Environmental and Social Impact Assessment (Draft)

March 2018

THA: Chonburi Power Plant Project
(Part 2 of 6)

Prepared by Gulf SRC Company Limited for the Asian Development Bank.

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CHAPTER 4

DESCRIPTION OF THE ENVIRONMENTAL (BASELINE DATA)

With the aim to understand existing natural and environmental conditions around the project area, both compilation of secondary data and the conduct of field survey are essential for the study of environmental impact assessment. The study is to present overall situations and environmental quality around the project areas. This covers the 4 categories of physical resources, biological resources, human use values and quality of life values. Since location of the project areas is at the Hemaraj Eastern Seaboard Industrial Estate (Hemaraj ESIE), examination and monitoring on various quality of environment is always conducted in order to control and closely observe those qualities. Accordingly, the result of examination and monitoring will be used as basic environmental data for clear considering the change of environmental qualities and forecasting the future environmental impact. Consequently, the result of the assessment and the forecast will be used to formulate environmental impact mitigation and preventive measures during the construction period and operation period. The study area is within 5 km radius surrounding the project areas (hereinafter referred to as "the study area"), covering the areas of Si Racha District and Nong Yai District, Chon Buri Province and Pluak Daeng District, Rayong Province. The details are as follows:

4.1 PHYSICAL RESOURCES

4.1.1 Topography

(1) Introduction

The objective of the study on topography is to understand the topographical condition of the project area and its vicinity. The result of the study will be used to assess appropriateness of the project location and environmental impact assessment during the construction period and operation period.

(2) Study methods

- Collect related secondary data as follows:
  - Satellite imgaes form Google Earth program
  - Topographic map with 1:50,000 from the Royal Thai Survey Department, L 7018, series 5235 (III), B.E. 2541 (1998)
- Field survey in study area of the project

(3) Study results

Chon Buri Province is located in the east of Thailand or on the east coast of the Gulf of Thailand, and is approximately 81 km from Bangkok. Its topography is diverse, ranging from undulating plains and hills in the east, coastal plains from the mouth of Bangpakong River to Sattahip District, Bangpakong River basin plentiful of sediment which is suitable for agriculture, high slope area and mountain in the central and the east, and several islands of various sizes.

Rayong Province is a part of the east coast of the Gulf of Thailand and located about 179 km from Bangkok. To the south, it consists of beaches and beach ridges. The areas to the north is tidal flats and former tidal flats, and is flood plains, being water-logged all year round or nearly all year round. The province's most areas are undulating and rolling, and located above the province's plain and low-lying areas, with the gradient ranging from 3-16 %. Moreover, Rayong Province's topography is hilly terrain and foothill slope, comprising small hill ranges. There are a lot of mountains and hills in the north, east, and the central of the province (in the north-south range). In this province, there are 2 main rivers: Rayong River which is approximately 50 km long and Prasae River, about 26 km long.

The Project's study areas covers some areas of the Districts of Si Racha, Nong Yai, and Ban Bueng of Chon Buri Province as well as some areas of Pluak Daeng District of Rayong Province. The areas are topographically undulating (the gradient percentage is 3-16) and undulating and rolling. Some parts are hilly terrains and foothill slopes, consisting of small hill ranges as well as various natural water sources, for example: Map Kradon Marsh, Khlong Rawoeng, Khlong Kram, Khlong Pluak Daeng, and Map Eiang marsh, according to **Figure 4.1.1-1**.

4.1.2 Geology/Seismology

4.1.2.1 Geology

(1) Introduction

The objective of geological study is to comprehend characteristic of geological structure of the project and adjacent areas. This basic data is used for assessing environmental impact from the project development and operation.

(2) Study methods

Secondary data had been gathered from related agencies and reports to be used in the study as basic information. The geological data compilation was taken from geological map of eastern part of Thailand of Geological Survey Division, the Department of Mineral Resources B.E. 2547 (2004).

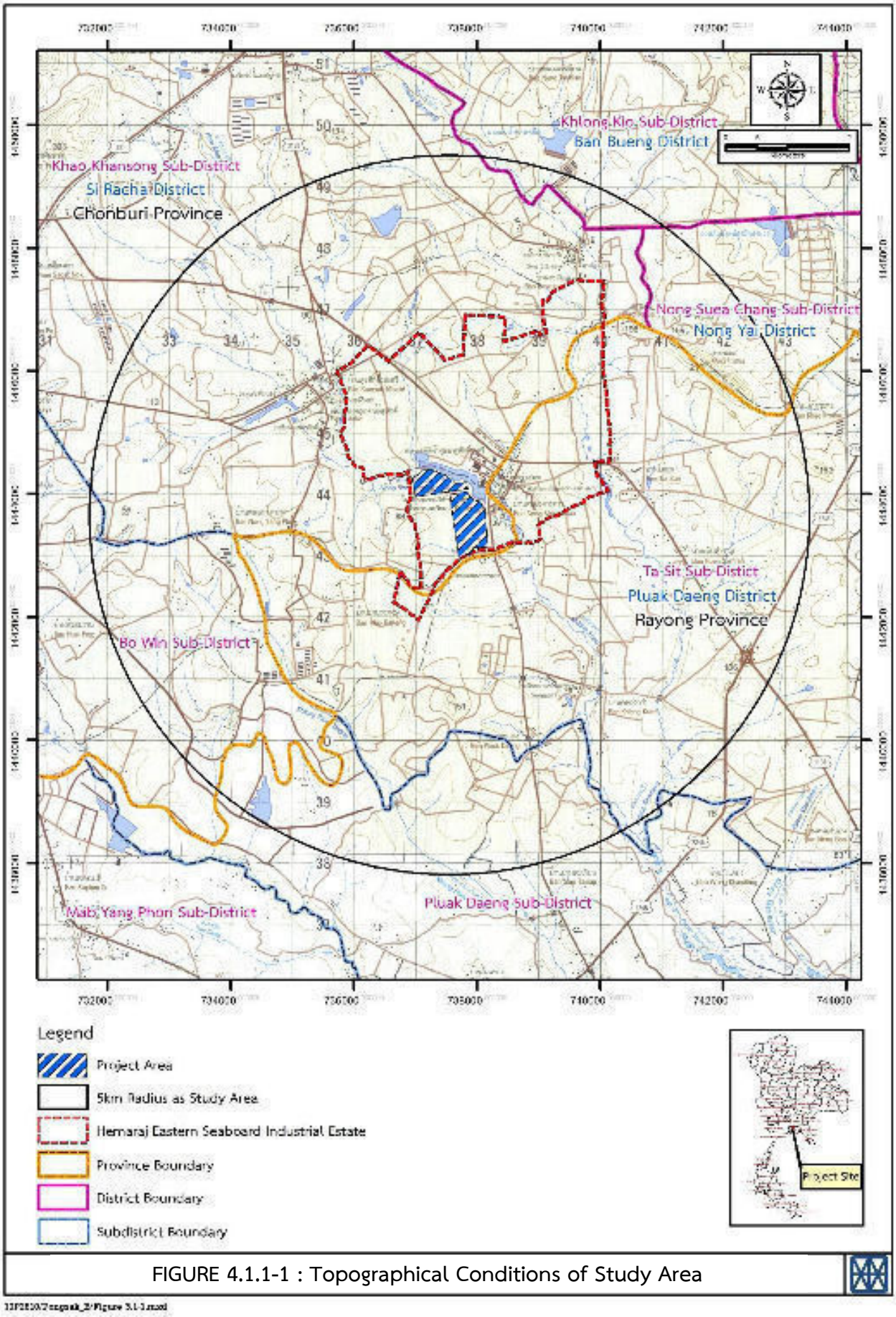


FIGURE 4.1.1-1 : Topographical Conditions of Study Area

(3) Study results

Geological conditions of Chon Buri and Rayong Provinces consist of 3 types of hard rocks: sedimentary rocks, igneous rocks, and metamorphic rocks. The proportion of these rocks have been roughly estimated based on rock type and rock's structural characteristics regardless of new deposits covering the top. The result shows that the geological conditions of the area are mainly metamorphic rocks (about 60 %) and igneous rocks (about 38 %) with small amount of sedimentary rocks (about 1 %).

The geological conditions of the study areas consist of biotite-muscovite granite, ranging from light colour to rather black color, some of which are coarse-grained to moderately coarse-grained. The granite in some areas has porphyritic texture with some pegmatite. Some are quartz stacked stone, and igneous rock group of carboniferous period. (See **Figure 4.1.2-1**)

4.1.2.2 Seismology

(1) Introduction

The objective of seismic study is to recognize active faults which still have energy causes to earthquake which might have an effect on the project and vicinity areas. This basic data is used to assess impact from the project development and impact on project operation.

(2) Methodof the study

Seismic -secondary data had been gathered from the related agencies such as the Meteorological Department, Department of Mineral Sources, etc. to used as basic data for seismology study.

(3) Study results

According to seismic data of the Meteorological Department, there are two sources of earthquake in Thailand, namely:

(a) Huge earthquake originates from outside Thailand, with vibration to the country. The original source is in the south of People Republic of China, Myanmar, Lao PDR, Andaman Sea and the north of Sumatra Island. High vibrating areas are in the north, the south, the west, the northeast of Thailand and Bangkok. According to previous data of earthquake, the hypocenter is mostly outside Thailand such as in the south of People Republic of China, Border between Thailand and Myanmar, Lao PRD, Andaman Sea and the north of Sumatra Island. Huge earthquake often occurs in these areas, because they are in hypocentric line of Alpine-Himalaya. Huge earthquake generates energetic vibration to Thailand, even the hypocenter is quite far from Thailand.

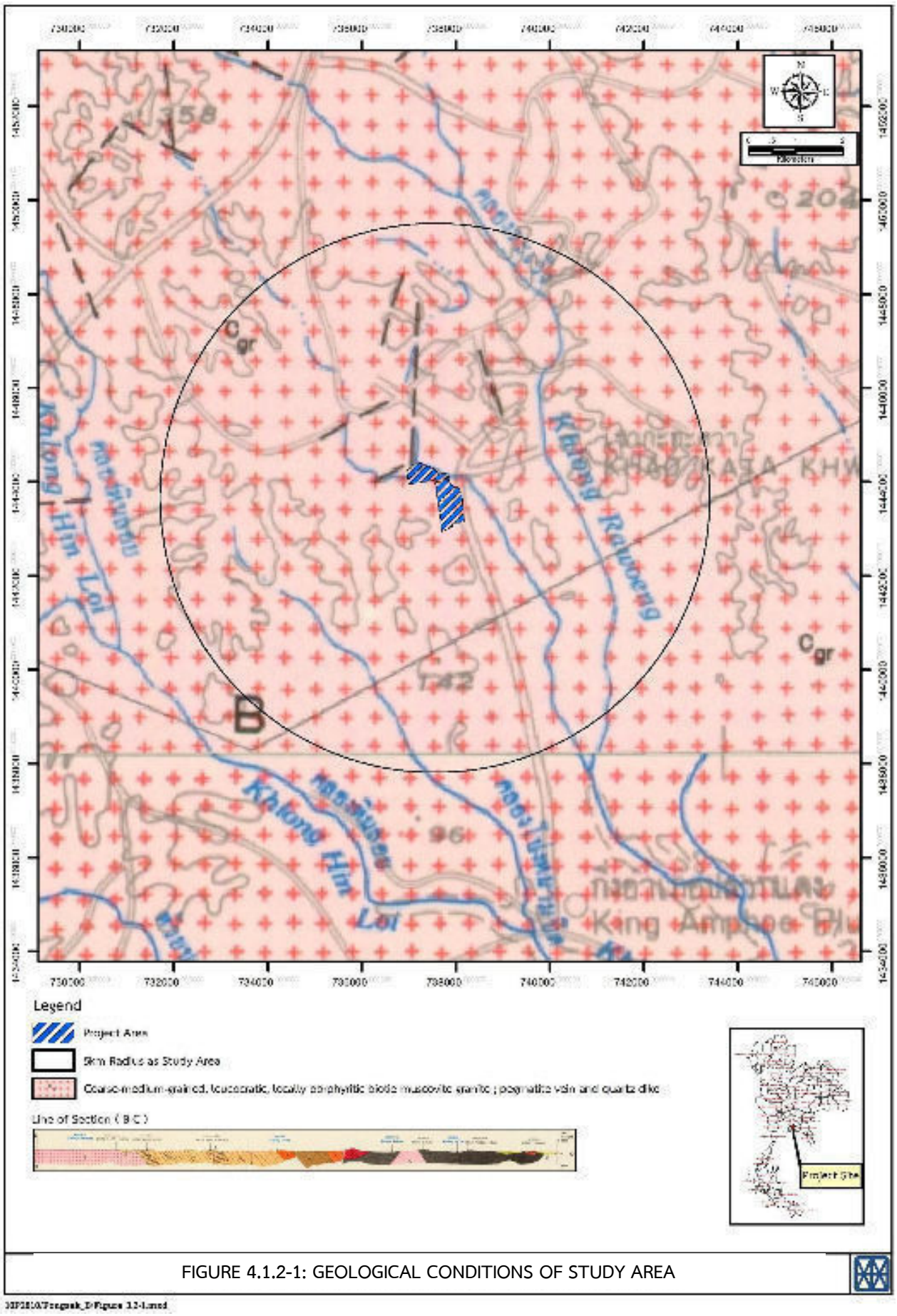


FIGURE 4.1.2-1: GEOLOGICAL CONDITIONS OF STUDY AREA

(b) There are 14 active faults which cause earthquake in Thailand as shown in **Figure 4.1.2-2**.

According to satellite data, most of active faults with severe occurrence in the past are large active faults aligning between the edge of the east–west namely; Mae Chan active faults. The other is Mae Hong Son active fault, locating between the north and the west regions of Thailand. The aligning is from the north down to the south paralleling with Dan Chedi Sam Ong (Three Pagoda Pass) active faults. In addition, map of earthquake hypocenter occurrence in Thailand and vicinity areas (between 1900-2014) as seen in **Figure 4.1.2-2** shows that the project location in the east zone has no seismic source and the distance from the hypocenter is about 300 km far.

Besides, compilation and review of seismic statistical data from 2009-2015 revealed that there was no seismic statistic in Chon Buri and Rayong Provinces areas. Hence the seismic statistic is reported as seen in **Table 4.1.2-1**. According to seismic risky area data revised in October B.E.2556 (2013), the risky areas are divided into 12 scales by level of severity of seismic (as in mercalli scale) as shown in **Figure 4.1.2-3**. This map shows that the study area is the risky area at 4 (IV) mercalli (moderate). At this scale, people can feel on the occurrence of abnormal. If it occurs in day time, people in house can feel as a normal but if it is in night time, they are be frightened and wake up.

4.1.3 Soil Resource

(1) Introduction

Study on soil resources is aim to understand the physical properties and fertility of soil in vicinity of the project. They are used in order to assess impact during the construction period and operation period.

(2) Study methods

(a) Compile and study data on soil resources used to assess impact. The data comprises:

- Data of soil series map and soil physical and chemical properties of soil in Chon Buri and Rayong Provinces (Land Development Department, 1985).
- Physical and chemical properties of soil consist of soil geology and parent material, soil texture, soil drainage, soil slope and soil organic matter.
- Map of landslide possible area and landslide communities in Chon Buri province (Department of Mineral Resources, 2010)

(b) Soil samples were collected from field on 14 Januaary 2015. The construction activity of power plant may affect soil erosion. According to study on area size and distribution of soil series (as shown in **Figure 4.1.3-1**), The criteria of soil sampling within 5 km radius of power plant is as follows:

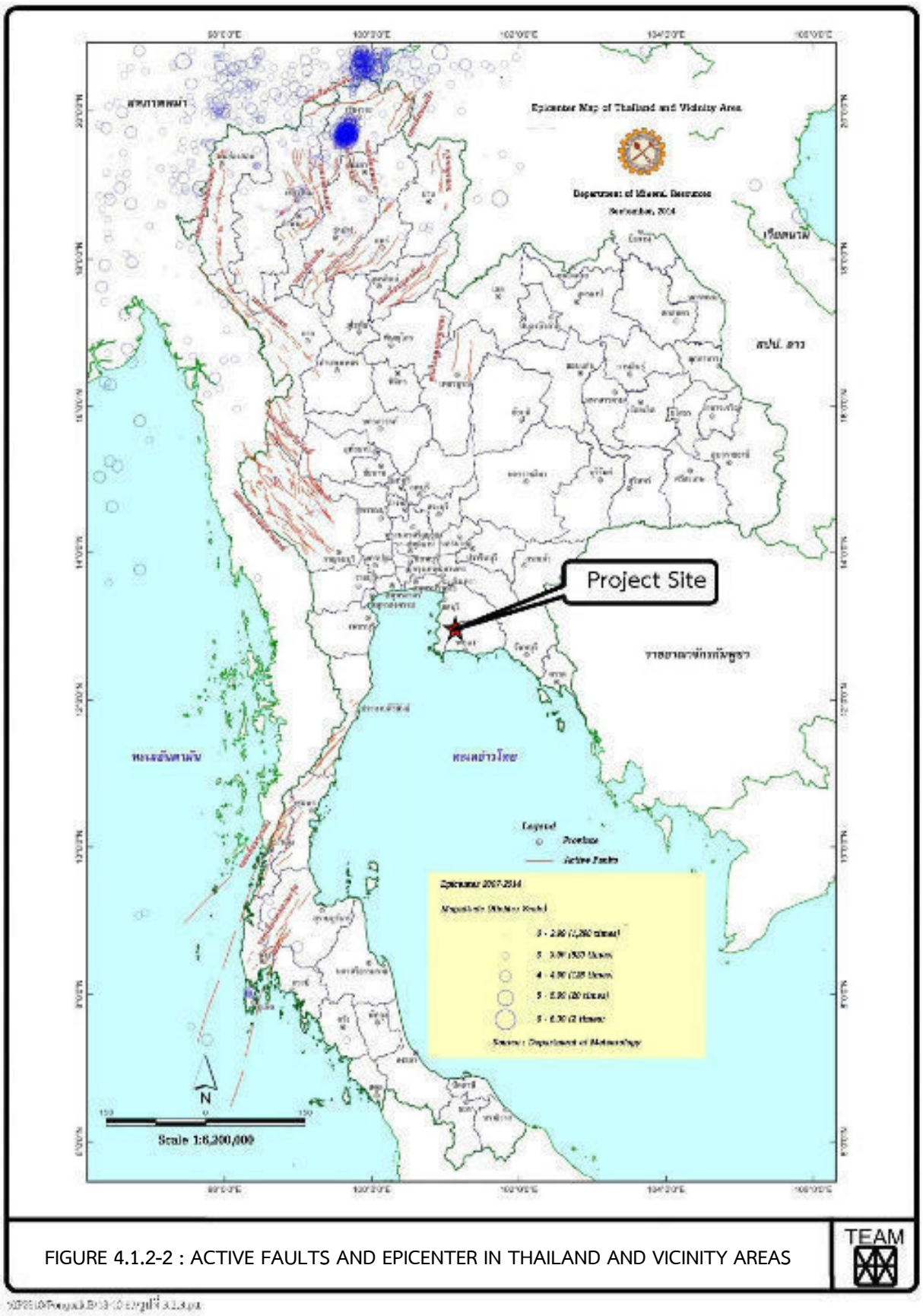


FIGURE 4.1.2-2 : ACTIVE FAULTS AND EPICENTER IN THAILAND AND VICINITY AREAS

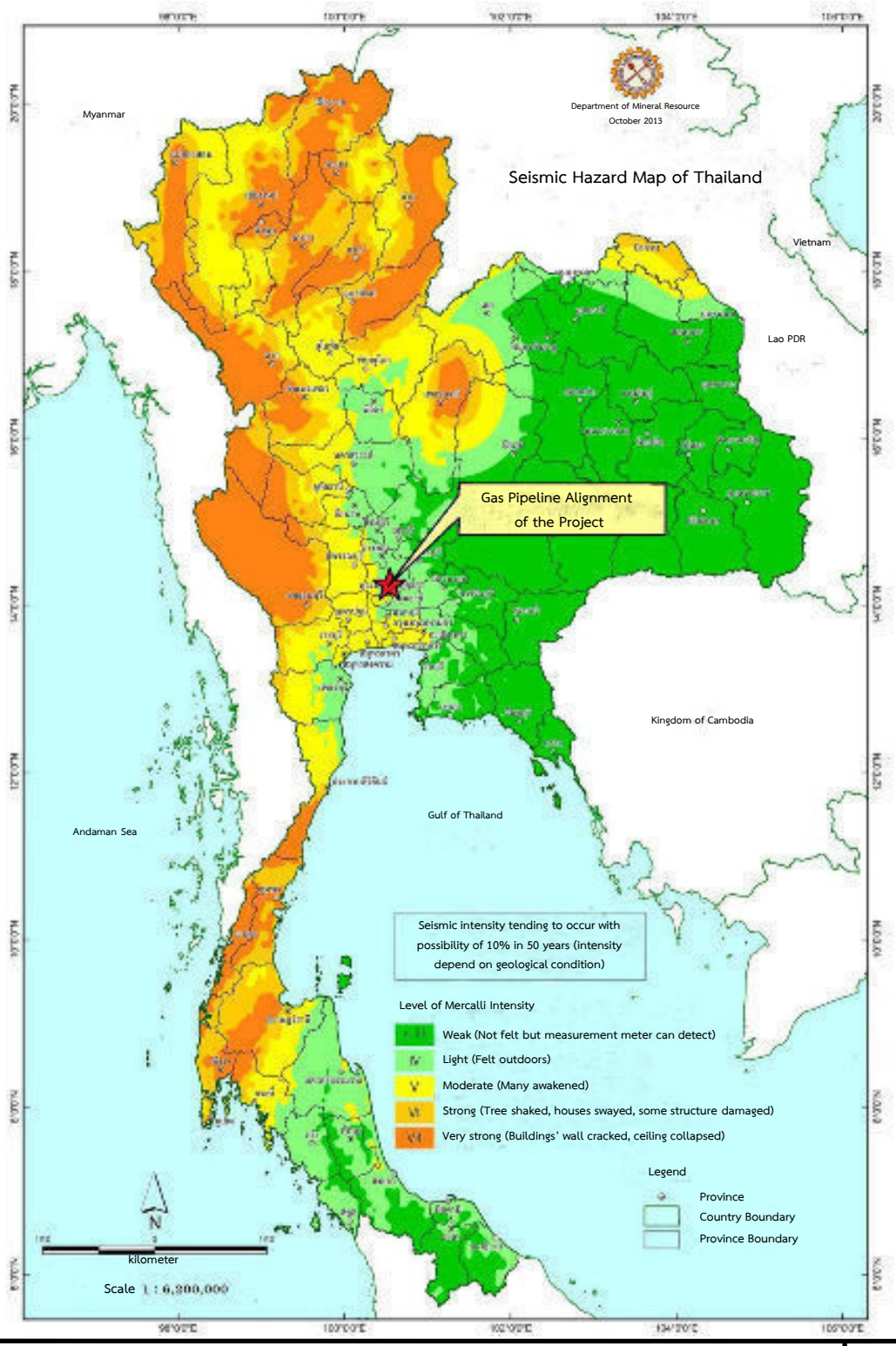


FIGURE 4.1.2-3 : SEISMIC MAP OF THAILAND

TEAM

TABLE 4.1.2-1

SEISMIC STATISTICAL DATA IN THAILAND (2009-2015)

DD/MM/YY	Center/Felt position	Size/Severe	Incident Record
Year 2009			
30 Sep 2009 17.16 p.m.	The central part of Sumatra Island 1.1 S 99.1 E	7.9	Sense shaking at high-rise buildings in various areas of Bangkok, 1,000 persons in Indonesia killed.
Year 2010			
20 Mar 2010 02.53 a.m.	Myanmar 21.2 N 100.3 E	5	Sense shaking at Chiang Rai Province
5 Apr 2010 06.42 a.m.	Wiangchai Chiang Rai Province 19.94 N 99.95 E	3.5	Sense shaking at Mueang District Chiang Rai Province
7 Apr 2010 05.15 a.m.	Northern of Sumatra Island 2.35 N 97.13 E	7.6	Sense shaking at high-rise buildings in various areas of Bangkok
9 May 2010 19:59 p.m.	Northern of Sumatra Island 3.59 N 96.04 E	7.3	Sense shaking at high-rise buildings in Phuket, Phang Nga, Suratthani, Songkla and Bangkok Provinces
6 Jul 2010 22:23 p.m.	Myanmar 20.42 N 99.83 E	4.5	Sense shaking at Mae Sai, Mae Jan, Chiang Saen, Mae Fah Luang districts Chiang Rai Province
Year 2011			
4 Feb 2011 20.54 p.m.	Border of Myanmar-India 24.64 N 99.73 E	6.8	Sense shaking at high-rise buildings in various areas of Bangkok
23 Feb 2011 22.53 p.m.	Laos 18.82N 101.74 E	5.4	Sense at Phrae, Nan, Udonthani, Lei, Nong Khai, Nongbualamphu, Khonkaen and Mahasalakham Province
24 Mar 2011 20.55 p.m.	Myanmar 20.52 N 99.92 E	6.8	Sense at North and Northeast of Thailand. Sense at high-rise buildings in various areas of Bangkok. Damage at Mae Sai district Chiang Rai Province and one person killed.
30 Apr 2011 18.12 p.m.	Andaman Sea 7.39 N 97.76 E	4.4	Sense at Phuket Province
10 May 2011 15.11 p.m.	Myanmar 20.82 N 99.88 E	4	Sense at Mae Sai district Chiang Rai Province
24 Jun 2011 23.42 p.m.	Hatsamran district Trang province 7.38 N 99.63 E	3.5	Sense at Kan Tang and Mueang districts Trang Province
6 Sep 2011 00.55 a.m.	Northern of Sumatra Island 2.79 N 97.7 E	6.7	Sense at Mueang district Phuket Province and Had Yai District Songkla Province
Year 2012			
20 Feb 2012 03.48 a.m.	Ta Kua Pa district Phang Nga Province 8.86 N 98.38 E	2.7	Sense at epicenter and small damage occur
5 Mar 2012 13.54 p.m.	Northern of Sumatra Island 4.15 N 97.11 E	5.2	A little bit sense at Phuket Province
11 Apr 2012 15.38 p.m.	West coastal of northern of Sumatra Island 2.43 N 93.11 E	8.6	Sense in various provinces of south, center and northeast of Thailand. Tsunami was 80 cm height at India and 30 cm height at Mieng Island Phang Nga Province.

TABLE 4.1.2-1

SEISMIC STATISTICAL DATA IN THAILAND (2009-2015) (Cont'd)

DD/MM/YY	Center/Felt position	Size/Severe	Incident Record
16 Apr 2012 16.44 p.m.	Sri Suntorn Sub-district, Ta Lang District, Phuket Province 8.02 N 98.37 E	4.3	Sense in various of Phuket Province. Houses were cracked in Ta Lang district, Phuket Province with more 26 times of aftershock.
4 Jun 2012 12.49 p.m.	Mueang district Ranong Province 9.84 N 98.58 E	4	Sense at Khao Nivat and Bangbon Sub-districts, Mueang Ranong district, Ranong Province
23 Jun 2012 11.34 a.m.	Northern of Sumatra Island 2.91 N 97.81 E	6.3	Sense at high-rise buildings in Phuket and Songkla Provinces
13 Sep 2012 01.55 a.m.	Chom Mok Kaew Sub-district, Mae Lao District, Chiang Rai Province 19.75 N 99.82 E	3.4	Sense shaking at Pan District, Chiang Rai Province. Mirror and house were shaken.
11 Nov 2012 8.12 a.m.	Myanmar 22.93 N 95.99 E	6.6	Sense shaking at Chiang Mai, Nontaburi and Bangkok Provinces
11 Nov 2012 17.54 p.m.	Myanmar 22.74 N 95.93 E	5.8	Sense shaking at Chiang Mai province and high-rise building in Bangkok
20 Dec 2012 07.54 a.m.	Myanmar 20.64 N 99.86 E	4.6	Sense shaking at Mae Sai Sub-district, Chiang Rai province and high-rise buildings in Chiang Mai Province
Year 2013			
7 Feb 2013 10.12 a.m.	Myanmar 21.10 N 99.85 E	4.3	Sense shaking at Mae Sai District, Chiang Rai Province
2 Mar 2013 20.35 p.m.	Tung Phay Sub-district, Mueang district, Lampang Province 18.36 N 99.56 E	3.4	Occurrence of a loud noise and shaking at Ton Phaiy, Pichai and Tontongchai Sub-districts, Lampang Province
5 Apr 2013 23.20 p.m.	Mae Win Sub-district, Mae Wang District, Chiang Mai Province 18.64 N 98.72 E	2.9	Sense shaking at Mae Wang, Hang Dong and Mueang Districts, Chiang Mai Province
11Apr 2013 05.05 a.m.	Myanmar 18.96 N 97.68 E	5.1	Sense shaking at Mae Hong Son Province
7 May 2013 03.17 a.m.	Myanmar 20.70 N 99.84 E	5.4	Sense shaking in houses and buildings at Mae Sai and Mueang Districts, Chiang Rai Province
7 Jun 2013 0.01 a.m.	Tung Pee Sub-district, Mae Wang District, Chiang Mai Province 18.61 N 98.74 E	3.1	Sense shaking at Mae Wang and Son Pa Tong Districts, Chiang Mai Province
2 Jul 2013 14.37 p.m.	Northern of Sumatra Island, Indonesia 4.64 N 96.56 E	6	Sense shaking at Phuket and Phang Nga Province and at high-rise buildings in Bangkok

TABLE 4.1.2-1

SEISMIC STATISTICAL DATA IN THAILAND (2009-2015) (Cont'd)

DD/MM/YY	DD/MM/YY	DD/MM/YY	DD/MM/YY
Year 2014			
1 Oct 2013 01.19 a.m.	Tung Luang Sub-district, Praow District, Chiang Mai Province 19.32N 99.24 E	4.1	Sense shaking at Phrao District, Chiang Mai Province but no damage was reported.
16 Jan 2014 12.18 p.m.	Khao Pang Sub-district, Ban Ta Khun District, Surattani Province 9.09N 98.67 E	4.0	No damage and sense shaking were reported.
21 Mar 2014 20.41 p.m.	Nicobar Island, India 7.64N/ 94.21E	6.4	Sense shaking at Muang District, Phuket Province
5 May 2014 18.08 p.m.	Sai Khao Sub-district, Pan District, Chiang Rai Province 19.68N 99.68 E	6.3	Sense shaking and damage was reported in all north provinces and other provinces including Bangkok
24 May 2014 10.12 a.m.	Na Noi District, Nan Province 18.40N 100.77E	3.6	Sense shaking at Nai Wieng Sub-district, Mueang district, Nan Province
9 Jun 2014 19.59 p.m.	Myanmar 20.52N 99.88E	5.1	Sense shaking at Wieng Chai, Mueang and Mae Sai Districts, Chiang Rai Province
26 Jun 2014 00.23 a.m.	Pan District, Chiang Rai Province 19.70N 99.71E	3.2	Sense shaking at Mae Lao and Mueang Districts, Chiang Rai Province
26 Jun 2014 14.29 p.m.	Mae Lao district, Chiang Rai Province 19.71N 99.67E	4.6	Sense shaking at Chiang Rai and Chiang Mai Provinces
15 Jul 2014 20.30 p.m.	Pan district, Chiang Rai Province 19.70N 99.70E	4.3	Sense shaking at Pan, Mae Lao, Mueang and Mae Sa Ruei Districts, Chiang Rai Province
16 Aug 2014 15.25 p.m.	Mae Sa Ruea district, Chiang Rai province 19.68N 99.61E	4.1	Sense shaking at Mae Sa Ruai District, Chiang Rai Province
25 Aug 2014 05.32 a.m.	Mae Sa Ruea District, Chiang Rai Province 19.71N 99.55E	4.8	Sense shaking at Chiang Rai Province
27 Oct 2014 07.02 a.m.	Northern of Sumatra Island, Indonesia 5.75N 98.23E	5.3	Sense shaking at Phuket Province
8 Nov 2014 19.51 p.m.	Mae Lao district, Chiang Rai Province 19.71N 99.65E	2.4	Sense shaking at Mae Lao District, Chiang Rai Province
23 Nov 2014 18.49 p.m.	Myanmar 20.56N 99.86E	4.4	Sense shaking at Mueang and Chiang Saen Districts, Chiang Rai Province and Bangkok
19 Dec 2014 2.28 a.m.	Myanmar 20.66N 99.76E	4	Sense of shaking frequency at Mueang and Chiang Saen Districts, Chiang Rai Province

TABLE 4.1.2-1

SEISMIC STATISTICAL DATA IN THAILAND (2009-2015) (Cont'd)

DD/MM/YY	DD/MM/YY	DD/MM/YY	DD/MM/YY
Year 2015			
19 Jan 2015 1.08 a.m.	Wieng Mok Sub-district, Teun district, Lampang Province 17.52N 99.38E	2.9	Occurrence of a loud noise and shaking at Wieng Mok subdistrict, Teun district, Lampang province
16 Feb 2015 13.05 p.m.	Pan district, Chiang Rai Province 19.69N 99.67E	3.2	Houses and buildings were shaken and loud noise at Pan District, Chiang Rai Province.
20 Feb 2015 13.02 p.m.	Phang Nga Bay in South of Yao Yai Island at Khao Yao District, Phang Nga Province 7.87N 98.75E	4.0	Sense shaking at Phang Nga, Phuket and Krabi Provinces
25 Mar 2015 05.32 a.m.	Outside of coastal in east of Phuket province 7.89N 98.52E	3.8	Sense shaking at Mueang, Kra Tu, Ta Lang Districts, Phuket province, and Yao Yai Island Phang Nga Province
6 May 2015 04.18 a.m.	In the sea at Khao Yao District Phang Nga Province 7.85N 98.54E	4.6	Sense shaking at Phang Nga, Kra Bi and Phuket Provinces
7 May 2015 00.30 a.m.	In the sea at Khao Yao District Phang Nga Province 7.84N 98.51E	4.5	Sense shaking at Phang Nga, Kra Bi and Phuket Provinces
24 May 2015 13.27 p.m.	Myanmar 20.56N 99.02E	5.1	Sense shaking at Chiang Mai, Chiang Rai and Mae Hong Son Provinces

Source: The Seismology Bureau, Meteorological Department, 2015

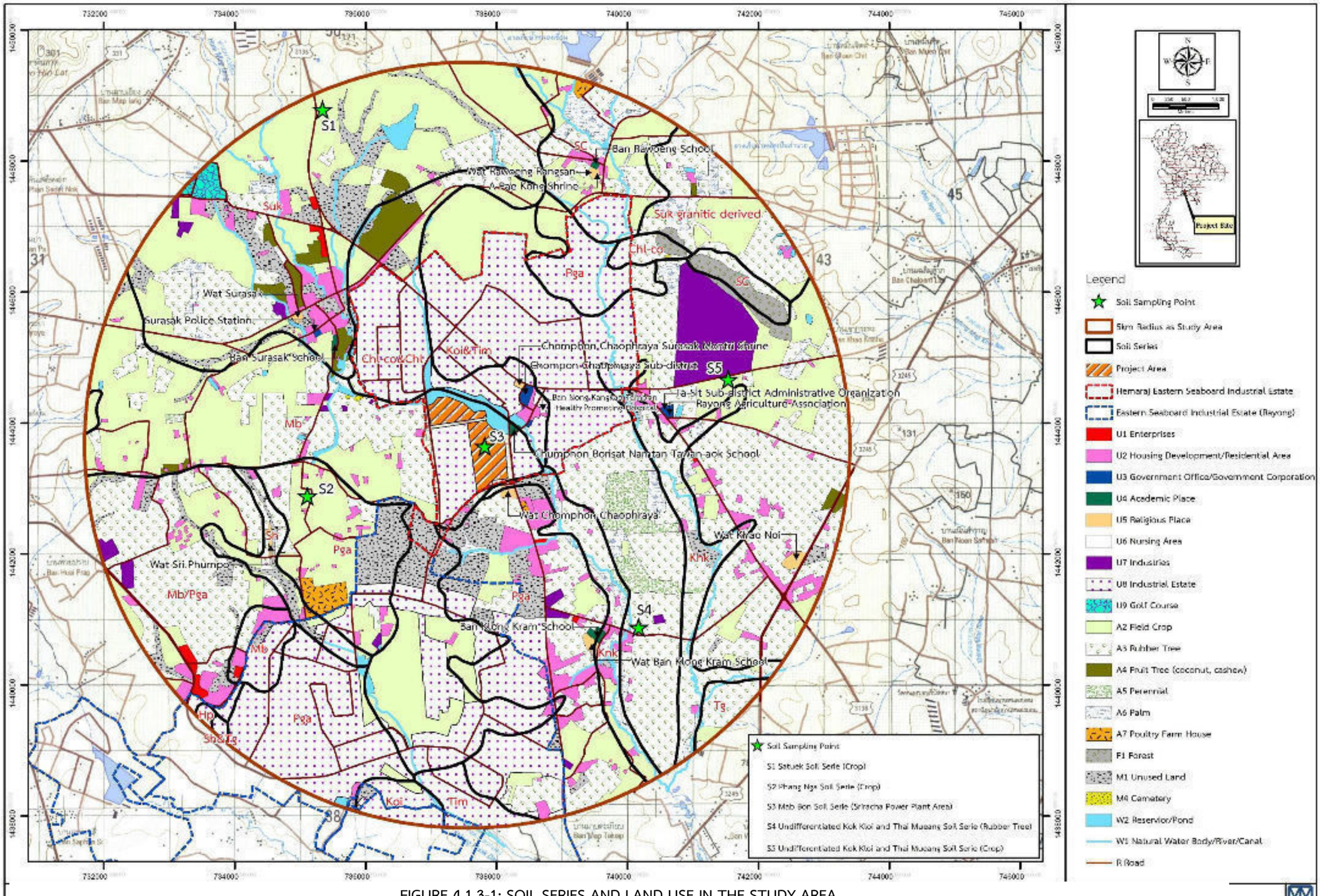


FIGURE 4.1.3-1: SOIL SERIES AND LAND USE IN THE STUDY AREA

- **Number of soil series** in the study area were 15 series. They are undifferentiated Khok Kloi and Thai Muang, Phang Nga series, Mab Bon serires, Satuk series, undifferentiated Chalong with less than 18% of clay and Chalong, Mab Bon and Phang Nga association, Khlong Nok Krathung series, Satuk sereis (which is derived from granite rocks), Sattahip series, Thung Wa series, Thai Muang series, Khok Kloi series, Chalong series with less than 18 % of clay, Huai Pong Series and undifferentiated Sattahip and Thung Wa.
- **Land use within 5 km radius of the project** found that it mostly is rubber tree area follow by crop (cassava/pineapple) and industrial estate area, respectively (**Table 4.1.3-1**).
- **Proportion of soil series area in the study area** is shown in **Table 4.1.3-1**. Among 15 soil series found that undifferentiated Khok Kloi and Thai Muang is the major series found in the study area followed by Phang Nga and Mab Bon series, respectively.

