

(1.16) Ta Chang Canal (Km.18+450): It is a branch canal of Klong Nong Bon and connected with Klong Prawet Burirom with 6 to 8 m. width. It is the drainage canal. Water is quite dark and floating debris due to receiving wastewater from household. Water flow is relatively slow. Water is turbidity. The sediment is dark black mud and strongly odor.

(1.17) Khlet Canal (Km.19+950): It is a branch canal of Klong Prawet Burirom with 12 to 15 m. width. used as water drainage. The water is quite dark. Water flow is relatively slow. Water is turbidity. The sediment is dark black mud and strongly odor, floating of Water hyacinth in a canal and grass covered by the bank.

(1.18) Bang Na Canal (Km.21+015): It is a branch canal connected with Chao Phraya River with 8 to 10 m. width. used as water drainage. The water is quite dark due to receiving wastewater from household and sub branch canals.

(1.19) Samrong Canal : It connected Chao Phraya River and Bangpakong River with a length of 55 kilometers. It drains water into Chao Praya River for flooding prevention. Water is rather putrid as it is a receiving body from household either side. Water flow is relatively slow. Water is turbidity. The sediment is dark black mud and strongly odor.

(2) Water drainage and flooding prevention in Bangkok and vicinity

Data collection and reviewed of water drainage and flooding prevention in Bangkok and vicinity from related documents and reports. As Flooding prevention and troubleshooting action plan of Bangkok, 2008 in the responsibilities of Department of Drainage and Sewerage, Bangkok 2009., Report on Chao Phraya River basin flood forecast and warning system. Chao Phraya River basin study and installation fo telemetering system for flood forecast and warning submitted to Royal Irrigation Department. Prepared by Water Development Consultant Co.,Ltd., Thai Engineering Consultant Co.,Ltd. and A.M.R Asis Co., Ltd., 2008 and full report of Hydrodynamic Flow Measurement Project conducted by Assoc. Prof. Chukiat Supphaisal et. al., 2004. Concluded that the Bangkok and vicinity (covered the project route) located in the northeast monsoon and the southwest monsoon zone. The influence of the southwest monsoon cause an average rainfall of 1,400 mm./year and the rain caused by a tropical storm and depression swept into the project area annually. The rain in a short Phase can cause temporary flooded in several areas. With the physical characteristics of Bangkok and vicinity has changed significantly from the past, especially the rapid expansion of the urban community and The use of land with not appropriate with the topography, such as reclamation for the construction of commercial buildings/offices and poaching to public canal etc., and various factors that affect in reduction of water supply way in size and number. The old drainage system has no capacity to support an urban expansion. The land subsidence problem due to unlimited groundwater pumping causing Bangkok and vicinity area which are lowland sinking when flooded.

(2.1) Maximum water level in Chao Phraya River in the Past

- In 1995, the water level is +2.27 m. (MSL) at Phra Buddha Yod Fa Chula Lok Bridge.
- In 2011 the water level is +2.48 m. (MSL) at Phra Buddha Yod Fa Chula Lok Bridge.

(2.2) The level of dyke along Chao Pro Ya River is controlled by the water level of Chao Pro Ya River as follows:

Chao Phraya River		Water level at MSL (m.)
Northern Bangkok	at Bang Khen Canal and Khlong Bang Sue	+ 2.50
Central Bangkok	at Phra Phuttha Yodfa Bridge (Memorial Bridge)	+ 2.30
Southern Bangkok	at Phra Khanong Canal and Bang Na Canal	+ 1.90

(2.3) Bangkok water drainage system construction in the area of the Bangkok Mass Transit Yellow Line Project : Lat Phrao - Samrong

Bangkok has construction project plans for flooding protection and drainage system in Bangkok areas to help drain water in an enclosed area. For the parts related to the Bangkok Mass Transit Yellow Line Project : Lat Phrao - Samrong which will affect the alignment of the route as below.

- Suan Luang Ro 9 Giant Tunnel Project, as shown in **Figure 4.3.4 - 1** diameter of 5.00 m. crossed Srinagarindra Road. The landscape design was completed now under further budgeting. Construction is expected to be in the year 2012 to 2016.
- Solving the flooded critical in Lat Phrao Road Project, as shown in **Figure 4.3.4 - 2.**
- Solving the flooded critical in Srinagarindra Road Project, as shown in **Figure 4.3.4- 3.**



Figure 4.3.4 - 1 The Suan Luang Ro 9 giant tunnel construction project



Figure 4.3.4 - 2 Flood control on Lat Phrao road project



Figure 4.3.4 - 3 : Flood control on Srinagarindra road project

4.4 Quality of Life Value

4.4.1 Socio-Economics

1) Methodology

- (1) study Secondary data and collect from related reports and documents.
- (2) Field survey for information collect information on community physical in the project area.
- (3) Sample Survey to collect the households socio-economic data including the attitudes and opinions to the of people with directly affected by the project development and people in the nearby area of project route.
- (4) assessment Impact of the project development including proposed prevention and mitigation measures and auditing requiriements.

2) Study Results

2.1) Secondary Data Collection and Analysis

(1) Administrative district

The data verification of the Bangkok Mass Transit Yellow Line Project : Lat Phrao-Samrong Section, it is a monorail transit passed through 2 provihces (Bangkok and Samut Prakran province). The project route starts from the linked of Bangkok MRT Chaloem Ratchamongkhon project at Ratchada - Lat Phrao Junction, located in Chatuchak. The route will lay along Lat Phrao Road until Bang Kapi Junction passed Huay Khwang, Wang Thonglang, Bang Kapi, then lay along Srinagarindra Road passed Suan Luang, Prawet until Si Thepha Junction, the route then lay along Thepharak Road passed Bang Na and ended at Thepharak – Sukhumvit Intersection in the area of Samrong Nua subdistrict, Muang Samut Prakan district, Samut Prakran province. The total distance of approximately 30 km with 23 stations, one depot, one park and ride buildings at an empty space of Si lam Interchange.

(2) Population

Collection and analysis of population data from Department of Provincial Administration, Ministry of Interior, which are collected and listed on the website www.dopa.go.th. The collection and study results of Bangkok and Samut Prakran province, December 2012 found that the population in district level that the routes passed , as shown in **Table 4.4.1 - 1**. The total population is 980,163 whereas 457,554 are male (46.68%) and 522,609 are female, or 53.32% when calculating of the density of population. Found that the average population density in Bangkok metropolitan area was 4,595.80 people per square kilometer and 553.44 people per square kilometer in Muang Samut Prakarn district. With a total of 528,809 households with average size was 1.85 people per household. This is a small household.

Table 4.4.1 - 1 Population Number, Population Density, Household Number and Household Size in Study Area

Province/District	Population number			Area (km ²)	Population Density (person/km ²)	Household Number (Unit)	Household Size (person/household)
	Male	Female	Total				
Bangkok Metropolitan Administration							
1. Chatuchak District	75,637	85,216	160,853	32.908	4,887.96	94,442	1.70
2. Huai Khwang District	35,884	42,323	78,207	15.033	5,202.35	55,133	1.42
3. Wang Thonglang District	52,758	61,990	114,748	18.905	6,069.72	55,960	2.05
4. Bang Kapi District	67,729	80,762	148,491	28.523	5,206.01	92,013	1.61
5. Suan Luang District	53,828	61,903	115,731	23.678	4,887.70	57,563	2.01
6. Prawet District	76,182	84,634	160,816	52.490	3,063.75	72,210	2.23
7. Bang Na District	45,248	50,607	95,855	18.789	5,101.66	55,043	1.74
Sub - total	407,266	467,435	874,701	190.326	4,595.80	482,364	1.81
Samut Prakran Province							
1. Mueang District	50,288	55,174	105,462	190.557	553.44	46,445	2.27
Sub - total	50,288	55,174	105,462	190.557	553.44	46,445	2.27
Grand total	457,554	522,609	980,163	380.883	2,573	528,809	1.85
Percentage (%)	46.68	53.32					

Source : Department of Provincial Administration, 2012.

2.2) Survey on Socio-Economic and opinions of public

(1) Target Population

The Bangkok Mass Transit Yellow Line Project : Lat Phrao-Samrong start at Ratchada Station to Samrong Station. It is a Straddle Monorail which elevated structure above traffic island the entire route. A distance of about 30 km. with 23 train stations, one park and ride building, one depot located near Si lam Station in the area of Srinagarindra - Bang Na – Trat Intersection. Some section of the route has to adjust for an engineering suitability. The study framework on socio-economic and opinion of public covered households and enterprises in the

nearby area of the construction sites and expected households/enterprises to be affected by the expropriation and relocation for the project construction.

- Group 1: A group of households/enterprises that are near or next to the project area emphasized on the owners or tenants of the building/land in the construction area of 23 stations and the surrounding area in the radius of 100 meters along the route of the Bangkok Mass Transit Yellow Line Project : Lat Phrao - Samrong, which is expected to be affected by the project construction activities. From counting the aerial photographs of recent years, 2007 and field survey found 1,401 households. Building in the project area (surrounding area of the station with in 100 meters) of The Bangkok Mass Transit Yellow Line Project : Lat Phrao - Samrong, as shown in **Table 4.4.1 - 2**.

Table 4.4.1 – 2 Number of building in Mass Transit Yellow Line Project study area and its vicinity (radius 100 meters from each station)

No.	Station/Area	Building in study area (Number)
1	YL - 01 : Ratchada station	38
2	YL - 02 : Phawana station	79
3	YL - 03 : Chok Chai 4 station	128
4	YL - 04 : Lat Phrao 71 station	45
5	YL - 05 : Lat Phrao 83 station	56
6	YL - 06 : Mahat Thai station	53
7	YL - 07 : Lat Phrao 101 station	76
8	YL - 08 : Bang Kapi station	111
9	YL - 09 : Lam Sali station	117
10	YL - 10 : Si Kritha station	31
11	YL - 11 : Phatthanakan station	45
12	YL - 12 : Kalantan station	30
13	YL - 13 : Si Nut station	63
14	YL - 14 : Srinagarindra 38 station	38
15	YL - 15 : Suan Luang Ro 9 station	35
16	YL - 16 : Si Udom station	43
17	YL - 17 : Si lam station	15
18	YL - 18 : Si La Salle station	39
19	YL - 19 : Si Bearing station	84
20	YL - 20 : Si Dan station	63
21	YL - 21 : Si Thepha station	65
22	YL - 22 : Thippawan station	57
23	YL - 23 : Samrong station	90
Total		1,401

Source : Field survey by Asian Engineering Consultants Corporation Limited, 2013.

- Group 2: A group of households/enterprises with building/constructs in the areas project construction, which is expected to have a direct impact from the project

construction. The field survey data found 158 constructs which is 104 residential buildings, 46 houses, and one condominium, the less are 3 abandoned buildings, one abandoned warehouse, 2 billboards and one lavatory are shown in **Table 4.4.1 - 3**, therefore, assumes that households and enterprises in a study area of 151 household/individual.

Table 4.4.1 - 3 Number of building in Right of Ways (ROW.) of Mass Transit Yellow Line Project

No.	Station/Area	Building in ROW. of Mass Transit Yellow Line Project (Number)
1	YL - 01 : Ratchada station	3
2	YL - 02 : Phawana station	6
3	YL - 03 : Chok Chai 4 station	11
4	YL - 04 : Lat Phrao 71 station	12
5	YL - 05 : Lat Phrao 83 station	1
6	YL - 06 : Mahat Thai station	1
7	YL - 07 : Lat Phrao 101 station	14
8	YL - 08 : Bang Kapi station	7
9	YL - 09 : Lam Sali station	5
10	YL - 10 : Si Kritha station	2
11	YL - 11 : Phatthanakan station	5
12	YL - 12 : Kalantan station	11
13	YL - 13 : Si Nut station	7
14	YL - 14 : Srinagarindra 38 station	8
15	YL - 15 : Suan Luang Ro 9 station	6
16	YL - 16 : Si Udom station	1
17	YL - 17 : Si lam station	1
18	YL - 18 : Si La Salle station	3
19	YL - 19 : Si Bearing station	10
20	YL - 20 : Si Dan station	11
21	YL - 21 : Si Thepha station	3
22	YL - 22 : Thippawan station	6
23	YL - 23 : Samrong station	3
24	Modify project route from Suan Luang station to Si Udom intersection	1
25	Modify project route from Si Udom station intersection to Si lam station interchange	1
26	Si Thepha station	0
27	Extension project route in the future (Samrong station)	2
28	Depot	17
Total		158

Source : Field survey by Asian Engineering Consultants Corporation Limited, 2013.

(2) Sample Size and Method

The data collection by interviewing with all the head of household/owner of the enterprise or representatives in the project area. Both nearby area and the directly affected group as a volunteer to answer the survey, with the number of samples collected as below.

(2.1) Groups that are near or next to the project area. (The area around the station, with in 100 meters) is expected to be indirectly affected by the construction project, which amounted to 1,401 household/individual with 1,169 respondents, or 83.44%.

(2.2) Groups that are directly affected (directly affected from expropriation), which amounted to 151 household/individual with 111 respondents, or 73.51%.

(3) Data Collection Tool

The tool used for data collection was a questionnaire (sample questionnaire shown in **Appendix 4I**), with 2 sets of the questionnaire as set 1 used to collect data from households near or next to the project construction area, and set 2 used to collect data from households in the area expected to be affected. Each set has the issues as follow.

Set 1: Questionnaire for households/enterprise near or next to the construction site, which the issue as below.

- General information ie sex, age, education
- Social and living conditions, use of the building and possession right of the building.
- Perception about the project
- Opinions on the project construction, advantages from the project, disadvantages during construction phase, perception on the impact of project construction.

Set 2: Questionnaire for households/enterprise in the construction site, expected to be directly affected by the project, which the issue as below.

- General information ie sex, age, education
- Social and living conditions, occupation, type of building, land/building use, land/resident right.
- Perception about the project
- Opinion on advantages and impact from the project construction
- Opinion on mitigation measures
- Opinion and recommendation on project construction

(4) Field Survey

The study was conducted a survey of households/enterprises that are near or next to the project area (approximately 100 meters in radius), which is expected to be indirectly affected by the project construction, during 24 to 26 July 2013 and to collect information from households/enterprises in the area are expected to be directly affected by the expropriation was conducted between 26 to 27 October, 2013.

(5) Analysis

The study was conducted data analysis by coding the data then recorded and check the accuracy of all information code. Then analyzed data by a computer program. The statistical analysis used in the study were the percentage and average.

(6) Result on Survey Data and Analysis

(6.1) Group of households and enterprises near or next to the project construction

The study was conducted field surveys during 24 to 26 July 2013, with 1,169 samples. Study Result and analysis are summarized below.

(1) Socio-Economic, Building Utilisation and Possession Right

Economic conditions of areas adjacent to the route of the Yellow Line Mass Transit Project (Lat Phrao – Samrong section) were trading zone. Most of the buildings along the road were commercial buildings which transformed from commercial or tenement building. It was a combined housing. Currently the building is use only for commercial, office buildings, shopping malls large retailers and markets.

An interview with the 1,169 residencies/buildings possessors nearby the route of Yellow Line Mass Transit Project (Lat Phrao – Samrong section). Found that most of the building use for a merchant with 50.13% use for only the merchant and 36.44% use as residential and merchant. The remaining 13.09% is residential only and 0.34% use as office buildings and government facilities. And when to ask the possession right of the buildings found that more than half of the possessors were tenants (53.38%). The remaining 46.62% was the owner. The use and possession of the building near the route of Yellow Line Mass Transit Project (Lat Phrao – Samrong section), as shown in **Table 4.4.1 - 4**.

(2) Perception about the Project

From the interview on perception about the project. Found that 54.83% of interviewee had been informed about the Yellow Line Mass Transit Project (Lat Phrao – Samrong section). The remaining 45.17% answered that they had not received information about the project. By those who had been informed of the information came from sources more than one source, namely television 81.44%, newspapers 36.66%, neighboring 22.62%, internet 18.10%, billboards 10.76%, radio 9.83% and project officers 2.96%. The perception about the construction of the Yellow Line Mass Transit (Lat Phrao - Samrong section), as shown in **Table 4.4.1 - 5**.

(3) Opinion on Yellow Line Mass Transit Project

(3.1) Attitude on Advantages or Positive impact of the Project

The opinion on the advantage or positive impact from the Yellow Line Mass Transit Project in 5 issues as 1. Yellow Line Mass Transit is one of the important travelling alternative, 2. Yellow Line Mass Transit will be the long term remedial option on traffic jams, 3. This project will support the better transportation, 4. save time and expense of traveling and 5. It is good to have a Yellow Line Mass Transit project. An overall of the data collection and analysis found major or most of the interviewees have a positive attitude towards the project, with the high ratio of those who agree and totally agree on the benefits in all issues as shown in **Table 4.4.1 - 6** Percentage breakdown of each issue as follows.

Table 4.4.1 - 4 Property rights and use of buildings near Mass Transit Yellow Line Project route

Property rights and use of buildings	Number	Percentage
Number of sample	1,169	100
1. Use of buildings		
- Residential area	153	13.09
- Commercial area	586	50.13
- Residential and commercial area	426	36.44
- Office/Enterprise/Government institute	4	0.34
2. Buildings property rights		
- Owner	545	46.62
- Rent	624	53.38

Source : Data from interview target groups in study area during 24 – 26 July, 2013.

Table 4.4.1 - 5 Obtaining Mass Transit Yellow Line Project information

Obtaining Mass Transit Yellow Line Project information	Number	Percentage
Number of sample	1,169	100
1. Never	528	45.17
2. Ever	641	54.83
Source (can answer more than 1 source)		
- Newspaper	235	36.66
- Radio	63	9.83
- Television	522	81.44
- Billboards	69	10.76
- Internet	116	18.10
- Neighborhood	145	22.62
- Project staffs	19	2.96

Source : Data from interview target groups in study area during 24 – 26 July, 2013.

a) **Yellow Line Mass Transit is one of the important travelling alternatives:** There are those who agree and totally agree on this point with 40.38% and 47.13%, respectively, while those who disagree and strongly disagree with 1.88% and 1.28%, respectively.

b) **Yellow Line Mass Transit will be the long term remedial option on traffic jams:** There are those who agree and totally agree on this point with 35.93% and 46.71%, respectively, while those who disagree and strongly disagree with 2.74% and 1.20%, respectively.

Table 4.4.1 - 6 Opinion on Mass Transit Yellow Line Project Lat Phrao – Samrong

Opinion on Yellow Line Mass Transit Project	Opinion							
	Strongly disagree		Disagree		uncertained/ not bothered		Agree	
	Number	%	Number	%	Number	%	Number	%
<u>Attitude on advantage or positive impact of the project</u>								
1. Yellow Line Mass Transit is one of the important travelling alternatives	15	1.28	22	1.88	109	9.32	472	40.38
2. Yellow Line Mass Transit will be the long term remedial option on traffic jams	14	1.20	32	2.74	157	13.43	420	35.93
3. This project will support the better transportation	12	1.03	19	1.63	101	8.64	419	25.84
4. Save time and travelling expenses	12	1.03	28	2.40	184	15.74	399	34.13
5. It is good to have a Yellow Line Mass Transit project	17	1.45	29	2.48	115	9.84	468	40.03
<u>Opinions on negative impact in the project construction phase</u>								
6. The traffic will be more jam during the construction period	15	1.28	17	1.45	130	11.12	358	30.62
7. Declining in sale balance in the construction phase	21	1.80	49	4.19	284	24.29	358	30.62
8. Noise from the construction activity will disturb nearby residents	13	1.11	34	2.91	177	15.14	459	39.26
<u>Opinions on implementation of the Yellow Line Mass Transit Project</u>								
9. Perception on any inconvenient impact occurring during the project construction phase	13	1.11	38	3.25	179	15.31	519	44.40
10. Land compensation with the market trading price plus the opportunity cost to the business	15	1.28	36	3.08	170	14.54	363	31.05
11. Confidence in the environmental impact management standard of the MRTA	19	1.63	40	3.42	315	26.95	456	39.01
12. Attitudes toward the Yellow Line Mass Transit	19	1.63	34	2.91	157	13.43	504	43.11
13. Requirement for quick construction the Yellow Line Mass Transit Project	22	1.88	29	2.48	178	15.23	462	39.52

Source : Data from interview target groups in study area during 26 – 27 October, 2013.

c) This project will support the better transportation:

There are those who agree and totally agree on this point with 35.84% and 52.87%, respectively, while those who disagree and strongly disagree with 1.63% and 1.03%, respectively.

d) Save time and travelling expenses:

There are those who agree and totally agree on this point with 34.13% and 46.71%, respectively, while those who disagree and strongly disagree with 2.40% and 1.03%, respectively.

e) It is good to have The Yellow Line Mass Transit

Project: There are those who agree and totally agree on this point with 40.03% and 46.19%, respectively, while those who disagree and strongly disagree with 2.48% and 1.45%, respectively.

(3.2) Opinions on negative impact in the project construction phase

The opinion on the negative impacts or problems occurred during the construction phase of Yellow Line Mass Transit Project in 3 issues: 1. The traffic will be more jam during the construction Phase, 2. Declining in sale balance in the construction phase, and 3. Noise from the construction activity will disturb nearby residents. Found that majority interviewees agree and totally agree towards the problems or impacts. As shown in **Table 4.4.1 - 4**, which have to aware of the impacts and provide effective mitigation measures. The comment enumeration in each point below.

a) The traffic will be more jam during the construction

Phase: There are those who agree and totally agree on this point with 30.62% and 55.52%, respectively, while those who disagree and strongly disagree with 1.45% and 1.28%, respectively.

b) Declining in sale balance in the construction phase:

There are those who agree and totally agree on this point with 30.62% and 39.09%, respectively, while those who disagree and strongly disagree with 4.19% and 1.08%, respectively.

c) Noise from the construction activities will disturb

nearby residents: There are those who agree and totally agree on this point with 39.26% and 41.57%, respectively, while those who disagree and strongly disagree with 2.91% and 1.11%, respectively.

(3.3) Opinions on implementation of the Yellow Line Mass Transit Project

In the construction and development of the Yellow Line Mass Transit Project could benefits or positive impacts significantly. On the other hand, it was expected to cause a negative impact on those who reside or having business in the nearby, especially during the construction phase. An interview with people nearby project area on the perception about the project, confidential on environmental impact management standard, including attitude and requirement to the project construction. The results of opinion polls on various issues can be described as follows.

a) Perception on any inconvenient impact occurring

during the construction phase: The majority of respondents which accounted for 80.33% accepted to the impacts that going to happen, with just a 4.36% reject, or not accepted, and 15.31% was uncertained.

b) Land compensation with the market trading price

plus the opportunity cost to the business: There are those who agree and totally agree on this

point with 31.05% and 50.04%, respectively, while those who disagree and strongly disagree with 3.08% and 1.28%, respectively. 14.54% was uncertained/not bothered.

c) Confidence in the environmental impact management standard of the MRTA: The majority of respondents which accounted for 68.01% feeling confident, while 26.95% answer uncertained and the less 5.05% feeling unconfident.

d) Attitudes toward the Yellow Line Mass Transit: In overall it appears that there are those who agree with the Yellow Line Mass Transit Project with the relatively high proportion of 43.11% and 29.00% totally agree. For those who disagree, and strongly disagree was low proportion in the range of 2.91% and 1.63%, respectively, while the remaining 13.43% was uncertained/not bothered.

e) Requirement for quick construction the Yellow Line Mass Transit Project: 39.52% and 40.89% agree and strongly for the quick construction the Yellow Line Mass Transit Project, 15.23% uncertained/not bothered. For those who disagree and strongly disagree with only a small proportion. In the range of 2.48% and 1.88% only.

(6.2) Households and enterprises in the area which expected to be directly affected

The information collection was conducted from those who are expected to be directly affected between 26 to 27 October 2013, with a total of 111 number of collected and analyzed samples out of 151 cases, or as 73.51%. Study analysis results are summarized below.

(1) Socio-Economic, building use and possession right

Most respondents (76.58%) were self-employed or trading. The remaining 19.82% were private employees and government/state enterprises officials and housewife/housemaker in equal proportion at 1.80% as shown in **Table 4.4.1 - 7**. The majority of relocated buildings/structures were tenement buildings/commercial buildings (75.68%), office buildings of 10.81% and single houses/Townhouses 8.11%, the remaining were dormitories, rental rooms, gas stations and condominiums.

In terms of land and buildings use found that it was used for residential and trader of 65.77%, secondary was trading and office only as of 24.32% and was used as residential only 9.91%, causing living/working in the building for over 10 years, as shown in **Table 4.4.1 - 7**.

(2) Perception about the project

From the perception about the project. Found that most of the respondents (78.38%) had been informed about the Yellow Line Mass Transit Project. The remaining 21.62% stated that they had not received information about the project. By those who had been informed of the information came from sources more than one source, namely project officers (41.38%), neighboring (40.23%), newspapers (32.18%), internet (27.59%), television (24.14%), billboards (11.49%) and radio (2.30%), as shown in **Table 4.4.1 - 8**.

Table 4.4.1 - 7 Occupations, use of buildings and buildings property rights in construction area of Mass Transit Yellow Line Project

Items	Number	Percentage
Number of Sample	111	100.00
1. Occupations		
- Business / Retail store	85	76.58
- Government Officer / Enterprise Officer	2	1.80
- Employees	22	19.82
- Housewife	2	1.80
2. Characteristics of Houses/Office Buildings/Offices		
- Commercial Building	84	75.68
- House / Townhouse	9	8.11
- Condominium	1	0.90
- Office buildings	12	10.81
- Dormitory/Apartment	3	2.70
- Gas station	2	1.80
3. Use of Land/Buildings		
- Residential area	11	9.91
- Commercial area	27	24.32
- Residential and commercial area	73	65.77
4. Land/Buildings Property Rights		
- Owner	92	82.88
- Rent	19	17.12
5. Duration of live/work in Buildings		
- < 1 year	3	2.70
- 1-5 years	6	5.41
- 6-10 years	9	8.11
- > 10 years	93	83.78

Source : Data from interview target groups in study area during 26 – 27 October, 2013.

Table 4.4.1 - 8 Obtaining construction of Mass Transit Yellow Line Project information

Obtaining Mass Transit Yellow Line Project information		Number	Percentage
Number of Sample		111	100.00
1	Never	24	21.62
2	Ever	87	78.38
<u>Sources</u> (can answer more than 1 source)			
*	Newspaper	28	32.18
*	Radio	2	2.30
*	Television	21	24.14
*	Billboards	10	11.49
*	Internet	24	27.59
*	Neighborhood	35	40.23
*	Project staffs	36	41.38

Source : Data from interview target groups in study area during 26 – 27 October, 2013.

(3) Opinions on Yellow Line Mass Transit Project (Lat Phrao – Samrong section)

The survey of households/enterprises expected to be directly affected by the project in the opinions on the Yellow Line Mass Transit Project (Lat Phrao – Samrong section). Data survey and analysis as shown in **Table 4.4.1 - 9** are summarized below.

- 93.69% thought that the Yellow Line Mass Transit Project route was appropriate.
- 75.65% thought that the station location of the Yellow Line Mass Transit Project was appropriate.
- 89.19% thought that the station design of the Yellow Line Mass Transit Project was appropriate.
- 89.19% thought that the construction design as Straddle Monorail of the Yellow Line Mass Transit Project was appropriate.
- 90.99% thought that the park and ride building of the Yellow Line Mass Transit Project was appropriate.
- 93.69% thought that the depot of the Yellow Line Mass Transit Project was appropriate.
- 93.69% thought that the linkage with other Line Mass Transit Projects or another mass transit system of the Yellow Line Mass Transit Project was appropriate.

Table 4.4.1 - 9 Opinion on Mass Transit Yellow Line Project Lat Phrao - Samrong

Opinion on Mass Transit Yellow Line Project	Number	Percentage
Number of sample	111	100.00
1. Project route		
- Suitability	104	93.69
- Unsuitability	7	6.31
2. Location of station		
- Suitability	84	75.68
- Unsuitability	27	24.32
3. Pattern of station		
- Suitability	99	89.19
- Unsuitability	12	10.81
4. The Mass Transit Yellow Line Project is monorail system		
- Suitability	99	89.19
- Unsuitability	12	10.81
5. Park and Ride Buildings		
- Suitability	101	90.99
- Unsuitability	10	9.01
6. Depot		
- Suitability	104	93.69
- Unsuitability	7	6.31
7. Other transportation connection (Mass rapid transit/Skytrain/Subway)		
- Suitability	104	93.69
- Unsuitability	7	6.31

Source : Data from interview target groups in study area during 26 – 27 October, 2013.

(4) Opinions of mitigation measures of the Yellow Line Mass Transit Project (Lat Phrao – Samrong section)

The opinion of those who are expected to be directly affected on the dissemination of mitigation measures of the project and suitability of the mitigation measures for the expected impact that arise from the project construction phase. Detailed shown in **Table 4.4.1 - 10**, which explained as follows.

Table 4.4.1 - 10 Opinion on Environmental Mitigation Measures of Mass Transit Yellow Line Project

Opinion on Environmental Mitigation Measures	Opinion result			
	Suitability		Not enough	
	Number	%	Number	%
1. Opinions on the Information of Mitigation Measures				
1. Coordinated or informed about the project to the people residing or working in the project construction area	62	55.86	49	44.14
2. Press release in advance on the impact or inconvenience that may be obtained from the construction of the project	62	55.86	49	44.14
3. Inform of the mitigation measures of construction projects	71	63.96	40	36.04
4. Public notification that people can complaint if affected by the project construction at project complaint center	62	55.86	49	44.14
5. Provide clarity in case of extenuating circumstances or unusual events from the construction	65	58.56	46	41.44
2. Opinions on Dust Mitigation Measures resulting from land leveling, materials piles, and Transportation.				
1. Spray water around the open space to reduce the diffusing of dust	94	84.68	17	15.32
2. Cover material piles to reduce the dust	97	87.39	14	12.61
3. Washing the dirt from the car and the wheels before leaving the construction area	98	88.29	13	11.71
4. Install a thick fence at least 2 meters high to prevent the dust from the construction area	94	84.68	17	15.32
5. Control vehicle speed inside the construction area to prevent dust diffusion	92	82.88	18	16.22
3. Opinions on Noise Mitigation Measures from construction activities				
1. Limit the working hour to control noise impact to nearby communities	91	81.98	20	18.02
2. No construction and loud noise activities after 22:00 hrs.	90	81.08	21	18.92
3. Check engine regularly to prevent loud noise	98	88.29	13	11.71
4. Opinions on Vibration mitigation measures from construction activities				
1. Set the construction activities that may cause a vibration to be in the daytime from 7:00 am. to 6:00 pm.	96	86.49	15	13.51
2. Energy reduction in drilling, bumping, hammering poles <i>Ixora chinensis</i> Lamk. <i>Ixora</i> spp. activities in the sensitive areas, such as hospitals, schools, temples etc.	98	88.29	13	11.71
3. Limit the trucks speed in the construction area to reduce the vibration	97	87.39	14	12.61
5. Opinions on traffic mitigation measures				
1. Traffic plan to inform the avoided route and shortcuts as an alternative	93	83.78	18	16.22
2. Promote to use bypass	91	81.98	20	18.02
3. Provide traffic concierge	92	82.88	19	17.12
4. Install clearly signs, lightings and traffic signals to facilitate travel	96	86.49	15	13.51

Table 4.4.1 - 10 Opinion on environmental mitigation measures of Mass Transit Yellow Line Project (Cont'd).

Opinion on environmental mitigation measures	Opinion result			
	Suitability		Not enough	
	Number	%	Number	%
6. Opinions on water drainage Mitigation Measures				
1. Provide temporary drainage systems to reduce water drainage problems	96	86.49	15	13.51
2. Cleaning in construction areas to avoid clogging problems	99	89.19	12	10.81
3. Requiring contractors to care monitor and prevent sediment and debris from construction to clog up the passage	97	87.39	14	12.61

Source : Data from interview target groups in study area during 26 – 27 October, 2013.

(4.1) Opinions on the information of mitigation measures

- Coordinat or inform about the project to the people residing or working in the project construction area, 55.86% thought appropriate and 44.14% thought, that is not enough.
- Press release inadvance on the impact or inconvenience that may be obtained from the construction of the project 55.86% thought appropriate and 44.14% thought that is not enough.
- Inform of the mitigation measures of construction projects that 63.96% thought appropriate and 36.04% thought that is not enough.
- Public notification that people can complaint if affected by the project construction at project complaint center, 55.86% thought appropriate and 44.14% thought that is not enough.
- Provide clarity in case of extenuating circumstances or unusual events from the construction, 55.86% thought appropriate and 44.14% thought that is not enough.

(4.2) Opinions on dust Mitigation Measures resulting from Land Leveling, Materials Piles, and Transportation.

- Spray water around the open space to reduce the diffusing of dust, 84.68% thought appropriate and 15.32% thought that is not enough.
- Cover material piles to reduce the dust, 87.39% thought appropriate and 12.61% thought that is not enough.
- Wash the dirt from the car and the wheels before leaving the construction area, 88.29% thought appropriate and 11.71% thought that is not enough.
- Install a thick fence at least 2 meters high to prevent the dust from the construction area, 84.68% thought appropriate and 15.32% thought that is not enough.
- Control vehicle speed inside the construction area to prevent dust diffusion, 82.88% thought appropriate and 16.22% thought that is not enough.

(4.3) Opinions on Noise Mitigation Measures from construction activities

- Limit the working hour to control noise impact to nearby communities, 81.98% thought appropriate and 18.02% thought that is not enough.
- No construction and loud noise activities after 22:00 hrs., 81.08% thought appropriate and 18.92% thought that is not enough.
- Check engine regularly to prevent loud noise, 88.29% thought appropriate and 11.71% thought that is not enough.

(4.4) Opinions on Vibration Mitigation Measures from construction activities

- Set the construction activities that may cause a vibration to be in the daytime from 7:00 am. to 6:00 pm., 86.49% thought appropriate and 13.51% thought that is not enough.
- Energy reduction in drilling, bumping, hammering poles *Ixora chinensis* Lamk. *Ixora* spp. activities in the sensitive areas, such as hospitals, schools, temples etc., 88.29% thought appropriate and 11.71% thought that is not enough.
- Limit the trucks speed in the construction area to reduce the vibration, 87.39% thought appropriate and 12.61% thought that is not enough.

(4.5) Opinions on Traffic Mitigation Measures

- Traffic plan to inform the avoided route and shortcuts as an alternative, 83.78% thought appropriate and 16.22% thought that is not enough.
- Promote to use bypass, 81.98% thought appropriate and 18.02% thought that is not enough.
- Provide traffic concierge, 82.88% thought appropriate and 17.12% thought that is not enough.
- Install clearly signs, lightings and traffic signals to facilitate travel, 86.49% thought appropriate and 13.51% thought that is not enough.

(4.6) Opinions on Water Drainage Mitigation Measures

- Provide temporary drainage systems to reduce water drainage problems, 86.49% thought appropriate and 13.51% thought that is not enough.
- Clean in construction areas to avoid clogging problems, 89.19% thought appropriate and 10.81% thought that is not enough.
- Requiring contractors to care monitor and prevent sediment and debris from construction to clog up the passage, 87.39% thought appropriate and 12.61% thought that is not enough.

(5) Recommendation on mitigation measures from the construction of the Yellow Line Mass Transit Project

Respondents provided additional recommendations on mitigation measures from the construction of the Bangkok Mass Transit Yellow Line Project : Lat Phrao-Samrong Section, as shown in **Table 4.4.1 - 11** are summarized below.

- Additional mitigation measures in case the station fronting the shop and shaded views.
- Should have the assistance measures for those who get the negative business impacts from the project.
- Strictly follow the mitigation measures.
- Minimum expropriation.
- Should educate the people about air and noise pollution from the project.
- Should set enough distance between the station and the building.
- During construction phase should have controlling measures on materials transportation.
- Should be MRT
- During the construction phase should have the flood protection measures, particularly along Lat Phrao Road.
- Should inform public if cutting water pipeline or electricity.
- Mitigation measures on relocation of water supply pipeline.
- During construction should have nighttime lighting system.
- Mitigation measures in case of cracking of the house from the construction.
- Set one way traffic.
- Start the construction as soon.

(6) Opinions on the Bangkok Mass Transit Yellow Line Project : Lat Phrao-Samrong Section

The respondents of households expected to be directly affected by the project on opinions to the Yellow Line Mass Transit Project (Lat Phrao – Samrong section) found that the majority (74.77%) agreed with the construction project, disagree with 18.92% and 6.31% no comment.

Most who were agree did not provide the reasons, however, there are some reasons to consider, such as reducing traffic congestion, increase travelling convenience, Town civilization, better development, reduction in fuel use, better environmental, decrease global warming. While the reasons of disagrees were payment of expropriation may be unfair, disagree with the monorail system should be MRT, could not do business during the construction and direct impact, criteria for choosing the Entrance - Exit of the station inappropriate.

the station location inappropriate, impact on the occupation and residential and Mass Transit Structure shaded the views on Lat Phrao Road make it was not beautiful as shown in Table 4.4.1 - 12.

Table 4.4.1-11 Suggestion on Environmental Mitigation Measures of Mass Transit Yellow Line Project

Suggestion on environmental mitigation measures	Number	Percentage
Number of sample	111	100.00
1. No suggestion	62	55.86
2. Suggestion (can answer more than 1 mitigation measure)	49	44.14
* Strictly follow the mitigation measures.	9	18.37
* During construction phase should have controlling measures on materials transportation.	4	8.16
* Should inform public if cutting water pipeline or electricity.	1	2.04
* Mitigation measures on relocation of water supply pipeline.	1	2.04
* Should set enough distance between the station and the building.	5	10.20
* During construction should have nighttime lighting system.	1	2.04
* Should educate the people about air and noise pollution from the project.	7	14.29
* During the construction phase should have the flood protection measures, particularly along Lat Phrao Road.	2	4.08
* Additional mitigation measures in case the station fronting the shop and shaded views.	13	26.53
* Mitigation measures incase of cracking of the house from the construction.	1	2.04
* Minimum expropriation.	8	16.33
* Should have the assistance measures for those who get the negative business impacts from the project.	13	26.53
* Should be MRT	4	8.16
* Set oneway traffic.	1	2.04
* Start the construction as soon	1	2.04

Source : Data from interview target groups in study area during 26 – 27 October, 2013.

Table 4.4.1 - 12 Summary Opinions on Mass Transit Yellow Line Project Lat Phrao – Samrong Section

Opinion on Mass Transit Yellow Line Project Lat Phrao – Samrong Section	รวม	
	จำนวน	ร้อยละ
Number of sample	111	100.00
1. Agree	83	74.77
2. Disagree	21	18.92
3. No opinion	7	6.31
<u>Agree reasons</u> (can answer more than 1 reason)		
* No reason	62	74.70
* Reduce traffic on the road	7	8.43
* Should be clear about station area	6	7.23
* Comfortable to travel	4	4.82
* Solve traffic problem on the road	3	3.61
* Should be clear about expropriation i.e. land, buildings	2	2.41
* Growth and well improvement of city	2	2.41
* Reduce fossil fuel consume for better environment, reduce global warming	1	1.20
<u>Disagree reasons</u> (can answer more than 1 reason)		
* No reason	2	9.52
* Effect to Livelihood and residential area	2	9.52
* The expropriation rate may be unfair	5	23.81
* Monorail is not suitable train but should be underground train. It has directly affected to trade during construction project.	5	23.81
* Criteria for entrance and exit station is not suitability.	4	19.05
* The location of stations are not suitability.	3	14.29
* Visual impact on Lat Phrao road from monorail structures	1	4.76

Source : Data from interview target groups in study area during 26 – 27 October, 2013.

4.4.2 Property compensation

1) Methodology

(1) Data collection and validation on the number, type, and condition of buildings. As well as land and property in the project construction area which is expected to be directly affected by the project.

(2) Data collection on the evaluation of assets, land, building in the project construction area.

(3) Land and property replacement cost valuation which expected to be affected by the project development.

(4) Make appropriate recommendations on compensation for the public. As well as the loss of public interest due to project construction and development.

(5) Formulate measures and action plans to mitigate the expropriation and migration impact.

2) Study Results

Studies and field surveys along the route of the Bangkok Mass Transit Yellow Line Project : Lat Phrao-Samrong Section (from Bangkok to Samut Prakan province). The project route starts from the linked of Bangkok MRT at Ratchada - Lat Phrao Junction, located in Chatuchak. The route will lay along Lat Phrao Road until Bang Kapi Junction passed Huay Khwang, Wang Thonglang, Bang Kapi, then lay along Srinagarindra Road passed Suan Luang, Prawet until Si Thepha Junction, the route then lay along Thepharak Road passed Bang Na and lay along Thepharak Road passed Bang Na district ended route at Pu Chao Saming Phrai Road. The Yellow Line Mass Transit Project is a monorail elevated the entire route. Generally the rail high 12 meters from the road and run along the center of the road in the line of a traffic island. Except during cross the tunnel, the rail will run along the side of the road and evated 21 to 24.50 meters from the road.

From the beginning at Ratchada station to Samrong station a distance of approximately 30 kilometers, with a total of 23 BTS stations. Ratchada Station is linked with Blue Line, Lam Sali Station is linked with Orange Line Train, Phatthanakan Station is linked with Airport Link and Samrong station is linked with Green Line. One park and ride building located at Bang Na – Trat intersection near Si lam Station and a depot located near Si lam Station at Srinagarindra - Bang Na – Trat intersecton. The development of the projects have to expropriate and relocate of buildings in the area along the route as below.

(1) Land

According to the study, if the construction of the Bangkok Mass Transit Yellow Line Project : Lat Phrao-Samrong Section most of the construction areas use the traffic island of Lat Phrao Road, Srinagarindra Road, and Thepharak Road. Except Suan Luang - Si Udom and from Si Udom junction - Si lam Interchange, Si Thepha Junction, extension route in the future (Samrong stations), the route must be adjuste, the have to expropriate the land for construction projects. Including the construction of 23 train stations include (Ratchada Station, Phawana Station, Chok Chai 4 Station, Lat Phrao 71 Station, Lat Phrao 83 Station, Mahat Thai Station, Lat Phrao 101 Station, Bang Kapi Station, Lam Sali Station, Si Kritha station, Phatthanakan station, Kalantan station, Si Nut station, Srinagarindra 38 station, Suan Luang Ro 9 station, Si Udom station, Si lam station, Si La salle station, Si Bearing station, Si Dan station, Si Thepha station, Tippawan station and Samrong Station), one parking and ride building, depot (located near Si lam Station in the area of Srinagarindra – Bang Na - Trat Intersection) and linked facilities such as parking lot, passenger areas. Then the project needs to use the land, which is owned for about 386 plots, the total area of 150 rais 964.4 squre meters (details shown in **Appendix 4J Table 1**).

The valuation fo compensation cost had been used information on land plot valuation cost, 2012 – 2015 of the Treasury Department, Ministry of Finance as base price in comparition with market price in the vicinity. Together with the pricing guidelines under the Expropriation Act (B.E. 2530) of Ministry of Transportation (2013) for the calculation. From a

comparative study found that the market price is higher than land plot valuation cost, 2012 – 2015 of the Treasury Department, Ministry of Finance about 2.86 times, so as to assess the primary land compensation cost of the project will be used the rate 2.86 times valuation base of land plot valuation cost, 2012 – 2015 of the Treasury Department, Ministry of Finance. When converted in to amount of money that have to be paid to those who expect to be expropriated under the rules of valuation were total of 4,729,574,421 baht (details shown in **Appendix 4J Table 1**).

(2) Structure Buildings

According to the field survey data, there are 158 buildings that expected to be expropriated. Most of the buildings, 104 were a business building which classified as commercial buildings and stores 87 buildings, one market, one of the bank, 2 fuel stations, 2 factories, one hospital, 7 car service centers/garages, one parking garage, 2 warehouses. The remaining buildings for residential housing 46 houses, one condominium, 3 abandoned buildings, one abandoned warehouse, 2 billboards and one toilet (details shown in **Appendix 4J Table 2**).

The valuation of compensation cost had been used building construction valuation cost, 2013 of The Valuers Association of Thailand. Together with the pricing guidelines under the Expropriation Act (B.E. 2530) of Ministry of Transportation (2013) for the calculation which were 0.03 times higher than building construction valuation cost, 2013 of The Valuers Association of Thailand., so as to value the building compensation cost of the project will be uses the rate 0.03 times building construction valuation cost, 2013 of The Valuers Association of Thailand. As calculated in accordance with the above valuation bases found that the building and structures compensation cost is approximately 674,876,735 baht (details shown in **Appendix 4J Table 2**)

(3) Summarize of the Assest Valuation

Study on assests valuation was the valuation of the assests expected to be paid a primary compensation. From the valuation of assests compensation cost worth a total 5,404,451,156 baht. Which as 386 plots in the area of 150 rais 964.4 squire meters cost 4,729,574,421 baht, 158 structure buildings compensation cost of 158,674,876,735 baht, as shown in **Table 4.4.2 - 1**.

4.4.3 Public Health and Safety

1) Methodology

(1) Compile, review, and analyze information from reports and documents of concerned organizations, especially information from nearby health care centers which may be in the form of watching outbreak diseases first 10 diseases, report on outpatient classified by 21 groups of disease or in form of Annual Report, etc.

(2) Investigate field to collect information about hospital and health center along the project alignment.

(3) Conduct environmental impact assessment on public health induced by project development, including proposing the mitigation and monitoring measures.

