Environmental Impact Assessment (Final)

Project Number: 51274-001
October 2017

THA: Bangkok Mass Rapid Transit (Pink Line) (Part 3 of 5)

Prepared by The Mass Rapid Transit Authority of Thailand.

CHAPTER 4

EXISTING ENVIRONMENTAL CONDITIONS

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In the Feasibility Study Review, Preliminary Design Plan Modification, and Preparation of Tender Documents for Pink Line Project, Khae Rai-Min Buri Section, some project descriptions are revised from the details originally presented in the EIA Report approved by the National Environment Board on March 16, 2012.

Since such revisions may cause environmental impacts to the project area and the vicinity, ***the Consultant carried out an additional study of the project's existing environmental conditions within a radius of 500 meters from the project route, but only the issues specifically associated to the changes from the original study.*** The results are to serve as a basis for evaluating environmental impacts expected to arise from the project. The study covers 4 environmental components, i.e., Physical Resources, Biological Resources, Human Use Values, and Quality of Life Values, with details as follows.

4.1 PHYSICAL RESOURCES

4.1.1 Topography

(1) Introduction

Topography study is intended to determine existing terrain characteristics of the project area and vicinity and conducted by collecting secondary data from government agencies and other related reports of the project area. Such information will be used to predict environmental impacts that may be caused by the project and environmental factors that may affect the project implementation, and to suggest measures to prevent and reduce environmental impact as well as measures to monitor environmental impact to the extent that is necessary to the topography.

(2) Methodology

Topography study was conducted by collection of secondary data from government agencies concerned, such as Royal Thai Survey Department, Land Development Department including from other related reports to the study area. Existing conditions of the project area were also explored.

(3) Study Results

The areas along the project route over the distance of 34.5 kilometers have been located in the upper administrative areas of Bangkok, i.e. *the districts of Lak Si, Bang Khen, Khanna Yao, Bueng Kum, Min Buri and Lat Krabang*, and in the administrative areas of Nonthaburi Province, i.e. *Mueang and Pak Kret Districts*. Most terrains are wetland of the flooded lower central area with a maximum height of 3.00 meters above MSL. There

are both natural canals and new main interconnected dug-up canals, or there are some canals flowing into the Chao Phraya River, such as *Saen Saep, Bang Talat, Bang Phut, Sam Wa, Lat Yao and Om Non*. Topographical survey of the areas along the project route in a radius of 500 meters can be described as follows:

(a) PK01 Nonthaburi Government Center Station-as the starting point of the project, located on Rattanathibet Road in front of Nonthaburi Government Center. Surrounding areas are lowland with Khlong Bang Sue Noi parallel to Rattanathibet Road (a distance of about 250 meters). From a survey of the area around the station in a radius of 500 meters from the project route, there are a large park, i.e., Makut Rommayasaran Park, large shopping centers such as Tesco Lotus of Rattanathibet Branch, Esplanade Khae Rai, 3-4 storeyed commercial buildings, crowded residential areas, such as Sunthonsap Mansion, major places including Thaikom Satellite Station and Domestic Satellite Communications Center, and schools, such as Siam Business Administration College of Technology (SBAC).

(b) PK 02 Khae Rai Station-located on Tiwanon Road Median. Surrounding areas are low land. From a survey of the area around the station in a radius of 500 meters from the project route, there are row houses/commercial buildings alternate with crowded residential areas, such as *Saeng Arunnives Village, Si Phiphat Village, Judicial Officials Condominiums, Chokchai Rungruang Village 3, and Sopha Village*. There are also major government places, e.g. *Nonthaburi Provincial Land Transport and Nonthaburi Telecommunications Center, etc.,* and health care facilities, i.e. *Central Chest Institute of Thailand and Boromarajonani College of Nursing.*

(c) PK03 Sanambin Nam Station-located on Tiwanon Road Median. From a survey of the area around the station in a radius of 500 meters from the project route, there are row houses/commercial buildings along the road alternate with condominiums, such as *Phong Suda Village, Ngam Wongwan 3 Village, Don Chedi Mansion 3, Kobsuk Apartment, Boon Mongkholchai Mansion*, small industries such as *Icehouse and Watthana Warin Limited Partnership*, and official places, e.g. *Quartermaster Department Royal Thai Army.*

(d) PK04 Samakkhi Station-located on Tiwanon Road Median. From a survey of the area around the station in a radius of 500 meters from the project route, there are row houses and commercial buildings alternate with empty spaces and medium-density residential areas, such as *Tiwanon Village, Thap Saithong Village, Saeng Arunnives Village, Chakhrit Apartment, Thong Praphakhom Apartment, Chonlaprathan Market, Phranakhon Cooperatives, and Chonlaprathan Golf Course*. In addition, there are schools, such as *Chonprathansongkhro School, Nurusmumimin School and Saman Phichakon School,* and important religious places, e.g. *Darul Mudtakin Mosque.*

(e) PK05 Royal Irrigation Department Station-located on Tiwanon Road Median in front of Chonprathanwitthaya School. Surrounding areas are low land as empty spaces alternate with official buildings. From a survey of the area around the station in a radius of 500 meters from the project route, there are major places, such as *Royal Irrigation Department, Educational Technology Center for the Blind, Skills Development Center for the Blind, Pak Kret Home for Babies, Grand de Ville Village, Kret Kaew Garden Village*, etc., and schools, e.g. *Chonprathanwitthaya School and Sri Sangwan School*, *etc*. and major religious places, e.g. *Wat Chonprathan Rangsarit.*

(f) PK06 Pak Kret Station-located between Tiwanon Road and Chaeng Watthana Road. Surrounding areas are low land. From a survey of the area around the station in a radius of 500 meters from the project route, there are row houses/abandoned commercial buildings alternate with empty spaces. Major places are e.g., *Welfare and Vocational Training for Women, Central Region. Ha Yaek Pak Kret Post Office, Audace Co., Ltd., Information Technology Center of Siam Commercial Bank of Thailand, Futsal Field, the Hattrick, Bangkok Cotton Mill, Cement Thai Home Mart, Pak Kret Telephone Exchange, Kuakun Nives Village, Suan Kulab Village, etc*., and schools, e.g. *Suankularb Wittayalai Nonthaburi School*, and religious places such as *Pak Kret Church.*

(g) PK07 Pak Kret Bypass Station-located on Chaeng Watthana Road Median. Surrounding areas are low land. From a survey of the area around the station in a radius of 500 meters from the project route, there are row houses/commercial buildings alternate with empty spaces. In the areas are residences, such as *Si Chaithong Village, Nonglak Village, Sailom Village, Nanthana Garden Village, Ban Suan Palm Condominium*, large shopping centers, e.g. *Big C Supercenter and Hompe Pro*. Major places are e.g. *Jasmin International Tower Building and Spansion Co., Ltd.*

(h) PK08 Chaeng Watthana-Pak Kret 28 Station-located on Chaeng Watthana Road Median. Surrounding areas are low land. From a survey of the area around the station in a radius of 500 meters from the project route, there are row houses and commercial buildings alternate with empty spaces. In the areas are residential areas of medium to high density, such *as Ratchaphruek Village, Si Chaithong 3 Village, Kanya House Village*, with a large shopping center, i.e. *Central Plaza Chaeng Watthana*, *etc.,* major official places, e.g. *Software Park Thailand Building, The Royal Thai Police Band Division, and international school (Hampton International School),* and health care facilities including *Bangkok Hospital, Talat Tambon Health Promoting Hospital*. In the future, there will be a construction project of Bangkok Chain Hospital in this area too.

(i) PK09 Muang Thong Thani Station-located on Chaeng Watthana Road Median. Surrounding areas are low land. From a survey of the area around the station in a radius of 500 meters from the project route, there are row houses and commercial buildings alternate with empty spaces. In the areas are residential areas of medium to high density, such as *Muangthong Thani Village, Sirisap Village, Janya Nives Village, Phongtham Nives Village, Tower Condominium, "The Key" Condominium Construction Project, IMPACT Exhibition and Convention Center*. Other major places are e.g. *Wandee Siam Building, Cement Thai Home Mart*, *etc.,* and schools, e.g. *Sukhothai Thammathirat Open University and Khlong Klua School.*

(j) PK10 Si Rat Station-located on Chaeng Watthana Road Median. Surrounding areas are low land, with Khlong Bang Phut flowing through the pipes underneath Chaeng Watthana Road in a distance of approximately 150 meters and Khlong Prapa flowing parallel to Prachachuen Road in a distance of approximately 500 meters. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces. In the areas are residential areas of low density, such as *Thai Airways Cooperatives Village*, with major places such as a golf-driving range, a large shopping center, e.g. *Makro Superstore, Chaeng Wattana Branch*, and government buildings/major places, e.g.

Bureau of Mechanical Equipment and Communications, Department of Highways, schools, e.g. Apakon Kindergarten School and Wanjai Kindergarten School.

(k) PK11 Chaeng Watthana 14 Station- located on Chaeng Watthana Road Median. Surrounding areas are low land, with Khlong Prapa flowing parallel to Prachachuen Road and through the pipes underneath Chaeng Watthana Road in a distance of approximately 200 meters. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings of 3-5 storeys alternate with empty spaces. In the areas are medium-density residential area, e.g. *Rung Arun Nakhon Village, Pailin Village, Phong Phet 2 Village, Garden City Lagoon 2 Village,* large department stores, e.g. *Tesco Lotus, Big C Supercenter of Chaeng Watthana Branch, Avenue Chaeng Watthana Shopping Center, Phong Phet Market,* and major places, such as *Chaeng Watthana Telephone Exchange, TK Palace Hotel, Jumbotale Hotel, Bua Restaurant*, *etc.,* schools, e.g. *Kraiumnuay Tiger Army School*, and hospitals, e.g. *Mongkutwattana Hospital*.

(l) PK12 Bangkok Government Complex Station- located on Chaeng Watthana Road Median. Surrounding areas are low land. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces. In the areas are government/state enterprise buildings, e.g. *Consular Department, Administrative Court, Department of Special Investigation, Department of Bangkok Youth Observation and Protection, the 1st Antiaircraft Artillery Regiment, the 1st Distant Patrol Troop of the 1st Division, King's Guard, Royal Thai Armed Force Headquarters, Communications Authority of Thailand (CAT), Shinnawatra Tower, the Government Complex Commemorating His Majesty the King's 80th Birthday Anniversary, 5th December 2007*.

(m) PK 13 TOT Station - located on Chaeng Watthana Road Median. Surrounding areas are plains with Khlong Prem Prachakon flowing parallel to Kampaeng Phet 6 Road and flowing underneath Chaeng Watthana Road. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces. In the area are government/state enterprise buildings, e.g. *Lak Si District Office, TOT Public Company Limited, Chulabhorn Research Institute.*

(n) PK 14 Lak Si Station-located at the intersection of Chaeng Watthana Road and Vibhavadi Rangsit Road. Surrounding areas are plains with Khlong Prem Prachakon flowing parallel to Kampaeng Phet 6 Road and flowing underneath Chaeng Watthana Road. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces. In the area are government/state enterprise buildings, e.g. *Chulabhorn Research Institute, Lak Si District Office, Don Muang Substation, Metropolitan Electricity Authority, Lak Si Highway Division, Deesawat Industries Co., Ltd., Friesland Campina (Thailand) PCL., etc.,* a large shopping center, e.g. *IT Square*, schools, e.g. *Wat Lak Si School, Technic Ratanakosin School, Rattanakosin Technological College and Charoen Phon Witthaya School* and religious places, e.g. *Lak Si Temple*.

(o) PK15 Phranakhon Rajabhat Station-located on Chaeng Watthana Road Median. Surrounding areas are plains with Khlong Thanon flowing underneath Chaeng Watthana Road. From a survey of the area around the station in a radius of 500

meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces. In the area, there are major places, e.g. *Bang Khen Telephone Exchange*, large department store, e.g. *Max Value*, schools, e.g. *Phranakhon Rajabhat University and Wat Phra Si Mahathat Demonstration Secondary School.*

(p) PK16 Wat Phra Si Mahathat Station–located at Lak Si Circle. Surrounding areas are plains. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces. In the area, there are government/state enterprises buildings, e.g. *Bang Khen District Office, Bang Khen Fire Station, Bang Khen District Office of Metropolitan Electricity Authority, Metropolitan Waterworks Authority, Buddhism and Philosophy College, Bangkhen Police Station, 4th Transport Military,* and schools, e.g. *Krirk University, Thainiyomsongkro School, Buddhism and Philosophy College.*

(q) PK17 Ram Inthra 3 Station-located on Ram Inthra Road Median. Surrounding areas are plains. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces. In the areas are residential areas, e.g. *Ram Inthra-Lak Si Lumpini Condo Project,* major places, e.g. *Royal Thai Army Sports Center Ram Inthra, Second Infantry Battalion, Central Ram Inthra Department Store, Pramochwittaya Ramintra School.*

(r) PK18 Lat Pla Khao Station-located on Ram Inthra Road Median. Surrounding areas are plains. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces. In the area, there are official places/major places, e.g. *Royal Thai Police Headquarters, Ram Inthra Fresh Market, Ram Inthra Substation*, large department stores, e.g. *Foodland Supermarket, Big C Extra*, and schools, e.g. *Suvicha School, Piyaphon Kindergarten School*

(s) PK19 Ram Inthra 31 Station - located on Ram Inthra Road Median. Surrounding areas are plains. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces. In the area, there are medium-density residences, e.g. *Raminthra Community Housing, Pan Thong Village, Chalermsuk Nives 9 Village, Narongkij Village*, and government offices/major places, e.g. *Pin Thong Market Km.4, Police Aviation Division.*

(t) PK20 Maiyalap Station-located on Ram Inthra Road Median. Surrounding areas are plains. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings of 3-5 storeys alternate with medium-density residences, e.g. *Inthraphitak Village, Nuanjan Village and the Welfare Soldier Village.* There are also official places and major places, e.g. *Police Aviation Division, Machine Tools Service Center, Ram Inthra Telephone Exchange*, and schools, e.g. *Saiaksorn School, Tasaneewan Kindergarten School, Pramoch School and Niramol Kindergarten School.*

(u) PK21 Watcharaphon Station-located on Ram Inthra Road Median before reaching Sukhaphiban Intersection 1.From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces and medium-density residences, e.g. *Prem Ruethai*

Lake Park Village, Patthavikon 2 Village, Ram Inthra Village, and Maneerat Apartment, major places, e.g. *Bureau of Personnel Competency Development, Development Army Welfare Housing Association, Jorakhey Bua Market, Sai Nate Market and An Ao Kop Mosque*, and schools, e.g. *Promochpattana Kindergarten School and Chatwittaya School.*

(v) PK22 Ram Inthra 40 Station-located on Ram Inthra Road Median. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces and medium-density residential area. Major places in the area are, e.g. *Siam Sport Syndicate Public Company Limited*, and schools, e.g. *Chatwittaya School and Saiaksorn School.*

(w) PK 23 Khu Bon Station-located on Ram Inthra Road Median. Surrounding areas are plains. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces. In the area are medium-density residences, e.g. *Prem Ruethai Lake Park Village 2, Patthavikon 2 Village, Ram Inthra Village, and Maneerat Apartment*, major places, e.g.*Jorakhey Bua Market, Sai Nate Market and An Ao Kop Mosque.*

(x) PK24 Ram Inthra 83 Station - located on Ram Inthra Road Median near Synphaet General Hospital. Surrounding areas are plains. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces. In the area, there are medium-density residences, e.g. *Theeppipat Co., Ltd., Toyota Showrooms, with Synphaet General Hospital, the main hospital.*