According to criteria mentioned above, five soil samples were collected from undifferentiated Khok Kloi and Thai Muang 2 samples, Satuk, Phang Nga and Mab Bon series 1 sample of each (each soil sample was collected from 3 holes). Soil sample collection was consider on most of land use type in study area which were rubber tree and crops, respectively. The top soil was collected at 0-30 cm depth as disturbed sample to study on soil characteristics. Top soil is fertility layer which may effect from project development. Soil sampling was conducted on 14 January 2015 (**Photo 4.1.3-1**). Samples were sent to laboratory to analyze the physical and chemical properties of soil samples. Analyzed result is attached in **Appendix 3A**. All data were used in order to assess impact on soil erosion caused by activities during the construction period and operation period.

(3) Study results

(3.1) Secondary data

(a) Data from the Geological Information System (GIS) (Land Development Department, 2008)

From the data collection of soil series conducted in the project's study areas (within 5 km radius from the project location), the total of 15 soil series were found. Most of the soil series are undifferentiated Khok Kloi and Thai Muang (24.32 %) followed by Phang Nga series (18.39 %). Other soil series found in the study areas include Mab Bon series, Satuk series, undifferentiated Chalong (less than 18 % of clay) and Chalong, Mab Bon and Phang Nga association, Khlong Nok Krathung series, Satuk series (which is derived from granite rocks), Sattahip series, Thung Wa series, Thai Muang series, Khok Kloi series, Chalong series (less than 18 % of clay), Huai Pong series, and undifferentiated Sattahip and Thung Wa. Besides, slope complex of which the soil series could not be classified (4.15 %), were found. Details are shown in **Table 4.1.3-2** and **Figure 4.1.3-1**.

TABLE 4.1.3-1

SOIL SERIES AND LAND USE IN THE STUDY AREA FOR CONSIDERING NUMBER AND LOCATION OF SOIL SAMPLE

Type of land use		Satuk series (which is derived from granite rocks)	Satuk seies	Slope complex	Undifferentiated Chalong (less than 18 % of clay) and Chalong,	Undifferentiated Khok Kloi and Thai Muang	Phang Nga series	Chalong (less than 18 % of clay)	Mab Bon series	Khlong Nok Krathung series	Thung Wa series	Mab Bon and Phang Nga association	Sattahip series	Huai Pong series	Sattahip and Thung Wa association	Thai Muang series	Khok Kloi series	Total area (Rai)	Percentage (%)
A2	Field crop / Cassava / Pineapple	636.97	5,369.57	896.55	500.66	2,736.80	2,448.82	0.00	4,694.85	288.58	46.96	766.25	167.09	0.00	0.00	0.00	27.35	18,580.66	27.83
A3	Rubber tree	1,029.63	1,647.63	753.23	190.18	6,886.55	2,117.89	138.68	1,931.50	1,787.79	318.96	2,645.79	223.46	0.00	0.00	1.89	0.00	19,672.37	29.47
A4	Orchard, coconut, cashew	11.23	359.39	0.00	297.60	51.13	0.00	0.00	35.72	0.00	0.00	0.83	0.00	0.00	0.00	0.00	0.00	755.91	1.13
A5	Perennial (Eucalyptus, fast growing tree, etc.)	0.00	0.00	0.00	0.00	629.58	0.00	0.00	22.97	48.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	701.27	1.05
A6	Oil palm	205.70	192.74	341.32	6.80	337.36	121.44	0.00	25.99	327.60	2.71	0.00	0.00	0.00	0.00	0.00	0.00	1,561.66	2.64
A7	Chicken farm	0.00	0.00	37.47	0.00	0.00	188.38	0.00	0.00	0.00	0.00	0.00	14.49	0.00	0.00	0.00	0.00	240.34	0.36
F1	Forest	29.91	0.00	280.98	0.00	111.13	0.00	58.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	480.78	0.72
M1	Unused area	0.00	1,432.02	0.00	144.98	71.11	1,245.51	0.00	654.07	121.83	0.00	330.57	204.12	0.00	0.00	0.00	36.53	4,240.75	6.35
M4	Graveyard/Cemetery	0.00	0.00	0.00	0.61	0.54	0.00	3.68	8.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.39	0.02
U1	Commercial area	0.00	45.70	0.00	0.00	2.63	14.71	0.00	12.05	0.00	0.00	68.99	0.00	0.00	0.00	0.00	0.00	144.08	0.22
U2	Residential area	31.56	491.53	104.93	122.84	510.70	767.26	0.00	331.56	195.52	0.00	319.67	31.99	0.00	0.00	0.08	2.84	2,910.49	4.36
U3	Government office/State enterprise	0.00	6.75	0.00	34.16	18.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59.84	0.09
U4	Education institution	0.00	8.27	8.27	8.27	8.27	8.27	8.27	8.27	8.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.17	0.10
U5	Religion/Historical place	0.00	13.60	14.31	9.52	42.76	48.85	0.00	0.00	14.11	0.00	0.00	18.37	0.00	0.00	0.00	0.00	161.52	0.24
U6	Hospital	0.00	0.00	0.00	4.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.17	0.01
U7	Factory/warehouse	0.00	70.51	3.49	0.00	1,062.87	79.61	0.00	21.93	0.00	0.00	92.59	0.00	0.00	0.00	0.00	0.00	1,331.00	1.99
U8	Industrial estate	0.00	0.00	321.91	1,831.90	3,746.26	5,208.71	72.80	2,461.56[1/]	160.08	0.00	90.22	138.81	46.88	45.71	537.15	410.59	15,072.58	22.58
U9	Golf field	0.00	150.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	150.80	0.23
W	water resource/pond	20.30	173.06	8.72	129.36	18.05	31.09	0.00	208.92	7.52	0.00	0.00	16.91	0.00	0.00	0.00	0.00	613.92	0.92
Total area		**1,965.30**	**9,961.67**	**2,771.28**	**3,281.05**	**16,234.68**	**12,280.54**	**282.20**	**10,417.96**	**2,960.03**	**367.83**	**4,314.92**	**815.24**	**46.88**	**45.71**	**539.12**	**477.31**	**66,761.70**	**100.00**
Percentage of soil series in study area		**2.94**	**14.92**	**4.15**	**4.91**	**24.32**	**18.39**	**0.42**	**15.60**	**4.43**	**0.55**	**6.46**	**1.22**	**0.07**	**0.07**	**0.81**	**0.71**	**100.00**	
Soil sample (sample)		**-**	**1**	**-**	**-**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**5**	

Remark : Rubber and field crops (cassava and pineapple) are the most land use area in the study area (Exclude industrial area). Soil sampling was considered on percentage of soil series. Samples were collected when soil series were more than 10 percentage in the study area and soil series at project area.

1/ Site of Sriracha power plant

Source : Field surveyed by Team consulting engineering and management Co., Ltd., 2015

TABLE 4.1.3-2

CHARACTERISTICS OF SOIL SERIES IN THE STUDY AREA OF SRIRACHA POWER PLANT PROJECT

Soil series	Description of soil series	Drainage	Permeability	Slope	Soil texture		pH		Fertility	Area	Percentage
				%	Top soil	Subsoil	Top soil	Subsoil		(Rai)	
Suk-granitic derived	Satuk sereis which is derived from granite rocks	Well	Moderate	2-8	Sandy loam	Sandy loam	5.5-6.5	4.5-5.0	Low	1,955.30	2.93
Suk	Satuk series	Well	Moderate	2-8	Sandy loam	Sandy loam	5.5-6.5	4.5-5.0	Low	9,924.44	14.87
SC	Slope complex	-	-	-	-	-	-	-	-	2,746.78	4.11
Chl-co&Chl	Undifferentiated Chalong with less than 18% of clay and Chalong	Well	Moderate	1-12	Sandy loam	Sandy clayed loam	4.5-6.0	4.5-5.5	Low	3,247.35	4.86
Koi&Tim	Undifferentiated Khok Kloi and Thai Muang	Well	Moderate	5-35	Sandy loam	Sandy clay	5.0-5.5	4.5-5.0	Low	16,069.07	24.07
Pga	Phang Nga series	Well	Moderate	2-12	Sandy loam	Sandy clayed loam	5.0-6.5	6.5	Low	12,083.45	18.10
Chl-co	Chalong series with less than 18% of clay	Well	Moderate	1-12	Sandy loam	Sandy clayed loam	4.5-6.0	4.5-5.5	Low	271.73	0.40
Mb	Mab Bon series	Well	Moderate	3-6	Sandy loam	Sandy clayed loam	6.0-7.0	4.8-5.4	Moderate	10,925.49	16.36
Knk	Khlong Nok Krathung series	Well	Rapid	2-12	Sandy loam	Sandy clayed loam	4.5-6.0	4.5-5.5	Low	2,960.25	4.43
Tg	Thung Wa series	Well	Moderate	2-12	Sandy loam	Sandy loam	5.0-6.0	4.5-5.5	Low	367.74	0.55
Mb/Pga	Mab Bon and Phang Nga association	Well	Moderate	3-6	Sandy loam	Sandy clayed loam	6.0-7.0	4.8-5.4	Moderate	4,326.48	6.48
Sh	Sattahip series	Rather well	Rapid	2-5	Loamy sand	Loamy sand	6.0-7.0	6.0-6.5	Low	811.53	1.22
Hp	Huai Pong series	Well	Well	1-12	Sandy loam	Sandy clayed loam	6.0-7.0	5.5-6.5	Low	45.41	0.07
Sh&Tg	Undifferentiated Sattahip and Thung Wa	Rather well	Rapid	2-5	Loamy sand	Loamy sand	6.0-7.0	6.0-6.5	Low	44.24	0.07
Tim	Thai Muang series	Well	Moderate	2-20	Loamy sand	Sandy clayed loam	5.0-6.0	6.5	Low	520.98	0.78
Koi	Khok Kloi series	Well	Moderate	5-35	Sandy loam	Sandy clay	5.0-5.5	4.5-5.0	Low	462.89	0.69
Total area										**66,761.70**	**100.00**

Source : Land Development Department, 2008

PHOTO 4.1.3-1: COLLECTION OF SOIL SAMPLE IN THE STUDY AREA

(3) Study results

(3.1) Secondary data

(a) Data from the Geological Information System (GIS) (Land Development Department, 2008)

From the data collection of soil series conducted in the project's study areas (within 5 km radius from the project location), the total of 15 soil series were found. Most of the soil series are undifferentiated Khok Kloi and Thai Muang (24.32 %) followed by Phang Nga series (18.39 %). Other soil series found in the study areas include Mab Bon series, Satuk series, undifferentiated Chalong (less than 18 % of clay) and Chalong, Mab Bon and Phang Nga association, Khlong Nok Krathung series, Satuk series (which is derived from granite rocks), Sattahip series, Thung Wa series, Thai Muang series, Khok Kloi series, Chalong series(less than 18 % of clay), Huai Pong series, and undifferentiated Sattahip and Thung Wa. Besides, slope complex of which the soil series could not be classified (4.15 %), were found. Details are shown in **Table 4.1.3-2** and **Figure 4.1.3-1**.

(b) Data received from soil surveys (Land Development Department 1985)

In overview, the soil series in the study areas of Sriracha Power Plant Project is totally sandy loam with well drainage, moderate soil permeability, and low fertility. The soil's geomorphological characteristics are caused by in situ decay and decomposition of granite and/or the soil had moved in short distance by the gravity. The said area condition is undulating and rolling with gradient percentage of 2-35. Soils in this area are highly to moderately acidic and often found in the granite area.

- Sriracha Power Plant Project is situated above Mab Bon soil series classified as soil series group no. 35. Its characteristics are sandy loam, having well drainage, moderate soil permeability, and low fertility. The soil's geomorphological condition is undulating and rolling with gradient percentage of 3-6. The limitations of this soil series are: low fertility and having been damaged by water erosion. Therefore, planting cover and rotated crops should be made to treat the erosion as well as to increase organic matters in the soils.

(c) Landslide

Landslide is regarded as a geoharzard and caused by the movement of soil mass and rocks down the hillsides by the influence of gravity. In Thailand, landslide is divided into 3 main types: landslide, earthflow, and rockfall or rockslide. Four contributing factors to the landslide (Somjai Yensabai and Wanpen Ouamjaibun, 2008, as referred to in the Department of Mineral Resources, 2011) are as follows:

- Geological characteristics: the area consists of weathered rocks with thick soil horizon while the geological structure comprises faults and cracks stretching and cutting through rock strata, etc.
- Topographical conditions: high and steep mountains.
- Environmental characteristics: land use change was not made according to principles. For example: building houses as well as farming and growing crops having been made by encroaching waterways and mountainous areas; cutting roads through high mountains; constructing buildings obstructing drainage channels (roads, bridges, drainage pipes, etc.).
- Rainfall volume is so high that soil horizon cannot absorb water. The general standard is to have rainfall of 100 mm in 24-hour period or the accumulated rainfall is at 300 mm.

The Department of Mineral Resources had thus conducted studies and surveys in order to make maps showing areas at risk from landslides and villages at risk from landslides in Chon Buri Province in 2010 using geological, topographical, and land use factors. The result shows that the steeply-mountainous geography such as Khao Mai Daeng, Khao Ta In, Khao Kheow, Khao Ta Baek, Khao Chompu, and Khao Nam Joan Mountains as

well as Chon Buri Province's central area and in Si Racha District and Bo Thong District and the geological conditions being sedimentary rocks pierced and cut by granite in the central area in fact accelerate the decay and decomposition of the thick soil horizon. Then when rainfall is over 150 mm/day or the accumulated rainfall is more than 300 mm, this may cause landslides in the areas of various villages located at the foothills.

Having checked the list of villages at risk from landslides in Chon Buri Province totaling 14 villages and covering the areas of 4 Sub-Districts and 4 Districts as compiled by Department of Mineral Resources (2010), the study area and the project area are not located in such areas at risk from landslide.

(3.2) Field surveys

Fieldwork soil samplings were undertaken in the project area on 14 January 2015 in the number of 5 samples (3 pits per sample). Disturbed soil samplings were made, according to **Figure 4.1.3-1**, in order to study soil properties at the depth level of 0-30 cm. Then the soil samplings were sent to the laboratory for chemical-physical properties analysis. The analyses results would be used to assess the soil fertility as well as the impact of soil erosion caused by the project's construction and operational activities, as follows:

(a) Soil fertility assessment

Soil fertility is assessed based on the amount of organic matters, the cation exchange capacity, the saturation with alkaline cations, and the amounts of available phosphorus and exchangeable potassium. The grading of soil fertility is divided into 3 levels: low, medium, and high in accordance with **Table 4.1.3-3**. The overall soil fertility of the study areas is as shown in **Table 4.1.3-4**.

Regarding the overall soil fertility in the study areas as shown in **Table 4.1.3-4**, the soil fertility is low (the average total score = 8.00).

TABLE 4.1.3-3

ASSESSMENT OF SOIL FERTILITY USING RESULTS OF SOIL ANALYSIS

Fertility level	Organic matter (%)	Base cation saturation (%)	Cation exchange capacity (meq/100 g soil)	Available P (ppm)	Exchangeable K (ppm)
Low	<1.5	<35	<10	<10	<60
(Score)	1	1	1	1	1
Moderate	1.5-3.5	35-75	10-20	10-25	60-90
(Score)	2	2	2	2	2
High	>3.5	>75	>20	>25	>90
(Score)	3	3	3	3	3

Remark : Total score of soil fertility can be divided into 3 levels.
Score 5-8 = low
Score 9-12 = moderate
Score 13-15 = high

Source : Land Development Department, 1991

TABLE 4.1.3-4

ASSESSMENT OF SOIL FERTILITY IN THE STUDY AREA

Soil sample	Soil series	OM		BS		CEC		P		K		Total score	Level of soil fertility[2/]
		Analytical result (%)	Score[1/]	Analytical result (%)	Score[1/]	Analytical result (meq/100 g.)	Score[1/]	Analytical result (mg/kg)	Score[1/]	Analytical result (mg/kg)	Score[1/]		
S1	Satuk series (Suk)	0.383	1.00	74.26	2.00	3.00	1.00	60.00	3.00	64.00	2.00	9.00	Moderate
S2	Phang Nga series (Pga)	0.493	1.00	19.37	1.00	1.00	1.00	66.00	3.00	32.00	1.00	7.00	Low
S3	Mab Bon series (Mb)	0.176	1.00	42.73	2.00	2.00	1.00	13.00	2.00	70.00	2.00	8.00	Low
S4	Undifferentiated Khok Kloi and Thai Muang (Koi&Tim)	0.605	1.00	19.20	1.00	3.00	1.00	28.00	3.00	49.00	1.00	7.00	Low
S5	Undifferentiated Khok Kloi and Thai Muang (Koi&Tim)	1.980	2.00	41.20	2.00	4.00	1.00	12.00	2.00	123.00	3.00	10.00	Moderate
Average of Undifferentiated Khok Kloi and Thai Muang (Koi&Tim)		1.293	1.00	30.20	1.00	3.50	1.00	20.00	2.00	86.00	2.00	7.00	Low
Overall of soil series in the study area[3/]		0.727	1.00	39.35	2.00	2.60	1.00	35.80	2.00	67.60	2.00	8.00	Low

Remark : [1/] Fertility level (Low = 1, Moderate = 2, High = 3)

[2/] Soil fertility level (Low = total score 5-8, Moderate = total score 9-12, High = total score 13-15)

[3/] Overall of soil series was averaged from data of soil samples in the study area

(b) Assessment of the impact of soil erosion

The soil-related impact arising from the project development is soil erosion resulted from open cut activity during the construction period. The erosion rate depends on soil properties. The comparative study was in 2 scenario: the present condition and the condition after the project having been established. The universal soil loss equation (USLE) of Wischmeir and Smith (1978) was used in the study as shown below:

A = RK(LS)CP

When A = Soil Loss Rate (ton/hectare/year)

R = Rainfall Erosivity Index (R-factor)

K = Soil Erodibility Index (K-factor)

L = Slope Length Index (L-factor)

S = Slope Steepness Index (S-factor)

C = Crop Management Index (C-factor)

P = Soil Conservation Measures Index (P-factor)

Each index value has to be calculated upon characteristics of project construction site in order to solve the above equation. Details of the calculation for each index value are as follows:

1. Rainfall Erosivity Index (R-factor) - According to the review of Manoo Sikajon et al. (1982), R-factor in Thailand is divided into 2 zones: tropical rainforest climate covering the southern region from Chumphon Province down and the lower eastern region including Chanthaburi and Trat Provinces; and Savannah climate the rest of Thailand. Sriracha Power Plant Project area is located on the fringe of Chon Buri and Rayong Provinces that have savannah climate. Regarding rainfall kinetic energy equation to find the R-factor suitable for Thailand, the KE>1 equation is more suitable than EI_{30}, so Y = 0.163X-0.0375, r = 0.727, and n = 22. The average amount of rainfall measured by Laem Chabang Meteorological Station equals 1.133 mm/year. Therefore, **R from the above equation = 184.65 m-ton/ha-yr**.

2. Soil Erodibility Index (K-factor) - This index is derived from the study of soil series properties in the project's study area, both field surveys and laboratory analyses. The study results depend on soil types and land use. K-factor is assessed using USDA (1990) equation, as follows;

K = K1*K2*K3*K4

When K1 = 0.2+0.3exp [-0.0256 Sand (1-Silt/100)]

K2 = $[Silt/ (Silt + Clay)]^{0.3}$

K3 = 1-[0.25C/{C + exp (3.72-2.95C)}]

K4 = 1-[0.7SN1/ {SN1+exp (-5.51+22.9SN1)}]

Sand, Silt, Clay = % of Soil Particulate, Sand, Silt, and Clay Particles

C = % of Organic carbon

SN1 = 1-Sand / 100

Using the above equation and the analyses of soil series properties conducted in the laboratory to get K-factor as shown in **Table 4.1.3-5**, the analyses of sampling of soil series properties in the project's study area in terms of the particle size distribution of sand, silt and clay shows that the soil texture is sandy loam with low amount of organic matters and having the average Soil Erodibility Index (K-factor) of 0.21.

3. LS Factors – The area conditions play the role in causing soil erosion in 2 ways: slope length and slope gradient. Wischmeier & Smith (USDA, 1978) had continuously studied the relations between the two factors and soil loss in the experimental plot in various environmental conditions for a long period of time. The results of this study was then developed into the mathematical equation for calculating LS factors to be used with the universal soil loss equation. The Land Development Department had thus conducted the comparative study of the calculations of S-factor and L-factor from various equations used in many countries, and applied the study results in Thailand. Therefore, in this project, the soil series maps was used as a basis for calculating total LS factors of slope steepness soil horizon in the soil series maps (see **Table 4.1.3-6**).

The study results shows that soil series in the area of project location is Mab Bon soil series that has slope steepness of 3-6 % (S value). According to **Table 4.1.3-6**, Mab Bon soil series is classified as being in the slope steepness soil horizon in the map of soil series C, with the slope length of 100 m. Therefore, the area's slope steepness factor equals 0.567.

4. Crop Management Index: C-factor - The project location's existing condition is an earthfilled area located in the unutilized industrial estate. Therefore, based on the criteria for soil erosion in Thailand (Land Development Department, 2002) as shown in **Table 4.1.3-7**, Crop Management Index or C-factor would equal 0.8. However, in the case of project existence but without management measures,

C will be 1.0 whereas in the case of project existence with management measures, C will be 0.015. Following the Project's construction and development as a power plant area, at least 5 % of the project area will be allocated as green area.

5. Soil Conservation Measures Index: P-factor

Considering the project location's existing condition, P is fixed at 1.0 since it is situated in the landfilled area of an unutilized industrial estate as shown in **Table 4.1.3-7**, with no soil conservation measures. However, in the case of project existence without conservation measures, P equals 1.0. After the project has been developed as a power plant area with at least 5 % of the project area allocated as green area, **P will equal to 1.0**.

TABLE 4.1.3-5

SOIL PROPERTIES AND K FACTOR OF SOIL SERIES IN THE STUDY AREA

Soil sample	Soil series	Soil texture[1/] (USDA)	Particle size distribution[1/]			Organic matter (OM) (%)	Organic carbon[1/] (OC) (%)	K factor[2/]
			Sand (%)	Silt (%)	Clay (%)			
S1	**Satuk (Suk)**	**Loamy Sand**	**87.4**	**4.0**	**8.6**	**0.383**	**0.22**	**0.09**
S2	**Phang Nga (Pga)**	**Loamy Sand**	**81.4**	**12.0**	**6.6**	**0.493**	**0.29**	**0.16**
S3	**Mab Bon (Mb)**	**Sandy Loam**	**55.4**	**28.0**	**16.6**	**0.176**	**0.10**	**0.27**
S4	**undifferentiated Khok Kloi and Thai Muang (Koi&Tim)**	**Sandy Loam**	67.4	20.0	12.6	0.605	0.35	0.23
S5		**Clay**	37.4	20.0	42.6	1.980	1.15	0.21
Average value of undifferentiated Kok Kloi and Thai Mueang (Koi & Tim)		**Sandy Clay Loam**	**52.4**	**20.0**	**27.6**	**1.293**	**0.75**	**0.22**
Overall of soil in the study area		**Sandy Loam**	**65.8**	**16.8**	**17.4**	**0.727**	**0.42**	**0.21**

Remark : [1/] Soil texture, particle size distribution and organic matter get from laboratory (% OC = % OM/1.724)

[2/] K factor gets from equation of Williams et al. (1990)

Source : Field surveyed by Team consulting engineering and management Co., Ltd., January 2015

TABLE 4.1.3-6

LS-FACTOR OF SLOPE LEVEL FROM GROUP OF SOIL SERIES MAP

Slope level from group of soil series map	Slope percentage (S value)	Length of slope (λ value, m)	LS - factor
A	1.2	160	0.226
B	2.0	150	0.323
C	**5.0**	**100**	**0.567**
D	12.0	50	1.927
E	20.0	50	2.753
F (Group 62)	35.0	50	4.571

Source : Land Development Department, 2000

TABLE 4.1.3-7

C-FACTOR AND P-FACTOR VALUE OF LAND USE MAP 1:50,000

Type of crops	C-factor	P-factor
Abandoned paddy field	0.100	0.100
Paddy field	0.280	0.100
Integrated farming/field	0.225	1.000
Wheat, Barley, Rye	0.280	1.000
Field crop, Integrated crops	0.340	1.000
Pineapple, Aloe Vera, Caribbean agave	0.380	1.000
Black bean, Red bean, Sesame, Opium	0.389	1.000
Green bean	0.390	1.000
Peanut	0.400	1.000
Soybean	0.406	1.000
Cotton, Abandoned crop	0.421	1.000
Corn	0.500	1.000
Cassava, Kenaf, Jute, Paper mulberry, Ramie, Fiber crops	0.502	1.000
Potato Jicama, Sweet potato, Watermelon, ginger, Cabbage, Tomato, Chili	0.600	1.000
Hashish, Roselle	0.600	1.000
Millet, Job's tears	0.650	1.000
Upland rice, Tobacco, Sunflower	0.700	1.000
Castor bean	0.790	1.000
Teak, Magosa, Acasia, *Pterocarpus* sp., *Gmelwa* sp.	0.088	1.000
Perennial, Mixed perennial, Rubber tree, Eucalyptus, Casuarina	0.150	1.000
Oil palm	0.300	1.000
Mangrove forest	0.000	0.000
Rakum, Sala	0.020	1.000
Rain tree	0.088	1.000
Tea, Bamboo, Orchard, Mixed orchard, Durian, Rambutan, Lychee, Mango	0.150	1.000
Banana, Tamarind, Longan, Jackfruit, Santol, Rose Apple, Mangosteen, Langsat	0.150	1.000
Sapodilla	0.150	1.000
Strawberry, Raspberry	0.270	1.000
Coffee, Kapok, *Cerlera* sp., Orange, Jujube, Custard apple, Guava, Lime	0.300	1.000
Sub-Tropical fruit	0.300	1.000
Floricultural	0.356	1.000
Betel palm, Coconut, Cashew, Toddy palm	0.400	1.000
Mulberry, *Croton* sp., Papaya, Horticulture, Mixed Horticulture, Grape, Pepper	0.000	1.000

TABLE 4.1.3-7

C-FACTOR AND P-FACTOR VALUE OF LAND USE MAP 1:50,000 (Cont'd)

Type of crops	C-factor	P-factor
Passion fruit, Hog plum	0.600	1.000
Abandoned crop	0.250	1.000
Swidden cultivation, Upland rice (swidden cultivation), Corn (swidden cultivation)	0.250	1.000
Bean (swidden cultivation), Sesame (swidden cultivation), Potato (swidden cultivation)	0.250	1.000
Vegetable (swidden cultivation), Opium (swidden cultivation)	0.250	1.000
Preparation area for swidden cultivation and abandoned shifting cultivation area	0.250	1.000
Area of abandoned Swidden cultivation and Shifting cultivation	0.250	1.000
Pasture and farm house	0.100	1.000
Mixed farm house, Cattle farm house, Poultry farm house, Swine farm house	0.000	0.000
Stable	0.000	0.000
Aquatic plant, Mixed aquatic plants, Reed, Lotus, Water chestnut, Water spinach, Watercress	0.000	0.000
Abandoned Aquacultural land, Mixed Aquacultural land	0.000	0.000
Fish farm, Shrimp farm, Crab/Shellfish farm, other aquacultural farms, Crocodile farm	0.000	0.000
Swamp forest, Mangrove forest	0.000	0.000
Tropical land forest, Evergreen forest, Other deciduous forests	0.001	1.000
Hill evergreen forest	0.003	1.000
Dry Evergreen Forest, Pine forest	0.019	1.000
Forest area, Mixed Deciduous Forest, Deciduous dipterocarp forest, Grove forest, Deciduous forest	0.020	1.000
Deteriorated evergreen forest, Deteriorated tropical land forest	0.040	1.000
Brake	0.048	1.000
Bamboo forest	0.150	1.000
Deteriorated deciduous forest, Deteriorated forest	0.250	1.000
Beach forest	0.450	1.000
Mangrove plantation	0.000	0.000
Pine plantation, Rubber plantation, Eucalyptus plantation, Teak plantation, Magosa plantation	0.088	1.000
Casuarina plantation, Acacia plantation, *Pterocarpus* sp. plantation, Gmelwa sp. plantation	0.088	1.000

TABLE 4.1.3-7

C-FACTOR AND P-FACTOR VALUE OF LAND USE MAP 1:50,000 (Cont'd)

Type of crops	C-factor	P-factor
Bestard Cedar plantation, Wild Himalayan Cherry plantation, Simaroubaceae plantation, Star apple plantation	0.088	1.000
Nitta tree plantation, Catechu tree plantation, other plantations	0.088	1.000
Forest plantation, Mixed forest plantation, Agro-forestry	0.088	1.000
Abandoned paddy field in irrigation zone	0.100	0.100
Paddy field in irrigation zone	0.280	1.000
Mixed orchard in irrigation zone	0.100	1.000
Banana in irrigation zone	0.150	1.000
Sugar cane in irrigation zone	0.400	1.000
Cassava in irrigation zone	0.600	1.000
Marsh and Swamp	0.000	0.000
Pasture, Natural pasture, Improved pasture, golf course	**0.015**	**1.000**
Bamboo	0.020	1.000
Rangeland	0.032	1.000
Grass and bush or bush, bush and Schrub	0.048	1.000
Abandoned pit, Laterite pit, Sand pit, Soil pit, others	0.000	0.000
Sand beach and emerged rock, sand area	0.800	1.000
Mine	0.800	1.000
Unoccupied area	0.800	1.000
Miscellaneous land	**0.800**	**1.000**
Garbage dump	0.000	0.000
Salt flat	0.000	0.100
Land Allocation project	0.000	0.000
City, Town, commercial, Village, Institutional land	0.000	0.000
Village, Hill tribe village, other residences	0.000	0.000
Transportation ceter, Airport, Train station, Transport station, port	0.000	0.000
Industrial zone, Industrial estate, Industry, Refugee camp	0.000	0.000
Graveyard, Recreation area	0.000	0.000
Water body, River, canal, Natural water body, Reservoir (Built-up)	0.000	0.000
Lake, marsh, Reservoir, pond	0.000	0.000

Source : Land Development Department, 2000

The results of assessment of soil erosion rate under various conditions is compared with the intensity level of soil erosion rate in Thailand with reference to Land Development Department (2002) in order to assess the intensity level of soil erosion caused by various activities of the project as shown in **Table 4.1.3-8**.

The analyses results of various factors affecting soil erosion are used to calculate the universal soil loss equation to assess soil erosion rate of the present project area, as follows:

Soil loss rate (A) .. = 184.65×0.21×0.567×0.800×1.00

..... = 17.58 tonnes/hectare/year

..... = 2.81 tonnes/rai/year

The soil loss rate assessment shows that the loss rate of soils in the existing project area equals 2.81 tonnes/rai/year. However, when this rate has been compared with the soil loss rate in Thailand classified by Land Development Department, 2002, it can be concluded that the loss rate of soil in the existing study area is moderate as shown in **Table 4.1.3-8**. When compared with the loss rate of soil tolerance goal according to the reference data of Land Development Department (2002) which is 2 tonnes/rai/year, the average soil loss rate in the study area's existing condition is slightly higher than that of the soil tolerance goal.

TABLE 4.1.3-8

SOIL EROSION RATE OF THAILAND

Soil erosion level	Soil loss rate (tonnes/rai/year)
Slight	0.00 - 2.00
Moderate	2.01 - 5.00
Severe	5.01 – 15.00
Very Severe	15.01 – 20.00
Extremely Severe	> 20.00

Source : Adapted from Land Development Department, 2002

4.1.4 Meteorology

(1) Introduction

Micro scale meteorological condition is an important factor effect to air pollutant diffusion from source to affected receptors in the study area. Level of severity which is more or less varied by geological coordinated between sources and affected receptors, including meteorological condition and climate change in each period of time. Thus, a study of micro scale meteorological condition is important, as basic information for the use of assessing impact on air quality in the construction period and operation period of the project.

(2) Study methods

Data from Laem Chabang Meteorological station in Si Racha District, Chon Buri Province, which is the nearest station to the project, has been used for the study. The station's location is at latitude 13° 4' 37.0" N and longitude 100° 52' 33.0" E. This data is periodical data of these 21 years. The basic data is used to assess impact of the project.

(3) Study results

Compilation of 22 years periodical data from Laem Chabang Meteorological station during 1993-2014 is shown in **Table 4.1.4-1**. Its summary is as follows:

- **Air pressure**

Average annual air pressure is equivalent to 1,009.41 hectopascal. Maximum air pressure is at 1,022.01 hectopascal in March while minimum air pressure is at 999.95 hectopascal in June.

- **Temperature**

Average annual temperature is 28.8 °C. Maximum monthly average temperature is at 33.4 °C in April while minimum monthly average temperature is at 22.2 °C in December and January.

- **Wind Speed and Direction**

Average wind speed is at a range of 4.8-9.8 knots (2.5-5.0 m/s). Minimum average wind speed is found in October while maximum average wind speed is found in June. Wind direction is from the south (S) during February to May, from south-southwest (SSW) during June to September, from east (E) during January to October and from north (N) during November to December **(Figure 4.1.4-1)**.

- **Volume of rainfall**

Average annual rainfall is equal to 1,133 mm. Monthly minimum average rainfall is in December, at 8.1 mm while monthly maximum average rainfall is in September, at 236.4 mm. An average number of raining days is 105 days.