2) Results

(1) Hospital and Health Center

From the secondary data about public health data of hospitals and health centers within a radius of 500 m from the center of the project alignment was presented in Table 4.4.3 – 1

Table 4.4.2 - 1 Number of Land, Area, Buildings and Property compensation values in Mass Transit Yellow Line Project : Lat Phrao – Samrong Section

No.	Construction area	Land					Building	
		No.	Expropriation land			Compensation values (Baht)	No.	Compensation values (Baht)
			Rai	Ngan	Wah ²			
1	YL - 01 : Ratchada Station	18	1	1	90.8	98,747,150	3	43,568,000
2	YL - 02 : Phawana Station	13	0	2	52.2	44,153,500	6	66,317,600
3	YL - 03 : Chok Chai 4 Station	10	0	3	26.8	27,691,750	11	25,113,600
4	YL - 04 : Lat Phrao 71 Station	27	1	2	9.5	55,842,100	12	42,544,800
5	YL - 05 : Lat Phrao 83 Station	7	0	3	65.8	33,098,750	1	13,760,000
6	YL - 06 : Mahat Thai Station	10	0	3	3.2	28,395,400	1	2,440,800
7	YL - 07 : Lat Phrao 101 Station	23	0	3	75.6	23,982,350	14	42,924,800
8	YL - 08 : Bang Kapi Station	11	1	0	38.6	40,792,150	7	3,692,700
9	YL - 09 : Lam Sali Station	17	0	2	3.8	19,340,300	5	15,640,000
10	YL - 10 : Si Kritha Station	7	2	1	24.9	80,936,750	2	8,112,000
11	YL - 11 : Phatthanakan Station	8	0	3	13.9	25,680,200	5	2,381,800
12	YL - 12 : Kalantan Station	8	1	1	14.5	59,159,200	11	10,841,500
13	YL - 13 : Si Nut Station	11	1	2	58.5	92,120,000	7	16,657,300
14	YL - 14 : Srinagarindra 38 Station	10	1	1	79.7	59,591,650	8	51,317,200
15	YL - 15 : Suan Luang Ro 9 Station	10	2	0	54.8	86,490,250	6	20,969,200
16	YL - 16 : Si Udom Station	10	1	2	28.4	83,282,000	1	2,675,200
17	YL - 17 : Si lam Station	0	0	0	0	0	1	1,344,000
18	YL - 18 : Si La Salle Station	11	2	1	63.7	59,177,500	3	6,498,000
19	YL - 19 : Si Bearing Station	16	1	1	53.5	29,099,200	10	17,702,600
20	YL - 20 : Si Dan Station	25	1	1	44.8	24,449,800	11	16,702,800
21	YL - 21 : Si Thepha Station	5	0	3	41.3	18,594,700	3	5,725,000
22	YL - 22 : Thippawan Station	6	1	2	51.2	34,172,750	6	15,798,000
23	YL - 23 : Samrong	11	0	2	66.3	16,693,900	3	22,518,100

Table 4.4.2 - 1 Number of Land, Area, Buildings and Properties Compensation values in Mass Transit Yellow Line Project : Lat Phrao – Samrong Section (Cont' d)

No.	Construction area	Land					Building	
		No.	Expropriation land			Compensation values (Baht)	No.	Compensation values (Baht)
			Rai	Ngan	Wah ²			
24	Modify Project route from Suan Luang to Si Udom Intersection	24	2	1	17.5	77,777,000	1	19,200,000
25	Modify project route from Si Udom Intersection to Si lam Interchange	27	0	0	96	9,600,000	1	9,600,000
26	Si Thepha	2	0	0	38.8	2,102,500	0	0
27	Extension project route in the future (Samrong station)	11	1	1	48	17,289,000	2	17,520,000
28	Depot	48	118	1	79	505,437,500	17	17,570,950
Sub - total		386	150	2	41.1	1,653,697,350	158	519,135,950
Compensation criteria rate						4,729,574,421		155,740,785
Grand total						4,729,574,421		674,876,735

Remark : 1 rai = 1,600 square meters

1 Ngan = 400 square meters

1 Wah² = 4 square meters

Source : Field survey and study results from Asian Engineering Consultants Corporation Limited, 2013.

Table 4.4.3 - 1 Public Health Personnel and Facilities along the Project Route

Public health facilities	Number of beds	Number of Public Health Personnel (person)					
		Physicians	Dentists	Pharmacists	Professional Nurses	Technical Nurses	Others
1. Lad Phrao Hospital	400	60	2	5	120	5	42
2. Vejthani Hospital	340	45	3	7	149	10	48
3. Samitivej Hospital Srinagarindra	500	80	5	8	215	18	150
4. Health Center 15 Lat Phrao	-	2	-	-	10	-	1
5. Health Center 37 Prasong-Soodsarkorn Tuchinda	-	2	-	-	7	-	1
6. Vibharam Hospital	400	27	4	5	206	96	78
7. Sikarin Hospital	216	36	2	6	157	18	45
8. Samrong Hospital	250	53	27	13	138	14	212
9. Chularat2 Hospital	250	7	-	1	10	-	-
10. Samrong Nuea Public Health Center	-	1	-	-	-	-	6
Total	2,356	313	43	45	1,012	161	583

Source: Medical Service Department/Health Department, Bangkok Metropolitan Administration, 2012 and Samut Prakan Provincial Public Health Office, 2012.

Public and Private Hospitals and Health Centers:

(1.1) Lat Phrao hospital is located on Lat Phrao Road with a total capacity of 400 beds. Available to all medical fields such as Internal Medicine, Obstetrics and Gynecology, Pediatrics, Cardiovascular, Plastic Surgery, Orthopaedic Surgery, Pediatrics Surgery, Urology Surgery, Otolaryngology, Ophthalmology (eye disease), Dental, Rehabilitation medicine and General disease etc.

(1.2) Vejthani Hospital is located on Lat Phrao Road with a total capacity of 340 beds. Available for Medical specialist fields such as Internal Medicine, General Surgery. Orthopaedic Surgery, Obstetrics and Gynecology, Pediatrics, Eye - Ear - Throat - Nose, Dental, Back-Neck Pain Clinic etc.

(1.3) Samitivej Srinagarindra Hospital is located on Srinagarindra Road, Suan Luang, Suan Luang, with a total capacity of 500 beds. Available to all medical fields such as Internal Medicine, Pediatrics, Eye - Ear - Throat - Nose, General Surgery, Orthopedics and Physiotherapy etc

(1.4) Health Center, Bangkok Health Department is responsible for the care and promote the population health, focusing on general treatment, disease prevention and control, rehabilitation, family planning and health education. Found 2 Health Centers: Health center 15 (Lat Phrao) is located in Soi Phawana (Lat Phrao 41), Lat Phrao Road, Sam Sen Nok, Huay Khwang and health center 37 Prasong – Sutsakorn Toojinda located on Phatthanakan Road, Suan Luang which not available for in-patients (no bed).

(1.5) Vibha-Ram Hospital is located on Phatthanakan Road, Suan Luang, Suan Luang, with a total capacity of 400 beds. Available in all medical fields such as Internal Medicine, Obstetrics and Gynecology, Pediatrics, Cardiovascular, Plastic Surgery, Orthopedics Surgery, Pediatrics Surgery, Urology Surgery, Otolaryngology Ophthalmology (eye disease), General disease, Dental and Rehabilitation medicine etc.

(1.6) Sikarin Hospital is located on Srinagarindra Road, Bang Na, Bang Na with a total capacity of 216 beds. Available for patients in all Medical specialist fields such as Internal Medicine, General Surgery, Orthopaedics, Obstetrics and Gynecology, Pediatrics, Eye - Ear - Throat - Nose, Dental and Back - Neck Pain Clinic etc.

(1.7) Samrong Hospital is located on Aupparaj Road, Samrong Nua, Muang district, Samut Prakran province with a total capacity of 250 beds. Available for patients in all medical fields such as Internal Medicine, Pediatrics, Eye - Ear - Throat - Nose, General Surgery, Orthopedics Surgery and physiotherapy etc.

(1.8) Chularat 2 Hospital is located on Thepharak Road, Samrong Nua Subdistrict, Muang district, Samut Prakran province with the up to 250 beds to accommodate patients. Available to all medical fields such as Internal Medicine, General Surgery, Pediatrics, Eye - Ear - Throat - Nose and Dental, etc.

(1.9) There are health centers and specialty hospitals under the Ministry of Health. Focused on health care providers and treatment of various diseases to the public. Found one of the health centers, Samrong Nua health centers, located in Samrong Nua subdistrict, Muang district, Samut Prakran province, responsible for two villages are Moo. 3 and 4, Dan Samrong Municipalities, and serve neighboring outside also. Samrong Nua Health Center is in the network of Samut Prakan Hospital.

(2) Health Personnel

Data collection on health personnel positioned at public and private hospitals and health centers along the project route and nearby areas within a radius of 500 meters was found.

(2.1) Public Health Personnel: Total of 23 Health personnel at 2 health centers, classified as 4 medical personnel, 17 nurses and 2 social workers. And Health personnel positioned at health center/Hospital under the Ministry of Health one health center is Sumrong Nua Health Center with total 7 personnel, one medical staff, and 6 health workers.

(2.2) Private Health Personnel positioned at 7 private hospitals with a total of 2,136 persons classified as 311 medical staffs, 43 dentists, 45 pharmacists, 995 nurses, 161 technical nurses and 581 health workers and shown in **Table 4.4.3 - 1**.

(3) Sickness of Population Statistics

From the report of out-patient according to 21 causes groups of Health Center in Bangkok area, 2010 to 2012 found that blood circulation disease was the highest with 1,382,346 patients, followed by the respiratory disease with 1,333,308 patients and third are diseases on the endocrine system, nutrition, and metabolism with 916,561 patients, respectively. A number of out-patient according to 21 causes groups of Health Center in Bangkok area, 2010 to 2012. As shown in **Table 4.4.3 - 2**.

From the report of out-patient according to 21 causes groups of Health Center in Samut Prakran province, 2010 to 2012 found that respiratory disease was the highest with 1,274,204 patients, followed by blood circulation disease with 1,084,377 patients and third are diseases on the endocrine system, nutrition, and metabolism with 881,852 patients, respectively. As shown in **Table 4.4.3 - 3**.

From patients epidemiological surveillance reports, 2012 of Bangkok Strategy and Evaluation Department found that patients in Bangkok got diarrhea the highest with 39,157 people, followed by influenza with 16,272 people and third is dengue with 10,081 patients as shown in **Table 4.4.3 - 4**.

From patients epidemiological surveillance reports, 2012 of Samut Prakran province Health Office found that the diseases Samut Prakran people get the most is diarrhea with 13,917 people, followed by fever or unknown origin fever with 2,714 people and third is tuberculosis with 2,635 patients, as shown in the **Table 4.4.3 - 5**.

4.4.4 Occupational Health and Safety

1) Methodology

- (1) Collect preliminary data about the law relating to work safety.
- (2) Collect, verify and analyze data from related documents and reports such as a highway accident statistics etc.
- (3) Environmental impact assessment of occupational health and safety from project development, including prevention and mitigation measures and audit requirements.

**Table 4.4.3 - 2 Illness Statistics of Out Patients Classified by Group of Illness Causes
(21 groups of disease) in Bangkok Metropolitan Administration during
2010 - 2012.**

Cause of illness (Disease Groups)	Fiscal year			Total
	2010	2011	2012	
1. Certain Infectious and Parasitic Diseases	22,709	19,473	16,873	59,055
2. Neoplasma (including Cancer)	2,795	2,735	2,099	7,629
3. In Cases of the Blood and Blood Forming Organs and Certain Disorders Involving the Immune Mechanism	6,843	7,241	8,243	22,327
4. Endocrine, Nutritiona and Metabolic Diseases	285,564	303,692	327,305	916,561
5. Mental and Behavioural Disorders	17,852	16,568	16,605	51,025
6. Diseases of the Nervous System	18,691	18,281	16,895	53,867
7. Diseases of the Eye and Adnera	32,616	29,974	25,021	87,611
8. Diseases of the Ear and Maslaid Process	12,603	12,550	12,896	38,049
9. Diseases of the Circulatory System	434,930	490,239	457,177	1,382,346
10. Diseases of the Respiratory System	311,331	778,779	243,198	1,333,308
11. Diseases of the Digestive System	85,057	85,727	78,774	249,558
12. Diseases of the Skin and Subcutaneous Tissue	59,465	58,821	54,593	172,879
13. Diseases of the Musculoskeletal System and Connective Tissue	92,772	94,313	87,403	274,488
14. Diseases of the Genotourinary System	23,093	23,778	19,394	66,265
15. Complication of Pregnancy, Childbirth and the Puerperium	2,305	2,378	1,771	6,454
16. Certain Conditions Originating in the Perinatal Phase	88	1,041	65	1,194
17. Congerita Malformations, Deformations and Chromosomal Abnormalities	264	662	442	1,368
18. Symptoms, Signs and Abnormal Clinical and Laboratory Findings, Not Elsewhere Classified	175,774	185,134	135,360	496,268
19. Poisoning, Toxic Effect, and their Sequelae	2,705	2,643	4,996	10,344
20. Transport Accidents and their Sequelae	28,624	28,745	30,006	87,375
21. Other External Causes of Morbidity and Mortality (eg. Accidents, Injuries, Intentional Self-harm, Assault, Animals and Plants, Complications of Medical and Surgical Care and Other Unspecified Causes)	131,059	136,761	121,415	389,235
Total	1,747,140	2,299,553	1,660,531	5,707,224

Source: Strategy and Evaluation Department, Bangkok Metropolitan Administration, 2013.

**Table 4.4.3 - 3 Illness Statistics of Out Patients Classified by Group of Illness Causes
(21 groups of disease) in Samut Prakan Province during 2010 - 2012**

Cause of illness (Disease Groups)	Fiscal year			Total
	2010	2011	2012	
1. Certain Infectious and Parasitic Diseases	127,131	97,524	74,528	299,183
2. Neoplasma (including Cancer)	17,005	22,540	9,114	48,659
3. In Cases of the Blood and Blood Forming Organs and Certain Disorders Involving the Immune Mechanism	21,272	20,005	12,100	53,377
4. Endocrine, Nutritiona and Metabolic Diseases	337,409	327,619	216,824	881,852
5. Mental and Behavioural Disorders	37,514	42,281	21,045	100,840
6. Diseases of the Nervous System	53,109	44,532	29,578	127,219
7. Diseases of the Eye and Adnera	78,131	65,759	47,917	191,807
8. Diseases of the Ear and Maslaid Process	26,606	26,880	14,289	67,775
9. Diseases of the Circulatory System	394,914	413,200	276,263	1,084,377
10. Diseases of the Respiratory System	499,829	459,312	315,063	1,274,204
11. Diseases of the Digestive System	265,157	418,190	118,946	802,293
12. Diseases of the Skin and Subcutaneous Tissue	89,065	71,980	52,495	213,540
13. Diseases of the Musculoskeletal System and Connective Tissue	256,536	189,658	136,161	582,355
14. Diseases of the Genotourinary System	84,610	75,307	47,359	207,276
15. Complication of Pregnancy, Childbirth and the Puerperium	16,126	14,070	8,785	38,981
16. Certain Conditions Originating in the Perinatal Phase	5,033	4,402	12,003	21,438
17. Congerita Malformations, Deformations and Chromosomal Abnormalities	3,013	3,936	2,532	9,481
18. Symptoms, Signs and Abnormal Clinical and Laboratory Findings, Not Elsewhere Classified	238,505	198,998	302,538	740,041
19. Poisoning, Toxic Effect, and their Sequelae	2,572	3,031	550	6,153
20. Transport Accidents and their Sequelae	23,119	23,927	7,764	54,810
21. Other External Causes of Morbidity and Mortality (eg. Accidents, Injuries, Intentional Self-harm, Assault, Animals and Plants, Complications of Medical and Surgical Care and Other Unspecified Causes)	92,579	78,422	48,582	219,583
Total	2,669,235	2,601,573	1,754,436	7,025,244

Source: Samut Prakan Provincial Public Health Office, 2013.

Table 4.4.3 - 4 The Ten Ranked of patients with Surveillance Epidemiology Diseases in Bangkok Metropolitan Administration, 2012.

Diseases	Number of patients (person)
1. Diarrhea	39,157
2. Influenza	16,272
3. Dengue hemorrhagic fever	10,081
4. Pneumonia	8,572
5. Hand, foot and mouth disease	6,914
6. Food poisoning	3,714
7. Chickenpox	2,514
8. Hemorrhagic conjunctivitis	1,532
9. Measles	255
10. Mumps	173

Source: Strategy and Evaluation Department, Bangkok Metropolitan Administration, 2013.

Table 4.4.2 - 5 The Ten Ranked of Patients with Surveillance Epidemiology Diseases in Samut Prakan Province, 2012.

Diseases	Number of patients (person)
1. Diarrhea	13,917
2. Pyrexia of unknown origin/ unknown origin of Fever/Fever cause)	2,714
3. Tuberculosis	2,635
4. Hemorrhagic conjunctivitis	2,449
5. Pneumonia	2,020
6. Pulmonary tuberculosis	902
7. Food poisoning	810
8. Influenza	788
9. Chickenpox	681
10. Herpes zoster	527

Source: Samut Prakan Provincial Public Health Office, 2013.

2) Study Results

(1) Occupational Health

Worker's occupational health was under the legal protection of the Labour Protection Act B.E. 2541, as well as the Notification of Ministry of Interior, 2002 related to safety in construction work as follows.

1) Ministerial Regulation under the Labour Protection Act B.E. 2541.

- Ministerial Regulation on administration and management standards of Safety, Occupational Health and Working environment on heating, lighting and sound, B.E. (2006)
- Ministerial Regulation on administration and management standards of Safety, Occupational Health and Working environment, B.E. 2549.

2) Notification of the Ministry Mahat Thai B.E. 2545

- Work Safety on electricity, consisting of a type of cables, wiring and fixing wiring, over current protection system, installation design, a ground line and grounding, lightning rod Installation, use of electrical protective gears etc.
- Work safety on machinery consists of personal safety protection on general machinery, standard on personal safety protection gears etc.
- Safety issues in the construction work about safety zoning in construction work etc
- Safety issues in crane work on mobile and a stationary crane working procedures.
- Safety issues in hammering *Ixora chinensis* Lamk. *Ixora* spp. poles consists with safety in hammering *Ixora chinensis* Lamk. *Ixora* spp. poles, type of hammering *Ixora chinensis* Lamk. *Ixora* spp. poles, personal safety protection etc.
- Safety in construction work about scaffolding, consists with construction work, scaffolding work, the building of scaffolding, using of scaffolding, scaffolding standard, standard safety protection about safety protection gears.

The practicing of construction workers must strictly follow the law above as an operation guideline.

(2) Land Accident Statistics

Collected and analyzed the statistical data on safety and accidents occurred due to land traffic condition in Bangkok in the past 3 years (2009-2011) of the National Statistical Office (2011). Found that accidents are increasing and have the highest damages valued in 2011 totaling 80,899,423 million baht and personal damages 8,258 cases (345 dies and 7,913 injured). The proportion of accidents vehicle, a personal car is the highest number of 12,390 cars, followed by 9,954 motorcycles, 3,214 small trucks (pickups), 2,874 taxis etc. as shown in the **Table. 4.4.4 - 1**.

Collected and analyzed the statistical data on safety and accidents occurred due to land traffic condition in Samut Prakran province in the past 3 years (2009 - 2011) of the National Statistical Office (2011). Found that accidents are increasing and have the highest damages valued in 2011 totaling 10,508,233 million baht and personal damages 414 cases (95 dies and 319 injured). The proportion of accidents vehicle, the motorcycle is the highest number of 508 units, followed by 338 small trucks (pickups), 289 personal cars, 65 taxis etc. as shown in the **Table. 4.4.4 - 2**.

4.4.5 Historical Site And Archaeology

1) Methodology

(1) Collect Data and analyze on historical, valuable and important artistic and architectural or features/unique of historic places/archaeology and communities important places along the project route and adjoining areas of Office of Archaeology, Fine Art Department and Department of Religious Affairs etc.

(2) Field survey and monitor to collect more information on value and importance to the local community, sensitivity level to the impacts, distance from the project route, height of historic places and archaeology and communities important places etc.

Table 4.4.4 - 1 Traffic Accidental Cases and Damages in Bangkok Metropolitan Administration during 2009 – 2011.

Traffic Accidental Cases/Damages	Number of Traffic Accident Cases and Properties Damage values		
	2009	2009	2009
1. Notified the police (time)	49,922	44,890	35,703
2. Pedestrian	923	1,009	1,102
3. Bicycle	131	116	116
4. Tricycle	16	16	16
5. Motorcycle	10,490	9,851	9,954
6. motor-tricycle	193	148	197
7. Car	13,064	12,688	12,390
8. Light bus (van)	501	505	521
9. Pickup truck	3,680	3,424	3,214
10. Heavy bus	751	630	649
11. Medium truck	363	361	387
12. Heavy truck and trailer truck	317	297	319
13. Farm truck	-	-	-
14. Taxi	2,667	2,540	2,874
15. Others	424	425	373
Total Traffic Accidental Cases	83,442	76,889	67,815
Value of property damage (Baht)	41,220,600	51,199,654	80,899,423
Person damages	6,508	7,117	8,258
1. Dead	265	280	345
2. Injury	6,243	6,837	7,913
Number of suspects	26,900	28,139	24,410
1. Arrested	26,841	28,084	24,353
2. No arrested	59	55	57

Source : National Statistical Office, 2012.

Table 4.4.4 – 2 Traffic Accidental Cases and Damages in Samut Prakan Province during 2009 – 2011.

Traffic Accidental Cases/Damages	Number of Traffic Accident Cases and Properties Damage Values		
	2009	2010	2011
1. Notified the police (time)	1,555	2,716	2,979
2. Pedestrian	9	26	53
3. Bicycle	-	2	18
4. Tricycle	-	-	-
5. Motorcycle	268	195	508
6. motor-tricycle	-	1	7
7. Car	38	26	289
8. Light bus (van)	7	2	18
9. Pickup truck	113	65	338
10. Heavy bus	1	8	26
11. Medium truck	3	9	45
12. Heavy truck and trailer truck	12	6	35
13. Farm truck	-	-	-
14. Taxi	6	10	65
15. Others	8	10	61
Total Traffic Accidental Case	2,020	3,076	4,442
Value of property damage (Baht)	105,200	4,536,000	10,508,233
Person damages	48	186	414
1. Dead	27	44	95
2. Injury	21	142	319
Number of suspects	558	1,707	1,889
1. Arrested	558	1,699	1,878
2. No arrested	-	8	11

Source : National Statistical Office, 2012.

2) Study Results

The field survey and monitor results and historical, valuable and important artistic and architectural or features/unique of historic places/archaeology and communities data important places along the project route and adjoining areas within a radius of 500 meters. From the start of the project at Ratchada Station in the area of Ratchada - Lat Phrao junction until ended at Samrong station in the area of Thapharak market. Found ancient and historic places that has been registered by the Fine Art Department and communities and religious landmarks (Buddhism/Islam /Christianity) that may be affected by the project development as follows.

(1) Two ancient and historic places that has been registered by the Fine Art Department which located nearby the project route as;

(1.1) Phang Faifa Fort located in Talad subdistrict, next to Pra Pradaeng Faifa Municipal School. Some parts still intact. The fort is one of the bases of Nakhon Khuean Khan city. As a base at Chao Phraya river mouth and as the city with many forts. Pra Bat Som Det Pra

Puttayatfa Chulalok Maharat, (King Rama 1) was initiative to protect the kingdom. Presently, Pra Pradaeng municipality has been restored as the public park. By the top of the fort has set the several ancient cannon barrels for visiting, the area surrounded by planted trees.

(1.2) Klang Worawihan Temple, located at Pak Nam subdistrict, Muang district, Samut Prakan with an area of 25 rais and 45 rais of the churchyard. It is the public benefit with markets, commercial buildings, homes, and schools. Klang Temple, formerly known as "Takothong Temple," because of the discovered golden ring under the Ebony tree. Later the villagers called "Klang Temple" because it is located between the outer temple (Pichaisongkram Temple) and inner temple (Nai Dem Song Wihan Temple). Klang Temple is the royal monastery type Worawihan, built in Ayutthaya Phase in the Age of King Boromakot. Klang Temple is templing, in B.E (2299), was restored and rased to be a royal monastery in the age of King, Rama 3 . In the reign of King Rama 4, 1958 offerings a Katin and built the pagoda cover Phra Samut Chedi (original). Later King Rama 5 please to restoration the education and religion. Klang Temple then is the center of education and religion orderingly. The reign of King Rama 6, 1954 repeatedly cited as a royal temple as King Rama 3.

(2) Religion places (Buddhism/Islam/Christianity) which located along the project route and adjoining areas within a radius of 500 meters, found 27 places.

(2.1) House of Christ Christendom is located in Soi Lat Phrao 25 (Soi Akom) Lat Phrao Road, Ladyao, Bang Khen, Bangkok, approximately 295 meters away from the project route, with the servants of God is Pastor Manot Sri Sungneun. It is a place of religious activity and religious rituals in Christianity.

(2.2) Siam Bethel Christendom is located in Soi Lat Phrao 41, Lat Phrao Road, Sam Sen Nok, subdistrict Huay Khwang, distoict Bangkok, approximately 140 meters away from the project route. It is a place of religious activity and religious rituals in Christianity.

(2.3) Baptist Lat Phrao Christendom is located in Soi Lat Phrao 45, Lat Phrao Road, Sam Sen Nok, subdistrict Huay Khwang, distoict Bangkok approximately 84 meters away from the project route, Philip Pope Family, American missionary was the founder. It is a place of religious activity and religious rituals in Christianity.

(2.4) Antioch Baptist Christendom is located in Soi Lat Phrao 64, Lat Phrao Road, Wang Thonglang, distoict Bangkok, approximately 275 meters away from the project route. It is a place of religious activity and religious rituals in Christianity.

(2.5) Hidayatul Is lam Mosque (Don Sakae) is located in Soi Lat Phrao 96, Lat Phrao Road, Wang Thonglang, Bangkok, approximately 361 meters from the project route. The history of Masjid Hidayatul Islam stating in 1952, Tao Yean Santae talked with decendants that would like to donate the land at Ban Don Sakae about 2 rais to build a mosque. But still do not have enough funds, then have to wait until finished rice season, selling rice, thus helping to collect funds to construct Masjid Hidayatul Islam (Don Sakae). The construction news was told to muslim people in the nearby area, including Mudjid Bang Aw, which that time was under demolished the old building to build the new one and donated the old wood to Don Sakae. The Mudjid Board agreed to use that wood for building "Balae" for teaching Al-Quran and religious morality. From the massive expansion of Muslim community around the mosque in 1963, the mosque committee and churchgoer have agreed to build a new mosque as a two-story-concrete buildings and relocation

the old building, but the original "Balae" for teaching Al-Quran still the same. When a Don Sakae community has expanded, 1967 then Don kae churchgoer help to construct a new Al-Quran building as a two-story concrete buildings, which is currently used as an ethical school for youth in every day (except Friday), while in Thursdays even Thursday are teaching a churchgoer in the community by inviting senior faculties to teach both subjects Tafsir al-Quran and Al-Hadith to interested adults and churchgoer. Only the mosque's board use the ground floor of the mosque instead of at the two-story concrete building that is more appropriate than the classroom of youngsters, routinely use (except Friday), while in the year 2005 the Education Board of the mosques (Don Sakae), thought that the area was too small due to increasing number of the youth in every year. Then agreed that Surowdonsakae School (general course under Bangkok) to restore some of the lands to the mosque (Don kae) that the mosque committee in 40 years ago, has lended to Bangkok. (Currently used as a multi-purpose field of Surowdonsakae School). Then the mosque will expand the building for religious and moral education to the youth.

(2.6) Peach of Bangkok Christendom is located in Soi Lat Phrao 87, Lat Phrao Road, Wang Thonglang, Bangkok is about 414 meters away from the project route, with the servants of God is Prof. Paitoon Hattamat. It is a place of religious activity and religious rituals in Christianity.

(2.7) Maria Rosa Mystica Christendom is, located in Soi Lat Phrao 87, Lat Phrao Road, Wang Thonglang, Bangkok is about 100 meters away from the project route. When the Bishops has announced the pastoral care and to guide pastoral activities of the Catholic monastery in Thailand. Christians all have contributed to the good news of the love of God in the everyday role and their duties, as well as to the lives of Christians in the 3rd millennium to be a witness of the love of God in today's society. As the mark of the preparation of both inner life and outer material that will contribute to the spiritual life have faith in God even more. The Executive Committee ask the resolution from Monsignor to create a new one. With the foreknowledge of God to show the love and mercy of God though Mr. Tanoo Ajaree, who kind and give expression to the life dedicated to the Blessed Mother donated the 3 rais empty land for the church. Construction was started on 29 Octobe 1998, a year passed by then a beautiful 2-stories building in the name "Maria Rosa Mystica Church" was finished. The ground floor was used as a parking lot and the various activities and the upstairs was used as a place of religious activities and rituals. Next to the Church is Maria's cave simulation Lady of Lourdes apparitions, which is adjacent to the office building and rectory.

(2.8) Ruamnimit Bangkok Christendom is located in Soi Lat Phrao 99, Lat Phrao Road, Wang Thonglang, Bangkok, about 204 meters away from the project route. The church started from the family of Prof. Nirut at the house at Suan Lam Thong 2 Village and on April 8, 1990, has a membership of about 20 people. Then with increasing of the interesting/new believers in the church until the house where filled up. God saw and already scheduled for Ruamnimit Bangkok church. When Prof. Nirut traveled to the Republic of Korea, he has been confirmed by God through Dr. Cho Yong-gi, who invited Prof. Nirut to sermon among the hundreds thousands of people in the largest church in the world. Upon his return, God has prepared a new replacement place of worship. On October 23, 1990, Ruamnimit Bangkok church was inaugurated official opeining ceremony by H.E the Deputy Prime Minister, General Arthid Kamlung Ake.

(2.9) Mahapawn Bangkok Christendom is located in Soi Lat Phrao 130, Lat Phrao Road, Klongchan, Bang Kapi, Bangkok, approximately 445 meters away from the project route.

(2.10) Gospel Bangkok Christendom is located in Soi Lat Phrao 140, Lat Phrao Road, Klongchan, Bang Kapi, Bangkok is approximately 219 meters away from the project route.

(2.11) Santisuk Community Christendom is located in Soi Lat Phrao 146/1, Lat Phrao Road, Klongchan, Bang Kapi, Bangkok is about 114 meters away from the project route. Prof. Kevin Walton as a servant of God, this is a place of religious activity and religious rituals in Christianity.

(2.12) Futhulbari Mosque located in Soi Ramkhamhaeng 95 (Soi Chueam Samphan Nua), Ramkhamhaeng Road, Hua Mark, Bang Kapi, Bangkok is approximately 46 meters away from the project route, this is a place of religious activity and religious rituals of Islam. Mr. Viroj Boonmalert as Imam.

(2.13) Phra Karunathikun Christendom is located in Soi Ramkhamhaeng 48, Hua Mark, Bang Kapi, Bangkok is about 351 meters away from the project route. Master Suwannee Khemthong is the servant of God, this is a place of religious activity and religious rituals in Christianity.

(2.14) Mae Pra Ong Upatham Church located in Srinagarindra Road, Hua Mark, Bang Kapi, Bangkok is approximately 153 meters away from the project route.

(2.15) Yamiaunishad Mosque (Hua Mak Yai) is located along Hua Mak Canal, Soi Sangupsuk, in the area of Motorway (Bangkok-Chonburi), Suan Luang, Bangkok, approximately 364 meters away from the project route, this is a place of religious activity and religious rituals of Islam. Mr. Prasert Sisai as Imam.

(2.16) Darius Salam Mosque is located in Soi Jinda Anan, Srinagarindra Road, Suan Luang, Bangkok is approximately 232 meters away from the project route, this is a place of religious activity and religious rituals of Islam. Mr. Samai Daengkomen as Imam.

(2.17) Suan Luang Christendom is located on Srinagarindra Road, Suan Luang, Bangkok, approximately 25 meters away from the project route. This is a place of religious activity and religious rituals in Christianity with Pastor Sroung Boonsanong as the servant of God.

(2.18) Khachon Siri Temple, (Khmer Temple) is located 239 meters away from Srinagarindra Road, built in the early Rattanakosin era in King Rama 3 around, 1849. It was built by and evacuated Cambodians, so-called "Khmer Temple", later in 1940 changed its name to Khachon Siri Temple as current. About the builder, presumably from the words of the former, Khmer inscriptions in the chapel ceiling together with in the year 1970, the wooden Broach spire as Phra Prang shaped has unearthed with the same top as the 3 Pagoda in Lopburi province and was Wisuongcamseamr on March 5, 1997. The point of interest is the fish feeding area with a lot of fish.

(2.20) Al latisom Mosque is located 430 meters away from Srinagarindra Road, so-called "Hua Pa Great Mosque". The Islamic's ascendant migrated from the south, mostly from Pattani Province was settled near the Great Mosque at the mouth of Khlet Canal. Later on, the family was expanded until the lack of the land for their livelihood, have to expand the new village located at "Hua Pa village" and has built a mosque called "New Hua Pa mosque" and later on the name was changed to "Al latisom Mosque".

(2.21) Darulamin Mosque is located in Soi So Udon, Srinagarindra Road, Suan Luang, Bangkok is approximately 71 meters away from the project route, this is a place of religious activity and religious rituals of Islam. Mr. Kasem So Udon as Imam.

(2.22) Si lam Temple is located at 111 Moo 11 Km. 4 Bangna Trad Road, Bang Na, Bangkok, 136 meters away from Srinagarindra Road under the Sangha Maha Nikai. The former name of the temple was Si lam Watthanaram Temple. The original as a house of priest was started in 1965 by Mrs. Ab Ongeium and children donated 6 rai of land to Phrakhu Sri Worapinij (Phra Maha Siri), the abbot of Bang Na Nai Temple. Founded in December 1973 and began to build on 20 May 1974. Later on Mr. Sukhum and Lady Fongchan Thirabuth was donated a land of 6 rai to Phraathikarn Prasert Suttadhammo in the Year of the Pig, 1983. The temple still named Si lam Watthanaram, which is hard to pronounce the cut the word Wathanaram off only Si lam Temple till the present.

(2.23) Bangna Immanuel Christendom is located at 112/1693, Bang Na housing, Soi 46, Bangna - Trad Road, Bangna, Bangkok, is approximately 225 meters away from Srinagarindra Road, this is a place of religious activity and religious rituals in Christianity with Pastor Suphanai Pholdee and Pastor Joshua Kim as the servant of God.

(2.24) Jaisamarn Samut Prakarn Christendom is located at 2091 Soi Tanyarom, Moo 7, Thepharak Road, Muang district, Samut Prakarn province is approximately 322 meters away from the project route, this is a place of religious activity and religious rituals in Christianity with Pastor Chatchai Moungron as the servant of God.

(2.25) Udom Suk Si Pha Rak Christendom is located at 130, Soi 10 Chalerm Phra Ror. 9, Nongbon, Prawet, Bangkok is 313 meters away from Srinagarindra Road, Udomsuk – Bangna (Km. 4-5). It is a slum with no church. Therefore, it has set up a church, which the starting work was set up a the prayer groups and focused on student group activities such as teaching English, Youth clubs. Currently, members have jointly established Nantaphara Organization, registered by the Evangelical Fellowship of Thailand. For the official religious and charitable mission of helping the local church and set up the churches in the country. Including all forms of social welfare.

(2.26) Samrong Christendom is located at 1415 Moo 9, Soi Wat Dansamrong, Sukhumvit 113 Road, Samrong Nua subdistrict, Muang district, Samut Prakarn province is approximately 379 meters away from the project route, this is a place of religious activity and religious rituals in Christianity with Pastor Johann Trakulsuk as a servant of God.

(2.27) Dansamrong Temple located in Samrong Nua subdistrict, Muang Samut Prakarn district, Samut Prakarn province is approximately 253 meters away from the project route.

4.4.6 Aesthetics and Tourism

1) Methodology

(1) Field survey and collect data to analyze the existing conditions in the scenery within a radius of 500 meters from the project route. By identifying the scenery characteristics of the existing environment, sensitive areas to the affected on scenery, leisure sources, the valuable and important on architectural and artistic sources, features / unique sources and specific important to the community places, along the project route and nearby areas.

(2) Collect and analyze the rules, requirements or criteria that are associated with scenery impact.

(3) Identifying the scenery impacts of the project by considering the height of structures with the distance between the viewing point, height of project structure and the view to the top of the structure that transversal the eyes are classified as 3 level below.

(3.1) The area with high level of scenery impact, sighter is a feeling that has completely obscured the scenery due to the angle view greater than 45 degrees, including an area that is away from the project route no more than 1 times of the project structure height.

(3.2) The area with a moderate level of scenery impact, sighter would have felt that there has been 50% obscured the scenery since the view is between 30 to 40 degrees include areas that are away from the project route at a distance of more than one time but not more than 3 times the project structure height.

(3.3) The area with low level of scenery impact, sighter would have felt that there has been less obscured the scenery since the view is low or lower than 14 degrees but not more than 30 degrees include areas that are away from the project route at a distance of more than 3 times until 8 times the project structure height.

2) Study Results

The survey and examined the exiting scenery along the project route within a radius of 500 meters can be described in detail below.

(1) The project route starts at Ratchada/Lat Phrao Station on Lat Phrao Road until Bang Kapi junction at the intersection of Lat Phrao and Srinagarindra Road. It can be explained that the area along both sides of the project route has the large urban communities scenery as moderate – high density of commercial/trade alternating with residential semi 3 to 6 floors commercial buildings, some were wilderness area with a low density of weeds/grass/vines. Some were housing (eg. Klang Muang Village, Porn Pailin Village, Thip Thani Village and Yu Charoen village etc.), Condominium or Apartment (eg. Life @ Rachada, The Room Ratchada-Ladprao, The Landmark Residence, P.K. Mansion, The Next Condominium, The Pluse Ladprao and Jittrapa Place, etc.), major government/state enterprises, religious places/community landmarks (eg. House of Christ Church, Lat Phrao Temple, Lat Phrao Church, Maria Rosa Mystica Church and Futhulbari Mosque etc.), large – medium hospitals (such as Health Centers 15 (Lat Phrao), Lat Phrao Hospital and Vejthani Hospital etc.), educational institutions (such as Phibun Uppatham School, Thanormpitvithaya School, Hua Mak Wittayanusorn School etc.), local tourism and leisure (such as Lat Phrao Driving Range Lat Phrao etc.) and there was a scenery of overpass along Lat Phrao Road, Si Rat Expressway elevated crossing Lat Phrao Road (north – south) etc. as well as scenery of medium – large shady tree line (such as *Millingtonia hortensis*, *Pterocarpus indicus* Willd., *Cassia fistula* L., *Alstonia scholaris* var. *scholaris*, *Mimusops elengi* L., *Peltophorum pterocarpum* (DC.) K.Heyne, *Tabebuia rosea* etc.) planted by both sides of the road and the traffic island Phaseically creates atmosphere and beauty to the landscape of large urban communities.

(2) From Bang Kapi junction at the area of the intersection of Lat Phrao Road and Srinagarindra Road, Phatthanakan junction. It can be explained that the area along both sides of the trail project has a large urban communities scenery as well as the starting section of the

project route. But as the commercial/trading zone with less density of commercial buildings and the residential communities alternating with empty space. Major government/state enterprises (such as Bang Kapi District Office, Lat Phrao Police Station, Hua Mak Train Station etc.), religious places and community landmarks (such as Masjid Yamiaulishard, Masjid Darissalam etc.), medium – large hospitals (eg. Vibha-Ram Hospital, Samitivej Srinagarindra Hospital, Health Centers 37 (Prasong - Sudsakorn) etc.), educational institutions (such as Hua Mak School, Sukonthee kindergarten etc.), local tourist/recreational areas (such as Krungthep-Kretha Glof Club etc.) and there was scenery of Interchange crossed Srinagarindra Road (east – west), as well as a medium – large tree shady scenery (eg. *Millingtonia hortensis* Lf., *Pterocarpus indicus* Willd, *Cassia fistula* L., *Lagerstroemia speciosa* var. *speciosa*, *Lagerstroemia macrocarpa* Wall., *Alstonia scholaris* var. *scholaris*, *Mimusops elengi* L. and *Swietenia macrophylla* King. etc.) planted by both sides of the Srinagarindra road and the traffic island Phaseically creates serenity atmosphere and beauty to the landscape of suburbs large urban communities.

(3) From Phatthanakan station on Srinagarindra Road until Expressway Control Center at the area of elevated road along Srinagarindra Road located between Toyota Body Service Co., and Siam Machinery Industry Co. Ltd., It can be explained that the area along both sides of the project route has the large urban communities scenery as moderate – high density of commercial/trading zone alternating with residential semi commercial buildings. In some section were the location of housings, apartments and government buildings (such as Hua Mak BTS station, Bangkok Land Office Phra Khanong Brance, Bus Operations Division 3 Zone 2, BMTA, Samut Prakan Highway District, Highway Information Service Center and Expressway Control Centre), religious places and community landmarks (such as Darius Salam mosque, Al latisom Mosque, Khmer temple, (Kachon Siri), Masjid Darul Amin, Meditation courtyard Suan Ashram Foundation, Si lam Temple etc., medium – large hospitals (such as Health Center 37 and Vibha-Ram Hospital) education institutions (such as Hua Mak municipality Schools, Khlong Ka Lantan School, Suraowmai School, Prasanwit Wattana School, Muchla Adulislam School, Kan Kong Upathum School, Parichat kindergarten and Wat Si lam School), local tourist and leisure places (such as Suan Luang Ror. 9).With the scenery of Soi Sukhumvit 103 (Udomsuk) elevated road and elevated road along Srinagarindra Road at Si lam temple etc.) as well as a serenity scenery from the line of medium – large trees (such as *Pterocarpus indicus* Willd, *Cassia fistula* L., *Alstonia scholaris* var. *scholaris*, *Bauhinia purpurea* L., *Polyalthia longifolia* Benth Hook.f. var. *Pandurata*, *Casuarina junghuhniana* Miq. etc.) planted by the side of the road and traffic island Phaseically to create the atmosphere and beautiful landscape of large urban communities.

(4) From Expressway Control Center at the area of elevated road along Srinagarindra Road located between Toyota Body Service Co., and Siam Machinery Industry Co. Ltd., until the end of the project near Su Thepha junction (Sukhumvit - Thepharak) close to Thepharak market. As explained that the area along both sides of the project route has a large urban communities scenery. But as the commercial/trading zone with a density of commercial buildings as residential aternate with empty space. Major governments/state enterprises (such as Mobile switching center, Flood Protecting Control Center Samut Prakran province, Dansamrong Municipality, Office of Welfare and Labour Protection Samut Prakran province, Sumrong Nua Municipality and Pu Chao Saming Phrai switching center), religious places and community landmarks (eg. Dansamrong

Temple, Samrong Church, Pu Chao Saming Phrai shrine etc.), small – large hospitals (eg. Jarusak dental clinic, Srinagarindra children clinic, Samrong Nua Health Center, Chularat 2 Hospital, Chulavej Hospital, Baramee Medical Hospital), education institutions (such as Klong Kratumrat Utid School, Deepphrom School, Samrong Canal School, Intarumphan Anusorn School, Uthip School, Wichian Pittaya School, Thepharak Kindergarten etc.) and there is junction scenery of Si Thepha market along Samrong Canal including serenity scenery of shady from the medium – large trees (eg. *Millingtonia hortensis* L.f., *Pterocarpus indicus* Willd, *Cassia fistula* L., *Lagerstroemia speciosa* (L.) Pers., *Alstonia scholaris* var. *scholaris*, *Mimusops elengi* L., *Tabebuia rosea*, *Peltophorum pterocarpum* (DC.) K.Heyne etc.), planted by both sides of the road and the traffic island Phaseically creates atmosphere and beauty to the landscape of large urban communities.

To determine the scenery impacts of the project by considering the height of structures with the distances between the viewing point, height of project structures and the view to the top of the structures. The area where may effect on scenery is about 55 meters from the project's structure which calculated by the average height of project's structures about 16 meters and the relationship of trigonometry. The survey and examined the exiting historical places, architectural and artistic sources, features/unique sources and specific important to the community places, along the project alignment and nearby areas can be summarized as follow:

Important place	Distance from project route (m)	Remark
1. House of Christ Church	450 m (north and east direction)	
2. Lat Phrao Temple	500 m (north direction)	Built in 1870
3. Lat Phrao Lutheran Church	20 m (south direction)	
4. Hidayatun Islam Mosque (Don Sakae)	420 m (south direction)	Built in 1952
5. Mae Phra Kularb Tip Church (Maria Rosa Mystica Church)	100 m (south direction)	Built in 1998
6. Ruam Nimit Bangkok Church	200 m (north direction)	Built in 1990
7. Fatthullbalee Mosque	20 m (east direction)	
8. The Church of God in Bangkok/District6	250 m (east direction)	
9. Jamiul Idhard Mosque (Hua Mak Yai)	250 m (north direction)	
10. Darissalam Mosque	150 m (south direction)	
11. Nam Phrathai Christian Church	470 m (south direction)	
12. Carissalam Mosque	400 m (west direction)	
13. An Latisom Mosque	400 m (southwest direction)	
14. Kom Temple (Khajonsiri)	220 m (southwest direction)	Built in 1849
15. Darul Amin Mosque	110 m (west direction)	
16. Si lam Temple	140 m (west direction)	Built in 1974
17. Udom Suk Si Pha Rak Christendom Church	310 m (southwest direction)	

Important place	Distance from project route (m)	Remark
18. Samrong Lutheran Church	350 m (northwest direction)	
19. Dan Samrong Temple	290 m (northwest direction)	

According to above table that the existing environment along the project route and adjoining areas (within a radius of 50 meters from the project route) doesn't has historical places and communities important places to the affected on scenery.

Chapter 5

Environmental Impact Assessment

The environmental impact assessment is the processes that evaluating the effects that may occur due to development projects in both construction Phase and operation Phase that cover in four areas, which are; physical environmental resources. Biological environmental resources, human use values and quality of life. By proceed accordingly with the guidelines of the Environmental Impact Assessment Division. Natural Resources and Environmental Policy and Planning Office. The results of the evaluation in each field can be summarized below.