(y) PK25 East Outer Ring Road Station - located on Ram Inthra Road Median next to the East Outer Ring Road. Surrounding areas are plains. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces and medium-density residential area, with large shopping centers, e.g. *Fashion Island Shopping Mall, The Promenade, and Grand Home Mart Group.*

(z) PK26 Nopparat Rajathanee Station - located on Ram Inthra Road Median near Nopparat Rajathanee Hospital and Nightingale Sports Stadium. Surrounding areas are plains, with Khlong Ban Ko flowing through on the southwest about 120 meters away. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces and medium-density residences, e.g. *Sri Suppachok Village, Saeng Arun Village, Kao Saen Village, Lerd Ubon 5 Village,* major places e.g. *Amorini Raminthra Boutique Mall, Ram Inthra Grand Bangkok Boulevard, Siam Park, Amornpan Swimming Pool Club, Thaksina Business Technological College, Nopparat Rajathani Hospital and Nopparat Rajathani College of Nursing.*

(aa) PK27 Bang Chan Station - located on Ram Inthra Road Median at Soi Ram Inthra 115 near Soi Phraya Suren 32. Surrounding areas are plains with Khlong Ban Chan flowing underneath Chan Road about 300 meters away. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces with major places, e.g. *UPD Building, Navago Immex Co., Ltd.*

(bb)PK28 Setthabutbamphen Station - located on Ram Inthra Road Median in front of Setthabutbamphen School. Surrounding areas are plains. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with empty spaces and low-density residences, e.g. *Siribut Village, Sin Thani 2 Village, Sue Trong Village, and Preecha 11 Village,* major places e.g. *Ram Inthra Fishing Park and Setthabutbamphen School.*

(cc) PK29 Min Buri Market Station - located on Sihaburanukit Road Median. Surrounding areas are plains with Khlong Chek flowing underneath Sihaburanukit Road about 30 meters away. From a survey of the area around the station in a radius of 500 meters from the project route, there are rowhouses and commercial buildings alternate with medium-density residences, e.g. Wanathip *Village, Mark Land City Village,* major places e.g. *Phra Rasami Church, Min Buri Revenue Office, Min Buri Pawn Shop, Jatujak 2 Market, Navamin Hospital*, large department store, e.g. *Jusco Min Buri*, and schools, e.g. *Min Buri Technical College, Piyaminkunanrak School, Min Buri Suksa School and Suknate School.*

(dd)PK30Min Buri Station-located at Depot of the Pink Line MRT Project on the south (end) of Ramkhamhaeng Road. Surrounding areas are low land and empty space. From a survey of the area around the station in a radius of 500 meters from the project route, there are agricultural areas and low-density residences, e.g. *Ram Inthra Housing, Rung Napa 2 Village, Thai Watsadu Store, Taeng Mo Futsal Field*, and schools, e.g. *Minprasat Witthaya School and Kasem Bundit University, Rom Klao Campus.*

(ee) Depot and Park-and-Ride Building at Rom Klao Intersection-located on the south (end) of Ramkhamhaeng Road adjacent to Khlong Song Ton Nun, with the areas of approximately 366,400 square kilometer or about 2.29 rai. Surrounding areas are low land. From a survey of the area around the station in a radius of 500 meters from the project route, it was found that there is land use on the former farmland and surrounding areas are low-density residential areas, e.g. *Rung Napa 2 Village, Preecha Village, Ram Inthra Housing and Min Buri Child Development Center,* and schools, e.g. *Minprasat Witthaya School and Kasem Bundit University, Rom Klao Campus.*

4.1.2 Surface Water Hydrology and Drainage

(1) Introduction

In the Project development from pre-construction, construction to operation, there may be activities that will affect conditions of surface water near the project route, e.g. water flow obstruction, traffic obstruction or impact on the uses of water resources of local communities. The proper choice of the construction methods as well as the management of each stage will reduce the level of the impact. Therefore, a study of existing conditions of the ground water in both physical condition and form of use of water resources is absolutely necessary. This is because the results obtained from such study will be used as a baseline to evaluate the impacts before project development in order to make project implementation plan so that the risks or potential impacts on water resources along the roadway passing through can be reduced.

(2) Methodology

In study of ground water hydrology, relevant data was collected from such document as topographic map with1: 50,000 scale of the Royal Thai Survey Department in addition to collection of secondary data from exploration of hydrological conditions of surface water in the project area.

(3) Study Results

(a) Surface water resources in project area

From the review and field survey, it was found that at the area of Depot and Park-and-Ride Building at Rom Klao Intersection, there is one surface water source, i.e., Khlong Song Ton Nun, which is a small canal for draining water into Khlong Saen Saep, with the width of 10 meters. It is used as a canal for drainage and waste water accommodation from canal tributaries (e.g. Khlong Bueng Kwang and Khlong Ta Nuay). In the area is also location of relatively densed residential areas (e.g. Ramkhamhaeng Community Housing, Rung Napha Village and Rinthong Village). Water flow in the canal is rather slow flowing from south to northwest.

(b) Flood drainage and protection at Depot and Park-and-Ride Building

At the Depot and Park-and-Ride Building at Rom Klao intersection, current land has been used as farmland and residential areas without drainage system. Rainfall has been drained along the slope of the area into Khlong Song Ton Nun, which is a public canal on the southwest of the Depot and Park-and-Ride Building at Rom Klao Intersection.

4.1.3 Surface Water Quality

(1) Introduction

Water source is part of the natural ecosystem. Activities arising from project development may cause adverse effects on surface water quality. This causes a change of aquatic ecosystems near the project area. Since the Depot and Park-and-Ride Building at Rom Klao Intersection, which is located nearby Khlong Son Ton Nun has been expanded the construction area, the activities in preparation, construction and operation stages may, therefore, affect the surface water quality in such area. Thus, it is necessary to study existing quality of the surface water that will be used as a basis for assessing impact from project development. This will lead to determination of protection and mitigation measures of environmental impact as well as monitoring measures of surface water quality in the future.

(2) Methodology

(a) Collecting secondary data on surface water quality of water sources in the project area. In this study, quality data of 95 canals in Y2012 of Water Quality Management Office of Bangkok Metropolitan Authority was used to determine monitoring stations of surface water quality in order to analyze conditions of the surface water sources at present. Guidelines in selection of stations to be used as surface water representatives are as follows.

- As surface water sources that lie across the project route or near the project line
- As water sources with such activities as utilization for consumption and farmland or important to the ecosystems, e.g., as aquatic conservation and breeding sources, etc.

(b) Field surveying to observe and collect water samples to analyze water quality. One sampling point of surface water was determined at construction site of the Depot and Park-and-Ride Building at Rom Klao Intersection on Ramkhamhaeng Road, i.e.*SW01 Station-Khlong Song Ton Nun*, located on Ramkhamhaeng Road, Khlong Song Ton Nun, Lad Krabang, Bangkok (coordinates 687233E, 1526719N). Water quality sampling points and aquatic ecology are as shown in ***Figure 4.1-1*** and ***Figure 4.1-2*****,** surveyed on November 6, 2012, with water quality parameters and monitoring procedures as shown in ***Table 4.1-1*****.**

(c) Comparing surface water quality from the samples collected from the field with the Notification of the National Environmental Board No. 8 (B.E.2537) issued under the National Environmental Quality Enhancement and Conservation Act B.E.2535 on Defined Water Quality Standards in Surface Water Sources. The Dissolved Oxygen (DO) as obtained from the analysis will be compared to the criteria of DO levels. Water quality and utilization are shown in ***Table 4.1-2***. Contamination value of water in form of organic matter (BOD_5) as obtained from the analysis will be compared to the BOD_5criteria, the water quality indicator determined by the Division of Water Quality Management, Pollution Control Department, as shown in ***Table 4.1–3*****.**

(d) Assessing the project impact on surface water quality in pre-construction, construction and operation stages by considering the effect of sewage sludge increase from construction and other activities.

(e) Preparing recommendations, measures and action plans to prevent, remedy and mitigate the impact on surface water quality.

(f) Preparing recommendations and action plans to monitor surface water quality

(3) Study Results

For surface water sources near Depot and Park-and-Ride Building at Rom Klao intersection at present, there is only 1 source, i.e. *Khlong Song Ton Nun* with the depth of 2.8 meters, used to receive water from the neighborhood as well as waste water from communities and farmland located along the canal. Based on the review of data from agencies concerned and more analyses of surface water quality on November 6, 2012 **(*Appendix 4A*),** the study results can be concluded as follows.

(a) Secondary data collection

According to the data review on the surface water sources along the public transport route, which was approved by the National Environment Board on March 16, 2012, it was found that the project route passes through 6 surface water sources, i.e. *Khlong Bang Talad, Khlong Prapa, Khlong Prem Prachakon, Khlong Lam Chala, Khlong Bang Chan and Khlong Saen Saep*. Based on the surface water quality survey and analysis according to the original study, the study results concluded that water quality in

Khlong Prapa was at fair-good level, suitable for water supply production and consumption, but needed to go through processes of regular disinfection and water quality improvement before. For water in such canals as Khlong Bang Talat, Khlong Prem Prachakon, Khlong Lam Chala, Khlong Bang Chan and Khlong Saen Saep, the quality was quite degraded due to the effluent volume released from residential communities, commercial/business areas or major places. For the index that indicated degradation of water quality was i.e. high-very high contamination of organic matters (BOD) and microorganisms, severe shortage of oxygen in water sources, or relatively considerable changes in oxygen amount during the day including contamination of phosphate and oil and high quantity of fat from wastewater from urban communities. Water quality in Khlong Bang Talad, Bang Khlong Prem Prachakon, Khlong Lam Chala, Khlong Bang Chan and Khlong Saen Saep was inappropriate to use for consumption and aquatic animals' living. However, the possible utilization is just for irrigation, transportation and drainage only.

Based on the water quality data of Khlong Song Ton Nun at Soi Ramkhamhaeng 192, and behind the Rom Klao Water Quality Control Plant during January-June 2012 of the Office of Water Quality Management, Department of Drainage and Sewerage, Bangkok Metropolitan Authority, pH value is in the range of 7.2-7.5-the normal pH value of natural water sources (between 5.0-9.0), water temperatures between 28.8-30.8 degrees Celsius, suspended solids9.0-29.8 mg/l., dissolved oxygen (DO) 2.6-3.0 mg/l., BOD_5 value 7.2-7.6 mg/l., and total contaminated coliform bacteria 1,220,000-2,440,000 MPN/100 ml. In general, water quality meets surface water quality standard of category 5 because of the BOD_5 exceeding 4.0 mg/l. and Fecal Coliform Bacteria more than 20,000 and 4,000 MPN/100 ml, respectively. Such water source was considered a water source receiving effluent from some activities, but still can be used for transportation.

(b) Field surveys

Analysis results of the surface water quality from water samples collected from Khlong Song Ton Nun on November 6, 2012 was shown in ***Table 4.1-4.*** The canal was 2.8 meters deep, with current velocity at 0.04 m/second, considered as still water source, with pH value at 6.61, water temperature at 30.9 degrees Celsius, transparency value at 0.36 meter, electrical conductivity at 0.62 micro Siemens/cm., suspended solids 30 mg/l, oil and fat less than 5.0 ./l., total iron content 1.2 mg/l, dissolved oxygen (DO) 1.58 mg/l, BOD_5 2.2 mg/l, contaminated amount of coliform bacteria 75,000 MPN/100 ml. and Fecal coliform bacteria of 24,000 MPN/100 ml. Heavy metals were found in small amounts, with cadmium content of less than 0.00002 mg/l, lead content less than 0.005 mg/l Overall water quality met surface water quality standard of Category 5 due to the amount of dissolved oxygen (DO) in water less than 2.0 mg/l, not suitable for aquatic plants and animals' survival. Bacteria of all coliform group as well as Fecal Coliform Bacteria were more than 20,000 and 4,000 MPN/100 ml, respectively. Such water source was, therefore, considered a water source receiving effluent from some activities, but still can be used for transportation only.

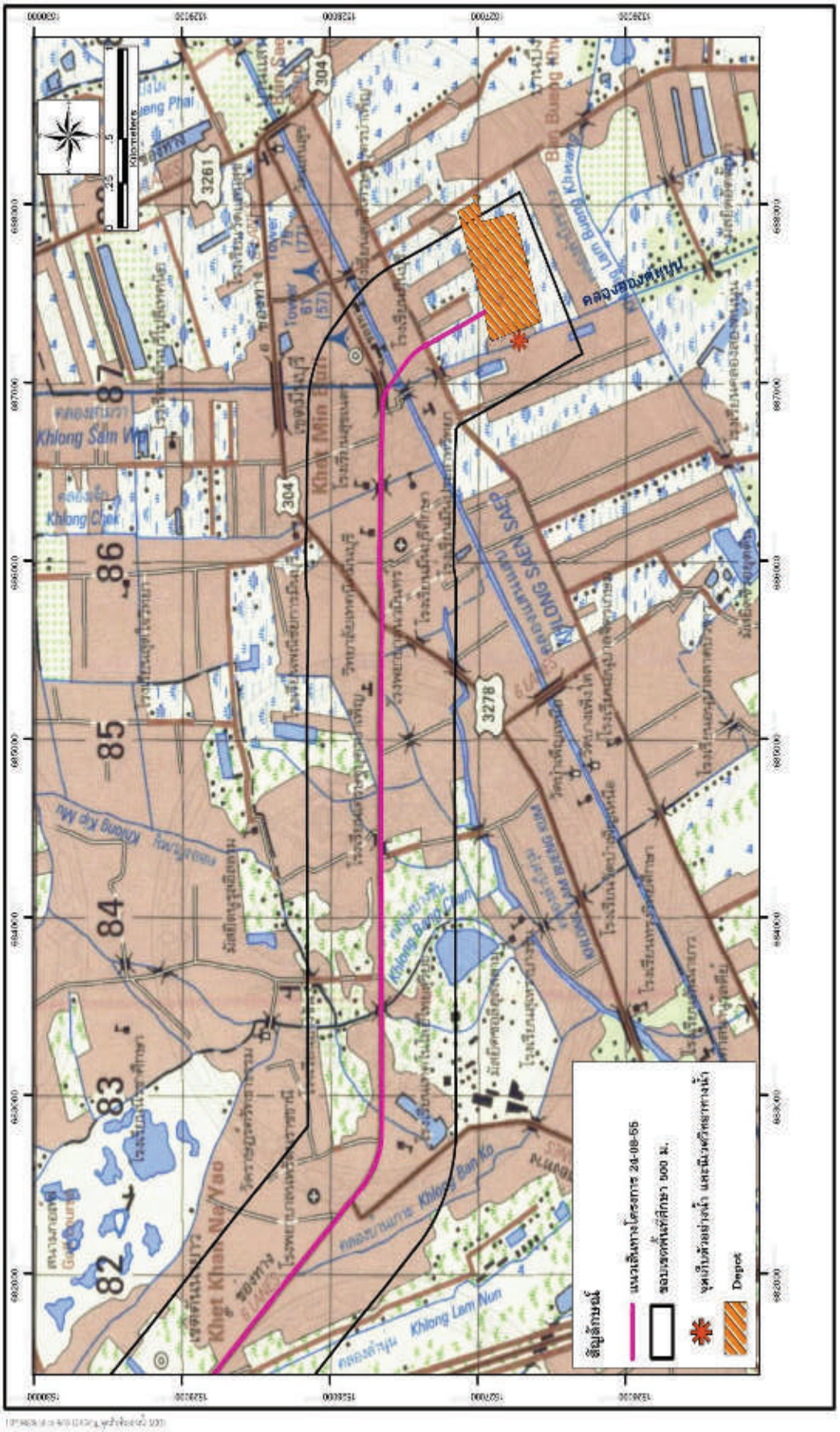


Figure 4.1-1: Surface Water Quality Sampling Points and Aquatic Ecology of Khlong Song Ton Nun.