TABLE 4.1.4-1

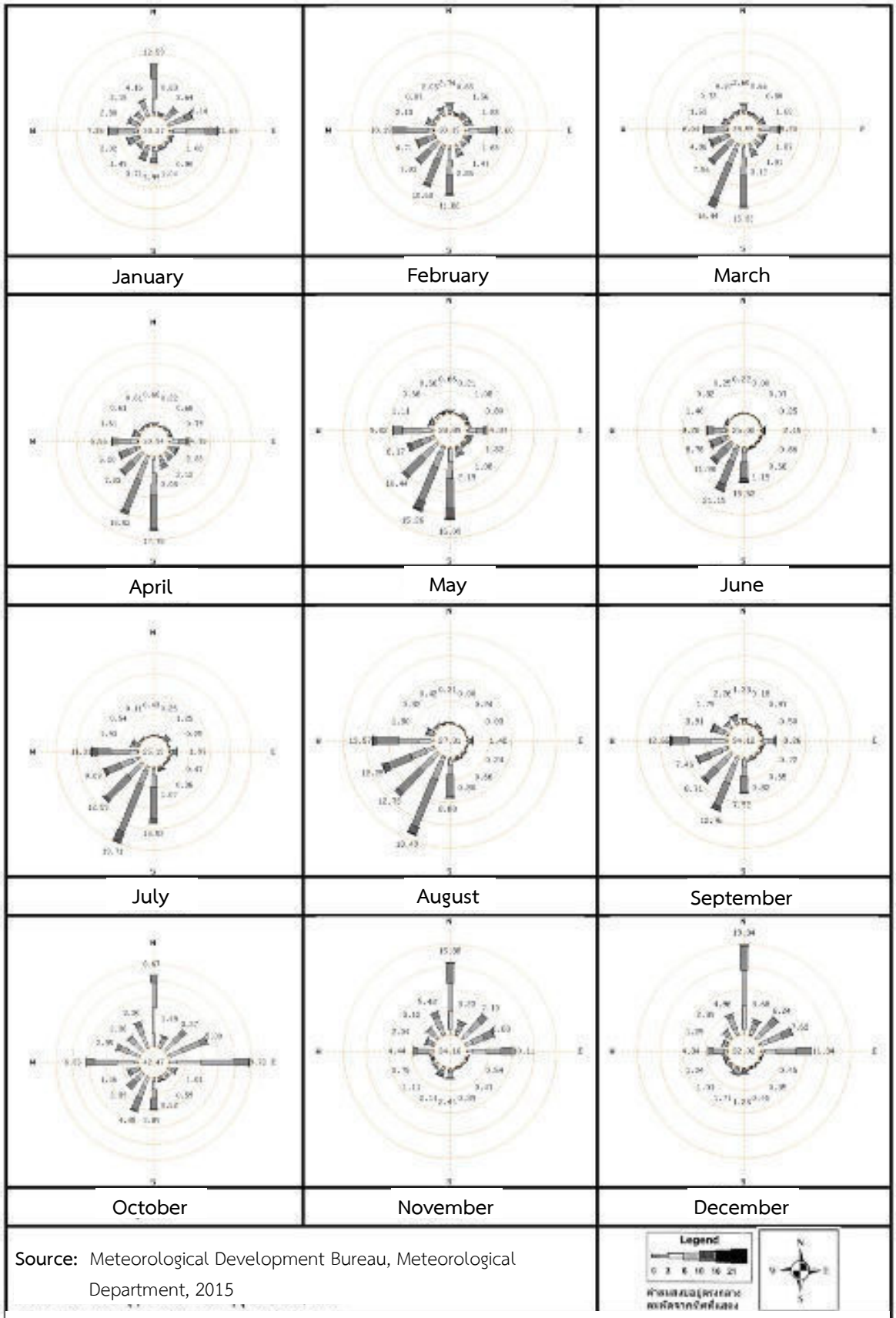
METEOROLOCIAL DATA OF LEAM CHABANG STATION DURING 1993-2014

Meteorological station 48463 –Laem Chabang Latitude 13° 4' 37.0" N

Elevation above MSL 81 meters Longitude 100° 52' 33.0" E

Elements	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pressure (hPa)													
Mean	1012.5	1011.2	1010.5	1009.2	1007.5	1006.9	1007.2	1007.5	1008.1	1009.8	1010.7	1011.8	1009.41
Mean Daily Range	4.4	4.3	4.5	4.3	3.9	3.2	3	3.3	3.9	4.3	4.2	4.2	3.96
Ext. Max.	1021.66	1019.26	1022.01	1015.51	1013.88	1012.88	1012.48	1014.51	1018.34	1016.21	1017.48	1018.76	1022.01
Ext. Min.	1005.9	1004.96	1003.6	1003.4	1002.05	999.95	1000.41	1000.71	1001.44	1002.61	1003.76	1005.13	999.95
Temperature (Celcius)													
Mean	28	28.3	28.9	29.8	29.9	29.1	28.7	28.8	28.4	28.3	28.7	28.1	28.8
Mean Max.	31.9	32	32.6	33.4	32.9	31.8	31.3	31.4	31.3	31.4	31.9	31.7	32
Ext. Max.	39	37.5	37.5	38.1	38.7	36.8	36.2	36.7	35.1	35	38	37.2	39
Mean Min.	22.2	23.4	24.5	25.5	25.7	25.7	25.6	25.1	24.4	23.9	23.5	22.2	24.3
Ext. Min.	14.9	16.5	18.5	19.2	19.2	20	20.1	21	19.6	20	17	14	14
Dew Point Temp. (Celcius)													
Mean	19.8	22.7	23.5	24.6	24.6	24.4	24	24	24.2	24	22	19.7	23.1
Humidity (%)													
Mean	64	73	74	74	74	76	76	76	78	78	69	62	72.8
Mean Max.	77	87	87	86	84	84	84	85	88	89	80	75	83.6
Mean Min.	53	62	65	65	66	70	70	69	71	70	60	52	64.4
Ext. Min.	23	29	25	44	43	53	56	49	55	45	25	27	23
Rainfall (mm)													
Mean	19.2	16.5	50.3	61.8	126	154.5	102.4	112.8	236.4	208.8	36.2	8.1	1133
Mean Rainy Day	1.7	2.4	4.8	6.1	11.7	13.1	12.1	13.3	17.1	16.7	4.5	1.3	104.8
Daily Max.	176.5	35.7	63.8	78.4	87.2	97.9	80.6	126	116.2	116.2	36.8	37.2	176.5
Pan Evaporation (mm.)													
Mean	-	-	-	-	-	-	-	-	-	-	-	-	-
Wind (Knots)													
Wind direct	E	SW	SW	SW	SW	SW	SW	SW	SW	E	N	N	-
Mean	6	7.1	8.3	7.1	7.8	9.8	9.6	8.6	6.8	4.8	5.5	6	7.3
Max.	30	35	36	50	50	52	48	52	60	45	30	37	60
Visibility (Km.)													
Mean	5.2	5.4	6.7	7.8	10.1	10.4	10.1	10.2	9.7	6.9	6.2	5.6	7.9
Time 07.00 AM	4.9	4.9	6	7.5	9.2	9.8	9.7	9.4	8.5	6.5	6.2	5.6	7.4
Phenomena (Days)													
Haze	21.1	13.1	10.3	7.6	2	0.4	0.4	0.6	0.7	7	18.1	24.4	105.7
Fog	0.3	0.2	0	0	0	0	0	0	0	0	0	0	0.5
thunderstorm	0.6	1	3.2	5.4	7.6	6	4.1	3.8	7.3	9.4	2.4	0.5	51.3
Squall	0	0	0.3	0	0.1	0	0.2	0.3	0.3	0	0	0	1.2

Source: The Meteorological Department, 2015



Source: Meteorological Development Bureau, Meteorological Department, 2015

FIGURE 4.1.4-1 : Wind Roase of Leam Chabang Meteorological Station during 1993-2014

4.1.5 Air Quality

(1) Introduction

The study of air quality around the project areas and its vicinity area helps recognize the existing air quality and carrying capacity of air pollutants of those areas. Thus, it is essential to study air quality to be used as basic data for impact assessment which might further occur.

(2) Study methods

- The air quality is studied by mean of secondary data regarding air quality in the vicinity of the project as stated in the report on compliance with the environmental impact mitigation and preventive measures and the environmental impact monitoring measures of Hemaraj ESIE during 2010-2014.
- The ambient air quality in the vicinity of the project is studied by measuring ambient air quality for 7 consecutive days, covering both work days and holidays, at 5 stations, 2 times per station (the prevailing wind direction period: during March – September and November – February at 5-7 months apart). The measured pollutants included total suspended particulates (TSP), particulate matter less than 10 microns (PM-10), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and carbon monoxide (CO) as well as wind speed and wind direction. The methods of sampling and analyses of the said variables used must be the methods accepted by the Office of Natural Resources and Environmental Policy and Planning (ONEP), as shown in **Table 4.1.5.1**.

TABLE 4.1.5-1

PARAMETER, SAMPLING AND ANALYZING METHOD

Parameters	Sampling and Analyzing method
1. Total suspended particulates (TSP)	- Sampling by High Volume Sampler and analyze by Gravimetric Method
2. Particulate matter less than 10 microns (PM-10)	- Sampling by PM-10 Sampler and analyze by Gravimetric Method
3. Nitrogen dioxide (NO_2)	- Sampling by Chemiluminescence Analyzer and analyze by Chemiluminescence Method
4. Sulfur dioxide (SO_2)	- Sampling by UV-Fluorescence Analyzer and analyze by UV-Fluorescence Method
5. Carbon monoxide (CO)	- Sampling by CO NDIR Analyzer and analyze by CO NDIR Method
6. Wind Speed and wind direction	- Using equipment to measure wind speed and wind direction

(3) Study results

(a) Secondary data collection

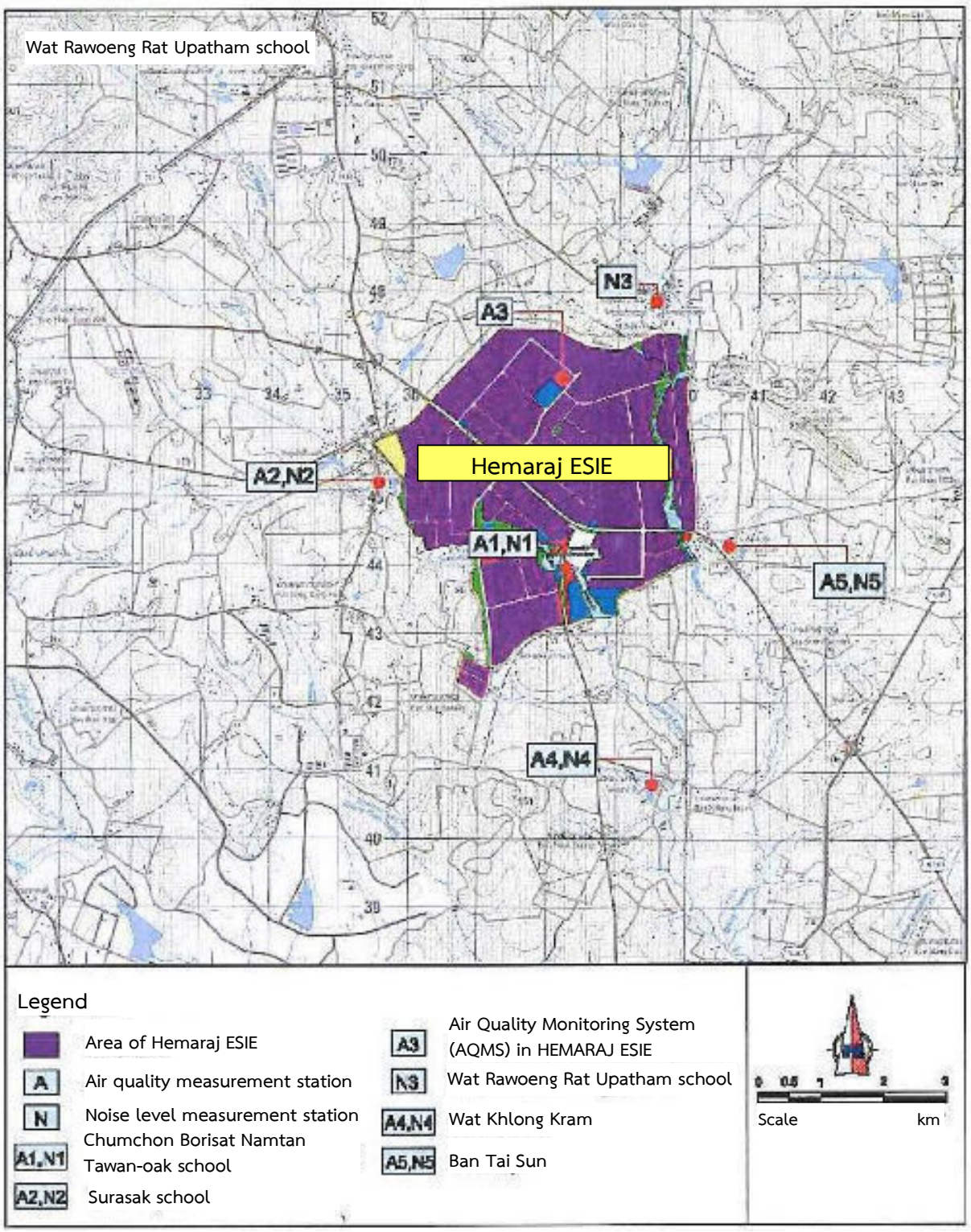
According to the data on air quality in the vicinity of the project in the report on compliance with the environmental impact mitigation and preventive measures and the environmental impact monitoring measures of Hemaraj ESIE during 2010-2014, the ambient air quality measurement took place at 5 stations: Chumchon Borisat Namtan Tawan-aok School Station, Surasak School Station, the Estate's Station of permanent air quality monitoring, Wat Khlong Kram Station, and Ban Tai Sun Station (see **Figure 4.1.5-1** and **Table 4.1.5-2**). The summary is as follows:

- **Chumchon Borisat Namtan Tawan-aok School Station (A1)**

Concentrations of air pollution at this station are within the ambient air quality standards. The measurement results during 2010-2014 are as follows. The 24-hour average of total suspended particulates (TSP) was 14-112 µg/m^3 or 4.24 -33.94 % of the standard (standard 24-hour average of TSP is 330 µg/m^3). The concentrations of particulate matter less than 10 microns (PM-10) was 3-71 µg/m^3 or 2.5–59.17 % of the standard (standard 24-hour average PM-10 is 120 µg/m^3). The 24-hour average sulfur dioxide (SO_2) was below 1-13.8 µg/m^3 or 0.33 – 4.60 % of the standard (standard 24-hour average SO_2 is 300 µg/m^3). The 1-hour average nitrogen dioxide (NO_2) was 0.1-43.1 µg/m^3 or 0.03–13.47 % of the standard (standard 1-hour average NO_2 is 320 µg/m^3). The details are shown in **Table 4.1.5-2**.

- **Surasak School Station (A2)**

Concentrations of air pollution at this station are within the ambient air quality standards. The measurement results during 2010-2014 are as follows. The 24-hour average total suspended particulates (TSP) was 13-218 µg/m^3 or 3.94-66.06 % of the standard (standard 24-hour average TSP is 330 µg/m^3). The concentrations of particulate matter less than 10 microns (PM-10) was 7-99 µg/m^3 or 5.83-82.5 % of the standard (standard 24-hour average PM-10 is 120 µg/m^3). The average 24-hour sulfur dioxide (SO_2) was below 1-11 µg/m^3 or 0.33-3.67 % of the standard (standard 24-hour average SO_2 is 300 µg/m^3). The 1-hour average nitrogen dioxide (NO_2) was 0.1-77.15 µg/m^3 or 0.03-24.11 % of the standard (standard 1-hour average NO_2 is 320 µg/m^3). The details are shown in **Table 4.1.5-2**.



Source : Report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE, 2014

FIGURE 4.1.5-1 : AMBIENT AIR QUALITY AND NOISE MONITORING STATIONS OF HEMARAJ EASTERN SEABOARD INDUSTRIAL ESTATE

TABLE 4.1.5-2

SUMMARY OF AMBIENT AIR QUALITY OF HEMARAJ EASTERN SEABOARD INDUSTRIAL ESTATE DURING 2010-2014

Station	Date	Results			
		TSP 24 hr µg/m³	PM-10 24 hr µg/m³	SO_2 24 hr µg/m³	NO_2 1 hr µg/m³
Chumchon Borisat Namtan Tawan-aok School (A1)	6-13/05/2553	30-50	20-30	9.2-11.5	<10-20
	11-18/10/2553	30-40	20-30	9.9-12.8	<10-20
	24-31/03/2554	15-104	6-57	<1	0.1-4.1
	05-12/09/2554	21-59	10-39	<1	0.3-5.7
	13-20/03/2555	33-84	19-38	<1-2	0.1-17.5
	15-22/11/2555	18-95	9-22	<1-2	0.5-25.6
	11-18/03/2556	61-97	25-71	<1	0.1-4.7
	11-18/11/2556	14-36	3-19	<1	0.8-43.1
	11-18/03/2557	73-112	23-37	2-11	3.76-18.82
	13-20/11/2557	21-48	8-19	9.6-13.8	7.53-24.46
	Min-Max	**14-112**	**3-71**	**<1-13.8**	**0.1-43.1**
Surasak School (A2)	6-13/05/2553	20-30	10-20	9.9-11.0	<10-20
	11-18/10/2553	20-40	10-20	3.4-4.7	<10-20
	24-31/03/2554	26-218	15-99	<1-3	0.1-2.8
	05-12/09/2554	23-33	11-28	<1	0.1-2.8
	13-20/03/2555	34-86	19-54	<1-2	5.5-21.2
	15-22/11/2555	13-85	8-19	<1-1	0.4-12.1
	11-18/03/2556	29-64	11-58	<1	1.0-16.3
	11-18/11/2556	17-84	7-29	<1	0.2-4.1
	11-18/03/2557	61-110	19-47	<1-1	22.58-75.27
	13-20/11/2557	17-44	7-30	1.9-2.1	24.46-77.15
	Min-Max	**13-218**	**7-99**	**<1-11.0**	**0.1-77.15**
Air Quality Monitoring System (AQMS) in HEMARAJ ESIE (A3)	5-11/09/2554	-	15.1-21.6	3-70	2.0-22.2
	13-19/03/2555	40-73	39-64	0.0-26	0.5-25.9
	15-21/11/2555	14-50	9-36	0.00	0.4-21.6
	11-17/03/2556	40-103	36-68	21-28	2.1-29.4
	11-18/11/2556	22-62	10-52	<1	18.3-73.6
	11-18/03/2557	58-70	35-47	0.5-1.5	5.65-62.10
	13-20/11/2557	29-42	22-37	5.4-9.5	12.42-38.01
	Min-Max	**14-103**	**9-68**	**0.0-70**	**0.4-73.6**
Standard		**330**[1/]	**120**[1/]	**300**[2/]	**320**[1/]

TABLE 4.1.5-2

SUMMARY OF AMBIENT AIR QUALITY OF HEMARAJ EASTERN SEABOARD INDUSTRIAL ESTATE DURING 2010-2014 (Cont'd)

Station	Measurement Date	Results			
		TSP 24 hr µg/m^3	PM-10 24 hr µg/m^3	SO_2 24 hr µg/m^3	NO_2 1 hr µg/m^3
Wat Khlong Kram (A4)	6-13/05/2553	40-70	20-40	7.6-9.9	<10-80
	11-18/10/2553	20-40	10-20	7.6-11.8	<10-30
	24-31/03/2554	16-49	7-35	<1	1.4-13.9
	05-12/09/2554	22-84	17-39	<1	1.4-13.9
	13-20/03/2555	41-76	19-48	<1-2	3.2-25.9
	15-22/11/2555	14-53	6-26	<1-1	0.4-9.4
	11-18/03/2556	19-51	15-43	<1	0.1-21.6
	11-18/11/2556	11-42	7-26	<1	0.2-16.8
	11-18/03/2557	45-64	17-36	2-4	9.41-22.58
	13-20/11/2557	36-67	11-28	8.1-13.2	3.76-16.94
	Min-Max	**11-84**	**6-48**	**<1-13.2**	**0.1-80**
Ban Tai Sun (A5)	6-13/05/2553	30-50	20-30	7.6-10.2	<10-20
	11-18/10/2553	20-40	10-30	6.8-10.2	<10-20
	24-31/03/2554	10-57	4-25	<1	0.2-9.1
	05-12/09/2554	20-62	17-30	<1	0.2-9.1
	13-20/03/2555	26-92	14-39	<1-2	9.2-53.5
	15-22/11/2555	20-56	10-29	<1-1	1.7-34.8
	11-18/03/2556	30-65	15-41	<1	0.3-10.9
	11-18/11/2556	20-83	4-22	<1	0.2-15.7
	11-18/03/2557	42-60	14-26	2-4	16.94-22.58
	13-20/11/2557	18-44	7-19	3.2-3.9	18.82-22.58
	Min-Max	**10-92**	**4-41**	**<1-10.2**	**0.2-53.5**
Standard		**330**[1/]	**120**[1/]	**300**[2/]	**320**[1/]

Remark : [1/] Ambient air quality standard in accordance with the notification of National Environmental Committee Vol. 10 B.E.2538 (1995) and Vol. 24 B.E.2547 (2004)

[2/] Ambient nitrogen dioxides in accordance with the notification of National Environmental Committee Vol. 33 B.E.2552 (2009)

Source : Report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2010-2014

- **Air Quality Monitoring System (AQMS) in HEMARAJ ESIE (A3)**

Concentrations of air pollution at this station are within the ambient air quality standards. The measurement results during 2010-2014 are as follows. The 24-hour average total suspended particulates (TSP) was 14-103 µg/m^3 or 4.24-31.21 % of the standard (standard 24-hour average TSP is 330 µg/m^3). The concentrations of particulate matter less than 10 microns (PM-10) was 9-68 µg/m^3 or 7.5-56.67 % of the standard (standard 24-hour average PM-10 is 120 µg/m^3). The average 24-hour sulfur dioxide (SO_2) was 0.00-70 µg/m^3 or 0.00-23.33 % of the standard (standard 24-hour average SO_2 is 300 µg/m^3). The 1-hour average nitrogen dioxide (NO_2) was below 0.4-73.6 µg/m^3 or 0.13-23.00 % of the standard (standard 1-hour average NO_2 is 320 µg/m^3). The details are shown in **Table 4.1.5-2**.

- **Wat Khlong Kram station (A4)**

Concentrations of air pollution at this station are within the ambient air quality standards. The measurement results during 2010-2014 are as follows. The 24-hour average total suspended particulates (TSP) was 11-84 µg/m^3 or 3.33-25.45 % of the standard (standard 24-hour average TSP is 330 µg/m^3). The concentrations of particulate matter less than 10 microns (PM-10) was 6-48 µg/m^3 or 5.0-40.0 % of the standard (standard 24-hour average PM-10 is 120 µg/m^3). The average 24-hour sulfur dioxide (SO_2) was below 1-13.2 µg/m^3 or 0.33-4.40 % of the standard (standard 24-hour average SO_2 is 300 µg/m^3). The 1-hour average nitrogen dioxide (NO_2) was 0.1-80 µg/m^3 or 0.03-25.00 % of the standard (standard 1-hour average NO_2 is 320 µg/m^3). The details are shown in **Table 4.1.5-2**.

- **Ban Tai Sun station (A5)**

Concentrations of air pollution at this station are within the ambient air quality standards. The measurement results during 2010-2014 are as follows. The 24-hour average total suspended particulates (TSP) was 10-92 µg/m^3 or 3.03-27.88 % of the standard (standard 24-hour average TSP is 330 µg/m^3). The concentrations of particulate matter less than 10 microns (PM-10) was 4-41 µg/m^3 or 3.33-34.17 % of the standard (standard 24-hour average PM-10 is 120 µg/m^3). The average 24-hour sulfur dioxide (SO_2) was below 1-10.2 µg/m^3 or 0.33-3.40 % of the standard (standard 24-hour average SO_2 is 300 µg/m^3). The 1-hour average nitrogen dioxide (NO_2) was 0.2-53.5 µg/m^3 or 0.06-16.72 % of the standard (standard 1-hour average NO_2 is 320 µg/m^3). The details are shown in **Table 4.1.5-2**.

Moreover, the consultants had collected the data from the ambient air quality measurement at the project vicinity. It was found that air monitoring and measurement was conducted by Pollution Control Department (1 station: the air quality measurement station located at Ta Sit Sub-district Administrative Organization, Pluak Daeng District, Rayong Province). The consultant collected that measurement data during 2010-2014 from the air quality database of Office of the Air and Noise Quality Management, Pollution Control Department, and collected data during 2012-2014 from the permanent air quality monitoring station of Hemaraj ESIE. The consultants used the highest value from the said measurements as representative in the assessment of impact on air quality, which is summarized below:

- **The highest value derived from the ambient air quality from Ta Sit station belonging to the Pollution Control Department** which is situated about 2.7 km from the project location to the east-northeast (ENE) direction: The data derived from the measurement results of NO_2, SO_2, and PM-10 during 2010-2014 were mostly within the standards, except 24-hour average PM-10 that exceeds the standard value. The details are as follows:

  - 1-hour average NO_2 was 0 – 50.81 μg/m^3
  - 1-year average NO_2 was 7.53 – 13.17 μg/m^3
  - 1-hour average SO_2 was 0 – 57.65 μg/m^3
  - 24-hour average SO_2 was 0 – 28.72 μg/m^3
  - 1-year average SO_2 was 2.62 – 15.72 μg/m^3
  - 24-hour average PM-10 was 0 – 152.33 μg/m^3
  - 1-year average PM-10 was 33.4 – 43.00 μg/m^3

Data checking had been made with Khao Khansong Highway Subdistrict Office, and it was found that the agreement on lane extension was made, from two lanes to four lanes, on the highway no. 3574 at Km.22+700 to 29+800 which is passing the Ta Sit Sub-District Administrative Organization which caused the PM-10 to be unusually high.

- **The highest value derived from the ambient air quality at the Air Quality Monitoring System (AQMS) in HEMARAJ ESIE:** This station is situated about 3 km north of the project location. The measurement data of NO_2, SO_2, TSP, and PM-10 during 2012-2014 can be concluded that most values were within the standards, except

1-hour average NO_2 and 24-hour average PM-10 that exceed the standard values. The details are as follows:

- 1-hour average NO_2 was 0 – 427.17 μg/m^3
- 1-year average NO_2 was 10.65 – 15.44 μg/m^3
- 1-hour average SO_2 was 0 – 106.91 μg/m^3
- 24-hour average SO_2 was 0 – 56.06 μg/m^3
- 1-year average SO_2 was 2.55 – 11.26 μg/m^3
- 24-hour average TSP was 0 – 303 μg/m^3
- 1-year average TSP was 43.64 – 49.15 μg/m^3
- 24-hour average PM-10 was 0 – 123 μg/m^3
- 1-year average PM-10 was 29.00 – 33.92 μg/m^3

(b) Field surveys

The consultants had set the measurement period for ambient air quality (in the prevailing wind period) in 2 periods: during March – September (the southwest monsoon) and November – February (the northeast monsoon) at 5 stations (as shown in **Figure 4.1.5-2**) comprising the project areas, the child development center of Chomphon Chao Phraya Sub-District Municipality, Ban Khlong Kram School, Wat Rawoeng Rangsan, and Ban Nong Kang Pla, twice each station for 7 consecutive days, covering both work days and holidays.

The 1st measurement was conducted during 4-11 February 2014 and used as representative of the measurement during the northeast monsoon season. The 2nd measurement was conducted during 14-21 August 2014 and used as representative of the measurement during the southwest monsoon season. Details are as shown in **Figure 4.1.5-3.** The air quality parameters measured consist of total suspended particulate (TSP), particulate matter less than 10 microns (PM-10), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and carbon monoxide (CO), including wind direction and wind speed. The results was then compared with the ambient air quality standards of Thailand. Details of the ambient air quality measurement are as follows:

1. The results of the 1st air quality measurement conducted during 4-11 February 2014

The results of air quality showed that all measured parameters were totally within the standards. The details are shown in **Table 4.1.5-3**, **Table 4.1.5-4**, **Figure 4.1.5-3**, and **Appendix 3B-1**, and can be summarized as follows:

- **The project area (A1)**

The results of ambient air quality measurement of all parameters was totally within the specified standards. The 24-hour average total suspended particulate (TSP) was 128-220 µg/m^3 or 38.79-66.67 % of the standard value (standard 24-hour average TSP is 330 µg/m^3). The 24-hour average of particulate matter less than 10 microns (PM-10) was 8-99 µg/m^3 or 48.33 – 82.50 % of the standard value (standard 24-hour average PM-10 is 120 µg/m^3). The 1-hour average nitrogen dioxide (NO_2) was 21.08-42.15 µg/m^3 or 6.59–13.17 % of the standard value (standard 1-hour average NO_2 is 320 µg/m^3). The 24-hour average and 1-hour average sulfur dioxide (SO_2) was 5.24-6.29 and 6.03-11.27 µg/m^3 or 1.75–2.10 and 0.77-1.44 % of the standard values, respectively (standard 24-hour average and 1-hour average SO_2 are 300 and 780 µg/m^3, respectively). The 1-hour average carbon monoxide (CO) was 343.68-1,260.16 µg/m^3 or 1.01–3.69 % of the standard value (standard 1-hour average CO is 34,200 µg/m^3). The details are as shown in **Table 4.1.5-3**.

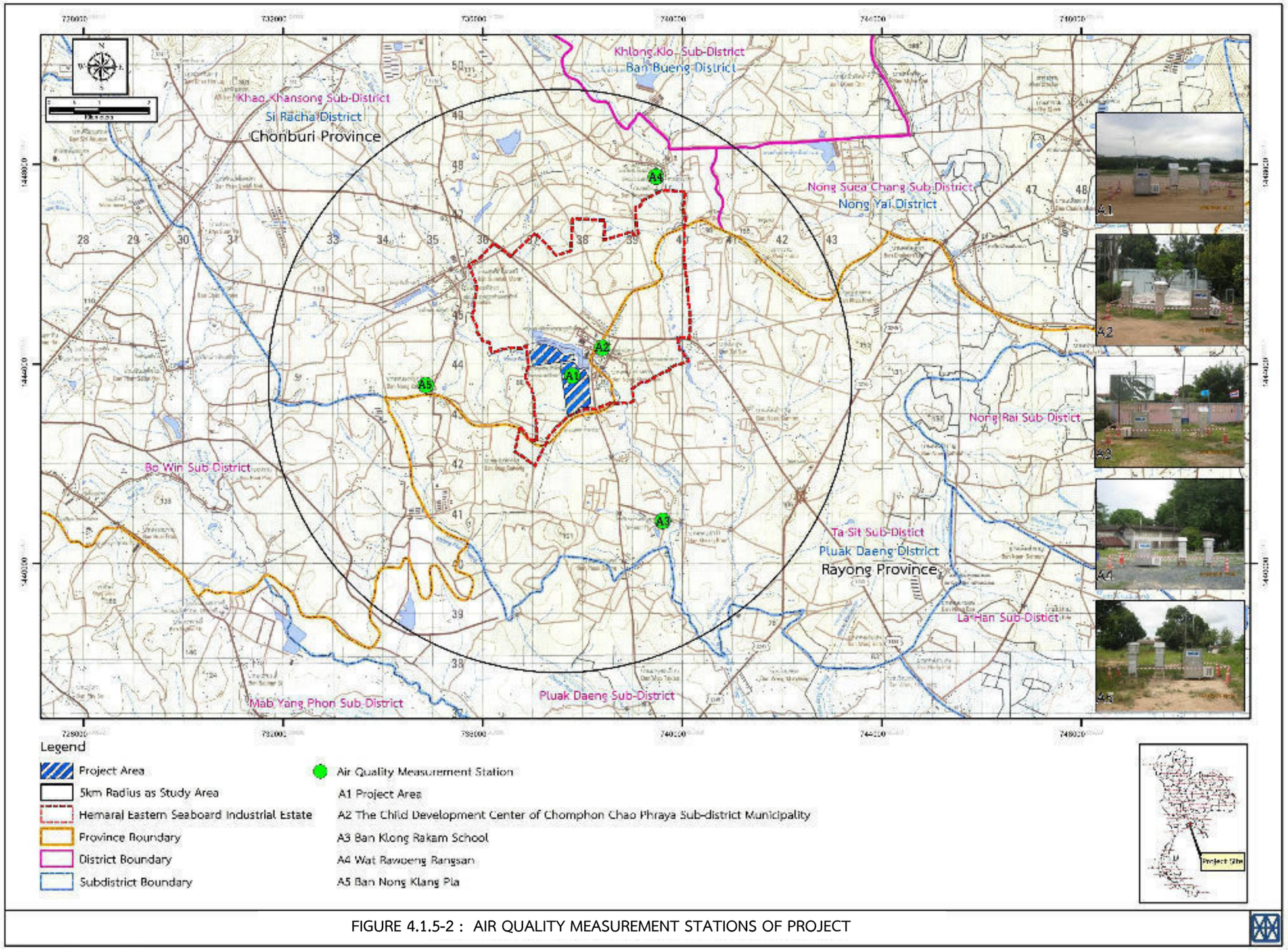
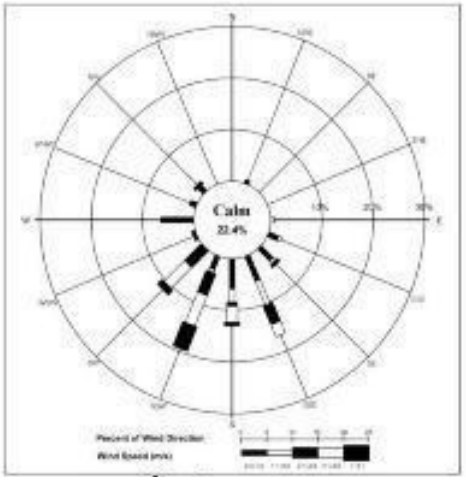
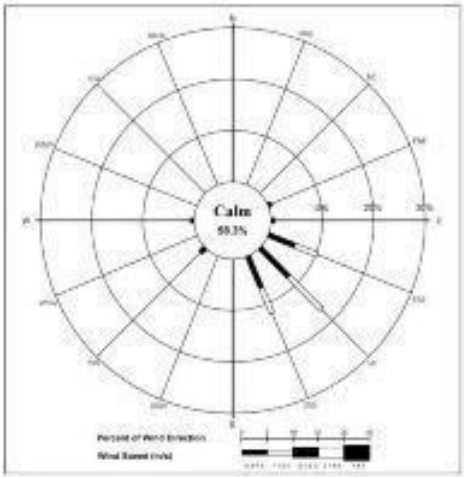


FIGURE 4.1.5-2 : AIR QUALITY MEASUREMENT STATIONS OF PROJECT

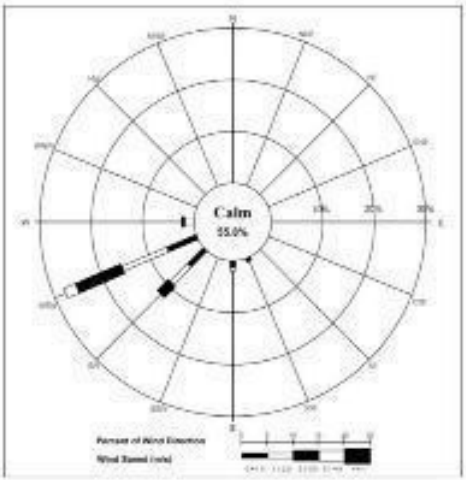
P02810/Pongsak_b/26-09-59/Figure 3.5-2.mxd



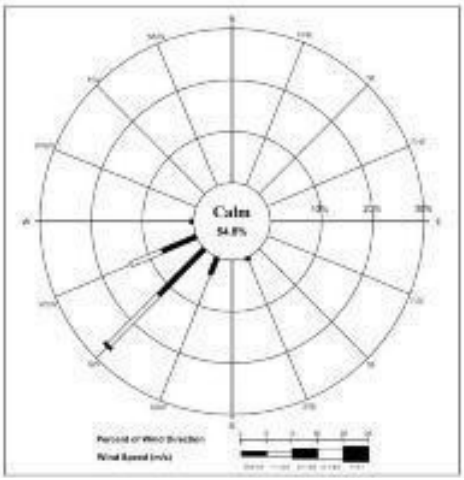
Project Area (A1)



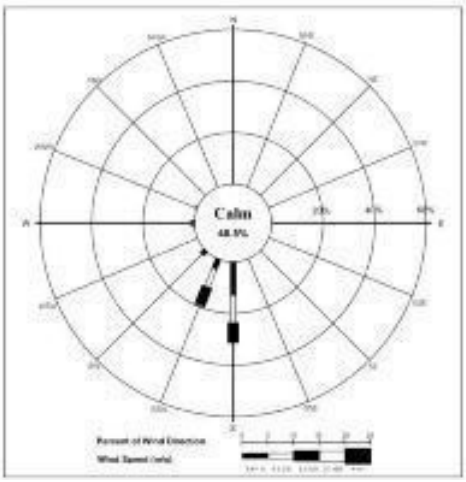
Child development center of Chomphon Chao Phraya Sub-district Municipality (A2)



Ban Khlong Kram school (A3)



Wat Rawoeng Rangsan school (A4)



Ban Nong Kang Pla (A5)

FIGURE 4.1.5-3 : WIND DIRECTION AND WIND SPEED (1ST MEASUREMENT)

TABLE 4.1.5-3

RESULTS OF AMBIENT AIR QUALITY MEASUREMENT DURING 4-11 FEBRUARY 2014

Station	Measurement date	Concentration of pollutants in ambient air (µg/m^3)					
		TSP 24 hr	PM-10 24 hr	NO_2 1 hr	SO_2 24 hr	SO_2 1 hr	CO 1 hr
Station 1: The project area (A1) Coordinate: 47P 0737393E 1444013N	4-5/02/57	207	97	27.47	5.50	7.60	572.80
	5-6/02/57	204	85	28.04	5.24	6.55	801.92
	6-7/02/57	184	70	22.77	5.24	6.29	572.80
	7-8/02/57	197	74	21.08	5.24	7.34	458.24
	8-9/02/57	134	68	28.60	5.24	6.03	458.24
	9-10/02/57	128	58	35.19	6.29	8.12	343.68
	10-11/02/57	220	99	42.15	5.76	11.27	1,260.16
	Min-Max	**128-220**	**58-99**	**21.08-42.15**	**5.24-6.29**	**6.03-11.27**	**343.68-1,260.16**
Satation 2: Child development center of Chomphon Chao Phraya Sub-district Municipality (A2) Coordinate: 47P 0738401E 1444314N	4-5/02/57	104	64	18.82	6.29	9.70	687.36
	5-6/02/57	129	67	19.57	5.50	11.53	801.92
	6-7/02/57	102	57	19.38	4.72	7.60	687.36
	7-8/02/57	85	48	27.47	4.98	9.43	572.80
	8-9/02/57	97	49	30.67	5.24	8.12	801.92
	9-10/02/57	71	43	22.39	4.98	8.12	572.80
	10-11/02/57	108	63	31.80	4.72	7.34	1,031.04
	Min-Max	**71-129**	**43-67**	**18.82-31.80**	**4.72-6.29**	**7.34-11.53**	**572.80-1,031.04**
Station 3: Ban Khlong Kram school (A3) Coordinate: 47P 0739639E 1440771N	4-5/02/57	110	52	32.56	4.72	7.34	687.36
	5-6/02/57	131	61	37.26	5.76	8.12	572.80
	6-7/02/57	103	50	28.23	4.98	8.12	458.24
	7-8/02/57	96	45	33.50	5.24	7.08	458.24
	8-9/02/57	83	41	29.92	5.76	7.86	458.24
	9-10/02/57	92	41	36.51	5.50	8.65	572.80
	10-11/02/57	120	60	35.19	4.98	9.43	572.80
	Min-Max	**83-131**	**41-61**	**28.23-37.26**	**4.72-5.76**	**7.08-9.43**	**458.24-687.36**
Standard		**330**[1/]	**120**[1/]	**320**[2/]	**300**[1/]	**780**[3/]	**34,200**[4/]