5.1 Physical Environmental Resources

5.1.1 Topography

5.1.1.1 The Impact of the Elevated Structures and the Stations area

1) Construction Phase

Since the construction of the MRT system build over the area along the median strip which the terrain is flat and low lying flood with an altitude of no more than 1.50 meters above mean sea level. However, during the construction Phase, the construction need to excavating / land leveling for the construction of elevated highways and Sky train stations that expecting little impact on the landscape or no impact at all.

2) Operation Phase

During the project operation Phase, the median strip will transform to support structures for the evaluated highway and Sky train stations with a height of 14-23 meters or approximately 29 meters / pillar. Plant and grass will be planted alongside the structures for the beauty and serenity. Therefore, it is not expected to affect the state of the landscape along the project in any way.

5.1.1.2 The Impact of Depot and Park and Ride buildings area

1) Construction Phase

The Depot and Park and Ride building will construct on a large flat area with the elevation less than 1.50 meters above mean sea level. The construction will be excavating and leveling the space with a maximum height of 15 meters. While Park and Ride buildings will be at the ground level, therefore there is limited chance of the impacts on the topography change or no impact occurs.

2) Operation Phase

The construction areas will be transformed into a reinforced concrete structure maintenance building with a maximum height of 25 meters and a seven story park and ride buildings with a maximum height up to 25 meters and parking space for 2,800 vehicles.

Furthermore, the construction area will be improved with a large modern building thus it is expected to have an impact on the landscape in the area when the construction project completed.

5.1.2 Soil Resources

5.1.2.1 The Impact of the Elevated Structures and the Stations area

1) Construction Phase

1.1 The impact on the structure and properties of the soil. Since the construction of the Monorail system involve the excavation out the soil and open up surface for the construction space, for the construction of the elevated highway support structure foundations in a distance of approximately 30 kilometers including the construction of 23 stations, consequently, disturbing the structure and properties of the soil will be unavoidable. This Phase will need to fill the space and ground resources with the rich soil that suitable for planting cover crops, shrubs/medium-sized trees to replace the original soil. Therefore, it has a direct negative impact on the structure and properties of the soil that vary from the property and structure of the original soil. However, the property and structure of original soil mostly consist of clay particle which originates from parent material in a flood plain. Top soil is dark gray - black clay and subsoil are sticky clay soil that medium to low in nutrients plants can not absorb soil nutrients. Thus, soil suitability for planting is low. In addition, the construction of elevated highways and stations will be taken place mainly on the traffic island. The impact on the structure and properties of the soil during the construction Phase is relatively low when to compare and contrast the benefits of soil that have lost permanent or inevitable for the construction project with the total distance of 30 km radius and 2.50 meters wide, the total area of no more than 45.68 Rais.

1.2 The impact of the changing condition of construction site on soil erosion. There will be a significant amount of excavating and leveling activities during the construction of elevated highways and stations, especially during the rainy season. the amount of soil from a number of drill rigs dropped or fall on a construction site or the road surface will be moving out of the area. Rainfall and runoff will flow along the slope of the road surface or into wetlands or low public water supply. It is a moderate impact on the accumulation of sediment, soil and shallow waters of the public water supply e.g. Num Kaeo Canal, Bang Sue Canal, Lat Phrao Canal, Jow Khun Sing Canal, Jun Canal, Yai Phuan Canal, Ta Nhung Canal, San Sab Canal, Ka Ja Canal, Hua Mak Canal, Ban Na Canal, and Samrong Canal etc.

2) Operation Phase

During the operation Phase, there will be no impact on soil resources and soil erosion due to the structure take place mostly on the traffic island where there is space under the elevated structure. Plus, there will be planting ground cover, shrubs or medium-sized trees throughout the route to mitigate soil erosion and to prevent sediments transport into the public sewer or public water sources.

5.1.2.2 Impact on Depot Area and Park and Ride buildings

1) Construction Phase

1.1 The structure and properties of the soil in Depot and Park & Ride buildings construction site are expected to impact. Since the current condition of construction sites are mainly lowland and flooded soils. Therefore, the area needs to filling and leveling for at least above the flood level of up to 50 centimeters (+1.5 m. MSL) by bringing soil from excavations for building foundations, supporting structures, elevated railways or soil from another area. Thus, it is unavoidable for the disturbing condition / structure / properties of the soils. However, the negative impact is expected low because the area around the depot is empty space. Moreover, the area of the Park and Ride buildings mainly consists of an office building and residents area of the highway district of Samut Prakan which not be used for agriculture nor directly related to the soil resources.

1.2 Soil erosion surrounding Depot and Park & Ride buildings is likely to occur at the moderate level. This is because the east end of the construction site of Depot and Park and Ride building is located close to Khlet Canal approximately 160 meters. During the rainy season, which would have a significant amount of rain and sediment erode and transport into Khlet Canal. Therefore, the impact caused by the deposition of sediment and silt of Khlet Canal.

2) Operation Phase

If the Depot and Park and Ride buildings are completed, there will be no impact occurs. Because most of the area has a concrete floor, and the buildings were elevated from the ground, about three meters (Depot). Also, the surrounding area of the construction sites consists of concrete wall and plant trees. It is very unlikely to cause erosion of the amount of sediment flowing into the public sewer.

5.1.3 Geology and Earthquake

5.1.3.1 The Impact of the Elevated Structures and the Stations area

1) Construction Phase

The construction of the project could affect the structural geology / geological foundation on the motion of the layer of soft clay since the construction area is located along the mild to moderate soft clay to a depth of about 18 meters. If drilling Circular Bored Pile in diameter from 1.50 to 1.80 meters or Barrette Pile to replace the volume of soil to be dug out. It is likely that the soft clay layer will be moved very easily. It is expected to have a moderate impact on the soil around the pile particularly on the construction site of the stations that take place near surface water since the soft clay layer will be expanded. Also, the amount of soil will be squeezed out to the side or moving in all directions. As a result, the building or structures near the rail system (about 20 meters corridor, including Phibul Uphatum schools, Soi Phawana Community, Lat Phrao Hospital, Vejthani Hospital , and Chularat II Hospital) or the utilities near sidewalks along both sides of the street e.g. concrete sewer pipes , water pipes, electricity cables underground or phone underground channels etc., might also be slightly damaged. The impact of

the earthquake is not expected to occur or to be affected by low level. Since the construction area is located in 2A in V-VII Section, according to Mercalli scale. The residents of the building are slightly shocked if the building is constructed in poorly designed. Therefore, it appears the damage or less risk of damage in the low to moderate levels.

2) Operation Phase

In operation Phase, the project is expected to have no impact from earthquake due to the elevated structure of the station designed to support in case of geohazard or earthquake according to AASHTO standards with the Acceleration Coefficient (0.075) and Site Coefficient (S) of 1:50 to 2:00. Also the design further reinforced by the special structure of the elevated structure to prevent it from moving out of the top spot. support structure

5.1.3.2 Impact on Depot Area and Park and Ride buildings

1) Construction Phase

The construction of the Park and Ride building could affect the structural geology / geological foundation on the motion of the layer of soft clay since the construction area is located along the mild to moderate soft clay to a depth of about 18 - 20 meters. If drilling Circular Bored Pile in diameter from 0.35 meters to replace the volume of soil to be dug out from the construction of Depot with the maximum height of 15 meters (2 stories). It is likely that the soft clay layer will be moved very easily. It is expected that the volume of soil around piles that is soft clay layer will be expanded or the amount of soil is squeezed out, moving in all directions. Consequently, the surrounding utilities nearby such as concrete sewer pipes and underground electrical/phone conduits, etc. expected to be slightly damaged. The impact of the earthquake is not expected to occur or to be affected by low level. Since the construction area is located in 2A area in V-VII Section, according to Mercalli scale. The residents of the building are slightly shocked if the building is constructed in poorly designed. Therefore, it appears the damage or less risk of damage in the low to moderate levels.

2) Operation Phase

In operation Phase, the project is expected to have no impact occurs. The Depot and Park & Ride buildings are concrete building that designed to support the case of geohazard or earthquake, according to the Ministry of Interior "Load resistance and durability of building ground for building vibration resistance of earthquake 2007" issued under the Building Control Act 1979.

5.1.4 Surface Water Quality

5.1.4.1 The Impact of the Elevated Structures and the Stations area

1) Construction Phase

1.1 The impact, regarding the construction activities particularly for the excavation, filling and leveling, excavation for the structure of the elevated Skytrain foundations support, or moving construction materials such as cement, sand, stone, clay, etc., is low. Since the

construction of the structure will not create any portion intrude into the surface water, therefore, there will be no activity interferes with surface water quality except for those station located less than 50 meters from surface water that are; Lat Phrao 101 stations, Kelantan station, and Suan Luang Ro 9 station. These three stations might affect by an increase in turbidity from soil erosion during the excavations, foundations and filling and leveling processes or might contaminate with oil from the equipment. However, the impact is expected to be low since the construction area is limited only in the traffic island. In addition, the analysis of surface water quality from water sources along the rail system showed that the surface water quality already deteriorated because they receiving sewer water from a large urban area. It has been contaminated by the dirty relatively in BOD (high) the dissolved oxygen (low) and the coliform bacteria (high). If water turbidity increase from the construction activities there will not affect much in the water quality.

1.2 The impact of the activities in the project office and construction of shelters for construction workers are considered into two scenarios:

A) With the project office

The Environmental Impact Evaluation Bureau, Office of Natural Resources and Environmental Policy and Planning (1999) has set the minimum rate of water use standard in the office. (No overnight stay) is 50 liters / person / day, equivalent to the amount of wastewater. Based on provided number, wastewater and sewage from the use of bathroom / toilet or washing dishes in the daily operation of the staff working in the office up to 200 people (according to the construction of Bangkok Mass Transit Line extension Sukhumvit Phase I, 2009) $50 \times 200 \times 0.80 = 8,000$ liters / day, or eight cubic meters / day (equivalent to the rate of water loss by 80 percent the amount of water used). Therefore, the adequate bathroom and toilet with sanitation should be one room for 10 people and installation of sewage treatment capacity of 2 cubic meters per tank (5 tanks total) as shown in **Figure 5.1.4 – 1**. Thus, the capacity of waste water treatment to cover the total volume of, wastewater that might occur within the project office should be ten cubic meters.

- The Environmental Impact Evaluation Bureau, Office of Natural Resources and Environmental Policy and Planning (1999) determined the rate of solid waste 3 liters / person /day. Therefore, the amount of solid waste that may result from activities of approximately 200 staffs while work each day in the offices is equivalent to the volume of solid waste equal to 0.60 cubic meters / day ($200 \times 3 / 1,000$). In order to limited the dumping of solid waste problems or littering that might blockage and affect surface water nearby, the project need to provide the trash with a capacity of 0.24 cubic meters of solid waste at least eight tanks (plastic squares. $0.58 \times 0.71 \times 1.07$ Meters or equivalent), with a total volume of 1.92 cubic meters (by 0.24 cubic meter $\times 8$ cans) distributed in the different locations in order to gather by the office for the district office in Bangkok under the waste collection disposal to comply with sanitary.

B) With the Project office and shelters for construction workers

- The Environmental Impact Evaluation Bureau, Office of Natural Resources and Environmental Policy and Planning (1999) determined the rate of water use in the office (no overnight stay) is 50 liters/person/day and the rate of water consumption in the

residential community of 200 liters/person/day. The estimation of wastewater and sewage that might occur from the daily use of bathroom / toilet, dishes washing or body cleansing during operation of approximately 1,400 people (200 office staffs – no overnight stay) and (1,200 construction workers – with overnight stay), number based on the construction of Bangkok mass transit line extension Sukhumvit 1, 2009, is expected to have the maximum volume of wastewater occurs equal to 200 cubic meters / day $[(200 \times 50 + 1,200 \times 200) \times 0.80] / 1,000$. Calculating based on 80 percent of the rate of water loss by the amount of water used, therefore adequate bathroom/toilet with the sanitation must provide for at least 10 people/ room and install wastewater treatment system with the capacity of 12 cubic meters/ tank for 20 tanks; as shown in **Figure 5.1.4 - 1**, Thus, a total volume of sewage for wastewater treatment activities that might occur within Office Project and construction worker shelters is approximately 240 cubic meters per day.

- The Environmental Impact Evaluation Bureau, Office of Natural Resources and Environmental Policy and Planning (1999) determined the rate of garbage per day is 3 liters / person. Therefore, the amount of waste from 1,200 construction workers in the construction shelters will be in a total amount of solid waste of 3.60 cubic meters / day $(1,200 \times 3 / 1,000)$. In order to prevent the problem of waste dumping, littering, or dropping garbage into a drainage around the office and residential area which will cause the blockage of surface water nearby, at least 50 trash cans with capacity of 0.24 cubic meters, (plastic squares. $0.58 \times 0.71 \times 1.07$ meters or equivalent) representing a total volume of 12 cubic meters (0.24×50) distributed into groups of 10 cans inside the office and construction worker shelters should be provided in order to gather by the office for the district office in Bangkok under the waste collection disposal to comply with sanitary.

Clearly, if the office project and the construction worker shelters are in the same place along the project route, the impact on waste water and solid waste management would be relatively high. The recommendation is that the "Office" should set up separately with the construction worker shelters by located approximately 5 kilometers away from the rail system and should propose for the approval from the MRTA and must comply with laws / regulations of local authorities in the construction of residential or strictly followed the. Ref. 1979, or the Building Control Regulation No. 55 Year 2000 Ministry of Interior.

1.3 The impact of the ongoing construction activities such as washing and cleaning construction equipment, vehicles, etc. that will take place in the office area, is expected to take water no more than 12 cubic meters / day (according to the Bangkok Mass Transit System Construction. Sukhumvit Line Phase I, 2009) as waste water 12×0.80 of 9.60 cubic meters / day. Therefore, two sewage treatments with a capacity of six cubic meters each or volume of 12 cubic meters in total should be installed for treat waste water from the activities that may occur.

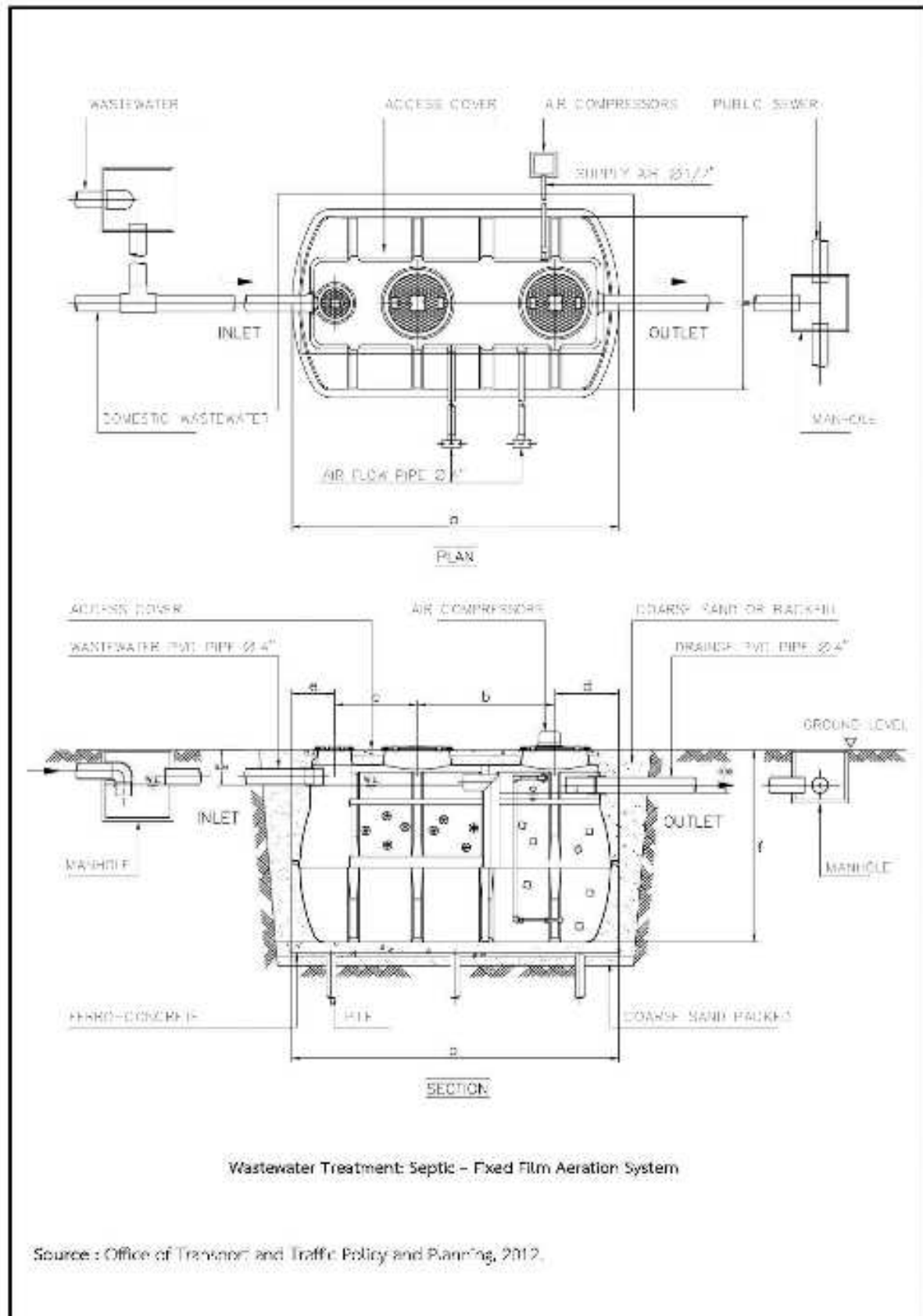


Figure 5.1.4 - 1 Example of wastewater treatment: septic - fixed film aeration system
(Cap. 2 - 12 cubic meters)

2) Operation Phase

As the Monorail system which runs on elevated structures, using electricity to drive, it does not affect surface water quality in the passing water sources. As for the stations, the daily amount of waste water from the use of the employee restroom that perform various functions such as ticketing, information, security and communications, etc. approximately 10 people/stations. The amount of water usage is 50 liters/person, equivalent to 400 liters of wastewater (50x10x0.80 / day or 0.40 cubic meters / day; equivalent. the rate of water loss by 80 percent the amount of water used), thus the amount of water that will be treated by the wastewater treatment plant with the capacity of 2 cubic meters, ready to be installed in all stations, there will be no impact occurs as shown in **Figure 5.1.4 - 1**.

5.1.4.2 Impact on Depot Area and Park and Ride buildings

1) Construction Phase

The Depot which located east of the Si lam Junction with construction activities especially the excavation leveling, drilling foundations for building for support a two-floor Depot or moving construction materials such as cement, sand, stone and clay, etc., is expected to have a low impact on the increasing in turbidity, impurities in BOD or contamination from the use of equipment with the use of oil, etc., even if the Depot is located adjacent to surface water (Khlet Canal), but no construction portion intrude into the canal and there is no activity that disturbs the surface water quality in the Khlet Canal.

2) Operation Phase

The Depot which located east of the Si lam junction will produce waste water from using the bathroom, toilet, and dish washing from the employees in the administration building and the control center, staff dormitory, and restaurants as well as the wastewater from washing and railcar maintenance activities. The amount of waste water will total 88.27 cubic meters/day as shown in **Figure 5.1.4 -2**. The amount of wastewater from mentioned activities will be treated using three small Onsite Treatment Plant which is Septic - Anaerobic Filter and Contact Aeration Process, with the capacity of 50 cubic meters in a total volume of 150 cubic meters, and followed by the retention. The wastewater from the traffic control centers and staff dormitory will be compiled into a septic system that directly installed onsite while the wastewater from restaurants and train maintenance and cleaning will flow through oil Interceptor to extract the fat and oil prior to discharge into the Khlet Canal. Therefore, the expected impact is low.

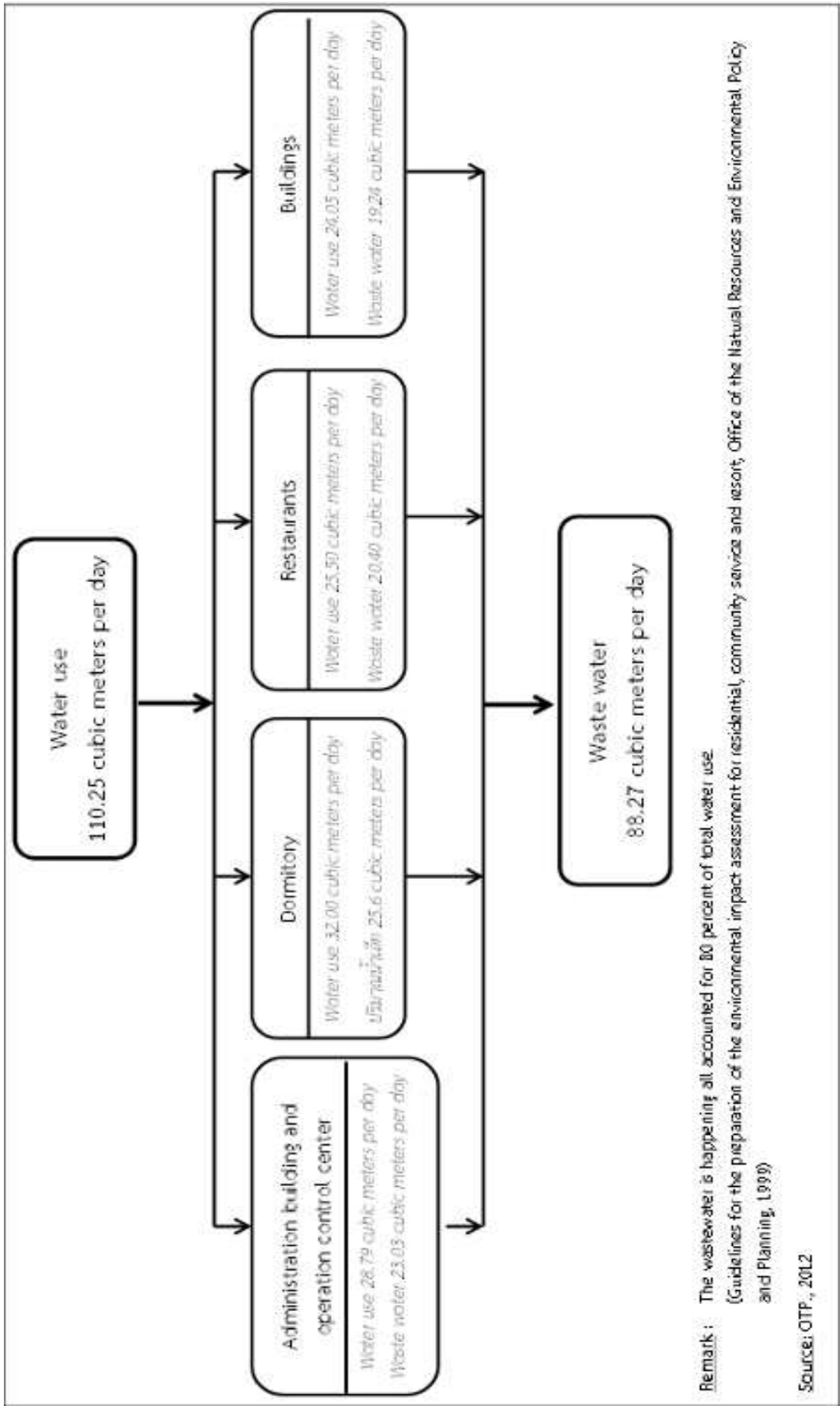


Figure 5.1.4-2 Summary water use demand in Depot

5.1.5 Air Quality

5.1.5.1 The Impact of the Elevated Structures and the Stations area

1) Construction Phase

Suspended Particulate Matter

Project construction activities, including site preparation and construction, site excavation, relocation of utilities, drilling rigs, casting the stanchion, the construction of the pillar structure as well as stations and escalator, machinery and transport equipment, construction materials, etc. The relocation of utilities, particularly water supply pipe in the middle of traffic island of Lat Phrao road will immediately relocate at the beginning of the project. Thus, the operations will cause a negative impact on air quality along the construction area of the project especially in dust and pollution from the use of construction equipment. The amount of dust that happens will depend on factors such as soil characteristics, soil moisture, wind speed and direction, the Phase of construction, and etc. The concentration of dust particles in the atmosphere will be varied with the origin and soil composition but inversely proportional to soil moisture. The impact assessment of the suspended particles from construction activities will be considered in the worst case, which can be calculated as the Box Model of John G. Rau and David C. Wooten. (1996) as follows:

$$C = \frac{Q}{D \times W \times U}$$

- Where C = The concentration of the pollutant (mg / m³).
 Q = The rate of discharge pollutant (mg / sec).
 D = Mixing Height (m)
 W = The width of the area perpendicular to the wind direction (m).
 U = Wind speed (m / s).

From the project construction activities based on the nature of the construction US.EPA (The Environmental Protection Agency) under "Compilations of Emission Factor, AP - 42" (Fifth Edition, Volume I: 1995), which states that "moderate construction activities with the volume of 30 percent loam, with the index evaporation of 50 percent would cause the emission of dust particles into the atmosphere, about 1.2 tons/acre/month". The construction activities of the project are the large construction project that must be open and recondition as well as the excavation, relocate utilities, drilling rigs and construction of foundation structures. The occurrence of total suspended particulates (TSP) will similar to activity, development, and large construction US.EPA (1995). Therefore, the construction activities of the project will emit suspended dust particle about 12 tons/acre/month, equivalent to 296.5 gram /square meter/month. In the construction projects scheduled for construction activities daily (30 days / month) worked eight hours per day.

For the construction area, the routes and the stations ascent/descent stairways will be constructed in section, by each section will simultaneously excavate the surface of the traffic island and one traffic lane on each side by a distance of 1000 meters. During the construction, the open area will cover 7, 8.4, and 7 meters on Lat Phrao road, Srinagarindra road and Thepharak road, respectively with the width of the construction area in the middle of the road approximately 10 meters. In which the calculation is based on the worst case is the longest side of the perpendicular. wind direction by a construction area of 10,000 square meters.

For the station, there will be 23 stations along the project route that construct in the middle of the route with the width and length of 23 and 120 meters respectively. The station construction will unearth to construct the foundations as the same procedure of the construction of the route foundations with a width of 10 meters. Therefore, each station will be the construction of bases and piles in the median of the road, six piles as 1200 square meter construction area per station or total construction area stations (23 stations) of 27,600 square meters.

For the stairways, there will be four stairways per station, two per side, with a width of approximately 18 meters and a length of about 26 meters each. The construction of stairways will excavate approximately 468 square meters per side or 1872 square meters per station. The total area of the building stairways (23 stations), equal to 43,056 square meters.

Based on the data from Don Muang airport weather stations, in a 30-year Phase (1981-2010), the average wind speed is 4.0 knots or minimum 2.06 m/s with the wind direction from the south and the Mixing Height of 1,000 meters (Leeuwen and Vermeir, 2007).

The calculation of the concentration of dust emission from construction projects using Box Model, which assesses the value of John G. Rau and David C. Wooten (1996) are summarized below.

A) The impact of the elevated structure less than 1000 m. per section

$$C = \frac{Q}{D \times W \times U}$$

$$Q = \frac{296.5 \times 10^3 \times 10,000}{30 \times 8 \times 3,600} \quad \text{Milligrams per second}$$

$$Q = 3,431.71 \quad \text{Milligrams per second}$$

$$C = \frac{3,431.71}{1,000 \times 1,000 \times 2.06} \quad \text{Milligrams per cubic meter}$$

$$C = 0.00167 \quad \text{Milligrams per cubic meter}$$

When combining the calculated results with the results from the measurement in Lat Phrao, road Srinagarindra road Theparak road, as shown in **Table 5.1.5 - 1**, the amount of total suspended particulates were 0.09167 0.18167 and 0.21667 milligrams per cubic

meter, respectively. However, the total amount of dust suspended in that area was lower than the air quality standards announced by the National Environment Board No. 24 (2004). Ambient Air Quality Standards which determines the concentration of total suspended particles in the atmosphere must not exceed 0.330 milligrams per cubic meter. By the percentage 27.78, 55.05, and 65.66 of the standard respectively, thus expect construction activities along the project route of the would generate the impact of low to moderate.

Table 5.1.5 - 1 The predicted concentration of TSP from construction activities along the project route

Project route	TSP from construction activities (mg/m ³)	Max. TSP from air quality sampling station (mg/m ³)	Total TSP (mg/m ³)
Lat Phrao road	0.00167	0.090 ^{1/}	0.09167
Srinagarindra road	0.00167	0.180 ^{2/}	0.18167
Thepharak road	0.00167	0.215 ^{3/}	0.21667
Standard^{4/}	0.330		

Remark :

- 1/ = The maximum concentration of TSP (average 24 hr.) is 0.090 mg/m³ at Pibool Upphatham School, Samsennok Sub-district, Huai Khwang District, Bangkok during 21 - 22 June, 2013.
- 2/ = The maximum concentration of TSP (average 24 hr.) is 0.180 mg/m³ at Klongkalantan school, Suan Luang Sub-district, Suan Luang District, Bangkok during 16 - 17 June, 2013.
- 3/ = The maximum concentration of TSP (average 24 hr.) is 0.215 mg/m³ at Chulavej hospital, Thepharak Sub-district, Mueang Samut Prakan District, Samut Prakan Province during 28 - 29 June, 2013.
- 4/ = Notification of National Environmental Board No. 24, 2004 (B.E. 2547). Total Suspended Particulate (TSP) average 24 hr. standard value is not exceed 0.33 mg/m³

B) The impact of the construction area and the stairways of 23 stations

$$C = \frac{Q}{D \times W \times U}$$

$$Q = \frac{296.5 \times 10^3 \times 3,072}{30 \times 8 \times 3,600} \quad \text{Milligrams per second}$$

$$Q = 1,054.22 \quad \text{Milligrams per second}$$

$$C = \frac{1,054.22}{1,000 \times 120 \times 2.06} \quad \text{Milligrams per cubic meter}$$

$$C = 0.00426 \quad \text{Milligrams per cubic meter}$$

When combining the calculated results with the results from the measurement in Lat Phrao, road Srinagarindra road Theparak road, as shown in **Table 5.1.5 - 2**, the amount of total suspended particulates was 0.09426, 0.18426, and 0.21926 milligrams per cubic meter, respectively. However, the total amount of dust suspended in the area is lower than the air

quality standards announced by the National Environment Board No. 24 (2004). Ambient Air Quality Standards which determines the concentration of total suspended particles in the atmosphere must not exceed 0.330 milligrams per cubic meter. By the percentage 28.57, 55.84, and 66.44 of the standard respectively, thus expect construction activities along the project route the would generate the impact of low to moderate.

Table 5.1.5 - 2 The predicted concentration of TSP from station construction area along the project route

Project route	TSP from construction activities (mg/m ³)	Max. TSP from air quality sampling station (mg/m ³)	Total TSP (mg/m ³)
Lat Phrao road	0.00426	0.090 ^{1/}	0.09426
Srinagarindra road	0.00426	0.180 ^{2/}	0.18426
Thepharak road	0.00426	0.215 ^{3/}	0.21926
Standard^{4/}	0.330		

Remark :

- 1/ = The maximum concentration of TSP (average 24 hr.) is 0.090 mg/m³ at Pibool Upphatham School, Samsennok Sub-district, Huai Khwang District, Bangkok during 21 - 22 June, 2013.
- 2/ = The maximum concentration of TSP (average 24 hr.) is 0.180 mg/m³ at Klongkalantan school, Suan Luang Sub-district, Suan Luang District, Bangkok during 16 - 17 June, 2013.
- 3/ = The maximum concentration of TSP (average 24 hr.) is 0.215 mg/m³ at Chulavej hospital, Thepharak Sub-district, Mueang Samut Prakan District, Samut Prakan Province during 28 - 29 June, 2013.
- 4/ = Notification of National Environmental Board No. 24, 2004 (B.E. 2547). Total Suspended Particulate (TSP) average 24 hr. standard value is not exceed 0.33 mg/m³

Toxic Gases Pollutants

The impact from the usage of vehicles for materials transportation, construction equipment and machinery used in construction which is considering from the vehicle used to transport various construction materials including the functioning of large machinery. This may cause a negative impact on communities near the construction area due to the spread of dust cause from running out of space and exhaust from vehicles and operation of machinery, such as carbon monoxide (CO), hydrocarbons (HC), oxides of nitrogen (NO_x) and. Total suspended particulates (TSP). The projected rate of pollution from machinery and equipment in the construction work will be considered from the Box Model of the John G. Rau and David C. Wooten (1996) as well as assessing the impact of suspended dust from construction activities which is considered the worst case scenario as follows

- The pollution from machinery and equipment, according to the construction of US.EPA is shown in **Table 5.1.5 - 3**.

- The number of machines, equipment and vehicles are expected to be used in construction projects shown in **Table 5.1.5 - 4**.

- The construction activities will be carried out 30 days / month and no more than eight hours a day.

Table 5.1.5 - 3 Emission Factor from construction equipments

Construction equipments	Concentration (kg/unit/hr)			
	CO	HC (in term of CH ₄)	NO _x (in term of NO ₂)	TSP
1. Bulldozer	0.35	1.05	2.30	0.08
2. Backhoe	0.25	0.09	1.09	0.08
3. Roller	0.10	-	0.45	-
4. Motor Grader	0.10	-	-	-
5. Truck Loader	0.05	-	0.25	0.05
6. Diesel Truck	0.61	0.20	3.45	0.12
7. Pickup Truck	1.04	0.05	0.02	0.03

Source : US.EPA. "Compilation of Air Pollutant Emission Factors", Publication No. AP - 42. (1995)

Table 5.1.5 - 4 Construction activities and construction equipments

Construction activities	Equipment/machine	No. of equipment per construction Phase (vehicle/day)		
		Guideway Structure	Station	Depot and Park & Ride
1. Ground clearing and preparation	Bulldozer	1	1	10
2. Digging trenches, filling and ground improvement.	Backhoe	1	1	10
3. Compacted ground	Roller	1	1	10
4. Ground leveling	Motor Grader	1	1	10
5. Soil moving	Truck Loader	1	1	25
6. Material moving	Diesel Truck	1	1	25
7. Transport staff	Car and Pickup Truck	2	2	10
Total		8	8	100

Source : Office of Transport and Traffic Policy and Planning, 2012.

- The construction area including the construction of elevate structures and station's ascent/descent stairway will assess the amount of total suspended particulates from the plant is 10,000 and 3072 square meters of construction area or length by width perpendicular to the wind direction. By considering the worst case scenario that the side is most perpendicular to the wind direction with the width of the elevated structure and station's ascent/descent stairway are 1,000 and 120 meters, respectively.

- Based on the data from Don Muang airport weather stations, in a 30-year Phase (1981-2010), the average wind speed is 4.0 knots or minimum 2.06 m/s with the wind direction from the south and the Mixing Height of 1,000 meters (Leeuwen and Vermeir, 2007).

The projected concentrations of exhaust pollution caused by equipment and vehicles used in the construction area; the details are as follows

A) The Impact of the Elevated Structures less than 1,000 m per section

The impact of the elevated structure construction less than 1,000 meters found that the carbon monoxide (CO) is equal to 0.00334 ppm. Hydrocarbon (HC) is equal to 0.00238 ppm. Nitrogen dioxide (NO₂) is equal to 0.00435 ppm. The total suspended particulates (TSP) equals 0.00042 Milligrams per cubic meter. In General, the total value not exceeding the Ambient Air Quality Standards announced by the National Environment Board No. 10 (1995) and No. 24 (2004) which determines the concentration of Carbon Monoxide (CO) the average one hour does not exceed 30 parts per million. Nitrogen dioxide (NO₂) the average one hour less than 0.170 parts per million. Average total suspended particulates and up to 24 hours while 0.33 Milligrams per cubic meter of gas hydrocarbons in the country has not yet determined its benchmark as shown in **Table 5.1.5 - 5**.

Table 5.1.5 - 5 Results of air quality impact prediction from the construction machines, equipments and vehicles at guideway structure construction area

Construction equipments	Concentration of air pollution from guideway structure construction area			
	CO (ppm)	HC (ppm)	NO ₂ (ppm)	TSP (mg/m ³)
1. Bulldozer	0.00038	0.00113	0.00248	0.00009
2. Backhoe	0.00027	0.00010	0.00118	0.00009
3. Roller	0.00011	-	0.00049	-
4. Motor Grader	0.00011	-	-	-
5. Truck Loader	0.00005	-	0.00027	0.00005
6. Diesel Truck	0.00066	0.00022	0.00372	0.00013
7. Pickup Truck	0.00224	0.00011	0.00004	0.00006
Total	0.00382	0.00156	0.00818	0.00042
Total (ppm)	0.00334	0.00238	0.00435	-
Standard	30 ppm ^{1/}	-	0.170 ppm ^{1/}	0.330 mg/cu.m. ^{2/}

Remark : 1/ Notification of National Environmental Board No. 10, 1995 (B.E. 2538).

2/ Notification of National Environmental Board No. 24, 2004 (B.E. 2547).

Combining the results from the calculation with the results from the measurement in the field during 14 June to 2 July, 2013, found that carbon monoxide (CO) is equal to 3.60334 ppm or 12.01 percent of the standard. Hydrocarbon (HC) is equal to 3.20238 ppm. Nitrogen dioxide (NO₂) is equal to 0.10445 ppm or 61.44 percent of the standard. And total suspended particles (TSP) equals 0.21542 Milligrams per cubic meter or 65.28 percent of the standard. The total value is still lower than the air quality standards announced by the National Environment Board No. 10 (1995) and No. 24 (2004). According to the Ambient Air Quality Standards, except hydrocarbons in Thailand that have not set the standard yet, is shown in **Table 5.1.5 - 6**. Considering the actual work in the construction area, the use of such equipment will follow the construction process. By not having work all together and not run the equipment all day, thus, the accumulation of pollutants from the equipment and vehicles will not accumulate. Moreover, the duration of each Phase of construction will take place only a short time and the equipment will be moved along the project route. Therefore, the impact is low to moderate.

Table 5.1.5 – 6 Results of air quality impact prediction from the guideway structure construction area, and the combinations of existing air quality condition during 14 June – 2 July, 2013

Item	Concentration of air pollution from guideway structure construction area including maximum baseline concentration			
	CO (ppm)	HC (ppm)	NO ₂ (ppm)	TSP (mg/m ³)
Prediction result	0.00334	0.00238	0.00435	0.00042
Max. concentration from sampling stations	3.6 ^{1/}	3.2 ^{2/}	0.1001 ^{3/}	0.215 ^{4/}
Total	3.60334	3.20238	0.10445	0.21542
% of standard	12.01	-	61.44	65.28
Standard	30^{5/}	-	0.170^{5/}	0.330^{6/}

Remark : 1/ The maximum concentration of CO (average 1 hr.) is 3.6 ppm at Chulavej hospital, Thepharak Sub-district, Mueang Samut Prakan District, Samut Prakan Province during 27 - 28 June, 2013.
2/ The maximum concentration of THC is 3.2 ppm at Klongkalantan school, Suan Luang Sub-district, Suan Luang District, Bangkok during 18 - 19 June, 2013.
3/ The maximum concentration of NO₂ (average 1 hr.) is 0.1001 ppm at Chulavej hospital, Thepharak Sub-district, Mueang Samut Prakan District, Samut Prakan Province during 29 - 30 June, 2013.
4/ The maximum concentration of TSP (average 24 hr.) is 0.215 mg/m³ at Chulavej hospital, Thepharak Sub-district, Mueang Samut Prakan District, Samut Prakan Province during 28 - 29 June, 2013.
5/ Notification of National Environmental Board No. 10, 1995 (B.E. 2538).
6/ Notification of National Environmental Board No. 24, 2004 (B.E. 2547).

B) The impact of the construction area and the stairways of 23 stations.

The impact of the station construction site found that there was Carbon Monoxide (CO) 0.0332 parts per million, Hydrocarbons (HC) 0.02375 parts per million, nitrogen dioxide (NO₂) 0.04346 parts per million and total suspended particles (TSP) 0.0042 milligrams per cubic meter, which is less than the threshold of air quality standards as well as the construction of elevated structures as shown in **Table 5.1.5 - 7**.

The results from the measurement in the field during 14 June to 2 July, 2013 confirmed that carbon monoxide (CO) is equal to 3.63332 parts per million or 12.11 percent of the standard. Hydrocarbons (HC) is equal to 3.22375 parts per million while nitrogen dioxide (NO₂) is equal to 0.14346 parts per million, or 84.39 percent of the standard. Also, total suspended particles (TSP) is equal to 0.2192 milligrams per cubic meter, representing 66.49 percent of the standard. The total value is still lower than the air quality standards according to the National Environment Board No. 10 (1995) and No. 24 (2007) Ambient Air Quality Standards (except hydrocarbons in Thailand that have not yet determined the standard) as shown in **Table 5.1.5 - 8**.

Considering the actual work in the construction area, the use of such equipment will follow the construction process. By not having work all together and not run the equipment all day, thus, the accumulation of pollutants from the equipment and vehicles will not accumulate. Moreover, the duration of each Phase of construction will take place only a short time and the equipment will be moved along the project route. Therefore, the impact is low to moderate

Table 5.1.5 - 7 Results of air quality impact prediction from the construction machines, equipments and vehicles at station construction area

Construction equipments	Concentration of air pollution from station construction area			
	CO (ppm)	HC (ppm)	NO ₂ (ppm)	TSP (mg/m ³)
1. Bulldozer	0.00378	0.01133	0.02481	0.00086
2. Backhoe	0.00270	0.00097	0.01176	0.00086
3. Roller	0.00108	-	0.00485	-
4. Motor Grader	0.00108	-	-	-
5. Truck Loader	0.00054	-	0.00270	0.00054
6. Diesel Truck	0.00658	0.00216	0.03722	0.00129
7. Pickup Truck	0.02240	0.00108	0.00043	0.00065
Total	0.03816	0.01554	0.08177	0.00420
Total (ppm)	0.03332	0.02375	0.04346	-
Standard	30 ppm ^{1/}	-	0.170 ppm ^{1/}	0.330 mg/cu.m. ^{2/}

Remark : 1/ Notification of National Environmental Board No. 10, 1995 (B.E. 2538).

2/ Notification of National Environmental Board No. 24, 2004 (B.E. 2547).

Table 5.1.5 - 8 Results of air quality impact prediction from the station construction area, and the combinations of existing air quality condition during 14 June - 2 July, 2013

Item	Concentration of air pollution from station construction area including maximum baseline concentration			
	CO (ppm)	HC (ppm)	NO ₂ (ppm)	TSP (mg/m ³)
Prediction result	0.03332	0.02375	0.04346	0.00420
Max. concentration from sampling stations	3.6 ^{1/}	3.2 ^{2/}	0.1001 ^{3/}	0.215 ^{4/}
Total	3.63332	3.22375	0.14346	0.2192
% of standard	12.11	-	84.39	66.49
Standard	30 ^{5/}	-	0.170 ^{5/}	0.330 ^{6/}

Remark : 1/ The maximum concentration of CO (average 1 hr.) is 3.6 ppm at Chulavej hospital, Thepharak Sub-district, Mueang Samut Prakan District, Samut Prakan Province during 27 - 28 June, 2013.

2/ The maximum concentration of THC is 3.2 ppm at Klongkalantan school, Suan Luang Sub-district, Suan Luang District, Bangkok during 18 - 19 June, 2013.

3/ The maximum concentration of NO₂ (average 1 hr.) is 0.1001 ppm at Chulavej hospital, Thepharak Sub-district, Mueang Samut Prakan District, Samut Prakan Province during 29 - 30 June, 2013.

4/ The maximum concentration of TSP (average 24 hr.) is 0.215 mg/m³ at Chulavej hospital, Thepharak Sub-district, Mueang Samut Prakan District, Samut Prakan Province during 28 - 29 June, 2013.

5/ Notification of National Environmental Board No. 10, 1995 (B.E. 2538).

6/ Notification of National Environmental Board No. 24, 2004 (B.E. 2547).

2) Operation Phase

The Monorail transit system that is mainly powered by electricity. The route is an elevated structure with the height from the road surface range from 14 - 25 meters thus, there will no pollution emission from the commuter train. However, the impact on air quality during the

Operation Phase of the project along the route will depend on the pollution from the exhaust of vehicles passing by on the main road along the project route such as Lat Phrao road, Srinagarindra road. Theparak road. The forecast volume of pollutants that occur in the following two cases.

A) The Impact of the Elevated Structures and the Stations area

Although the conditions and forms of land use along the route during the project to a medium to high density commercial and very dense residential area, the train system located on the traffic island of the main road that consist of a solid structure with a clear separation between the route about 6 meters, which can be vented to the top. It is expected that concentrations of air pollution caused by gases include CO 1-hour, NO₂ 1 hour, and THC from the exhaust of vehicles passing by on the main road along the project including Lat Phrao road, Srinagarindra road, and Theparak road will not exceed the standards which agree with the results from the air quality measurements that the maximum index were still not exceeded the standard in the area include Chulavej Hospital (CO 1-hour and NO₂ 1-hour peak of 3.6 and 0.1001. parts per million) and Kelantan Canal school (max THC was 3.20 parts per million), etc. Thus, areas with elevated structures along the project route are expected to prevent the formation of air pollution in the area even there are traffic jams on the main roads.