Figure 4.1-2: Water Quality Sampling and Aquatic Ecology of Khlong Song Ton Nun

Table 4.1-1 Surface Water Quality Index and Analytical Methods

Features	Surface Water Quality Index	Impacts	Analytical Methods
1 Physical	1.1 Depth	Construction activities in the rainy season cause soil erosion and increase sedimentation in the river resulting in shallow water sources	Meter Stick
	1.2 Temperature[1/]	Leakage of chemicals or construction materials into the rivers may cause reaction and affect the temperatures.	Thermometer
	1.3 Transparency	Construction activities in the rainy season cause soil erosion and decrease transparency in the rivers	Secchi Disc
	1.4 Salinity[1/]	Increased chloride contents in water decrease dissolved oxygen in the rivers.	Refractometer
	1.5 Conductivity[1/]	Leakage of chemicals or acidic soils may affect the conductivity.	Conductivity Meter
	1.6 Velocity	Higher velocity will be the factor that contributes to soil erosion and increased sedimentation in the river.	Flow meter
2. Chemical	2.1 pH[1/]	Leakage of chemicals or materials into water may affect the pH level.	pH Meter
	2.2 Dissolved Oxygen (DO) [1/]	Deterioration in water sources will result in lower levels of dissolved oxygen.	Dissolved Oxygen Meter
	2.3 Filth in form of oxygen demand for decomposing organic matters (BOD_5) [1/]	Discharging of sewage from labor communities and offices gives rise to waste water in water sources	Azide Modification

Table 4.1-1 Surface Water Quality Index and Analytical Methods (Cont'd)

Features	Surface Water Quality Index	Impacts	Analytical Methods
	2.4 Suspended Solids[1/]	Construction activities in the rainy season cause soil erosion and suspended solids in the rivers.	Dried at 103-105°C
	2.5 Oil & Grease[3/]	Washing-up of oil and grease from machines or leaving of oil/grease without measures will affect water sources nearby.	Partition-Gravimetric Method
	2.6 Total Iron[1/]	Disposal of waste materials and waste water from construction activities into water sources may cause higher iron content in water sources.	Phenanthroline Method
3. Biological	3.1 Total coliform bacteria[2/]	Discharging of sewage from labor communities and offices gives rise to waste water and increasing bacterial contamination in water sources.	Fecal Coliform Procedure
	3.2 Fecal coliform bacteria[2/]	Discharging of sewage from labor communities and offices gives rise to waste water and increasing bacteria contamination in water sources.	Multiple Tube Fermentation Technique
4.Heavy Metal	4.1 Lead (Pb)[1/]	Disposing of waste materials, effluents and waste from construction activities into water sources may result in higher amount of lead in water sources.	Air-C_2H_2 Flame Atomic Absorption Spectrometric Method
	4.2 Cadmium (Cd) [1/]	Disposing of waste materials, effluents and waste from construction activities into water sources may result in higher amount of cadmium in water sources.	Air-C_2H_2 Flame Atomic Absorption Spectrometric Method

Remark : 1/ Water samples collected at mid-depth
2/ Water samples collected at about 30 cm. below the surface
3/ Water samples collected at surface level.

Table 4.1-2 Dissolved Oxygen Levels, Water Quality and Utilization of Water Resources

DO Levels (mg/l)	Water Quality	Utilization
8-9	Good	For uses and consumption
6.7-8	Contamination started	For uses
4.5-6.7	Moderately contaminated	For agricultural and industrial use
< 4.5	Highly contaminated	Plants and animals start to get dangerous. Water getting less useful
<4	Water in crisis	Plants and animals have been harmed. Water sources cannot be used.
< 2	Water in crisis	Plants and animals cannot live. Water sources cannot be used at all.

Source: Nopphawan Teeraphancharoen, 2012.

Table 4.1-3 BOD, Water Quality Indicator

Water Quality	BOD in 5 Days (mg. / l.)
Pure water	0
Very clean water	1
Clean water	2
Moderately clean water	3
Unclean water	5
Dirty water	10

Source: Bureau of Water Quality Management, Pollution Control Department

Table 4.1-4 Water Quality Analysis Results of Khlong Song Ton Nun from Field Surveys on November 6, 2012

Index	Unit	Surface Water Quality	Water quality standards for surface water source 1/		
			Category 3	Category 4	Category 5
Depth	m	2.8	-	-	-
Current Velocity	m/s	0.04	-	-	-
Transparency	m	0.36	-	-	-
pH	-	6.61	5-9	5-9	-
Water Temperature	°C	30.9	-	-	-
Conductivity	s/cm	0.62	-	-	-
Dissolved Oxygen (DO)	mg/l	1.58	>4	>2	<2
Suspended Solids (SS)	mg/l	30	-	-	-
BOD	mg/l	2.2	<2	<4	>4
Oil & Grease	mg/l	<5.0	-	-	-
Cadmium (Cd)	mg/l	<0.00002	0.005*	0.005*	-
Lead (Pb)	mg/l	<0.005	0.05	0.05	-
Total Iron (Fe)	mg/l	1.2	-	-	-
Total Coliform Bacteria	MPN/100 ml	75,000	<20,000		-
Fecal Coliform Bacteria	MPN/100 ml	24,000	<4,000		-

Note: 1/Notification of the National Environment Board No. 8 (B.E.2537) issued under the provision in the Enhancement and Conservation of National Environmental Quality Act B.E.2535 in relation to Defined Water Quality Standards for Surface Water Source
* Determined for water with hardness in form of $CaCO_3$not exceeding 100 mg.
Source: TEAM Consulting Engineering and Management Co., Ltd., Nov. 2012

4.1.4 Meteorology and Air Quality

4.1.4.1 Meteorology

(1) Introduction

This study will focus on the study of current meteorological characteristics in the project area that could have a direct influence on pollution generation in the atmosphere, especially the spread of pollutants resulted from projectimplementation, both in construction and operation stages. Therefore, the study of meteorological conditions in the project area is critical to the project implementation, particularly the air pollution caused by the project implementation and the expanded construction area of the Depot and Park-and-Ride Building at Rom Klao Intersection.Since construction activities and implementing period may affect sensitive area and its surroundings, it is, therefore, necessary to explore existing conditions to be used as data for assessment ofenvironmental impact later.

(2) Methodology

- Collecting secondary data from Don Muang Weather Station. The data used was the data of 30-year period from 1982-2011.
- Collecting secondary data from the Environmental Impact Study of the Pink Line MRT Project, 2012.
- Field survey to study meteorological conditions in the study area by monitoring and processing of wind direction and velocity data in sensitive areas exposed to environmental impact in the study area.

(3) Study Results

(a) Collection of secondary data

The distribution of air pollution consists of 3 interrelated factors, i.e., *Emission Source, Atmosphere and Receptor*. Atmosphere is needed to support the air pollutants that are emitted from the source and is the intermediary for air pollutants to spread out to the receptors, with the meteorological factors, such as air temperature, wind velocity and direction, etc., as major parts in determination of the spreading character of pollutants in the air. Accordingly, meteorological statistics were collected from the Meteorological Department. The weather station of Meteorological Department that is near the project line is Don Muang Weather Station. Meteorological data during the 30-year period (1982-2011) of the Department of Meteorology is shown in ***Table 4.1-5***.

Table 4.1-5 Climate Statistics of Don Muang Weather Station during 1982-2011

Station	DON MUANG AIRPORT	Elevation of station above MSL	12	Meters
Index Station	48456	Height of barometer above MSL	12.3	Meters
Latitude	13.55.9 N	Height of Thermometer above ground	17.5	Meters
Longitude	100.36.18 E	Height of wind vane above ground	10.5	Meters
		Height of rain gauge	16.5	Meters

Elements		N-Years	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
Pressure (hPa)	Mean	30	1012.57	1011.35	1010	1008.64	1007.36	1006.78	1006.94	1007.07	1008.25	1010.05	1011.69	1013.11	1009.48
	Mean Daily Range	30	4.84	4.92	4.84	4.81	4.47	3.71	3.84	4.01	4.58	4.62	4.5	4.66	4.48
	Ext.Max.	29	1023.71	1021.33	1024.85	1017.27	1018.31	1013.27	1013.55	1013.21	1015.58	1019.82	1021	1023.37	1024.85
	Ext.Min.	29	1005.08	1002.37	1001.36	1001.51	1000.68	998.98	999.47	999.32	999.89	999.89	999.89	1003.49	998.98
Temperature (Celcius)	Mean Max.	30	32.2	33.6	34.7	35.7	34.7	33.9	33.4	33.1	32.9	32.3	31.9	31.3	33.3
	Ext.Max.	30	36.6	38.5	40	39.9	40.8	40	39.3	38.1	39.4	37.2	36.9	36.7	40.8
	Mean Min.	30	22.4	23.9	25.2	26.3	26.4	26.2	25.9	25.8	25.3	25.2	24.1	22.1	24.9
	Ext.Min.	30	14.4	17.4	14.9	20.4	22.4	22	21.5	19	22	20.8	0	11.7	0
	Mean	30	27	28.3	29.4	30.4	29.9	29.4	29	28.9	28.4	28.2	27.7	26.5	28.6
Dew Point emp. (Celcius)	Mean	30	19.7	21.6	22.8	24.1	24.3	24	23.7	23.8	24	23.6	21.4	18.9	22.7
Relative Humidity (%)	Mean	30	67	70	70	72	75	74	75	75	79	78	70	65	72.5
	Mean Max.	30	86	89	89	88	89	88	88	88	91	91	86	83	88
	Mean Min.	30	46	46	48	51	56	57	58	59	61	60	53	46	53.3
	Ext.Min.	30	14	16	11	22	24	27	30	35	33	30	25	15	11
Visibility (Km.)	Mean	30	7.5	7.8	8.4	9	9.7	10	9.9	9.9	9.5	9.1	9.1	8.5	9
	07.00LST	30	4.5	4.6	5.9	7.3	8.9	9.2	9.2	9.2	8.5	7.5	7.1	6.4	7.3
Cloud Amount (1-10)	Mean	30	4.6	4.8	5.4	6	7.1	7.6	7.8	8.1	8	7.2	5.5	4.6	6.4
Wind (Knots)	Prev.Wind	30	E	S	S	S	S	S,SW	SW	SW	SW	NE	N	N	-
	Mean	30	4.1	5.4	6.2	6.1	5.9	6.5	6.6	6.2	5	4	4.1	4	5.3
	Max.	30	34	41	45	56	53	44	150	180	47	40	32	32	180
Pan Evaporation (mm.)	Total	12	-	-	0	-	-	-	-	-	-	-	-	-	0
Rainfall (mm)	Total	30	12.2	10.2	44.6	93.1	208.3	171.1	166.1	178.1	286.1	192.6	33.8	6.8	1402.9
	Num. of Days	30	1.4	1.3	3.5	7.1	14.3	14.8	15.2	17	19.1	14.6	4.1	1	113.4
	Daily Max.	30	69.3	41.5	90.5	121.1	210.7	106.7	100.9	124	144.6	207.7	60.2	34.6	210.7
Phenomena (Days)	Fog	30	2.5	1.8	0.2	0.1	0	0	0	0	0	0.1	0.3	0.4	5.4
	Haze	30	27.9	22.9	20.8	16.9	6.4	5.3	3.9	3.6	3.8	9	15	22.9	158.4
	Hail	30	0	0	0	0	0	0	0	0	0	0	0	0	0.2
	Thunder Storm	30	0.3	0.4	2.4	5.8	10.7	7.2	6.4	6.7	10.1	8.5	1.5	0.4	60.4
	Squall	30	0	0	0	0	0	0.1	0	0	0	0	0	0	0.1

Based on the meteorological data of Don Mueang Weather Station during 1982-2011, the annual average rainfall was approximately of 116.97 mm. with September as the month with the highest rainfall. The annual average number of days of rain in one month was equivalent to 19.1 days. For air pressure, the annual average pressure was equal to 1,009.48 ha Pascal. The month with the highest average pressure was December. Monthly average temperature was in the range of 31.3°C in December to 35.7°C in April. Annual average temperature was equal to 33.3°C. Relative humidity will be correlated with the air mass and the monsoon influence. Annual average relative humidity was equal to 72.5 percent, while monthly average was in the range of 65-79 percent. Monthly average wind speeds were in the range of 4 knots in October and December to 6.6 knots in July.

Based on the meteorological data collected from the EIA Study Report of the Pink Line MRT Project, 2012, the wind speed and direction measured in susceptible areas to the effects, i.e., Wat Saensuk, as shown in ***Figure 4.1-3***, during the dry season between 5-17 March 2008, and between 14-26 May 2008 in the rainy season as in ***Figure 4.1-4*** can be summarized as follows.

During the dry season

The average wind speed measured at Wat Saensuk during the dry season was in the range of 0.3-5.3 m/s. Most winds were likely the southwest (SW) winds.

During the rainy season

The average wind speed measured at Wat Sensuk during the rainy season was in the range of 0.3-5.3 m/s. Most winds were likely the east-southeast (ESE) winds.

(b) Field surveys

The study of meteorological conditions in the study areas during 7-12 November 2012by installing a device to measure wind speed and direction at susceptible areas to the effects in the study area, i.e. Kasem Bundit University, Rom Klao Campus, is shown in ***Figure 4.1-3***. The data measured during such period was then processed to show the wind direction and speed as shown in ***Table 4.1-6*** and ***Figure 4.1-5***, which can be concluded as follows. (Monitoring results of meteorological conditions are shown in ***Appendix 4 B-1***).

Average wind speed measured in the vicinity of Kasem Bundit University, Rom Klao Campus, was in the range of 0-2.2 m/s. Occurrence of calm wind was 28.4 percent. Most winds were likely the south-southwest winds (SSW), representing 16.7 percent, followed by the north (N) winds, representing 14.2 percent.