Remark : [1/] Ambient air quality standard in accordance with the notification of National Environmental Committee Vol. 24 B.E.2547 (2004)

[2/] Ambient nitrogen dioxide standard in accordance with the notification of National Environmental Committee Vol. 33 B.E.2552 (2009)

[3/] Ambient 1-hour sulfur dioxide standard in accordance with the notification of National Environmental Committee Vol. 12 B.E.2538 (1995)

[4/] Ambient air quality standard in accordance with the notification of National Environmental Committee Vol. 10 B.E.2538 (1995)

Source : Team Consulting Engineering and Management Co., Ltd., February 2014

TABLE 4.1.5-3

RESULTS OF AMBIENT AIR QUALITY MEASUREMENT DURING 4-11 FEBRUARY 2014

(Cont'd)

Station	Measurement date	Concentration of pollutants in ambient air (µg/m³)					
		TSP 24 hr	PM-10 24 hr	NO_2 1 hr	SO_2 24 hr	SO_2 1 hr	CO 1 hr
Staton 4: Wat Rawoeng Rangsan school (A4) Coordinate: 47P 0739467E 1447841N	4-5/02/57	63	32	32.93	4.45	8.12	916.48
	5-6/02/57	62	29	27.85	5.50	9.43	572.80
	6-7/02/57	75	36	30.86	3.93	5.50	801.92
	7-8/02/57	67	33	26.16	5.24	7.08	458.24
	8-9/02/57	65	30	27.85	5.50	6.03	572.80
	9-10/02/57	57	29	22.02	5.24	5.76	458.24
	10-11/02/57	93	42	38.01	5.76	6.29	801.92
	Min-Max	**57-93**	**29-42**	**22.02-38.01**	**3.93-5.76**	**5.50-9.43**	**458.24-916.48**
Station 5: Ban Nong Kang Pla (A5) Coordinate: 47P 0734949E 1443383N	4-5/02/57	67	29	29.36	4.19	6.55	801.92
	5-6/02/57	62	25	27.29	4.45	5.76	572.80
	6-7/02/57	72	45	33.12	4.19	6.29	572.80
	7-8/02/57	76	44	31.43	4.45	9.17	572.80
	8-9/02/57	93	43	18.63	6.55	12.32	572.80
	9-10/02/57	118	37	22.58	7.34	12.84	572.80
	10-11/02/57	112	35	28.60	7.08	10.74	1,031.04
	Min-Max	**62-118**	**25-45**	**18.63-33.12**	**4.19-7.34**	**5.76-12.84**	**572.80-1,031.04**
Standard		**330**[1/]	**120**[1/]	**320**[2/]	**300**[1/]	**780**[3/]	**34,200**[4/]

Remark : [1/] Ambient air quality standard in accordance with the notification of National Environmental Committee Vol. 24 B.E.2547 (2004)

[2/] Ambient nitrogen dioxide standard in accordance with the notification of National Environmental Committee Vol. 33 B.E.2552 (2009)

[3/] Ambient 1-hour sulfur dioxide standard in accordance with the notification of National Environmental Committee Vol. 12 B.E.2538 (1995)

[4/] Ambient air quality standard in accordance with the notification of National Environmental Committee Vol. 10 B.E.2538 (1995)

Source : Team Consulting Engineering and Management Co., Ltd., February 2014

TABLE 4.1.5-4

RESULT OF WIND SPEED AND WIND DIRECTION MEASUREMENT DURING 4-11 FEBRUARY 2014

Wind direction	Percentage of wind direction				
	Project area	Child development center of Chomphon Chao Phraya sub-district municipality	Ban Khlong Kram school	Wat Rawoeng Rangsan	Ban Nong Kang Pla
N	0.0	0.0	0.0	0.0	0.0
NNE	0.6	0.0	0.0	0.0	0.0
NE	0.0	0.0	0.0	0.0	0.0
ENE	0.0	0.6	0.0	0.0	0.0
E	0.6	0.6	0.0	0.0	0.0
ESE	2.5	10.2	0.0	0.0	0.0
SE	4.4	16.6	0.0	0.0	0.0
SSE	16.5	11.9	0.6	0.6	0.0
S	12.6	0.0	1.8	0.0	30.9
SSW	18.9	0.0	0.0	3.6	19.0
SW	11.4	1.2	12.0	26.8	1.8
WSW	0.6	0.0	27.4	13.6	0.0
W	6.3	0.6	2.4	0.6	1.2
WNW	1.3	0.0	0.0	0.0	0.6
NW	1.9	0.0	0.0	0.0	0.0
NNW	0.0	0.0	0.0	0.0	0.0
Total	**77.6**	**41.7**	**44.2**	**45.2**	**53.5**
Calm wind (<1 km/h)	**22.4**	**58.3**	**55.8**	**54.8**	**46.5**

Source : Team Consulting Engineering and Management Co., Ltd., February 2014

The measurement results of wind direction and wind speed in the project location showed that most winds blew from the south-southwest (SSW), accounting for 18.9 % of the total wind direction measurement followed by the winds blowing from the south-southeast (SSE), accounting for 16.5 % of the total wind direction measurement, the calm wind with the speed of 0.4-<4.0 m/s, accounting for 22.4 % of the total wind direction measurement. Details are as shown in **Table 4.1.5-4** and **Figure 4.1.5-3**

- **Child development center of Chomphon Chao Phraya sub-district municipality (A2)**

The results of ambient air quality measurement of all parameters was totally within the standards. The 24-hour average total suspended particulate (TSP) was 71-129 µg/m^3 or 21.52-39.09 % of the standard value (standard 24-hour average TSP is 330 µg/m^3). The 24-hour average of particulate matter less than 10 microns (PM-10)

was 43-67 µg/m^3 or 35.83-55.83 % of the standard value (standard 24-hour average PM-10 is 120 µg/m^3). The 1-hour average nitrogen dioxide (NO_2) was 18.82-31.80 µg/m^3 or 5.88-9.94 % of the standard value (standard 1-hour average NO_2 is 320 µg/m^3). The 24-hour average and 1-hour average sulfur dioxide (SO_2) was 4.72-6.29 and 7.34-11.53 µg/m^3 or 1.57–2.10 and 0.94-1.48 % of the standard values, respectively (standard 24-hour average and 1-hour average SO_2 are 300 and 780 µg/m^3, respectively). The 1-hour average carbon monoxide (CO) was 572.80-1,031.4 µg/m^3 or 1.67-3.02 % of the standard value (standard 1-hour average CO is 34,200 µg/m^3). The details are as shown in **Table 4.1.5-3**.

The measurement results of wind direction and wind speed at child development center of Chomphon Chao Phraya Sub-district municipality showed that most winds blew from the southeast (SE), accounting for 16.6 % of the total wind direction measurement followed by the winds blowing from the south-southeast (SSE), accounting for 11.9 % of the total wind direction measurement, the calm wind with the speed of 0.4-2.0 m/s, accounting for 58.3 % of the total wind direction measurement. Details are as shown in **Table 4.1.5.4** and **Figure 4.1.5-3**.

- **Ban Khlong Kram school (A3)**

The results of ambient air quality measurement of all parameters was totally within the standards. The 24-hour average total suspended particulate (TSP) was 83-131 µg/m^3 or 25.15-39.70 % of the standard value (standard 24-hour average TSP is 330 µg/m^3). The 24-hour average of particulate matter less than 10 microns (PM-10) was 41-61 µg/m^3 or 34.17-50.83 % of the standard value (standard 24-hour average PM-10 is 120 µg/m^3). The 1-hour average nitrogen dioxide (NO_2) was 28.23-37.26 µg/m^3 or 8.82-11.64 % of the standard value (standard 1-hour average NO_2 is 320 µg/m^3). The 24-hour average and 1-hour average sulfur dioxide (SO_2) was 4.72-5.76 and 7.08-9.43 µg/m^3 or 1.57-1.92 and 0.91-1.21 % of the standard values, respectively (standard 24-hour average and 1-hour average SO_2 are 300 and 780 µg/m^3, respectively). The 1-hour average carbon monoxide (CO) was 458.24-687.36 µg/m^3 or 1.34-2.01 % of the standard value (standard 1-hour average CO is 34,200 µg/m^3). The details are as shown in **Table 4.1.5-3**.

The measurement results of wind direction and wind speed at Ban Khlong Kram school showed that most winds blew from the west-southwest (WSW), accounting for 27.4 % of the total wind direction measurement followed by the winds blowing from the southwest (SW), accounting for 12.0 % of the total wind direction measurement, the calm wind with the speed of 0.4-4.0 m/s, accounting for 55.8 % of the total wind direction measurement. Details are as shown in **Table 4.1.5.4** and **Figure 4.1.5-3**.

- **Wat Rawoeng Rangsan school (A4)**

The results of ambient air quality measurement of all parameters was totally within the standards. The 24-hour average total suspended particulate (TSP) was 57-93 µg/m^3 or 17.27-28.18 % of the standard value (standard 24-hour average TSP is 330 µg/m^3). The 24-hour average of particulate matter less than 10 microns (PM-10) was 29-42 µg/m^3 or 24.17-35.00 % of the standard value (standard 24-hour average PM-10 is 120 µg/m^3). The 1-hour average nitrogen dioxide (NO_2) was 22.02-38.01 µg/m^3 or 6.88-11.88 % of the standard value (standard 1-hour average NO_2 is 320 µg/m^3). The 24-hour average and 1-hour average sulfur dioxide (SO_2) was 3.93-5.76 and 5.50-9.43 µg/m^3 or 1.31-1.92 and 0.71-1.21 % of the standard values, respectively (standard 24-hour average and 1-hour average SO_2 are 300 and 780 µg/m^3, respectively). The 1-hour average carbon monoxide (CO) was 458.24-916.48 µg/m^3 or 1.34-2.68 % of the standard value (standard 1-hour average CO is 34,200 µg/m^3). The details are as shown in **Table 4.1.5-3**.

The measurement results of wind direction and wind speed at Wat Rawoeng Rangsan school showed that most winds blew from the southwest (SW), accounting for 26.8 % of the total wind direction measurement followed by the winds blowing from the west-southwest (WSW), accounting for 13.6 % of the total wind direction measurement, the calm wind with the speed of 0.4-3.0 m/s, accounting for 54.8 % of the total wind direction measurement. Details are as shown in **Table 4.1.5.4** and **Figure 4.1.5-3**.

- **Ban Nong Kang Pla (A5)**

The results of ambient air quality measurement of all parameters was totally within the standards. The 24-hour average total suspended particulate (TSP) was 62-118 µg/m^3 or 18.79-35.76 % of the standard value (standard 24-hour average TSP is 330 µg/m^3). The 24-hour average of particulate matter less than 10 microns (PM-10) was 25-45 µg/m^3 or 20.83-37.50 % of the standard value (standard 24-hour average PM-10 is 120 µg/m^3). The 1-hour average nitrogen dioxide (NO_2) was 18.63-33.12 µg/m^3 or 5.82-10.35 % of the standard value (standard 1-hour average NO_2 is 320 µg/m^3). The 24-hour average and 1-hour average sulfur dioxide (SO_2) was 4.19-7.34 and 5.76-12.84 µg/m^3 or 1.40-2.45 and 0.74-1.65 % of the standard values, respectively (standard 24-hour average and 1-hour average SO_2 are 300 and 780 µg/m^3, respectively). The 1-hour average carbon monoxide (CO) was 572.80-1,031.04 µg/m^3 or 1.67-3.01 % of the standard value (standard 1-hour average CO is 34,200 µg/m^3). The details are as shown in **Table 4.1.5-3**.

The measurement results of wind direction and wind speed at Ban Nong Kang Pla showed that most winds blew from the south (S), accounting for 30.9 % of the total wind direction measurement followed by the winds blowing from the south-southwest (SSW), accounting for 19.0 % of the total wind direction measurement, the calm wind with the speed of 0.4-4.0 m/s, accounting for 46.5 % of the total wind direction measurement. Details are as shown in **Table 4.1.5.4** and **Figure 4.1.5-3**.

2. The results of the 2nd air quality measurement conducted during 14-21 August 2014

The results of air quality showed that all measured parameters were totally within the standards. The details are shown in **Table 4.1.5-5**, **Table 4.1.5-6**, **Figure 4.1.5-4**, and **Appendix 3B-2**, and can be summarized as follows:

- **The project area (A1)**

The results of ambient air quality measurement of all parameters was totally within the standards. The 24-hour average total suspended particulate (TSP) was 35-153 µg/m^3 or 10.61-46.36 % of the standard value (standard 24-hour average TSP is 330 µg/m^3). The 24-hour average of particulate matter less than 10 microns (PM-10) was 21-81 µg/m^3 or 17.50-67.50 % of the standard value (standard 24-hour average PM-10 is 120 µg/m^3). The 1-hour average nitrogen dioxide (NO_2) was 27.10-47.23 µg/m^3 or 8.47-14.76 % of the standard value (standard 1-hour average NO_2 is 320 µg/m^3). The 24-hour average and 1-hour average sulfur dioxide (SO_2) was 4.45-5.24 and 4.98-7.08 µg/m^3 or 1.48-1.75 and 0.64-0.91 % of the standard values, respectively (standard 24-hour average and 1-hour average SO_2 are 300 and 780 µg/m^3, respectively). The 1-hour average carbon monoxide (CO) was 572.80-801.92 µg/m^3 or 1.67-2.34 %t of the standard value (standard 1-hour average CO is 34,200 µg/m^3). The details are as shown in **Table 4.1.5.5**.

The measurement results of wind direction and wind speed in the project location showed that most winds blew from the south-southeast (SSE), accounting for 19.1 % of the total wind direction measurement followed by the winds blowing from the southeast (SE), accounting for 11.3 % of the total wind direction measurement, the calm wind with the speed of 0.4-<4.0 m/s, accounting for 33.6 % of the total wind direction measurement. Details are as shown in **Table 4.1.5-6** and **Figure 4.1.5-4**.

TABLE 4.1.5-5

RESULTS OF AMBIENT AIR QUALITY MEASUREMENT DURING 4-11 AUGUST 2014

Station	Measurement date	Concentration of pollution in ambient air (µg/m³)					
		TSP 24 hr	PM-10 24 hr	NO_2 1 hr	SO_2 24 hr	SO_2 1 hr	CO 1 hr
Station 1: The project location area (A1) Coordinate: 47P 0737393E 1444013N	14-15/08/57	81	46	37.82	5.24	7.08	572.80
	15-16/08/57	153	81	45.54	5.24	6.55	572.80
	16-17/08/57	126	69	33.31	4.72	5.50	801.92
	17-18/08/57	35	21	36.32	4.72	5.50	801.92
	18-19/08/57	50	31	47.23	4.72	5.50	687.36
	19-20/08/57	54	30	27.10	4.45	4.98	687.36
	20-21/08/57	80	46	30.11	4.72	6.55	572.80
	Min-Max	**35-153**	**21-81**	**27.10-47.23**	**4.45-5.24**	**4.98-7.08**	**572.80-801.92**
Station 2: Child development center of Chomphon Chao Phraya sub-district municipality (A2) Coordinate: 47P 0738401E 1444314N	14-15/08/57	54	29	30.67	4.45	5.50	572.80
	15-16/08/57	53	34	19.38	4.72	5.50	572.80
	16-17/08/57	46	31	18.63	4.72	5.24	572.80
	17-18/08/57	40	27	24.65	4.98	5.76	572.80
	18-19/08/57	61	41	25.40	5.76	7.86	801.92
	19-20/08/57	43	28	22.58	4.98	5.50	458.24
	20-21/08/57	47	30	26.72	5.24	6.03	687.36
	Min-Max	**40-61**	**27-41**	**18.63-30.67**	**4.45-5.76**	**5.24-7.86**	**458.24-801.92**
Station 3: Ban Khlong Kram school (A3) Coordinate: 47P 0739639E 1440771N	14-15/08/57	100	53	27.47	4.19	4.72	572.80
	15-16/08/57	69	35	20.32	4.72	5.76	801.92
	16-17/08/57	52	27	21.45	4.45	4.98	801.92
	17-18/08/57	95	58	25.78	4.72	5.24	687.36
	18-19/08/57	59	36	28.98	4.98	5.24	687.36
	19-20/08/57	98	58	19.19	4.98	6.03	572.80
	20-21/08/57	45	30	24.84	4.19	4.98	801.92
	Min-Max	**45-100**	**27-58**	**19.19-28.98**	**4.19-4.98**	**4.72-6.03**	**572.80-801.92**
Standard		**330**[1/]	**120**[1/]	**320**[2/]	**300**[1/]	**780**[3/]	**34,200**[4/]

TABLE 4.1.5-5

RESULTS OF AMBIENT AIR QUALITY MEASUREMENT DURING 4-11 AUGUST 2014 (Cont'd)

Station	Measurement date	Concentration of pollutants in ambient air (μg/m³)					
		TSP 24 hr	PM-10 24 hr	NO_2 1 hr	SO_2 24 hr	SO_2 1 hr	CO 1 hr
Station 4: Wat Rawoeng Rangsan School (A4) Coordinate: 47P 0739467E 1447841N	14-15/08/57	37	24	20.14	4.45	6.03	343.68
	15-16/08/57	42	30	13.17	5.24	6.29	572.80
	16-17/08/57	35	22	9.22	5.24	6.03	458.24
	17-18/08/57	33	21	16.94	4.45	5.50	458.24
	18-19/08/57	33	21	14.68	4.19	5.76	572.80
	19-20/08/57	31	22	16.00	4.72	5.50	572.80
	20-21/08/57	30	19	18.63	4.45	5.24	687.36
	Min-Max	**30-42**	**19-30**	**9.22-20.14**	**4.19-5.24**	**5.24-6.29**	**343.68-687.36**
Station 5: Ban Nong Kang Pla (A5) Coordinate: 47P 0734949E 1443383N	14-15/08/57	45	25	28.42	4.45	5.24	343.68
	15-16/08/57	42	28	26.53	3.93	6.03	458.24
	16-17/08/57	49	30	34.25	3.67	4.45	572.80
	17-18/08/57	34	18	22.96	4.19	4.98	458.24
	18-19/08/57	48	28	33.31	4.98	5.50	687.36
	19-20/08/57	33	20	25.22	4.45	5.50	458.24
	20-21/08/57	43	27	22.77	4.45	5.76	572.80
	Min-Max	**33-49**	**18-30**	**22.77-34.25**	**3.67-4.98**	**4.45-6.03**	**343.68-687.36**
Standard		**330**[1/]	**120**[1/]	**320**[2/]	**300**[1/]	**780**[3/]	**34,200**[4/]

Remark :
1/ Ambient air quality standard in accordance with the notification of National Environmental Committee Vol. 24 B.E.2547 (2004)
2/ Ambient nitrogen dioxide standard in accordance with the notification of National Environmental Committee Vol. 33 B.E.2552 (2009)
3/ Ambient sulfur dioxide 1 hour standard in accordance with the notification of National Environmental Committee Vol. 12 B.E.2538 (1995)
4/ Ambient air quality standard in accordance with the notification of National Environmental Committee Vol. 10 B.E.2538 (1995)

Source : Team Consulting Engineering and Management Co., Ltd., August 2014

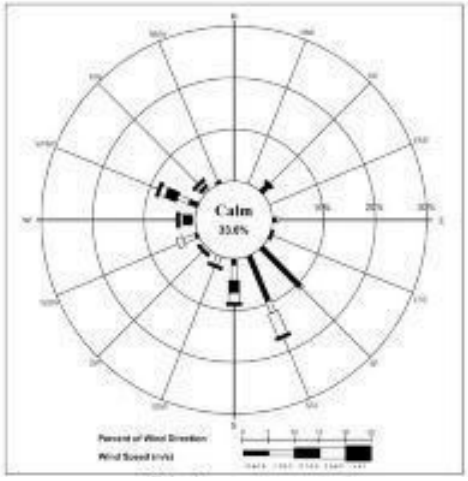
TABLE 4.1.5-6

RESULTS OF WIND SPEED AND WIND DIRECTION MEASUREMENT

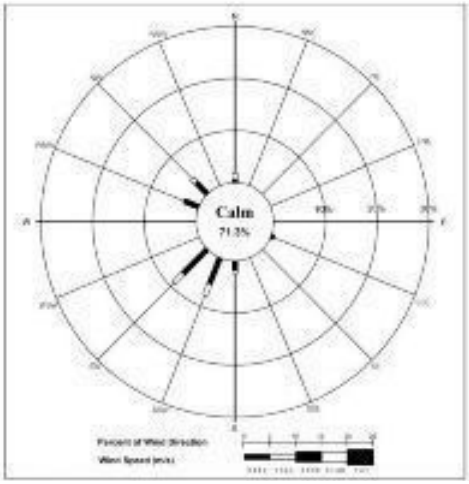
DURING 4-11 AUGUST 2014

Wind direction	Percentage of wind direction				
	Project area	Child development center of Chomphon Chao Phraya sub-district municipality	Ban Khlong Kram school	Wat Rawoeng Rangsan school	Ban Nong Kang Pla
N	0.0	1.8	0.6	0.0	2.4
NNE	0.0	0.0	1.2	0.0	0.0
NE	2.4	0.0	0.0	1.2	0.6
ENE	0.0	0.0	0.6	0.0	0.0
E	1.2	0.0	0.6	0.6	0.0
ESE	0.6	0.6	1.2	0.6	2.4
SE	11.3	0.0	2.4	3.6	6.0
SSE	19.1	0.0	7.2	11.3	14.3
S	9.0	2.4	10.7	6.5	3.0
SSW	2.4	7.8	11.4	1.8	2.4
SW	1.2	8.9	1.2	1.2	4.2
WSW	4.2	0.0	0.0	6.5	7.2
W	3.6	0.0	1.2	4.2	1.8
WNW	8.4	3.0	2.4	4.2	0.0
NW	2.4	4.2	3.0	3.0	0.6
NNW	0.6	0.0	0.0	0.0	1.2
รวม	**66.3**	**28.7**	**43.7**	**44.7**	**46.1**
Calm wind (<1 km/h)	**33.6**	**71.3**	**56.3**	**55.3**	**53.9**

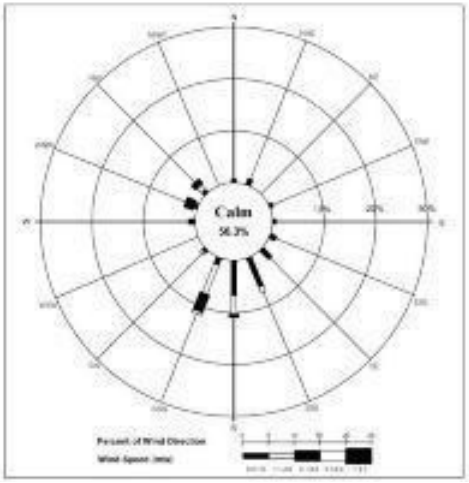
Source : Team Consulting Engineering and Management Co., Ltd., August 2014



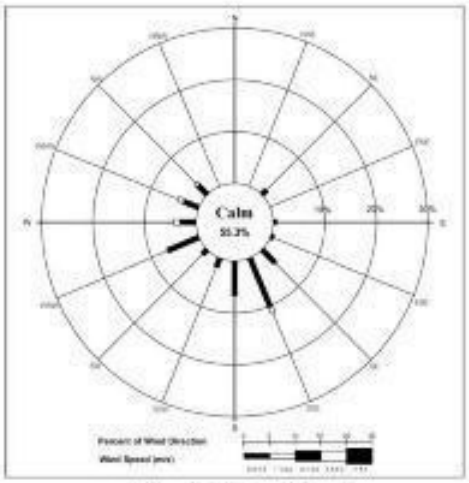
Project Area (A1)



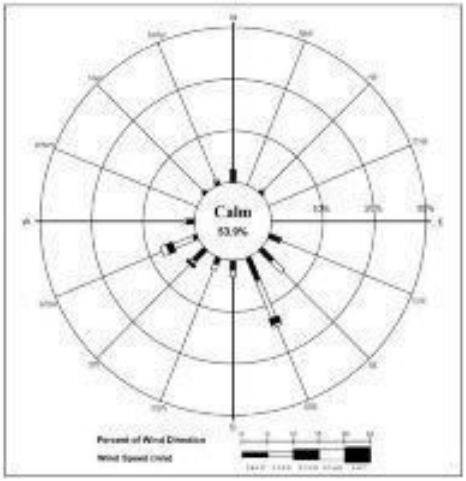
Child development center of Chomphon Chao Phraya Sub-district Municipality (A2)



Ban Khlong Kram school (A3)



Wat Rawoeng Rangsan school (A4)



Ban Nong Kang Pla (A5)

FIGURE 4.1.5-4 : WIND DIRECTION AND WIND SPEED (2ND MEASUREMENT)

- **Child development center of Chomphon Chao Phraya sub-district municipality (A2)**

The results of ambient air quality measurement of all parameters was totally within the standards. The 24-hour average total suspended particulate (TSP) was 40-61 µg/m^3 or 12.12-18.48 % of the standard value (standard 24-hour average TSP is 330 µg/m^3). The 24-hour average of particulate matter less than 10 microns (PM-10) was 27-41 µg/m^3 or 22.50-34.17 % of the standard value (standard 24-hour average PM-10 is 120 µg/m^3). The 1-hour average nitrogen dioxide (NO_2) was 18.63-30.67 µg/m^3 or 5.82-9.58 % of the standard value (standard 1-hour average NO_2 is 320 µg/m^3). The 24-hour average and 1-hour average sulfur dioxide (SO_2) was 4.45-5.76 and 5.24-7.86 µg/m^3 or 1.48-1.92 and 0.67-1.01 % of the standard values, respectively (standard 24-hour average and 1-hour average SO_2 are 300 and 780 µg/m^3, respectively). The 1-hour average carbon monoxide (CO) was 458.24-801.92 µg/m^3 or 1.34-2.34 % of the standard value (standard 1-hour average CO is 34,200 µg/m^3). The details are as shown in **Table 4.1.5.5**.

The measurement results of wind direction and wind speed at child development center of Chomphon Chao Phraya Sub-district municipality showed that most winds blew from the southwest (SW), accounting for 8.9 % of the total wind direction measurement followed by the winds blowing from the south-southwest (SSW), accounting for 7.8 % of the total wind direction measurement, the calm wind with the speed of 0.4-2.0 m/s, accounting for 71.3 % of the total wind direction measurement. Details are as shown in **Table 4.1.5-6** and **Figure 4.1.5-4**.

- **Ban Khlong Kram school (A3)**

The results of ambient air quality measurement of all parameters was totally within the standards. The 24-hour average total suspended particulate (TSP) was 45-100 µg/m^3 or 13.64-30.30 % of the standard value (standard 24-hour average TSP is 330 µg/m^3). The 24-hour average of particulate matter less than 10 microns (PM-10) was 27-58 µg/m^3 or 22.50-48.33 % of the standard value (standard 24-hour average PM-10 is 120 µg/m^3). The 1-hour average nitrogen dioxide (NO_2) was 19.19-28.98 µg/m^3 or 6.00-9.06 % of the standard value (standard 1-hour average NO_2 is 320 µg/m^3). The 24-hour average and 1-hour average sulfur dioxide (SO_2) was 4.19-4.98 and 4.72-6.03 µg/m^3 or 1.40-1.66 and 0.61-0.77 % of the standard values, respectively (standard 24-hour average and 1-hour average SO_2 are 300 and 780 µg/m^3, respectively). The 1-hour average carbon monoxide (CO) was 572.80-801.92 µg/m^3 or 1.67-2.34 % of the standard value (standard 1-hour average CO is 34,200 µg/m^3). The details are as shown in **Table 4.1.5.5**.

The measurement results of wind direction and wind speed at Ban Khlong Kram school showed that most winds blew from the west-southwest (WSW), accounting for 27.4 % of the total wind direction measurement followed by the winds blowing from the southwest (SW), accounting for 12.0 % of the total wind direction measurement, the calm wind with the speed of 0.4-4.0 m/s, accounting for 55.8 % of the total wind direction measurement. Details are as shown in **Table 4.1.5-6** and **Figure 4.1.5-4**.

- **Wat Rawoeng Rangsan school (A4)**

The results of ambient air quality measurement of all parameters was totally within the standards. The 24-hour average total suspended particulate (TSP) was 30-42 µg/m^3 or 9.09-12.73 % of the standard value (standard 24-hour average TSP is 330 µg/m^3). The 24-hour average of particulate matter less than 10 microns (PM-10) was 19-30 µg/m^3 or 15.83-25.00 % of the standard value (standard 24-hour average PM-10 is 120 µg/m^3). The 1-hour average nitrogen dioxide (NO_2) was 9.22-20.14 µg/m^3 or 2.88-6.29 % of the standard value (standard 1-hour average NO_2 is 320 µg/m^3). The 24-hour average and 1-hour average sulfur dioxide (SO_2) was 4.19-5.24 and 5.24-6.29 µg/m^3 or 1.40-1.75 and 0.67-0.81 % of the standard values, respectively (standard 24-hour average and 1-hour average SO_2 are 300 and 780 µg/m^3, respectively). The 1-hour average carbon monoxide (CO) was 343.68-687.36 µg/m^3 or 1.00-2.01 % of the standard value (standard 1-hour average CO is 34,200 µg/m^3). The details are as shown in **Table 4.1.5.5**.

The measurement results of wind direction and wind speed at Wat Rawoeng Rangsan school showed that most winds blew from the south-southeast (SSE), accounting for 11.3 % of the total wind direction measurement followed by the winds blowing from the west-southwest (WSW) equal to the south (S), accounting for 6.5 % of the total wind direction measurement, the calm wind with the speed of 0.4-2.0 m/s, accounting for 55.3 % of the total wind direction measurement. Details are as shown in **Table 4.1.5-6** and **Figure 4.1.5-4**.

- **Ban Nong Kang Pla (A5)**

The results of ambient air quality measurement of all parameters was totally within the standards. The 24-hour average total suspended particulate (TSP) was 33-49 µg/m^3 or 10.00-14.85 % of the standard value (standard 24-hour average TSP is 330 µg/m^3). The 24-hour average of particulate matter less than 10 microns (PM-10) was 18-30 µg/m^3 or 15.00-25.00 % of the standard value (standard 24-hour average PM-10 is 120 µg/m^3). The 1-hour average nitrogen dioxide (NO_2) was 22.77-34.25 µg/m^3 or 7.12-10.70 %of the standard value (standard 1-hour average NO_2 is 320 µg/m^3). The 24-hour average and 1-hour average sulfur dioxide (SO_2) was 3.67-4.98 and 4.45-6.03 µg/m^3 or 1.22-1.66 and

0.57-0.77 % of the standard values, respectively (standard 24-hour average and 1-hour average SO_2 are 300 and 780 µg/m^3, respectively). The 1-hour average carbon monoxide (CO) was 343.68-687.36 µg/m^3 or 1.00-2.01 % of the standard value (standard 1-hour average CO is 34,200 µg/m^3). The details are as shown in **Table 4.1.5.5**.

The measurement results of wind direction and wind speed at Ban Nong Kang Pla showed that most winds blew from the south-southeast (SSE), accounting for 14.3 % of the total wind direction measurement followed by the winds blowing from the west-southwest (WSW), accounting for 7.2 % of the total wind direction measurement, the calm wind with the speed of 0.4-4.0 m/s, accounting for 53.9 % of the total wind direction measurement. Details are as shown in **Table 4.1.5-6** and **Figure 4.1.5-4**.

4.1.6 Noise

(1) Introduction

The study of existing noise level in the project and vicinity areas, which reflects level of quality of life of local people, is used as basic data for co-analyzing with noise level occurring from the project activities in order to formulate proper mitigation measures for reducing impact, later on.

(2) Study methods

- Compile secondary data from report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE, 2010-2014
- Measure existing noise level in the surrounding of project area (Leq 24 hr, L_{dn}, L_{max}, L_{90}) in 3 stations for 5 consecutive days with covering of working day and weekend between 5-10 February 2014.

(3) Study results

(a) Secondary data collection

According to the data derived from noise measurement in the vicinity of the project location from the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of the Hemaraj ESIE during 2010-2014, noise level measurement were made at 5 stations including Chumchon Borisat Namtan Tawan-oak School, Ban Surasak School, Rawoeng Rat Upatham School, Wat Khlong Kram, and Wat Tai Sun (**Figure 4.1.5-1**). It was found that the 24-hour average noise level (Leq 24 hr) and the maximum noise (L_{max}), from the measurement conducted during 2010-2014 were within the standards - standard Leq 24 hr is not exceeding 70 dB(A) and standard L_{max} is not exceeding 115 dB(A) as shown in **Table 4.1.6-1** and particularly described below.