B) The impact of construction area and the stairways of 23 stations

To study the impact on air quality from the road below the train station (Platform), the Box Model of John G. Rau and David C. Wooten (1996) was used to predict the concentration of pollutants from motor vehicles by considering the pollution caused by traffic problems include carbon monoxide (CO) that is a pollutant released from the exhaust of the vehicle while running at low speed, or in idle. The carbon monoxide from the exhaust gas, depending on the type and speed of various vehicles are based on Environmental Impact Assessment Report on the MRTA Initial System (1993). A study and analysis of carbon monoxide, which is released from vehicles on the main road in an urban area with six lanes and traffic density, the speed of the vehicle has a value of 0-1 km/hour and 8 km/hr During the year of 1993, 2006 and 2019 respectively was conducted for forecast the pollution emission from vehicles on the road with six lanes with a heavy traffic is shown in **Table 5.1.5 - 9**. As a result, the amount of carbon monoxide is likely to decline in the future if the power grid or mass transit, as well as the technology of fuel-burning vehicles running on the road, were developed more efficient. This will significantly reduce carbon monoxide emission. Therefore, the impact assessment considers the worst case scenario by the emission of carbon monoxide from the vehicle at the speed of 0-1 km/hr and 8 km/hr in 1993 as the highest rate of exhaust gas that is likely to occur underneath the train station in the current year (2013). Also, using the decreasing trend in the future during 2006 and 2019 projected in 2026 and 2039, respectively.

Table 5.1.5 - 9 Vehicles emission prediction on 6-lanes road and traffic jam condition

Vehicle speed (km/hr)	Concentration of CO (ppm)					
	1993		2006		2019	
	g/100 m/hr	g/sec/m ²	g/100 m/hr	g/sec/m ²	g/100 m/hr	g/sec/m ²
0 - 1	50,506	7.01	33,915	4.71	26,672	3.70
8	16,800	2.33	11,300	1.57	8,900	1.24

Remark : Apply from Environmental Impact Assessment Report on the MRTA Initial System, 1993.

Source : Office of Transport and Traffic Policy and Planning, 2012.

The prediction of carbon monoxide (CO) concentration, the forecast by application of Box Model John G. Rau and David C. Wooten (1996) as follows.

$$C = \frac{Q}{D \times W \times U}$$

Where C = The concentration of the pollutant (mg / m³).

Q = The rate of discharge pollutant (mg / sec).

= 7.01 g/s/m at the speed of 0-1 km/hr and 2.33 g/s/m at the speed of 8 km/hr. at the worst case scenario in one square meter in the area

D = The minimum height of the station (14 meters).

W = The width of the area perpendicular to the wind direction (m). The worst case scenario that the width of the space station was 120 meters.

U = The lowest average wind speed in the 30-year Phase (1981-2010) from Don Muang airport weather stations, that is 4 knots or 2.06 m/s.

Thus, at the vehicle speed of 0-1 km/hr, the concentration of carbon monoxide (CO) can be calculated as follows.

$$C = \frac{7,010}{14 \times 120 \times 2.06} \quad \text{Milligrams per cubic meter}$$

$$C = 2.03 \quad \text{Milligrams per cubic meter}$$

$$C = 1.77 \quad \text{parts per million}$$

At the vehicle speed 8 km/h, the concentration of carbon monoxide (CO) can be calculated as follows.

$$C = \frac{2,330}{14 \times 120 \times 2.06} \quad \text{Milligrams per cubic meter}$$

$$C = 0.67 \quad \text{Milligrams per cubic meter}$$

$$C = 0.59 \quad \text{parts per million}$$

The prediction of carbon monoxide (CO) concentration in the street below the train station each year is shown in **Table 5.1.5 - 10**. Combining the concentration of carbon monoxide

(CO) observed from the road under with a total maximum value of the measurement along the project route, the results of each predicted year shown in **Table 5.1.5 - 11**, which are summarized below.

(1) In the case of the vehicle speed of 0-1 km/hr.

(a) The carbon monoxide (CO) concentration from the forecast.

- Year 2013 = 1.77 parts per million
- Year 2026 = 1.19 parts per million
- Year 2039 = 0.93 parts per million

(b) The carbon monoxide (CO) concentration from the forecast combine with the maximum value that measured from the following routes

Lat Phrao Road area, using maximum value measured from Vejthani Hospital, which is equal to 2.3 parts per million. The values are as follows:

- Year 2013 = 1.77+2.3 = 4.07 parts per million
- Year 2026 = 1.19+2.3 = 3.49 parts per million
- Year 2039 = 0.93+2.3 = 3.23 parts per million

Srinagarindra Road area, using maximum value measured from Si lam Temple, which is equal to 2.7 parts per million. The values are as follows:

- Year 2013 = 1.77+2.7 = 4.47 parts per million
- Year 2026 = 1.19+2.7 = 3.89 parts per million
- Year 2039 = 0.93+2.7 = 3.63 parts per million

Theparak Road area, using maximum value measured from Chulavej Hospital, which is equal to 3.6 parts per million. The values are as follows:

- Year 2013 = 1.77+3.6 = 5.37 parts per million
- Year 2026 = 1.19+3.6 = 4.79 parts per million
- Year 2039 = 0.93+3.6 = 4.53 parts per million

Table 5.1.5 – 10 Results of Carbon Monoxide (CO) concentration prediction from roads under the station only during operation Phase.

Vehicle speed (km/hr)	Concentration of CO 1 hr (ppm)		
	2013	2026	2039
0 - 1	1.77	1.19	0.93
8	0.59	0.39	0.31

Table 5.1.5 – 11 Results of Carbon Monoxide (CO) concentration prediction from roads under the station, and the combinations of existing air quality condition

Project route	Vehicle speed (km/hr)	Concentration of CO 1 hr including maximum baseline concentration of CO ^{1/} (ppm)		
		2013	2026	2039
Lat Phrao road	0 - 1	4.07	3.49	3.23
	8	2.89	2.69	2.61
Srinagarindra road	0 - 1	4.47	3.89	3.63
	8	3.29	3.09	3.01
Thepharak road	0 - 1	5.37	4.79	4.53
	8	4.19	3.99	3.91
Standard^{2/}		30		

Remark : 1/ = Lat Phrao road section, the maximum concentration of CO (average 1 hr.) is 2.3 ppm at Vejthani hospital during 27 - 28 June, 2013.

= Srinagarindra road section, the maximum concentration of CO (average 1 hr.) is 2.7 ppm at Klongkalantan school during 17 - 18 June, 2013 and at Si lam Temple during 20 - 21 June, 2013.

= Thepharak road section, the maximum concentration of CO (average 1 hr.) is 3.6 ppm at Chulavej hospital during 27 - 28 June, 2013 and at Si lam Temple during 20 - 21 June, 2013.

2/ = Notification of National Environmental Board No. 10, 1995 (B.E. 2538). CO standard is not exceed 30 ppm.

(2) In case of the vehicle speed of 8 km/hr.

(a) The carbon monoxide (CO) concentration from the forecast.

- Year 2013 = 0.59 parts per million
- Year 2026 = 0.39 parts per million
- Year 2039 = 0.31 parts per million

(b) The carbon monoxide (CO) concentration from the forecast combine with the maximum value that measured from the following routes

Lat Phrao Road, using maximum value measured from Vejthani Hospital, which is equal to 2.3 parts per million. The values are as follows:

- Year 2013 = 0.59+2.3 = 2.89 parts per million
- Year 2026 = 0.39+2.3 = 2.69 parts per million
- Year 2039 = 0.31+2.3 = 2.61 parts per million

Srinagarindra Road area, using maximum value measured from Si lam Temple, which is equal to 2.7 parts per million. The values are as follows:

- Year 2013 = 0.59+2.7 = 3.29 parts per million
- Year 2026 = 0.39+2.7 = 3.09 parts per million
- Year 2039 = 0.31+2.7 = 3.01 parts per million

Thepharak Road area, using maximum value measured from Chulavej Hospital, which is equal to 3.6 parts per million. The values are as follows:

- year 2013 = 0.59+3.6 = 4.19 parts per million
- year 2026 = 0.39+3.6 = 3.99 parts per million
- year 2039 = 0.31+3.6 = 3.91 parts per million

The forecast report of carbon monoxide (CO) at the stations along the project found that combined the calculated carbon monoxide (CO) with the measured carbon monoxide (CO), show the highest value from the measurements in Lat Phrao road, Srinagarindra road, and Theparak road, (in case of the vehicle speed is 0-1 km/hr) that observed in 2013 were 4.07, 4.47, and 5.37 parts per million, respectively. The total value is lower than the air quality standard according to the Board of Directors of the National Environmental Act No. 10 of 1995 which states that the carbon monoxide average one hour should not exceed 30 parts per million. As the road structure below the train station almost every station, except Phawana station Chok Chai 4 station, Lat Phrao 101 station, and Samrong station, are open space with no high-rise buildings (more than two floors) on both sides of the train station. So that there is no obstruction for the pollution from vehicles that passing under the train station. Therefore, the air flow around the station is in a good condition just like the condition before the project construction. Also. the concentration of pollutants (CO - 1 hour) is not to exceed air quality standards or harm the health of a community or sensitive area, such as religious place, schools, or hospitals, etc. that located nearby stations. Thus, the impact is low. However, the project route is located mainly on the traffic median that passes through the urban commercial district, moderate density residential area, with open space, which in the future, may likely to expand along the both sides of Main Street. This may cause blocking ventilation. To prevent health problems, in the long run, the measures to prevent and minimize the impact on air quality is recommended. For Samrong station (YL - 23) that bordered by commercial structures on both sides of the road even, there is a gap between the station and commercial buildings about 6 - 8 meters, the area is considered with poor air circulation. It could impact negatively on the health level of the community and the public with the activities in the area on both sides of the Samrong station (YL - 23). Thus, to minimize the impact on air quality, the prevention measures is recommended.

5.1.5.2 Impact on Depot Area and Park and Ride buildings

1) Construction Phase

Depot is located east of the junction of the Srinagarindra intersection with Bang Na - Trat Road, an area of 122 Rais or 494,000 square meters. The widest of the area is about 380 meters and its longest is approximately 1300 meters. The Park & Ride building is located in the Samut Prakan highway district covers 39.9 Rais, or 63,840 square meters, with a width of about 100 meters and a length of about 600 meters. Considering in the worst case, the idea for construction is to excavate all together with the construction area of 494,000 square meters and 63,840 square meters, respectively.

According to meteorological data from Don Muang airport weather stations, in 30 years-Phase (1981-2010), the average minimum wind speed is approximately 4.0 knots or 2.06 m/s with the wind direction from the south therefore the Mixing Height is circa 1,000 meters (Leeuwen and Vermeir, 2007).

The calculation of the dust concentration caused by construction activities using Box Model, which assesses the value of John G. Rau and David C. Wooten (1996) are summarized below.

A) The impact at Depot construction area

$$C = \frac{Q}{D \times W \times U}$$

$$Q = \frac{296.5 \times 10^3 \times 494,000}{30 \times 8 \times 3,600} \quad \text{Milligrams per second}$$

$$Q = 169,526.62 \quad \text{Milligrams per second}$$

$$C = \frac{169,526.62}{1,000 \times 1,300 \times 2.06} \quad \text{Milligrams per cubic meter}$$

$$C = 0.0633 \quad \text{Milligrams per cubic meter}$$

The calculated results were combined with the results from the measurements near Si lam Temple, Bangna, Bangkok which the amount of suspended dust in a 24-hour Phase from 20 - 21 June 2013 was 0.139 Milligrams per cubic meter. Thus, the total suspended dust particle was as follows;

$$C = 0.2023 \quad \text{Milligrams per cubic meter}$$

The assessment of the dust concentration caused by the Depot construction activities will cause maximum dust 0.2023 milligrams per cubic meter. According to the National Environment Board No. 24 (2004), the dust concentration in the atmosphere must not exceed 0.330 milligrams per cubic meter. Apparently, the dust concentration from the project is lower than the air quality standards (61.30 percent). Therefore, it is expected that construction activities from Depot will cause the medium impact.

The impact from the use of vehicles, including for transport materials, construction equipment as well as the large machinery, may cause a negative impact on the community nearby construction area due to the emission of dust from running in and out the construction area and exhaust from vehicles and machinery, such as carbon monoxide (CO), Hydrocarbons (HC), oxides of nitrogen (NO_x), and total suspended particles (TSP). The projected rate of pollution from machinery and other equipment used in construction will apply the Box Model (John G. Rau and David C. Wooten, 1996), as well as assess the impact of dust from construction activities (considering the worst case) as follows.

- The pollution from machinery and equipment according to the construction of US.EPA is shown in **Table 5.1.5 - 3**.

- The number of machines, equipment, and vehicles that expected to be used in the projects construction is shown in **Table 5.1.5 - 4**.

- The construction activities will be carried out 30 days/month and no more than eight hours a day.

- The Depot and park and ride buildings construction area will assess the amount of dust from the construction same as the project construction area. The width of the construction area will perpendicular to the wind direction. Considering the worst case, the longest

side is most perpendicular to the wind direction with the width of the Depot at 1300 meters, the width of the park and ride buildings is 600 meters.

- According to meteorological data from Don Muang airport weather stations, in 30 years-Phase (1981-2010), the average minimum wind speed is approximately 4.0 knots or 2.06 m/s with the wind direction from the south therefore the Mixing Height is circa 1,000 meters (Leeuwen and Vermeir, 2007).

The predicted concentrations of exhaust pollution caused by the equipment and vehicles used in the construction area. The details are as follows

The impact from the Depot construction show that Carbon Monoxide (CO) is equal to 0.02524 parts per million, Hydrocarbons (HC) is equal to 0.02124 parts per million, nitrogen dioxide (NO₂) is equal to 0.05783 parts per million and total suspended particles (TSP) is equal. 0.00510 mg/m. According to the air quality standards announced by the National Environment Board No. 10 (1995) and No. 24 (2004) Ambient Air Quality Standards which determines that the concentration of Carbon Monoxide (CO) average one hour should not exceed 30 parts per million, nitrogen dioxide (NO₂) the average one hour should not exceed 0.170 parts per million and average suspended particle over 24-hour should not exceed 0.33. mg / m (the standard of hydrocarbons in the Thailand has not yet determined) as shown in **Table 5.1.5 - 12**.

Table 5.1.5 - 12 Results of air quality impact prediction from the construction machines, equipments and vehicles at Depot construction area

Construction equipments	Concentration of air pollution from Depot construction area			
	CO (ppm)	HC (ppm)	NO ₂ (ppm)	TSP (mg/m ³)
1. Bulldozer	0.0029	0.0087	0.0191	0.0007
2. Backhoe	0.0021	0.0007	0.0090	0.0007
3. Roller	0.0008	-	0.0037	-
4. Motor Grader	0.0008	-	-	-
5. Truck Loader	0.0010	-	0.0052	0.0010
6. Diesel Truck	0.0127	0.0041	0.0716	0.0025
7. Pickup Truck	0.0086	0.0004	0.0002	0.0002
Total	0.02890	0.01390	0.10880	0.00510
Total (ppm)	0.02524	0.02124	0.05783	-
Standard	30 ppm ^{1/}	-	0.170 ppm ^{1/}	0.330 mg/cu.m. ^{2/}

Remark : 1/ Notification of National Environmental Board No. 10, 1995 (B.E. 2538).

2/ Notification of National Environmental Board No. 24, 2004 (B.E. 2547).

The results from the calculation were merged with the measurement from the monitoring station located near Si lam Temple, which measures from 20 to 25 June 2013. The results show that Carbon Monoxide (CO) is equal to 2.72524 parts per million indicating 9.08 percent of standard components. Hydrocarbons (HC) is equal to 2.79124 parts per million, Nitrogen Dioxide (NO₂) is equal to 0.10213 parts per million, indicating 60.08 percent of the standard. And total suspended particles (TSP) is equal to 0.1441 mg / m³, indicating 43.67 percent of the standard. However, the total value is still lower than the air quality standards according to the National Environment Board No. 10 (1995) and No. 24 (2004) Ambient Air Quality Standards (except

hydrocarbons in Thailand has not yet determined the criterion standard) as shown in **Table 5.1.5 - 13**. Also, as the construction of Depot and the use of equipment will follow the construction procedures by not having to work all together at the same time and not continuously run the machine for a whole day. Consequently, the accumulation of pollutants from both the equipment and vehicles will not take long. Therefore, its impacts are low to moderate.

Table 5.1.5 - 13 Results of Air Quality Impact Prediction from the Depot construction area, and the combinations of existing air quality condition during 14 June - 2 July, 2013

Item	Concentration of air pollution from Depot construction area including maximum baseline concentration			
	CO (ppm)	THC (ppm)	NO ₂ (ppm)	TSP (mg/m ³)
Prediction result	0.02524	0.02124	0.05783	0.00510
Max. concentration from sampling stations	2.7 ^{1/}	2.77 ^{2/}	0.0443 ^{3/}	0.139 ^{4/}
Total	2.72524	2.79124	0.10213	0.1441
% of standard	9.08	-	60.08	43.67
Standard	30^{5/}	-	0.170^{5/}	0.330^{6/}

Remark : 1/ The maximum concentration of CO (average 1 hr.) is 2.7 ppm at Si lam Temple, Bang Na Sub-district, Bang Na District, Bangkok during 20 - 21 June, 2013.

2/ The maximum concentration of THC is 2.77 ppm at Si lam Temple, Bang Na Sub-district, Bang Na District, Bangkok during 21 - 22 June, 2013.

3/ The maximum concentration of NO₂ (average 1 hr.) is 0.0443 ppm at Si lam Temple, Bang Na Sub-district, Bang Na District, Bangkok during 20 - 21 June, 2013.

4/ The maximum concentration of TSP (average 24 hr.) is 0.139 mg/m³ at Si lam Temple, Bang Na Sub-district, Bang Na District, Bangkok during 20 - 21 June, 2013.

5/ Notification of National Environmental Board No. 10, 1995 (B.E. 2538).

6/ Notification of National Environmental Board No. 24, 2004 (B.E. 2547).

B) The impact of Park and Ride buildings construction area

$$C = \frac{Q}{D \times W \times U}$$

$$Q = \frac{296.5 \times 10^3 \times 63,840}{30 \times 8 \times 3,600} \quad \text{Milligrams per second}$$

$$Q = 21,908.06 \quad \text{Milligrams per second}$$

$$C = \frac{21,908.06}{1,000 \times 600 \times 2.06} \quad \text{Milligrams per cubic meter}$$

$$C = 0.01772 \quad \text{Milligrams per cubic meter}$$

The calculated results were combined with the results from the measurement from a monitoring station near Si lam Temple, Bangna, Bangkok. The amount of dust suspended in a 24-hour Phase from 20 - 21 June 2013 was 0.139 milligrams per cubic meter. Thus, the total amount of suspended particles is as follows.

$$C = 0.15672 \text{ Milligrams per cubic meter}$$

The assessment of the dust concentration caused by the Park and Ride buildings construction activities will cause maximum dust 0.15672 milligrams per cubic meter which are lower than the air quality standard, according to the National Environment Board No. 24 (2004), the dust concentration in the atmosphere must not exceed 0.330 milligrams per cubic meter. Apparently, the dust concentration from the project is lower than the standards (47.49 percent) therefore, it is expected that construction activities from Depot will cause the medium impact.

The impact from the use of vehicles, including for transport materials, construction equipments as well as the large machinery, may cause a negative impact on the community nearby construction area due to the emission of dust from running in and out the construction area and exhaust from vehicles and machinery, such as carbon monoxide (CO), Hydrocarbons (HC), oxides of nitrogen (NO_x), and total suspended particles (TSP). The projected rate of pollution from machinery and other equipment used in construction will apply the Box Model (John G. Rau and David C. Wooten, 1996), as well as assess the impact of dust from construction activities (considering the worst case) as follows.

The impact from the Park and Ride buildings construction show that Carbon Monoxide (CO) is equal to 0.05475 parts per million, Hydrocarbons (HC) is equal to 0.04646 parts per million, Nitrogen Dioxide (NO₂) is equal to 0.12533 parts per million and total suspended particles (TSP) is equal. 0.01090 mg/m. According to the air quality standards announced by the National Environment Board No. 10 (1995) and No. 24 (2004) Ambient Air Quality Standards which determines that the concentration of carbon monoxide (CO) average one hour should not exceed 30 parts per million, Nitrogen Dioxide (NO₂) the average one hour should not exceed 0.170 parts per million and average suspended particle over 24-hour should not exceed 0.33. mg / m (the standard of hydrocarbons in the Thailand has not yet determined) as shown in **Table 5.1.5 - 14**.

The results from the calculation were merged with the measurement from the nearest monitoring station located nearby Si lam Temple, which measures from 20 to 25 June 2013. The results show that Carbon Monoxide (CO) is equal to 2.75475 parts per million representing 9.18 percent of standard components. Hydrocarbon (HC) is equal to 2.81645 parts per million, Nitrogen Dioxide (NO₂) is equal to 0.16963 parts per million, representing 99.78 percent of the standard, and total suspended particles (TSP) is equal to 0.1499 mg / m³, representing 34.79 percent of the standard. However, the total value is still lower than the air quality standards according to the National Environment Board No. 10 (1995) and No. 24 (2004) Ambient Air Quality Standards (except hydrocarbons in Thailand has not yet determined the criterion standard) as shown in **Table 5.1.5 - 15**. Also, as the construction of Park and Ride buildings and the use of equipment will follow the construction procedure by not having to work all together at the same time and not continuously run the machine for a whole day. Consequently, the accumulation of pollutants from both the equipment and vehicles will not take long. Therefore, it impacts is low to moderate.

Table 5.1.5 - 14 Results of air quality impact prediction from the construction machines, equipments and vehicles at Park and Ride construction area

Construction equipments	Concentration of air pollution from Park and Ride construction area			
	CO (ppm)	HC (ppm)	NO ₂ (ppm)	TSP (mg/m ³)
1. Bulldozer	0.0063	0.0189	0.0414	0.0014
2. Backhoe	0.0045	0.0016	0.0196	0.0014
3. Roller	0.0018	-	0.0081	-
4. Motor Grader	0.0018	-	-	-
5. Truck Loader	0.0022	-	0.0112	0.0022
6. Diesel Truck	0.0274	0.0090	0.1551	0.0054
7. Pickup Truck	0.0187	0.0009	0.0004	0.0005
Total	0.06270	0.03040	0.23580	0.01090
Total (ppm)	0.05475	0.04646	0.12533	-
Standard	30 ppm^{1/}	-	0.170 ppm^{1/}	0.330 mg/cu.m.^{2/}

Remark : 1/ Notification of National Environmental Board No. 10, 1995 (B.E. 2538).

2/ Notification of National Environmental Board No. 24, 2004 (B.E. 2547).

Table 5.1.5 - 15 Results of air quality impact prediction from the Park and Ride construction area, and the combinations of existing air quality condition during 14 June - 2 July, 2013

Item	Concentration of air pollution from Park and Ride construction area including maximum baseline concentration			
	CO (ppm)	HC (ppm)	NO ₂ (ppm)	TSP (mg/m ³)
Prediction result	0.05475	0.04646	0.12533	0.01090
Max. concentration from sampling stations	2.7 ^{1/}	2.77 ^{2/}	0.0443 ^{3/}	0.139 ^{4/}
Total	2.75475	2.81646	0.16963	0.1499
% of standard	9.18	-	99.78	34.79
Standard	30^{5/}	-	0.170^{5/}	0.330^{6/}

Remark : 1/ The maximum concentration of CO (average 1 hr.) is 2.7 ppm at Si lam Temple, Bang Na Sub-district, Bang Na District, Bangkok during 20 - 21 June, 2013.

2/ The maximum concentration of THC is 2.77 ppm at Si lam Temple, Bang Na Sub-district, Bang Na District, Bangkok during 21 - 22 June, 2013.

3/ The maximum concentration of NO₂ (average 1 hr.) is 0.0443 ppm at Si lam Temple, Bang Na Sub-district, Bang Na District, Bangkok during 20 - 21 June, 2013.

4/ The maximum concentration of TSP (average 24 hr.) is 0.139 mg/m³ at Si lam Temple, Bang Na Sub-district, Bang Na District, Bangkok during 20 - 21 June, 2013.

5/ Notification of National Environmental Board No. 10, 1995 (B.E. 2538).

6/ Notification of National Environmental Board No. 24, 2004 (B.E. 2547).

2) Operation Phase

A) The impact at Depot operation area

Depot is located east of the Si lam intersection. There are major sources of pollution from the exhaust emissions from the vehicles in and out the Depot. To study the impact

on air quality, the Box Model of John G. Rau and David C. Wooten (1996) was used to predict the concentration of pollutants from motor vehicles by considering the pollution caused by traffic problems include carbon monoxide (CO) that is a pollutant released from the exhaust of the vehicle while running at low speed, or in idle. The carbon monoxide from the exhaust gas, depending on the type and speed of various vehicles are based on Environmental Impact Assessment Report on the MRTA Initial System (1993). A study and analysis of carbon monoxide, which is released from vehicles on the main road in an urban area with six lanes and traffic density, the speed of the vehicle has a value of 0-1 km/hr and 8 km/hr during the year of 1993, 2006 and 2019 respectively was conducted for forecast the pollution emission from vehicles on the road with six lanes with a heavy traffic is shown in **Table 5.5.1 - 8**. The impact assessment has considered the worst case scenario considered by the release of carbon monoxide (CO) of the vehicle at a speed of 0-1 km / hour in a year which is equal to 7.01. g/s/m in 1993. The highest rate of Carbon monoxide (CO) emission most likely to occur on a depot in the current year (Year 2013) and the trend in the forecast year Year 2026, Year 2039 and will be assessed by applying the assumptions Box Model of John G. Rau. and David C. Wooten (1996) as follows.

$$C = \frac{Q}{D \times W \times U}$$

- Where C = The concentration of the pollutant (mg / m³).
- Q = The rate of discharge pollutant (mg / sec).
= 7.01 g/s/m at the speed of 0-1 km/hr and 2.33 g/s/m
The speed of 8 km/h. in the worst case scenario for one square meter
- D = The height of the depot from ground (8 meters.)
- W = The width of the area perpendicular to the wind direction (m). In the worst case scenario that the width of the Depot at 1300 meters.
- U = The lowest average wind speed in the 30-year Phase (1981-2010) from Don Muang airport weather stations, that is 4 knots or 2.06 m/s.

Thus, at the vehicle speed of 0-1 km/hr, the concentration of carbon monoxide (CO) can be calculated as follows

$$C = \frac{7,010}{8 \times 1,300 \times 2.06} \quad \text{Milligrams per cubic meter}$$

$$C = 0.33 \quad \text{Milligrams per cubic meter}$$

$$C = 0.29 \quad \text{parts per million}$$

At the vehicle speed 8 km/h, the concentration of carbon monoxide (CO) can be calculated as follows

$$C = \frac{2,330}{8 \times 1,300 \times 2.06} \quad \text{Milligrams per cubic meter}$$

C	=	0.11	Milligrams per cubic meter
C	=	0.096	parts per million

In the worst case scenario, the concentration of carbon monoxide at the is 0.33 mg/m or 0.29 parts per million as shown in **Table 5.1.5 - 16**. Combining the concentration of carbon monoxide (CO) in the depot with a maximum value from measurement at Si lam temple (2.7 parts per million), which concluded that the vehicle speed 0-1 km/h, the concentration of carbon monoxide was 0.29 + 2.7 equals 2.99 parts per million which not to exceed air quality standards by the Board of Directors of the National Environmental Act No. 10 of 1995 of carbon monoxide, an average one hour does not exceed 30 parts per million as shown in **Table 5.1.5 - 17**. Due to the traffic to the depot has not continued throughout the day and the surrounding area is an open space with no high buildings (up to two floors), to block the exhaust from vehicles so there is no obstruction for the pollution from vehicles that passing under the train station. Therefore, the air flow around the station is in a good condition just like the condition before the project construction. Also. the concentration of pollutants (CO - 1 hour) is not to exceed air quality standards or harm the health of a community or sensitive area, such as religious place, schools, or hospitals, etc. that located nearby stations. Thus, the impact is low.

Table 5.1.5 - 16 Results of Carbon Monoxide (CO) concentration prediction at Depot during operation Phase.

Vehicle speed (km/hr)	Concentration of CO 1 hr (ppm)		
	2013	2026	2039
0 - 1	0.29	0.19	0.15
8	0.10	0.06	0.05

Table 5.1.5 - 17 Results of Carbon Monoxide (CO) concentration prediction at Depot and the combinations of existing air quality condition

Vehicle speed (km/hr)	Concentration of CO 1 hr including maximum baseline concentration of CO ^{1/} (ppm)		
	2013	2026	2039
0 - 1	2.99	2.89	2.85
8	2.80	2.76	2.75
Standard^{2/}	30		

Remark : 1/ = The maximum concentration of CO (average 1 hr.) is 2.7 ppm at Wat Si lam (temple), Bang Na Sub-district, Bang Na District, Bangkok during 20 - 21 June, 2013.

2/ = Notification of National Environmental Board No. 10, 1995 (B.E. 2538). CO standard is not exceed 30 ppm.

B) The Impact near Park & Ride building^{1/}

Park and Ride buildings are located near the Si lam intersection. There are major sources of pollution from the exhaust emissions from the vehicles in and out the Park and Ride buildings. To study the impact on air quality, the Box Model of John G. Rau and David C. Wooten (1996) was used to predict the concentration of pollutants from motor vehicles by considering the pollution caused by traffic problems include carbon monoxide (CO) that is a pollutant released from the exhaust of the vehicle while running at low speed, or in idle. The

carbon monoxide from the exhaust gas, depending on the type and speed of various vehicles are based on Environmental Impact Assessment Report on the MRTA Initial System (1993). A study and analysis of carbon monoxide, which is released from vehicles on the main road in an urban area with six lanes and traffic density, the speed of the vehicle has a value of 0-1 km/hr and 8 km/hr during the year of 1993, 2006 and 2019 respectively was conducted for forecast the pollution emission from vehicles on the road with six lanes with a heavy traffic is shown in **Table 5.5.1 - 8**. The impact assessment has considered the worst case scenario by the release of carbon monoxide (CO) of the vehicle at a speed of 0-1 km / hour in a year which is equal to 7.01. g/s/m in 1993. The highest rate of Carbon monoxide (CO) emission most likely to occur on a depot in the current year (Year 2013) and the trend in the forecast year Year 2026, Year 2039 and will be assessed by applying the assumptions Box Model of John G. Rau. and David C. Wooten (1996) as follows.

$$C = \frac{Q}{D \times W \times U}$$

Where C = The concentration of the pollutant (mg / m³).

Q = The rate of discharge pollutant (mg / sec).

= 7.01 g/s/m at the speed of 0-1 km/hr and 2.33 g/s/m The speed of 8 km/hr. in the worst case scenario for one square meter

D = The height of the depot from ground (3 meters.)

W = The width of the area perpendicular to the wind direction (m). In the worst case scenario that the width of the Depot at 600 meters

U = The lowest average wind speed in the 30-year Phase (1981-2010) from Don Muang airport weather stations, that is 4 knots or 2.06 m/s.

Thus, at the vehicle speed of 0-1 km/hr, the concentration of carbon monoxide (CO) can be calculated as follows

$$\begin{aligned} C &= \frac{7,010}{3 \times 600 \times 2.06} && \text{Milligrams per cubic meter} \\ C &= 1.89 && \text{Milligrams per cubic meter} \\ C &= 1.65 && \text{parts per million} \end{aligned}$$

At the vehicle speed 8 km/hr, the concentration of carbon monoxide (CO) can be calculated as follows

$$\begin{aligned} C &= \frac{2,330}{3 \times 600 \times 2.06} && \text{Milligrams per cubic meter} \\ C &= 0.63 && \text{Milligrams per cubic meter} \\ C &= 0.55 && \text{parts per million} \end{aligned}$$

In the worst case scenario, the concentration of carbon monoxide at the is 1.89 mg/m or 1.65 parts per million as shown in **Table 5.1.5 - 18**. Combining the concentration of

carbon monoxide (CO) in the depot with a maximum value from measurement at Si lam temple (2.7 parts per million), which concluded that the vehicle speed 0-1 km/hr, the concentration of carbon monoxide was 1.65+2.7 equals 4.35 parts per million which not to exceed air quality standards by the Board of Directors of the National Environmental Act No. 10 of 1995 of carbon monoxide, an average one hour does not exceed 30 parts per million as shown in **table 5.1.5 - 19**. Due to the traffic to the depot has not continued throughout the day and the surrounding area is an open space with no high buildings (up to two floors), to block the exhaust from vehicles so there is no obstruction for the pollution from vehicles that passing under the train station. Therefore, the air flow around the station is in a good condition just like the condition before the project construction. Also. the concentration of pollutants (CO - 1 hour) is not to exceed air quality standards or harm the health of a community or sensitive area, such as religious place, schools, or hospitals, etc. that located nearby stations. Thus, the impact is low.

Table 5.1.5 – 18 Results of Carbon Monoxide (CO) concentration prediction at Park and Ride during operation Phase.

Vehicle speed (km/hr)	Concentration of CO 1 hr (ppm)		
	2013	2026	2039
0-1	1.65	1.11	0.87
8	0.55	0.37	0.29

Table 5.1.5 - 19 Results of Carbon Monoxide (CO) concentration prediction at Park and Ride and the combinations of existing air quality condition

Vehicle speed (km/hr)	Concentration of CO 1 hr including maximum baseline concentration of CO ^{1/} (ppm)		
	2013	2026	2039
0-1	4.35	3.81	3.57
8	3.25	3.07	2.99
Standard^{2/}	30		

Remark : 1/ = The maximum concentration of CO (average 1 hr.) is 2.7 ppm at Si lam Temple, Bang Na Sub-district, Bang Na District, Bangkok during 20 - 21 June, 2013.

2/ = Notification of National Environmental Board No. 10, 1995 (B.E. 2538). CO standard is not exceed 30 ppm.

5.1.6 Noise Level

5.1.6.1 The Impact of the Elevated Structures and the Stations area

1) Construction Phase

Construction activities along the project including area preparation, utilities relocation excavation, drilling or piling. The operation of heavy equipment equipment and materials transportation, etc., may create noise disturbing the residents near the project construction area. The construction activities that are excavating and leveling the area, digging and constructing foundations as well as the construction of various structures, and finishing work and quality service are the use of equipment simultaneously in each of a maximum noise level of 88 dB (A) (Canter, 1977) volume that occur at different stages of construction activities in the construction sector.

(Sound level at a distance of 15-meter origin dB (A)), as shown in **Table 5.1.6 - 1**. However, considering the project activities that occur during work in the area, the activity of the drill rigs will possibly create highest noise level. The distance from the equipment in the 15 meters with a noise level of 96 dB (A) (US. Department of Transportation, 1995) the volume formed by the machinery and equipment at a distance from the source of 15 meters is shown. **table 5.1.6 - 2**. However, the rigs drilling activity will occur only in the construction of the depot and Park and Ride buildings thus, the maximum noise resulting from drilling rigs will be considered for the worst case scenario along the route with the construction activities for a Phase of eight working hours.

The noise level of the construction activities that impact on the sensitive area and communities adjacent using the equation (1) below.

$$Lp_2 = Lp_1 - 20 \log (r_2/r_1) \dots\dots\dots(1)$$

where Lp_2 = Predicted noise level (dB (A)).

Lp_1 = Reference noise level at 15 meter (dB (A))

r_2 = The distance between the noise source and community

(meters).

r_1 = the distance from the reference measurement (15 meters).

To adjust the noise level of the construction for a 24-hour average noise level using equation (2) below.

$$Leq_T = Lp + 10 \log (t/T) \dots\dots\dots(2)$$

where Leq_T = noise level at any given time (dB (A))

Lp = noise level from the noise source (dB (A)).

t = Time of noise from the source (hr)

T = Time of noise (hr)

Table 5.1.6 - 1 Noise level from construction activities (at distance 15 m., dB(A))

Construction activities	Domestic Housing		Office Building, Hotel, School, Public Works		Industrial Parking Store, Service Station		Road, Highway Sewer	
	I	II	I	II	I	II	I	II
Ground clearing	83	83	84	84	84	83	84	84
Excavation	88	75	89	79	89	71	88	78
Foundation	81	81	78	78	77	77	88	88
Structure	81	65	87	75	84	72	79	78
Finishing	88	72	89	75	89	74	84	84

Remark: I = All pertinent equipment, II = Minimum requirement

Source: Larry W. Canter, 1997. Environmental Impact Assessment.

Table 5.1.6 - 2 Noise Level from construction equipments/machines (at distance 15 m.)

Equipments/Machine	Sound level (dB(A))
Air Compressor	81
Backhoe	80
Concrete Mixer	85
Concrete Pump	82
Concrete Vibrator	76
Crane (Derrick)	88
Crane (Mobile)	83
Dozer	85
Generator	81
Grader	85
Jack Hammer	88
Loader	85
Pile Driver (Sonic)	96
Pneumatic Tool	85
Pump	76
Shovel	82
Truck	88

Source : US. Department of Transportation, 1995. "Transit Noise and Vibration Impact Assessment", Final Report. April.

The result from the calculation of the noise level occurred in the vulnerable area in each sector along the project route found that the eight-hours of noise level from construction activities will be in the range of 65.5 to 91.6 dB (A). Then the calculating the eight-hours noise level of construction from average 24 hours using equation (2.) will be in the range of 60.8 to 86.8 dB (a). The vulnerable environmental are expected to be affected by the noise during the construction Phase, as shown in **table 5.1.6 - 3**. The vulnerable areas defined as the space along the middle project route less than 174 meters, which noise level higher than the standard set for the general noise level averaged 24 hours (Leq24) does not exceed 70 decibels (A). Then, combining with volume and average 24 hours in the current conditions measured by the closest monitoring stations in the area from 14 June to 2 July, 2013 (**Table 4.1.6 - 2**) showed that the volume will be in the range of 66.5 to 86.6 dB (A), as shown in **Table 5.1.6 - 3**. In detail, the vulnerable areas will be effected within 30 meters from the center line of the route. Therefore, the vulnerable area of the project is not much left.

As for the noise, according to the Pollution Control Board that set the procedure on how to measure noise level without disturbing, to measurements and calculate the noise level during a disturbance, to calculate the level of interference and the noise measurement, to calculate the volume during a disturbance for measuring the noise level in the field. Therefore, the calculation method applied in the calculation of the level of interference from project activities are as follows;

(1) Use the results from the predicted noise level that might occur in the project activity. (forecast + measurements) subtract by the noise level while no interference (noise level of Leq measurement current) results as a different of the noise level.

(2) Use the results of the noise level from 1) compare against the value in **Table 5.1.6 - 4** to adjust the noise level

Table 5.1.6 - 3 Noise level in construction Phase at sensitive areas along the project route

No.	Sensitive areas	Distance from center line of project (m)	Noise level (dB(A))			
			Construction period (8 hr) ^{1/}	Construction period (24 hr) ^{2/}	Existing noise level ^{3/}	Total ^{4/}
1	Charu Wattananakun Kindergarten School	337.97	68.9	64.2	67.1	68.9
2	Yamsaard Kindergarten School	390.31	67.7	62.9	67.1	68.5
3	Rungwittaya Kindergarten School	222.73	72.6	67.8	67.1	70.5
4	House of Christ Christendom	295.98	70.1	65.3	67.1	69.3
5	Chidanakun School	434.58	66.8	62.0	67.1	68.3
6	Siam Bethel Church	140.75	76.6	71.8	67.1	73.1
7	Siriphan Vittaya School	99.45	79.6	74.8	67.1	75.5
8	Lad Prao Baptist Christendom	84.28	81.0	76.2	67.1	76.7
9	Pibool Upphatham School	86.50	80.8	76.0	67.1	76.5
10	Sirithap School	477.02	66.0	61.2	67.1	68.1
11	Wat Lat Phrao School	494.01	65.6	60.9	67.1	68.0
12	Chaemsuksa School	160.58	75.4	70.6	67.1	72.2
13	Settabutr Upathum School	188.00	74.0	69.3	67.1	71.3
14	Thanornpitvithaya School	75.22	82.0	77.2	67.1	77.6
15	Kurusapa Business Organization Kindergarten School	72.51	82.3	77.5	67.1	77.9
16	Tangtung Vittaya School	496.81	65.6	60.8	67.1	68.0
17	Karnda School	206.38	73.2	68.5	67.1	70.8
18	Antioch Ladphrao Baptist Christendom	275.42	70.7	66.0	67.1	69.6
19	Nawamintharachinuthit Bodindecha School	382.99	67.9	63.1	67.1	68.6
20	Surao Don Sakae School	317.97	69.5	64.7	61.3	66.3
21	Hidayatun Islam Mosque (Don Sakae)	361.03	68.4	63.6	61.3	65.6
22	Jitnatda Kindergarten School	160.92	75.4	70.6	61.3	71.1
23	Santisuk Bangkok Christendom	414.40	67.2	62.4	61.3	64.9
24	Bankru Kindergarten School	455.74	66.3	61.6	61.3	64.5
25	Bangkok Suksa School	106.54	79.0	74.2	61.3	74.4
26	Bangkok Withaya School	280.81	70.6	65.8	61.3	67.1
27	Lad Prao Hospital	52.57	85.1	80.3	61.3	80.4
28	Ruam Nimit Bangkok Christendom	204.89	73.3	68.5	61.3	69.3
29	Rajapongsa Kindergarten School	498.98	65.6	60.8	61.3	64.1
30	Wat Mae Phra Kularb Tip (Maria Rosa Mystica Christendom)	87.83	80.6	75.9	61.3	76.0
31	Lat Phrao English School	362.22	68.3	63.6	61.3	65.6
32	Pramote Gym Buddhaisawan School	185.35	74.2	69.4	61.3	70.0
33	Kanathip Child and Elderly Care School	252.46	71.5	66.7	70.6	72.1
34	Mahapawn Bangkok Alliance Christendom	445.67	66.5	61.8	70.6	71.1

**Table 5.1.6 - 3 Noise level in construction Phase at sensitive areas along the project route
(Cont'd)**

No.	Sensitive areas	Distance from center line of project (m)	Noise level (dB(A))			
			Construction period (8 hr) ^{1/}	Construction period (24 hr) ^{2/}	Existing noise level ^{3/}	Total ^{4/}
35	Suranarabribal School	64.84	83.3	78.5	70.6	79.2
36	Patarabutr Kindergarten School	133.44	77.0	72.2	70.6	74.5
37	Vejthani Hospital	105.80	79.0	74.3	70.6	75.8
38	Bangkok Good News Christendom	219.09	72.7	67.9	70.6	72.5
39	Mawadi Music School	118.15	78.1	73.3	70.6	75.2
40	Peace of Bangkok Christendom	114.66	78.3	73.6	70.6	75.3
41	Fatthullbalee Mosque	46.40	86.2	81.4	56.1	81.4
42	Huamarkwittayanusorn School	225.82	72.4	67.7	56.1	68.0
43	Huamark Kindergarten School	230.26	72.3	67.5	56.1	67.8
44	Kanchanaphon Kindergarten	156.87	75.6	70.8	56.1	71.0
45	Grace Lutheran Christendom	351.52	68.6	63.8	56.1	64.5
46	Kornsupa Kindergarten School	275.27	70.7	66.0	56.1	66.4
47	International Hotel & Tourism Industry Management School	294.51	70.1	65.4	56.1	65.9
48	Krirk Thai Skill Development Center School	151.98	75.9	71.1	56.1	71.2
49	Sudnaree Kindergarten	116.60	78.2	73.4	56.1	73.5
50	Mae Phra Ong Uppatham Catholic Christendom (Christendom of Christ)	153.58	75.8	71.0	56.1	71.2
51	Chutima Kindergarten School	108.62	78.8	74.0	56.1	74.1
52	Jamiul Idhard Mosque (Huamak Yai)	364.80	68.3	63.5	56.1	64.2
53	Huamak School	223.35	72.5	67.8	56.1	68.1
54	Darissalam Mosque	232.65	72.2	67.4	56.1	67.7
55	Darissalam School	207.27	73.2	68.4	56.1	68.7
56	Hishaladademee School	404.89	67.4	62.6	56.1	63.5
57	Vibharam Hospital	469.67	66.1	61.3	56.1	62.5
58	Suan Luang Christendom	24.92	91.6	86.8	65.1	86.8
59	Klongkalantan School (Meesuwan Anusorn)	79.91	81.5	76.7	65.1	77.0
60	Piyajit Vittaya School	372.65	68.1	63.3	65.1	67.3
61	Mandaumoucinin School	219.88	72.7	67.9	65.1	69.7
62	Triamudomsakkapatanakran School	500.00	65.5	60.8	65.1	66.5
63	Aliatisorn (Nana Uthit) School	343.92	68.8	64.0	63.5	66.8
64	Suraomai School	395.39	67.6	62.8	63.5	66.2
65	Prasarnwitwatana School	368.96	68.2	63.4	63.5	66.5
66	Masla Artul Islam School	402.61	67.4	62.7	63.5	66.1
67	An Latisom Mosque	430.65	66.8	62.1	63.5	65.9
68	Khajonsiri Temple	239.75	71.9	67.2	63.5	68.7

**Table 5.1.6 - 3 Noise level in construction Phase at sensitive areas along the project route
(Cont'd)**

No.	Sensitive areas	Distance from center line of project (m)	Noise level (dB(A))			
			Construction period (8 hr) ^{1/}	Construction period (24 hr) ^{2/}	Existing noise level ^{3/}	Total ^{4/}
69	Hussanaveeya Sayowan Anusorn School	164.21	75.2	70.4	63.5	71.2
70	Jaipranee Kindergarten School	299.37	70.0	65.2	63.5	67.5
71	Salahnoi School	302.09	69.9	65.1	61.3	66.6
72	Liswanul Islameeya School	250.03	71.6	66.8	61.3	67.9
73	Darul Amin Mosque	71.73	82.4	77.6	61.3	77.7
74	Darul Amin School	87.66	80.7	75.9	61.3	76.0
75	Bride of Christ Christendom	173.64	74.7	70.0	69.3	72.7
76	Dusit Thani College	163.34	75.3	70.5	69.3	72.9
77	Plengprasiddhi Kindergarten School	201.87	73.4	68.6	69.3	72.0
78	Bangkok Dance Academy (Paradise Park Branch)	80.27	81.4	76.7	69.3	77.4
79	Graduate School of Public Administration, Burapha University (Paradise Park)	99.01	79.6	74.8	69.3	75.9
80	Sereeruk Kindergarten School	361.47	68.4	63.6	69.3	70.3
81	BARTER International Maritime School	274.01	70.8	66.0	69.3	71.0
82	Si lam Temple	136.53	76.8	72.0	69.3	73.9
83	Srieam Anusorn School	157.64	75.6	70.8	69.3	73.1
84	Bangna Immanuel Christendom	225.42	72.5	67.7	69.3	71.6
85	Suthibongkot School	370.33	68.2	63.4	69.3	70.3
86	Sikarin Hospital	419.51	67.1	62.3	69.3	70.1
87	Bang Kaeo Prachasan School	457.22	66.3	61.5	63.9	65.9
88	Khlong Samrong School	435.65	66.7	62.0	63.9	66.1
89	Jaisamarn Full Gospel Christendom	322.43	69.4	64.6	63.9	67.3
90	Bangmueang Khian Phong Anusorn School (Debsirin Samut Prakan School)	493.14	65.7	60.9	63.9	65.7
91	Intarumphun Anusorn School	398.62	67.5	62.7	63.9	66.4
92	Uthip School	461.09	66.2	61.5	63.9	65.9
93	Chandna Kindergarten School	471.52	66.1	61.3	63.9	65.8
94	Siriwutti Wittaya school	74.20	82.1	77.3	63.9	77.5
95	Chularat2 Hospital	32.73	89.2	84.5	63.9	84.5
96	Udom Suk Si Pha Rak Christendom	313.32	69.6	64.8	73.7	74.2
97	Raak Daroon Kindergarten School	123.34	77.7	72.9	73.7	76.3
98	Hope of Samut Prakan Christendom	498.99	65.6	60.8	73.7	73.9
99	Klongkratumratutit School	66.70	83.0	78.3	73.7	79.6
100	DeeProm Kindergarten School	102.40	79.3	74.5	73.7	77.2
101	Samrong Nuea Public Health Center	341.92	68.8	64.1	73.7	74.1

**Table 5.1.6 - 3 Noise level in construction Phase at sensitive areas along the project route
(Cont'd)**

No.	Sensitive areas	Distance from center line of project (m)	Noise level (dB(A))			
			Construction period (8 hr) ^{1/}	Construction period (24 hr) ^{2/}	Existing noise level ^{3/}	Total ^{4/}
102	Daroonrat School	309.73	69.7	64.9	73.7	74.2
103	Jaturamuk Kindergarten School	388.03	67.7	63.0	73.7	74.1
104	Samrong Lutheran Christendom	379.71	67.9	63.2	73.7	74.1
105	Jatupornwittaya School	335.21	69.0	64.2	73.7	74.2
106	Dan Samrong Temple	253.75	71.4	66.7	73.7	74.5
107	Watdansamrong School	335.01	69.0	64.2	73.7	74.2
108	Matthayomdansamrong School	355.39	68.5	63.7	73.7	74.1
109	Dansamrong Adult Education School	346.45	68.7	64.0	73.7	74.1
110	Samrong Hospital	466.58	66.1	61.4	73.7	73.9
111	Chulavej Hospital	33.07	89.1	84.4	73.7	84.7
Standard ^{5/}			Not exceed 70			

Remark: 1/ calculated by equation (1)

2/ calculated to Leq24 by equation (2)

3/ maximum Noise Level (Leq24hr) at noise sampling stations along the project route during 14 June to 2 July, 2013.