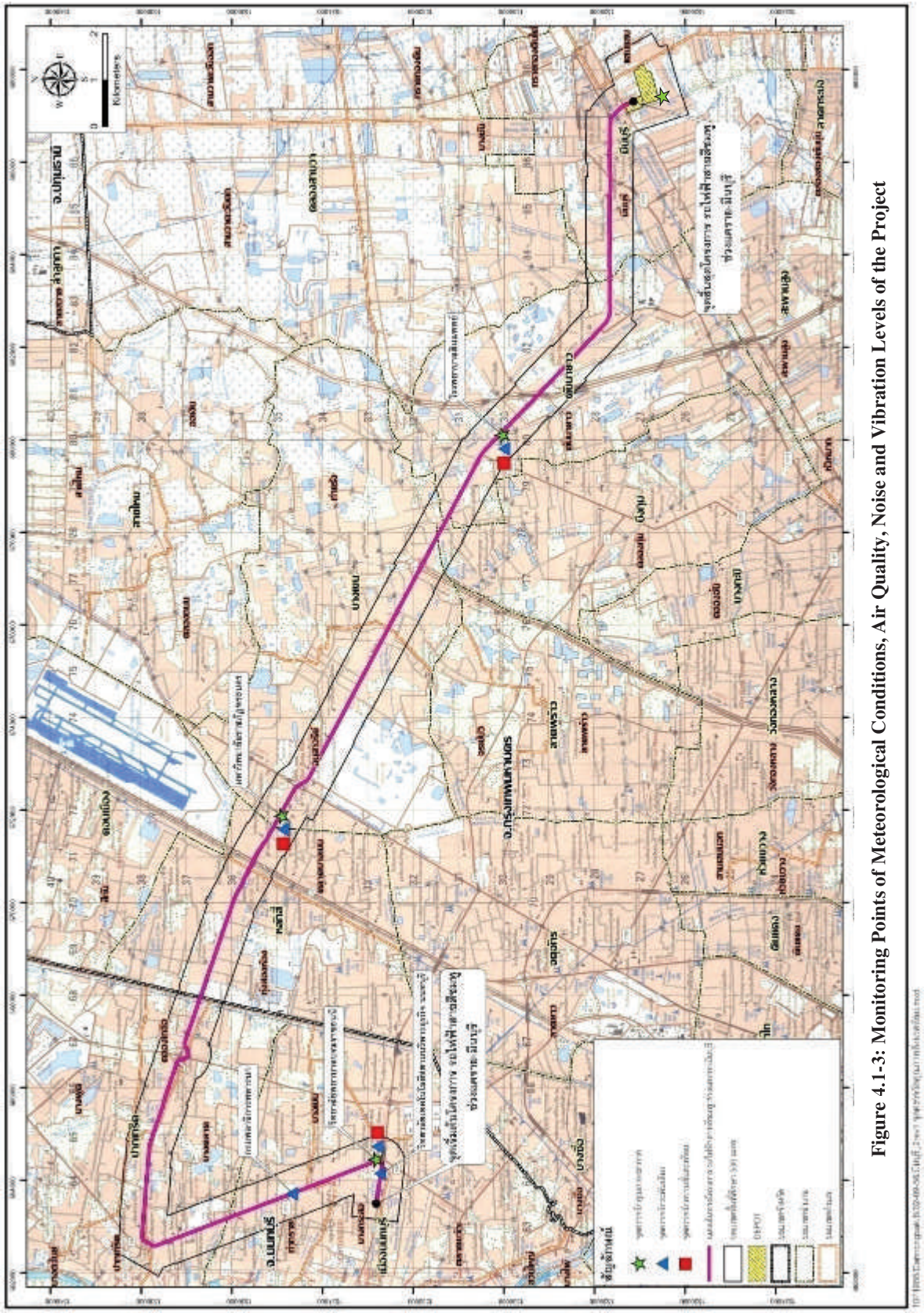
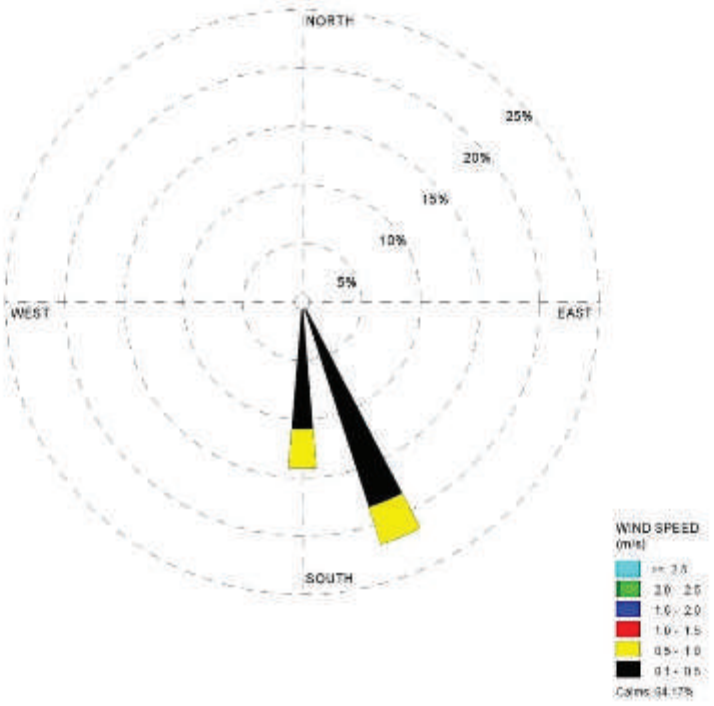
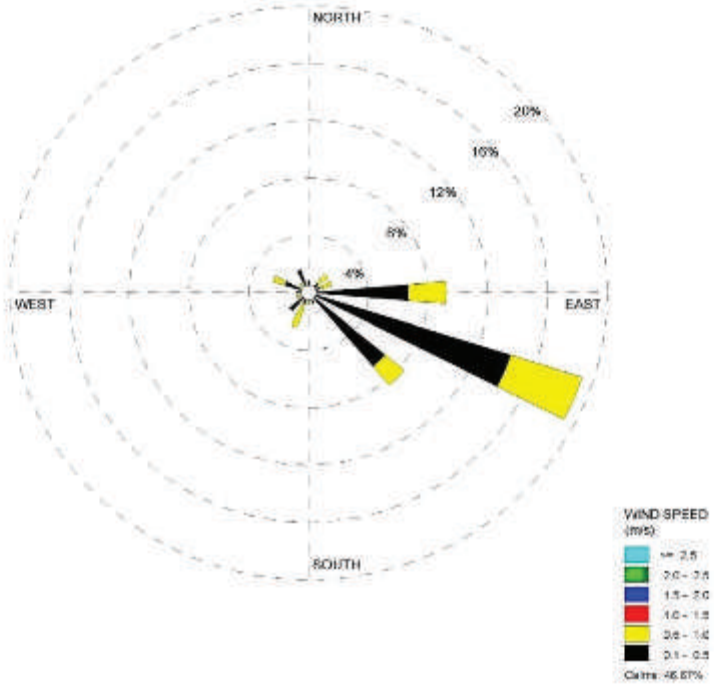


Figure 4.1-3: Monitoring Points of Meteorological Conditions, Air Quality, Noise and Vibration Levels of the Project



(A) Wind speed and direction monitoring resultsin the dry season (5-17 March 2008)



(B) Wind speed and direction monitoring results in the rainy season (14-26 May 2008)

Figure 4.1-4: Wind Speed and Direction Monitoring Results at Wat Saensuk during The dry and the Rainy Seasons.

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Table 4.1-6 Wind Direction Monitored in Susceptible Areas to Environmental Effects in the Study Areas

Direction	Percent of Wind Direction
	Areas susceptible to environmental impact
	Kasem Bundit University, Romklao Campus
North (N)	14.2
North-northeast (NNE)	7.5
Northeast (NE)	4.1
East-northeast (ENE)	1.7
East (E)	0.0
East-southeast (ESE)	0.0
Southeast (SE)	1.7
South-southeast (SSE)	2.5
South (S)	2.5
South-southwest (SSW)	16.7
Southwest (SW)	12.5
West-southwest (WSW)	2.5
West (W)	0.0
West-northwest (WNW)	1.6
Norhtwest (NW)	0.0
North-northwest (NNW)	4.1

Source: - Data compiled and processed by TEAM Consulting Engineering and Management Co., Ltd., November 2012
- Data measured and processed by Environment Research and Technology, Co., Ltd., November 2012

4.1.4.2 Air Quality

(1) Introduction

The study of air quality is one of the important factors to assess environmental impact of the project. Therefore, it is necessary to collect and study the current air quality in order to assess effects of the air pollutants that may arise from construction activities and the increasing number of vehicles after project implementation to the sensitive areas exposed to environmental impact, e.g. communities, schools and religious places, etc. located nearby the project area.

(2) Methodology

Field surveys to study air quality of the study area by monitoring and processing air quality data insusceptible areas to environmental impacts.

(3) Study Results

A survey of existing conditions of the project in a radius of 500 meters from the project route was conducted. The criteria used to select representatives of susceptible areas exposed to environmental impact was to determine monitoring points of environmental quality located in the area where the transit system passed through to serve as representatives of sensitive areas to environmental impacts, e.g. schools/colleges/ universities, religious places/temples/churches/mosques, healthcare/hospitals/health centers, important places, for instance. 3 air quality monitoring stations were, therefore, positioned, i.e. Boromarajonani College of Nursing, Synphaet General Hospital, and Phranakhon Rajabhat University, as shown in ***Figure 4.1-3*** during July 27-August 1, 2013, as shown in ***Table 4.1-7***. Air quality monitoring results can be summarized as follows.

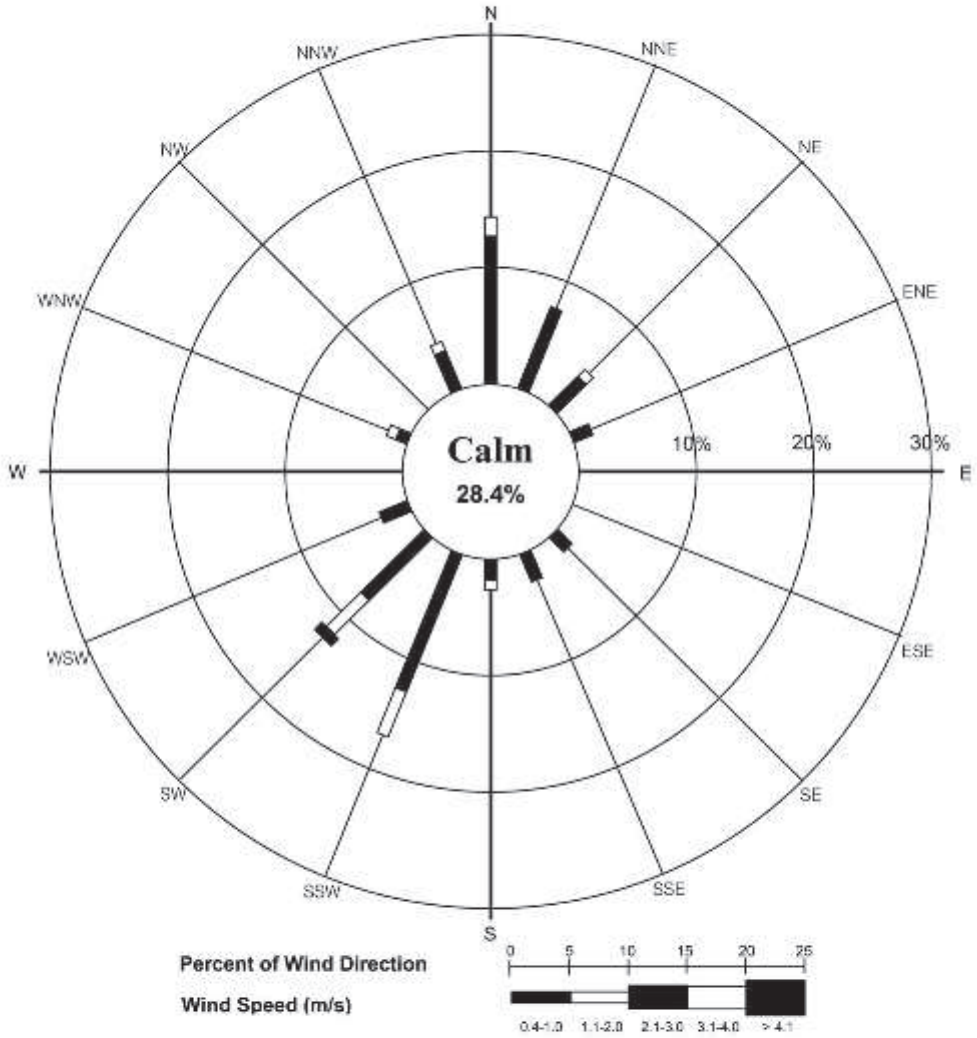

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Figure 4.1-5: Wind Direction and Speed in the Study Area between 7-12 November 2012

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Table 4.1-7 Air Quality Monitoring Results at Sensitive Areas nearby Project Area

Monitoring Stations	Pollutant Concentrations			
	TSP (Avg. 24 hours) (micrograms /m^3)	PM-10 (Avg. 24 hours) (micrograms /m^3)	CO (Avg. 1 hour) (micrograms /m^3)	NO_2 (Avg. 1 hour) (micrograms /m^3)
Boromarajonani College of Nursing, Nonthaburi	94-155	46-62	1,145.19-2,519.43	69.80-110.63
Synphaet General Hospital	38-54	20-31	1,145.19-2,290.39	44.02-54.00
Phranakhon Rajabhat University	51-95	24-46	1,603.27-2,977.51	143.17-184.94
Standard	**330**[1/]	**120**[1/]	**34,200**[2/]	**320**[3/]

Notes: [1/] Notification of the National Environment Board No. 24 (B.E.2547)
[2/] Notification of the National Environment Board No. 10 (B.E.2538)
[3/] Notification of the National Environment Board No. 33 (B.E.2552)
Source: - Data compiled and processed by TEAM Consulting Engineering and Management Co., Ltd., August 2012
- Data measured and processed by Environment Research and Technology, Co., Ltd., August 2012

(a) Boromrajonani College of Nursing, Nonthaburi

- Total suspended particles (TSP) in 24-hour average was in the range of 94-155 micrograms/cubic meter, with the highest value measured representing 47.27 percent of the standard of air quality in general, which requires a 24-hour average TSP not exceeding 330 micrograms/cubic meter.

- Particulate matters less than 10 microns (PM-10) in 24-hour average were in the range of 46-62 micrograms/cubic meter. The highest value measured represented 51.67 percent of the standard of air quality in general, which requires a 24-hour average PM-10 not exceeding120 micrograms/cubic meter.

- The highest value of carbon monoxide (CO) in 1-hour average was in the range of 1,145.19-2,519.43 micrograms/cubic meter. The highest value measured represented 7.37 percent of the standard of air quality in general, which requires a 1-hour average CO not exceeding 34,200 micrograms/cubic meter.

- The highest value of nitrogen dioxide (NO_2) in 1-hour average was in the range of 69.80-110.63 micrograms/cubic meter. The highest value measured 34.57 percent of the standard of air quality in general, which requires a 1-hour average NO_2not exceeding320 micrograms/cubic meter.

(b) Synphaet General Hospital

- Total suspended particles (TSP) in 24-hour average was in the range of 38-54 micrograms/cubic meter. The highest value measured represented 16.36 percent of the standard of air quality in general, which requires a 24-hour average TSP not exceeding 330 micrograms/cubic meter.

- Particulate matters less than 10 microns (PM-10) in 24-hour average were in the range of 20-31 micrograms/cubic meter. The highest value measured represented 25.83 percent of the standard of air quality in general, which requires a 24-hour average PM-10 not exceeding120 micrograms/cubic meter.

- The highest value of carbon monoxide (CO) in 1-hour average was in the range of 1,145.19-2,290.39 micrograms/cubic meter. The highest value

measured represented6.70 percent of the standard of air quality in general, which requires a 1-hour average CO not exceeding 34,200 micrograms/cubic meter.

- The highest value of nitrogen dioxide (NO_2) in 1-hour average was in the range of 44.02-54.00 micrograms/cubic meter. The highest value measured 16.88 percent of the standard of air quality in general, which requires a 1-hour average NO_2not exceeding 320 micrograms/cubic meter.

(c) Phranakhon Rajabhat University

- Total suspended particles (TSP) in 24-hour average was in the range of 51-95 micrograms/cubic meter. The highest value measured represented 28.79 percent of the standard of air quality in general, which requires a 24-hour average TSP not exceeding330 micrograms/cubic meter.

- Particulate matters less than 10 microns (PM-10) in 24-hour average were in the range of 24-46 micrograms/cubic meter. The highest value measured represented 38.33 percent of the standard of air quality in general, which requires a 24-hour average PM-10 not exceeding120 micrograms/cubic meter.

- The highest value of carbon monoxide (CO) in 1-hour average was in the range of 1,603.27-2,977.51 micrograms/cubic meter. The highest value measured represented8.71 percent of the standard of air quality in general, which requires a 1-hour average CO not exceeding 34,200 micrograms/cubic meter.

- The highest value of nitrogen dioxide (NO_2) in 1-hour average was in the range of 143.17-184.94 micrograms/cubic meter. The highest value measured 57.79 percent of the standard of air quality in general, which requires a 1-hour average NO_2not exceeding320 micrograms/cubic meter.