TABLE 4.1.6-1

RESULT OF NOISE LEVEL MEASUREMENT DURING 2010-2014

Station	Measurement date	Noise level (dB(A))		
		Leq 24 hr	L90	L_{max}
1. Chumchon Borisat Namtan Tawan-aok School (N1)	06-09/05/53	54.2-57.8	37.6-58.6	87.5-95.8
	11-14/10/53	49.6-54.5	42.7-51.0	81.8-98.8
	24-27/03/54	55.4-58.6	47.2-57.7	85.6-104.7
	06-09/09/54	60.1-63.2	40.8-57.2	105.2-107.3
	13-16/03/55	55.4-57.3	37.9-54.8	92.7-107.8
	15-18/11/55	53.9-57.5	38.9-54.5	87.2-92.0
	14-17/03/56	53.7-57.3	40.9-59.6	82.3-93.7
	14-17/11/56	53.9-57.3	40.4-57.1	78.3-95.0
	11-14/03/57	53.2-54.7	43.1-50.3	85.2-97.9
	13-16/11/57	56.2-69.8	47.4-49.1	97.0-114.9
	Min-Max	**49.6-69.8**	**37.6-59.6**	**78.3-114.9**
2. Ban Surasak School (N2)	06-09/05/53	52.3-55.0	39.6-55.8	87.2-100.7
	11-14/10/53	52.5-55.1	39.5-57.5	82.4-91.9
	24-27/03/54	54.9-55.6	48.9-54.1	84.4-85.8
	06-09/09/54	58.9-60.1	40.0-58.7	83.9-91.1
	13-16/03/55	59.3-60.2	42.8-58.8	94.3-100.8
	15-18/11/55	52.6-61.1	41.1-60.1	91.4-97.5
	14-17/03/56	58.4-62.2	48.6-66.8	96.0-98.1
	14-17/11/56	53.0-60.5	41.1-58.7	90.2-97.7
	11-14/03/57	51.0-52.4	37.3-49.2	89.0-93.9
	13-16/11/57	52.5-53.9	42.7-44.0	90.5-95.4
	Min-Max	**51.0-62.2**	**39.5-66.8**	**82.4-100.8**
3. Rawoeng Rat Upatham School (N3)	06-09/05/53	50.0-58.0	37.7-61.1	86.4-102.0
	11-14/10/53	47.4-58.6	32.1-65.4	87.2-99.8
	24-27/03/54	49.6-58.6	37.5-53.3	85.8-95.1
	06-09/09/54	55.1-58.3	39.3-55.8	90.8-103.1
	13-16/03/55	53.9-57.9	37.5-59.5	82.7-109.7
	15-18/11/55	53.1-56.4	37.5-54.5	84.1-94.8
	14-17/03/56	50.1-55.1	37.5-51.3	94.9-96.5
	14-17/11/56	51.7-55.0	37.5-49.7	83.7-98.6
	11-14/03/57	56.7-60.9	30.4-47.6	93.2-95.1
	13-16/11/57	53.0-62.7	38.7-43.0	96.3-111.2
	Min-Max	**47.4-62.7**	**30.4-65.4**	**82.7-111.2**
Standard[1/]		**70.0**	**-**	**115**

TABLE 4.1.6-1

RESULT OF NOISE LEVEL MEASUREMENTS DURING 2010-2014 (Cont'd)

Station	Measurement Date	Noise level (dB(A))		
		Leq 24 hr	L_{90}	L_{max}
4. Wat Khlong Kram (N4)	06-09/05/53	49.6-57.4	39.6-60.7	85.0-102.2
	11-14/10/53	49.6-57.4	42.9-59.8	80.3-97.1
	24-27/03/54	53.6-57.8	46.4-57.3	81.7-103.0
	06-09/09/54	57.2-59.1	46.4-58.7	81.1-101.2
	13-16/03/55	58.7-61.3	43.2-53.3	84.9-94.8
	15-18/11/55	53.0-53.5	36.2-52.3	89.4-100.0
	14-17/03/56	58.7-59.8	51.1-56.6	87.7-91.7
	14-17/11/56	51.7-52.9	38.9-52.1	80.2-84.3
	11-14/03/57	52.7-53.1	41.3-49.0	81.2-90.6
	13-16/11/57	53.2-60.2	48.5-48.8	78.2-94.3
	Min-Max	**49.6-61.3**	**36.2-60.7**	**78.2-103.0**
5. Wat Tai Sun (N5)	06-09/05/53	51.1-56.5	41.8-58.2	80.6-94.6
	11-14/10/53	58.0-59.3	42.8-61.4	86.0-99.5
	24-27/03/54	56.7-59.6	49.6-55.6	90.6-105.5
	06-09/09/54	52.2-59.5	39.1-56.7	87.5-104.5
	13-16/03/55	59.2-61.6	44.4-55.6	88.3-99.1
	15-18/11/55	58.5-60.7	42.7-52.4	94.1-105.4
	14-17/03/56	59.4-62.3	53.3-60.2	94.2-97.5
	14-17/11/56	60.2-61.1	51.0-59.9	83.9-98.0
	11-14/03/57	52.0-53.1	43.7-53.4	78.9-90.6
	13-16/11/57	53.7-54.3	45.9-47.6	82.2-87.8
	Min-Max	**51.1-62.3**	**39.1-61.4**	**78.9-105.5**
Standard[1/]		**70.0**	**-**	**115**

Remark : [1/] Standard of noise level in accordance with the notification of national Environmental Committee Vol. 15 B.E.2540 (1997)

Source : Report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE, 2010-2014

- **Chumchon Borisat Namtan Tawan-aok School (N1):** 24-hour average noise level (Leq 24 hr) was in the range of 49.6-69.8 dB(A) or 70.86-99.71 % of the standard value (standard Leq 24 hr is 70 dB(A)). L_{90} was in the range of 37.6-59.6 dB(A). Maximum noise level (L_{max}) was in the range of 78.3-114.9 dB(A) or 68.09-99.91 % of the standard value (standard L_{max} is 115 dB(A)).
- **Ban Surasak School (N2):** 24-hour average noise level (Leq 24 hr) was in the range of 51.0-62.2 dB(A) or 72.86-88.86 % of the standard value (standard Leq 24 hr is 70 dB(A)). L_{90} was in the range of 39.5-66.8 dB(A). Maximum noise level (L_{max}) was in the range of 82.4-100.8 dB(A) or 71.65-87.65 % of the standard value (standard L_{max} is 115 dB(A)).
- **Rawoeng Rat Upatham School (N3):** 24-hour average noise level (Leq 24 hr) was in the range of 47.4-62.7 dB(A) or 67.71-89.57 % of the standard value (standard Leq 24 hr is 70 dB(A)). L_{90} was in the range of 30.4-65.4 dB(A). Maximum noise level (L_{max}) was in the range of 82.7-111.2 dB(A) or 71.91-96.70 % of the standard value (standard L_{max} is 115 dB(A)).
- **Wat Khlong Kram (N4):** 24-hour average noise level (Leq 24 hr) was in the range of 49.6-61.3 dB(A) or 70.86-87.57 % of the standard value (standard Leq 24 hr is 70 dB(A)). L_{90} was in the range of 36.2-60.7 dB(A). Maximum noise level (L_{max}) was in the range of 78.2-103.0 dB(A) or 68.00-89.57 % of the standard value (standard L_{max} is 115 dB(A)).
- **Wat Tai Sun (N5)):** 24-hour average noise level (Leq 24 hr) was in the range of 51.1-62.3 dB(A) or 73.00-89.00 % of the standard value (standard Leq 24 hr is 70 dB(A)). L_{90} was in the range of 39.1-61.4 dB(A). Maximum noise level (L_{max}) was in the range of 78.9-105.5 dB(A) or 68.61-91.74 % of the standard value (standard L_{max} is 115 dB(A)).

(b) Field surveys

The measurement of the present noise level in the study area was carried out to find the value of indices including Leq 24 hr, L_{dn}, L_{max}, and L_{90}. The consultant selected the stations expected to be affected most by the noise caused by the project which were 3 stations: the project area, Chumchon Borisat Namtan Tawan-oak school, and Wat Chomphon Chao Phraya (see **Figure 4.1.6-1**). Noise level measurement was conducted for 5 consecutive days during 6-11 February 2014, covering both work days and holidays. Details are shown in **Table 4.1.6-2** and **Appendix 3C** and as summarized below.

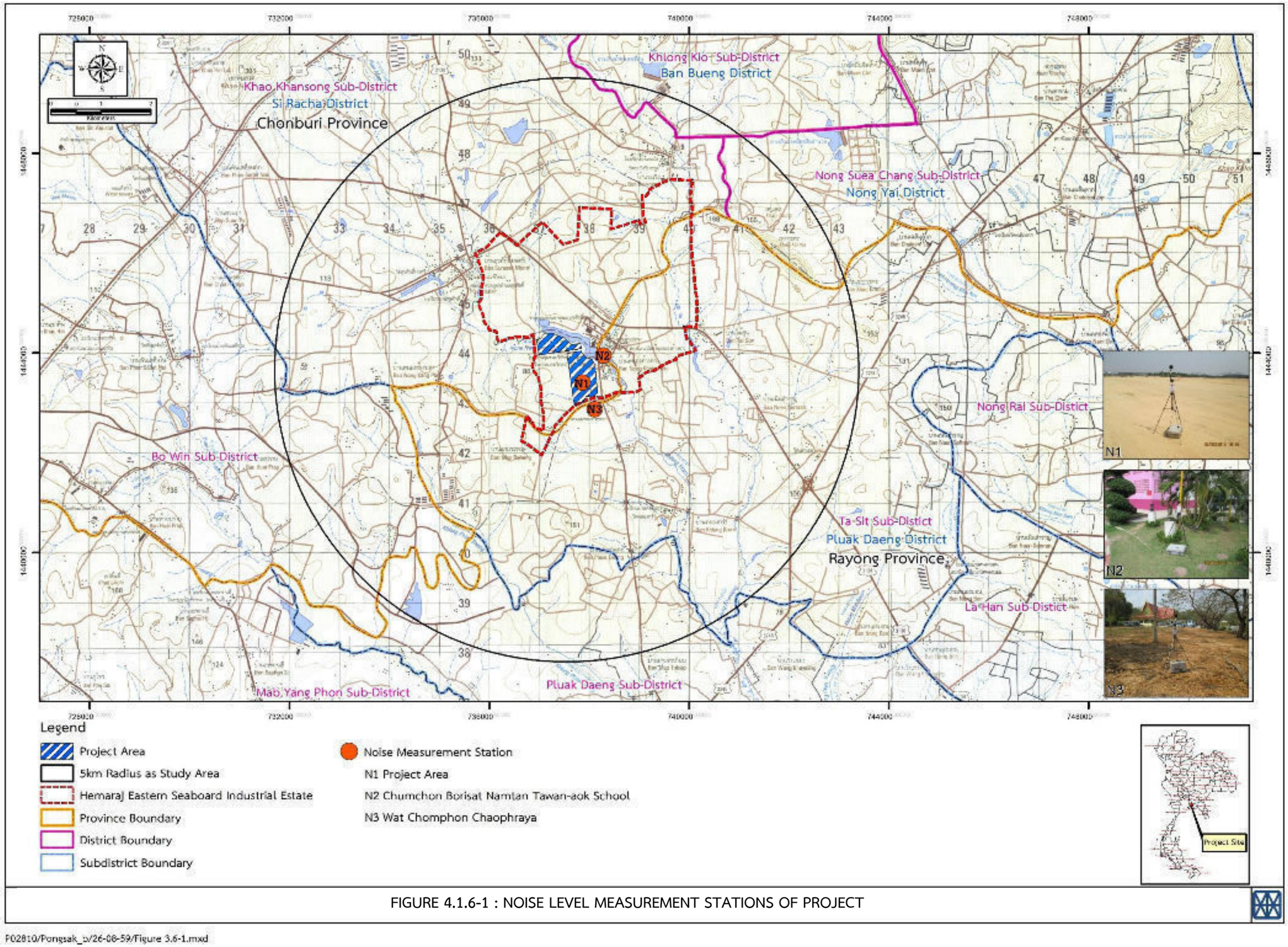


FIGURE 4.1.6-1 : NOISE LEVEL MEASUREMENT STATIONS OF PROJECT

P02810/Pongsak_tv/26-08-59/Figure 3.6-1.mxd

TABLE 4.1.6-2

RESULT OF NOISE LEVEL MEASUREMENT DURING 6-11 FEBRUARY 2014

Station	Measurement date	Noise level (dB(A))			
		Leq 24 hr	L_{max}	L_{dn}	L_{90}
1. The project area (N1) Coordinate 47P 0737762E 1443963N	6-7/02/57	48.8	78.8	53.2	42.8
	7-8/02/57	49.7	82.1	53.1	42.8
	8-9/02/57	48.9	88.9	52.3	42.1
	9-10/02/57	47.7	76.8	54.1	41.6
	10-11/02/57	49.7	81.3	55.5	44.8
	Min-Max	**47.7-49.7**	**76.8-88.9**	**52.3-55.5**	**41.6-44.8**
2. Chumchon Borisat Namtan Tawan-aok School (N2) Coordinate 47P 0738295E, 1443947N	6-7/02/57	65.6	106.9	66.3	57.4
	7-8/02/57	62.8	101.4	63.4	55.2
	8-9/02/57	53.6	84.2	57.7	47.3
	9-10/02/57	57.6	90.0	59.8	51.3
	10-11/02/57	62.6	109.3	63.4	54.8
	Min-Max	**53.6-65.6**	**84.2-109.3**	**57.7-66.3**	**47.3-57.4**
3. Wat Chomphon Chao Phraya (N3) Coordinate 47P 0738230E, 1442903N	6-7/02/57	53.3	78.5	57.4	46.8
	7-8/02/57	52.9	79.0	56.4	46.2
	8-9/02/57	52.6	81.0	56.5	45.5
	9-10/02/57	52.0	81.5	56.3	44.6
	10-11/02/57	53.7	85.0	57.4	46.7
	Min-Max	**52.0-53.7**	**78.5-85.0**	**56.3-57.4**	**44.6-46.8**
Standard[1/]		**70.0**	**115.0**	**-**	**-**

Remark : [1/] Standard of noise level in accordance with the notification of national Environmental Committee Vol. 15 B.E.2540 (1997)

Source : Team Consulting Engineering and Management Co., Ltd., February 2014

- **The project area (N1)**

The 24-hour average noise level (Leq 24 hr) and the maximum noise level (L_{max}) were 47.7-49.7 dB(A) and 76.8-88.9 dB(A), respectively or 68.1-71.0 and 66.8-77.3 % of the standard values, respectively (standard L_{eq} 24 hr and L_{max} are 70 and 115 dB(A), respectively). The average noise level at daytime-nighttime (L_{dn}) and the percentile noise level at 90 (L_{90}) were 52.3-55.5 dB(A) and 41.6-44.8 dB(A), respectively.

- **Chumchon Borisat Namtan Tawan-aok School (N2)**

The 24-hour average noise level (Leq 24 hr) and the maximum noise level (L_{max}) were 53.6-65.6 dB(A) and 84.2-109.3 dB(A), respectively or 76.6-93.7 and 73.2-95.0 % of the standard values, respectively (standard L_{eq} 24 hr and L_{max} are 70 and 115 dB(A), respectively). The average noise level at daytime-nighttime (L_{dn}) and the percentile noise level at 90 (L_{90}) were 57.7-66.3 dB(A) and 47.3-57.4 dB(A), respectively.

- **Wat Chomphon Chao Phraya (N3)**

The 24-hour noise average level (Leq 24 hr) and the maximum noise level (L_{max}) were 52.0-53.7 dB(A) and 78.5-85.0 dB(A), respectively or 74.3-76.7 and 68.3-73.9 % of the standard values, respectively (standard Leq 24 hr and L_{max} are 70 and 115 dB(A), respectively). The average noise level at daytime-nighttime (L_{dn}) and the percentile noise level at 90 (L_{90}) were 56.3-57.4 dB(A) and 44.6-46.8 dB(A), respectively.

4.1.7 Hydrology

(1) Introduction

Existing situation of hydrology is examined. Results are used as basic information for environmental impact assessment, formulating the environmental impact mitigation and preventive measures and environmental impact monitoring measures.

(2) Study Methods

- Compilation of water use data or ralated reports were such as directory of water resources in Center of Thailand Book No. 1 and 3, briefing and development in 3 years of Local Administrative Organization, topographic map with 1:50,000 from the Royal Thai Survey Department, L7018, series 5235 (III), B.E. 2541 (1998) and Satellite map form Google Earth program etc.
- Water resources and use of water in the study area of project were conducted in field survey. The results were used to assess environmental impact from project development.
- Report on analysis of impact of BOD and TDS from cooling water of power plant projects in Hemaraj ESIE, July 2015

(3) Study Results

The project's study area is located on the fringe of Si Racha District, Ban Bueng District, and Nong Yai District of Chon Buri Province and Pluak Daeng District of Rayong Province. It is also situated in the central east region with topographical characteristics of undulating and rolling, including some parts being hilly terrains and foothill slopes as well as small hill ranges. The region's south and west is plain areas and

therefore most surface water come from the highlands of the region's central flowing towards the Gulf of Thailand (in the south of the region). These areas possess many natural water sources such as Rawerng Canal, Kram Canal, Map Kradon Marsh, and Pluak Daeng Canal **(Figure 4.1.7-1)**. Details are shown below.

- **Kram Canal**

Kram Canal is a short natural waterway located in the study area. Its water source is in the area of Khao Khansong Sub-district, Si Racha District, Chon Buri Province. Kram Canal flows from the north down to the southeast of the study area. The canal's average width (of the part flowing past Hemaraj ESIE) is 12 m, and its depth from bottom to banks is averagely 2 m. The canal is flooded during rainy season; however, during summer and cool seasons, its flowing speed is slow. The canal bed consists of sand, silt and clay. Along both banks grow reed and grass mixed with rubber and eucalyptus trees. Moreover, communities are sparse and found along the canal banks. Therefore, Kram Canal receives wastewater from Hemaraj ESIE as well as from these communities and agricultural areas. This canal meets Rawerng Canal at the distance approximae 8.2 km from the drainage point of Hemaraj ESIE.

- **Rawerng Canal**

Rawerng Canal is the main perennial canal which flows past Hemaraj ESIE and into Nong Pla Lai Reservoir for the total distance of 15 km. The canal's average width in the area beyond the junction with Kram Canal is 12 m and its depth from bottom to banks is 1.5 m. When flowing past the junction point, which is the location of Ban Wang Khayaeng Dam, the canal's width is about 26 m and its depth from bottom to banks is averagely 3 m. The dam's downstream point is 12.5 m wide and its average depth from bottom to banks is 2.5 m. The canal's bedload consists of loam. Along both banks grow rubber trees and tapioca. Weeds such as reed, grass and mimosa grow along the waterfronts. In the downstream area from Hemaraj ESIE, densely-populated waterside communities are situated around Ban Wang Khayaeng Dam right through to Nong Pla Lai Reservior.

- **Pluak Daeng Canal**

Pluak Daeng Canal is a short natural waterway located in the study area. It flows past Bo Win Sub-District, Si Racha District, Chon Buri Province, from the west to the south of the study area before passing Ta Sit and Pluak Daeng Sub-districts, Pluak Daeng District, Rayong Province. The canal's total length is approximately 11 km; its width is about 6 m; its average depth is 1.2 m. However, the canal water is available in some seasons only. At present, people in the area use the canal water for agriculture and consumption.

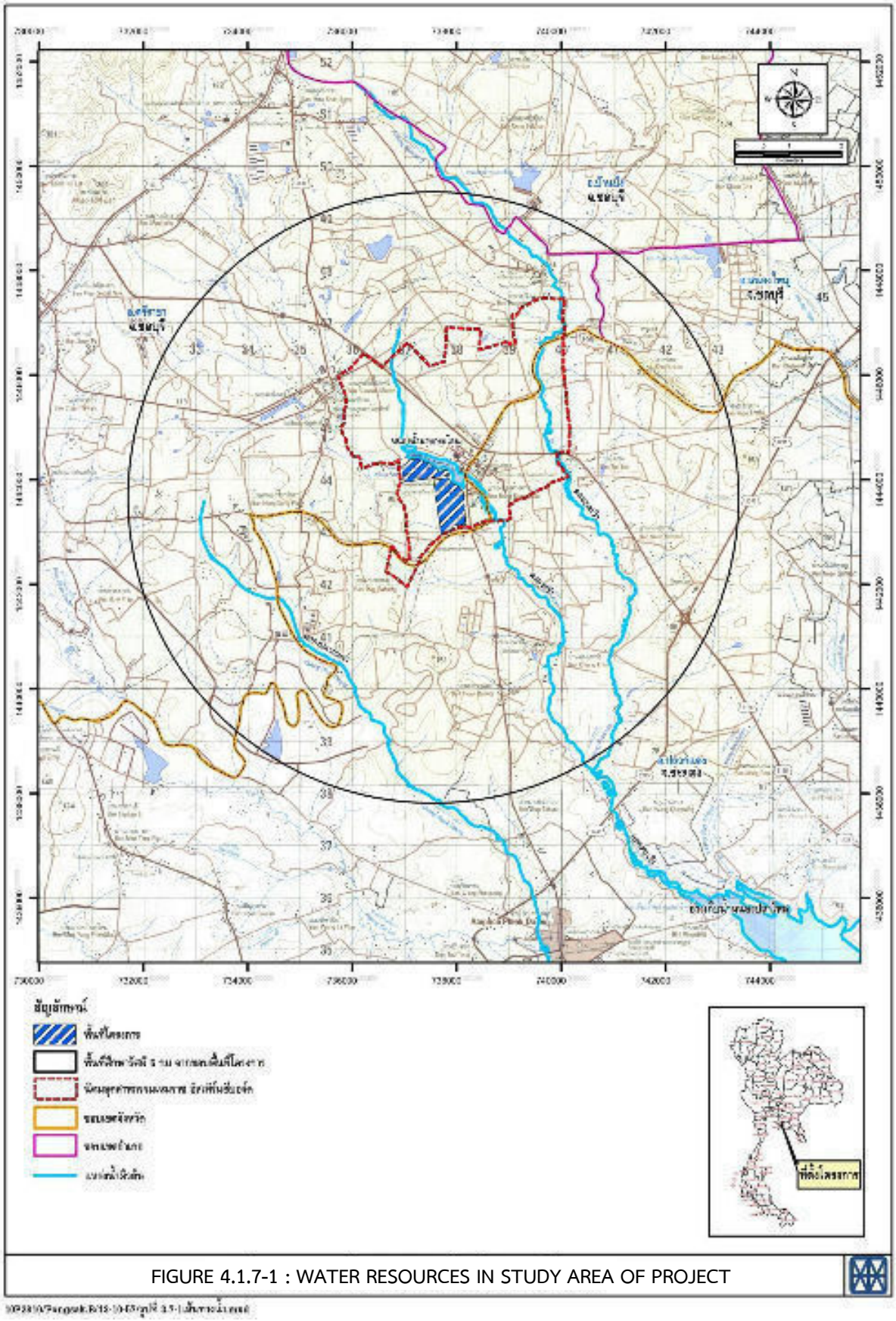


FIGURE 4.1.7-1 : WATER RESOURCES IN STUDY AREA OF PROJECT

4.1.8 Water Quality

(1) Introduction

Construction and operation activities of power plant project create wastewater which affect the water quality in surrounding areas and project area. Thus, exiting of water quality is studied in physical, chemical and biological of water resources in vicinity of project area. Results of the study surface water quality is used as basic information for environmental impact assessment, formulating the environmental impact mitigation and preventive measures and environmental impact monitoring measures.

(2) Study methods

(a) Secondary data collection

Secondary data of surface water quality in the project area or in the vicinity come from the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2013 and the report on analysis of impact of BOD and TDS from cooling water of power plant projects in Hemaraj ESIE, July 2015

(b) Field surveys

The project had gathered surface water quality samples from the surface water sources in both seasons: dry and rainy. The surface water sources from which the sampling gatherings were made are in the project area or the vicinity and used as representative of the surface water sources directly affected by the project development activities.

The Project had determined the sites of surface water quality measurement of Kram Canal. The surface water sources near the project area comprised 4 stations: The upstream about 500 m before the project area (W1), Map Kradon Marsh (W2), the estate's wastewater drainage point (W4), and the downstream area about 500 m from the estate's wastewater drainage point (W5). Furthermore, the Project had collected water quality samples from a shallow water well in the area of Water Pumping Station of Chomphon Chao Phraya Sub-district Municipality (W3) near the project location. So there were 5 stations in total for surface water quality measurement (**Figure 4.1.8-1**). The survey activities are shown in **Photo 4.1.8-1**.

The period of surface water quality study covered both in dry season (in February 2014) and rainy season (in August 2014).

(c) Measurement of indices, sampling methods, and analyses methods

Totally 14 indices of water quality were analyzed against the Standard Method for the Examination of Water and Wastewater, 22nd Edition, 2012, as shown in **Table 4.1.8-1**.

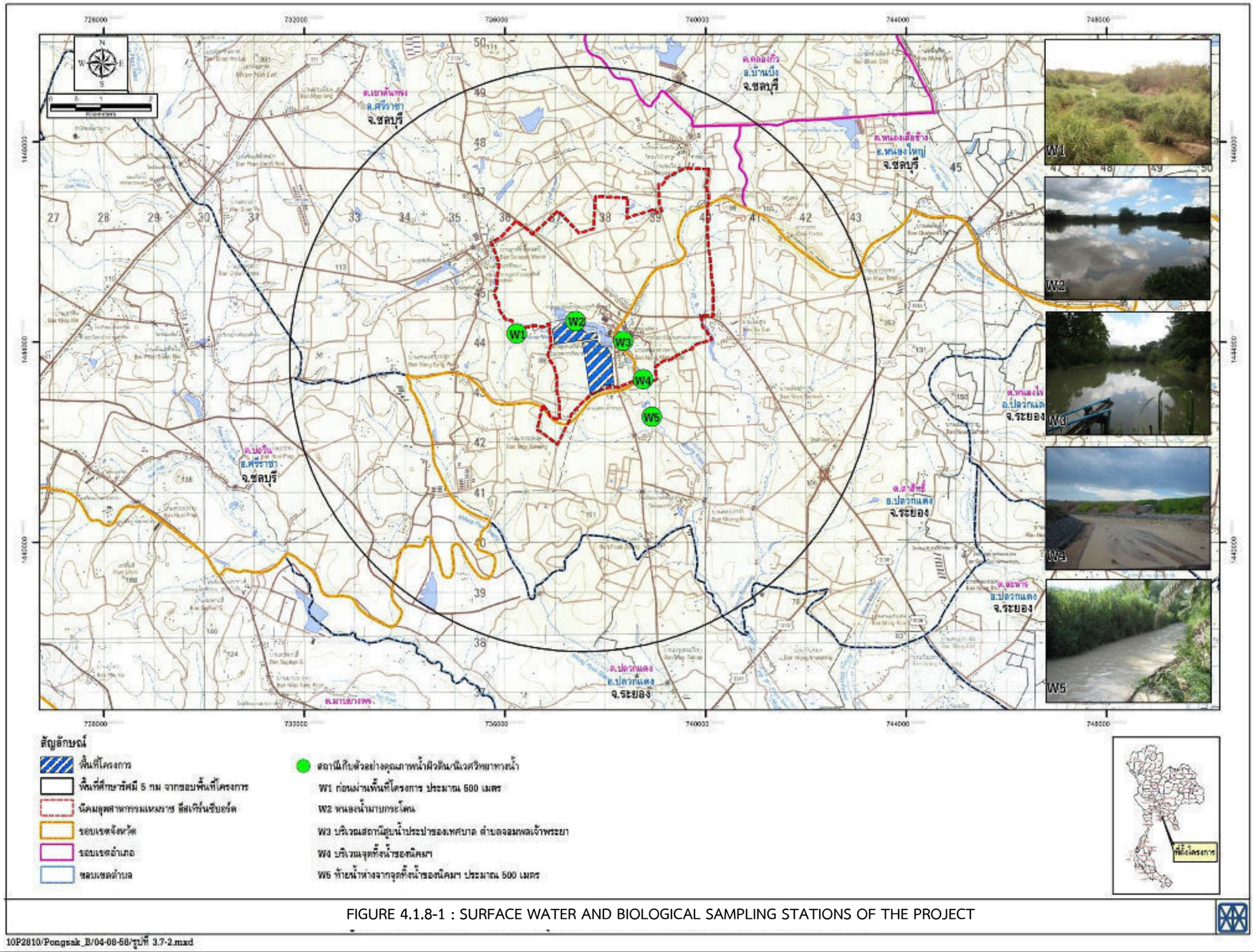


FIGURE 4.1.8-1 : SURFACE WATER AND BIOLOGICAL SAMPLING STATIONS OF THE PROJECT

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Station W1 : The upstream about 500 m before the project area


Station W2 : Map Kradon Marsh


Station W3 : Tap water Pumping Station of Chomphon Chao Phraya Sub-district Municipality


Station W4 : The estate's wastewater drainage point


Station W5 : The downstream about 500 m from the estate's wastewater drainage point

PHOTO 4.1.8-1 : SURFACE WATER QUALITY AND BIOLOGICAL SAMPLING ACTIVITIES

TABLE 4.1.8-1

INDECS OF SURFACE WATER QUALITY AND ANALYSIS METHODS

Property	Indecs of surface water quality	Methods
1. Physical	1.1 Depth	Meter Stick
	1.2 Temperature	Thermometer on site
	1.3 Transparation	Secchi Disc
	1.4 Water speed	Flow Meter
	1.5 Conductivity	Conductivity Meter
2. Chemical	2.1 DO	Dissolved Oxygen Meter
	2.2 BOD	5-Day BOD Test
	2.3 pH	pH Meter
	2.4 TDS	Dried at 180°C
	2.5 SS	Dried at 103-105°C
	2.6 Nitrate-Nitrogen	Ultraviolet Spectrophotometric Screening
	2.7 Oil and grease*	Soxhlet Exteaction
3. Biological	3.1 Total coliform bacteria	Multiple Tube Fermentation Technique
	3.2 Total fecal coliform bacteria	Multiple Tube Fermentation Technique

Remark : *Sample was collected at the surface of water.

The Composite method was used in the sampling of water quality. The grab sampling method was used 3 times in order to prevent error from one-time sampling. The results of analysis of surface water quality of each measurement station were then compared with the standards for surface water quality to assess the existing water quality as well as to classify the type of water quality in the surface water sources based on the utilization in accordance with the surface water quality standards prescribed in the Notification of National Environment Board No. 8 (B.E. 2537), issued by virtue of the Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 re: Prescribing Standards for Water Quality of the Surface Water Source (**Table 4.1.8-2**). The amount of dissolved oxygen (DO) was compared with the criteria showing the dissolved oxygen level, water quality, and the utilization of water sources (**Table 4.1.8-3**).

Regarding biochemical oxygen demand (BOD_5) derived from the analyses, the project compared the level with the criteria showing the 5-day BOD (BOD_5) which indicates the water quality and specified by the Water Quality Management Division, Pollution Control Department (**Table 4.1.8-4**).

TABLE 4.1.8-2

STANDARD OF SURFACE WATER RESOURCES QUALITY

No.	Indices	Statistic value	Unit	Category of water quality[1/, 2/]				
				Category 1	Category 2	Category 3	Category 4	Category 5
1.	Color, Odour and Taste		-	n	n	n	n	-
2.	Water Temp.		°C	n	n'	n'	n'	-
3.	pH		-	n	5.0-9.0	5.0-9.0	5.0-9.0	-
4.	DO	P20	mg/l	n	<6.0	<4.0	<2.0	-
5.	BOD_5	P80	mg/l	n	>1.5	>2.0	>4.0	-
6.	Nitrate (NO_3) in unit of Nitrogen		mg/l	5.0				
7.	Total Coliform Bacteria	P80	MPN / 100 ml	n	>5,000	>20,000	-	-
8.	Faecal Coliform Bacteria	P80	MPN / 100 ml	n	>1,000	>4,000	-	-

Remark : 1/ Standard of surface water qualiy can be divided into 5 category

Category 1 : Extra clean fresh surface water resources used for :

(1) Conservation not necessary pass through water treatment process require only ordinary process for pathogenic destruction

(2) Ecosystem conservation where basic organisms can breed naturally

Category 2: Very clean fresh surface water resources used for :

(1) Consumption which requires ordinary water treatment process before use

(2) Aquatic organism of conservation

(3) Fisheries

(4) Recreation

Category 3: Medium clean fresh surface water resources used for :

(1) Consumption, but passing through an ordinary treatment process before using

(2) Agriculture

Category 4: Fairly clean fresh surface water resources used for :

(1) Consumption, but requires special water treatment process before using

(2) Industry

Category 5: The sources which are not classification in class 1-4 and used for navigation.

n naturally

n' naturally but changing not more than 3 °C

2/ Specified standard value of issues in Category 2-4. For Category 1 is naturally and Category 5 is no specifie vale

- No specific value

< Not less than ; > Not more than

P20 is percentile 20th of total number of examined water samples from continuously collecting

P80 is percentile 80th of total number of examined water samples from continuously collecting

MPN is Most Probable Number

Source : Notification of the National Environment Board, No.8 B.E. 2537 (1994), Issued under the Enhancement and conservation of national Environment Quality Act B.E.2535 (1992), published in the Royal Government Gazette. Vol. 111. Part 16. Dated February 24. B.E.2537 (1994).

TABLE 4.1.8-3

DISSOLVED OXYGEN (DO) LEVEL, WATER QUALITY AND USE OF WATER

DO (mg/L)	Water Quality	Use of Water
9-8	Good	Consumption (Drinking)
8-6.7	Start with contaminate	Domestic use
6.7-4.5	Moderate contaminated	Use in agricultural and industry
< 4.5	High contaminated	Aquatic plants and animals were begin in danger and make use of the water source was limited.
< 4	Crisis	Aquatic plants and animals were in danger and could not make use of the water source
< 2	Crisis	Aquatic plants and animals were unable to live and could not make use of the water source

Source : Noppawan, 2007

TABLE 4.1.8-4

BOD_5 INDICATED WATER QUALITY

Water Quality	BOD 5 day (mg/l)
Pure water	0
Very clean water	1
Clean water	2
Moderate clean water	3
Unclean water	5
Dirty water	10

Source : Division Water Quality Management, Pollution control Department, 2013

(d) Environmental Impact Assessment

- Assess the impact on water quality in the construction period such as the area adjustment and the power plant construction with the emphasis on turbidity increase/suspended particulate, dissolved oxygen, and oil arising from various construction equipment.
- Assess the impact on water quality of the main water ways in the operation period caused by discharged wastewater from the Power Plant.
- Assess the impact on other related aspects.

(e) Environmental Impact Prevention and Mitigation Measures

The environmental impact mitigation and preventive measures and environmental impact monitoring measures for surface water and the water quality monitoring measures for the related water ways are to be proposed during both construction period and operation period.

(3) Study results

(a) Secondary data collection

(a1) Report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE

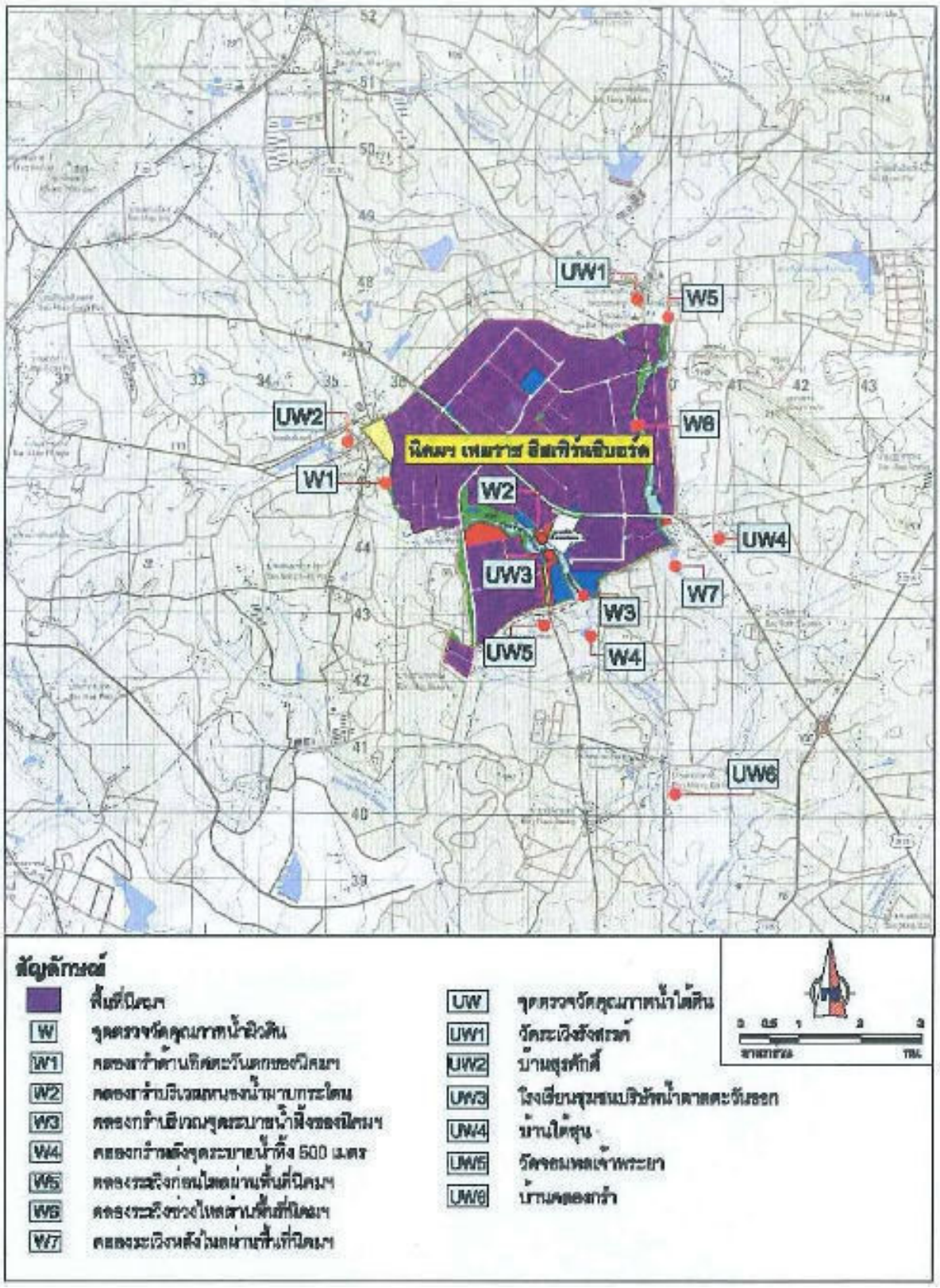
According to the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014, water quality measurements were made in Hemaraj ESIE since 2011-2014 with 17 rounds of samplings, 9 of which were made during rainy season, and 8 of which were made during dry season at 7 sampling stations (as shown in **Figure 4.1.8-2**): 4 stations in the Kram Canal area including the Estate's west side area (W1), Map Kradon Marsh (W2), the estate's wastewater drainage point area in Kram Canal (W3), and the downstream about 500 m from the Estate's wastewater drainage point in Kram Canal (W4), and 3 stations in Rawerng Canal area such as before the canal flowing through the Estate area (W5), the canal flowing through the Estate area (W6), and the canal has already flowed through the Estate area (W7). The measurement stations mentioned in the said report are situated in the adjacent position of the project's stations of water quality measurement which are W2, W3 and W4. Details of the the measurement of surface water quality between 2011-2014 are as shown in **Appendix 3A-1**, and also as summarized below.

Kram Canal on the estate's west side (W1)

According to the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014, the BOD_5 measured in May 2012 and May and September 2014 exceeded 4 mg/l, thus the water in this area was classified in **Category 5 of the Surface Water Quality** as prescribed in the Notification of National Environment Board No. 8, B.E. 2537 (1994) which is the water source receiving wastewater from some kinds of activities and could be used for transportation.

Map Kradon Marsh (W2)

According to the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014, the BOD_5 measured in September 2014 exceeded 4 mg/l, thus the water in this area was classified **in Category 5 of the Surface Water Quality** as prescribed in the Notification of National Environment Board No. 8, B.E. 2537 (1994) which is the water source receiving wastewater from some kinds of activities and can be used for transportation.



Source : Report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE, 2013

FIGURE 4.1.8-2 : SURFACE WATER MONITORING STATIONS OF HEMARAJ EASTERN SEABOARD INDUSTRIAL ESTATE

The estate's wastewater drainage point area in Kram Canal (W3)

According to the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014, found that most of BOD_5 measured in between 2-4 mg/l. Moreover, fecal coliform bacteria (FCB) and total coliform bacteria (TCB) exceeded the Surface Water Quality in Category 3. Thus, the overall of water in this area was classified in **Category 4 of the Surface Water Quality** as prescribed in the Notification of National Environment Board No. 8, B.E. 2537 (1994) which is the water source receiving wastewater from some kinds of activities and can be used for consumption after normal sterilization and special treatment process, and in industry.