- No. 1 - 19 use noise level (Leq24hr) at Pibool Uppatham School, Samsennok Sub-district, Huai Khwang District, Bangkok.
- No. 20 - 32 use noise level (Leq24hr) at Wat Mae Phra Kularb Tip (Maria Rosa Mystica Church), Wang Thonglang Sub-district, Wang Thonglang District, Bangkok.
- No. 33 - 40 use noise level (Leq24hr) at Vejthani Hospital, Khlong Chan Sub-district, Bang Kapi District, Bangkok.
- No. 41 - 57 use noise level (Leq24hr) at Mae Phra Ong Uppatham Catholic Church (Church of Christ), Huamak Sub-district, Bang Kapi District, Bangkok.
- No. 58 - 62 use noise level (Leq24hr) at Klongkalantan School, Suan Luang Sub-district, Suan Luang District, Bangkok.
- No. 63 - 70 use noise level (Leq24hr) at Khajonsiri Temple, Suan Luang Sub-district, Suan Luang District, Bangkok.
- No. 71 - 74 use noise level (Leq24hr) at Darul Amin Mosque, Suan Luang Sub-district, Suan Luang District, Bangkok.
- No. 75 - 86 use noise level (Leq24hr) at Sri Iam Temple, Bang Na Sub-district, Bang Na District, Bangkok.
- No. 87 - 95 use noise level (Leq24hr) at Siriwutti Wittaya School, Thepharak Sub-district, Mueang Samut Prakan District, Samut Prakan Province.
- No. 96 - 111 use noise level (Leq24hr) at Chulavej hospital, Thepharak Sub-district, Mueang Samut Prakan District, Samut Prakan Province.

4/ calculation by $L_{p_{total}}$ equation

5/ refer ambient noise standard in Notification of National Environmental Board No. 15, 1997 (B.E. 2540).

Source: ENRICH Consultant Co., Ltd., 2013.

Table 5.1.6 - 4 Noise value modifier for annoyance noise level calculation

Difference of Noise Level (dB(A))	Noise value modifier (dB(A))
Less than 1.4 and 1.4	7.0
1.5 - 2.4	4.5
2.5 - 3.4	3.0
3.5 - 4.4	2.0
4.5 - 6.4	1.5
6.5 - 7.4	1.0
7.5 - 12.4	0.5
12.5 and more than 12.5	0

Source : Pollution Control Department, 2007.

(3) Then use the predicted noise level of the project activities. (forecast + measurements) subtract by the adjusted noise level from the 2) therefore, the results are the noise level with disturbing.

(4) Bring up the noise level during a disturbance in step 3) subtract by the noise level-based from the measurements (L90).

The predicted results of the interference levels indicated that the most vulnerable areas to the impacts of disturbances in the construction Phase projects above the standard (not exceed 10 dB (A)). Due to the current measured noise level is relatively high, as a result, the expectations are high as well as shown in **Table 5.1.6 - 5**. The project has prepared the measures to prevent and mitigate the impact on neighboring communities during the construction Phase. By scheduling the construction carried out only during daytime hours only in order to not disturb the living conditions of residents in the adjacent to sensitive areas along the project route and requiring the contractors to use equipment that produces sound at a low level, etc. In addition, construction activities will occur from time to time as the construction activities within the project route. Therefore, the anticipated noise is temporarily hence the impact is moderate.

2) Operation Phase

During the operation Phase, the impact of noise from the train caused by contact between the train wheels against the rails. According to the paper "Transit Noise and Vibration Impact Assessment, 2006 Second Edition", Federal Monorail Administration (FTA), USA indicated that the noise level of the transit system, the types of is 82 dB (A) at a distance of 50 feet (about 15 meters) from the train rails at a speed of 80 km/hr (the train runs in the straight path). However, in the case of the train ran through a curved path, the squeal will occur consequently the noise level will be higher than the train ran over the straight path details shown in **Table 5.1.6 - 6**.

To study and analyze the impact of noise from train operation system an equation to calculate the noise average one hour. (Leq-1 hour) from the transit system will be used. While the type of rail will be defined using the guideline from "Transit Noise and Vibration Impact Assessment, 2006 Second Edition", Federal Transit Administration (FTA), U.S.A. details in equation (3) as follows.

$$\text{Leq (hr)} = \text{SEL}_{\text{ref}} + 10 \log (N_{\text{cars}}) + 20 \log (S/50) + 10 \log (V) - 35.6 \dots(3)$$

Where SEL_{ref} = reference noise level at the distance of 50 feet (15 meters) from the sound source.

N_{cars} = The number of cars per train.

S = The speed of the train (Miles / hour)

V = The number of train trips (Number of trains / hour)

Table 5.1.6 - 5 Annoyance noise level in construction Phase at sensitive areas along the project route

No.	Sensitive areas	Distance from center line of project (m)	Existing noise level ^{1/} (dB(A))		Noise level during construction period (dB(A))		Annoyance noise level (dB(A))
			Leq ₂₄	L ₉₀	Before adjust value ^{2/}	After adjust value ^{3/}	
1	Charuwattananukun Kindergarten School	337.97	67.1	55.0	68.9	64.4	9.4
2	Yamsaard Kindergarten School	390.31	67.1	55.0	68.5	61.5	6.5
3	Rungwittaya Kindergarten School	222.73	67.1	55.0	70.5	67.5	12.5
4	House of Chris Christendom	295.98	67.1	55.0	69.3	64.8	9.8
5	Chidanukun School	434.58	67.1	55.0	68.3	61.3	6.3
6	Siam Bethel Christendom	140.75	67.1	55.0	73.1	71.6	16.6
7	Siriphan Vittaya School	99.45	67.1	55.0	75.5	75.0	20.0
8	Lad Prao Baptist Christendom	84.28	67.1	55.0	76.7	76.2	21.2
9	Pibool Uppatham School	86.50	67.1	55.0	76.5	76.0	21.0
10	Sirithep School	477.02	67.1	55.0	68.1	61.1	6.1
11	Wat Lat Phrao School	494.01	67.1	55.0	68.0	61.0	6.0
12	Chaemsuksa School	160.58	67.1	55.0	72.2	70.7	15.7
13	Settabutr Upathum School	188.00	67.1	55.0	71.3	69.3	14.3
14	Thanornpitvithaya School	75.22	67.1	55.0	77.6	77.1	22.1
15	Kurusapa Business Organization Kindergarten School	72.51	67.1	55.0	77.9	77.4	22.4
16	Tangtung Vittaya School	496.81	67.1	55.0	68.0	61.0	6.0
17	Kamda School	206.38	67.1	55.0	70.8	68.8	13.8
18	Antioch Ladphrao Baptist Christendom	275.42	67.1	55.0	69.6	66.6	11.6
19	Nawamintharachinuthit Bodindecha School	382.99	67.1	55.0	68.6	64.1	9.1
20	Surao Don Sakae School	317.97	61.3	53.3	66.3	64.8	11.5
21	Hidayatun Islam Mosque (Don Sakae)	361.03	61.3	53.3	65.6	63.6	10.3
22	Jitnatda Kindergarten School	160.92	61.3	53.3	71.1	70.6	17.3
23	Santisuk Bangkok Christendom	414.40	61.3	53.3	64.9	62.9	9.6
24	Bankru Kindergarten School	455.74	61.3	53.3	64.5	61.5	8.2
25	Bangkok Suksa School	106.54	61.3	53.3	74.4	74.4	21.1
26	Bangkok Withaya School	280.81	61.3	53.3	67.1	65.6	12.3
27	Lad Prao Hospital	52.57	61.3	53.3	80.4	80.4	27.1
28	Ruam Nimit Bangkok Christendom	204.89	61.3	53.3	69.3	68.8	15.5
29	Rajapongsa Kindergarten School	498.98	61.3	53.3	64.1	61.1	7.8
30	Wat Mae Phra Kularb Tip (Maria Rosa Mystica Christendom)	87.83	61.3	53.3	76.0	76.0	22.7
31	Lat Phrao English School	362.22	61.3	53.3	65.6	63.6	10.3
32	Pramote Gym Buddhasawan School	185.35	61.3	53.3	70.0	69.5	16.2
33	Kanathip Child and Elderly Care School	252.46	70.6	65.3	72.1	67.6	2.3
34	Mahapawn Bangkok Alliance Christendom	445.67	70.6	65.3	71.1	64.1	-
35	Suranarabibal School	64.84	70.6	65.3	79.2	78.7	13.4
36	Patarabutr Kindergarten School	133.44	70.6	65.3	74.5	72.5	7.2
37	Vejthani Hospital	105.80	70.6	65.3	75.8	74.3	9.0
38	Bangkok Good News Christendom	219.09	70.6	65.3	72.5	68.0	2.7
39	Mawadi Music School	118.15	70.6	65.3	75.2	73.7	8.4
40	Peace of Bangkok Christendom	114.66	70.6	65.3	75.3	73.8	8.5
41	Fatthullbalee Mosque	46.40	56.1	53.0	81.4	81.4	28.4
42	Huamarkwittayanusorn School	225.82	56.1	53.0	68.0	67.5	14.5

Table 5.1.6 - 5 Annoyance noise level in construction Phase at sensitive receptors along the project route (Cont' d)

No.	Sensitive areas	Distance from center line of project (m)	Existing noise level ^{1/} (dB(A))		Noise level during construction period (dB(A))		Annoyance noise level (dB(A))
			Leq ₂₄	L ₉₀	Before adjust value ^{2/}	After adjust value ^{3/}	
43	Huamark Kindergarten School	230.26	56.1	53.0	67.8	67.3	14.3
44	Kanchanaphon Kindergarten	156.87	56.1	53.0	71.0	71.0	18.0
45	Grace Lutheran Christendom	351.52	56.1	53.0	64.5	64.0	11.0
46	Kornsupa Kindergarten School	275.27	56.1	53.0	66.4	65.9	12.9
47	International Hotel & Tourism Industry Management School	294.51	56.1	53.0	65.9	65.4	12.4
48	Krirk Thai Skill Development Center School	151.98	56.1	53.0	71.2	71.2	18.2
49	Sudnaree Kindergarten	116.60	56.1	53.0	73.5	73.5	20.5
50	Mae Phra Ong Uppatham Catholic Christendom (Christendom of Christ)	153.58	56.1	53.0	71.2	71.2	18.2
51	Chutima Kindergarten School	108.62	56.1	53.0	74.1	74.1	21.1
52	Jamiul Idhard Mosque (Huamak Yai)	364.80	56.1	53.0	64.2	63.7	10.7
53	Huamak School	223.35	56.1	53.0	68.1	67.6	14.6
54	Darissalam Mosque	232.65	56.1	53.0	67.7	67.2	14.2
55	Darissalam School	207.27	56.1	53.0	68.7	68.7	15.7
56	Hishaladademee School	404.89	56.1	53.0	63.5	62.5	9.5
57	Vibharam Hospital	469.67	56.1	53.0	62.5	61.0	8.0
58	Suan Luang Christendom	24.92	65.1	50.0	86.8	86.8	36.8
59	Klongkalantan School (Meesuwan Anusorn)	79.91	65.1	50.0	77.0	76.5	26.5
60	Piyajit Vittaya School	372.65	65.1	50.0	67.3	62.8	12.8
61	Mandaumoucinin School	219.88	65.1	50.0	69.7	68.2	18.2
62	Triamudomsakkapatanakran School	500.00	65.1	50.0	66.5	59.5	9.5
63	Aliatisorn (Nana Uthit) School	343.92	63.5	51.1	66.8	63.8	12.7
64	Suraomai School	395.39	63.5	51.1	66.2	63.2	12.1
65	Prasarnwitwatana School	368.96	63.5	51.1	66.5	63.5	12.4
66	Masla Artul Islam School	402.61	63.5	51.1	66.1	63.1	12.0
67	An Latisorn Mosque	430.65	63.5	51.1	65.9	61.4	10.3
68	Khajonsiri Temple	239.75	63.5	51.1	68.7	67.2	16.1
69	Hussanaveeya Sayowan Anusorn School	164.21	63.5	51.1	71.2	70.7	19.6
70	Jaipranee Kindergarten School	299.37	63.5	51.1	67.5	65.5	14.4
71	Salahnoi School	302.09	61.3	57.9	66.6	65.1	7.2
72	Liswanul Islameeya School	250.03	61.3	57.9	67.9	66.9	9.0
73	Darul Amin Mosque	71.73	61.3	57.9	77.7	77.7	19.8
74	Darul Amin School	87.66	61.3	57.9	76.0	76.0	18.1
75	Bride of Christ Christendom	173.64	69.3	66.7	72.7	69.7	3.0
76	Dusit Thani College	163.34	69.3	66.7	72.9	70.9	4.2
77	Plengprasiddhi Kindergarten School	201.87	69.3	66.7	72.0	69.0	2.3
78	Bangkok Dance Academy (Paradise Park Branch)	80.27	69.3	66.7	77.4	76.9	10.2
79	Graduate School of Public Administration, Burapha University (Paradise Park)	99.01	69.3	66.7	75.9	74.9	8.2
80	Sereeruk Kindergarten School	361.47	69.3	66.7	70.3	63.3	-
81	BARTER International Maritime School	274.01	69.3	66.7	71.0	66.5	-
82	Si lam Temple	136.53	69.3	66.7	73.9	72.4	5.7
83	Srieam Anusorn School	157.64	69.3	66.7	73.1	71.1	4.4
84	Bangna Immanuel Christendom	225.42	69.3	66.7	71.6	67.1	0.4

Table 5.1.6 - 5 Annoyance noise level in construction Phase at sensitive receptors along the project route (Cont'd)

No.	Sensitive areas	Distance from center line of project (m)	Existing noise level ^{1/} (dB(A))		Noise level during construction period (dB(A))		Annoyance noise level (dB(A))
			Leq ₂₄	L ₉₀	Before adjust value ^{2/}	After adjust value ^{3/}	
85	Suthibongkot School	370.33	69.3	66.7	70.3	63.3	-
86	Sikarin Hospital	419.51	69.3	66.7	70.1	63.1	-
87	Bang Kaeo Prachasan School	457.22	63.9	56.6	65.9	61.4	4.8
88	Khlong Samrong School	435.65	63.9	56.6	66.1	61.6	5.0
89	Jaisamarn Full Gospel Christendom	322.43	63.9	56.6	67.3	64.3	7.7
90	Bangmueang Khian Phong Anusorn School (Debsirin Samut Prakan School)	493.14	63.9	56.6	65.7	61.2	4.6
91	Intarumphun Anusorn School	398.62	63.9	56.6	66.4	61.9	5.3
92	Uthip School	461.09	63.9	56.6	65.9	61.4	4.8
93	Chandna Kindergarten School	471.52	63.9	56.6	65.8	61.3	4.7
94	Siriwutti Wittaya school	74.20	63.9	56.6	77.5	77.5	20.9
95	Chularat2 Hospital	32.73	63.9	56.6	84.5	84.5	27.9
96	Udom Suk Si Pha Rak Christendom	313.32	73.7	68.3	74.2	67.2	-
97	Raak Daroon Kindergarten School	123.34	73.7	68.3	76.3	73.3	5.0
98	Hope of Samut Prakan Christendom	498.99	73.7	68.3	73.9	66.9	-
99	Klongkratumratutit School	66.70	73.7	68.3	79.6	78.1	9.8
100	DeeProm Kindergarten School	102.40	73.7	68.3	77.2	75.2	6.9
101	Samrong Nuea Public Health Center	341.92	73.7	68.3	74.1	67.1	-
102	Daroonrat School	309.73	73.7	68.3	74.2	67.2	-
103	Jaturamuk Kindergarten School	388.03	73.7	68.3	74.1	67.1	-
104	Samrong Lutheran Christendom	379.71	73.7	68.3	74.1	67.1	-
105	Jatupornwittaya School	335.21	73.7	68.3	74.2	67.2	-
106	Dan Samrong Temple	253.75	73.7	68.3	74.5	67.5	-
107	Watdansamrong School	335.01	73.7	68.3	74.2	67.2	-
108	Matthayomdansamrong School	355.39	73.7	68.3	74.1	67.1	-
109	Dansamrong Adult Education School	346.45	73.7	68.3	74.1	67.1	-
110	Samrong Hospital	466.58	73.7	68.3	73.9	66.9	-
111	Chulavej Hospital	33.07	73.7	68.3	84.7	84.2	15.9
Standard ^{4/}							Not exceed 10

Remark: 1/ Maximum noise level (Leq24hr) at noise sampling stations along the project route during 14 June to 2 July, 2013.

- No. 1 - 19 use noise level (Leq24hr) at Pibool Uppatham School, Samsennok Sub-district, Huai Khwang District, Bangkok.
- No. 20 - 32 use noise level (Leq24hr) at Wat Mae Phra Kularb Tip (Maria Rosa Mystica Church), Wang Thonglang Sub-district, Wang Thonglang District, Bangkok.
- No. 33 - 40 use noise level (Leq24hr) at Vejthani Hospital, Khlong Chan Sub-district, Bang Kapi District, Bangkok.
- No. 41 - 57 use noise level (Leq24hr) at Mae Phra Ong Uppatham Catholic Church (Church of Christ), Huamak Sub-district, Bang Kapi District, Bangkok.
- No. 58 - 62 use noise level (Leq24hr) at Klongkalantan School, Suan Luang Sub-district, Suan Luang District, Bangkok.
- No. 63 - 70 use noise level (Leq24hr) at Khajonsiri Temple, Suan Luang Sub-district, Suan Luang District, Bangkok.
- No. 71 - 74 use noise level (Leq24hr) at Darul Amin Mosque, Suan Luang Sub-district, Suan Luang District, Bangkok.
- No. 75 -86 use noise level (Leq24hr) at Sri lam Temple, Bang Na Sub-district, Bang Na District, Bangkok.
- No. 87 - 95 use noise level (Leq24hr) at Siriwutti Wittaya School, Thepharak Sub-district, Mueang Samut Prakan District, Samut Prakan Province.
- No. 96 - 111 use noise level (Leq24hr) at Chulavej hospital, Thepharak Sub-district, Mueang Samut Prakan District, Samut Prakan Province.

2/ Predicted noise level from construction period in **Table 5.1.6-3**

3/ Use noise value modifier of Pollution Control Department method in **Table 5.1.6-4**

4/ Notification of National Environmental Board No. 29, 2007 (B.E. 2550).

Source: ENRICH Consultant Co., Ltd., 2013.

Table 5.1.6 - 6 Additional noise values from Monorail operation on the curve of guideway

Radius of guideway curve (m)	Adjust noise value (dB(A))
1. Less than 300 m	+8
2. 300 – less than 500 m	+3
3. More than 500 m	+0

Source : The Initial Environmental Evaluation of CMIP (OCMRT, 1996)

The predicted noise levels in the operation Phase can be calculated the level using equation (1) in the worst case scenario that is the maximum noise with the distant 15 meters (50 ft.) from the train rails is equal to 82 dB (A) train 1 train a number of carriages up to six cabinets have a top speed of 50 miles/hour (80 km / hr.) and a maximum frequency of train rush hours, 2 minutes. one of the convoys, a convoy of 30/hr. The example results from the measurement noise level from the Monorail train operator in Singapore. According to the data collected from the various Monorail manufacturers, the noise level that occurred while the train runs at a speed of 55 km/hr is equal to 72.4 dB (A) at a distance of 10 meters from the center of the runway. These values are lower than the standard of maximum level (Lmax) that defined up to 115 dB (A), so use the noise level of 82 dB (A) at a distance from the train rails 15 meters is the most serious case in this study. It can be calculated as follows:

$$\begin{aligned} \text{Leq (hr)} &= 82 + 10 \log (6) + 20 \log (50/50) + 10 \log (30) - 35.6 \\ &= 68.95 \text{ dB(A)} \end{aligned}$$

Thus, the average noise level one hour. (Leq - 1 hour) in the operation Phase at a distance of 15 meters (50 feet) from the train, rail is equal to 68.95 dB (A). Also, due to the operation hour will be during 6:00 - 24:00 AM. or 18 hours and the height of the elevated structure is 15 meters high from the ground level by considering the worst case (worst case) is that every hour during opening hours. there are a number of train trips during the rush hour.

The impact of noise levels in operation Phase consideration of the noise level averaged 24 hours (Leq - 24 hour), so that the calculation of noise level from the beginning of service of the project or the noise level averaged 18 hours (Leq - 18 hours. .) to the noise level averaged 24 hours (Leq - 24 hour) compared to the standard noise level using equation (4).

$$\text{Leq}_T = \text{Lp} + 10 \log (t/T) \dots \dots \dots (4)$$

where Leq_T = Noise level at any given time (dB (A))

Lp = Noise level from the noise source (dB (A)).

t = Time of noise from the source (hr).

T = Time of noise (hr)

Substituting in the equation (4) to the 24-hour average sound level (Leq - 24 hrs.) at a distance of 15 meters (50 feet) from the train tracks is equal to $68.95 + 10 \log (18/24)$ at 67.70 dB (A), which represents the volume of the origin of the operation Phase.

To reduce the impact of noise in operation Phase distance to the recipient in a direct line to the equation (1) above are as follows.

$$\text{Lp}_2 = \text{Lp}_1 - 20 \log (r_2/r_1) \dots \dots \dots (1)$$

- where L_{p1} = Noise levels measurement distance r_1 from the source.
 L_{p2} = Noise levels occurred r_2 distance from the source.
 r_1, r_2 = The distance from the origin to measure the volume L_{p1}, L_{p2} (meters).

The Noise levels calculated from equation (1) is the noise from the trains running and included with the average noise level in the current condition of measurements in the field. Based on the accumulation noise as the energy, details in equation (4).

$$L_{p_{Total}} = 10 \log \left(\sum_{i=1}^N 10^{L_{pi}/10} \right) \dots\dots\dots (4)$$

- where $L_{p_{total}}$ = Total noise level (dB (A)).
 L_{pi} = The volume formed by the source in each case. (dB (A)).

The predicted Noise levels at the different distance in the operation Phase in the urban areas and vulnerable areas to the effects found that the level of noise caused by the train is equal to 67.70 dB (A) lower than the benchmark level by the Board of Directors of the National Environmental Act No. 15 of 2003 does not exceed 70 dB(A). When taken the distance from sensitive areas into account, the sensitive areas that most affected is Suan Luang Christendom with the distance of 24.92 meters along the path of the 24-hour average noise level of 63.3 dB (A) that lower than the standard. However, when the noise of the train together with the measurement results in the current Phase of June 14 to July 2, 2013, at monitoring stations close to sensitive areas that most affected, found that the noise average 24-hour values ranged from 56.2 to 73.9 dB (A). Vejthani Most of which is lower than the standard set except for sensitive areas in the vicinity of the Vetch Thanee Hospital and the Chulavej Hospital that the current conditions above the standard. When combined with the value of the project during the operation thus the noise level of the vulnerable area prone to affects at the high impact as shown in **Table 5.1.6 - 7**.

Given the predicted level of interference, the area most vulnerable to the effects of environmental noise level are below set standard in operation Phase (up to 10 dB (A)) due to the noise from the train system is relatively low. As a result, the forecasts are not significantly different from the current conditions. No noise in the area except Suan Luang Christendom that the noise level higher than the standard as shown in **Table 5.1.6 - 8**. The project has prepared measures to prevent and reduce the impact on the communities nearby in operation Phase. To reduce the impact of development projects to a level as low as possible. Therefore, it is expected that the noise level of activity of the project will affect the livelihood of the people is low only.

Table 5.1.6 - 7 Noise level prediction at sensitive areas during operation Phase

No.	Sensitive areas	Distance from center line of project (m)	Leq24hr (dB(A))		
			Monorail operation ^{1/}	Existing noise level ^{2/}	Total ^{3/}
1	Charuwattananukun Kindergarten School	337.97	40.6	67.1	67.1
2	Yamsaard Kindergarten School	390.31	39.4	67.1	67.1
3	Rungwittaya Kindergarten School	222.73	44.3	67.1	67.1
4	House of Christ Christendom	295.98	41.8	67.1	67.1
5	Chidanukun School	434.58	38.5	67.1	67.1
6	Siam Bethel Christendom	140.75	48.3	67.1	67.2
7	Siriphan Vittaya School	99.45	51.3	67.1	67.2
8	Lad Prao Baptist Christendom	84.28	52.7	67.1	67.3
9	Pibool Upphatham School	86.50	52.5	67.1	67.2
10	Sirithep School	477.02	37.7	67.1	67.1
11	Wat Lat Phrao School	494.01	37.3	67.1	67.1
12	Chaemsuksa School	160.58	47.1	67.1	67.1
13	Settabutr Upathum School	188.00	45.7	67.1	67.1
14	Thanormpitvithaya School	75.22	53.7	67.1	67.3
15	Kurusapa Business Organization Kindergarten School	72.51	54.0	67.1	67.3
16	Tangtung Vittaya School	496.81	37.3	67.1	67.1
17	Karnda School	206.38	44.9	67.1	67.1
18	Antioch Ladphrao Baptist Christendom	275.42	42.4	67.1	67.1
19	Nawamintharachinuthit Bodindecha School	382.99	39.6	67.1	67.1
20	Surao Don Sakae School	317.97	41.2	61.3	61.3
21	Hidayatun Islam Mosque (Don Sakae)	361.03	40.1	61.3	61.3
22	Jitnatda Kindergarten School	160.92	47.1	61.3	61.5
23	Santisuk Bangkok Christendom	414.40	38.9	61.3	61.3
24	Bankru Kindergarten School	455.74	38.0	61.3	61.3
25	Bangkok Suksa School	106.54	50.7	61.3	61.7
26	Bangkok Withaya School	280.81	42.3	61.3	61.4
27	Lad Prao Hospital	52.57	56.8	61.3	62.6
28	Ruam Nimit Bangkok Christendom	204.89	45.0	61.3	61.4
29	Rajapongsa Kindergarten School	498.98	37.3	61.3	61.3
30	Wat Mae Phra Kularb Tip (Maria Rosa Mystica Christendom)	87.83	52.3	61.3	61.8
31	Lat Phrao English School	362.22	40.0	61.3	61.3
32	Pramote Gym Buddhaisawan School	185.35	45.9	61.3	61.4
33	Kanathip Child and Elderly Care School	252.46	43.2	70.6	70.6
34	Mahapawn Bangkok Alliance Christendom	445.67	38.2	70.6	70.6

Table 5.1.6 - 7 Noise level prediction at sensitive areas during operation Phase (Cont'd)

No.	Sensitive areas	Distance from center line of project (m)	Leq24hr (dB(A))		
			Monorail operation ^{1/}	Existing noise level ^{2/}	Total ^{3/}
35	Suranarabibal School	64.84	55.0	70.6	70.7
36	Patarabutr Kindergarten School	133.44	48.7	70.6	70.6
37	Vejthani Hospital	105.80	50.7	70.6	70.6
38	Bangkok Good News Christendom	219.09	44.4	70.6	70.6
39	Mawadi Music School	118.15	49.8	70.6	70.6
40	Peace of Bangkok Christendom	114.66	50.0	70.6	70.6
41	Fatthullbalee Mosque	46.40	57.9	56.1	60.1
42	Huamarkwittayanusorn School	225.82	44.1	56.1	56.4
43	Huamark Kindergarten School	230.26	44.0	56.1	56.4
44	Kanchanaphon Kindergarten	156.87	47.3	56.1	56.6
45	Grace Lutheran Christendom	351.52	40.3	56.1	56.2
46	Kornsupa Kindergarten School	275.27	42.4	56.1	56.3
47	International Hotel & Tourism Industry Management School	294.51	41.8	56.1	56.3
48	Krirk Thai Skill Development Center School	151.98	47.6	56.1	56.7
49	Sudnaree Kindergarten	116.60	49.9	56.1	57.0
50	Mae Phra Ong Uppatham Catholic Christendom (Christendom of Christ)	153.58	47.5	56.1	56.7
51	Chutima Kindergarten School	108.62	50.5	56.1	57.2
52	Jamiul Idhard Mosque (Huamak Yai)	364.80	40.0	56.1	56.2
53	Huamak School	223.35	44.2	56.1	56.4
54	Darissalam Mosque	232.65	43.9	56.1	56.4
55	Darissalam School	207.27	44.9	56.1	56.4
56	Hishaladademee School	404.89	39.1	56.1	56.2
57	Vibharam Hospital	469.67	37.8	56.1	56.2
58	Suan Luang Christendom	24.92	63.3	65.1	67.3
59	Klongkalandan School (Meesuwan Anusorn)	79.91	53.2	65.1	65.4
60	Piyajit Vittaya School	372.65	39.8	65.1	65.1
61	Mandaumoucinin School	219.88	44.4	65.1	65.1
62	Triamudomsakkapatanakran School	500.00	37.2	65.1	65.1
63	Aliatisorn (Nana Uthit) School	343.92	40.5	63.5	63.5
64	Suraomai School	395.39	39.3	63.5	63.5
65	Prasarnwitwatana School	368.96	39.9	63.5	63.5
66	Masla Artul Islam School	402.61	39.1	63.5	63.5
67	An Latisom Mosque	430.65	38.5	63.5	63.5
68	Khajonsiri Temple	239.75	43.6	63.5	63.5

Table 5.1.6 - 7 Noise level prediction at sensitive areas during operation Phase (Cont'd)

No.	Sensitive areas	Distance from center line of project (m)	Leq24hr (dB(A))		
			Monorail operation ^{1/}	Existing noise level ^{2/}	Total ^{3/}
69	Hussanaveeya Sayowan Anusorn School	164.21	46.9	63.5	63.6
70	Jaipranee Kindergarten School	299.37	41.7	63.5	63.5
71	Salahnoi School	302.09	41.6	61.3	61.3
72	Liswanul Islameeya School	250.03	43.3	61.3	61.4
73	Darul Amin Mosque	71.73	54.1	61.3	62.1
74	Darul Amin School	87.66	52.4	61.3	61.8
75	Bride of Christ Christendom	173.64	46.4	69.3	69.3
76	Dusit Thani College	163.34	47.0	69.3	69.3
77	Plengprasiddhi Kindergarten School	201.87	45.1	69.3	69.3
78	Bangkok Dance Academy (Paradise Park Branch)	80.27	53.1	69.3	69.4
79	Graduate School of Public Administration, Burapha University (Paradise Park)	99.01	51.3	69.3	69.4
80	Sereeruk Kindergarten School	361.47	40.1	69.3	69.3
81	BARTER International Maritime School	274.01	42.5	69.3	69.3
82	Si lam Temple	136.53	48.5	69.3	69.3
83	Srieam Anusorn School	157.64	47.3	69.3	69.3
84	Bangna Immanuel Christendom	225.42	44.2	69.3	69.3
85	Suthibongkot School	370.33	39.9	69.3	69.3
86	Sikarin Hospital	419.51	38.8	69.3	69.3
87	Bang Kaeo Prachasan School	457.22	38.0	63.9	63.9
88	Khlong Samrong School	435.65	38.4	63.9	63.9
89	Jaisamarn Full Gospel Christendom	322.43	41.1	63.9	63.9
90	Bangmueang Khian Phong Anusorn School (Debsirin Samut Prakan School)	493.14	37.4	63.9	63.9
91	Intarumphun Anusorn School	398.62	39.2	63.9	63.9
92	Uthip School	461.09	37.9	63.9	63.9
93	Chandna Kindergarten School	471.52	37.8	63.9	63.9
94	Siriwutti Wittaya school	74.20	53.8	63.9	64.3
95	Chularat2 Hospital	32.73	60.9	63.9	65.7
96	Udom Suk Si Pha Rak Christendom	313.32	41.3	73.7	73.7
97	Raak Daroon Kindergarten School	123.34	49.4	73.7	73.7
98	Hope of Samut Prakan Christendom	498.99	37.3	73.7	73.7
99	Klongkratumratutit School	66.70	54.7	73.7	73.8
100	DeeProm Kindergarten School	102.40	51.0	73.7	73.7
101	Samrong Nuea Public Health Center	341.92	40.5	73.7	73.7

Table 5.1.6 - 7 Noise level prediction at sensitive areas during operation Phase (Cont'd)

No.	Sensitive areas	Distance from center line of project (m)	Leq24hr (dB(A))		
			Monorail operation ^{1/}	Existing noise level ^{2/}	Total ^{3/}
102	Daroonrat School	309.73	41.4	73.7	73.7
103	Jaturamuk Kindergarten School	388.03	39.4	73.7	73.7
104	Samrong Lutheran Christendom	379.71	39.6	73.7	73.7
105	Jatupornwittaya School	335.21	40.7	73.7	73.7
106	Dan Samrong Temple	253.75	43.1	73.7	73.7
107	Watdansamrong School	335.01	40.7	73.7	73.7
108	Matthayomdansamrong School	355.39	40.2	73.7	73.7
109	Dansamrong Adult Education School	346.45	40.4	73.7	73.7
110	Samrong Hospital	466.58	37.8	73.7	73.7
111	Chulavej Hospital	33.07	60.8	73.7	73.9
Standard^{4/}			Not exceed 70		

Remark: 1/ calculated by equation (1) and equation (2)

2/ maximum noise level (Leq24hr) at noise sampling stations along the project route during 14 June to 2 July, 2013.

- No. 1 - 19 use noise level (Leq24hr) at Pibool Upphatham School, Samsennok Sub-district, Huai Khwang District, Bangkok.
- No. 20 - 32 use noise level (Leq24hr) at Wat Mae Phra Kularb Tip (Maria Rosa Mystica Church), Wang Thonglang Sub-district, Wang Thonglang District, Bangkok.
- No. 33 - 40 use noise level (Leq24hr) at Vejthani Hospital, Khlong Chan Sub-district, Bang Kapi District, Bangkok.
- No. 41 - 57 use noise level (Leq24hr) at Mae Phra Ong Uppatham Catholic Church (Church of Christ), Huamak Sub-district, Bang Kapi District, Bangkok.
- No. 58 - 62 use noise level (Leq24hr) at Klongkalantan School, Suan Luang Sub-district, Suan Luang District, Bangkok.
- No. 63 - 70 use noise level (Leq24hr) at Khajonsiri Temple, Suan Luang Sub-district, Suan Luang District, Bangkok.
- No. 71 - 74 use noise level (Leq24hr) at Darul Amin Mosque, Suan Luang Sub-district, Suan Luang District, Bangkok.
- No. 75 - 86 use noise level (Leq24hr) at Sri lam Temple, Bang Na Sub-district, Bang Na District, Bangkok.
- No. 87 - 95 use noise level (Leq24hr) at Siriwutti Wittaya School, Thepharak Sub-district, Mueang Samut Prakan District, Samut Prakan Province.
- No. 96 - 111 use noise level (Leq24hr) at Chulavej hospital, Thepharak Sub-district, Mueang Samut Prakan District, Samut Prakan Province.

3/ calculation by $L_{p_{Total}}$ equation

4/ refer ambient noise standard in Notification of National Environmental Board No. 15, 1997 (B.E. 2540).

Source: ENRICH Consultant Co., Ltd., 2013.

Table 5.1.6 - 8 Annoyance noise level from monorail operation activities at sensitive areas along the project route

No.	Sensitive areas	Distance from center line of project (m)	Existing noise level ^{1/} (dB(A))		Noise level during monorail operation period (dB(A))		Annoyance noise level (dB(A))
			Leq ₂₄	L ₉₀	Before adjust value ^{2/}	After adjust value ^{3/}	
1	Charuwattananukun Kindergarten School	337.97	67.1	55.0	67.1	60.1	5.1
2	Yamsaard Kindergarten School	390.31	67.1	55.0	67.1	60.1	5.1
3	Rungwittaya Kindergarten School	222.73	67.1	55.0	67.1	60.1	5.1
4	House of Christ Christendom	295.98	67.1	55.0	67.1	60.1	5.1
5	Chidanukun School	434.58	67.1	55.0	67.1	60.1	5.1
6	Siam Bethel Christendom	140.75	67.1	55.0	67.2	60.2	5.2
7	Siriphan Vittaya School	99.45	67.1	55.0	67.2	60.2	5.2
8	Lad Prao Baptist Christendom	84.28	67.1	55.0	67.3	60.3	5.3
9	Pibool Upphatham School	86.50	67.1	55.0	67.2	60.2	5.2
10	Sirithep School	477.02	67.1	55.0	67.1	60.1	5.1
11	Wat Lat Phrao School	494.01	67.1	55.0	67.1	60.1	5.1
12	Chaemsuksa School	160.58	67.1	55.0	67.1	60.1	5.1
13	Settabutr Upathum School	188.00	67.1	55.0	67.1	60.1	5.1
14	Thanormpitvithaya School	75.22	67.1	55.0	67.3	60.3	5.3
15	Kurusapa Business Organization Kindergarten School	72.51	67.1	55.0	67.3	60.3	5.3
16	Tangtung Vittaya School	496.81	67.1	55.0	67.1	60.1	5.1
17	Karnda School	206.38	67.1	55.0	67.1	60.1	5.1
18	Antioch Ladphrao Baptist Christendom	275.42	67.1	55.0	67.1	60.1	5.1
19	Nawamintharachinuthit Bodindecha School	382.99	67.1	55.0	67.1	60.1	5.1
20	Surao Don Sakae School	317.97	61.3	53.3	61.3	54.3	1.0
21	Hidayatun Islam Mosque (Don Sakae)	361.03	61.3	53.3	61.3	54.3	1.0
22	Jitnatda Kindergarten School	160.92	61.3	53.3	61.5	54.5	1.2
23	Santisuk Bangkok Christendom	414.40	61.3	53.3	61.3	54.3	1.0
24	Bankru Kindergarten School	455.74	61.3	53.3	61.3	54.3	1.0
25	Bangkok Suksa School	106.54	61.3	53.3	61.7	54.7	1.4
26	Bangkok Withaya School	280.81	61.3	53.3	61.4	54.4	1.1
27	Lad Prao Hospital	52.57	61.3	53.3	62.6	55.6	2.3
28	Ruam Nimit Bangkok Christendom	204.89	61.3	53.3	61.4	54.4	1.1
29	Rajapongsa Kindergarten School	498.98	61.3	53.3	61.3	54.3	1.0
30	Wat Mae Phra Kularb Tip (Maria Rosa Mystica Christendom)	87.83	61.3	53.3	61.8	54.8	1.5
31	Lat Phrao English School	362.22	61.3	53.3	61.3	54.3	1.0
32	Pramote Gym Buddhaisawan School	185.35	61.3	53.3	61.4	54.4	1.1
33	Kanathip Child and Elderly Care School	252.46	70.6	65.3	70.6	63.6	-
34	Mahapawn Bangkok Alliance Christendom	445.67	70.6	65.3	70.6	63.6	-

Table 5.1.6 - 8 Annoyance noise level from monorail operation activities at sensitive areas along the project route (Cont'd)

No.	Sensitive areas	Distance from center line of project (m)	Existing noise level ^{1/} (dB(A))		Noise level during monorail operation period (dB(A))		Annoyance noise level (dB(A))
			Leq ₂₄	L ₉₀	Before adjust value ^{2/}	After adjust value ^{3/}	
35	Suranarabibal School	64.84	70.6	65.3	70.7	63.7	-
36	Patarabutr Kindergarten School	133.44	70.6	65.3	70.6	63.6	-
37	Vejthani Hospital	105.80	70.6	65.3	70.6	63.6	-
38	Bangkok Good News Christendom	219.09	70.6	65.3	70.6	63.6	-
39	Mawadi Music School	118.15	70.6	65.3	70.6	63.6	-
40	Peace of Bangkok Christendom	114.66	70.6	65.3	70.6	63.6	-
41	Fatthullbalee Mosque	46.40	56.1	53.0	60.1	53.1	0.1
42	Huamarkwittayanusorn School	225.82	56.1	53.0	56.4	49.4	-
43	Huamark Kindergarten School	230.26	56.1	53.0	56.4	49.4	-
44	Kanchanaphon Kindergarten	156.87	56.1	53.0	56.6	49.6	-
45	Grace Lutheran Christendom	351.52	56.1	53.0	56.2	49.2	-
46	Kornsupa Kindergarten School	275.27	56.1	53.0	56.3	49.3	-
47	International Hotel & Tourism Industry Management School	294.51	56.1	53.0	56.3	49.3	-
48	Kirk Thai Skill Development Center School	151.98	56.1	53.0	56.7	49.7	-
49	Sudharee Kindergarten	116.60	56.1	53.0	57.0	50.0	-
50	Mae Phra Ong Uppatham Catholic Christendom (Church of Christ)	153.58	56.1	53.0	56.7	49.7	-
51	Chutima Kindergarten School	108.62	56.1	53.0	57.2	50.2	-
52	Jamiul Idhard Mosque (Huamak Yai)	364.80	56.1	53.0	56.2	49.2	-
53	Huamak School	223.35	56.1	53.0	56.4	49.4	-
54	Darissalam Mosque	232.65	56.1	53.0	56.4	49.4	-
55	Darissalam School	207.27	56.1	53.0	56.4	49.4	-
56	Hishaladademee School	404.89	56.1	53.0	56.2	49.2	-
57	Vibharam Hospital	469.67	56.1	53.0	56.2	49.2	-
58	Suan Luang Christendom	24.92	65.1	50.0	67.3	62.8	12.8
59	Klongkalandan School (Meesuwan Anusorn)	79.91	65.1	50.0	65.4	58.4	8.4
60	Piyajit Vittaya School	372.65	65.1	50.0	65.1	58.1	8.1
61	Mandaumoucinin School	219.88	65.1	50.0	65.1	58.1	8.1
62	Triamudomsakapatanakran School	500.00	65.1	50.0	65.1	58.1	8.1
63	Aliatisorn (Nana Uthit) School	343.92	63.5	51.1	63.5	56.5	5.4
64	Suraomai School	395.39	63.5	51.1	63.5	56.5	5.4
65	Prasarnwitwatana School	368.96	63.5	51.1	63.5	56.5	5.4
66	Masla Artul Islam School	402.61	63.5	51.1	63.5	56.5	5.4
67	An Latisorn Mosque	430.65	63.5	51.1	63.5	56.5	5.4
68	Khajonsiri Temple	239.75	63.5	51.1	63.5	56.5	5.4

Table 5.1.6 - 8 Annoyance noise level from monorail operation activities at sensitive areas along the project route (Cont'd)

No.	Sensitive areas	Distance from center line of project (m)	Existing noise level ^{1/} (dB(A))		Noise level during monorail operation period (dB(A))		Annoyance noise level (dB(A))
			Leq ₂₄	L ₉₀	Before adjust value ^{2/}	After adjust value ^{3/}	
69	Hussanaveeya Sayowan Anusorn School	164.21	63.5	51.1	63.6	56.6	5.5
70	Jaipranee Kindergarten School	299.37	63.5	51.1	63.5	56.5	5.4
71	Salahnoi School	302.09	61.3	57.9	61.3	54.3	-
72	Liswanul Islameeya School	250.03	61.3	57.9	61.4	54.4	-
73	Darul Amin Mosque	71.73	61.3	57.9	62.1	55.1	-
74	Darul Amin School	87.66	61.3	57.9	61.8	54.8	-
75	Bride of Christ Christendom	173.64	69.3	66.7	69.3	62.3	-
76	Dusit Thani College	163.34	69.3	66.7	69.3	62.3	-
77	Plengprasiddhi Kindergarten School	201.87	69.3	66.7	69.3	62.3	-
78	Bangkok Dance Academy (Paradise Park Branch)	80.27	69.3	66.7	69.4	62.4	-
79	Graduate School of Public Administration, Burapha University (Paradise Park)	99.01	69.3	66.7	69.4	62.4	-
80	Sereeruk Kindergarten School	361.47	69.3	66.7	69.3	62.3	-
81	BARTER International Maritime School	274.01	69.3	66.7	69.3	62.3	-
82	Si lam Temple	136.53	69.3	66.7	69.3	62.3	-
83	Srieam Anusorn School	157.64	69.3	66.7	69.3	62.3	-
84	Bangna Immanuel Christendom	225.42	69.3	66.7	69.3	62.3	-
85	Suthibongkot School	370.33	69.3	66.7	69.3	62.3	-
86	Sikarin Hospital	419.51	69.3	66.7	69.3	62.3	-
87	Bang Kaeo Prachasan School	457.22	63.9	56.6	63.9	56.9	0.3
88	Khlong Samrong School	435.65	63.9	56.6	63.9	56.9	0.3
89	Jaisamarn Full Gospel Christendom	322.43	63.9	56.6	63.9	56.9	0.3
90	Bangmueang Khian Phong Anusorn School (Debsirin Samut Prakan School)	493.14	63.9	56.6	63.9	56.9	0.3
91	Intarumphun Anusorn School	398.62	63.9	56.6	63.9	56.9	0.3
92	Uthip School	461.09	63.9	56.6	63.9	56.9	0.3
93	Chandna Kindergarten School	471.52	63.9	56.6	63.9	56.9	0.3
94	Siriwutti Wittaya school	74.20	63.9	56.6	64.3	57.3	0.7
95	Chularat2 Hospital	32.73	63.9	56.6	65.7	58.7	2.1
96	Udom Suk Si Pha Rak Christendom	313.32	73.7	68.3	73.7	66.7	-
97	Raak Daroon Kindergarten School	123.34	73.7	68.3	73.7	66.7	-
98	Hope of Samut Prakan Christendom	498.99	73.7	68.3	73.7	66.7	-
99	Klongkratumratutit School	66.70	73.7	68.3	73.8	66.8	-
100	DeeProm Kindergarten School	102.40	73.7	68.3	73.7	66.7	-
101	Samrong Nuea Public Health Center	341.92	73.7	68.3	73.7	66.7	-

Table 5.1.6 - 8 Annoyance noise level from monorail operation activities at sensitive areas along the project route (Cont'd)

No.	Sensitive areas	Distance from center line of project (m)	Existing noise level ^{1/} (dB(A))		Noise level during monorail operation period (dB(A))		Annoyance noise level (dB(A))
			Leq ₂₄	L ₉₀	Before adjust value ^{2/}	After adjust value ^{3/}	
102	Daroonrat School	309.73	73.7	68.3	73.7	66.7	-
103	Jaturamuk Kindergarten School	388.03	73.7	68.3	73.7	66.7	-
104	Samrong Lutheran Christendom	379.71	73.7	68.3	73.7	66.7	-
105	Jatupornwittaya School	335.21	73.7	68.3	73.7	66.7	-
106	Dan Samrong Temple	253.75	73.7	68.3	73.7	66.7	-
107	Watdamsamrong School	335.01	73.7	68.3	73.7	66.7	-
108	Matthayomdamsamrong School	355.39	73.7	68.3	73.7	66.7	-
109	Dansamrong Adult Education School	346.45	73.7	68.3	73.7	66.7	-
110	Samrong Hospital	466.58	73.7	68.3	73.7	66.7	-
111	Chulavej Hospital	33.07	73.7	68.3	73.9	66.9	-
Standard ^{4/}							Not exceed 10

Remark: 1/ Maximum noise level (Leq_{24hr}) at noise sampling stations along the project route during 14 June to 2 July, 2013.