4.1.5 Noise

(1) Introduction

Construction activities and project implementation may cause noise in communities near the project area, particularly the increasing volume of construction and vehicles in the project area. Thus, it is required to measure the current noise level to serve as a basis for evaluating the effects expected to arise from project construction and operation as well as for preparing protection and mitigation plans for environmental impact to the lowest level.

(2) Methodology

Field surveys were conducted to determine the noise level of the study area by measuring and processing data of the noise level in sensitive areas exposed to the environmental impact.

(3) Study Results

Noise level data was reviewed to determine the monitoring stations to be used as reference points for predicting the noise levels from the construction activities. From the current study, since construction of Depot and Park-and-Ride Building, for Pink Line Project, Khae Rai-Min Buri Section, at Sanambin Nam Intersection was already cancelled, there was no effect from construction of such depot. Furthermore, as the maximum noise level measured at Sai Lom Village cannot be used as reference at present, additional noise level measurement needs to be done in order to reflect the existing conditions of the project as much as possible. The noise levels in sensitive areas close to the Depot and Park-and-Ride Building at Rom Klao Intersection were measured at one station, i.e. Kasem Bundid University, Rom Klao Campus, during 7-12 November 2012.The noise levels in the project area were measured more at 5 stations, e.g. Siam Business Administration Nonthaburi Technological College (SBAC), Quartermaster Department Royal Thai Army, Boromarajonani College of Nursing, Synphaet General Hospital and Phranakhon Rajabhat University, during July 27-August 1, 2013. The results of the measurements were used to predict the noise levels during the construction phase. In this study, the measured maximum 24-hour average of the L_{eq} noise level was used as representative in predicting the noise levels from construction activities of all 30 stations.

From the results of the noise levels measurement in the area exposed to environmental impact in the study area at 5 stations including Siam Business Administration Nonthaburi Technological College (SBAC), Quartermaster Department Royal Thai Army, Boromarajonani College of Nursing, Synphaet General Hospital and Phranakhon Rajabhat University, as shown in ***Figure 4.1-3***, during July 27-August 1, 2013, the measured noise levels were found in the benchmark that a 24-hour average L_{eq} not exceeding70 dB(A), as shown in ***Table 4.1-8*****.** Details are as follows.

Table 4.1-8 Noise levels measurement in sensitive areas to environmental impacts in project area

Noise Monitoring Stations	Noise Monitoring Results		
	24 Hrs Avg. L_{eq}	L_{max}	L_{90}
Siam Business Administration Nonthaburi Technological College	68.6-70.5	97.0-101.4	63.5-65.4
Quartermaster Department Royal Thai Army	65.6-66.4	94.4-97.2	59.9-60.9
Boromarajonani College of Nursing, Nonthaburi	67.3-68.3	95.2-105.2	60.2-62.3
Synphaet General Hospital	73.4-74.2	95.6-100.8	68.5-69.4
Phranakhon Rajabhat University	64.2-85.7	104.4-114.9	48.9-68.8
Standard [1]	**70**	**115**	**-**

Note: 1/ According to the Notification of the National Environmental Board No. 15 (B.E.2540) on Normal Sound Level Standard.

Source: - Data compiled and processed by TEAM Consulting Engineering and Management Co., Ltd., August 2013
- Data measured and processed by Environment Research and Technology, Co., Ltd., August 2013

(a) Siam Business Administration Nonthaburi Technological College

- A 24-hour average L_{eq} was in the range of 68.6-70.5 dB(A),with the maximum value measured representing 100.71 percent of the normal sound level standard, which requires a 24-hour average L_{eq} not exceeding70 dB(A).

- A 24-hour L_{max} was in the range of 97.0-101.4 dB(A),with the maximum value measured representing 88.17 percent of the normal sound level standard, which requires L_{max} at any time not exceeding115 dB(A).

- A 24-hour $L_{90}$was in the range of 63.5-65.4 dB(A).

(b) Quartermaster Department Royal Thai Army

- A 24-hour L_{eq} was in the range of 65.6-66.4 dB(A), with the maximum value measured representing 94.86 percent of the normal sound level standard, which requires a 24-hour average L_{eq} not exceeding70 dB(A).

- A 24-hour L_{max} was in the range of 94.4-97.2 dB(A), with the maximum value measured representing 88.17 percent of the normal sound level standard, which requires L_{max} at any time not exceeding115 dB(A).

- A 24-hour L_{90} was in the range of 59.9-60.9 dB(A).

(c) Boromarajonani College of Nursing, Nonthaburi

- A 24-hour L_{eq} was in the range of 67.3-68.3 dB(A), with the maximum value measured representing97.57percent of the normal sound level standard, which requires a 24-hour average L_{eq} not exceeding70 dB(A).

- A 24-hour L_{max} was in the range of 95.2-105.2 dB(A),with the maximum value measured representing91.48percent of the normal sound level standard, which requires L_{max} at any time not exceeding115 dB(A).

- A 24-hour L_{90}wasin the range of 60.2-62.3 dB(A).

(d) Synphaet General Hospital

- A 24-hour L_{eq} was in the range of 73.4-74.2 dB(A), with the maximum value measured representing106percent of the normal sound level standard, which requires a 24-hour average L_{eq} not exceeding70 dB(A).

- A 24-hour L_{max} was in the range of 95.6-100.8 dB(A), with the maximum value measured representing 87.65 percent of the normal sound level standard, which requires L_{max} at any time not exceeding 115 dB(A).

- A 24-hour L_{90}wasin the range of 68.5-69.4 dB(A).

(e) Phranakhon Rajabhat University

- A 24-hour L_{eq} was in the range of 64.2-85.7 dB(A), with the maximum value measured representing 122.43 percent of the normal sound level standard, which requires a 24-hour average L_{eq} not exceeding70 dB(A).

- A 24-hour L_{max} was in the range of 95.6-100.8 dB(A), with the maximum value measured representing 99.91 percent of the normal sound level standard, which requires L_{max} at any time not exceeding115 dB(A).
- A 24-hour L_{90}wasin the range of 48.9-68.8dB.

According to the results of noise levels monitoring in another sensitive receptor in the study area at Kasem Bundit University, Rom Klao Campus, as shown in ***Figure 4.1-3*** during November 7-12, 2012, the noise levels measured were found within the benchmark requiring a24-hour avg. L_{eq} not exceeding 70 dB(A), as shown in **Table 4.1-9.**Details are as follows. (Noise level monitoring results were shown in ***Appendix 4B-2***).

Table 4.1-9 Noise Level Monitoring Results during November 7-12, 2012

Monitoring Stations	Monitoring Results		
	24-Hour $_{eq}$L	**L_{max}**	**L_{90}**
Kasem Bundit University, Rom Klao Campus	55.1-56.1	83.6-94.4	43.2-44.9
Standard/1	**70**	**115**	**-**

Note: 1/Notification of the National Environment Board No. 15 (B.E.2540)in relation to Normal Sound Level Standard
Source: - Data compiled and processed by TEAM Consulting Engineering and Management Co., Ltd., November 2012
- Data measured and processed by Environment Research and Technology, Co., Ltd., November 2012

- A 24-hour L_{eq} was in the range of 55.1-56.1 dB(A),with the maximum value measured representing 80.14 percent of the normal sound levelstandard, which reguires L_{eq} 24 hours not exceeding 70 dB(A).
- A 24-hour $L_{max}$was in the range of 83.6-94.4 dB(A), with the maximum value measured representing 82.09 percent of the normal sound level standard, which reguires L_{max} at any time not exceeding 115 dB(A).
- A 24-hour L_{90} was in the range of 43.2-44.9 dB(A).

4.1.6 Vibration

(1) Introduction

The vibration is considered a factor affected from the project development, both from construction activities and project implementation. The vibration of existing conditions was studied to serve as basic information for assessment of probable impact that may occur.

(2) Methodology

Field surveys were conducted to study the vibration of the study area by measuring and processing vibration levels of the sensitive areas exposed to environmental impact in the study area.

(3) Study Results

Existing conditions within 500 meters of the project route were explored more. With the criteria in selection of representative areas for sensitive receptors, the environmental quality monitoring places located along the mass transit line were determined to represent susceptible areas exposed to environmental impact, including for example, educational institutes/schools/universities/religious places/temples/churches/ mosques, clinic/hospital/health station, major places, for example. To achieve this, 3 vibration measuring stations were determined, i.e. Boromarajonani College of Nursing, Synphaet General Hospital and Phranakhon Rajabhat University, as shown in ***Figure 4.1-3***, during July 27-August 1, 2013, as shown in ***Table 4.1-10***, as follows. (Vibration levels measuring are shown in ***Appendix 4B-3***).

Table 4.1-10 Vibration Levels Measured in Sensitive Receptors nearby Project Area

Stations	Measuring Periods	Maximum particle velocity at any axis (mm / s)	Frequency (Hz)	Sources of vibration
Boromarajonani College of Nursing, Nonthaburi	27-28 Jul..2013	1.90 (Vert)	3.2	Passing cars
	28-29 Jul..2013	2.43 (Vert)	3.0	Passing cars
	29-30 Jul..2013	1.78 (Vert)	3.8	Passing cars
	30-31 Jul..2013	2.44 (Vert)	N/A	Passing cars
	31 Jul-1 Aug2013	3.67 (Vert)	2.8	Passing cars
Synphaet General Hospital	27-28 Jul..2013	2.08 (Vert)	3.3	Passing cars
	28-29 Jul..2013	1.96 (Vert)	3.6	Passing cars
	29-30 Jul..2013	1.98 (Vert)	3.3	Passing cars
	30-31 Jul..2013	2.27 (Vert)	3.3	Passing cars
	31 Jul.-1 Aug. 2013	1.97 (Vert)	3.8	Passing cars
Phranakhon Rajabhat University	27-28 Jul..2013	2.22 (Vert)	4.6	Passing cars
	28-29 Jul..2013	2.06 (Vert)	10.0	Passing cars
	29-30 Jul..2013	2.76 (Vert)	4.3	Passing cars
	30-31 Jul..2013	2.46 (Vert)	4.0	Passing cars
	31 Jul.-1 Aug. 2013	2.59 (Vert)	3.8	Passing cars

Note: Tran = Vibrations in Transverse Geophone
Vert = Vibrations in Vertical Geophone
Long = Vibrations in Longitudinal Geophone
N/A = Not Available
Source: - Data compiled and processed by TEAM Consulting Engineering and Management Co., Ltd., August 2013
- Data measured and processed by Environment Research and Technology, Co., Ltd., August 2013

(a) Boromarajonani College of Nursing, Nonthaburi

The vibrations measured were mainly due to passing cars, with the maximum particle velocity in the range of 1.78-3.67 mm/s, and with frequency in the range immeasurable up to 3.8 Hz, as shown in ***Table 4.1-10***. When compared to the recommended criteria of Whiffin and Leonard, as shown in ***Table 4.1-11***, if the vibration is continuing, it will create the feeling of annoyance, but will not cause damage to buildings or architectural structures. When compared to the Notification of the National Environmental Act No. 37, B.E.2010 in relation to Vibration Standards to Prevent Impact to structures, as shown in ***Table 4.1-12***, the vibrations measured from the buildings of category 2, the foundation or the building ground floor, do not cause fatigue or resonance of the building structure.

(b) Synphaet General Hospital

The vibrations measured were mainly due to passing cars, with the maximum particle velocity in the range of 1.96-2.27 mm/s, and with frequency in the range of3.3-3.8 Hz, as shown in ***Table 4.1-10***.When compared to the recommended criteria of Whiffin and Leonard, as shown in ***Table 4.1-11***, the vibrations can be felt and a higher level of vibration will result in destruction or damage to the historic sites. When compared to the Notification of the National Environmental Act No. 37, B.E.2010 in relation to Vibration Standards to Prevent Impact to Structures, as shown in ***Table 4.1-12***, the vibrations measured from the buildings of category 2, the foundation or the building ground floor did not cause fatigue or resonance of the building structures.

(c) Phranakhon Rajabhat University

The vibrations measured were mainly due to passing cars, with the maximum particle velocity in the range of 2.06-2.76 mm/s, and with frequency in the range of 3.8-10.0 Hz, as shown *in* ***Table 4.1-10***. When compared to the recommended criteria of Whiffin and Leonard, as shown in ***Table 4.1-11***, it was found that if the vibration is continuing, it will create the feeling of annoyance, but will not cause damage to buildings or architectural structures. When compared to the Notification of the National Environmental Act No.37, B.E.2010 in relation to Vibration Standards to Protect the Buildings, as shown in ***Table 4.1-12***, the vibrations measured from the buildings of category 2, the foundation or the buildings ground floor, did not cause fatigue or resonance of the building structures.

Table4.1-11 Effects due to Vibrations on People and Structures

Maximum Particle Velocity mm. / sec. (inch / sec).	Effects on People	Effects on Structures
0-0.15 (0-0.006)	Unable to feel the vibration	No effects/damages to structures of all types
0.15-0.3 (0.006-0.012)	Possible to feel the vibration	No effects/damages to structures of all types
2.0 (0.079)	Able to feel the vibration	Higher levels of vibrations will result in destruction or damage to historic sites.
2.5 (0.098)	If vibration continues, it will create a feeling of annoyance	No risk of damage to occur to buildings or architectural structures
5 (0.197)	Vibration disturbance to people living in the buildings (corresponding to the level that affects people on the bridge and affected in a short time).	Level that will result in damage to architectural structures, houses with walls and ceilings of plaster (a mixture of cement, sand, water and fibers). In case of houses with flexible wall/ceiling, damage will be slightly.
10-15 (0.394-0.591)	People will feel dissatisfied If the vibration continues, and people walking on the bridge will not be tolerated.	Vibration levels higher than normal traffic, which will cause damage to architectural structures and slightly damage to structures.

Source: Whiffin, A.C., and Leonard, D.R., A Survey of Traffic Induced Vibration, Eng., 1971.

Table 4.1-12 Vibration Standards for Buildings Protection

Building Category	Measuring Points	Frequency (Hertz)	Maximum Particle Velocity (mm / s)	
			Vibration Case 1	Vibration Case 2
1	1.1 Foundation or ground floor of buildings	$f \leq 10$	20	-
		$10 < f \leq 50$	0.5 f + 15	
		$50 < f \leq 100$	0.2 f + 30	
		$f > 100$	50	
	1.2 Top floor of buildings	All frequencies	40*	10*
	1.3 Each floor of buildings	All frequencies	20**	10**
2	2.1 Foundation or buildings ground floor	$f \leq 10$	5	-
		$10 < f \leq 50$	0.25 f + 2.5	
		$50 < f \leq 100$	0.1 f + 10	
		$f > 100$	20	
	2.2 Top floor of buildings	All frequencies	15*	5*
	2.3 Each building floor	All frequencies	20**	10**
3	3.1 Foundation or ground floor of buildings	$f \leq 10$	3	-
		$10 < f \leq 50$	0.125 f + 1.75	
		$50 < f \leq 100$	0.04 f + 6	
		$f > 100$	10	
	3.2 Top floor of buildings	All frequencies	8*	2.5*
	3.3 Each building floor	All frequencies	20**	10**

Note: 1) **Building category 1** including 1) Buildings used as plants under the Factory Law 2) commercial buildings, offices, warehouses, special buildings, big buildings under the Building Control Law 3) any other buildings with the use of the building the same as those in 1) and 2).

Building category 2 including 1) Residential buildings**:** flat, row houses, detached houses, town houses,under the Building Control Law, 2) Condominiums under the Condominium Law, 3) Dormitory condominium under the Condominium Law, 4) Buildings used as a hospitals under the Hospital Law, and buildings used as a hospitals of the government, 5) Buildings used as places for study in accordance with the Laws on Private and Public Schools, Educational Institutes, Private and Public Universities6) Buildings used for religious activities, and7) any other buildings with the same uses as those in 1), 2), 3), 4), 5) and 6).