The downstream about 500 m from the estate's wastewater drainage point in Kram Canal (W4)

According to the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014, the BOD_5 measured in March 2014 exceeded 4 mg/l, thus the water in this area was classified **in Category 5 of the Surface Water Quality** as prescribed in the Notification of National Environment Board No. 8, B.E. 2537 (1994) which is the water source receiving wastewater from some kinds of activities and can be used for transportation.

Before Rawerng canal flowing through the Estate area (W5)

According to the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014, the BOD_5 measured in September 2014 exceeded 4 mg/l, thus the water in this area was classified in **Category 5 of the Surface Water Quality** as prescribed in the Notification of National Environment Board No. 8, B.E. 2537 (1994) which is the water source receiving wastewater from some kinds of activities and can be used for transportation.

Rawerng canal flowing through the Estate area (W6)

According to the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014, the BOD_5 measured in September 2014 exceeded 4 mg/l, thus the water in this area was classified in **Category 5 of the Surface Water Quality** as prescribed in the Notification of National Environment Board No. 8, B.E. 2537 (1994) which is the water source receiving wastewater from some kinds of activities and can be used for transportation.

Rawerng canal has already flowed through the Estate area (W7)

According to the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014, the BOD_5 measured in September 2014 exceeded 4 mg/l, thus the water in this area was classified in **Category 5 of the Surface Water Quality** as prescribed in the Notification of National Environment Board No. 8, B.E. 2537 (1994) which is the water source receiving wastewater from some kinds of activities and can be used for transportation.

According to the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014, the index that is likely to exceed the value of category 4 of the standards for surface water quality is BOD_5 which is also likely to increase in the most recent year (2014) at almost every measurement station. Moreover, the measurement showed that total fecal coliform bacteria (FCB) and total coliform bacteria (TCB) at most measurement stations exceeded the value of category 3 of the standards for surface water quality in almost every measurement.

(a2) Report on analysis of impact of BOD and TDS from cooling water of Power Plant Projects in Hemaraj ESIE, July 2015

The surface water quality data used in analyzing the impact of cooling water regarding BOD and TDS of the Power Plant Project in Hemaraj ESIE (July 2015) come from the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2010-2013, together with the sampling of water in Kram and Rawerng Canals, and also in Nong Pla Lai Reservior, altogether 7 stations (as shown in **Figure 4.1.8-3**) on 18 October 2014. The indices measured were pH value, dissolved oxygen, BOD, total dissolved solid, and electrical conductivity value. The measurement results are as shown in **Table 4.1.8-5** and the report is as shown in **Appendix 3A-2**.

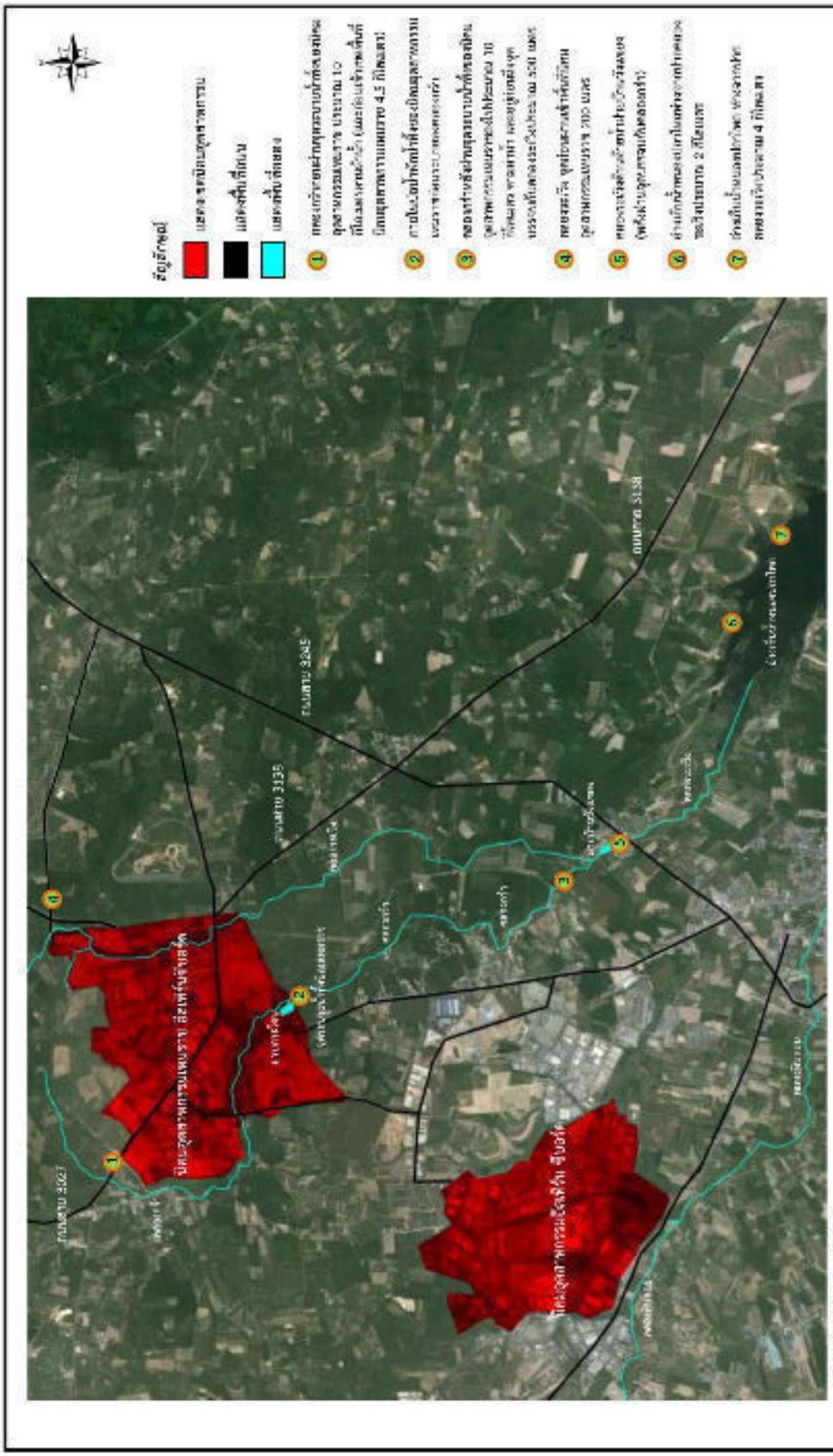


FIGURE 4.1.8-3 : SURFACE WATER AND BIOLOGICAL SAMPLING STATIONS IN KRAM AND RAWERNG CANALS AND NONG PLA LAI RESERVIOR

TABLE 4.1.8-5

RESUTLS OF SURFACE WATER RESOURCES QUALITY IMPACTS OF BOD AND TDS FROM COOLING WATER OF POWER PLANT PROJECTS IN HEMARAJ EASTERN SEABOARD INDUSTRIAL ESTATE

Characteristics	Indices	Unit	Station[2/]							Standard of surface water[1/]		
			Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	2	3	4
Physical	- Total Dissolved Solids	mg/l	162	678	200	108	170	108	130	-	-	-
	- Conductivity	µmhor/cm	202	1,141	280	168	221	184	220	-	-	-
Chemical	- pH	-	6.9	6.7	7.0	7.0	6.8	7.2	7.6	5-9	5-9	5-9
	- DO	mg/l	7.1	2.0	6.6	7.3	7.2	9.6	9.2	> 6	> 4	> 2
	- BOD_5	mg/l	2.7	9.2	3.3	1.8	1.4	2.9	2.3	< 1.5	< 2	<4
Category of surface water quality standard			**4**	**5**	**4**	**3**	**2**	**4**	**4**			

Remark : Station 1 Upstream of Kram Canal before flowing through the Estate area (West)
Station 2 The estate's wastewater drainage point area in Kram Canal
Station 3 Downstream of Kram Canal of estate before Rawerng canal
Station 4 Rawerng canal flowing through the Estate area
Station 5 Rawerng canal has already flowed through the Estate area near Wang Kayang weir
Station 6 Upstream of Nong Pla Lai Reservoir
Station 7 Downstream of Nong Pla Lai Reservoir

Source : 1/ Notification of the National Environment Board, No.8 B.E. 2537 (1994), Issued under the Enhancement and conservation of national Environment Quality Act B.E.2535 (1992), published in the Royal Government Gazette. Vol. 111. Part 16. Dated February 24. B.E.2537 (1994).

2/ The report on analysis of impact of BOD and TDS from cooling water of power plant projects in Hemaraj ESIE, July 2015

(b) Field surveys

The project had conducted the samplings as well as the analyses of surface water quality at 5 stations (**Figure 4.1.8-1**) as representative of dry season (on 20 February 2014) and of rainy season (on 18 August 2014). The result of the analysis of the representative of dry season are as shown in **Table 4.1.8-6** (**Appendix 3A-3**), and of rainy season, **Table 4.1.8-7**(**Appendix 3A-4**). The measurement results are summarized, as follows:

- **Survey results of dry season (on 20 February 2014)**

Station 1 (W1): The upstream about 500 m before the project area

Coordinate: 47P 0736931E 1444302N

The sampling point of water quality was in the upstream about 500 m before the project area. This area was not used for fishery. Regarding physical properties of water source, it was found that the water was stagnant with temperature at 25.2 °C which falls within the temperature range of general water source in Thailand. The water was yellow, clear, with sediments. The depth level of water was 5 m. The total dissolved solid and suspended particulate were 124 and 6.5 mg/l, respectively.

Regarding chemical properties: the pH value was 6.52, and dissolved oxygen (DO) was 2.44 mg/l which indicated that the water quality was in crisis, and aquatic plants and animals were in danger and could not make use of the water source (Noppawan, 2007). The BOD_5 was 0.8 mg/l which is lower than the <1 mg/l standard set up by the Water Quality Management Division, Pollution Control Department, indicating that the water was very clean. However, since the dissolved oxygen (DO) was < 4 mg/l, the overall water quality was in **Category 4 of the surface water quality standard** as prescribed in the Notification of the National Environment Board No. 8, B.E. 2537 which is the water source receiving wastewater from some kinds of activities, and can be used for consumption after normal sterilization and special treatment process, and in industry.

Station 2 (W2) Map Kradon Marsh

Coodinate 47P 0738187E 1444302N

The sampling point of water quality was in the Map Kradon Marsh which was discharge point of cooling water. This area was not used for fishery. Water was used for other activities in estate such as pray on the road and tree watering. Regarding physical properties of water source, it was found that the water was stagnant with temperature at 26.8 °C which falls within the temperature range of general water source in Thailand. The water was clear with no sediments. The depth level of water was 2 m. The total dissolved solid and suspended particulate were 180 and 5 mg/l, respectively.

TABLE 4.1.8-6

RESULTS OF SURFACE WATER QUALITY IN DRY SEASON (ON 20 FEBRUARY 2014)

Characteristics	Indices	Unit	Station[2/]					Standard of surface water[1/]		
			W1	W2	W3	W4	W5	2	3	4
Physical	- Depth	m	5.00	2.00	1.00	0.35	0.20			
	- Water flow rate	m/s	Stagnant	Stagnant	Stagnant	0.14	0.20			
	- Temperature	°C	25.2	26.8	27.1	27.1	26.8	n	n	n
	- Salinity	ppt	0.1	0.1	0.1	0.1	0.1			
	- Suspended Solids	mg/l	6.50	<5.0	11.0	5.0	5.0	-	-	-
	- Total Dissolved Solids	mg/l	124.0	180.0	200.0	180.0	192.0	-	-	-
	- Turbidity	NTU	304.5	151.0	211.5	277.0	228.5			
	- Conductivity	µmhor/cm	243.80	205.30	247.50	250.00	247.30	-	-	-
.	- Transparency	m	0.47	0.52	0.50	0.35	0.20			
Chemical	- pH	-	6.52	6.68	6.28	6.65	6.64	5-9	5-9	5-9
	- Dissolved Oxygen	mg/l	2.44	2.20	1.50	3.98	3.96	> 6	> 4	> 2
	- BOD_5	mg/l	0.8	1.1	0.8	1.1	0.6	< 1.5	< 2	<4
	- Oil & Grease	mg/l	<5.0	<5.0	<5.0	<5.0	<5.0			
	- Nitrate-Nitrogen	mg/l	0.54	0.23	0.24	0.25	0.78	<5.0	<5.0	<5.0
Biological	- Total Coliform	MPN/100 ml.	2,400	930	2,400	46,000	7,500	<5,000	<20,000	-
	- Fecal Coliform	MPN/100 ml	930	93	93	150	430	<1,000	<4,000	-
Category of surface water quality standard			**4**	**4**	**5**	**4**	**4**			

Remark : Station W1 The upstream about 500 m before the project area Station W4 The estate's wastewater drainage point
Station W2 Map Kradon Marsh Station W5 The downstream about 500 m from the estate's wastewater drainage point
Station W3 Tap Water Pumping Station of Chomphon Chao Phraya Sub-district Municipality

Source : 1/ Notification of the National Environment Board, No.8 B.E. 2537 (1994), Issued under the Enhancement and conservation of national Environment Quality Act B.E.2535 (1992), published in the Royal Government Gazette. Vol. 111. Part 16. Dated February 24. B.E.2537 (1994).

2/ Field survey of Team consulting engineering and management Co., Ltd., 20 February 2014

TABLE 4.1.8-7

RESULTS OF SURFACE WATER QUALITY IN RAINNY SEASON (ON 18 AUGUST 2014)

Characteristics	Indices	Unit	Station[2/]					Standard of surface water[1/]		
			W1	W2	W3	W4	W5	2	3	4
Physical	- Depth	m	0.15	2.40	3.20	0.30	0.35			
	- Water flow rate	m/s	0.50	Stagnant	Stagnant	0.90	0.85			
	- Temperature	°C	28.6	30.0	30.0	28.2	28.1	n	n	n
	- Salinity	ppt	0.1	0.1	0.1	0.1	0.1			
	- Suspended Solids	mg/l	142.0	228.0	16.0	344.4	354.0	-	-	-
	- Total Dissolved Solids	mg/l	160	132	76	172	176	-	-	-
	- Turbidity	NTU	251.5	343.0	36.1	375.5	371.5			
	- Conductivity	µmhor/cm	201.0	198.9	171.9	174.6	210.50	-	-	-
.	- Transparency	m	0.05	0.08	0.37	0.14	0.08			
Chemical	- pH	-	7.16	7.12	6.91	7.10	7.02	5-9	5-9	5-9
	- Dissolved Oxygen	mg/l	5.64	4.75	5.80	4.80	5.73	> 6	> 4	> 2
	- BOD_5	mg/l	2.4	3.2	2.0	2.1	5.5	< 1.5	< 2	<4
	- Oil & Grease	mg/l	5.4	6.4	<5.0	<5.0	<5.0			
	- Nitrate-Nitrogen	mg/l	0.88	1.1	0.36	1.0	1.1	<5.0	<5.0	<5.0
Biological	- Total Coliform	MPN/100 ml.	110,000	75,000	4,300	46,000	110,000	<5,000	<20,000	-
	- Fecal Coliform	MPN/100 ml	7,500	2,400	2,100	24,000	15,000	<1,000	<4,000	-
Category of surface water quality standard			4	4	3	4	5			

Remark : Station W1 The upstream about 500 m before the project area Station W4 The estate's wastewater drainage point
Station W2 Map Kradon Marsh Station W5 The downstream about 500 m from the estate's wastewater drainage point
Station W3 Tap Water Pumping Station of Chomphon Chao Phraya Sub-district Municipality

source : 1/ Notification of the National Environment Board, No.8 B.E. 2537 (1994), Issued under the Enhancement and conservation of national Environment Quality Act B.E.2535 (1992), published in the Royal Government Gazette. Vol. 111. Part 16. Dated February 24. B.E.2537 (1994).

2/ Field survey of Team consulting engineering and management Co., Ltd., 18 August 2014

Regarding chemical properties: the pH value was 6.68, and dissolved oxygen (DO) was 2.20 mg/l which indicated that the water quality was in crisis, and aquatic plants and animals were in danger and could not make use of the water source (Noppawan, 2007). The BOD_5 was 1.1 mg/l which is in between 1-2 mg/l standard set up by the Water Quality Management Division, Pollution Control Department, indicating that the water was very clean. However, since the dissolved oxygen (DO) was < 4 mg/l, the overall water quality was in **Category 4 of the surface water quality standard** as prescribed in the Notification of the National Environment Board No. 8, B.E. 2537 which is the water source receiving wastewater from some kinds of activities, and can be used for consumption after normal sterilization and special treatment process, and in industry.

Station 3 (W3) Tap Water Pumping Station of Chomphon Chao Phraya Sub-district Municipality

Coordinate 47P 0738431E 1444347N

The sampling point of water quality was tap water pumping station of Chomphon Chao Phraya Sub-district Municipality which was shallow well. This area was not used for fishery. The water pumping station was used to produce tap water and distribute in the area. Regarding physical properties of water source, it was found that the water was stagnant with temperature at 27.1 °C which falls within the temperature range of general water source in Thailand. The water was yellow, clear, with sediments. The depth level of water was 1 m. The total dissolved solid and suspended particulate were 200 and 11 mg/l, respectively.

Regarding chemical properties: the pH value was 6.28, and dissolved oxygen (DO) was 1.5 mg/l which indicated that the water quality was in crisis, and aquatic plants and animals were unable to live and could not make use of the water source (Noppawan, 2007). The BOD_5 was 0.8 mg/l which is < 1 mg/l standard set up by the Water Quality Management Division, Pollution Control Department, indicating that the water was very clean. However, since the dissolved oxygen (DO) was < 2 mg/l, the overall water quality was in **Category 5 of the Surface Water Quality** as prescribed in the Notification of National Environment Board No. 8, B.E. 2537 (1994) which is the water source receiving wastewater from some kinds of activities and can be used for transportation.

Nitrate-Nitrogen and biological properties were in **Category 3 of the Surface Water Quality** as prescribed in the Notification of National Environment Board No. 8, B.E. 2537 (1994).

Station 4 (W4) The estate's wastewater drainage point

Coordinate 47P 0738890E 1443200N

The sampling point of water quality was The estate's wastewater drainage point in Kram Canal. This area was not used for fishery. Regarding physical properties of water source, it was found that the water flow was slow with temperature at 27.1 °C which falls within the temperature range of general water source in Thailand. The water was yellow, clear, with no sediments. Water body at sampling point was shallow. The total dissolved solid and suspended particulate were 180 and 5 mg/l, respectively.

Regarding chemical properties: the pH value was 6.65, and dissolved oxygen (DO) was 3.98 mg/l which indicated that the water quality was in crisis, aquatic plants and animals were in danger and could not make use of the water source (Noppawan, 2007). The BOD_5 was 1.1 mg/l which is in between 1-2 mg/l standard set up by the Water Quality Management Division, Pollution Control Department, indicating that the water was clean. However, since the dissolved oxygen (DO) was < 4 mg/l and total coliform bacteria was more than 20,000 MPN/100 ml, the overall water quality was in **Category 4 of the surface water quality standard** as prescribed in the Notification of the National Environment Board No. 8, B.E. 2537(1994) which is the water source receiving wastewater from some kinds of activities, and can be used for consumption after normal sterilization and special treatment process, and in industry.

Station 5 (W5) The downstream about 500 m from the estate's wastewater drainage point

Coordinate 47P 0738666E 1442830N

The sampling point of water quality was in the downstream about 500 m from the estate's wastewater drainage point. This area was not used for fishery and water flowed through agricultural area in the communities. Regarding physical properties of water source, it was found that the water flow was slow with temperature at 26.8 °C which falls within the temperature range of general water source in Thailand. The water was yellow, clear, with no sediments. Water body at sampling point was shallow. The total dissolved solid and suspended particulate were 192 and 5 mg/l, respectively.

Regarding chemical properties: the pH value was 6.64, and dissolved oxygen (DO) was 3.96 mg/l which indicated that the water quality was in crisis, aquatic plants and animals were in danger and could not make use of the water source (Noppawan, 2007). The BOD_5 was 0.6 mg/l which is < 1 mg/l standard set up by the Water

Quality Management Division, Pollution Control Department, indicating that the water was clean. However, since the dissolved oxygen (DO) was < 4 mg/l, the overall water quality was in **Category 4 of the surface water quality standard** as prescribed in the Notification of the National Environment Board No. 8, B.E. 2537 (1994) which is the water source receiving wastewater from some kinds of activities, and can be used for consumption after normal sterilization and special treatment process, and in industry.

- **Survey results of rainny season (on 18 August 2014)**

Station 1 (W1): The upstream about 500 m before the project area

Coordinate: 47P 0736931E 1444302N

The sampling point of water quality was in the upstream about 500 m before the project area. This area was not used for fishery. Regarding physical properties of water source, it was found that the water flow was slow with temperature at 28.6 °C which falls within the temperature range of general water source in Thailand. The water was yellow and clear. The depth level of water was 0.15 m. The total dissolved solid and suspended particulate were 160 and 142 mg/l, respectively.

Regarding chemical properties: the pH value was 7.16, and dissolved oxygen (DO) was 5.64 mg/l which indicated that the water quality was moderately contaminated, and can use in agricultural and industry (Noppawan, 2007). Since the BOD_5 was 2.4 mg/l, It was indictated that water quality was moderate clean as prescribed in the Division Water Quality Management, Pollution control Department, 2013. The overall water quality was in **Category 4 of the surface water quality standard** as prescribed in the Notification of the National Environment Board No. 8, B.E. 2537 (1994) which is the water source receiving wastewater from some kinds of activities, and can be used for consumption after normal sterilization and special treatment process, and in industry because the BOD_5 was in between 2-4 mg/l, total coliform bacteria and total fecal coliform bacteria exceeded Category 3 of the surface water quality standard.

Station 2 (W2): Map Kradon Marsh,

Coordinate: 47P 0738187E 1444302N

The sampling point of water quality was in Map Kradon Marsh. This area was not used for fishery. Water was used for other activities in estate such as pray on the road and tree watering. Regarding physical properties of water source, it was found that the water was stagnant with temperature at 30.0 °C which falls within the temperature range of general water source in Thailand. The water was clear. The depth level of water was 2.4 m. The total dissolved solid and suspended particulate were 132 and 228 mg/l, respectively.

Regarding chemical properties: the pH value was 7.12, and dissolved oxygen (DO) was 4.75 mg/l which indicated that the water quality was moderately contaminated, and can use in agricultural and industry (Noppawan, 2007). Since the BOD_5 was 3.2 mg/l, It was indictated that water quality was moderate clean as prescribed in the Division Water Quality Management, Pollution control Department, 2013. The overall water quality was in **Category 4 of the surface water quality standard** as prescribed in the Notification of the National Environment Board No. 8, B.E. 2537 (1994) which is the water source receiving wastewater from some kinds of activities, and can be used for consumption after normal sterilization and special treatment process, and in industry because the BOD_5 was in between 2-4 mg/l, total coliform bacteria and total fecal coliform bacteria exceeded Category 3 of the surface water quality standard.

Station 3 (W3) Tap Water Pumping Station of Chomphon Chao Phraya Sub-district Municipality

Coordinate 47P 0738431E 1444347N

The sampling point of water quality was at Tap Water Pumping Station of Chomphon Chao Phraya Sub-district Municipality. This area was not used for fishery. The water pumping station was used to produce tap water and distribute in the area. Regarding physical properties of water source, it was found that the water was stagnant with temperature at 30.0 ºC which falls within the temperature range of general water source in Thailand. The water was clear. The depth level of water was 3.2 m. The total dissolved solid and suspended particulate were 76 and 16 mg/l, respectively.

Regarding chemical properties: the pH value was 6.91, and dissolved oxygen (DO) was 5.8 mg/l which indicated that the water quality was moderately contaminated, and can use in agricultural and industry (Noppawan, 2007). Since the BOD_5 was 2 mg/l, It was indictated that water quality was clean as prescribed in the Division Water Quality Management, Pollution control Department, 2013. The overall water quality was in **Category 3 of the surface water quality standard** as prescribed in the Notification of the National Environment Board No. 8, B.E. 2537 (1994) which is the water source receiving wastewater from some kinds of activities, and can be used for consumption after normal sterilization and treatment process, and in agricultural because the BOD_5 was in between 1.5-2 mg/l, total coliform bacteria and total fecal coliform bacteria exceeded Category 3 of the surface water quality standard.

Station 4 (W4) The estate's wastewater drainage point

Coordinate 47P 0738890E 1443200N

The sampling point of water quality was in The estate's wastewater drainage point Kram Canal. This area was not used for fishery. Regarding physical properties of water source, it was found that the water flow was slow with temperature at 28.2 °C which falls within the temperature range of general water source in Thailand. The water was unclear. The depth level of water was 0.3 m. The total dissolved solid and suspended particulate were 172 and 344.4 mg/l, respectively.

Regarding chemical properties: the pH value was 7.1, and dissolved oxygen (DO) was 4.8 mg/l which indicated that the water quality was moderately contaminated, and can use in agricultural and industry (Noppawan, 2007). Since the BOD_5 was 2.1 mg/l, It was indictated that water quality was clean as prescribed in the Division Water Quality Management, Pollution Control Department, 2013. The overall water quality was in **Category 4 of the surface water quality standard** as prescribed in the Notification of the National Environment Board No. 8, B.E. 2537 (1994) which is the water source receiving wastewater from some kinds of activities, and can be used for consumption after normal sterilization and special treatment process, and in industry because the total coliform bacteria and total fecal coliform bacteria exceeded Category 3 of the surface water quality standard.

Station 5 (W5) The downstream about 500 m from the estate's wastewater drainage point

Coordinate 47P 0738666E 1442830N

The sampling point of water quality was in the downstream about 500 m from the estate's wastewater drainage point. This area was not used for fishery and water flowed through agricultural area in the communities. Regarding physical properties of water source, it was found that the water flow was slow with temperature at 28.1 °C which falls within the temperature range of general water source in Thailand. The water was unclear. The depth level of water was 0.35 meter. The total dissolved solid and suspended particulate were 176 and 354 mg/l, respectively.

Regarding chemical properties: the pH value was 7.02, and dissolved oxygen (DO) was 5.73 mg/l which indicated that the water quality was moderately contaminated, and can use in agricultural and industry (Noppawan, 2007). Since the BOD_5 was 5.5 mg/l, It was indictated that water quality was unclean as prescribed in the Division

Water Quality Management, Pollution Control Department, 2013. The overall water quality was **Category 5 of the Surface Water Quality** as prescribed in the Notification of National Environment Board No. 8, B.E. 2537 (1994) which is the water source receiving wastewater from some kinds of activities and can be used for transportation because the BOD_5 was more than 4 mg/l, total coliform bacteria and total fecal coliform bacteria exceeded Category 3 of the surface water quality standard.

BOD at W5 was unusually high because the sampling position was the curve of the water way which had accumulated sediments, sand and gravels and organic matters as shown in **Photo 4.1.8-2**. Also the sampling was done soon after the rain that had caused turbidity and spreading of organic substances from the floor, resulting higher BOD.

	
Kram Canal	**Sediment of gravel and sand in the bottom of Kram Canal**

PHOTO 4.1.8-2 : SAMPLING POINT AT W5

4.1.9 Groundwater Hydrology and Groundwater Quality

4.1.9.1 Groundwater Hydrology

(1) Introduction

The study of groundwater hydrology is to use as basic data for environmental impact assessment, preparing the environmental impact mitigation and preventive measures and environmental impact monitoring measures.

(2) Study methods

Analyse characteristics of hydrogeology of the project area and its vicinity by compilation of secondary data from hydrogeology map with scale of 1:100,000 prepared by Survey and Groundwater Map Preparation Bureau, Department of Groundwater Resources.

(3) Study results

(3.1) Hydrogeology

Data from the Dapartment of Groundwater Resources's hydrogeological map, scale: 1:100,000 as of 2004 as shown in **Figure 4.1.9-1** show that the characteristics of hydrogeology in the study area are foothill sedimentary-rock aquifers (Colluvium: Qcl) which are the sedimentary rock strata accumulated on the hillside or at the glen. They are derived from the weathering of hard rocks in the area and of crumbly rocks which have accumulated along the narrow areas of hillside or slope areas, most of which developed into low hills with the topography of terrain rise or rolling hill. The thickness of crumbly rocks of colluvium type ranged from less than 20 m to more than 100 m. Since this type of crumbly rocks mostly consist of round rock wastes mixed with clay which have been decomposed from the original rocks (country rocks) and are accumulated from the weathering on high mountains and then rapidly falling down to valleys or sloping hillside areas, mixed sizes of deposits were found, consisting of clay and breccia. This contributed to low porosity and low water absorption or made them become aquifers of low productivity and potential.

(3.2) Groundwater flow direction

The flow direction in the project's study area as shown in **Figure 4.1.9-2** was derived from data of groundwater level of the wells located in the study and surrounding areas. The groundwater flows mostly from north to south because the north of the area comprises high mountain ranges while the south comprises plain areas and low hills as well as reservoirs. Thus, the groundwater flows from high areas and down to low areas.

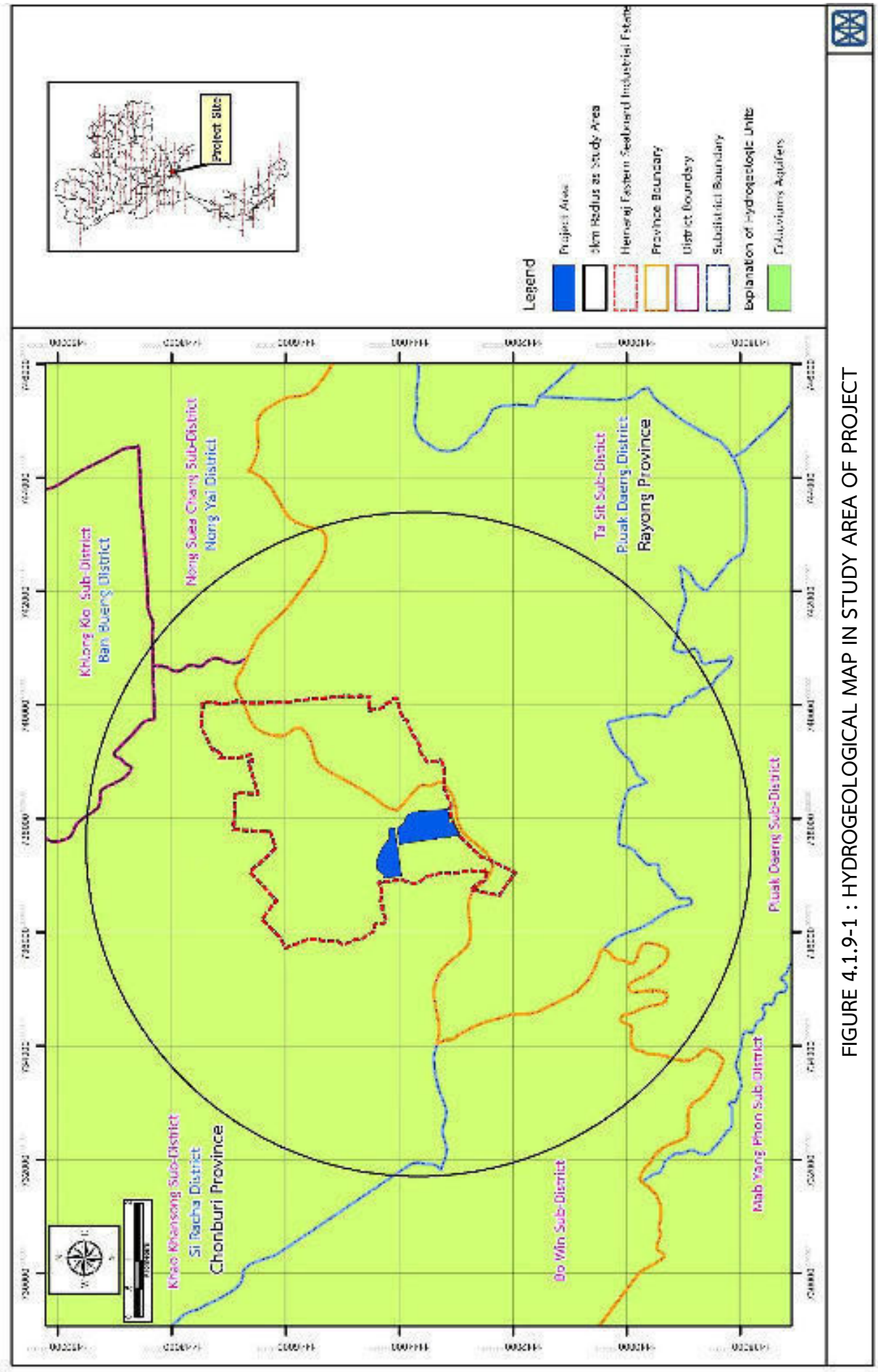


FIGURE 4.1.9-1 : HYDROGEOLOGICAL MAP IN STUDY AREA OF PROJECT

4.1.9.2 Groundwater Quality

(1) Introduction

The study of existing groundwater quality is to use as basic data for environmental impact assessment, preparing the environmental impact mitigation and preventive measures and environmental impact monitoring measures.

(2) Study methods

- Compile groundwater quality from database of groundwater well information of Information and Communication Technology Center, Department of Groundwater Resources (http://map.dgr.go.th) and Groundwater Potential Assessment of Department of Groundwater Resources.
- Study the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014.
- Survery on groundwater quality for 2 sampling stations were the area of Wat Chomphon Chao Phraya (GW1) and the area of Ban Surasak School (GW2). Groundwater sampling was conducted in dry season on 20 February 2014 and in rainy season on 8 May 2015.

(3) Study results

(a) Secondary data

(a.1) Data from the Dapartment of Groundwater Resources

According to the Dapartment of Groundwater Resources's database of groundwater wells, the study areas are found to cover the areas of Bo Win and Khao Khansong Sub-districts, Si Racha District as well as Khlong Kio Sub-district, Ban Bueng District, Chon Buri Province; and Ta Sit and Pluak Daeng Sub-districts, Pluak Daeng District, Rayong Province which have total 18 usable groundwater wells. The depth of those wells ranges from 18 to 124 m; water quantity is 0.72-9.00 m^3/h. The water quality parameter data have also shown chloride (Cl) being between 6.00-65.00 mg/l, iron amount (Fe) being between 0.13-9.30 mg/l, Nitrate (NO_3^-) being between 0.00-27.00 mg/l, and pH found in those wells equaling 8.10, and total dissolved solids (TDS) being between 114.00-470.0 mg/l. Details are as shown in **Table 4.1.9-1**.