- No. 1 - 19 use noise level (Leq_{24hr}) at Pibool Upphatham School, Samsennok Sub-district, Huai Khwang District, Bangkok.
- No. 20 - 32 use noise level (Leq_{24hr}) at Wat Mae Phra Kularb Tip (Maria Rosa Mystica Church), Wang Thonglang Sub-district, Wang Thonglang District, Bangkok.
- No. 33 - 40 use noise level (Leq_{24hr}) at Vejthani Hospital, Khlong Chan Sub-district, Bang Kapi District, Bangkok.
- No. 41 - 57 use noise level (Leq_{24hr}) at Mae Phra Ong Uppatham Catholic Church (Church of Christ), Huamak Sub-district, Bang Kapi District, Bangkok.
- No. 58 - 62 use noise level (Leq_{24hr}) at Klongkalantan School, Suan Luang Sub-district, Suan Luang District, Bangkok.
- No. 63 - 70 use noise level (Leq_{24hr}) at Khajonsiri Temple, Suan Luang Sub-district, Suan Luang District, Bangkok.
- No. 71 - 74 use noise level (Leq_{24hr}) at Darul Amin Mosque, Suan Luang Sub-district, Suan Luang District, Bangkok.
- No. 75 - 86 use noise level (Leq_{24hr}) at Sri Iam Temple, Bang Na Sub-district, Bang Na District, Bangkok.
- No. 87 - 95 use noise level (Leq_{24hr}) at Siriwutti Wittaya School, Thepharak Sub-district, Mueang Samut Prakan District, Samut Prakan Province.
- No. 96 - 111 use noise level (Leq_{24hr}) at Chulavej hospital, Thepharak Sub-district, Mueang Samut Prakan District, Samut Prakan Province.

2/ Predicted noise level from monorail operation period in **Table 5.1.6-7**

3/ Use noise value modifier of Pollution Control Department method in **Table 5.1.6-4**

4/ Notification of National Environmental Board No. 29, 2007 (B.E. 2550).

Source: ENRICH Consultant Co., Ltd., 2013.

5.1.6.2 Impact on Depot Area and Park and Ride building

1) Construction Phase

A) The impact on the Depot construction area

The Depot will be located east of the Si Iam junction. The nearest village and vulnerable areas to be affected is Prem Ruethai Udomsuk where located about 200 meters from the predicted noise levels caused by the Depot in the most serious cases (worst case scenario) or noise from construction projects is the most activity drilling and pile driving which is create the noise level of 96 dB (A) at a distance of 15 meters from the source as shown in **Table 5.1.6-2** and the predicted impact noise occurs. By substituting into the equation (1) are as follows.

$$Lp_2 = 96 - 20 \log (200/15)$$

$$Lp_2 = 73.5 \text{ dB(A)}$$

Comparing the calculated noise levels with the standard and the noise is not continuous, and the maximum noise level ($L_{\max}$) is expected to not exceed 115 dB (A) therefore, the level of noise emissions from hammering and drilling rigs is still lower than the standard limit. However, when considering the case of hammering or drilling rigs continuous eight

hours can adjust the volume formed by the construction of a volume average 24 hours using equation (2) with the following details.

$$Leq_T = 73.5 + 10 \log (8/24)$$

$$Leq_{24} = 68.7 \text{ dB(A)}$$

Considering the results of the calculation of the noise level occurred in terms of the noise level 24-hour average compared to the standard level set for the general noise level averaged 24 hours (Leq_{24}) does not exceed 70 decibels (A), the noise level happens to be less than the standard limit. Also, the noise level has the total volume of up to 24 hours on average in the current measurements from the closest monitoring stations in the area from 14 June to 2 July, 2013 (**Table 4.1.6 - 2**) that is Si lam Station (69.3 dB (A)), the noise level will be 72.0 dB (A), which still higher than the standard.

The calculated average noise for a 24 hour is higher than the standards has two aspects: the noise level average 24 hours in the current conditions measured at Si lam Temple is close to the standard (69.3 dB (A)) and noise level forecasts predict an average 24 hours of continuous operation. In fact, the project activities (hammering or drilling rigs,) will be implemented during operation hour and will be suspended the operations during the night when people stay living at home. However, the noise level before adjusting is equal to 72.0 dB (A) and the adjusted noise level is shown in **Table 5.1.6 - 4** which found that the noise level is equal to 69.0 dB (A) after subtracted from the measurement (L_{90}) measured at Si lam Temple (66.7 dB (A)) that is the interference of 2.3 dB (A) lower than the level of interference. imposed (up to 10.0 dB (A)). Thus, the construction activities like drilling and piling will not interference Prem Ruethai Udomsuk village where located about 200 meters away, but the effects that occurred in the whole of the Depot construction is expected to be moderate. The project has already taken measures prevent and reduce the impact caused by the project.

B) The Impact on Park & Ride buildings construction area

The Park and Ride buildings construction area are located at the East of the Si lam junction. The closest residential areas that vulnerable to the effects is Si lam Temple where located approximately 150 meters away. In the worst case scenario, the predicted noise level from the construction of the Park and Ride buildings will be from piling and drilling activity with the noise level of 96 dB (A) at a distance of 15 meters from the source details as shown in **Table 5.1.6 - 2**. The predicted impact noise occurs by substituting into the equation (1) as follows.

$$Lp_2 = 96 - 20 \log (150/15)$$

$$Lp_2 = 76.0 \text{ dB(A)}$$

The noise level were compared to the standard level from the events which will be pile create noise infrequently. The noise is not continuous that the maximum noise level (L_{max}) is set for the common areas must not exceed 115 dB (A). In short, the level of noise emissions from hammering and drilling rigs is still lower than the standard limit. However, when considering the case of hammering or drilling rigs continuous eight hours can adjust the volume formed by the construction of a volume average 24 hours using equation (2) with the following details.

$$\begin{aligned} \text{Leq}_T &= 76.0 + 10 \log (8/24) \\ \text{Leq}_{24} &= 71.2 \text{ dB(A)} \end{aligned}$$

Considering the results of the calculation noise level average 24 hours compared to the standard level set for the general noise level averaged 24 hours (Leq_{24}) does not exceed 70 dB (A), found that the noise level happens to exceed the standards set. the noise level has the total volume average 24 hours in the current conditions measured by the monitoring stations in the area that is closest from 14 June to 2 July, 2013 (**Table 4.1.6 - 2**) was measured at Si lam Temple monitoring stations (69.3 dB (A)), found that the volume is equal to 73.4 dB (A) which is higher than the standards.

The calculated average noise for a 24 hour is higher than the standards set has two aspects: the noise level average 24 hours in the current conditions measured at Si lam Temple is close to the standard (69.3 dB (A)) and noise level forecasts predict an average 24 hours of continuous operation. In fact, the project activities (hammering or drilling rigs,) will be implemented during operation hour and will be suspended the operations during the night when people stay living at home. However, the noise level before adjusting is equal to 73.4 dB (A) and the adjusted noise level is shown in **Table 5.1.6 – 4** which found that the noise level is equal to 71.4 dB (A) after subtracted from the measurement ((L_{90}) measured at Si lam Temple (66.7 dB (A)) that is the interference of 4.7 dB (A) lower than the level of interference. imposed (up to 10.0 dB (A)). Thus, the construction activities like drilling and piling will not interference Prem Ruethai Udomsuk village where located about 150 meters away, but the effects that occurred in the whole of the Depot construction is expected to be moderate. The project has already taken measures prevent and reduce the impact that expected to reduce the impact caused by the project.

2) Operation Phase

A) The impact on Depot

During the operation Phase, the activities of the depot are mainly maintenance and repair. The maintenance activities will mainly take place inside the hangar building. The building is closed and will not cause noise disturbance to residents living in the neighborhood particularly Prem Ruethai Udomsuk where located about 200 meters from the depot. Consider the worst case scenario by the set the noise up from maintenance and replacement of equipment of the train is 90 dB (A) at a distance of 15 meters from the noise source. The anticipated impact of noise occurring substituting into the equation (1) are as follows.

$$\begin{aligned} L_{p_2} &= 90 - 20 \log (200/15) \\ L_{p_2} &= 67.5 \text{ dB(A)} \end{aligned}$$

As the noise levels compare with the standard level, the maintenance activities will not cause continuous noise whereas the maximum noise level ($L_{\max}$) is set for the common areas must not exceed 115 dB (A). Thus, it was concluded that the noise level caused by maintenance activities within the Depot is also lower than the standard.

Considering the worst case scenario, that the taken place continuously 24-hours, the results of the calculation noise level is equal to 67.5 dB(A). While the standard level set

for the general noise level averaged 24 hours (Leq24) should not exceed 70 dB (A), found that the noise level happens to exceed the standards. the noise level has the total volume average 24 hours in the current conditions measured by the monitoring stations in the area that is closest from 14 June to 2 July, 2013 (Table 4.1.6 - 2) was measured at Si lam Temple monitoring stations (69.3 dB (A)), found that the noise level is equal to 73.4 dB (A) which is higher than the standards.

The average noise level for a 24-hour forecasting is overestimated than the standards has three possible aspects.

(1) The noise level average 24 hours in current conditions measured at Si lam Temple is close to the standard that is 69.3 dB (A).

(2) The predicted noise level average 24-hour is calculated based on the continuous operation, However, in reality, the maintenance activities that will take place during the operation hours only.

(3) The maximum noise level from the train maintenance activities is 90 decibels (A) at a distance of 15 meters from the source without compromising the level of noise from the building that reduces the noise level significantly.

Considering the level of noise disturbance by evaluating the procedure to assess noise mentioned earlier the noise level is equal to 71.5 dB (A) and the adjusting level is shown in Table 5.1.6 - 4 that the noise level is equal to 67.0 dB (A), and when. to subtract from the noise level-based measurement ((L₉₀) measured at Si lam Temple (66.7 dB (a)), the interference is 0.3 dB (A) which lower than the interference level defined (up to 10.0 dB (A)). Therefore, the maintenance of the rail project does not interfere Prem Ruethai Udomsuk village where located 200 meters away. The impact of noise occurring in the whole of the Depot is expected to be low.

B) The Impact on Park & Ride buildings

The Park and Ride buildings will be used for private car parking in the building and travel by project. The closest representative vulnerable areas to be of affected is Wat Si lam where located approximately 150 meters from the predicted noise level from the park and ride buildings. The activities, in the worst case scenario, will be consists of the car run in and out the building for 18-hour Phase with the opening of the system. On the level of the noise from the cars of 85 dB (A) at a distance of 7.5 meters from the source. Ministry of Natural Resources and Environment set the noise of the car, dated 8 August 2003 when the impact of noise occurring by substituting into the equation (1) are as follows.

$$L_{p_2} = 85 - 20 \log (150/7.5)$$

$$L_{p_2} = 59.0 \text{ dB(A)}$$

Comparing the calculated noise levels with the maximum standard level (L_{max}) which set that must not exceed 115 dB (A), therefore, it was concluded that the level of noise emissions from activities in the park and ride buildings is also lower than the standard limit. Considering the case of a 24-hour continuous operation can adjust the noise level from the 18-hour average to the 24-hour average using equation (2), as detailed below.

$$Leq_T = 59.0 + 10 \log (18/24)$$

$$Leq_{24} = 57.7 \text{ dB(A)}$$

Comparing the results of the calculation noise level in 24-hour average with the standard level set for the general noise level averaged 24 hours (Leq_{24}) which should not exceed 70 dB (A), found that the noise level happens to exceed the standards. the noise level has the total volume average 24 hours in the current conditions measured by the monitoring stations in the area that is closest from 14 June to 2 July 2013 (Table 4.1.6 - 2) was measured at Si lam Temple monitoring stations (69.3 dB (A)), found that the noise level is equal to 69.6 dB (A) which is lower than the standards.

The average noise level for a 24-hour estimated close to the standards has two aspects: the average noise level 24-hour in the current conditions measured Si lam Temple is close to the standard (69.3 dB (A)) and the noise level predict in the average 24 hours of continuous operation. In fact, the activity of park and ride buildings will take place over the operation hours. The range of most vehicles in the morning rush (6:00 to 9:00 AM.) and during the evening rush. (16:00 to 18:00 PM.) is the only primary considering the level of noise disturbance. The evaluation procedure to assess noise above. Before adjusting the noise level that equal to 69.6 dB (A) and details in the **Table 5.1.6 - 4** found that the noise level is equal to 62.6 dB (A). When the offset from noise level-based measurement ((L_{90}) measured at Si lam Temple (66.7 dB (A)) is the interference of -4.1 dB (A) lower than the level of interference defined (up to 10.0 dB (A)). Considering the operational activities in the park and ride buildings does not interfere with measurements Si lam Temple and communities approximately 150 meters, so the impact on the noise from the operation area of park and ride buildings is expected to be low.

5.1.7 Vibration

5.1.7.1 The Impact of the Elevated Structures and the Stations area

1) Construction Phase

The project construction activities include excavation and reclamation of open space, drilling rigs for support of the elevated structure and the station, material and construction equipment transportation, etc. Those activities may cause vibration of the adjacent area. The level of vibration will depend on the type of equipment to use and how the distance of the source of the vibration, etc. In assessing the impact of the vibration, according to the vibration caused by the mechanical device while construction activities took place at a distance of 25 feet or 7.62 meters of origin that the US.EPA (1995) reported in Transit Noise and Vibration Impact Assessment, as shown in **Table 5.1.7 - 1** in which the calculation of vibration occurred along the project route using the following equation:

$$PPV_{\text{equip}} = PPV_{\text{ref}} \times (25/D)^{1.5} \dots\dots\dots (1)$$

Where PPV_{equip} = Peak Particle Velocity (PPV) Caused by equipment in the various distance (inches / sec).

PPV_{ref} = the reference vibration at a distance of 25 feet or 7.62 meters (inches / sec).

D = The distance from the equipment to the community (feet).

To replace the value of the distance, the use of construction equipment and the communities and vulnerable areas to the effects of the equation (1), the calculated results are shown in **Table 5.1.7 - 2**.

Table 5.1.7 - 1 The vibration caused by the mechanical device while construction activities took place at a distance of 25 feet or 7.62 meters of vibration sources

Construction Machinery	Peak Particle Velocity at 25 feet (7.62 meters)	
	inch/sec.	mm./sec.
1. Pile Drive (Sonic)	0.734	18.644
2. Clam Shovel Drop (Slurry Wall)	0.202	5.131
3. Hydromill (Slurry Wall) (In Soil)	0.008	0.203
4. Large Bulldozer	0.089	2.261
5. Loaded Trucks	0.076	1.930
6. Jackhammer	0.035	0.889
7. Small Bulldozer	0.003	0.762

Source: US.EPA, 1995. Transit Noise and Vibration Impact Assessment.

Table 5.1.7 - 2 The calculation of vibration caused by the mechanical device while construction activities took place at a distance of 25 feet or 7.62 meters of vibration sources

Construction Machinery	Peak Particle Velocity (mm./sec.) ^{1/}								
	Distance from vibration sources (meters)								
	10	20	30	50	100	150	200	250	300
1. Pile Drive (Sonic)	12.401	4.384	2.387	1.109	0.392	0.213	0.139	0.099	0.075
2. Clam Shovel Drop (Slurry Wall)	3.413	1.207	0.657	0.305	0.108	0.059	0.038	0.027	0.021
3. Hydromill (Slurry Wall) (In Soil)	0.135	0.048	0.026	0.012	0.004	0.002	0.002	0.001	0.001
4. Large Bulldozer	1.504	0.532	0.289	0.134	0.048	0.026	0.017	0.012	0.009
5. Loaded Trucks	1.284	0.454	0.247	0.115	0.041	0.022	0.014	0.010	0.008
6. Jackhammer	0.591	0.209	0.114	0.053	0.019	0.010	0.007	0.005	0.004
7. Small Bulldozer	0.051	0.018	0.010	0.005	0.002	0.001	0.001	0.000	0.000

Source: ^{1/} calculated by the equation of $PPV_{equip} = PPV_{ref} \times (25/D)^{1.5}$

The predictions are based on the vibration of the construction equipment which is expected to cause a maximum vibration in the worst case scenario. The data in **Table 5.1.7 - 1** showed that using Pile Drive (Sonic) will cause a maximum vibration. with the maximum speed of the particles 0.734 inches/second or 18.644 mm/sec at a distance of 25 feet or 7.62 meters from the source. The predicted results from each of the vulnerable will be compared with the criteria proposed in the impact of vibration on the human by Whiffin, AC and Leonard, DR (1971) and the requirements vibration to the building of DIN 4150 (Nelson, 1987). The impact due to. vibrations on humans and buildings / structures as shown in **Table 5.1.7 - 3** and vibration to the building of DIN 4150, as shown in **Table 5.1.7 - 4**.

Table 5.1.7 - 3 The Impact due to Vibrations on Humans and Buildings/Structures

Peak Particle Velocity mm./sec. (inch/sec.)	Human Impacts ^{1/}	Building Structure Impacts ^{2/}
0 to 0.15 (0-0.006)	Not be expected to notice vibration	} cannot be damage to building
0.15 to 0.30 (0.006-0.012)	can be expected to be disturbed by vibration to some extent	
2.00 (0.079)	can be expected to be disturbed by vibration	can be damage to ancient building
2.50 (0.098)	can be expected to be annoyed by vibration	cannot be damage to building
5.00 (0.197)	human in the building can be disturbed by vibration	building damage is primary concerned
10.00 to 15.00 (0.394-0.591)	human can be annoyed by vibration	can be damage to residential

Remark : ^{1/} according to the criteria of Reiher & Meister (1931)

^{2/} according to the criteria of DIN 4150 (Nelson, 1987)

Source : Whiffin, A.C., and Leonard, D.R., 1971. A Survey of Traffic Induced Vibration, Eng.

Table 5.1.7 - 4 Summary of Building Damage criteria in DIN 4150

Peak Particle Velocity mm./sec. (inch/sec.)	Building Damage
2 mm./sec. (0.079 inch/sec.)	cannot be damage to building (also ancient building)
5 mm./sec. (0.0197 inch/sec.)	building damage is primary concerned
10 mm./sec. (0.394 inch/sec.)	can be tolerated for residential
20-40 mm./sec. (0.787-1.575 inch/sec.)	can be tolerated for Industrial

Source: DIN 4150 (Nelson, 1987)

The predicted results of the vibration from the projects construction found that the vibration source at the community and the impact on sensitive areas along the route are less than 0.30 mm/sec or less than 0.012 inches/second, which humans cannot sense or merely feel or it is possible to not affected without disturbing the structural or damage to the buildings or structures of all types except Suan Luang Christendom where located from the center line of Route 24.92 meters, with the vibration of 3.152 mm/sec. or 0.124 inches/second, which is in the range of vibrations that interfere with a human in the buildings if it happens continuously. The impact on the structure and the building are not vulnerable to damage the building or architectural structure or with a slight impact in damage to the architectural structure. Typical houses with walls and a plaster ceiling (a mixture of cement, sand, water, and fiber) in the wall / ceiling flexible will receive the minor damage as shown in **Table 5.1.7 - 5**. The vulnerable areas prone to the impact located from the center line of project route from 32.73 to 118.15 meters, including Chularat 2 Hospital, Chulavej Hospital. Hung Bari mosque Lat Phrao Hospital, Kuru Sapa Kindergarten Thanornpivitvithaya School, Wat Phra Mae Kulapthip and the Santi Chumchon Christendom with the vibrations in the range of 0.305 to 2.094 mm/sec or 0.012 to 0.082 inches/second, which humans can feel the vibrations but it is not vulnerable to cause the damage to

the building or architectural structure as shown in **Table 5.1.7 - 5**. Therefore, it is expected that the sources of vibration from drilling rigs for the foundation and structure support of the elevated station / train / maintenance building / park and ride buildings will create PPV_{max} only over a short time Phase and incoherent. This case will occur only in each area of construction with a length of 1,000 meters, it is expected that the impact is low to moderate.

Considering the severity of the vibrations impact from drilling rigs for foundation and structures support as shown in **Table 5.1.7 - 5**, can be concluded that the effects of vibration in the construction Phase is low to moderate. The details are as follows

(1) The construction of the elevated structures expected to have the impact prone, communities and vulnerable, areas of the vibration in a range of drilling rigs in the distance from the source of up to 33 meters, the particles velocity ranged up to 2.094 mm./Sec. or no more than 0.082 inches/second that is Chularat 2 Hospital and Chulavej Hospital as shown in **Table 5.1.7 - 5** which is the vibration that humans can feel to annoyed but not to the level of disrupt on humans who live in the building, according to Reiher & Meister (1931). Thus, there is no risk of damage to be caused to buildings or architectural structures according to DIN 4150 (Nelson, 1987) as shown in **table 5.1.7 - 3** and **table 5.1.7 - 4**.

(2) The construction of the stations expected to have the impact prone, communities and vulnerable, areas of the vibration in a range of drilling rigs in the distance from the source of up to 33 meters, as well as the construction of the elevated structure. The peak particle velocity in the range is less than 2.094 mm/sec., or less than 0.082 inches/second that are Chularat 2 Hospital and Chulavej Hospital (**Table 5.1.7 - 5**), which is the vibration that humans can feel to annoyed but not to the level of disrupt on humans who live in the building, according to Reiher & Meister (1931). Thus, there is no risk of damage to be caused to buildings or architectural structures according to DIN 4150 (Nelson, 1987) as shown in 5.1.7 - 5.1.7 and table 3 - 4.

2) Operation Phase

In the operation Phase, there the impact expected to have on the vibration from the main two sources, that are:

(1) During the operation Phase, the volume of traffic on the road beneath the elevated structures station, which the traffic volume is no different from present conditions, is expected to cause the vibration. The level of the vibration will depend on many factors, including road surface condition surface roughness, the slope of the area, vehicle speed, the weight of the vehicle, the distance from the origin to the sources of vibration, and the ability to absorb vibration of each soil type, etc. In order to calculate the vibrations from traffic on the street during the operation Phase, the equation of the Transport and Road Research Laboratory of the United Kingdom will be used to calculate the maximum particle velocity (Peak Particle Velocity, PPV), as detailed below.

$$V = 0.021a(v/50)(w/15)tp(r/6)^x \dots\dots\dots (2)$$

Table 5.1.7 - 5 Peak particle velocity in construction period at sensitive areas along the project route

No.	Sensitive areas	Distance from center line of project		Peak particle velocity from monorail operation ^{1/}		Construction period, Impact on	
		m.	ft.	mm/sec	inch/sec	Human ^{2/}	Building ^{3/}
1	Charuwattananukun Kindergarten School	337.97	1,108.81	0.06	0.002	A	1
2	Yamsaard Kindergarten School	390.31	1,280.53	0.05	0.002	A	1
3	Rungwittaya Kindergarten School	222.73	730.73	0.12	0.005	A	1
4	House of Christ Christendom	295.98	971.05	0.08	0.003	A	1
5	Chidanukun School	434.58	1,425.77	0.04	0.002	A	1
6	Siam Bethel Christendom	140.75	461.77	0.23	0.009	B	1
7	Siriphan Vittaya School	99.45	326.28	0.40	0.016	B-C	1-2
8	Lad Prao Baptist Christendom	84.28	276.51	0.51	0.020	B-C	1-2
9	Pibool Upphatham School	86.50	283.79	0.49	0.019	B-C	1-2
10	Sirithep School	477.02	1,565.01	0.04	0.001	A	1
11	Wat Lat Phrao School	494.01	1,620.75	0.04	0.001	A	1
12	Chaemsuksa School	160.58	526.83	0.19	0.008	B	1
13	Settabutr Upathum School	188.00	616.79	0.15	0.006	B	1
14	Thanornpivitvithaya School	75.22	246.78	0.60	0.024	B-C	1-2
15	Kurusapa Business Organization Kindergarten School	72.51	237.89	0.64	0.025	B-C	1-2
16	Tangtung Vittaya School	496.81	1,629.93	0.04	0.001	A	1
17	Karnda School	206.38	677.09	0.13	0.005	A	1
18	Antioch Ladphrao Baptist Christendom	275.42	903.60	0.09	0.003	A	1
19	Nawamintharachinuthit Bodindecha School	382.99	1,256.51	0.05	0.002	A	1
20	Surao Don Sakae School	317.97	1,043.20	0.07	0.003	A	1
21	Hidayatun Islam Mosque (Don Sakae)	361.03	1,184.47	0.06	0.002	A	1
22	Jitnatda Kindergarten School	160.92	527.95	0.19	0.008	B	1
23	Santisuk Bangkok Christendom	414.40	1,359.56	0.05	0.002	A	1
24	Bankru Kindergarten School	455.74	1,495.19	0.04	0.002	A	1
25	Bangkok Suksa School	106.54	349.54	0.36	0.014	B-C	1-2
26	Bangkok Withaya School	280.81	921.28	0.08	0.003	A	1
27	Lad Prao Hospital	52.57	172.47	1.03	0.041	B-C	1-2
28	Ruam Nimit Bangkok Christendom	204.89	672.20	0.13	0.005	A	1
29	Rajapongsa Kindergarten School	498.98	1,637.05	0.04	0.001	A	1
30	Wat Mae Phra Kularb Tip (Maria Rosa Mystica Church)	87.83	288.15	0.48	0.019	B-C	1-2
31	Lat Phrao English School	362.22	1,188.37	0.06	0.002	A	1
32	Pramote Gym Buddhaisawan School	185.35	608.10	0.16	0.006	B	1
33	Kanathip Child and Elderly Care School	252.46	828.27	0.10	0.004	A	1
34	Mahapawn Bangkok Alliance Christendom	445.67	1,462.15	0.04	0.002	A	1
35	Suranarabibral School	64.84	212.73	0.75	0.030	B-C	2
36	Patarabutr Kindergarten School	133.44	437.79	0.25	0.010	B	1
37	Vejthani Hospital	105.80	347.11	0.36	0.014	B-C	1-2
38	Bangkok Good News Christendom	219.09	718.79	0.12	0.005	A	1
39	Mawadi Music School	118.15	387.63	0.31	0.012	B-C	1-2
40	Peace of Bangkok Christendom	114.66	376.18	0.32	0.013	B-C	1-2

Table 5.1.7 - 5 Peak particle velocity in construction period at sensitive areas along the project route (Cont'd)

No.	Sensitive areas	Distance from center		Peak particle velocity		Construction period,	
		line of project		from monorail operation ^{1/}		Impact on	
		m.	ft.	mm./sec	inch/sec	Human ^{2/}	Building ^{3/}
41	Fatthullbalee Mosque	46.40	152.23	1.24	0.049	B-C	1-2
42	Huamarkwittayanusorn School	225.82	740.87	0.12	0.005	A	1
43	Huamark Kindergarten School	230.26	755.44	0.11	0.004	A	1
44	Kanchanaphon Kindergarten	156.87	514.66	0.20	0.008	B	1
45	Grace Lutheran Christendom	351.52	1,153.27	0.06	0.002	A	1
46	Kornsupa Kindergarten School	275.27	903.11	0.09	0.003	A	1
47	International Hotel & Tourism Industry Management School	294.51	966.23	0.08	0.003	A	1
48	Krirk Thai Skill Development Center School	151.98	498.62	0.21	0.008	B	1
49	Sudnaree Kindergarten	116.60	382.54	0.31	0.012	B-C	1-2
50	Mae Phra Ong Uppatham Catholic Christendom (Christendom of Christ)	153.58	503.87	0.21	0.008	B	1
51	Chutima Kindergarten School	108.62	356.36	0.35	0.014	B-C	1-2
52	Jamiul Idhard Mosque (Huamak Yai)	364.80	1,196.84	0.06	0.002	A	1
53	Huamak School	223.35	732.77	0.12	0.005	A	1
54	Darissalam Mosque	232.65	763.28	0.11	0.004	A	1
55	Darissalam School	207.27	680.01	0.13	0.005	A	1
56	Hishaladademee School	404.89	1,328.36	0.05	0.002	A	1
57	Vibharam Hospital	469.67	1,540.89	0.04	0.002	A	1
58	Suan Luang Christendom	24.92	81.76	3.15	0.124	D-E	3-4
59	Klongkalandan School (Meesuwan Anusorn)	79.91	262.17	0.55	0.022	B-C	1-2
60	Piyajit Vittaya School	372.65	1,222.59	0.05	0.002	A	1
61	Mandaumoucinin School	219.88	721.38	0.12	0.005	A	1
62	Triamudomsakkapatanakran School	500.00	1,640.40	0.04	0.001	A	1
63	Aliatorm (Nana Uthit) School	343.92	1,128.33	0.06	0.002	A	1
64	Suraomai School	395.39	1,297.20	0.05	0.002	A	1
65	Prasarnwitwatana School	368.96	1,210.48	0.06	0.002	A	1
66	Masla Artul Islam School	402.61	1,320.88	0.05	0.002	A	1
67	An Latisom Mosque	430.65	1,412.88	0.04	0.002	A	1
68	Khajonsiri Temple	239.75	786.57	0.11	0.004	A	1
69	Hussanaveeya Sayowan Anusorn School	164.21	538.74	0.19	0.007	B	1
70	Jaipranee Kindergarten School	299.37	982.17	0.08	0.003	A	1
71	Salahnoi School	302.09	991.10	0.07	0.003	A	1
72	Liswanul Islameeya School	250.03	820.30	0.10	0.004	A	1
73	Darul Amin Mosque	71.73	235.33	0.65	0.025	B-C	1-2
74	Darul Amin School	87.66	287.59	0.48	0.019	B-C	1-2
75	Bride of Christ Christendom	173.64	569.68	0.17	0.007	B	1
76	Dusit Thani College	163.34	535.89	0.19	0.007	B	1
77	Plengprasiddhi Kindergarten School	201.87	662.30	0.14	0.005	B	1
78	Bangkok Dance Academy (Paradise Park Branch)	80.27	263.35	0.55	0.021	B-C	1-2
79	Graduate School of Public Administration, Burapha University (Paradise Park)	99.01	324.83	0.40	0.016	B-C	1-2
80	Sereeruk Kindergarten School	361.47	1,185.91	0.06	0.002	A	1
81	BARTER International Maritime School	274.01	898.97	0.09	0.003	A	1

Table 5.1.7 - 5 Peak particle velocity in construction period at sensitive areas along the project route (Cont'd)

No.	Sensitive areas	Distance from center line of project		Peak particle velocity from monorail operation ^{1/}		Construction period, Impact on	
		m.	ft.	mm./sec	inch/sec	Human ^{2/}	Building ^{3/}
82	Si lam Temple	136.53	447.93	0.25	0.010	B	1
83	Srieam Anusorn School	157.64	517.19	0.20	0.008	B	1
84	Bangna Immanuel Christendom	225.42	739.56	0.12	0.005	A	1
85	Suthibongkot School	370.33	1,214.98	0.06	0.002	A	1
86	Sikarin Hospital	419.51	1,376.33	0.05	0.002	A	1
87	Bang Kaeo Prachasan School	457.22	1,500.05	0.04	0.002	A	1
88	Khlong Samrong School	435.65	1,429.28	0.04	0.002	A	1
89	Jaisamarn Full Gospel Christendom	322.43	1,057.83	0.07	0.003	A	1
90	Bangmueang Khian Phong Anusorn School (Debsirin Samut Prakan School)	493.14	1,617.89	0.04	0.001	A	1
91	Intarumphun Anusorn School	398.62	1,307.79	0.05	0.002	A	1
92	Uthip School	461.09	1,512.74	0.04	0.002	A	1
93	Chandna Kindergarten School	471.52	1,546.96	0.04	0.002	A	1
94	Siriwutti Wittaya school	74.20	243.44	0.61	0.024	B-C	1-2
95	Chularat2 Hospital	32.73	107.38	2.09	0.082	C-D	2-3
96	Udom Suk Si Pha Rak Christendom	313.32	1,027.94	0.07	0.003	A	1
97	Raak Daroon Kindergarten School	123.34	404.65	0.29	0.011	B	1
98	Hope of Samut Prakan Christendom	498.99	1,637.09	0.04	0.001	A	1
99	Klongkratumratutit School	66.70	218.83	0.72	0.028	B-C	1-2
100	DeeProm Kindergarten School	102.40	335.95	0.38	0.015	B-C	1-2
101	Samrong Nuea Public Health Center	341.92	1,121.77	0.06	0.002	A	1
102	Daroonrat School	309.73	1,016.16	0.07	0.003	A	1
103	Jaturamuk Kindergarten School	388.03	1,273.05	0.05	0.002	A	1
104	Samrong Lutheran Christendom	379.71	1,245.75	0.05	0.002	A	1
105	Jatupornwittaya School	335.21	1,099.76	0.06	0.003	A	1
106	Dan Samrong Temple	253.75	832.50	0.10	0.004	A	1
107	Watdansamrong School	335.01	1,099.10	0.06	0.003	A	1
108	Matthayomdansamrong School	355.39	1,165.96	0.06	0.002	A	1
109	Dansamrong Adult Education School	346.45	1,136.63	0.06	0.002	A	1
110	Samrong Hospital	466.58	1,530.76	0.04	0.002	A	1
111	Chulavej Hospital	33.07	108.50	2.06	0.081	C-D	2-3

Remark: 1/ calculated by equation (3)

2/ Vibration impacts upon human beings of Reiher & Meister (1931)

A = Imperceptible

B = Just perception

C = Clearly perceptible

D = Unpleasant or disturbing for people staying inside a premise (in conformed with vibration level affecting a man standing on time)
a bridge for a short exposure

E = Continuity of perceptible vibration cause unpleasant or disturbing and a man walking on a bridge cannot accept it or unendurance

3/ Vibration determination on building structures of DIN4150 (Nelson, 1987)

1 = No impact/damage upon all types of structure

2 = A higher vibration level results in destruction or causing damages to historical sites

3 = No risk of damage likely to affect general building or architectural structures.

4 = Causing damages to architectural structures, houses with rigid plaster wall and ceiling (mixed component of cement, sand, water and various fibers) whereas for flexible wall and ceiling, the damages will be quite small.

5 = Vibration level is higher than normal road traffic which causes damage to architectural structures and a slight damage to housing structure.

Source: ENRICH Consultant Co., Ltd., 2013.

- Where V = The peak particle velocity (mm / sec.).
- a = The roughness of the road surface (Peak to Peak) = 1.40.
- v = The maximum speed of vehicles moving through the 100 km /hr.
- w = The weight of the truck (ton).
- t = Ground Factor
- (Soft Clay = 3.0
- Sand = 1.0
- Gravel = 0.2
- p = 0.75 (The road surface rough)
- = 1.00 (Other cases)
- r = The distance from the source / curb the building (m).
- x = Distance Power
- Soft Clay = -0.67
- Sand = -1.40
- Gravel = -0.90

Substituting those value in equation (1) based on the weight of the truck, from 10-25 ton that vehicle with a payload of 25 tons have a top speed of 100 km/hr and buildings / building away from the source/edge of the road at 4 meters, thus the maximum particle velocity (PPV) is equal to 0.838 mm/sec., which is the vibration that human merely feel or possible to feel but not to the degree of the vibration standards according to Reiher & Meister (1931) and no effect on any historic building follows the DIN 4150 standard (Nelson, 1987), as shown in **Table 5.1.7 - 6**.

Table 5.1.7 - 6 The Calculation of Peak Particle Velocity on Operation Period from the traffic under the Elevated Structure and Station

Distance from vibration sources/roadside to building (meters)	Peak Particle Velocity (mm./sec.) ^{1/}			
	Weight of Truck/Vehicles			
	10 Tons	15 Tons	20 Tons	25 Tons
4	0.419	0.503	0.670	0.838
8	0.211	0.316	0.421	0.527
10	0.181	0.272	0.363	0.453
15	0.138	0.207	0.276	0.346
20	0.114	0.171	0.228	0.285
25	0.098	0.147	0.196	0.245
30	0.087	0.130	0.174	0.217
50	0.062	0.093	0.123	0.154
100	0.039	0.058	0.078	0.097
150	0.030	0.044	0.059	0.074
200	0.024	0.037	0.049	0.061
250	0.021	0.031	0.042	0.052
300	0.019	0.028	0.037	0.046
350	0.017	0.025	0.034	0.042
400	0.015	0.023	0.031	0.038
450	0.014	0.021	0.028	0.035

Remark: ^{1/} calculated by the equation of $V = 0.021a(v/50)(w/15)^{1/3}(r/6)^x$

(2) The vibrations caused by the rail system is determined by the Monorail Noise and Vibration Impact Assessment, 2006. Second Edition of the Federal Transit Administration (FTA), USA, which set the vibration on the ground caused by the system or the system. The rail (Rapid Transit) at speeds up to 50 miles/h or 80 km/h. will affect the level of vibration at ground level 73 VdB (velocity level in Decibel) as shown in. **Figure 5.1.7 - 1**, since the vibration source, are VdB (RMS Vibration Velocity) is required, to convert the units PPV (Peak Particle Velocity) equation (2) is used as below.

$$L_v = 20 \times \log_{10}(v/v_{ref}) \dots\dots\dots(2)$$

เมื่อ L_v = The level of vibration (VdB).

v = RMS Velocity Amplitude (Inches/second)

v_{ref} = Reference Velocity Amplitude = 1×10^{-6} Inches second

Substitute the values in the equation (2) for Peak Particle Velocity calculation

$$73 = 20 \times \log_{10}(v/1 \times 10^{-6})$$

$$73 = 20 \times (\log_{10}(v) - \log_{10}(1 \times 10^{-6}))$$

$$73/20 = \log_{10}(v) - \log_{10}(1 \times 10^{-6})$$

$$\log_{10}(v) = (73/20) + \log_{10}(1 \times 10^{-6})$$

$$\log_{10}(v) = -2.35$$

$$v = 0.0045 \text{ Inches/second}$$

$$= 0.1143 \text{ mm/second.}$$

The calculation of the vibration of the train system has Peak Particle Velocity 0.0045 inch/sec or 0.1143 mm/sec. where the vibration occurs near the ground, the position of the pillar of the elevated station only. The vibrations are transferred from the elevated rail structure and foundations and passed down to the ground level deeper than 50 meters, which compared to the measurement of vibration of pillar of Bangkok Mass Transit System (BTS) Mo Chit station (August 9, 2548) found that the vibration of the train station, in the center of the road And stanchion outside the station along the sidewalk, is in the range from 0.968 to 1.240 and 1.760 to 2.020 mm/sec. as shown in **Table 5.1.7 - 7**. The measured value is greater than the calculated vibration from equation (1). To assess the impact of the vibration of the project, the maximum vibrations is set to 2.020 mm/sec. for a reference value (r_o). The impact of vibration caused by the rail system will use the equations of Whiffin and Leonard (1971.) as follows:

$$A_r = \left(A_o \sqrt{r_o/r} \right) e^{-\alpha(r-r_o)} \dots\dots\dots(3)$$

where A_r = the vibration at a distance r from the origin, mm./Sec.

A_o = The vibration measuring the distance r_o from the source, mm. / Sec.
= 2.020 mm / sec. (Worst Case) PPV_{max} measured using a pillar outside edge of the road or away from the train station.
Building / building about 3 meters).