Building category 3including 1) Archaeological sites under the Law on Archaeological Sites and Objects, Objects of Art and National Museum and 2) Other buildings or structures which are not stable, but with strong cultural values.

2) Vibration Case 1 is the vibration that does not cause fatigue and resonance of the building structures. Vibration Case 2 is the vibration that causes fatigue or resonance of the building structures.

3) f = Frequency of vibration at the time of the maximum particle velocity, which is measured in hertz.

4) * = Standards are provided only of the maximum particle velocity in horizontal axis.

5) ** = Standards are provided only of the maximum particle velocity in vertical axis.

6) To measure the maximum vibration of the vibration case 2 in items 1.2, 2.2 and 3.2 is to measure at the top floor or other floors of the building with the highest vibration level.

7) To measure vibrations at the building floor in each floor according to items1.3, 2.3 and 3.3, except for the vibrations at the foundation or the building ground floor.

Source: The Notification of the National Environmental Board No. 37 (B.E.2553) in relation to Vibration Standard for Building Protection in Government Gazette, Volume 127, Special Part69, dated June 2, 2010.

4.2 BIOLOGICAL RESOURCES

4.2.1 Aquatic Ecosystems

(1) Introduction

Aquatic Ecology has a direct relationship to ground water quality. It represents the abundance of the ground water sources. Construction activities of the Pink Line MRT Project, Khae Rai-Min Buri Section may affect the aquatic ecosystems in the project area in pre-construction phase, construction phase and operation phase.

Therefore, before implementation of the project, it needs to study existing conditions of aquatic ecology in vicinity of the project area, which consists of phytoplankton, zooplankton and benthos. The data from the recent surveys will be used to assess potential impacts on aquatic ecological conditions due to an increase in suspended chemistry sediments or waste from the project. This will lead to preparation of measures for preventing, improving and reducing impacts on aquatic ecosystems that are appropriate for the project, as well as to determination of the monitoring measures later.

(2) Methodology

Collecting secondary data of Aquatic Ecology consisting of phytoplankton, zooplankton and benthos in water sources near project area by using the data on aquatic ecology of Khlong Saen Saep from the EIA Report of the Pink Line Project as representative of the secondary data.

Exploring the existing conditions of aquatic ecology through field surveys in order to observe and collect water samples for analysis of surface water quality. Surface water sampling points were determined in construction area of the Depot and Park & Ride Building at Rom Klao Intersection at Ramkhamhaeng Road at1 station, i.e. Station 1 (SW01) Khlong Song Ton Nun, at Ramkhamhaeng Road, Khlong Song Ton Nun, Lat Krabang, Bangkok (coordinates 687233E, 1526719N), which was conducted on November 6, 2012, as shown in ***Figure 4.2- 1*** and ***Figure 4.2-2*****.**

Sampling of phytoplankton and zooplankton

1) Phytoplankton and zooplankton: Collecting surface water of 20 liter (approximately 0 -3 0 cm depth) and pouring into plankton bags, with grid size of 5 9 microns. Phytoplankton/zooplankton samples were collected into sampling bottles and preserved by adding formaldehyde solution of 5% concentrations. Taking the samples to analyze types and quantities at laboratory of Kasetsart University, Bangkhen Campus.

2) Benthos: In plankton sampling, benthos samples were also collected by using Ekman Dredge (area of 0.5 sq. ft) to collect two soil samples from riverbed. Two-point sampling was made at each station (totally 1 sq. ft). The soil samples were sorted by sieve, with a mesh size of 850 microns, to separate unwanted debris and keeping the rest in sampling bottles, preserved by adding formaldehyde solution of 7% concentration. Taking the samples to analyze for the types and counting quantities at laboratory of Kasetsart University, Bangkhen Campus.

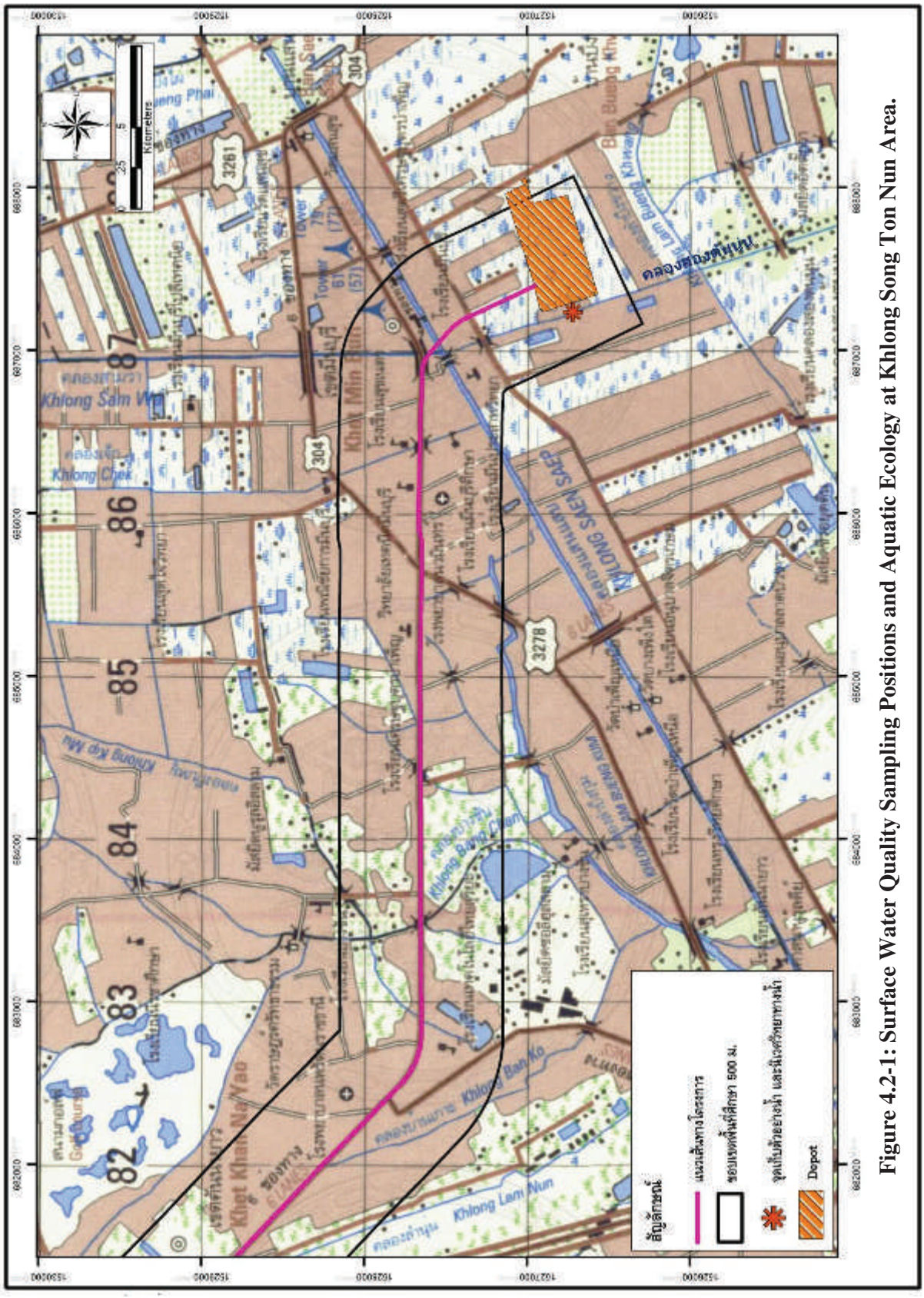

Figure 4.2-1: Surface Water Quality Sampling Positions and Aquatic Ecology at Khlong Song Ton Nun Area.

Figure 4.2-2: Surface Water Quality Sampling and Aquatic Ecology at Khlong Song Ton Nun Area

3) Data Analysis

- **Analysis of plankton types, density and species diversity**

Plankton density was stated in cells/cubic meter, while its types analysis referred to by the documents of Ladda (1999), Smith (1950), Mizuno (1969), Carr and Whitton (1973) and Bold and Wynne (1978).

After the completion of analysis of plankton types and density collected from each station, Species Diversity Index (SDI) was assessed by using the formula of Shannon and Wiener (1963) as follows.

$$H' = -\sum_{i=1}^{s} (n_i / n) \ell n (n_i / n)$$

When H' = Species Diversity Index
s = Number of plankton species
n = Total number of plankton
n_i = Number of plankton of each species$_i$

Species diversity acquired is an indicator of water quality according to the standards by Wilhm and Dorris (1968), categorized as follows.

$H' < 1.0$ Water quality is low, not suitable for water creatures to live in

$H' = 1.0\text{-}3.0$ Water quality is fair; water creatures still can live in

H′> 3.0 Water quality is good to very good, suitable for water creatures to live in.

- **Benthos species and abundance (density) analysis**

Analysis of benthos species was referred from the literatures of Prachuab (1982), Supa (1982), Saowapa (1985), Brinkhurst (1971), Brandt (1974), Merritt and Cummins (1984), and Williams and Felmate (1992).

(3) Study Results

(3.1)Secondary data collection

Based on aquatic ecology data of Khlong Saen Saep from the EIA Report of the Pink Line MRT Project, which represents the secondary data, it can be summarized as follows:

(a) Phytoplankton and Zooplankton

Phytoplankton

Phytoplankton of 5 lineages (i.e. Cyanophycaea-*the Blue Green Algae*, Chlorophycaea-*the Green Algae*, Bacillariophycaea-*the Diatoms,* Euglenophyta-*the Euglenoids* and Dinophyceae-*the Dinoflagellates*), 21 species were found. In the dry season, Cyanophycaea or *the blue green algae*, was found the dominant and the most abundant species, especially *Oscillatoria limnetica* with density equivalent to 2,352,000 cells/cubic meter. In the rainy season, Bacillariophycaea, or *the Diatoms*, were dominant and the most abundant species, especially *Cyclotella meneghiniana*with density equivalent to 1,508,400 cells/cubic meter. Total amounts of phytoplankton from random sampling survey were equal to 3,206,349-3,882,688 cells/cubic meter. Species Diversity Index (SDI) according to the method of Shannon-Weiner (1968) was equal to1:57-2:17. That the index was in the range of 1-3 indicated that water quality was considered fair and water creatures still can live in.

Zooplankton

Zooplankton of 3 phylums (i.e. Arthropoda, Protozoa and Rotifera), 5 species were found. In the dry season, Nauplius larvaes of Copepoda subclass, species of which cannot be identified, were found the dominant with maximum density equivalent to 571,200 cells/cubic meter. In the rainy season, zooplankton of *Cyclops* family was found the dominant species, with the maximum density equivalent to 2,600 cells/cubic meter. Total amounts of zooplankton, according to the sampling surveys, were equal to 7,800-62,160 cells/cubic meter. Species Diversity Index (SDI), according to the method of Shannon-Weiner (1968), was equal to 0.37-0.63. The index less than 1 indicated that water quality was low, not suitable for water creatures to live in.

(b) Benthos

From benthos sampling, the benthos found were of 2 phylums (Annelida and Mollusca), 4 lineages (Oligochaeta, *fresh water earthworms,* Insecta-*insects,* Crustacea-*crustacean,* and Gastropoda-*snails*), 4 orders (Diptera, Decapoda, Mesogastropoda and Basommatophora), 7 families (Tubificidae, Chironomidae, Palaemonidae, Viviparidae, Thiaridae, Bithyniidae and Bulinidae), 9 species. In the dry season, freshwater snails of

Finopaludina family were found the dominant phylum, with the maximum density of 132 snails/square meter. In the rainy season, freshwater earthworms were the dominant phylum, with the maximum density of 88 worms/square meter. Total density of benthos equaled 308 and 264/square meter in the dry and the rainy seasons, respectively.

(3.2)Field Surveys

Existing conditions of aquatic ecology of ground water sources near the project area were explored at 1 station i.e. Station 1 (SW0 1) Khlong Song Ton Nun, at Ramkhamhaeng Road, Khlong Song Ton Nun, Lat Krabang, Bangkok (coordinates 687233E, 1526719N). The survey was conducted on November 6, 2012, as shown in ***Figure 4.2-1*** and ***Figure 4 . 2 -2*** , at the same area where sampling of surface water quality was conducted. Sampling results of phytoplankton, zooplankton and benthos were as follows.

(a) Phytoplankton and Zooplankton

Phytoplankton

According to the sample survey and analysis, phytoplankton found were of 3 divisions (Cyanophyta Chlorophyta and Chromophyta), 5 lineages (i.e., Cyanophycaea-*the blue green algae*, Chlorophycaea-*the green algae*, Euglenophyta-*the Euglenoids,* Bacillariophycaea-*the Diatoms*, and Dinophyceae-*the Dinoflagellates*), 55 species. It was found that Cyanophycaea family or *the blue green algae*, was the dominant and the most abundant species, especially *Oscillatoria limnetica* and *Rhaphidiopsis*, with density equivalent to 26,816,000 and 691,200 cells/cubic meter, respectively. Followed were Bacillariophycaea, or *the Diatoms,* especially *Strephanodiscus hanztschii*, with density of 563,200 cells/cubic meter. Total amounts of phytoplankton from random sampling survey were equal to 31,590,400cells/cubic meter.

Zooplankton

According to the sample survey and analysis, the zooplankton found were of 4 phylums, (Arthropoda, Protozoa Rotifera and Nematoda), 2 subclasses (Copepoda and Ostracoda), 30 species, with Rotifera the dominant phylum, especially *Horaella*, the dominant family, with density of 320,000 cells/cubic meter. Followed were Rotifera *Polyarthra vulgaris* and *Brachionusangularis*, with density of 256,000 and 217,600 cells/cubic meter, respectively. The secondary dominant phylum was Nauplius larvae of Copepoda subclass, species of which cannot be identified, with density of 179,200 cells/cubic meter. Total amounts of the zooplankton, according to the random survey, were equivalent to 1,881,600 cells/cubic meter, as shown in ***Table 4.2-1***.