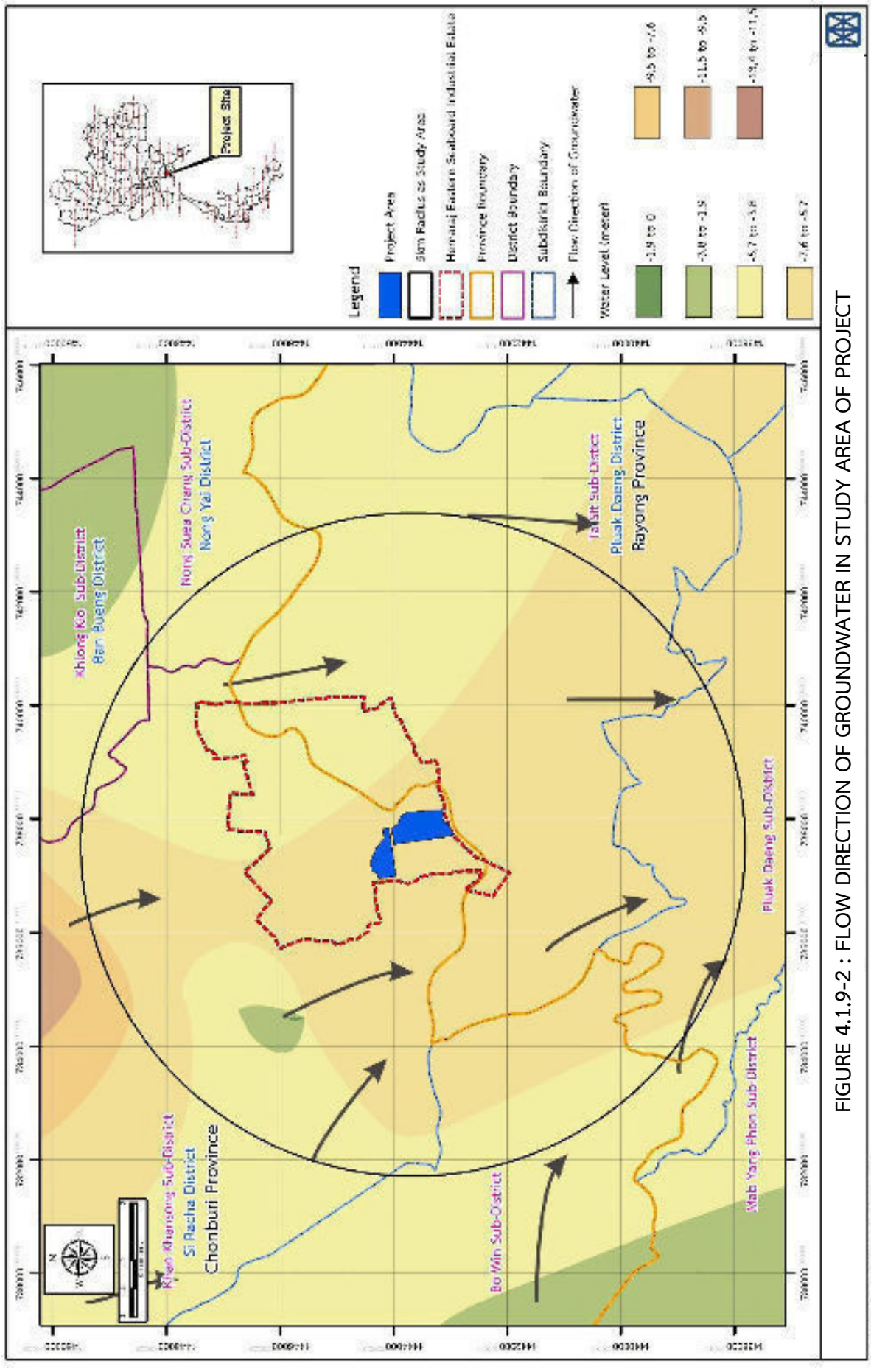


FIGURE 4.1.9-2 : FLOW DIRECTION OF GROUNDWATER IN STUDY AREA OF PROJECT

TABLE 4.1.9-1

DATA OF THE GROUNDWATER WELLS LOCATED IN STUDY AREA OF PROJECT

No.	Well no.	Location of wells	Village no.	Sub-disrict	District	Province	Depth of groundwater development (meter)	Water table (meter)	Drawdown (meter)	Water quantity (m^3/hr)	Water condition	Chloride (Cl) (mg/l)	Iron (Fe) (mg/l)	Nitrate (NO_3^-) (mg/l)	pH	Total dissolved solids (TDS) (mg/l)
1	CB247	Phutthamonthon, Chon Buri Province (well 2)	5	Khlong Kio	Ban Bueng	Chon Buri	124	10.3	-	-	Useble-fresh water	-	-	-	-	-
2	CB245	Phutthamonthon, Chon Buri Province (well 1)	5	Khlong Kio	Ban Bueng	Chon Buri	120	10.95	59.5	0.72	Useble-fresh water	-	-	-	-	-
3	PW10393	Ban Muen Chit	5	Khlong Kio	Ban Bueng	Chon Buri	-	5	9	1	Useble-fresh water	-	-	-	-	-
4	DMR160	Ban Muen Chit School	5	Khlong Kio	Ban Bueng	Chon Buri	18	2.1	8.4	2.27	Useble-fresh water	6	0.13	0	8.1	180
5	X687	Surasak Police Station (Ban Surasak Montri)	5	Khao Khansong	Si Racha	Chon Buri	36	1.2	22.5	3.41	Useble-fresh water	23	0.68	14	-	-
6	DH68	Wat Rawoeng Rangsan (Ban Rawoeng)	7	Khao Khansong	Si Racha	Chon Buri	21	3.6	11.4	1.59	Useble-fresh water	-	-	-	-	-
7	DH414	Ban Surasak	5	Khao Khansong	Si Racha	Chon Buri	55	3	19	1.5	Useble-fresh water	32	5.4	2.1	-	333
8	TD195	Ban Surasak Montri	5	Khao Khansong	Si Racha	Chon Buri	67.5	1	12	9	Useble-fresh water	6.8	9.3	0.1	-	114
9	TD393	Child development center of Ban Khao Khansong	4	Khao Khansong	Si Racha	Chon Buri	73.5	8	46	1	Useble-fresh water	-	-	-	-	-
10	PW7573	Wat Rawoeng Rangsan (9699/264-30)	7	Khao Khansong	Si Racha	Chon Buri	24.3	4.5	15.5	4	Useble-fresh water	-	-	-	-	-
11	CB251	Phan Saget Nok School	10	Khao Khansong	Si Racha	Chon Buri	87	4	-	2	Useble-fresh water	-	-	-	-	-
12	CB273	Ban Surasak School	5	Khao Khansong	Si Racha	Chon Buri	40	2	36	3	Useble-fresh water	-	-	-	-	-
13	5409G02	Wat Surasak	5	Khao Khansong	Si Racha	Chon Buri	72	3	40	3	Useble-fresh water	-	-	-	-	-
14	DH109	Wat Noen Chabok	7	Bo Win	Si Racha	Chon Buri	90	13.5	28.5	1.59	Useble-fresh water	38	0.86	0.1		220
15	PW6188	Ban Chaloem Lap	5	Nong Suea Chang	Nong Yai	Chon Buri	-	4	14	1	Useble-fresh water	-	-	-	-	-
16	TD302	Wat Chaloem Lap	5	Nong Suea Chang	Nong Yai	Chon Buri	103	8	35	1	Useble-fresh water	-	-	-	-	-
17	X957	Ban Ta Sit	-	Ta Sit	Pluak Daeng	Rayong	24	3	16.5	1.14	Useble-fresh water	22	0.24	0.5	-	470
18	PW23273	Ban Wang Khayaeng	5	Pluak Daeng	Pluak Daeng	Rayong	18.5	4.8	8.2	2	Useble-fresh water	-	-	-	-	-

Remark : - is no specific value

Source : Department of groundwater resources (http://www.dgr.go.th/), 2014

(a.2) Results of measurement by Hemaraj ESIE

Data from the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014 show that groundwater quality measurement was conducted in 6 stations as shown in **Figure 4.1.9-3**. Then the measurement results were compared with the values prescribed in the Notification of Ministry of Natural Resources and Environment re: Prescribing Academic Standards for Protection of Public Health and Environmental Pollution (B.E. 2551). The measurement stations similar to those of the project's groundwater quality sampling were Stations UW2 and UW5. The measurement results are as shown in **Appendix 3E-1** and as summarized below.

Station 1: The area of Wat Rawoeng Rangsan (UW1)

According to the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014, most measured parameters were within the Maximum Acceptable Concentration and the Maximum Allowable Concentration as prescribed in the Notification of Ministry of Natural Resources and Environment, B.E. 2551 re: Prescribing Academic Standards for Protection of Public Health and Environmental Pollution, except pH value that exceeded the Maximum Allowable Concentration in June and May 2012 and in March 2013.

Station 2: Ban Surasak School (UW2)

According to the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014, most measured parameters were within Maximum Acceptable Concentration and the Maximum Allowable Concentration as prescribed in the Notification of Ministry of Natural Resources and Environment, B.E. 2551 re: Prescribing Academic Standards for Protection of Public Health and Environmental Pollution, except pH value that exceeded the Maximum Allowable Concentration in March, 2012, and in March and June 2013 while the 4 measurements made in 2014 were within the Maximum Allowable Concentration. Moreover, Manganese (Mn) measured in March, June, and September 2013 and the 4 measurements conducted in 2014 exeeded the Maximum Allowable Concentration. Iron (Fe) measured in March 2014 also exceeded the Maximum Allowable Concentration.

Station 3: Chumchon Borisat Namtan Tawan-aok School (UW3)

According to the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014, most measured parameters were within Maximum Acceptable Concentration and the Maximum Allowable Concentration as prescribed in the Notification of Ministry of Natural Resources and Environment, B.E. 2551 re: Prescribing Academic Standards for Protection of Public Health and Environmental Pollution, except pH value that exceeded the Maximum Allowable Concentration in June 2011, June 2012 and September 2014.

Station 4 : Ban Tai Sun (UW4)

According to the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014, most measured parameters were within Maximum Acceptable Concentration and the Maximum Allowable Concentration as prescribed in the Notification of Ministry of Natural Resources and Environment, B.E. 2551 re: Prescribing Academic Standards for Protection of Public Health and Environmental Pollution, except pH value that exceeded the Maximum Allowable Concentration in March 2011, May 2012, and March and September 2013. Iron (Fe) measured in June 2013 also exceeded the Maximum Allowable Concentration.

Station 5 : Wat Chomphon Chao Phraya (UW5)

According to the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014, most measured parameters were within Maximum Acceptable Concentration and the Maximum Allowable Concentration as prescribed in the Notification of Ministry of Natural Resources and Environment, B.E. 2551 re: Prescribing Academic Standards for Protection of Public Health and Environmental Pollution, except pH value that most of results exceeded the Maximum Allowable Concentration but pH value in September 2011, September 2013, as well as January, June and September 2014 were not exceed the Maximum Allowable Concentraion.

Station 6 : Ban Khlong Kram (UW6)

According to the report on compliance with the environmental impact mitigation and preventive measures and environmental impact monitoring measures of Hemaraj ESIE during 2011-2014, most measured parameters were within Maximum Acceptable Concentration and the Maximum Allowable Concentration as prescribed in the

Notification of Ministry of Natural Resources and Environment, B.E. 2551 re: Prescribing Academic Standards for Protection of Public Health and Environmental Pollution, except pH value that most of results exceeded the Maximum Allowable Concentration but pH value in September 2011 and September 2013, were not exceed the Maximum Allowable Concentraion. Iron (Fe) measured in November 2012, and March and September 2013 also exceeded the Maximum Allowable Concentration.

(b) Data derived from measurements

The project had specified the sampling of groundwater quality in the area near the project location at 2 stations, in dry season on 20 February 2014 (**Appendix 3E-2**) and in rainy season on 8 May 2015 **(Appendix 3E-3)** as shown in **Figure 4.1.9-3**. The measurement results are as shown in **Table 4.1.9-2**, with the following details:

Survey conducted in dry season (on 20 February 2014)

- **Station 1 (GW1): Wat Chomphon Chao Phraya** (Coordinate: 47P 0738780E 1442892N)

The results of groundwater quality measurement at Station 1: all measured parameters were within the standards for groundwater quality as prescribed in the Notification of National Environment Board No. 20 B.E. 2543 re: Prescribing Standards for Groundwater Quality. However, when the measured parameters were compared with the groundwater standards used for consumption, pH was not within the Maximum Allowable Concentration for consumption water as prescribed in the Notification of Ministry of Natural Resources and Environment re: Prescribing Academic Standards for Protection of Public Health and Environmental Pollution B.E. 2551, which specifies that the pH value must be between 6.5-9.2 whereas the pH value at Station 1 was 5.65.

- **Station 2 (GW2): Ban Surasak School** (Coordinate: 47P 0735479E 1445159N)

The groundwater quality at Station 2: all the measured parameters were within the standards for underground water quality as prescribed in the Notification of National Environment Board No. 20 B.E. 2543 re: Prescribing Standards for Underground Water Quality. However, when the measured parameters were compared with the groundwater standards used for consumption, pH was not within the Maximum Allowable Concentration for consumption water as prescribed in the Notification of Ministry of Natural Resources and Environment re: Prescribing Academic Standards for Protection of Public Health and Environmental Pollution B.E. 2551, which specifies that the pH value must be between 6.5-9.2 whereas the pH value at Station 2 was 5.73.

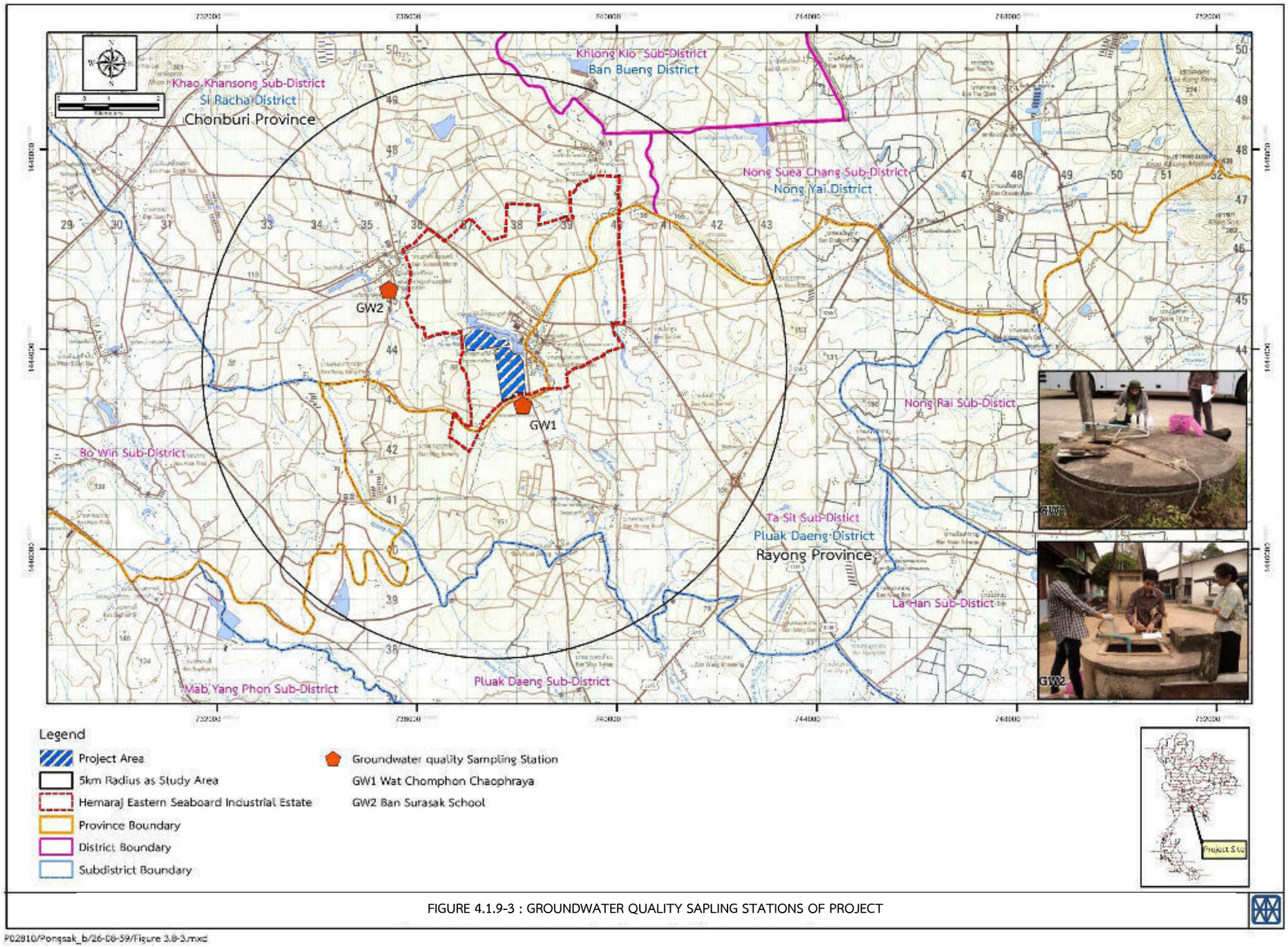


FIGURE 4.1.9-3 : GROUNDWATER QUALITY SAPLING STATIONS OF PROJECT

P02810/Ponqsak_b/26-08-59/Figure 3.8-3.mxd

TABLE 4.1.9-2

GROUNDWATER QUALITY FROM FIELD SURVEY OF THE PROJECT

No.	Prameters	Unit	Station				Standard		
			GW1		GW2		(1)	(2)	(3)
			20 Feb 2014	8 May 2015	20 Feb 2014	May 2015			
1.	pH	-	5.65	5.7	5.73	6.7	-	7.0-8.5	6.5-9.2
2.	Water Temperature	ºC	27.2	29.0	26.1	29.1	-	-	-
3.	Conductivity	µS/cm	115.90	86.9	152.20	237.5	-	-	-
4.	Turbidity	NTU	19.6	0.36	15.6	0.37	-	5	20
5.	Total dissolved solids (TDS)	mg/L	128.0	90.2	168.0	205.0	-	600	1,200
6.	Suspended solids (SS)	mg/L	<5.0	<5.0	<5.0	<5.0	-	-	-
7.	Total Hardness	Mg/L as $CaCO_3$	29	12.5	16	58.7	-	300	500
8.	Carbonate Hardness	Mg/L as $CaCO_3$	<1.0	12.5	<1.0	58.7	-	-	-
9.	Sulfate (SO_4)	mg/L	<2.0	<5.0	<2.0	<5.0	-	200	250
10.	Manganese (Mn)	mg/L	0.039	0.052	0.188	0.026	0.5	0.3	0.5
11.	Iron (Fe)	mg/L	0.06	0.07	0.04	<0.03	-	0.5	1.0
12.	Copper (Cu)	mg/L	0.006	<0.03	0.006	<0.03	1.0	1.0	1.5
13.	Zinc (Zn)	mg/L	0.033	0.020	0.045	0.059	5.0	5.0	15
14.	Magnesium (Mg)	mg/L	0.923	0.879	2.02	4.79	-	-	-
15.	Calcium (Ca)	mg/L	9.01	3.69	3.87	13.7	-	-	-
16.	*E.Coli*	MPN/100 ml	None	None	None	None	-	None	-
17.	Total Coliform Bacteria	MPN/100 ml	43	<1.1	210	<1.1	-	<2.2	-
18.	Fecal Coliform Bacteria	MPN/100 ml	23	<1.1	<1.8	<1.1	-	<2.2	-

Standard : (1) The standards for groundwater quality as prescribed in the Notification of National Environment Board No. 20 B.E. 2543 re: Prescribing Standards for Groundwater Quality

(2) The suitable concentration for consumption water as prescribed in the Notification of Ministry of Natural Resources and Environment re: Prescribing Academic Standards for Protection of Public Health and Environmental Pollution B.E. 2551

(3) The maximum allowable concentration for consumption water as prescribed in the Notification of Ministry of Natural Resources and Environment re: Prescribing Academic Standards for Protection of Public Health and Environmental Pollution B.E. 2551

Remark : Field survey of Team consulting engineering and management Co., Ltd., Febuary 2014 and May 2015

Station 1 (GW1) is the area of Wat Chomphon Chao Phraya Station 2 (GW2) is the area of Ban Surasak School

Survey conducted in rainy season (on 8 May 2015)

- **Station 1 (GW1) the area of Chomphon Chao Phraya Temple**

(Coordinate: 47P 0738172E 1442886N)

The groundwater quality at Station 1: all the measured parameters were within the standards for groundwater quality as prescribed in the Notification of National Environment Board No. 20 B.E. 2543 re: Prescribing Standards for Groundwater Quality. However, when the measured parameters were compared with the groundwater standards used for consumption, pH was not within the Maximum Allowable Concentration for consumption water as prescribed in the Notification of Ministry of Natural Resources and Environment re: Prescribing Academic Standards for Protection of Public Health and Environmental Pollution B.E. 2551, which specifies that the pH value must be between 6.5-9.2 whereas the pH value at Station 1 was 5.70.

- **Station 2 (GW2), the area of Ban Surasak School** (Coordinate: 47P 0735494E 1445249N)

The groundwater quality at Station 2: all the measured parameters were within the standards all the parameters measured were within the standards for groundwater quality as prescribed in the Notification of National Environment Board No. 20 B.E.2543 re: Prescribing Standards for Groundwater Quality and within the Maximum Allowable Concentration for consumption water as prescribed in the Notification of Ministry of Natural Resources and Environment re: Prescribing Academic Standards for Protection of Public Health and Environmental Pollution B.E. 2551.

Considering the measurement results of groundwater quality conducted in the areas of Wat Chomphon Chao Phraya (GW1) and Ban Surasak School (GW2), the value of total coliform bacteria (TCB) and fecal coliform bacteria (FCB) in the 1st measurement (February 2014) and the 2nd measurement (May 2015), were greatly different (see **Table 4.1.9-2**) due to the well structure - both sampling areas were shallow wells and during the 1st sampling period, the wells were not covered. Details are as follows.

- Wat Chomphon Chao Phraya (GW1): The well's location was in a temple and the well location was near the shelters for dogs and cats. According to the interview with the villagers, in dry season, the well would be opened for use included cleaning minibuses and tour buses (parked in the temple area) used for picking-up and sending-off the estate's staff. Moreover, the well mouth was only slightly higher than the ground and so dirty water from the washing activities easily flew into the well. As a result,

the measurement results of total coliform bacteria (TCB) and fecal coliform bacteria (FCB) were high as shown in **Photo 4.1.9-1**. For the 2nd measurement, some materials were used to cover the well's mouth and therefore the measurement results this time were within the standards as shown in **Photo 4.1.9-2**.

- Ban Surasak School (GW2): The well's location was in the school. During dry season when the 1st sampling was conducted, the well was opened and there were dust and soil particles around the well's mouth as shown in **Photo 4.1.9-1**. The dust, sand or fallen leaves, etc. could have easily fallen into the well and the measurement results thus showed high value of total coliform bacteria (TCB), but low fecal coliform bacteria (FCB) (because the well water had not been contaminated by excretion). For the 2nd measurement, the well was permanently closed and water pumping was made through pipe system as shown in **Photo 4.1.9-2** and the sampling was conducted through faucets. The 2nd measurement results showed that the water quality was within the standards.

Wat Chomphon Chao Phraya (GW1)

Ban Surasak School (GW2)

PHOTO 4.1.9-1 : GROUNDWATER STATION IN 1st SAMPLING

Wat Chomphon Chao Phraya (GW1)

Ban Surasak School (GW2)

PHOTO 4.1.9-2 : GROUNDWATER STATION IN 2nd SAMPLING

4.2 BIOLOGICAL RESOURCES

4.2.1 Terrestrial Ecology

(1) Introduction

The aim of this study is to study on existing of terrestrial ecology in project area and study area in 5 km radius, changing of ecology cause by project activity and preparing the environmental impact mitigation and preventive measures and environmental impact monitoring measures of terrestrial ecology later.

(2) Study methods

- Gather and study on secondary data from topographic map with 1:50,000 and others from relevant authorities such as Rayal Forest Department, Department of National Parks, Wildlife and Plant Conservation and guideline of birds in Thailand (Boonsong Lekagul) etc.
- Field survey on terrestrial ecology during 9-13 February 2014

(3) Result

(3.1) Forest and Wildlife Resources in Chonburi Province

In 2014, total forest area in Chon Buri Province was 339,683.18 rai (12.46 % of total area in Chon Buri Province) (Forest Land Management Bureau, Royal Forest Department, 2015). While, total forest area was 350,937.56 rai in 2013 (12.87 % of total area in Chonburi Province) so the forest area was decreased 3.21 %. Details are described as follow:

- **Nine National Forests** cover total area of 906,396 rai. Details are shown in **Table 4.2.1-1**.
- **One Arboretum** is Nong Ta Yu Arboretum that covers an approximate area of 483 rai. It is rehabilitated forest in a form of plantation. Plant species were planted such as *Eucalyptus globulus*, *Swietenia macrophylla*, *Casuarina junghuhniana*, *Casuarina equisetifolia*, *Acacia auriculiformis*, *Pterocarpus macrocarpus*, *Tectona grandis* and *Dipterocarpus alatus*. Currently, it is fertile mixed declduous forest that is located at Surasak Sub-district in Si Racha District.
- **One Forest Park** is Nam Tok Khao Chao Bo Forest Park that covers an approximate area of 19,473 rai. Major area is mixed declduous forest, which is wellhead of 5 waterfalls: Rom Sai Thong, Khao Khang Pla, Hree Pee and 2 nameless waterfalls, plant species were found such as *Afzelia xylocarpa*, *Pterocarpus macrocarpus*, *Bombax ceiba*, *Ailanthus triphysa*, *Lagerstroemia floribunda*, *Spondias mombin*, etc.

TABLE 4.2.1-1

AREA OF NATURAL FORESTS IN CHON BURI AND RAYONG PROVINCES

Chonburi Province			Rayong Province		
Name of National Park	Coverage area	Area (rai)	Name of National Park	Coverage area	Area (rai)
1. Khao Khiao Forest	Si Racha, Ban Bung and Mueang Chonburi Districts	55,625	1. Kached, Pae and Klaeng Forests	Mueang Rayong and Ban Khai Districts	28,937
2. Khao Chomphu Forest	Ban Bung and Si Racha Districts	28,589	2. Khao Huai Ma Hat, Khao Nang Yong and Khao Khrok Forest	Ban Chang and Mueang Rayong Districts	17,811
3. Khao Pu forest	Mueang Chonburi and Si Racha Districts	5,482	3. Khlong Rawerng-Khlong Samed Forest	Ban Khai and Pluak Daeng Districts	137,500
4. Khao Rua Taek Forest	Ban Bung and Si Racha Districts	1,500	4. Cha Wae, Ta Sit and Wang Sai Forests	Ban Khai and Klaeng Districts	-
5. Khao Hin Dad and Khao Pai Forests	Ban Bung District	2,125	5. Ban Na and Thung Khwai Kin Forest	Klaeng District	313,500
6. Khlong Ta Khian Forest	Phanat Nikhom District	378,750	6. Ban Pae Forest	Mueang Rayong District	625
7. Daeng and Chumchon Klang Forests	Ban Bung District	160,625	7. Phu Khao Hin Tang Forest	Mueang Rayong and Klaeng Districts	5,700
8. Tha Boon Mee and Bo Thong Forests	Phanat Nikhom District	170,625	8. Len Pra Sae and Pang Rad Forest	Klaeng District	9,090
9. Bang Lamung Forest	Bang Lamung District	103,075	10. Nong Sanom Forest	Mueang Rayong District	580
Total		**906,396**	**Total**		**513,743**

Source : Office of Planing and Information, Royal Forest Department, 2015
(http://forestinfo.forest.go.th/55/National_Forest.aspx)

- **Two No Hunting Wildlife Areas** (Department of National Parks, Wildlife and Plant Conservation, 2015; www.dnp.go.th) are as follow:

  - Khao Chi On No Hunting Wildlife Area covers an area of 2,299 rai. It was dry evergreen forest and tropical rain forest. Plant species were found such as *Diospyros mollis*, *Lagerstroemia floribunda*, *Anisoptera costata*, *Tetrameles nudiflora*, *Syzygium cumini*, *Pterocarpus macrocarpus*, *Spondias pinnata*, etc. Wild animals were found such as *Macaca mulatta*, *Viverricula indica*, *Paradoxurus hermaphrodites*, *Paradoxurus*, *Prionailurus bengalensis*, *Hystrix brachyura*, *Prionailurus viverrinus,* Order of Serpentes*, Streptopelia chinensis*, *Geopelia striata* and *Streptopelia tranquebarica*.

  - Bang Phra Reservoir No Hunting Wildlife Area covers an area of 11,600 rai. The type of forest is plantation that is newly planted. Plant species were found such as *Samanea saman*, *Acacia auriculiformis*, *Eucalyptus globulus*, *Peltophorum pterocarpum*, *Hopea odorata*, *Dipterocarpus alatus*, *Acacia catechu*, *Tectona grandis*, *Pterocarpus macrocarpus*, etc. More than 130 types of birds were found such as *Garrulax leucolophus*, *Mycteria leucocephala*, *Pelecanus philippensis*, *Ardea cinerea*, *Sciuridae*, *Tupaiidae*, *Cervus unicolor*, *Viverricula indica*, *Nycticebus coucang*, *Prionailurus viverrinus*, *Oreoglanis siamensis*, etc.

- **Two Wildlife Sanctuaries** (Department of National Parks, Wildlife and Plant Conservation, 2015; www.dnp.go.th) are as follow:

  - Khao Ang Rue Nai Wildlife Sanctuary covered in 5 provinces: Rayong Chonburi Chantaburi Sakaeo and Chachoengsao Provinces. It was dry evergreen forest and plant species were found such as *Lagerstroemia calyculata*, *Irvingia malayana*, *Dipterocarpus turbinatus*, *Tetrameles nudiflora*, *Hopea odorata*, *Pterocymbium tinctorium*, *Aglaia edulis*, *Pterospermum diversiolium*, *Sandoricum koetjape*, *Carallia brachiate*, *Aphanamixis polystachya*, *Xerospermum noronhianum*, *Murraya paniculata*, *Excoecaria oppositifolia*, *Dialium cochinchinense*, *Diospyros ferrea*, *Mansonia gagei*, *Diospyros buxifolia*, *Sageraea elliptica*, *Laportea interrupta, Pterocarpus macrocarpus*, *Bombax anceps*, *Albizia odoratissima*, *Schleichera oleosa*, *Terminalia bellirica*, *Vitex pinnata*, *Walsura robusta*, *Cratoxylum formosum*, *Markhamia stipulata*, *Harpullia arborea*, *Semecarpus cochinchinensis*, *Spondias pinnata*, etc. Wildlife were found as follow: 64 types of mamals were found such as *Ratufa bicolor*, *Callosciurus finlaysoni*, *Hylobates pileatus*, *Muntiacus muntjak*, *Elephas maximus*, *Bos gaurus*, etc., 246 types of birds were found such as *Buceros bicornis*, *Rhyticeros undulatus, Lophura diardi*, *Pitta moluccensis*, *Lonchura punctulata*, *Streptopelia chinensis*, *Pycnonotus blanfordi*, *Acridotheres tristis*, *Elanus caeruleus*, etc., 53 types of reptiles were found such as *Ahaetulla prasina*, *Sphenomorphus maculatus*, *Eutropis macularius*, *Varanus bengalensis*, *Dendrelaphis suborcularis*, etc., and 18 types of amphibians were found such as *Rhocoprus leucomystax*, *Hylarana erythraea*, *Fejervarya limnocharis*, *Kaloula pulchra*, *Microhyla berdmorei*, etc.

  - Khao Khiao-Khao Chomphu Wildlife Sanctuary was located in Nong Ree and Nong Khang Khok Sub-districs in Muang Chonburi District, Bang Phra and Nong Kham Sub-district in Si Racha District, Nong Samsak, Ban Bung and Khlong Kio Sub-districts in Ban Bung District Chonburi Province. Forest was divided into 3 characters. (1) Mixed Declduous Forest was found plant species such as *Phyllocarpus septentrionalis*, *Afzelia xylocarpa*, *Phyllanthus emblica*, *Wrightia religiosa*, *Spondias mombin*, *Gigantochloa albociliata*, etc. (2) dry evergreen forest was found plant species such as *Irvingia malayana*, *Tetrameles nudiflora*, *Lagerstroemia floribunda*, etc. and (3) tropical rain forest was found plant species such as *Dalbergia oliveri*, *Hopea odorata*, *Dipterocarpus alatus*, *Aphanamixis polystachya*, *Afzelia xylocarpa*, etc. Wildlife were found such as *Cervidae*, *Muntiacus muntjak*, *Panthera pardus*, *Ursidae Prionailurus bengalensis*, *Viverridae, Paradoxurus*, *Macaca mulatta*, *Cercopithecidae*, *Hylobates lar*, *Sus scrofa*, *Nycticebus coucang*, *Tragulus napu*, *Gallus gallus*, etc. Various types of birds were found. Reptiles were found

such as Order of Serpentes, *Varanus bengalensis*, *Varanus salvator*, *Varanus rudicollis* etc. Amphibians were found such as *Hoplobatrachus* sp., *Occidozyga* sp., *Cyclemys* sp., *Indotestudo* sp. etc.

(3.2) Forest and Wildlife Resources in Rayong Province

In 2014, total forest area in Rayong Province was 176,427.14 rai (7.95 % of total area in Rayong Province) (Forest Land Management Bureau, Royal Forest Department, 2015). While, total forest area was 196,527.18 rai in 2013 (8.85 % of total area in Rayong Province) so the forest area was decreased 10.23 %.

- **Nine National Forests** cover total area of 513,743 rai. Details are shown in **Table 4.2.1-1**.
- **Two National Parks** (Department of National Parks, Wildlife and Plant Conservation, 2015; www.dnp.go.th) are as follow:

- Khao Laem Ya-Mu Koh Samed National Park that is mixed declduous forest and plant species were found such as *Lagerstroemia loudonii*, *Dolichandrone serrulata*, *Xylia xylocarpa*, *Terminalia bellirica*, *Phoebe paniculata*, *Vitex peduncularis*, *Croton oblongifolius*, *Microcos tomentosa*, *Syzygium cumini*, *Parkia sumatrana*, *Caryota mitis*, *lxora Cibdela*, *Acacia pennata*, *Aporusa villosa*, etc. Plant species were found in unoccupied area and deforested area such as *Croton oblongifolius*, *Syzygium cumini*, *Hymenodictyon orixense*, *Xerospermum noronhianum*, etc. Wildlife were found no less than 268 types such as *Muntiacus muntjak*, *Hylobates lar*, *Paradoxurus hermaphrodites*, *Aonyx cinerea*, *Ratufa bicolor*, *Callosciurus caniceps*, *Menetes berdmorei*, *Cynopterus sphinx*, *Macroglossus sobrinus*, *Eonycteris spelaea*, *Pellorneum ruficeps*, *Garrulax leucolophus*, *Gampsorhynchus torquatus*, *Pycnonotus melanicterus*, *Pycnonotus finlaysoni*, *Pycnonotus* sp., *Chrysocolaptes lucidus*, *Picus vittatus*, *Hemicircus canente*, *Microhierax caerulesens*, *Rhinortha chlorophaea*, *Harpactes erythrocephalus*, *Megalaima mystacophonos*, *Eutropis macularia*, *Sphenomorphus maculatus*, *Draco maculatus*, *Calotes versicolor*, *Calotes emma*, *Gekko gecko*, *Bungarus fasciatus*, *Rhabdophis subminiatus*, *Hylarana erythraea*, *Rana nigrocinctus*, *Fejervarya limnocharis*, *Chiromantis* sp. *Rhacophorus orlovi*, *Duttaphrynus melanostictus*, *Kaloula pulchra*, *Microhyla heymonsi*, *Micryletta inornata*, *Microhyla fissipes*, etc.

- Khao Chamao-Khao Wong National Park is hill evergreen forest, dry evergreen forest, tropical rain forest and limestone vegetation. Plant species were found such as *Irvingia malayana*, *Tetrameles nudiflora*, Afzelia xylocarpa *Pterocarpus macrocarpus*, *Spondias pinnata* etc. Wildlife were found no less than 137 types such as

Sus scrofa, *Nycticebus coucang*, Order of Serpentes, *Varanus bengalensis*, *Elephas maximus*, *Bos javanicus*, *Panthera tigris*, etc.

- **One Wildlife Sanctuary** is Khao Ang Rue Nai wildlife sanctuary that covers 5 provinces: Rayong, Chonburi, Chantaburi, Sa Kaeo and Chachoengsao Provinces. Khao Ang Rue Nai wildlife sanctuary is dry evergreen forest. Plant species were found such as *Lagerstroemia calyculata*, *Irvingia malayana*, *Dipterocarpus turbinatus*, *Tetrameles nudiflora*, *Hopea odorata*, *Pterocymbium tinctorium*, *Aglaia edulis*, *Pterospermum diversiolium*, *Sandoricum koetjape*, *Carallia brachiate*, *Aphanamixis polystachya*, *Xerospermum noronhianum*, *Murraya paniculata*, *Excoecaria oppositifolia*, *Dialium cochinchinense*, *Diospyros ferrea*, *Mansonia gagei*, *Diospyros buxifolia*, *Sageraea elliptica*, *Laportea interrupta*, *Pterocarpus macrocarpus*, *Bombax anceps*, *Albizia odoratissima*, *Schleichera oleosa*, *Terminalia bellirica*, *Vitex pinnata*, *Walsura robusta*, *Cratoxylum formosum*, *Markhamia stipulata*, *Harpullia arborea*, *Semecarpus cochinchinensis*, *Spondias pinnata*, etc. Wildlife were found as follow: 64 types of mamals were found such as *Ratufa bicolor*, *Callosciurus finlaysoni*, *Hylobates pileatus*, *Muntiacus muntjak*, *Elephas maximus*, *Bos gaurus*, etc. 246 type of birds were found such as *Buceros bicornis*, *Rhyticeros undulatus*, *Lophura diardi*, *Pitta moluccensis*, *Lonchura punctulata*, *Streptopelia chinensis*, *Pycnonotus blanfordi*, *Acridotheres tristis*, *Elanus caeruleus*, etc. 53 types of reptiles were found such as *Ahaetulla prasina*, *Sphenomorphus maculatus*, *Eutropis macularius*, *Varanus bengalensis*, *Dendrelaphis suborcularis*, etc. 18 types of amphibians were found such as *Rhocoprus leucomystax*, *Hylarana erythraea*, *Fejervarya limnocharis*, *Kaloula pulchra*, *Microhyla berdmorei*, etc.
- **Two Arboretum** are as follow:
  - Pae Arboretum is pine forest along the beach. Major plant species was *Casuarina equisetifolia*. Pae Arboretum was public recreational area where rare wildlife was not found but various types of birds were found.
  - Nong Sanom Arboretum is forest beach. Plant species were found such as *Dipterocarpus alatus*, Vatica odorata, Artocarpus lacucha, Garcinia cowa, Casearia grewiifolia, Mangifera pentandra, Melodorum fruticosum, *Suregada multiflorum*, etc.

(3.3) Forest and Wildlife Resources in project area

Project area is located in Hemaraj ESIE that has been just reclaimed land. Plant species were found in unoccupied area such as *Imperata cylindrical*, Eleusine indica, Leucaena leucocepphala, *Mimosa pudica*, etc. Wildlife were found such as *paser montanus*, *Streptopelia chinensis*, *Vanellus indicus*, *Cypsiurus batasiensis*, *Acridotheres tristis*, etc.

4.2.2 Aquatic Ecology

(1) Intruduction

Construction activities of the project may cause impact on aquatic ecology in terms of turbidity which would be effect to organisms in water sources. Hence the project has to study the existing situation of water sources including biological resources in order to assess impacts together with propose environmental impact mitigation and preventive measures including environmental impact monitoring measures for the least impacts

(2) Method o the study

(a) Secondary data

Secondary data of aquatic ecology of surface water had been gathered from project area or vicinity area.