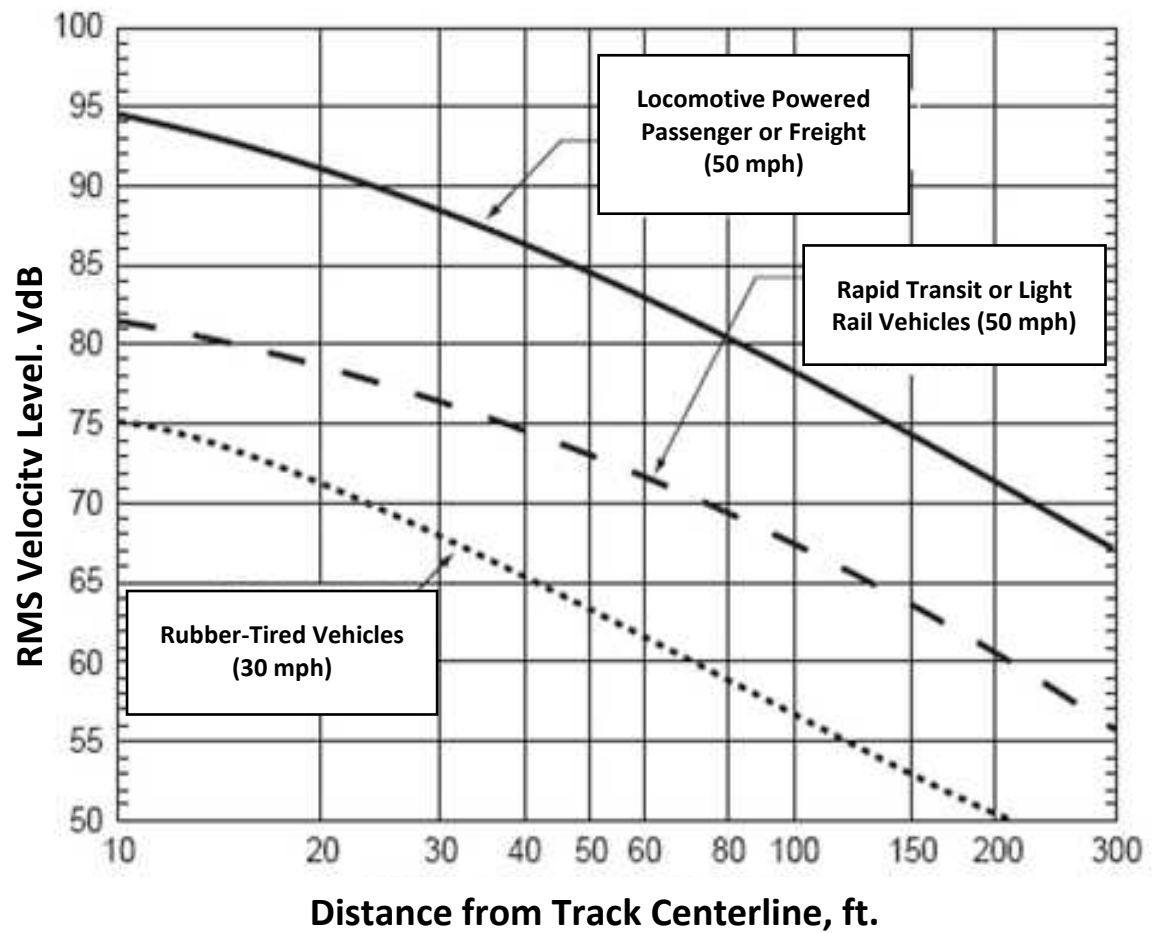


Figure 5.1.7 - 1 Level of Vibration at Ground from the Rapid Transit

Table 5.1.7 – 7 The measurement of vibration of pillar of Bangkok Mass Transit System (BTS) Mo Chit station (August 9, 2548)

Measured Stations	Date and Time	Axis	Peak Particle Velocity (mm./sec.)	Frequency (Hz)	Distance (mm.)
1. Underground the pillar of Mo Chit Station					
1.1 Inbound train	9/08/48	Transverse	0.762	8	0.01580
	12.14 p.m.	Vertical	0.508	2	0.04680
		Longitudinal	0.381	2	0.02950
Peak Particle Velocity (by average of 3 axis)			0.968		
1.2 Outbound train	9/08/48	Transverse	0.953	9	0.04310
	12.49 p.m.	Vertical	0.889	2	0.09020
		Longitudinal	0.635	n/a	0.06590
Peak Particle Velocity (by average of 3 axis)			1.240		
2. Underground the pillar of Mo Chit Station (outside)					
2.1 Inbound train	9/08/48	Transverse	1.270	37	0.00419
	02.02 p.m.	Vertical	1.140	47	0.00366
		Longitudinal	1.590	57	0.00508
Peak Particle Velocity (by average of 3 axis)			1.760		
2.2 Outbound train	9/08/48	Transverse	1.330	57	0.00360
	01.02 p.m.	Vertical	1.330	51	0.00347
		Longitudinal	1.970	43	0.00673
Peak Particle Velocity (by average of 3 axis)			2.020		

Remark: n/a = not applicable

Source: Final EIA Report () of MRTA Blue Line (Bang Sue – Tha Pra Section), 2008

α = The vibration absorption coefficient of each soil type

Moist Clay, Clay Soil	=	0.025-0.250
Silty Clay	=	0.019-0.430
Wet Clay	=	0.310-0.500
Looses at Natural Moisture	=	0.040-0.130
Dry Sand	=	0.007-0.070
Dense Sand and Gravel	=	0.015-0.045
Gravel Plus Sand and Silt	=	0.023-0.053

Substituting in the equation (3), and calculate the vibration for the sensitive areas impact by the distance from the center of the project, found that the vibration is in the range of 6.0×10^{-7} to 0.29084 mm / sec. Thus, the vibration mainly in the sense that humans cannot feel or merely feel or possibly feel follows the standards of Reiher & Meister (1931). The impact of vibration on structures revealed that the vibration occurred without any consequences to the historic building according to DIN 4150 standards (Nelson, 1987). The vulnerable areas to be impact by the vibration in operation Phase is shown in **Table 5.1.7 - 8**.

Table 5.1.7 - 8 Peak particle velocity in operation period at sensitive areas along the project route

No.	Sensitive areas	Distance from center line of project		Peak particle velocity from monorail operation ^{1/}		Operation period, Impact on	
		m.	ft.	mm./sec	inch/sec	Human ^{2/}	Building ^{3/}
1	Charuwattananukun Kindergarten School	337.97	1,108.81	0.00004	0.000002	A	1
2	Yamsaard Kindergarten School	390.31	1,280.53	0.00001	0.0000004	A	1
3	Rungwittaya Kindergarten School	222.73	730.73	0.00096	0.000038	A	1
4	House of Christ Christendom	295.98	971.05	0.00013	0.000005	A	1
5	Chidanukun School	434.58	1,425.77	0.000003	0.0000001	A	1
6	Siam Bethel Christendom	140.75	461.77	0.00942	0.000371	A	1
7	Siriphan Vittaya School	99.45	326.28	0.03147	0.001239	A	1
8	Lad Prao Baptist Christendom	84.28	276.51	0.04995	0.001967	A	1
9	Pibool Upphatham School	86.50	283.79	0.04665	0.001836	A	1
10	Sirithep School	477.02	1,565.01	0.0000011	0.00000004	A	1
11	Wat Lat Phrao School	494.01	1,620.75	0.0000007	0.00000003	A	1
12	Chaemsuksa School	160.58	526.83	0.00537	0.000212	A	1
13	Settabutr Upathum School	188.00	616.79	0.00250	0.000098	A	1
14	Thanormpitvithaya School	75.22	246.78	0.06632	0.002611	A	1
15	Kurusapa Business Organization Kindergarten School	72.51	237.89	0.07228	0.002846	A	1
16	Tangtung Vittaya School	496.81	1,629.93	0.0000007	0.00000003	A	1
17	Karnda School	206.38	677.09	0.00151	0.000059	A	1
18	Antioch Ladphrao Baptist Christendom	275.42	903.60	0.00023	0.000009	A	1
19	Nawamintharachinuthit Bodindecha School	382.99	1,256.51	0.00001	0.000001	A	1
20	Surao Don Sakae School	317.97	1,043.20	0.00007	0.000003	A	1
21	Hidayatun Islam Mosque (Don Sakae)	361.03	1,184.47	0.00002	0.000001	A	1
22	Jitnatda Kindergarten School	160.92	527.95	0.00532	0.000209	A	1
23	Santisuk Bangkok Christendom	414.40	1,359.56	0.00001	0.0000002	A	1
24	Bankru Kindergarten School	455.74	1,495.19	0.000002	0.0000001	A	1
25	Bangkok Suksa School	106.54	349.54	0.02547	0.001003	A	1
26	Bangkok Withaya School	280.81	921.28	0.00020	0.000008	A	1
27	Lad Prao Hospital	52.57	172.47	0.13975	0.005502	A	1
28	Ruam Nimit Bangkok Christendom	204.89	672.20	0.00157	0.000062	A	1
29	Rajapongsa Kindergarten School	498.98	1,637.05	0.000001	0.00000003	A	1
30	Wat Mae Phra Kularb Tip (Maria Rosa Mystica Christendom)	87.83	288.15	0.04478	0.001763	A	1
31	Lat Phrao English School	362.22	1,188.37	0.00002	0.000001	A	1
32	Pramote Gym Buddhaisawan School	185.35	608.10	0.00269	0.000106	A	1
33	Kanathip Child and Elderly Care School	252.46	828.27	0.00043	0.000017	A	1
34	Mahapawn Bangkok Alliance Christendom	445.67	1,462.15	0.000003	0.0000001	A	1
35	Suranarabibal School	64.84	212.73	0.09259	0.003645	A	1
36	Patarabutr Kindergarten School	133.44	437.79	0.01162	0.000457	A	1
37	Veithani Hospital	105.80	347.11	0.02603	0.001025	A	1
38	Bangkok Good News Christendom	219.09	718.79	0.00107	0.000042	A	1
39	Mawadi Music School	118.15	387.63	0.01809	0.000712	A	1
40	Peace of Bangkok Christendom	114.66	376.18	0.02004	0.000789	A	1
41	Fatthullbalee Mosque	46.40	152.23	0.17356	0.006833	B	1
42	Huamarkwittayanusorn School	225.82	740.87	0.00089	0.000035	A	1
43	Huamark Kindergarten School	230.26	755.44	0.00079	0.000031	A	1

Table 5.1.7 - 8 Peak particle velocity in operation period at sensitive areas along the project route (Cont'd)

No.	Sensitive areas	Distance from center line of project		Peak particle velocity from monorail operation ^{1/}		Operation period, Impact on	
		m.	ft.	mm./sec	inch/sec	Human ^{2/}	Building ^{3/}
44	Kanchanaphon Kindergarten	156.87	514.66	0.00596	0.000235	A	1
45	Grace Lutheran Christendom	351.52	1,153.27	0.00003	0.000001	A	1
46	Kornsupa Kindergarten School	275.27	903.11	0.00023	0.000009	A	1
47	International Hotel & Tourism Industry Management School	294.51	966.23	0.00014	0.000005	A	1
48	Krirk Thai Skill Development Center School	151.98	498.62	0.00685	0.000270	A	1
49	Sudnaree Kindergarten	116.60	382.54	0.01893	0.000745	A	1
50	Mae Phra Ong Uppatham Catholic Christendom (Christendom of Christ)	153.58	503.87	0.00654	0.000258	A	1
51	Chutima Kindergarten School	108.62	356.36	0.02394	0.000943	A	1
52	Jamiul Idhard Mosque (Huamak Yai)	364.80	1,196.84	0.00002	0.000001	A	1
53	Huamak School	223.35	732.77	0.00095	0.000037	A	1
54	Darissalam Mosque	232.65	763.28	0.00074	0.000029	A	1
55	Darissalam School	207.27	680.01	0.00147	0.000058	A	1
56	Hishaladademee School	404.89	1,328.36	0.00001	0.0000003	A	1
57	Vibharam Hospital	469.67	1,540.89	0.000001	0.0000001	A	1
58	Suan Luang Christendom	24.92	81.76	0.40518	0.015952	A	1
59	Klongkalan School (Meesuwan Anusorn)	79.91	262.17	0.05722	0.002253	A	1
60	Piyajit Vittaya School	372.65	1,222.59	0.00002	0.000001	A	1
61	Mandaumoucinin School	219.88	721.38	0.00104	0.000041	A	1
62	Triamudomsakkapatanakran School	500.00	1,640.40	0.0000006	0.00000002	A	1
63	Aliatisorn (Nana Uthit) School	343.92	1,128.33	0.00004	0.000001	A	1
64	Suraomai School	395.39	1,297.20	0.00001	0.000000	A	1
65	Prasarnwitwatana School	368.96	1,210.48	0.00002	0.000001	A	1
66	Masla Artul Islam School	402.61	1,320.88	0.00001	0.0000003	A	1
67	An Latisom Mosque	430.65	1,412.88	0.000004	0.0000002	A	1
68	Khajonsiri Temple	239.75	786.57	0.00061	0.000024	A	1
69	Hussanaveeya Sayowan Anusorn School	164.21	538.74	0.00485	0.000191	A	1
70	Jaipranee Kindergarten School	299.37	982.17	0.00012	0.000005	A	1
71	Salahnoi School	302.09	991.10	0.00011	0.000004	A	1
72	Liswanul Islameeya School	250.03	820.30	0.00046	0.000018	A	1
73	Darul Amin Mosque	71.73	235.33	0.07410	0.002917	A	1
74	Darul Amin School	87.66	287.59	0.04501	0.001772	A	1
75	Bride of Christ Christendom	173.64	569.68	0.00373	0.000147	A	1
76	Dusit Thani College	163.34	535.89	0.00497	0.000196	A	1
77	Plengprasiddhi Kindergarten School	201.87	662.30	0.00171	0.000067	A	1
78	Bangkok Dance Academy (Paradise Park Branch)	80.27	263.35	0.05658	0.002228	A	1
79	Graduate School of Public Administration, Burapha University (Paradise Par	99.01	324.83	0.03189	0.001256	A	1
80	Sereeruk Kindergarten School	361.47	1,185.91	0.00002	0.000001	A	1
81	BARTER International Maritime School	274.01	898.97	0.00024	0.000010	A	1
82	Si lam Temple	136.53	447.93	0.01063	0.000418	A	1
83	Srieam Anusorn School	157.64	517.19	0.00584	0.000230	A	1
84	Bangna Immanuel Christendom	225.42	739.56	0.00090	0.000035	A	1
85	Suthibongkot School	370.33	1,214.98	0.00002	0.000001	A	1
86	Sikarin Hospital	419.51	1,376.33	0.00001	0.0000002	A	1
87	Bang Kaeo Prachasan School	457.22	1,500.05	0.000002	0.0000001	A	1

Table 5.1.7 - 8 Peak particle velocity in operation period at sensitive areas along the project route (Cont'd)

No.	Sensitive areas	Distance from center line of project		Peak particle velocity from monorail operation ^{1/}		Operation period, Impact on	
		m.	ft.	mm./sec	inch/sec	Human ^{2/}	Building ^{3/}
88	Khlong Samrong School	435.65	1,429.28	0.000003	0.0000001	A	1
89	Jaisamarn Full Gospel Christendom	322.43	1,057.83	0.00007	0.000003	A	1
90	Bangmueang Khian Phong Anusorn School (Debsirin Samut Prakan School)	493.14	1,617.89	0.000001	0.00000003	A	1
91	Intarumphun Anusorn School	398.62	1,307.79	0.00001	0.0000003	A	1
92	Uthip School	461.09	1,512.74	0.000002	0.0000001	A	1
93	Chandna Kindergarten School	471.52	1,546.96	0.000001	0.0000001	A	1
94	Siriwutti Wittaya school	74.20	243.44	0.06850	0.002697	A	1
95	Chularat2 Hospital	32.73	107.38	0.29084	0.011450	B	1
96	Udom Suk Si Pha Rak Christendom	313.32	1,027.94	0.00008	0.000003	A	1
97	Raak Daroon Kindergarten School	123.34	404.65	0.01555	0.000612	A	1
98	Hope of Samut Prakan Christendom	498.99	1,637.09	0.000001	0.00000003	A	1
99	Klongkratumratutit School	66.70	218.83	0.08714	0.003431	A	1
100	DeeProm Kindergarten School	102.40	335.95	0.02881	0.001134	A	1
101	Samrong Nuea Public Health Center	341.92	1,121.77	0.00004	0.000002	A	1
102	Daroonrat School	309.73	1,016.16	0.00009	0.000004	A	1
103	Jaturamuk Kindergarten School	388.03	1,273.05	0.00001	0.0000005	A	1
104	Samrong Lutheran Christendom	379.71	1,245.75	0.00001	0.000001	A	1
105	Jatupornwittaya School	335.21	1,099.76	0.00005	0.000002	A	1
106	Dan Samrong Temple	253.75	832.50	0.00042	0.000016	A	1
107	Watdansamrong School	335.01	1,099.10	0.00005	0.000002	A	1
108	Matthayomdansamrong School	355.39	1,165.96	0.00003	0.000001	A	1
109	Dansamrong Adult Education School	346.45	1,136.63	0.00004	0.000001	A	1
110	Samrong Hospital	466.58	1,530.76	0.000002	0.0000001	A	1
111	Chulavej Hospital	33.07	108.50	0.28689	0.011295	B	1

Remark: 1/ calculated by equation (3)

2/ Vibration impacts upon human beings of Reiher & Meister (1931)

A = Imperceptible

B = Just perception

C = Clearly perceptible

D = Unpleasant or disturbing for people staying inside a premise (in conformed with vibration level affecting a man standing on time)
a bridge for a short exposure

E = Continuity of perceptible vibration cause unpleasant or disturbing and a man walking on a bridge cannot accept it or unendurance

3/ Vibration determination on building structures of DIN4150 (Nelson, 1987)

1 = No impact/damage upon all types of structure

2 = A higher vibration level results in destruction or causing damages to historical sites

3 = No risk of damage likely to affect general building or architectural structures.

4 = Causing damages to architectural structures, houses with rigid plaster wall and ceiling (mixed component of cement, sand, water and various fibers) whereas for flexible wall and ceiling, the damages will be quite small.

5 = Vibration level is higher than normal road traffic which causes damage to architectural structures and a slight damage to housing structure.

Source: ENRICH Consultant Co., Ltd., 2013.

5.1.7.2 Impact on Depot Area and Park and Ride buildings

1) Construction Phase

A) Impact on Depot Construction area

The maintenance center construction activities consist of digging and filling of open space, drilling rigs for the elevated structures and buildings, construction material and equipment transportation. The activities may cause the vibration of the adjacent area. The residential communities or vulnerable areas to be impacted is Prem Ruethai Udomsuk village where located 200 meters away. To evaluate the impact of the vibration from the Depot construction, the project defined the distance from the Prem Ruethai Udomsuk village as the worst case. The level of vibrations caused by machinery and equipment, while construction (at a distance of 25 feet or 7.62 meters from the origin) are based on studies of US.EPA (1995). In the worst cases, the use of pile drivers that cause the most vibration, the peak particle velocity of 18.644 mm/sec., or 0.734 inches/second, as shown in **Table 5.1.7 - 1** when evaluating the impact of vibration caused by equation (1), as detailed below.

$$\begin{aligned} \text{PPV}_{\text{equip}} &= \text{PPV}_{\text{ref}} \times (25/D)^{1.5} \dots\dots\dots(1) \\ \text{PPV}_{\text{equip}} &= 18.644 \times (25/200)^{1.5} \\ &= 0.139 \text{ mm/sec., or } 0.005 \text{ inches/sec.} \end{aligned}$$

The predicted vibration level from the Depot showed that the most vulnerable areas to be impacted are Prem Ruethai Udomsuk village at a distance of 200 meters to get the peak particle velocity up to 0.139 mm/sec. or 0.005 inches/second, as shown in **Table 5.1.7 - 2** which are the level of vibration that human could not feel of harm to health according to Reiher & Meister (1931), as shown in **Table 5.1.7 - 3**. Thus, there is no effects or damage to the structures of all types according to DIN 4150 (Nelson, 1987), as shown in **table 5.1.7 - 4**.

B) Impact on Park & Ride Construction area

The park and ride buildings construction activities including excavation and reclamation areas, drilling rigs for building, construction material and equipment Transportation, etc. Those activities may cause the vibration disrupt the people near the construction area as well. In vulnerable areas to be impacted by the park and ride buildings construction in Si lam Temple where located approximately 150 meters. Therefore, the vibration impact assessment will reference, according to the distance, Si lam Temple as worst case. As for the level of vibrations that caused by machinery and equipment, while construction activities (at a distance of 25 feet or 7.62 meters from the origin) are based on studies of US.EPA (1995) is considered the worst cases, the use of pile drivers that cause the most vibration. The peak particle velocity is 18.644 mm/sec or 0.734 inches/second, as shown in **Table 5.1.7 - 1** when evaluating the effects of vibration caused by the equation (1), as detailed below.

$$\begin{aligned} \text{PPV}_{\text{equip}} &= \text{PPV}_{\text{ref}} \times (25/D)^{1.5} \dots\dots\dots(1) \\ \text{PPV}_{\text{equip}} &= 18.644 \times (25/150)^{1.5} \\ &= 0.213 \text{ mm/sec., or } 0.005 \text{ inches/sec.} \end{aligned}$$

The predicted vibration level from the park and ride buildings showed that the most vulnerable area to be impacted is Si lam Temple at a distance of 200 meters to get the peak particle velocity up to 0.213 mm/sec. or 0.008 inches/second, as shown in Table 5.1.7 - 2 which are the level of vibration that human could not feel of harm to health according to Reiher & Meister (1931), as shown in Table 5.1.7 - 3. Thus, there is no effects or damage to the structures of all types including the ancient building according to DIN 4150 (Nelson, 1987), as shown in table 5.1.7 - 4.

2) Operation Phase

A) Impact on Depot

During the operation Phase, the activities within the Depot comprise of train maintenance the train parking, etc. Those activities may cause the vibration of the Depot adjacent area. The nearest residential area is Prem Ruethai Udomsuk village where located approximately 200 meters near Depot so the impact of the vibration near Depot is determined by the activity of train parking in the depot. This is an activities that contributes to the vibration of the Depot. By substituting in the equation (3), and calculate the vibration of vulnerable areas at Prem Ruethai Udomsuk village. The details are as follows

$$\begin{aligned} A_r &= \left(A_o \sqrt{r_o/r} \right) e^{-\alpha(r-r_o)} \dots\dots\dots(3) \\ A_r &= \left(2.02 \sqrt{3/200} \right) e^{-0.025(200-3)} \\ A_r &= 0.002 \text{ mm/sec., or } 0.0001 \text{ inches/sec.} \end{aligned}$$

The results from equation (3), and calculate the impact of vibration of vulnerable areas at Prem Ruethai Udomsuk village showed the peak particle velocity from the Monorail is equal to 0.002 mm/sec. or 0.0001 inches/second which are the level of vibration that human could not feel of harm to health according to Reiher & Meister (1931), Thus, there is no effects or damage to the structures of all types including the ancient building according to DIN 4150 (Nelson, 1987), as shown in Table 5.1.7 - 3 and Table 5.1.7 - 4.

B) The Impact on Park & Ride buildings

During the operation Phase, the activities in park and ride buildings including in and out of vehicles, parking in the building for passenger who traveling by train, etc., those activities may cause the vibration of the adjacent buildings located near park and ride building especially Si lam Temple, the nearest structure to park and ride buildings (distance 150 meters). The main impact of the vibration from park and ride building will from the activities in Si lam station that occurred mostly in park and ride buildings. By substituting in the equation (3), and calculate the vibration vulnerable areas to the effects Si lam Temple. The details are as follows

$$\begin{aligned} A_r &= \left(A_o \sqrt{r_o/r} \right) e^{-\alpha(r-r_o)} \dots\dots\dots(3) \\ A_r &= \left(2.02 \sqrt{3/150} \right) e^{-0.025(150-3)} \\ A_r &= 0.007 \text{ mm/sec., or } 0.0003 \text{ inches/sec.} \end{aligned}$$

The results from equation (3), and calculate the impact of vibration of vulnerable areas at Prem Ruethai Udomsuk village showed the peak particle velocity from the MRT is equal to 0.007mm/sec. or 0.0003 inches/second which are the level of vibration that human could not feel of harm to health according to Reiher & Meister (1931), Thus, there is no effects or damage to the structures of all types including the ancient building according to DIN 4150 (Nelson, 1987), as shown in **Table 5.1.7 - 3** and **Table 5.1.7 - 4**.

5.2 Biological Environmental Resources

5.2.1 Aquatic Ecology

5.2.1.1 The Impact of the Elevated Structures and the Stations area

1) Construction Phase

The construction activities especially the excavation and reclamation, drilling and foundations to support the of the elevated and the stations or construction material transportation (such as cement, sand, stone, clay, etc.), is not expected to cause a negative impact on the aquatic ecosystem in the surface water. There are 19 surface water bodies along the project route to cut through, however, the construction of the piers of the elevated structures and stations will not create any part of intrusion into the water. Thus, there is no activity to disturb the surface water quality and ecological impact directly on the water except three stations which located from the surface water up to 50 meters, Lat Phrao 101 stations Kalanton station, Suan Luang Ro 9 Station that may be affected by an increase in turbidity from soil erosion during the excavations and reclamation. Also, surface water may be contaminated with oil from the construction equipment. The amount of turbidity and oil will block the light from the sun into the water level, making phytoplankton photosynthesis less hence dissolved oxygen is produced by phytoplankton is reduced. The expected impact is only temporary low in the construction Phase. The construction area is limited only on the traffic island in the middle of the road. According to a literature review of information suspended solids (2012) and analysis of total suspended solids (2013) from the surface water examples along the canal include Lad Phrao Canal, Saen Saeb Canal, Hua Mak Canal, Phra Khanong Canal, Bangna Canal and Samrong Canal. The total suspended solids values ranged from 2.0 to 70.0 mg/L, which fall into low - moderate category (<25-100 mg/L, Boyd, 1979) and does not impact the aquatic species (fish, phytoplankton - and benthos). However, the total suspended solids from the Saen Saeb Canal (2512) is from 276.0 to 870.0 mg/l which is relatively high. However, Saen Saeb Canal is located away from the construction area of the pillar of elevated structures approximately 240 meters.

2) Operation Phase

Since a single track rail system to be run on the elevated structure powered by electricity. Thus, it does not impact the aquatic ecology in the surface water especially the stations that located away from the surface water up to 50 meters, including Lat Phrao 101 Station Kalanton Station, Suan Luang Ro 9 Station. These three stations would have wastewater discharge from the toilets during the daytime activities such as ticketing, public relations security and

communication, etc. approximately up to 10 people per day wastewater per station 0.40 cubic meters/day (see details in section 4.2.1: surface water quality), the amount of wastewater that will happen will be treated by the wastewater treatment plant with the capacity of 2 cubic meters of ready-installed in all stations. The effluent quality, according to the Ministry of Natural Resources and Environment. "Standards Control Sewerage from some building types and sizes, "published in Volume 122 at 125 dated December 29, 2005, and therefore does not affect the ecology of the water in the surface water.

5.2.1.2 The Impact on Depot and Park and Ride buildings

1) Construction Phase

Depot is located east of the Si lam junction nearby the surface water source (Khlet Canal), without the construction of any part of the structure intruded into the canal however, it may be impacted by an increase in turbidity from soil erosion during the excavations and cover of the areas which subject to contamination from oil used in construction equipment during Depot construction. The amount of turbidity and oil will partial block the light from the sun into the surface water. As a result, phytoplankton can photosynthesis less and dissolved oxygen produced by phytoplankton is also reduced. The expected impact is only temporary low in the construction Phase.

2) Operation Phase

During the operation Phase, the amount of wastewater from the use of toilets and wash dishes in the management and control building, the restaurant, the staff dormitory, wastewater from washing and maintenance activities, approximately 142.60 cubic meters/day in total (see details in Chapter 2). The amount of wastewater going to the treatment systems using Onsite Treatment Plant which is a Septic - Anaerobic Filter and Contact Aeration Process with the capacity of 50 cubic meters/3 containers with a total volume of 150 cubic meters, followed by a retention. Therefore, the wastewater quality meets the "Standards Control sewerage from certain building types and sizes," according to the Ministry of natural Resources and the environment, published in Volume 122 at 125D dated December 29, 2003. The amount of waste water before discharge into the Khlet Canal is expected to have no impact on aquatic ecology in the surface water.

5.2.2 Terrestrial Ecology

5.2.2.1 Forest resources

1. The Impact area of the Elevated Structures and the Stations

(1) Construction Phase

The construction of elevated structures and stations will consider the construction area of about eight meters wide on the traffic island of Lat Phrao Road. Srinagarindra Road and Theparak Road. Therefore, trees with a height of over 10 meters to be obstructed by the construction must be cut or removed. The area is also the location of a piles support elevated

structure and stations. It is expected to have an impact on the loss of the balance of ecosystems and vegetation is low because the trees are found along the sidewalks on both sides with a total of 4,571 trees (60 species) and the median of the road, with a total of 681 trees. (2 species) and over 95% of the trees in the city, which has planted by humans (such as Pink Tecoma (*Tabebuia rosea*), Copper pod (*Peltophorum pterocarpum*), White Cheesewood (*Alstonia scholaris*), Mahogany (*S. macrophylla*), and Cork Tree (*Millingtonia hortensis*), etc.) and only 5% is the tree itself under natural conditions. (such as Raintree (*Samanea saman* (Jacq.) Merr.), Manila Tamarind (*Pithecellobium dulce*), jujube (*Ziziphus mauritiana*), and Tropical almond (*Terminalia catappa*) etc.).

(2) Operation Phase

During the operation Phase, the impact is expected to have a low impact on the ecosystem and disrupt plant communities along the project route. The plant will have the capacity to adapt to resist the changing environmental condition. In the large communities, some plants will be less receive sun light because the sun light has obscured by the elevated structure and stations. This makes the process of photosynthesis of plants for use in food production potential deteriorate.

2. The Impact on Depot

(1) Construction Phase

Due to the current conditions of the Depot construction area is a bare land. Only plant shrubs and medium-sized tree covered within the Depot 39 trees (6 species), it is estimated that only some of the trees were cut down or move out of the construction area. The trees removed will not affect the balance of the ecosystem and economic value. Thus, the impact is low.

(2) Operation Phase

In the operation Phase, there will be no change to impact the balance of ecosystems and vegetation as a landscape architect, a Depot for the trees / shade by adding more green space and trees medium - large and beautiful flowering trees and ornamental plants. To replace the trees that may be cut or removed in the construction Phase.

5.3 Human Use Values

5.3.1 Land Use

5.3.1.1 The Impact of the Elevated Structures and the Stations area

1) Construction Phase

Since the construction area of elevated structures is approximately 7 meters wide on the traffic island. Therefore, it is expected to have a fair impact on land use change. Due to the current conditions in the land use is relatively intense in particular, in the form of the medium to the high density residential area or commercial area. The infrastructure and utilities accounted for 90 percent while the empty space will be transformed into the medium density

residential area. Thus, the expected impact is low. In the certain sector of the project, the route will deviate from the median line to the pedestrian area hence the certain commercial buildings and some commercial area will change into the elevated structure permanently. As the land use patterns have not changed much compared to the use of land surrounding neighborhood is commercial / business, therefore, the impact is low.

2) Operation Phase

In the operation Phase of the project, patterns of land use along the project route will be slightly changed from the current condition. As the ratio of current patterns of land use in more than 90 percent cannot be expanded or changed, such as a medium to the high density residential area, commercial/business zone, government institutions, and public utilities. Nonetheless, the wasteland at some point can be improved follow the regulations/specifications of Bangkok principle city planning (2013). Also, the draft of principle city plan of Samutprakarn could be converted into a residential, semi-commercial due to the convenience of traffic or development projects that are good motivation and stimulus for the investment to take place, especially around the stations. Consequently, the current land use pattern might be improved for development patterns to the residential and commercial area, such as apartments, condominiums, large shopping center. office building or entertainment, etc., hence the impact is moderate.

5.3.1.2 Impact on Depot Area and Park and Ride buildings

1) Construction Phase

The area of Depot is about 122 rais that necessary to convert the land use from partly bare land with a few shrubs covered into a five-story Depot building. Likewise, a seven-story building of Samut Prakan highway district office building will be converted into Park and Ride building with an area of 39.9 rais. Thus, the impact is in the moderate to high as the land use patterns will permanently change. However, due to changing land use patterns are not take place in many areas compared to the pattern of land use surrounding residential community that is less dense - medium.

2) Operation Phase

The Depot and Park & Ride located near the intersection of Srinagarindra Road and Bang Na - Trat, Road with a combined area of approximately 161.9 Rais. It is expected that the land used surrounding the Depot and Park and Ride building are likely to change from the current form because of the attraction of the Monorail system. With the land use patterns of current condition that account for the use of more than 75 percent is less dense residential community and semi-commercial area or wasteland area/green space. Therefore, in certain areas may have to be expanded or changed according to regulations / specifications of Bangkok Principle City Planning (2013) and the draft Samut Prakan Principle Citi Planning. It can be converted into a medium to high density residential communities - such as flats, apartment, condominium, and housing, etc., or the commercial/trade or landmarks like government/state enterprise, gas station, shopping mall, private hospitals, educational institution, office building or entertainment, etc. Thus, the positive impact is low to moderate.

5.3.2 Transportation

5.3.2.1 The Impact of the Elevated Structures and the Stations area

1) Construction Phase

1.1) Since most of the construction activities will take place on the traffic median on Lat Phrao Road, Srinagarindra Road, and Thepharak road, the impact on the ability to accommodate traffic on the existing road network is expected to affect the amount of the traffic jam as follows:

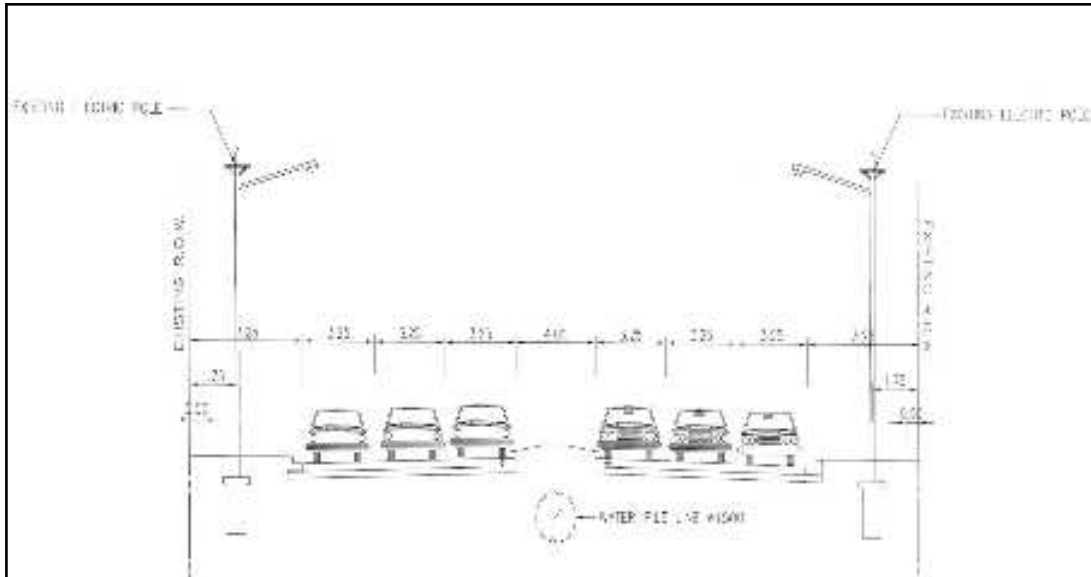
- **Lat Phrao Road** in Ratchada - Lat Phrao intersection to the Happyland with the traffic corridor of 30 meters wide with, the current six-lane (in bound - out bound) the width of the traffic lanes is 3.25 m while the traffic island wide approximately 4.0 meters and include the sidewalks both sides of the road, as shown in **Figure 5.3.2 - 1**. By the time of the construction of the foundations and piers along the traffic Island of Lat Phrao Road must isolate for the construction site at least 7 m interval of approximately 500 meters and must keep out one traffic lane for materials and equipment transportation or the ground drilling during the night time. However, during the normal operation hours, the traffic lanes must be managed by reducing the width of the traffic lanes from 3.25 meters/lane to 3.00 and 2.75 meters/lane as shown in **Figure 5.3.2 - 2**, which gives the ability to support high traffic volumes decrease. Thus, the impact is moderate.

The construction at Bang Kapi intersection requires the relocation of Bang Kapi viaduct for constructing the pillar structures in the middle of the viaduct. Consequently, the traffic must be sealed during the construction near the ramp of a viaduct in front of Tawana department store. As a result, local people cannot use the viaduct. However, the construction on the other site will operate by the middle of the viaduct. By demolishing the viaduct to one lane on each side so that the user can use the viaduct. Therefore, the viaduct has only one lane on each side, which allows traffic flow to a certain extent only. As a result, the impact is expected in medium - high.

- **Srinagarindra Road** South-Lumsali Intersection to Phatthanakan intersection, the traffic corridor width is 30 meters wide with the current six-lanes (in bound - out bound). The width of the traffic lanes is 3.25 m the traffic island wide approximately 4.00 meters with the sidewalks on both sides of the road. By the time, the construction of the foundations and piers along the traffic island require the construction site at least 7.00-meter interval of approximately 500 meters per section. As a result, the construction area must isolate at least one additional lane for use in materials, equipment or the volume of excavated soil transportation during the night. In normal operation hours, the traffic would have to manage as detailed for the traffic management on Srinagarindra Road at South-Lumsali Intersection to Phatthanakan intersection as well as a separate management traffic plan on Lat Phrao Road

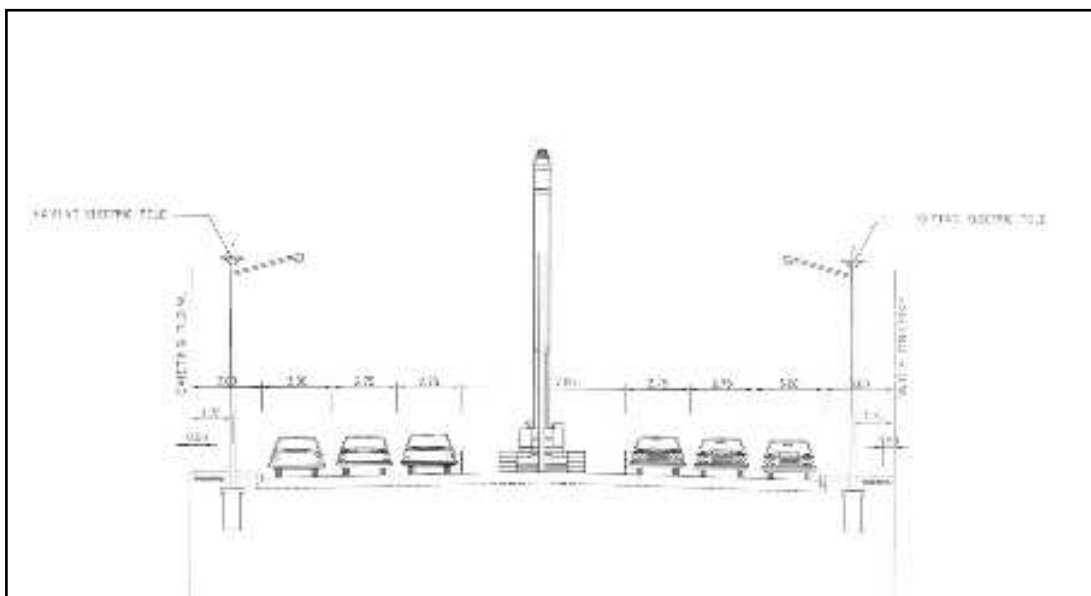
- **Srinagarindra Road** From Rama 9 intersection to Bang Na - Trat intersection with the traffic corridor of 40 meters wide with the current eight lanes (in bound - out bound) width of 3.50 meters and a pedestrian lane on both sides of the road as shown in **Figure 5.3.2 - 3**. During the construction of the foundations and piers along the traffic island of Srinagarindra Road, it is necessary to isolate the construction site at least 7 m interval or approximately 500 meters

per section. Consequently, the construction site of one more lane will be used in materials and equipment or the excavated ground transportation during the night. In normal hours, it is necessary to manage a number of traffic lanes as the current conditions. By reducing the width of the lane down from 3.50 m/ traffic lane to 3.15 m traffic lane. As a result, the surface traffic after the reduction has the total width of 12.60 meters/direction four lanes per direction same as the current conditions. Nonetheless, the ability to accommodate maximum traffic volume is reduced as shown in **Figure 5.3.2 - 4**. Thus, the impact is moderate.



Source : Office of Transport and Traffic Policy and Planning, 2012.

Figure 5.3.2 - 1 Existing of traffic management on 3-lane Lat Phrao Road (2.75-3.00 m/lane)



Source : Office of Transport and Traffic Policy and Planning, 2012.

Figure 5.3.2-2 Existing of traffic management during the construction on 3-lane Lat Phrao Road (2.75-3.00 m/lane)

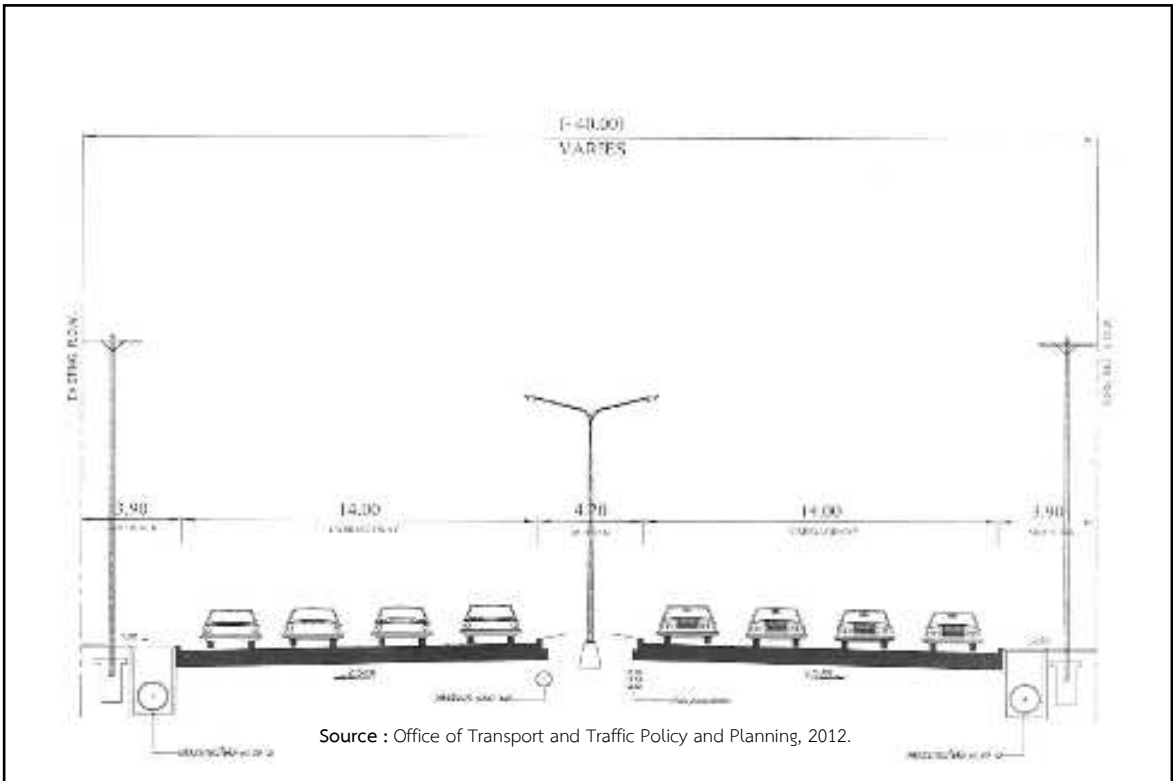


Figure 5.3.2 - 3 The pattern of traffic management on 8-lane road (3.50 m/lane)

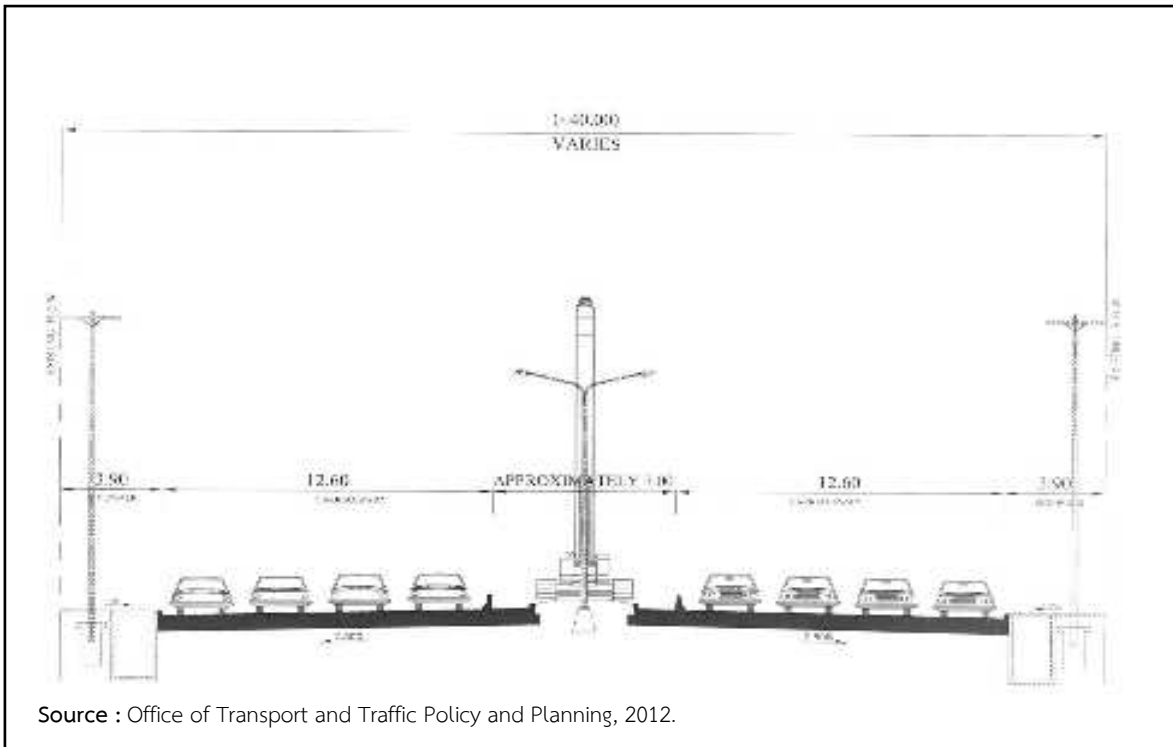
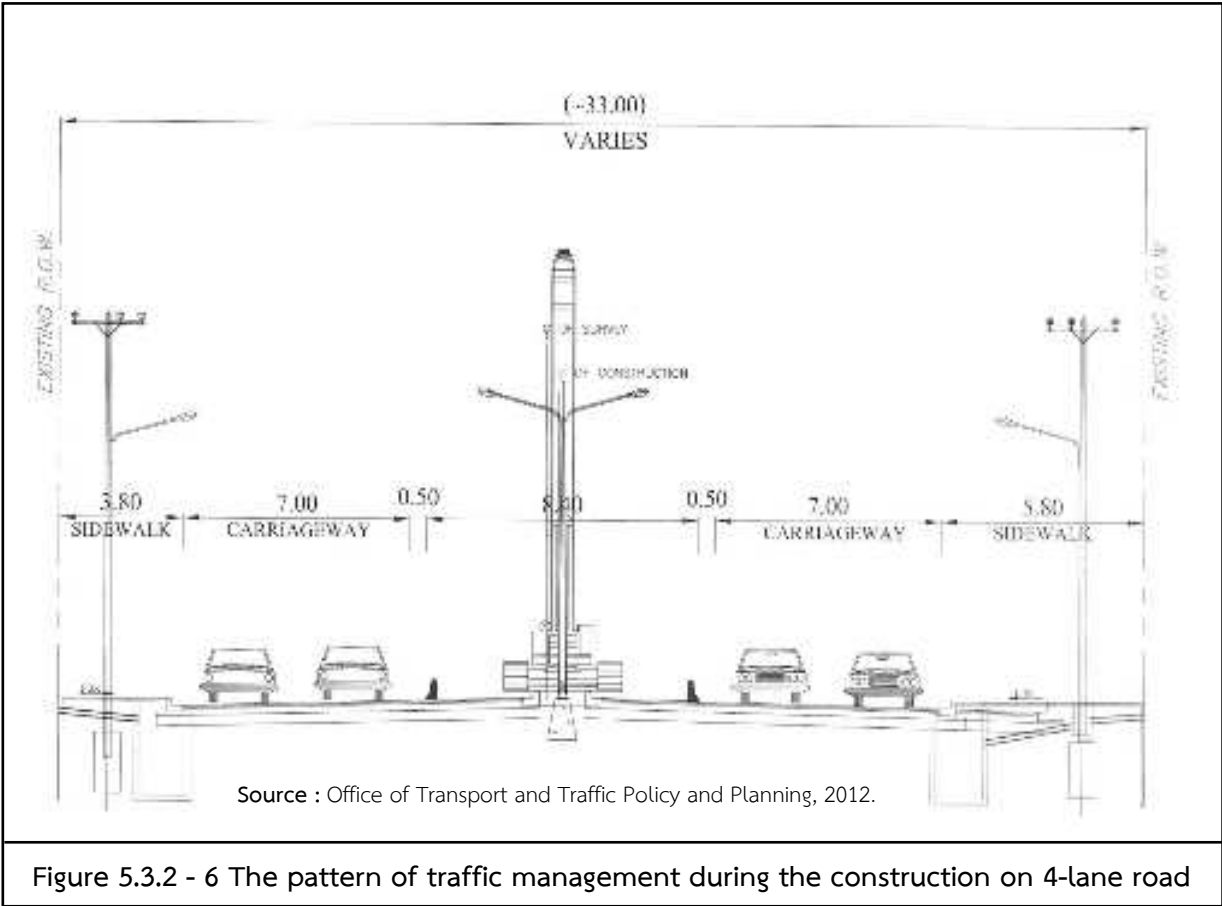
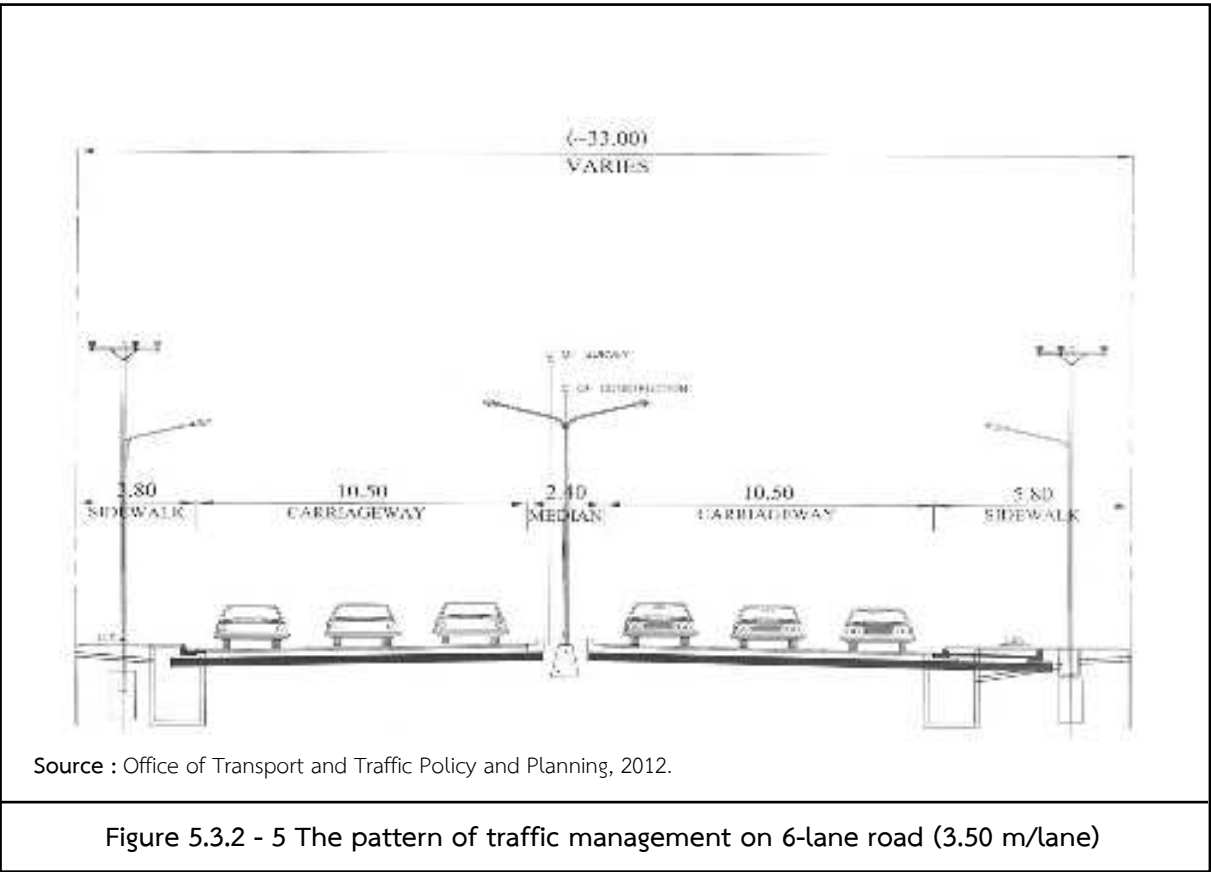


Figure 5.3.2 - 4 The pattern of traffic management during the construction on 8-lane road

- **Theparak Road** at Sri Thepa intersection to Samrong Pu Chao Saming Phrai intersection with the traffic corridor of 33 meters wide with six traffic lanes (in bound - out bound). The width of the traffic lanes is 3.50 m and sidewalks on both side of the road as shown in **Figure 5.3.2 - 5**. During the construction of the foundations and piers along the traffic island of Theparak Road, it is necessary to isolate the construction site at least 7 m interval or approximately 500 meters per section. Consequently, the construction site of one more lane will be used in materials and equipment or the excavated ground transportation during the night. In normal hours, it is necessary to manage a number of traffic lanes as the current conditions. By reducing the width of the lane down from 3 traffic lanes per direction to 2 traffic lane per direction. As a result, the surface traffic after the reduction has the total width of 7 meters/direction. Nonetheless, the ability to accommodate maximum traffic volume is reduced as shown in **Figure 5.3.2 - 6**. Thus, the impact is high.