Table 4.2-1 Plankton Phylum/Species and Amount from Sampling Surveys in Khlong Song Ton Nun on November 6, 2012

Plankton Species	Plankton Amount (Cells/ Cubic Meter)
PHYTOPLANKTON	
Division Cyanophyta	
Class Cyanophyceae (blue green algae)	
Oscillatoria sp.	26,816,000
Rhaphidiopsis sp.	691,200
Spirulina platensis	38,400
S. laxissima	25,600
Chroococus minutus	25,600
Division Chlorophyta	
Class Chlorophyceae	
Eudorina elegans	460,800
Pandorina morum	76,800
Chlamydomonas angulosa	153,600
Actinastrum hantzschii	153,600
Ulothrix aqaulis	38,400
U. variabilis	51,200
Closterium gracile	25,600
C. tumidum	12,800
Schroederia setigera	25,600
Pediastrum duplex	12,800
P. simplex	12,800
Closteriopsis sp.	12,800
Dictyosphaerium pulchellum	25,600
Crucigenia fenestrata	12,800
Westella botryoides	25,600
Gonium pectorale	25,600
Tetraedron trigonum	25,600
T. gracile	12,800
Ankistrodesmus falcatus	25,600
Kirchneriella subsolitaria	12,800
Class Euglenophyta (euglenoids)	
Lepocinolis ovum	204,800
Euglena oxyuris	281,600
E. acus	256,000
E. caudatus	140,800
E. fusca	51,200
E. deses	51,200
E. spirogyra	38,400
E. proxima	115,200
E. rostrifera	38,400
E. tripteris	25,600
E. rubra	12,800
Phacus helikoides	12,800
P. longicauda	25,600
P. pleuronectes	25,600
P. angulatus	12,800
P. stokosii	12,800
Trachelomonas volvocina	332,800
T. oblonga	204,800
T. crebea	76,800
T. scabra	64,000
Strombomonas gibberosa	51,200
S. fluviatilis	25,600
S. australica	12,800
Division Chromophyta	
Class Bacillariophyceae (diatom)	
Strephanodiscus hanztschii	563,200
Cyclotella sp.	25,600
Synedra acus	25,600
Fragilaria capucina	12,800
Frustulia vulgaris	12,800
Gyrosigma sp.	12,800
Class Dinophyceae (dinoflagellate)	
Peridinium sp.	64,000

Table 4.2-1 Plankton Phylum / Species and Amount from Sampling Surveys in Khlong Song Ton Nun on November 6, 2012 (Cont'd)

Plankton Species	Plankton Amount (Cells / Cubic Meter)
ZOOPLANKTON	
Phylum Arthropoda	
Subclass Copepoda	
*Nauplius stage	179,200
Subclass Ostracoda	
Alona sp.	12,800
Phylum Protozoa (Protozoans)	
Arcella megastoma	12,800
A. vulgaris	51,200
Vorticella sp.	89,600
Difflugia lobostoma	25,600
Didinium sp.	12,800
Paramecium sp.	38,400
Centropyxis ecornis	12,800
Pyxicola sp.	12,800
Phylum Rotifera (Rotifers)	
Brachionus calyciflorus	25,600
B. angularis	217,600
B. falcatus	179,200
B. caudatus	25,600
B. forficula	12,800
Filinia terminaris	166,400
F. opoliensis	25,600
Horaella sp.	320,000
Hexarthra mira	38,400
Trichocerca pusilla	12,800
Polyarthra vulgaris	256,000
Keratella tecta	12,800
Asplanchnopus sp.	25,600
Asplanchna priodonta	25,600
Cephalodella sp.	25,600
Mytilina sp.	12,800
Lecane ionpinata	12,800
L. hastata	12,800
Lepadella rhomboides	12,800
Phylum Nematoda	
*Nematods	12,800
Total amounts	
Phytoplankton	31,590,400
Zooplankton	1,881,600
Total	33,472,000
Total species	
Phytoplankton	55
Zooplankton	30
Total	85
Phytoplankton / Zooplankton Proportion	**16.79**
Diversity Index	**1.23**

Source: Field survey and samplingby TEAM Consulting Engineering and Management Co., Ltd. on November 6, 2012.
Note:* = Species cannot be identified.

Species Diversity Index (SDI), according to the method of Shannon-Weiner (1968), was equivalent to 1.23. The index in the range of 1-3 indicated that water quality was fair and water creatures still can live in the water. The ratio of phytoplankton amounts to zooplankton amounts was equal to 16.79.Density of phytoplankton was higher than that of zooplankton. This represents normal ecological condition of all water resources and in the order of food chains in its natural conditions.

(b) Benthos

From benthos survey and sampling, the benthos found were of 2 phylums (Annelida and Mollusca), 3lineages (Oligochaeta-*fresh water earthworms,* Insecta-*insects,* and Gastropoda-*snails*), 2 orders (Diptera and Mesogastropoda), 4 families (Tubificidae-*fresh water earthworms,* Chironomidae-*fresh water gnat larvae*, Viviparidae-*fresh water snails,* and Amblemidae-*golden apple snails*), and 4 species. Gnat larvaes were found the dominant phylum, with density of 44 families/square meter. Followed by freshwater earthworms, snails and golden apple snails. Total density of benthos was equal to 110/square meter. The riverbed at the sampling area is of muddy ground. Details are shown in ***Table 4.2-2*.**

Table 4.2-2 Benthos Phylum / Species and Amount from Surveys and Samplings in Khlong Song Ton Nun on November 6, 2012

Benthos Phylum / Species	Benthos Quantities (per square meter)
PHYLUM ANNELIDA	
Class Oligochaeta (Freshwater Earthworms)	
Family Tubificidae	22
PHYLUM ARTHROPODA	
Class Insecta	
Order Diptera	
Family Chironomidae (Freshwater Gnat Larvae)	44
PHYLUM MOLLUSCA	
Class Gastropoda (Snails)	
Order Mesogastropoda	
Family Viviparidae (Periwinkle)	
Filopaludina sp.	22
Family Ampullariidae	
Pomacea sp. (หอยเชอรี่)	22
Total (One benthos / Square meter)	**110**
Total Benthos (Species)	**4**

Source: Field surveys and samplings by TEAM Consulting Engineering and Management Co., Ltd., November 6, 2012

Note: Muddy ground form

4.3 HUMAN USE VALUE

4.3.1 Land Use

(1) Introduction

Land use study is intended to classify the current land use in the study area in range of 500 meters on each side of the project route and surrounding areas of the Depot and Park-and-Ride Buildings at Rom Klao Intersection. The results of this study will be used as preliminary data for impact assessment on the land use and to suggest measures to prevent, remedy and minimize the impact, as well as appropriate environmental monitoring measures later.

(2) Methodology

Study and analysis of land use forms were conducted as follows.

(a) Study and analysis of land use forms under existing conditions along the transit system and in vicinity areas were conducted based on the documents/reports and the information gathered from various agencies as follows.

- Topographic map with scale of 1: 50,000 (L7018) of Royal Thai Survey Department(1999)
- Aerial photographs with scale of 1: 15,000 of Royal Thai Survey Department(2002)
- IKONOS satellite maps with high-resolution scale (Space View: Bangkok), with scale of 1: 10,000 of Space Imaging Southeast Asia Co., Ltd. and Map Points Asia (Thailand) Co., Ltd. (2004)
- Satellite photos with scale of 1:4,000 from http://PointAsia.com (2007)
- Bangkok Comprehensive Plan and Land Use Regulations of Department of City Planning (2006).
- Nonthaburi Comprehensive Plan and Land Use Regulations of Department of Public Works and Town Planning (2005)

(b) A field survey and inspection of the project area in October 2012 to serve as information for the study, and updating of the land use forms since the data in point (1) may provide limited details of the project area, and certain issues have not yet updated.

(c) The study and analysis of changes in land use patterns along the mass transit system and adjoining areas

(3) Study Results

Land uses based on the current study, along the route of the mass transit system and adjoining areas, within a radius of 500 meters from the center of the project alignment, were studied. According to this study, the route of Pink Line MRT Project, Khae Rai-Min Buri Section still remains the same, with a total distance of 34.50 km.

However, due to adjustment of the station locations and the increase in number of the stations from 24 to 30 stations, more basic information studies and field surveys, only on the parts of totally 20that were changed from the original study, were, therefore, conducted in October 2012 (Land use based on the current study is shown in ***Appendix 4 C***). Survey results can be summarized as follows.

PK02 Khae Rai Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.544 square kilometer was used as residential areas, representing 45.638 percent, followed by Government/State Enterprise places of 0.280 square kilometer, representing 23.490 percent, and commercial areas of0.208 square kilometer, representing 17.449 percent as shown in ***Table 4.3-1***.

Table 4.3-1 Land Use in the Study Area of PK02 Khae Rai Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Area
U1 = Commercial areas	0.208	17.449
U2 = Residential areas	0.544	45.638
U3 = Government/State Enterprise places	0.280	23.490
U4 = Schools	0.010	0.839
U6 = Hospitals	0.071	5.956
U7 = Industrial plants	0.013	1.091
M1 = Abandoned areas	0.066	5.537
Total Study Areas	**1.192**	**100.000**

PK06 Pak Kret Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.495 square kilometer was used as residential areas, representing 42.344 percent, followed by commercial areas of 0.243 square kilometer, representing 20.787 percent, and abandoned areas of 0.219 square kilometer, representing 18.734 percentas shown in ***Table 4.3-2*.**

Table 4.3-2 Land Use in the Study Area of PK06 Pak Kret Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.243	20.787
U2 = Residential areas	0.495	42.344
U3 = Government/State Enterprise places	0.032	2.737
U4 = Schools	0.01	0.855
U5 = Religious/Archaeological and Historic places	0.038	3.251
U6 = Hospitals	0.039	3.336
U7 = Industrial plants	0.042	3.593
U9 = Abandoned plants	0.018	1.54
A4 = Mixed fruit orchard	0.010	0.855
A5 = Vegetable Garden	0.011	0.941
A6 = Fish pond	0.012	1.027
M1 = Abandoned areas	0.219	18.734
Total Study Areas	**1.169**	**100.000**

PK07 Pak Kret bypass Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.501 square kilometer was used as residential areas, representing 41.960 percent, followed by abandoned areas of 0.321 square kilometer, representing 26.884 percent, and commercial areas of 0.187 square kilometer, representing 15.662 percent, as shown in ***Table 4.3-3*****.**

Table 4.3-3 Land Use in the Study Area of PK07 Pak Kret Bypass Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.187	15.662
U2 = Residential areas	0.501	41.960
U4 = Schools	0.054	4.523
U5 = Religious/Archaeological and Historic places	0.006	0.502
U7 = Industrial plants	0.125	10.469
M1 = Abandoned areas	0.321	26.884
Total Study Areas	**1.194**	**100.000**

PK08 Chaeng Watthana-Pak Kret 28 Station: According to the land use surveys in the study area of 5 0 0 meters, it was found that the land of 0 .656 square kilometer was used as residential areas, representing 54.261 percent, followed by abandoned areas of 0.275 square kilometer, representing 22.747 percent, and commercial areas of 0.163 square kilometer, representing 13.484 percent, as shown in ***Table 4.3-4*****.**

Table 4.3-4 Land Use in the Study Area of PK08 Chaeng Watthana-Pak Kret 28 Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.163	13.484
U2 = Residential areas	0.656	54.261
U3 = Government/State Enterprise Places	0.045	3.724
U4 = Schools	0.060	4.963
U6 = Hospitals	0.008	0.662
M1 = Abandoned areas	0.275	22.747
W1 = Water sources	0.002	0.159
Total Study Areas	**1.209**	**100.000**

PK09 Muang Thong Thani Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.697square kilometer was used as residential areas, representing 60.980 percent, followed by abandoned areas of 0.234 square kilometer, representing 20.473 percent, and commercial areas of 0.166 square kilometer, representing 14.523 percent, as shown in ***Table 4.3-5*****.**

Table 4.3-5 Land Use in the Study Area of PK09 Muang Thong Thani Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.166	14.523
U2 = Residential areas	0.697	60.980
U4 = Schools	0.007	0.612
U7 = Industrial plants	0.022	1.925
M1 = Abandoned areas	0.234	20.473
W1 = Water sources	0.017	1.487
Total Study Areas	**1.143**	**100.000**

PK12 Bangkok Government Complex Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.931 square kilometer was used as Government/State Enterprise places, representing 60.980 percent, followed by residential areas of 0.149 square kilometer, representing 11.997 percent, and abandoned areas of 0.109 square kilometer, representing 8.776 percent, as shown in ***Table 4.3-6*.**

Table 4.3-6 Land Use in the Study Area of PK12 Bangkok Government Complex Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.047	3.784
U2 = Residential areas	0.149	11.997
U3 = Government/State Enterprise places	0.931	74.96
U7 = Industrial plants	0.006	0.483
M1 = Abandoned areas	0.109	8.776
Total Study Areas	**1.242**	**100.000**

PK13 TOT Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.742 square kilometer was used as Government/ State Enterprise places, representing 60.130 percent, followed by residential areas of 0.276 square kilometer, representing 22.366 percent, and industrial plants of 0.079 square kilometer, representing 6.402 percent, as shown in ***Table 4.3-7*.**

Table 4.3-7 Land Use in the Study Area of PK13 TOT Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.073	5.916
U2 = Residential areas	0.276	22.366
U3 = Government/State Enterprise places	0.742	60.130
U4 = Schools	0.003	0.243
U5 = Religious/Archaeological and Historic places	0.016	1.297
U7 = Industrial plants	0.079	6.402
M1 = Abandoned areas	0.032	2.593
W1 = Water sources	0.013	1.053
Total Study Areas	**1.234**	**100.000**

PK14 Lak Si Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.342 square kilometer was used as residential areas, representing 25.58 percent, followed by commercial areas of 0.225 square kilometer, representing 16.829 percent, and religious/archaeological and historic places of 0.222 square kilometer, representing 16.604 percent, as shown in ***Table 4.3-8*****.**

Table 4.3-8 Land Use in the Study Area of PK14 Lak Si Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.225	16.829
U2 = Residential areas	0.342	25.58
U3 = Government/State Enterprise Places	0.147	10.995
U4 = Schools	0.015	1.122
U5 = Religious/Archaeological and Historic places	0.222	16.604
U7 = Industrial plants	0.191	14.286
M1 = Abandoned areas	0.182	13.612
W1 = Water sources	0.013	0.972
Total Study Areas	**1.337**	**100.000**

PK15 Phranakhon Rajabhat University Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.499 square kilometer was used as residential areas, representing 42.541 percent, followed by schools of 0.229 square kilometer, representing 19.522 percent, and commercial areas of 0.145 square kilometer, representing 12.361 percent, as shown in ***Table 4.3-9*****.**

Table 4.3-9 Land Use in the Study Area of PK15 Phranakhon Rajabhat University Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.145	12.361
U2 = Residential areas	0.499	42.541
U3 = Government/State Enterprise places	0.002	0.171
U4 = Schools	0.229	19.522
U5 = Religious/Archaeological and Historic places	0.057	4.859
U7 = Industrial plants	0.087	7.417
M1 = Abandoned areas	0.131	11.168
W1 = water sources	0.023	1.961
Total Study Areas	**1.173**	**100.000**

PK16 Wat Phra Si Maha That Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.312 square kilometer was used as Government/State Enterprise places, representing 29.213 percent, followed by religious/archaeological and historic places of 0.305 square kilometer, representing 28.558 percent, and commercial areas of 0.116 square kilometer, representing 10.861 percent, as shown in ***Table 4.3-10*****.**

Table 4.3-10 Land Use in the Study Area of PK16 Wat Phra Si Maha That Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.116	10.861
U2 = Residential areas	0.113	10.581
U3 = Government/State Enterprise places	0.312	29.213
U4 = Schools	0.082	7.678
U5 = Religious/Archaeological and Historic places	0.305	28.558
U6 = Hospitals	0.023	2.154
U8 = Park/Golf Driving Range/Stadium	0.008	0.749
M1 = Abandoned areas	0.097	9.082
W1 = Water sources	0.012	1.124
Total Study Areas	**1.068**	**100.000**

PK17 Ram Inthra 3 Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.653 square kilometer was used as Government/State Enterprise places, representing 53.612 percent, followed by residential areas of 0.359 square kilometer, representing 29.475 percent, and commercial areas of 0.131 square kilometer, representing 10.755 percent, as shown in ***Table 4.3-11*.**

Table 4.3-11 Land Use in the Study Area of PK17 Ram Inthra 3 Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.131	10.755
U2 = Residential areas	0.359	29.475
U3 = Government/State Enterprise places	0.653	53.612
U4 = Schools	0.027	2.217
M1 = Abandoned areas	0.022	1.806
W1 = Water sources	0.026	2.135
Total Study Areas	**1.218**	**100.000**

PK19 Ram Inthra 31 Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.942 square kilometer was used as residential areas, representing 76.773 percent, followed by commercial areas of 0.157 square kilometer, representing 12.795 percent, and commercial areas of 0.095 square kilometer, representing 7.742 percent, as shown in ***Table 4.3-12*.**