1.2) Due to the materials, construction equipment/machinery to be used in construction will transport through the road network that are Lat Phrao Road, Srinagarindra Road, and Theparak Road. The impact on the renewal of the existing road network may be a major cause of the pavement damaged or deteriorated faster than expected. During the normal operation Phase of the road network, including the Lat Phrao Road, Srinagarindra Road, Theparak Road and surrounding areas may not be impacted by the loss of the original surface traffic due to the elevated structure and the train station will be constructed on the traffic island. The number of traffic lanes in each direction will be the as the original during the operation Phase. However, there may have a direct impact on traffic conditions on the road network as a whole which highly flexible, or have less traffic congestion, especially during the morning rush hour (7:00 to 9:00 AM.) and evening rush hour (16:00 to 19:00 PM.). Because there are people who use the road and some have turned to using the Monorail and public transportation increasingly. Since, it can be transported in mass passengers, approximately 247 874 passengers/day during its operation in 2019 and will be increased to more than 532,000 people/day in the year 2049, Thus, it is an alternative route for the traveler on the entire road network.

1.3) The impact on the accidents in the construction area that might occur from the activities of the construction could cause an accident or construction workers who commute. Also, unorganized materials storing might obstruct walkways and the truck in and out the project area. This may be the cause of the accident, the vehicles used the route. As the problem of accidents caused by vehicles used for transport construction materials, tools, equipment and workers and so on. The project entered the construction area by the construction of the new vertical line extending toward the other. The tools, equipment, and materials as well as other construction equipment will be stored in the provided space and moving by truck or tow truck that might cause the problem of increased traffic from vehicles. Implementation of the project has not yet determined the exact route. It assesses the impact of increased traffic from vehicles at major intersections



2) Operation Phase

During the normal operation Phase of the road network (Lat Phrao Road, Srinagarindra Road, Theparak Road) and surrounding areas may not be impacted by the loss of the original surface traffic due to the elevated structure and the train station will be constructed on the traffic island. The number of traffic lanes in each direction will be the as the original during the operation Phase. However, there may have a direct impact on traffic conditions on the road network as a whole which highly flexible, or have less traffic congestion, especially during the morning rush hour (7:00 to 9:00 AM.) and evening rush hour (16:00 to 19:00 PM.). Because there are people who use the road and some have turned to using the Monorail and public transportation increasingly. Since, it can be transported in mass passengers, approximately 247 874 passengers/day during its operation in the year 2019 and will be increased to more than 532,000 people/day in the year 2049, Thus, it is an alternative route for the traveler on the entire road network.

5.3.2.2 Impact on Depot Area and Park and Ride buildings

1) Construction Phase

The construction of Depot and Park and Ride buildings will use the current road network for transport construction materials, equipment/machinery to be used in the Depot and park and ride construction. As a result, the existing road network might damage or deteriorate faster than the normal Phase. However, it will not impact the ability to accommodate traffic on the road network due to the Depot and park and ride building construction area are not located on the traffic island and the existing road network.

2) Operation Phase

In operation Phase, the Depot is expected to have the volume of traffic on the existing road network from the employee commute. It is expected that there will be no additional traffic volume because the employees can access directly to the depot by using the project train. Consequently, the traffic volume from the use of the personal car will be reduced. Also, the park and ride building is expected to reduce the use of personal cars for the commute to the city. The passenger can take a train into the city without affecting the overall traffic. Thus, the positive impact is low to moderate.

5.3.3 Public Utilities and Infrastructure

5.3.3.1 The Impact of the Elevated Structures and the Stations area

The construction of elevated structures with the total distance of about 30 km and 23 stations may have a negative impact on public utilities and infrastructure including Bang Kapi viaduct as described below:

1) Construction Phase The impact of the relocation of public utilities and infrastructure as follows:

1.1) The relocation of waterworks system (The Metropolitan Waterworks Authority) along the traffic island and along the two sidewalks across the street at a construction Phase is consists of Lat Phrao Road and Srinagarindra Road with the total length of 20,620 meters

1.2) The relocation of high voltage towers/wires/ electrical equipment. (The Metropolitan Electricity Authority) along the sides of Lat Phrao Road, Srinagarindra Road, Theparak Road, and Pu Chao Saming Phrai Road in a total of 440 towers.

1.3) The relocation of utilities (Department of Highways) along the roads sides and in the center of traffic island of Lat Phrao Road, Srinagarindra Road, Theparak Road, and Pu Chao Saming Phrai Road can be summarized as follows:

a) The reinforced concrete culvert size ϕ 1,000 - 1,200 mm. in total 3300 meters

b) The lighting poles (two pairs of legs luminaire) of 820 poles.

1.4) The relocation of landlines – aerial antenna Size 9 - D4 ", 12 - D4", 16 - D4 " (TOT Public Company Limited) along the sides of Srinagarindra Road, Theparak Road with a total length of 2,700 meters.

1.5) The relocation of communication cables - fiber optic communication lines - copper wires and conduits (CAT Telecom Public Company Limited ()) along the sides of Lat Phrao Road, Srinagarindra Road, and Theparak Road with a total length of 17,100 meters.

1.6) The relocation communication line - optical fiber and communication cable - copper wires and conduits (TOT Public Company Limited) along the sides of Lat Phrao Road, Srinagarindra Road, and Theparak Road with a total length of 11,700 meters.

1.7) The relocation of pipelines, oil and gas companies, Fuel Pipeline of the Transportation Company Limited and the PTT Public Company Limited, near Phatthanakan intersection that the project route will be used the space in the traffic median of Srinagarindra Road for the construction. The area is also overlapped with the construction of a through the tunnel the Phatthanakan and Srinagarindra intersection. As a result, the oil and gas pipeline at the intersection require the relocation of such a length of 30 meters for oil pipelines, and 30 meters of gas pipelines, as well.

1.8) The Bang Kapi viaduct, of Bangkok Metropolis, is a four-lane bridge, car traffic has surfaced asphalt concrete. The exits of the bridge are on Lat Phrao Road and Seri Thai Road and the level crossing at the junction of the Lat Phrao and Srinagarindra Road. The impact of the construction Phase of the yellow line in the area of the relocation elevated bridge crossing the front the Mall Bangkapi between km. 8 + 200 to 9 + 007. The total distance is 807 meters from the 1,820 meters long bridges.

2) Operation Phase

In the operation Phase, there may be a positive impact on the overall public utility system and infrastructure as the area along the project route will increase the public utilities and infrastructure such as lighting systems, water supply systems, telecommunications, etc. The impact of the power of the electric drive system on the environment found that the train system powered by the rail power supply (Power Rails) with voltage DC 1,500 Volt from electric power drive systems (Traction Power Substation - TPS) for supplying electricity to drive the train system (monorail). The rail power supply is mounted on both sides of the rails along the path level and within the garage for maintenance (Depot) rail power supply to electric voltage (+). DC 1,500 Volt directly from a power station to drive the power supply system that powered devices such as air

conditioning, motors, and lighting system inside the train, etc. The electricity will flow back to the rail station to the Negative Bus Power Drive system. Nonetheless, the train system that installed the power system follows the standards and control the electric field and magnetic field with the maximum safety, to meet the requirements of the WHO (World Health Organization: WHO), has set a maximum level of electric and the magnetic field generated by the power system in which people can safely, so to decrease the electromagnetic emissions and the noise from the power supply in the drive train, the design of the electrical installation requirements follows the Electromagnetic Compatibility (EMC) Standardn (IEC 6100).

5.3.3.2 Impact on Depot Area and Park and Ride buildings

1) Construction Phase and Operation Phase

The Depot and Park and Ride building construction in both construction Phase and operation Phase will not relocate any infrastructure and utilities. Thus, it does not affect the utilities and infrastructure.

5.3.4 Water Drainage Hydrology and Flood Prevention

5.3.4.1 The Impact of the Elevated Structures and the Stations area

1) Construction Phase

It is expected the construction of the elevated structures and the stations will not disrupt the natural flow of water from the existing condition since there is no structure intruded in the surface water bodies. However, it is expected to have obstructed water flow occurs due to the construction of the elevated structures and stations require the construction space about eight meters wide on the traffic island especially in some sections of the Srinagarindra roads that drainage the water storm trough in the middle of the road. In addition, a moderate impact on the flow of water into the sewer system, waste materials such as debris, concrete, stone /clay/sand etc that put piles of construction materials. Or place against a solid concrete wall along the boundary of the construction area. This may obstruct the flow of rainwater falling onto the road surface and then flow into the sewer drainage. Therefore, the potential flooding on the traffic surface along the construction area of the project could occur.

2) Operation Phase

In operation Phase, It is expected to have no change of the surface drainage on the roads along the project route as follows:

2.1) The elevated structures in the total distance of approximately 30 kilometers consists of the precast concrete box beam structure. As the surface of the elevated structure superimposed on the existing road surface, therefore, there will not be decreased of the surface water drainage but still capable for draining the sewer from rainstorm without the chance of flooding. Thus, the impact is low.

2.2) The 23 stations, 26 meters wide and 120 meters long with a total area of 2,835 square meters station superimposed over the existing road surface. However, there is no drainage surface reduced due to the surface area of the train station roof still receive the rainfall

as not very different from the pre-existing projects. The rainwater will flow through the pipes to collect rainwater measuring ϕ 0.15 meters before entering the reservoir in the traffic island and flows through the pipe size ϕ 0.30 meters into the drainage system along the train system. Thus, the impact is low.

5.3.4.2 Impact on Depot Area and Park and Ride buildings

1) Construction Phase

The Depot, located east of the Si Lam junction, will not expect to impact the surface water hydrology and the drainage. The current conditions of construction area are a bare land which including the construction of a five-floor Depot which will store the equipment and materials to be used in the project. The improper storage may obstruct the flow of water during heavy rain. However, it will not flood due to the overflow from Khet Canal which flows parallel to the construction area. Furthermore, the natural water body, with the ability to fully drain the flooding is also located on the north side of the construction area.

For the Khet Canal and Bang Na Canal is in charge of the Department of Drainage and Sewerage, Bangkok and is the main drainage, flood prevention and drainage of the East of Bangkok. There are restrictions that prevent water obstacles from any action in relation to the water of Bangkok if the water way is changed from the original size of water or more. To avoid squeezing the water. This will cause a back water upstream.

The calculation and design of the drainage project and the Depots drainage area designed the intensity of the rain (I) on the return Phase of 5 years, as for the sediment trap (U-ditch) is designed to have the intensity of the rain (I) to return. Phase of 10 years for the max capacity for receiving rain water in three hours. Therefore, the assessment of a temporarily sediment trap in the construction Phase of the project in the Depot will adjust the intensity of the rain return Phase of 10 years in accordance with the design of the U-ditch scheme with details as follows;

The drainage rate before construction - construction Phase project.

The guidelines for calculation and design of the project drainage use the rainfall chart amounts and intensity of rain in Bangkok. The pond water is used to design the flow rate of the highest incidence of rainfall Phases (Return Phase) 10 years, calculated from the Rational Method follows.

The calculation of rain storm that overflows in the areas.

	Q	=	0.278 CIA
where	Q	=	The flow rate of the water (m/s)
	C	=	The overflow coefficient of the area
	I	=	The rainfall intensity (mm/hour)
	A	=	Drainage area (sq.km)

where

- The overflow coefficient (C) of the area before the construction which is the bare land is set $C = 0.30$ and the coefficient of overflow in the area during the construction Phase, an area that has been excavated at the Depot is set $C = 0.40$.

- The Depot area (A) of 194,400 square meters, or 0.1944 square kilometers.

- The rainfall intensity (I) will use, a 10-year Phase of rainfall intensity chart in Bangkok that is 86.8 mm/hour as shown in **Table 5.3.4 - 1**

- The flow of water before the construction = 1.407 m / sec

The flow of water in the construction Phase = 1.876 m / sec

A dampening water to temporarily sediment trap, about 3 hours

The amount of water in the pre-construction = $1.407 \times 60 \times 60 \times 3$
= 15,195.6 cubic meters

Amount of water in the construction Phase = $1.876 \times 60 \times 60 \times 3$
= 20,260.8 cubic meters

So the difference the amount of water is required to delay the water before discharging into the public trough body was 5065.2 cubic meters.

In the operation Phase, the project has created delay pond on the south side of the two ponds with a total capacity of 21,339 cubic meters and the construction will proceed to dig a temporary pit emptying areas such capacity not less than 5,100 cubics meters to receive the rain water during the construction. Before being released into the Khlet Canal and Saria Canal along with the construction of a temporary conduit for the water from the Depot into a temporary trap sediment and drain water from the pond into the public ditch.

Table 5.3.4-1 Rainfall (mm.), Rainfall Intensities (mm./hr) and Return Period of Rainfall in Bangkok.

Return Period (Year)	Period								
	5 นาที	10 นาที	15 นาที	30 นาที	1 ชม.	2 ชม.	6 ชม.	12 ชม.	24 ชม.
2	11.3	20.2	25.0	42.5	58.7	72.4	85.8	90.0	93.6
	(135.5)	(121.1)	(99.8)	(84.9)	(58.7)	(36.2)	(14.3)	(7.5)	(3.9)
5	14.1	24.3	31.7	54.3	76.0	95.0	114.0	120.0	122.4
	(168.9)	(152.0)	(126.7)	(108.6)	(76.0)	(47.5)	(19.0)	(10.0)	(5.1)
7	14.9	26.9	33.7	58.0	81.5	102.2	123.0	129.6	134.4
	(178.3)	(161.4)	(134.9)	(115.9)	(81.5)	(51.1)	(20.5)	(10.8)	(5.6)
10	15.7	28.4	35.7	61.5	86.8	109.2	132.0	139.2	144.0
	(188.3)	(170.2)	(142.7)	(122.9)	(86.8)	(54.6)	(22.0)	(11.6)	(6.0)
12	17.1	31.0	39.2	67.9	96.5	122.4	149.4	157.2	163.2
	(204.9)	(185.9)	(156.9)	(135.7)	(96.5)	(61.2)	(24.9)	(13.1)	(6.8)

Remark : Rainfall Intensities (mm/hour)

Source : Meteorological Department

2) Operation Phase

The Depot located east of the Si Iam junction lies near the Khlet Canal in the district of Bangkok and part of the Depot are a cross over the Sarai Canal (Bang Na Canal) Branch and some part into are cross a bit into Samut Prakarn province. The Sarai canal is borderline Bangkok and Samut Prakarn. Therefore, it is necessary to divert the water from Sarai /Bang Na canal Along the side of the depot, and then return the water to the existing waterways. The information of the size of the original Sarai /Bang Na canal were obtained from the surveys for flood protection and drainage east of Bangkok. Using cutting the water of the canal near the Bang Na area most projects. Consideration will be converted to the form of water standards. To monitor the flow rate through the cross-sectional area being considered which sets the coefficient for the none-lining canal. The slope and the water flat for the catchment level, the estimated level.

For the Khet Canal and Bang Na Canal is in charge of the Department of Drainage and Sewerage, Bangkok and is the main drainage, flood prevention and drainage of the east of Bangkok. There are restrictions that prevent water obstacles from any action in relation to the water of Bangkok if the waterway is changed from the original size of water or more. To avoid squeezing the water. This will cause a back water upstream.

The water from soil and liquidity requirements set found that the canal can drain about 11 cubic meters/second. For the provision of a canal to divert is set to take up the cross but as canal lining, so the coefficients of the canal will change. The water will flow better. The new canal linings can be found in water about 20 cubic meters/second, which has been more change on the water line from the water to the side of the building until the end of the line will then converge back into the original waterway.

5.4 Quality of Life value

5.4.1 Socio-Economic

The construction of the yellow line will impact the socio-economic conditions in both the construction Phase and operation Phase of the project. The impacts are expected to occur with the community and people living in areas along the project route. The general public who use the road network and surrounding area Depot that covers both the positive and the negative as follows:

1) Construction Phase

1.1) The positive impact on the community economy is low Because during the construction Phase with the construction workers and skilled workers who make a purchase or circulation of currency. During the construction Phase of approximately 48 months, resulting in a cash flow into the economy, the community.

1.2) The impact on the conflict between pedestrians pass - on the road network in the local community or the public employees and construction workers will rarely occur or almost never happen. Since most of the construction will carry out in the traffic median area of Lat Phrao Road, Srinagarindra Road, and Theparak Road in marginal areas where there is a clear boundary. Therefore, the staff or construction workers will rarely make contact or interaction to the passer on

the road network within the local community or the public. Moreover, the project requires the contractors to build the worker shelters located approximately 5 kilometers away from the project route and reserve the vehicles for the employees commute from the shuttle to the construction sites during the working hours.

1.3) There are the impact on annoyance and inconvenience of pedestrians passing on the road network or the adjacent area that urgent to resolve or minimize the impact such as the relocation of buildings/obstacles in the way, the dirty from dust blowing, traffic jams during construction, the noise from the machinery and construction equipment. The dropping of equipment or materials in the construction and air pollution from traffic jams and so on.

1.4) The impact on the existing commercials area in the construction area especially in the construction of the station that may obstruct or block the entrance of various businesses such as cargo transporting, dust pollution, difficulties for the customer, the view obscured and lack of privacy, lack of customer etc. As a result, the number of customers and income from operations will be reduced. Thus, the construction of the station will be impacted in the medium - high.

2) Operation Phase

2.1) The positive impact on economic conditions of the communities is low due to the increase in hiring skilled workers with knowledge and skills.

2.2) The impact on the value of the land, due to the development project will contribute to the convenience of travel which is the significant motivation and attraction for the investment of the train station surrounding the area. Also, the impact of changes in land use patterns, for example the bare land that has not been exploited and low density residential district may change to the residential medium density, such as condominiums, apartment house, etc., or the semi-commercial residential in density neighborhood commercial or commercial buildings such as offices, mega shopping centers, entertainment venues. It is likely that the price of land in the area surrounding the train station and the Depot increase the value.

2.3) Since the rail system is a monorail system that does not cause the air pollution, the high noise level, and vibration. The system also assists to flow the current traffic conditions as an alternative of travel choice besides the bus or taxi and minimize the use of personal vehicles. Therefore, the impact on quality of life of residents living near the project route or the pedestrians on the road network is the medium positive impact that enhances the quality of life, such as reducing the travel time, reducing the stress from the travel and improve the mental health of people along the project corridor. It will also increase the income from employment growth and reduce the use of energy (fuel) that cause pollution or save time and travel costs, and so on.

2.4) The impact on the existing businesses.

a) The small businesses and commercial buildings nearby station without the parking space but required to front store for the business will be the group that expected to have a moderate negative impact because the structure of the pillars of the elevated station will be permanently obfuscated the front of business. As a result, the customers cannot see the store

signs and advertising boards. This impacts the number of customers who use the service less hence it is expected income from operations is reduced.

b) Large business establishments along the rail system are likely or somewhat to get a positive impact are a real estate, large shopping centers, office buildings and entertainment complex, etc., due to various businesses will do more quickly and conveniently.

2.5) Since the project will carry out in the traffic median area of Lat Phrao Road, Srinagarindra Road, and Theparak Road. Also, the current communities on both sides of the road are separated by an existing road network and the communities on both sides of the road can communicate and interact with each other by the flyover connecting intermittently throughout the Monorail system including the local train station will install the escalator or a ramp (for disable) to connect communities on both sides of the road. Thus, it does not impact the separation of communities on both sides of the road.

5.4.2 Property Compensation

1) In case without the project

No compensation for property

2) In case with the project

(1) Pre- Construction Phase

Due to the construction of the Bangkok Mass Transit Yellow Line Project : Lat Phrao-Samrong, Section from Bangkok to Samut Prakan with the connection route starts at the MRT Ratchada - Lat Phrao Road and end at Pu Chao Saming Phrai road. The yellow line is a monorail that constructs elevated structure throughout the project route runs along the traffic median with a distance of approximately 30 kilometers. The project train station with a total of 23 stations and one depot located near the area Si lam station adjacent to the intersection of Srinagarindra and Bang Na - Trat Road. In the development of the project will impact the private land that must be expropriated and compensation for damages. The detailed information on the expropriation and compensation are as follows:

The project route construction area is a monorail that constructs elevated structure throughout the project route runs along the traffic median of Lat Phrao Road, Srinagarindra Road, and Theparak Road. with a distance of approximately 30 kilometers. which is not to be expropriated except in the Suan Luang - Si Udom and Si Udom – Si lam and Si Thepha intersection. The extension line in the future (Samrong Station) need to adjust the project route construction area where the expropriation of 64 parcels total area of 3 Rai 2 Ngan 200.3 square wah, a total compensation of 153,088,500 Baht that divided into 106,768,500 Baht compensation for land and 46.32 million baht compensation for buildings. The impact on the parcel is summarized as follows:

- There are 24 land parcels (37.5 percent) that expropriated a whole parcel.
- There are 10 parcels of land (15.63 percent) that expropriated, then the space of less than 25 square wahs.

- There are 30 parcels of land (46.87 per cent) that expropriated and then left the area more than 25 square wahs.

- There are four buildings, two business building, an abandoned building, and an abandoned warehouse.

The MRT stations construction area: The Bangkok Mass Transit Yellow Line Project : Lat Phrao-Samrong Section consists of 23 stations namely Ratchada Station, Phawana Station, Chok Chai 4 station, Lat Phrao 71 station, Lat Phrao 83 stations, Mahat Thai stations, Lat Phrao 101 stations, Bang Kapi station, Lam Sali station, Si Kritha station, Phatthanakan station. Kalantan station, Si Nut station, Srinagarindra 38 station, Suan Luang Ro 9 station, Si lam station, Si La Salle Station, Si Bearing station, Si Dan station, Si Thepha station, Thipphawan station, Sri Sumrong station were expropriated 274 parcels total area of 27rai 3 ngan 161.8 square wahs. The total compensation is 1,496,736,350 Baht that divided into the land compensation. 1,041,491,350 Baht and buildings compensation 455,245,000 baht. The impact on each parcle is summarized below.

- There are 57 parcle of land (20.80 percent) that expropriated a whole parcel.
- There are 98 parcels of land (35.77percent) that expropriated, then the space of less than 25 square wahs.

- There are 119 parcels of land (43.43 per cent) that expropriated and then left the area more than 25 square wahs.

- There are 137 buildings, 33 for residential buildings, 32 houses, 1 condominium, 100 commercial building which divided into 85 commercial and shop, a market, a bank, two gas stations, a hospital, 7 garages, a parking garage, two warehouses. For the rest four building, that is abandon building, a billboard, and a toilet.

The Depot: the Yellow Line Project require a Depot located in the area near the Si lam station at Srinagarindra and Bang Na - Trat intersection with the total area of 118 rai 1 ngan 79 square wahs, an area of 48 parcels. the total compensation of 523,008,450 baht divided into 505,437,500 baht for the land compensation and 17,570,950 baht for the buildings compensation. The impact assessment on the parcels can be summarized as follows:

- There is 44 parcels of land (91.67percent) that expropriated a whole parcel.
- There are 4 parcels of land (8.33 per cent) that expropriated and then left the area more than 25 square wahs.

- There are 17 buildings that are expropriated including 14 housing, a billboard, and two factories.

The Section overall construction of the Bangkok Mass Transit Yellow Line Project : Lat Phrao-Samrong. There are 386 parcels of land were expropriated resulted in a total of 150 rais 2 ngan 41.1 square wahs. The total compensation is 5,404,451,156 Baht which classified as land compensation. 4,729,574,421 Baht and buildings compensation impact 674,876,735 baht on the conversion can be summarized below.

- There is 125 parcels of land (32.38 percent) that expropriated a whole parcel.
- There are 108 parcels of land (27.98 per cent) that expropriated and then left the area less than 25 square wahs.

- There are 153 parcels of land (39.64 per cent) that expropriated and then left the area more than 25 square wahs of the land used for the construction of the Yellow Line, and 158 building

The construction of the project needs to be expropriated the commercial district for 386 parcels of land value appraisal of land parcel from 2012 to 2013 by the Treasury Department, Ministry of Finance up to 1653 million baht as well as a building to be demolished 158 units valued at 519 million baht therefore the impact assessment of land expropriation and relocation of buildings out of the zone could significant impact the economy, society and could impede the construction and operation projects. However, since the project is an approach to land valuation allowance using the actual price that traded on the market. Together with the pricing guidelines under the Expropriation Act of 1987, the Ministry of Transport (2013), which was 2.86 times higher than the appraised value of the Treasury Department and the building appraised value of the building in 2013 set by the Association of Valuers of more than 0.03 are considered, including the opportunity cost to the merchant to the expropriation appropriately and fairly. with Therefore, it is estimated that the impact caused by the expropriation and relocation for the construction of the project. The impact on the acceptable level.

(2) Operation Phase

There is no impact in terms of compensation for property due to reimburse all property will continue to be completed before the construction project.

5.4.3 Public health and health

1) Construction Phase

(1) Health problems

The project could potentially impact the adjacent communities to the project area. The health problems that affected this group from the construction activities of the project including illnesses, especially respiratory disease from the dusty air, the contagious diseases of foreign workers, the problem of noise from the construction. In addition, the increasing of the worker community in the area may also affect the ability to provide health services. This makes local health departments must rise the responsibility for providing medical care.

(2) Solid waste/wastewater problem

The solid waste from activities in the workers shelters including garbage, sewage and waste water from washing and other activities if there is no proper the management of the waste generated, these wastes can be a breeding ground for germs and disease which can spread to the community. Also, there is potential leaching into nearby water sources can cause wastage. However, it is expected to have slightly impact due to the short time impact in a construction Phase only.

(3) Environmental issues and the spread of disease.

This issue is caused by the community of construction workers, such as drinking water - water used, toilet, waste disposal, flies and animal-borne diseases control, etc. If the internal management in worker shelter were no sanitary and hygienic habits may cause the spread of diseases such as cholera, diarrhea, and dysentery, food poisoning. According to the report by

patients, the epidemiological surveillance of public health agencies in the project area found that diarrheal disease is the first priority for surveillance primacy while the second one is food poisoning, which is caused by the lack of sanitary. The contractor must supply drinking water - clean water to workers adequately as well as enjoin the workers on the environmental sanitation construction shelter worker area to hygienically clean the leftovers of a meal, water or waste residues remaining.

(4) Issues of adequate health facilities and medical personnel.

The current state of public health in Bangkok and Samut Prakan revealed that the number of health facilities and medical staff provide adequate support to the workers and the surrounding area and can access to the whole health services. However, the construction activities may need to get more health care and medical services, if the contractor does not provide or prepare hospitals and medical personnel outside the area to accommodate sick employees/workers. The groups that risk being affected are the people who live in the district and adjoining areas. Considering the overall impact on public health and the health effects which can be prevented by managing environmental sanitation in the area of construction workers as well as provide adequate first aid tools, and given the proper procedures in the workplace. Therefore, the impact is low.

2) Operation Phase

(1) Health Problems

The monorail that runs on the elevated 13 - 23 meters high from the existing road will be no ventilation of air pollution during the operation Phase. The impact on air quality caused by pollution from the exhaust of the vehicle on the road network. The pollutant is particulate matter, carbon monoxide and the accumulation of air pollution because the building is a three-stories high building which is lined on both sides of the road. Although there is a gap between the train station and the building approximately 4 meters, as an area with poor air circulation the negative impact is moderate. Clearly, that the issues affecting health problem (respiratory disease) and vulnerable groups will be affected along the route. Because air pollution is likely to occur less than that occur in construction Phase excepted for those who live in commercial buildings which have to pay extra extension for health monitoring.

(2) Solid waste/Wastewater Problem

In the operation Phase, the project will provide sufficient trash cans in each station separate wet waste and dry waste to contain garbage from passengers and station staff. The project is established the waste collection for the relevant authorities carry out the waste collection for disposal of the waste/hazardous. Also, the waste collection program will put the container with the lid closed, stored in a waste storage building before sending it to the operators licensed by the department to the treatment of hazardous waste disposal. For wastewater that occurs in each station, the project will provide adequate toilets and install the wastewater treatment. Thus, the impact is low.

(3) Environmental issues and the spread of disease.

The project will manage the sanitation stations in the Depots. By providing waste management and waste water, to prevent a further spread of the insect-borne diseases such as dengue, diarrhea, food poisoning and so on.

(4) Issues of adequate health facilities and medical personnel.

The development project is an alternative for the people of Bangkok and Samut Prakan province to increase the use of electricity or public transport for saving time on the commute, comfortable and faster, etc. If considered overview of traffic conditions in the area, this will help in case of moving or transporting sick people from different locations of the various hospitals quickly, convenience and can receive medical treatment immediately to reduce the loss of life. Thus, the positive impact is moderate.

5.4.4 Occupational health and safety

1) Construction Phase

The construction activities during the construction Phase, which are quite a variety, such as leveling the reclamation area, excavation, laying the foundation and connecting evaluated structures. Some activities require the use of heavy equipment which contributes to the risk of accidents from working or a worker in a construction area. The main cause is usually affected by negligence or unsafe as not working properly, inexpert in the use of machinery and equipment, careless or unsafe equipment from malfunctioning or from unorganized material storage including the respiratory illness that is caused by exposure to dust result from the operation. Hearing problems that are caused by the use of noisy machines, which work as a contractor must have personal protective equipment such as dust masks safety shoes, safety glasses and helmet and so on. As well as safety requirements when working with materials / equipment or construction activities at risk and the need for workers to know how to use, how to treat engines machines correctly. Also within the construction area, the authorities must provide the adequate first aid. The staff can initially aid correctly and prevention of various diseases control and surveillance of the disease and the spread of dangerous diseases among construction workers as well as to provide a vehicle to be used to transport patients. in the case of injured by accidents from construction activities to the nearest health facilities. And because a large construction project, the construction has to be transported/moving equipment and construction materials several times a day. Therefore, the probability of an accident on the road construction is relatively modest. The project must establish measures in the traffic system including the creation of a temporary access road to the construction of a Depot for minimally disturbed communities including the driver transporting the materials/equipment, and control drive speed regulatory government agencies strictly defined.

2) Operation Phase

As for the security issues due to unforeseen emergencies such as fire stations or train derailed when entering the station platform, the chance to occur is slim or never happen at all. The project development needs to prepare equipment/tools or safety personnel to meet various

standards, such as NFPA-National Fire Protection Association, etc. and monitoring system regularly. As well as be prepared to coordinate with the relevant authorities in case of an emergency, such as the National Police Agency, Office of Disaster Prevention and Mitigation Bangkok, Hospitals affiliated with government agencies, Department of Disaster Prevention and Mitigation Ministry of Interior. Thus, the negative impact is low

5.4.5 Historical Site and Archaeology

5.4.5.1 The Impact of the Elevated Structures and the Stations area

1) Construction Phase

In the construction of elevated structures and stations will be no direct impact on the loss or relocation of history and archeology due to the construction area will carry out on most of the traffic island in the middle of the road network. However, the effects are indirectly related to 19 community landmarks within 500 meters of the project route, including House of Christ Christendom, Lat Phrao Temple, Suan Luang Christendom, Hidayatul Islam Mosque (Don Sakae), Kulabthip Temple, Rum Nimit Bangkok Christendom, Futhulbari Mosque, Yamiaun It-hal mosque (Heu Mak Yai), Christendom of God in Bangkok, Darius Salam Mosque, Num Phra Tai Christendom, AIE Al Somers mosque, Khom Temple (Kajon Siri), Darul Amin Mosque, Si lam Temple, Udomsuk Sri Pharak Samut Christendom Sumrong Christendom, Samrong Deansmorg Temple, and Pu Chao Saming Phrai shrine as shown in **Table 5.4.5 - 1** will taking into consideration issues such as the impact of the dirt from blowing the dust, the noise vibration and inconveniency of access - as follows.

1.1) The spread of dust of construction activities, almost all the dust samples not exceed air quality standards announced by the General Directorate of National Environment No. 24 of 2003 ($<0.330 \text{ mg / m}^3$), thus there is no causing damage or dirt or disturbance to the access of the historical and archeological landmarks related to the communities located within a radius of up to 50 meters.

1.2) The noise level of construction activities revealed that the noise level from activities eight hours will be in the range of 65.5 to 91.6 dB (A) when calculating the noise level of the construction of eight hours, noise level average 24 hours will be in the range of 60.8 to 86.8 dB (A). Consider the project details found that in sensitive areas along the project route within 30 meters from the center line of the route, most of the land was already expropriated to the project. Thus, only the small vulnerable area will be impacted thus, the impact is moderate. As for the nuisance or disturbance to access or leaning visit of the historic and archeological landmarks related to the community, located in a radius of fewer than 50 meters from the source of noise (2 places) that are Suan Luang Christendom and Fut Hut Bari Mosque.

1.3) The predicted vibration from the construction found that the vibration source in the community and sensitive areas along the route most are less than 0.30 mm/sec. or less than 0.012 inches/second, which humans sense cannot feel or no possibility to recognize the impact. There is no impact on the damage of the buildings or structures of all types except Suan Luang church that located at a distance from the center line of route 24.92 meters, with the vibration of 3.152 mm/sec. or 0.124 inches/second, which is in the range of vibrations to be a

nuisance if ongoing continuously and a range of vibrations that interfere with a human in the buildings. The impact on the structures and the buildings are in a range that is not vulnerable to damage caused to the buildings or architectural structure.

Table 5.4.5 - 1 Archeological landmarks related to the community (radius 50 meters from center line of project)

Important place	Distance from project route (m)	Remark
1. House of Christ Christendom	450 m (north and east direction)	
2. Lat Phrao Temple	500 m (north direction)	Built in 1870
3. Lat Phrao Lutheran Christendom	20 m (south direction)	
4. Hidayatun Islam Mosque (Don Sakae)	420 m (south direction)	Built in 1952
5. Wat Mae Phra Kularb Tip (Maria Rosa Mystica Church)	100 m (south direction)	Built in 1998
6. Ruam Nimit Bangkok Christendom	200 m (north direction)	Built in 1990
7. Fatthullbalee Mosque	20 m (east direction)	
8. The Church of God in Bangkok/District6	250 m (east direction)	
9. Jamiul Idhard Mosque (Hua Mak Yai)	250 m (north direction)	
10. Darissalam Mosque	150 m (south direction)	
11. Nam Phrathai Christian Christendom	470 m (south direction)	
12. Carissalam Mosque	400 m (west direction)	
13. An Latisom Mosque	400 m (southwest direction)	
14. Kom Temple (Khajonsiri)	220 m (southwest direction)	Built in 1849
15. Darul Amin Mosque	110 m (west direction)	
16. Si lam Temple	140 m (west direction)	Built in 1974
17. Udom Suk Si Pha Rak Christendom Christendom	310 m (southwest direction)	
18. Samrong Lutheran Christendom	350 m (northwest direction)	
19. Dan Samrong Temple	290 m (northwest direction)	

1.4) Obstructing convenient access to religious places or landmarks that are relevant to the community of people who visit and learn or who practice religious activity or religious rituals (such as charity/alms offer, dharma hearing, funeral, prayers or sermons, etc.), or seeking the quiet place.

- (1) Darius Salam Mosque is located near the Hua Mak Canal Srinagarindra Road, Bang Kapi, Bangkok, that away from the route in approximately 400 meters.
- (2) Al AIE Ti Som Mosque is located near Khlong Phra Khanong, On Nut Soi 43, Sukhumvit Road, Suan Luang, Bangkok, that away from the route in approximately 400 meters.

- (3) Khom Temple (Kajon Siri) is located, near Old Phra Khanong Canal Sukumvit Road, Suan Luang, Bangkok, that away from the route in approximately 200 meters.
- (4) Darul Amin Mosque is located near Chum Sakol Canal community, Srinagarindra Road, Bangkok that away from the route in approximately 110 meters.
- (5) Si lam Temple is located on Bang Na - Trat Road, Bangna, Bangkok that away from the route in approximately 140 meters.
- (6) The Udomsuk Sripharak Samut Prakarn Christendom is located in Udom Suk 52, Muang Samut Prakarn that away from the route in approximately 310 meters.
- (7) The Samrong Christendom is located on Sukhumvit Road, North Samrong sub-district, Muang Samut Prakan that away from the route in approximately 350 meters.
- (8) Dan Samrong Temple is located near Sumrong canal Sukhumvit 113 North Samrong sub-district, Muang Samut Prakan that away from the route in approximately 290 meters.

2) Operation Phase

In the operation Phase is not expected to cause any impact. The historic and archeological landmarks related to the community may have a positive impact on the convenience and rapidity of travel of those who want to learn or to enter into religious activity or other seeking a peaceful place to. practice, etc. as well as to promote the historic and archeological landmarks related to the communities along the project route for passersby.

5.4.5.2 Impact on Depot Area and Park and Ride buildings

The Depot and park & ride buildings In the construction Phase and operation Phase will not affect historical and archeological landmarks related to the community because there is no place within a radius of 500 meters is located.

5.4.6 Aesthetics and Tourism

5.4.6.1 The Impact area of the Elevated Structures and the Stations

1) Construction Phase

The construction of elevated structures and stations generally affects the city vista in low level. Since along the sides of the elevated structure and Skytrain stations is a busy city that is home to commercial, residential, semi-commercial and 3 - 6 stories residential building, the wasteland area with weeds / grass / tree and the vine, the village, apartment house, government/state organizations, religious communities etc. The only important exception of some parts of the trail project will have an unique important place in the history / culture or building with valuable and prominent location within the zone of influence would have affected the scenes or up to 50 meters from the path that are two places, Lat Phrao church (20 meters) and

Fut Hulbari mosque (20 meters), so the impact is moderate in the overshadowed issues leash with height or appearance of a conflict within the elements of the scenery.

2) Operation Phase

In the operation Phase is not expected to affect the city vistas due to the elevated structure and the station since most are located on the traffic island of the road network. The reasons are technical support.

2.1) Case 1 (the elevated structures) before the project, along the traffic island, consists of the open spaces with rows of medium size trees or shrubs, the viaduct over the intersections, utility poles, etc. Considering the different perspectives of the clutter of disorganized power line and towers, poles, high voltage transmission lines, the viaduct over the intersections or vehicles passing by - on the road network, etc. However, the project found that a different view to narrow down the clutter of the power line will be lost. The elevated structure will block the level of visibility. Nevertheless, the elevated structure will be designed and construction is not confined airy structure, rounded and compact. Besides, the project will plant the medium. shrubs/vines to landscape or reduce the hardness look of the elevated structure on an empty space of the island's road network, or along the side of the pavement. Therefore, the city vista is improved.

2.2) Case 2 (the stations) if the view along the train system is in harmony with the ascent-descent to the train station that barrier the sight. However, in the design and construction will use bright colors and structure of the station is in compact appearance, a transparent and non-abrasive sight that consistency and harmony, without obscuring the surrounding regions. Thus, It does not impact the view of the city.

5.4.6.2 Impact on Depot Area and Park and Ride buildings

The Depot and Park & Ride building in the construction Phase and operation Phase will have no impact on its vista, leash with height or appearance of conflict within the elements of the scenery because there is no the historical and cultural landmarks or valuable and prominent building located within a radius of 500 meters. The length of the zone of influence would impact the views are within a distance of 50 meters only.