Table 4.3-12 Land Use in the Study Area of PK19 Ram Inthra 31 Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.157	12.795
U2 = Residential areas	0.942	76.773
U7 = Industrial plants	0.026	2.119
M1 = Abandoned areas	0.095	7.742
W1 = Water sources	0.007	0.571
Total Study Areas	**1.227**	**100.000**

PK20 Maiyalap Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.846 square kilometer was used as residential areas, representing 67.735 percent, followed by Government/State Enterprise places of 0.141 square kilometer, representing 11.289 percent, and abandoned areas of 0.115 square kilometer, representing 9.207 percent, as shown in ***Table 4.3-13*****.**

Table 4.3-13 Land Use in the Study Area of PK20 Maiyalap Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.112	8.967
U2 = Residential areas	0.846	67.735
U3 = Government/State Enterprise places	0.141	11.289
U7 = Industrial plants	0.033	2.642
M1 = Abandoned areas	0.115	9.207
W1 = Water sources	0.002	0.160
Total Study Areas	**1.249**	**100.000**

PK21 Watcharaphon Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.730 square kilometer was used as residential areas, representing 60.281 percent, followed by abandoned areas of 0.222 square kilometer, representing 18.332 percent, and commercial areas of 0.126 square kilometer, representing 10.405 percent, as shown in ***Table 4.3-14*****.**

Table 4.3-14 Land Use in the Study Area of PK21 Watcharaphon Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.126	10.405
U2 = Residential areas	0.730	60.281
U3 = Government/State Enterprise places	0.057	4.707
U4 = Schools	0.002	0.165
U7 = Industrial plants	0.046	3.798
U8 = Park/Golf Driving Range/Stadium	0.025	2.064
M1 = Abandoned areas	0.222	18.332
W1 = Water sources	0.003	0.248
Total Study Areas	**1.211**	**100.000**

PK22 Ram Inthra 40 Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.800 square kilometer was used as residential areas, representing 68.026 percent, followed by abandoned areas of 0.180 square kilometer, representing 15.335 percent, and commercial areas of 0.112 square kilometer, representing 9.543 percent, as shown in ***Table 4.3-15*****.**

Table 4.3-15 Land Use in the Study Area of PK22 Ram Inthra 40 Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.112	9.543
U2 = Residential areas	0.800	68.026
U4 = Schools	0.021	1.795
U7 = Industrial plants	0.033	2.773
U8 = Park/Golf Driving Range/Stadium	0.011	0.897
M1 = Abandoned Areas	0.180	15.335
W1 = Water Sources	0.019	1.631
Total Study Areas	**1.176**	**100.000**

PK24 Ram Inthra 83 Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.573square kilometer was used as residential areas, representing 47.631 percent, followed by abandoned areas of 0.374 square kilometer, representing 31.089 percent, and commercial areas of 0.210 square kilometer, representing 17.457 percent, as shown in ***Table 4.3-16.***

Table 4.3-16 Land Use in the Study Area of PK24 Ram Inthra 83 Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.210	17.457
U2 = Residential areas	0.573	47.631
U6 = Hospitals	0.027	2.244
U7 = Industrial plants	0.019	1.579
M = Abandoned areas	0.374	31.089
Total Study Areas	**1.203**	**100.000**

PK25 East Outer Ring Road Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.437 square kilometer was used as abandoned areas, representing 35.529 percent, followed by commercial areas of 0.365 square kilometer, representing 29.675 percent, and residential areas of 0.316 square kilometer, representing 25.691 percent, as shown in ***Table 4.3-17.***

Table 4.3-17 Land Use in the Study Area of PK25 Outer Ring Road Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.365	29.675
U2 = Residential areas	0.316	25.691
U3 = Government /State Enterprise places	0.001	0.081
U8 = Park/Golf Driving Range/Stadium/Amusement Park	0.111	9.024
M = Abandoned areas	0.437	35.529
Total Study Areas	**1.230**	**100.000**

PK26 Nopparat Rajathanee Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.516 square kilometer was used as residential areas, representing 43.108 percent, followed by abandoned areas of 0.215 square kilometer, representing 17.962 percent, and commercial areas of 0.152 square kilometer, representing 12.698 percent, as shown in ***Table 4.3-18*.**

Table 4.3-18 Land Use in the Study Area of PK26 Nopparat Rajathanee Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.152	12.698
U2 = Residential areas	0.516	43.108
U4 = Schools	0.016	1.337
U6 = Hospitals	0.133	11.111
U7 = Industrial plants	0.080	6.683
U8 = Park/Golf Driving Range/Stadium	0.057	4.762
A5 = Vegetable garden	0.028	2.339
M = Abandoned areas	0.215	17.962
Total Study Areas	**1.197**	**100.000**

PK27 Bang Chan Station: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.492 square kilometer was used as abandoned areas, representing 40.494 percent, followed by residential areas of 0.392 square kilometer, representing 32.263 percent, and commercial areas of 0.160 square kilometer, representing 13.169 percent, as shown in ***Table4.3-19*.**

Table 4.3-19 Land Use in the Study Area of PK27 Bang Chan Station

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.160	13.169
U2 = Residential areas	0.392	32.263
U7 = Industrial plants	0.072	5.926
U8 = Park/Golf Driving Range/Stadium	0.029	2.387
A5 = Vegetable garden	0.007	0.576
M = Abandoned areas	0.492	40.494
W1 = Water Sources	0.063	5.185
Total Study Areas	**1.215**	**100.000**

Depot and Park-and-Ride Building at Rom Klao Intersection: According to the land use surveys in the study area of 500 meters, it was found that the land of 0.885 square kilometer was used as residential areas, representing 36.345 percent, followed by abandoned areas of 0.792 square kilometer, representing 32.525 percent, and commercial areas of 0.195 square kilometer, representing 8.008 percent, as shown in ***Table4.3-20*.**

Table 4.3-20 Land Use in the Study Area of Depot and Park-and-Ride Building at Rom Klao Intersection

Land Use Types	Study Areas of 500 m. (sq. km.)	Percent of Study Areas
U1 = Commercial areas	0.195	8.008
U2 = Residential areas	0.885	36.345
U4 = Schools	0.118	4.846
U7 = Industrial plants	0.158	6.489
U8 = Park/Golf Driving Range/Stadium/Amusement Park	0.015	0.616
A1 = Paddy fields	0.157	6.448
A2 = Grass Farms	0.087	3.573
M = Abandoned areas	0.792	32.525
W1 = Water Sources	0.028	1.150
Total Study Areas	**2.435**	**100.000**

4.4 QUALITY OF LIFE VALUE

4.4.1 Removal and Expropriation

(1) Introduction

Though Pink Line MRT Project, Khae Rai-Min Buri Section will be constructed within the road median areas, some parts of the project still may affect buildings and people's houses, e.g. train station accesses, for example. Thus, such buildings and people's houses need to be removed. Anyhow, Mass Rapid Transit Authority of Thailand (MRTA) plans to expropriate the public space to a minimum. Therefore, the areas requiring expropriation and property of people who have to rehabilitate need to be assessed. Compensations will be made for buildings, demolition costs, removal costs of debris and damages to people who have to leave their properties, in accordance with Article 21, last paragraph.

(2) Methodology

The study is conducted by collecting secondary data, e.g. areas expropriated, property assessment prices of housing and building sin land registration on real estate in Bangkok and Nonthaburi, field surveying and analyzing data related to removal and expropriation of land and property due to the mass transit systems development.

(3) Study results

From field surveys and monitoring of property removal and expropriation for Pink Line MRT Project, Khae Rai-Min Buri Project from the starting point at PK0 1 Nonthaburi Government Center Station to the end at PK30Min Buri Station and the Depot and Park-and-Ride Building at Rom Klao Intersection, with a total distance of 3 4 . 5 0 kilometers, total compensations for expropriated land were equal to 5,623,342,745.00 baht, for immovable property 510,334,524.00 baht, and for other real properties such as relocation of utilities 613,367,741.00 land. Land prices (baht/square wah) were obtained from the appraised value for land registration of the Treasury Department during accounting period of 2012-2015. Building construction cost estimate (baht/square meter)

was obtained from the referenced prices of the Valuers Association of Thailand 2011. Details as shown in ***Table 4.4-1*** can be summarized as follows.

(1) Areas to be expropriated (Rai-Ngan-Square Wah)

- **Train station areas from PK01 to PK29 totalling 23-3-48.77**

  Divided into government areas of 10-0-12.79 and private areas of 13-3-35.98

- **Along the project route totaling 24-5-6.86**

  - During Km. 9+500 to Km. 11+100

    Divided into private areas of 2-3-69.01 and government areas of 10-3-60.56

  - During Km. 14+900 to Km.15+800

    Divided into private areas of 0-0-81.74 and government areas of 3-1-8.36

  - During Km.32+200 to Km. 32+700

    As government areas of 1-3-17.88

  - During Km. 16+400 to Km. 17+800

    Divided into private areas of 2-2-79.34 and government areas of 3-1-89.97

- **PK30 Station Areas and Depot and Park-and-Ride Building totaling 229-0-43.94**

  All as private areas

(2) Buildings to be relocated

- **From PK01 to PK29 totaling 105 buildings**

  Divided into 1 government building and 104 private buildings

- **Along the project route totaling 71 buildings**

  - From Km. 9+500 to Km. 11+100 were 15 private buildings
  - From Km. 14+900 to Km.15+800 were 15 private buildings
  - From Km. 32+200 to Km.32+700 were 4 private buildings
  - From Km. 16+400 to Km.17+800 were 15 private buildings

- **AtPK30 Station and Depot and Park-and-Ride Building totaling 9 buildings**

  All were private areas.

Table 4.4-1 Amounts of Land and Buildings within Right-of-way and Areas to be Expropriated

พื้นที่ที่ต้องการเพื่อ	ประเภทพื้นที่		พื้นที่ที่ต้องแนวเส้น (ไร่-งาน-ตร.วา)		ลักษณะที่ต้องรื้อย้าย (หลัง)		ค่าทดแทนและอัตราเงินสงเคราะห์เบื้องต้น (บาท)			
ตำแหน่ง	ราษฎร	เอกชน	ราษฎร	เอกชน	ราษฎร	เอกชน	ที่ดิน	สาธารณ	อื่นๆ	รวม
PK-01	4	0	5 - 3 - 42.76	0 - 0 - 0	0	0	413,795,616.00	-	41,379,562.00	455,164,057.00
PK-02	1	37	0 - 0 - 0.74	0 - 0 - 39.34	0	34	8,771,721.00	1,005,992.00	977,572.00	10,755,585.00
PK-03	0	26	0 - 0 - 0	0 - 0 - 52.43	0	24	11,953,034.00	979,776.00	1,293,287.00	14,226,147.00
PK-04	0	21	0 - 0 - 0	0 - 0 - 00.07	0	14	17,391,402.00	2,983,680.00	2,037,510.00	22,412,592.00
PK-05	2	0	0 - 0 - 39.57	0 - 0 - 0	0	0	2,661,007.00	-	256,189.00	2,917,196.00
PK-06	0	16	0 - 0 - 0	5 - 0 - 71.27	0	12	345,804,102.00	35,317,530.00	39,102,173.00	419,123,805.00
PK-07	0	19	0 - 0 - 0	0 - 0 - 70.6	0	16	20,457,519.00	435,456.00	2,090,299.00	22,983,274.00
PK-08	0	8	0 - 0 - 0	0 - 0 - 41.21	0	0	9,360,609.00		935,061.00	10,295,670.00
PK-09	6	3	2 - 0 - 22.6	0 - 0 - 86.57	1	2	155,841,972.00	23,353,676.00	17,930,565.00	197,126,213.00
PK-10	1	4	0 - 0 - 17	0 - 0 - 2.05	0	0	4,709,549.00	-	470,955.00	5,180,503.00
PK-11	1	36	0 - 0 - 0.13	0 - 0 - 94.01	0	0	34,717,169.00	-	3,471,745.00	38,189,214.00
PK-12	2	4	0 - 0 - 47.96	0 - 0 - 52.16	0	1	18,313,152.00	167,600.00	1,847,014.00	20,317,716.00
PK-13	1	10	0 - 0 - 6	0 - 0 - 31.3	0	0	12,331,105.00	-	1,233,110.00	13,564,215.00
PK-14	1	1	0 - 0 - 98	2 - 1 - 80.5	0	0	351,896,625.00		35,189,663.00	387,086,288.00
PK-15	1	1	0 - 1 - 4.17	0 - 0 - 3.75	0	0	14,193,055.00	-	1,419,305.00	15,601,360.00
PK-16	0	4	0 - 0 - 0	3 - 2 - 75.95	0	0	276,595,040.00	-	27,659,504.00	303,255,524.00
PK-17	0	5	0 - 0 - 0	0 - 0 - 69.59	0	0	18,765,824.00		1,979,581.00	20,864,405.00
PK-18	0	5	0 - 0 - 0	0 - 0 - 63.72	0	0	15,937,350.00	-	1,593,735.00	17,531,085.00
PK-19	0	11	0 - 0 - 0	0 - 0 - 9.49	0	0	2,552,908.00		255,292.00	2,808,200.00
PK-20	0	33	0 - 0 - 0	0 - 0 - 36.14	0	0	10,335,040.00	-	1,033,504.00	11,368,544.00
PK-21	13	5	0 - 0 - 73.97	0 - 0 - 6.16	0	0	11,199,969.00	-	1,119,997.00	12,319,966.00
PK-22	0	5	0 - 0 - 0	0 - 0 - 42.91	0	1	8,192,513.00	167,625.00	835,025.00	9,185,364.00
PK-23	0	2	0 - 0 - 0	0 - 0 - 42.25	0	0	4,211,350.00	-	421,135.00	4,632,485.00
PK-24	0	12	0 - 0 - 0	0 - 0 - 37.55	0	0	7,029,143.00	-	702,915.00	7,732,058.00
PK-25	2	3	0 - 0 - 23.95	0 - 0 - 60.07	0	0	10,736,954.00	-	1,073,695.00	11,810,649.00
PK-26	0	0	0 - 0 - 0	0 - 0 - 0	0	0	-	-	-	-
PK-27	0	1	0 - 0 - 0	0 - 0 - 20.02	0	0	744,344.00	-	74,434.00	818,778.00
PK-28	0	4	0 - 0 - 0	0 - 0 - 36.9	0	0	4,245,170.00	-	424,539.00	4,669,709.00
PK-29	1	31	0 - 0 - 34.9	0 - 0 - 21.97	0	0	12,404,579.00	-	1,240,457.00	13,645,146.00
DEPOT	0	79	0 - 0 - 0	229 - 0 - 43.94	0	9	1,797,124,259.00	105,607,908.00	190,273,221.00	2,093,005,388.00
9+500 - 11+100	9	52	2 - 3 - 69.01	10 - 2 - 60.56	0	15	1,291,242,591.00	76,903,522.00	126,717,610.00	1,503,863,713.00
14+000 - 15+900	2	30	0 - 0 - 81.74	3 - 1 - 0.36	0	15	329,312,269.00	61,362,892.00	39,067,617.00	419,742,577.00
32+200 - 32+700	0	14	0 - 0 - 0	1 - 3 - 17.97	0	4	83,065,213.00	9,947,952.00	9,301,319.00	102,314,483.00
16+400 - 17+900	11	109	2 - 2 - 79.34	3 - 1 - 09.97	0	37	409,457,077.00	203,179,914.00	61,164,701.00	672,911,692.00
รวม	57	591	15 - 3 - 42.89	282 - 1 - 56.49	1	194	5,623,342,795.00	518,334,524.00	913,367,791.00	6,797,045,110.00

Note: Land estimated prices (baht/square wah) obtained from the estimated prices for land registration of the Treasury Department in accounting period of 2012-2015.
Buildings construction cost estimate (baht/square meter) was obtained from the referenced prices of the Valuers Association of Thailand 2011.