(b) Field study

There will be 5 stations to collect aquatic ecology samples. These were the same stations where surface water samples were collected both during the rainy and dry seasons. The sampling methods were:

Plankton Sampling

Plankton sampling was collected by taking 20 liters of surface water sampling (about 0-30 cm depth, and put into plankton bag with mesh size of 70 micron for phytoplankton and 120 micron for zooplankton. The sampling was preserved by formalin with 5 % concentration and kept in sampling bottles. Analysis on species and quantity was undertaken at laboratory of Faculty of Fisheries at Kasesart University (Bang Khen Cumpus).

Density of organism in the water had been calculated in a unit of cell per m^3. Species analysis is referred to Ladda (B.E. 2542), Smith (1950), Mizuno (1969), Carr and Whitton (1973) and Bold and Wynne (1978)

Calculation of plankton density was calculated with reference to Shannon-Wiener Index (1963) formula, as follows:

$$H' = -\sum\left(n_i / n\right)\ell n\left(n_i / n\right)$$

Where H' = Species diversity index

s = Number of plankton species

n = Total number of plankton

ni = Number of each plankton species

Biological diversity is indicated water quality standard (Wilhm and Dorris, 1968):

H'	<	1.0	Poor water quality, Not suitable for organism in water
H'	=	1.0-3.0	Fair water quality, Organism in water can live
H'	>	3.0	Good water quality, Suitable for organism in water

Benthos sampling

Benthos samplings were taken by Ekman Dredge (0.25x0.25 m^2 area), 2 points at one station (Total 1 sq. foot). The collected samplings were put on strainer to separate scrap out. Sieve size was 850 micron. Sievable samplings were preserved by 7 % concentration formalin, and kept in bottles. Analysis of samples were undertaken at laboratory of Faculty of Fisheries at Kasesart University (Bang Khen Cumpus).

Benthos was analyzed with the reference to Prachuab (B.E. 2525), Supawadee (B.E. 2525), Saowapa (B.E. 2538), Brinkhurst (1971), Brandt (1974), Merritt and Cummins (1984) and Williams and Felmate (1992).

(c) Fishing activity survey

Surveys will be conducts on fishing activities in the project's water sources such as fishing locations and fish farming in fish cages.

(d) Environmental impact assessment

Assess environmental impact on ecology from the project both during the construction period and operation period. The life forms to be assessed were phytoplankton, zooplanktons, benthic animals and fishing activities.

(e) Preventive, mitigation and monitoring measures on environmental impact

Suitable measures to minimize impact on aquatic ecology during the construction period and operation period of the power plant project were to be proposed, as well as monitoring measures on environmental impact assessment.

(3) Studies

(a) Secondary data

The aquatic ecology study in the Impact Assessment Report: Cooling Blowdown from Power Plant Projects in Hemaraj ESIE, August 2015, disclosed data on phytoplankton, zooplankton, benthic animals, fish eggs and fry using data collection standard APHA-AWWA-WEE (1995):

Aquatic ecology samples were collected at 7 stations (**Figure 4.1.8-3**)

Station 1 – Khlong Kram approximately 10 km upstream of the Hemaraj ESIE wastewater discharge point and 4.5 km upstream of Hemaraj ESIE property.

Station 2 – Inside Hemaraj ESIE's wastewater holding pond before discharging into Khlong Kram.

Station 3 – Khlong Kram downstream about 10 km after Hemaraj ESIE's discharge point and about 500 m before the confluence with Khlong Rawoeng.

Station 4 – Khlong Rawoeng 200 m before entering Hemaraj ESIE area.

Station 5 – Khlong Rawoeng at the back of Ban Wang Kha Yang weir (downstream of confluence with Khlong Kram).

Station 6 – Ning Pla Lai reservoir – 2 km from the mouth of Khlong Rawoeng River.

Station 7 – Nong Pla Lai reservoir – 4 km from the mouth of Khlong Rawoeng River.

The study found the following:

(a1) Phytoplankton

Station 1 – Khlong Kram upstream of the Hemaraj ESIE – 6 kinds of phytoplanktons were found with a combined species abundance of 133,280 units/m^3 and diversity index of 1.65. The top 3 dominant species (gauging from species abundances) were *Synedra* sp., *Spirogyra* sp. and *Trachelomonas hispida.*

Station 2 – Inside Hemaraj ESIE's wastewater holding pond before discharging into Khlong Kram – 8 kinds of phytoplanktons were found with a combined species abundance of 636,000 units/m^3 and diversity index of 1.1. The top 3 dominant species were *Chroococus* sp., *Chlorella* sp. and *Oscillatoria* sp.

Station 3 – Khlong Kram downstream after Hemaraj ESIE's discharge point - 10 kinds of phytoplanktons were found with a combined species abundance of 204,200 units/m^3. The top 3 dominant species were 1) Synedra sp., 2) *Spirogyra* sp. and 3) *Oscillatoria* sp. and *Gomphonema* sp. (equal abundance for the 2 species).

Station 4– Khlong Rawoeng before entering Hemaraj ESIE area - 8 kinds of phytoplanktons were found with a combined species abundance of 242,500 units/m^3 and diversity index of 1.98. The top 3 dominant species were *Nitzchia* sp., *Ocystis* sp. and *Actinastrum* sp.

Station 5 – Khlong Rawoeng at the back of Ban Wang Kha Yang Wier and downstream from Hemaraj ESIE - 11 kinds of phytoplanktons were found with a combined species abundance of 1,276,700 units/m^3 and diversity index of 0.34. The top 3 dominant species were *Aulacoseira granulate, Nitzschia* sp.and *Oscillatoria* sp.

Station 6 – Nong Pla Lai reservoir – 2 km from the mouth of Khlong Rawoeng river – 16 kinds of phytoplanktons were found with a combined species abundance of 3,033,320 units/m^3 and diversity index of 1.17. The top 3 dominant species were *Oscillatria* sp., *Aulacoseira granulate* and *Microcystis aeruginosa*.

Station 7 – Nong Pla Lai reservoir – 4 km from the mouth of Khlong Rawoeng river - 10 kinds of phytoplanktons were found with a combined species

abundance of 2,087,680 units/m^3 and diversity index of 1.32. The top 3 dominant species were *Aelacoseira granulate, Microcystis aeruginosa* and *Oscillatoria* sp.

From the survey results at the 7 stations, it is apparent that the diversity indexes in Khlong Kram, Khlong Rawoeng and Nong Pla Lai reservoir were greater than 1 but less than 3 at almost all the stations. The only exception was Station 5 Khlong Rawoeng at the back of Ban Wang Kha Yang reservoir with diversity index of 0.34 as per Wilhm and Dorris (1968) method. It can be concluded that the water quality in Khlong Kram, Khlong Rawoeng and Nong Pla Lai reservoir were suitable for phytoplanktons. Exception is made for Station 5 where the diversity index is below 1 which might be due to the location being near dense human habitat and community potable water plant. Sediments from the community potable water plant may disrupt phytoplanktons habitat. The higher species abundance in the Nong Pal Lai reservoir than both Khlong Kram and Khlong Rawoeng indicate that the reservoir water is richer than water in the streams. This might be due to the fact that the reservoir contain more water throughout the year and that phytoplankton's can take advantage of feeding on all the nutrients that come from the streams.

(a2) Zooplanktons

Station 1 – Khlong Kram upstream of the Hemaraj ESIE – 4 kinds of zooplanktons were found with a combined species abundance of 33,600 units/m^3 and diversity index of 1.6. The dominant species was Cyclopoid Copepod.

Station 2 – Inside Hemaraj ESIE's wastewater holding pond before discharging into Khlong Kram - 4 kinds of zooplanktons were found with a combined species abundance of 22,260 units/m^3 and diversity index of 1.35. The 3 dominant species were *Brach onus caudatus* and *Lepadella* sp. under Phylum Rotifer and Cyclopoid Copepod under Phylum Arthropoda.

Station 3 – Khlong Kram downstream after Hemaraj ESIE's discharge point - 4 kinds of zooplanktons were found with a combined species abundance of 12,600 units/m^3 and diversity index of 1.31. The 3 dominant species were *Brachionus caudatus, Lepadella* sp. and Cyclopoid Copepod like at Station 2.

Station 4 – Khlong Rawoeng before entering Hemaraj ESIE area - 3 kinds of zooplanktons were found with a combined species abundance of 22,500 units/m^3 and diversity index of 0.97. The 2 dominant species were *Centropyxis aculeata* under Phylum Protozoa and *Lepadella* sp.

Station 5 – Khlong Rawoeng downstream from Hemaraj ESIE – 3 kinds of zooplanktons were found with a combined species abundance of 19,800 units/m^3 and diversity index of 0.57. The dominant species was *Lapadella* sp. under Phylum Protozoa.

Station 6 – Nong Pla Lai reservoir – 2 km from the mouth of Khlong Rawoeng river - 8 kinds of zooplanktons were found with a combined species abundance of 282,080 units/m^3 and diversity index of 1.07. The dominant species was the Nauplius stage of Copepod.

Station 7 – Nong Pla Lai reservoir – 4 km from the mouth of Khlong Rawoeng river - 11 kinds of zooplanktons were found with a combined species abundance of 704,400 units/m^3 and diversity index of 0.62. The dominant species was the Nauplius stage of Copepod.

The survey results from the 7 stations found that diversity indexes in Khlong Kram at Station 7, 3, Hemaraj ESIE wastewater holding pond and Station 2 were greater than 1 but less than 3 (Wilhm and Dorris (1968). This indicate suitable environment for zooplanktons. However, the water in Rawoeng River at station 4 and 5, the diversity indexes were lower indicating that the water is not so suitable to zooplanktons. This might be due to the strong water current of Rawoeng River and with it, a large of sediments which disrupts zooplanktons. However, the water current in Khlong Kram is slow and hold less sediments. Station 6 at the Nong Pla Lai reservoir has a diversity index of 1.07 which is greater than 1 and less than 3 (Wilhm and Dorris (1968). Station 6 sees water quality suitable to zooplanktons but station 7 has diversity of less than 1 indicating unsuitable environment for zooplanktons. However, both station 6 and 7 have approximately twice the zooplanktons than in Khlong Kram and Khlong Rawoeng and much greater species abundances than in the Khlongs. This indicate that Nong Pa Lhai reservoir is ecologically richer than Khlong Kram and Khlong Rawoeng due to the reservoir being a larger body of water all year round ad zooplanktons feeding on phytoplankton which were more abundant in the reservoir.

(a3) Benthos

Station 1 – Khlong Kram upstream of the Hemaraj ESIE – 2 kinds of benthos were found; 1 in the Phylum Annelida – Neididae and 1 in the both in the Phylum Mollusea - *Clea* sp. The combined species abundance is 30 individuals/m^2 and a diversity index of 0.69.

Station 2 – Inside Hemaraj ESIE's wastewater holding pond before discharging into Khlong Kram – no benthos were found because the pond bed is compact pebbles and the water is deep at 5-6 m, thus unsuitable for benthos to survive.

Station 3 – Khlong Kram downstream after Hemaraj ESIE's discharge point – 2 kinds of benthos were found: 1 Bivalvia - *Ensidens* sp. and 1 insect - *Chironomus* sp. The combined species abundance is 30 individuals/m^2 and a diversity index of 0.69.

Station 4 – Khlong Rawoeng before entering Hemaraj ESIE area - 2 kinds of benthos were found: 1 Bivalvia - *Uniandra* sp. and 1 insect - *Chironomus* sp. The combined species abundance is 30 individuals/m^2 and a diversity index of 0.69.

Station 5 – Khlong Rawoeng at the back of Ban Wang Kha Yang reservoir and downstream from Hemaraj ESIE: 3 benthos were found and all were bivalvias - *Ensidens* sp., *Uniandra* sp. and *Scabies* sp. The combined species abundance is 195 individuals/m^2 and a diversity index of 0.90.

Station 6 –Nong Pla Lai reservoir – 2 km from the mouth of Khlong Rawoeng River: 2 benthos were found and both were gastropodas - *Melanoides* sp. and *Clea* sp. The combined species abundance is 30 individuals/m^2 and a diversity index of 0.69.

Station 7– Nong Pla Lai reservoir – 4 km from the mouth of Khlong Rawoeng River: 3 benthos were found, two of which were bivalvias - *Scabies* sp. and *Corbicula* sp. – and one insect - *Chironomus* sp.

From the study, it was found that the diversity indexes were below 1 except for Station 7. This may be due to the water beds being coarse sand or pebbles which are unsuitable for benthos to make habitat. Note that most of the benthos found were mollusks which have the ability to anchor themselves in sand and pebbles and can withstand strong water current. As for station 7, Nong Pla Lai reservoir and 4 km from the mouth of Khlong Rawoeng river, the diversity index is above 1 possibly due to the lack of current and more organic matters can settle down to the bottom where benthos could feed on more easily. At station 5 Khlong Rawoeng, the diversity index is a low 0.9 but with a species abundance of 195 individuals/m^2 which may be greater than most other stations. This might be due to water bed environment being not as suitable as habitat for benthos but higher abundance of available organic matter from nearby Ban Wang Kha Yang weir might explain why there are many of them.

(a4) Fish eggs and fry

The study found no fish eggs and fry at Station 1 and 2 along Khlong Kram and this could be due to shallow waters, strong currents and waterbed pebbles unsuitable to fish eggs. From interviews with local inhabitants along the river, only a few species of fish – and in small numbers - are found in the water such as Tire track eel, Two-spot catfish and Gourami. In the Hemaraj ESIE waste water holding pond, no fish eggs and fry were found as it is not a natural habitat for fish. At Station 4 by Khlong Rawoeng, 5,000 fish eggs/1,000 m^3 of water were found and at Station 5 both fish eggs and fish fry were found at a rate of 5,000/1,000 m^3 and 5,000/1,000 m^3 respectively. Interviews with the villagers who fish in this area (near Station 5 at the back of Ban Wang Kha Yang weir) several

species of fish are caught: Carp, Minnow, Two-spot catfish and fresh water shrimp. At Station 6 – Nong Pla Lai reservoir – 10,000 fish eggs/1,000 m^3 and 35,000 fish eggs/1,000 m^3 were found. At Station 7, 10,000 fish eggs/1,000 m^3 and 30,000 fish eggs/1,000 m^3 were found. Interviews with fishermen at the reservoir found the following fish species were mainly caught: Carp, Tilapia and Rohu. Others also found Mekong giant catfish (released by the Fishery Department), Wrestling halfbeak, and Walking catfish. The diet of the majority of fish found here (Carp and Tilapia) are organic matters and phytoplankton.

(b) Field Survey

The consultant has conducted a field survey and collected aquatic ecology specimens as representatives for dry season (on February 2014) and as representatives for rainy (on 18 August 2014). The dry season field survey results are shown as **Table 4.2.2-1** and **Table 4.2.2-2**, while the rainy season results are **Table 4.2.2-3** and **4.2.2-4.** They are summarized as follows:

- **Dry season survey (20 February 2014) (Table 4.2.2-1 and Table 4.2.2-2)**

Station W1 – The upstream about 500 m before the project area

Phytoplankton

Three divisions of phytoplankton were found: Cyanophyta, Chlorophyta and Chromophyta. Four classes were found: Cyanophyceae, Chlorophyceae, Euglenophyta and Bacillariophyceae - 10 different species of these were identified. The dominant species is *Chlorella* with density of 138,600 cells/m^3. Next was *Ulothrix aequalis* at 50,400 cells/m^3. The total phytoplankton found was 352,800 cells/m^3 with a diversity index of 1.93 (phytoplankton diversity index range from 1.0 to 3.0). These indicate that the water at Station W1 is sufficiently suitable as habitat for aquatic life forms.

Zooplankton

Two phylum of zooplankton were found: Protozoa and Rotifera) with a total of 5 species. The dominant species was *Polyarthra vulgaris* with a density of 88,200 cells/m^3. Next most abundant was a Protozoa, *Difflugia lobostoma,* with a density of 37,800 cells/m^3. The total zooplankton count is 176,400 cells/m^3 with a diversity index of 1.33 (zooplankton diversity index range from 1.0-3.0). These indicate that the water at Station W1 is sufficiently suitable as habitat for aquatic life forms.

TABLE 4.2.2-1

SPECIES AND VOLUME OF PLANKTON IN THE STUDY AREA

FROM FIELD SURVEY IN DRY SEASON

Volume of plankton (cell/m³)

Plankton Species	Stations				
	SW 1	SW 2	SW 3	SW 4	SW 5
Phytoplankton					
Division Cyanophyta					
Class Cyanophyceae (blue green algae)					
Oscillatoria sp.	37,800	26,200	98,400	12,950	23,400
Rhaphidiopsis sp.	25,200		24,600		
Division Chlorophyta					
Class Chlorophyceae					
Chlorella sp.	138,600	91,700	86,100	103,600	46,800
Ulothrix aequalis	50,400	39,300			
Rhizoclonium sp.	25,200				
Geminella mutabilis	12,600		24,600		
Spirogyra crassa		144,100		25,900	
Pediastrum duplex			12,300	12,950	
Dictyosphaerium pulchellum			24,600		23,400
Chlamydomonas angulosa					23,400
Oedogonium crispum					11,700
Class Euglenophyta(euglenoids)					
Trachelomonas volvocina	25,200	26,200			
Euglena deses		13,100			
E. oxyuris				12,950	
Division Chromophyta					
Class Bacillariophyceae(diatom)					
Synedra ulna	12,600	26,200	24,600	51,800	11,700
Surirella elegans	12,600				11,700
S. ovata	12,600				
S. robusta		13,100	12,300	90,650	11,700
S. striatula					11,700
Fragilaria capucina			24,600	12,950	
Gyrosigma sp.			12,300		58,500
Frustulia vulgaris				12,950	
Class Dinophyceae (dinoflagellate)					
Peridinium sp.			246,000	25,900	81,900
Voume of Photoplankton	352,800	379,900	590,400	362,600	315,900
Species of Photoplankton	10	8	11	10	11
Phytoplankton Diversity Index	**1.93**	**1.73**	**1.85**	**1.95**	**2.13**

TABLE 4.2.2-1

SPECIES AND VOLUME OF PLANKTON IN THE STUDY AREA

FROM FIELD SURVEY IN DRY SEASON (Cont'd)

Volume of plankton (cell/m³)

Plankton Species	Stations				
	SW 1	SW 2	SW 3	SW 4	SW 5
Zooplankton					
Phylum Arthropoda					
Subclass Copepoda					
*Nauplius stage		13,100	61,500	12,950	23,400
Order Cyclopoida					
*Cyclopoids copepods		26,200			
Subclass Ostracoda					
Moina sp.		13,100			
Alona sp.		26,200			
Bosminopsis sp.		13,100			
Phylum Protozoa (Protozoans)					
Tintinnidium sp.	25,200	13,100			
Difflugia lobostoma	37,800	13,100			
D. lebes	12,600				
Arcella megastoma		13,100			11,700
Paramecium sp.			12,300		
Centropyxis ecornis				12,950	11,700
Vorticella sp.				12,950	
Phylum Rotifera					
Polyarthra vulgaris	88,200		36,900		
Trichocerca capucina	12,600		24,600		
Brachionus falcatus			49,200		
Cephalodella sp.				12,950	
Colurella colurus				12,950	11,700
Volume of Zooplankton	176,400	131,000	184,500	64,750	58,500
Species of Zooplankton	5	8	5	5	4
Zooplankton Diversity Index	**1.33**	**2.03**	**1.49**	**1.61**	**2.44**

Remark * = Not Identifies

Station W1 : The upstream about 500 m before the project area

Station W2 : Map Kradon Swamp

Station W3 : Tap water Pumping Station of Chomphon Chao Phraya Sub-district Municipality

Station W4 : The estate's wastewater drainage point

Station W5 : The downstream about 500 m from the estate's wastewater drainage point

Source: Field survey of Team consulting engineering and management Co., Ltd., 20 February 2014

TABLE 4.2.2-2

SPECIES AND DENSITY OF BENTHOS FROM FIELD SURVEY IN DRY SEASON

density (individuals/squre meters)

Phylum / Species of Benthos	Stations					
	SW1	SW2	SW3	SW4	SW5	Total
PHYLUM ANNELIDA						
Class Oligochaeta						
Family Tubificidae	-	88	-	-	-	**88**
PHYLUM ARTHROPODA						
Class Insecta						
Order Diptera						
Family Chironomidae	22	-	22	-	-	**44**
Order Odonata						
Family Libellulidae	-	22	-	-	-	**22**
Family Gomphidae	-	22	-	-	22	**44**
Order Trichoptera						
Family Limnephilidae	22	-	-	-	-	**22**
Class Crustacea						
Order Decapoda						
Family Palaemonidae						
Macrobrachium sp,	22	-	22	-	-	**44**
PHYLUM MOLLUSCA						
Class Gastropoda						
Order Mesogastropoda						
Family Viviparidae						
Filopaludina sp.	44	-	22	66	-	**132**
Family Thiaridae						
Thiara sp.						
Melanoides sp.	242	-	-	396	-	**638**
Family Bithyniide						
Bithynia sp.	-	88	-	-	-	**88**
Class Bivalvia						
Order Veneroida						
Family Corbiculidae						
Corbicula sp.	-	44	-	132	-	**176**
Order Unionoida						
Family Amblemidae						
Pseudodon sp.	-	-	-	22	-	**22**
Scabies sp.	-	22	-	-	-	**22**
Total (individuals/squre meters)	**352**	**286**	**66**	**616**	**22**	**1,342**
Total of Benthos species	**5**	**6**	**3**	**4**	**1**	**12**

Remark : the water beds being coarse sand or pebbles

Source: Field survey of Team consulting engineering and management Co., Ltd., 20 February 2014

TABLE 4.2.2-3

SPECIES AND VOLUME OF PLANKTON IN THE STUDY AREA FROM FIELD SURVEY IN RAINY SEASON

Volume of plankton (cell/m³)

Plankton Species	Stations				
	SW 1	SW 2	SW 3	SW 4	SW 5
Phytoplankton					
Division Cyanophyta					
Class Cyanophyceae (blue green algae)					
Oscillatoria sp.	23,700	11,600		3,050	3,250
Spirulina platensis	3,950	11,600			3,250
Division Chlorophyta					
Class Chlorophyceae					
Volvox aureus	292,300	110,200			
Ulothrix aequalis	173,800	23,200		3,050	19,500
U. variabilis	142,200	11,600		9,150	42,250
Closterium acerosum	11,850	5,800			
C. praelongum	7,900				
C. lineatum	7,900				
C. tumidum	7,900				
C. kutzingii	3,950				
C. moniliferum	3,950				
Pediastrum duplex	3,950				
P. simplex	3,950				
Oedogonium crispum	7,900	5,800		6,100	3,250
Triploceras sp.	7,900				
Hydrodictyon sp.		29,000		3,050	
Mougeotia scalaris				3,050	6,500
Spirogyra crassa					3,250
Hyalotheca mucosa					3,250
Class Euglenophyta(euglenoids)					
Euglena fusca		5,800	8,900		
E. proxima			4,450		
E. rostrifera			4,450		
E. caudatus			4,450	3,050	
Euglena oxyuris				3,050	
Lepocinolis ovum			8,900		
Phacus pleuronectes			4,450		
P. myersi			4,450		

TABLE 4.2.2-3

SPECIES AND VOLUME OF PLANKTON IN THE STUDY AREA FROM FIELD SURVEY IN RAINY SEASON (Cont'd)

Volume of plankton (cell/m³)

Plankton Species	Stations				
	SW 1	SW 2	SW 3	SW 4	SW 5
Division Chromophyta					
Class Bacillariophyceae(diatom)					
Fragilaria capucina	39,500				
Synedra ulna	27,650				
Gyrosigma sp.	7,900				
Coscinodiscus sp.	3,950			3,050	
Eunotia sp.	3,950				
Bacillaria paradoxa	3,950				
Surirella striatula	3,950				3,250
Nitzschia filiformis			4,450		
Frustulia vulgaris			4,450		
Cymbella naviculiformis				3,050	
Class Dinophyceae (dinoflagellate)					
Peridinium sp.			97,900		
Voume of Photoplankton	793,950	214,600	146,850	39,650	87,750
Species of Photoplankton	22	9	10	10	9
Phytoplankton Diversity Index	**1.95**	**1.62**	**1.35**	**2.2**	**1.61**
<u>Zooplankton</u>					
Phylum Arthropoda					
Subclass Copepoda					
*Nauplius stage	3,950	104,400	89,000	3,050	
Order Cyclopoida					
*Cyclopoids copepods	3,950	11,600	17,800	6,100	
Order Calanoida					
*Calanoids copepods		11,600		3,050	
Subclass Ostracoda					
Moina sp.	7,900	11,600	8,900		
Diaphanosoma sp.		5,800			
*Ostracods			4,450		
Bosminopsis sp.			22,250		
Alona sp.			8,900		

TABLE 4.2.2-3

SPECIES AND VOLUME OF PLANKTON IN THE STUDY AREA FROM FIELD SURVEY IN RAINY SEASON (Cont'd)

Volume of plankton (cell/m³)

Plankton Species	Stations				
	SW 1	SW 2	SW 3	SW 4	SW 5
Phylum Protozoa (Protozoans)					
Arcella megastoma	11,850				6,500
A. vulgaris	7,900	5,800	8,900	3,050	9,750
A. bathystoma		5,800			3,250
Centropyxis ecornis	23,700	5,800	22,250	12,200	9,750
C. aculeata				3,050	
Difflugia oblonga	3,950				
D. lebes	3,950		4,450		
D. acuminatus		5,800			
D. lobostoma			4,450		
Protocucurbitella coroniformis			8,900		
Cyclopyxis puteus			4,450		
Volticella sp.			4,450		
Coleps sp.				3,050	
Phylum Rotifera					
Trichocerca capucina	3,950	11,600			
Lecane bulla		5,800			
Keratella lenzi		5,800		3,050	
Brachionus plicatilis		5,800	4,450		
B. falcatus			17,800	6,100	3,250
B caudatus			8,900		
B. bidentatus			4,450		
Polyarthra vulgaris		5,800	13,350		
Filinia terminalis			17,800		
Ascomorpha saltans			4,450		3,250
Asplanchna priodonta				3,050	
Phylum Nematoda					
*Nematods			4,450		6,500
Volume of Zooplankton	71,100	203,000	284,800	45,750	42,250
Species of Zooplankton	9	14	21	10	7
Zooplankton Diversity Index	**1.95**	**1.91**	**2.55**	**2.15**	**1.84**

Remark * = Not Identifies

Source: Field survey of Team consulting engineering and management Co., Ltd., 20 February 2014

TABLE 4.2.2-4

SPECIES AND DENSITY OF BENTHOS FROM FIELD SURVEY IN RAINY SEASON

density (individuals/squre meters)

Phylum / Species of Benthos	Stations					
	SW1	SW2	SW3	SW4	SW5	Total
PHYLUM ANNELIDA						
Class Polychaeta (ไส้เดือนน้ำเค็ม)						
Family Nereidae			44			**44**
Class Oligochaeta (ไส้เดือนน้ำจืด)						
Family Tubificidae					22	**22**
PHYLUM ARTHROPODA						
Class Insecta						
Order Diptera						
Family Chironomidae (ตัวอ่อนริ้นน้ำจืด)	22					**22**
Class Crustacea						
Order Decapoda						
Family Palaemonidae						
Macrobrachium sp. (กุ้งฝอย)				88	44	**132**
Family Parathelpusidae (ปูน้ำจืด)						
Siamthelphusa sp.				22		**22**
PHYLUM MOLLUSCA						
Class Gastropoda (หอยฝาเดียว)						
Order Mesogastropoda						
Family Thiaridae (หอยขี้นก)						
Thiara sp.				66		**66**
Brotia sp.				330		**330**
Order Neogastropoda						
Family Buccinidae						
Clea sp.	22					**22**
Class Bivalvia (หอยสองฝา)						
Order Veneroida						
Family Corbiculidae						
Corbicula sp.	22			22		**44**
Order Unionoida (หอยกาบน้ำจืด)						
Family Amblemidae						
Ensidens sp.		22				**22**
Unaindra sp.			22			**22**
Total (individuals/squre meters)	**66**	**22**	**22**	**528**	**66**	**704**
Total of Benthos species	**3**	**1**	**1**	**5**	**2**	**11**

Remark : the water beds being coarse sand or pebbles

Source: Field survey of Team consulting engineering and management Co., Ltd., 20 February 2014

Benthos

Two phylum of benthos were found: 5 species under Arthropoda and Mollusca. The dominant species was the *Melanoides* sp. with a density of 2 4 2 individuals/m^2. Next was *Filopaludina* sp. with a density of 44 individuals/m^2. The total density of benthos is 352 individuals/m^2.

Station W2 – Map Kradon Swamp

Phytoplankton

Three *divisions* of phytoplankton were found: Cyanophyta, Chlorophyta and Chromophyta. Four classes were found: Cyanophyceae, Chlorophyceae, Euglenophyta and Bacillariophyceae - 8 different species of these were identified. The dominant species is *Spirogyra crassa* with density of 144,100 cells/m^3. Next was *Chlorella* sp. at 91,700 cells/m^3. The total phytoplankton found was 379,900 cells/m^3 with a diversity index of 1.73 (phytoplankton diversity index range from 1.0 to 3.0). These indicate that the water at Station W2 is sufficiently suitable as habitat for aquatic life forms.

Zooplankton

Two phylum of zooplankton were found: Arthropoda and Protozoa) with a total of 8 species. The dominant species was Cyclopoids copepods (inseparable) and subclass Ostracod found *Alona* sp. with a density of 26,600 cells/m^3 each. The total zooplankton count is 131,000 cells/m^3 with a diversity index of 2.03 (zooplankton diversity index range from 1.0-3.0). These indicate that the water at Station W2 is sufficiently suitable as habitat for aquatic life forms.

Benthos

Three phylum of benthos were found: 6 species under Annelida, Arthropoda and Mollusca. The dominant classes was Oligochaete and Gastropoda (*Bithynia* sp.) with a density of 88 individuals/m^2 each. The total density of benthos is 286 individuals/m^2.

Station W3–Tap Water Pumping Station of Chomphon Chao Phraya Sub-district Municipality

Phytoplankton

Three divisions of phytoplankton were found: Cyanophyta, Chlorophyta and Chromophyta. Four classes were found: Cyanophycaea, Chlorophyceae, Bacillariophycaea and Dinophyceae - 11 different species of these were identified. The dominant species was *Peridinium* sp. in class Dinophyceae with density of 246,000

cells/m³. Next was *Oscillatoria* sp. in class Cyanophyeae at 94,400 cells/m³. The total phytoplankton found was 590,400 cells/m³ with a diversity index of 1.85 (phytoplankton diversity index range from 1.0 to 3.0). These indicate that the water at Station W3 is sufficiently suitable as habitat for aquatic life forms.

Zooplankton

Three phylum of zooplankton were found: Arthropoda, Protozoa and Rotifera) with a total of 5 species. The dominant species was Nauplius stage (inseparable) with a density of 61,500 cells/m³. Next was *Brachionus falcatus* at 49,200 cells/m³. The total zooplankton count is 184,500 cells/m³ with a diversity index of 1.49 (zooplankton diversity index range from 1.0-3.0). These indicate that the water at Station W3 is sufficiently suitable as habitat for aquatic life forms.

Benthos

Two phylum of benthos were found: 3 species under Arthropoda and Mollusca. The dominant species was not found in this station. The total density of benthos is 66 individuals/m^2.

Station W4–The estate's wastewater drainage point

Phytoplankton

Three divisions of phytoplankton were found: Cyanophyta, Chlorophyta and Chromophyta. Five classes were found: Cyanophycaea, Chlorophyceae, Euglenophyta and Bacillariophyceae - 10 different species of these were identified. The dominant species was *Chlorella* sp. in class Chlorophycaea with density of 103,600 cells/m³. Next was *Surirella robusta* in class Bacillariophyceae at 90,650 cells/m³. The total phytoplankton found was 362,600 cells/m³ with a diversity index of 1.95 (phytoplankton diversity index range from 1.0 to 3.0). These indicate that the water at Station W4 is sufficiently suitable as habitat for aquatic life forms.

Zooplankton

Three phylum of zooplankton were found: Arthropoda, Protozoa and Rotifera) with a total of 5 species. The dominant species was not found in this station. The total zooplankton count is 64,750 cells/m³ with a diversity index of 1.61 (zooplankton diversity index range from 1.0-3.0). These indicate that the water at Station W4 is sufficiently suitable as habitat for aquatic life forms.

Benthos

One phylum of benthos was found: 4 species under Mollusca. The dominant species was *Melanoides* sp. of Family Thiaridae with a density of 396 individuals/m^2. Next was *Corbicula* sp. at 132 individuals/m^2. The total density of benthos is 616 individuals/m^2.

Station W5–The downstream about 500 m from the estate's wastewater drainage point

Phytoplankton

Three divisions of phytoplankton were found: Cyanophyta, Chlorophyta and Chromophyta. Four classes were found: Cyanophycaea, Chlorophyceae, Bacillariophyceae and Dinophyceae - 11 different species of these were identified. The dominant species was *Peridinium* sp. in Class Dinophyceae with density of 81,900 cells/m^3. Next was *Gyrosigma* sp. in class Bacillariophyceae at 58,500 cells/m^3. The total phytoplankton found was 315,900 cells/m^3 with a diversity index of 2.13 (phytoplankton diversity index range from 1.0 to 3.0). These indicate that the water at Station W5 is sufficiently suitable as habitat for aquatic life forms.

Zooplankton

Three phylum of zooplankton were found: Arthropoda, Protozoa and Rotifera) with a total of 5 species. The dominant species was Nauplius stage (inseparable) with density of 23,400 cells/m^3. The total zooplankton count is 58,500 cells/m^3 with a diversity index of 2.44 (zooplankton diversity index range from 1.0-3.0). These indicate that the water at Station W5 is sufficiently suitable as habitat for aquatic life forms.

Benthos

One phylum of benthos was found which it was Arthropoda in Order Odonata with density of 22 individuals/m^2.

- **Rainny season survey (18 August 2014) (Table 3.10-3 and Table 3.10-4)**

Station W1 – The upstream about 500 m before the project area

Phytoplankton

Three divisions of phytoplankton were found: Cyanophyta, Chlorophyta and Chromophyta. Three classes were found: Cyanophyceae, Chlorophyceae, and Bacillariophyceae - 22 different species of these were identified. The dominant species

was *Volvox aureus* with density of 292,300 cells/m³. Next was *Ulothrix aequalis* at 173,800 cells/m³. The total phytoplankton found was 793,950 cells/m³ with a diversity index of 1.95 (phytoplankton diversity index range from 1.0 to 3.0). These indicate that the water at Station W1 is sufficiently suitable as habitat for aquatic life forms.

Zooplankton

Three phylum of zooplankton were found: Arthropoda, Protozoa and Rotifera) with a total of 9 species. The dominant species was *Centropyxis ecornis* with density of 23,700 cells/m³. Next was *Arcella megastoma* at 11,850 cells/m³. The total zooplankton count is 71,100 cells/m³ with a diversity index of 1.95 (zooplankton diversity index range from 1.0-3.0). These indicate that the water at Station W1 is sufficiently suitable as habitat for aquatic life forms.

Benthos

Two phylum of benthos was found: 3 species under Arthropoda and Mollusca. The dominant species was not found. The total density of benthos is 66 individuals/m^2.

Station W2 – Map Kradon Swamp

Phytoplankton

Three divisions of phytoplankton were found: Cyanophyta, Chlorophyta and Euglenophyta. Three classes were found: Cyanophyceae, Chlorophyceae and Euglenophyta - 9 different species of these were identified. The dominant species is *Volvox aureus* with density of 110,200 cells/m³. Next was *Hydrodictyon* sp. at 214,600 cells/m³. The total phytoplankton found was 379,900 cells/m³ with a diversity index of 1.62 (phytoplankton diversity index range from 1.0 to 3.0). These indicate that the water at Station W2 is sufficiently suitable as habitat for aquatic life forms.

Zooplankton

Three phylum of zooplankton were found: Arthropoda, Protozoa and Rotifera) with a total of 14 species. The dominant species was Nauplius stage in Subclass Copepoda with density of 104,400 cells/m³. The total zooplankton count is 203,000 cells/m³ with a diversity index of 1.91 (zooplankton diversity index range from 1.0-3.0). These indicate that the water at Station W2 is sufficiently suitable as habitat for aquatic life forms.

Benthos

One phylum of benthos was found which it was *Ensidens* in Order Unionoida with density of 22 individuals/m^2.

Station W3–Tap Water Pumping Station of Chomphon Chao Phraya Sub-district Municipality

Phytoplankton

Three divisions of phytoplankton were found: Cyanophyta, Chlorophyta and Chromophyta. Three classes were found: Euglenophyta, Bacillariophyeae, and Dinophyceae - 10 different species of these were identified. The dominant species was *Euglena fusca* and *Lepocinolis ovum* with density 8,900 cells/m³ each. Next was *Oscillatoria* sp. in class Cyanophyeae at 94,400 cells/m³. The total phytoplankton found was 146,850 cells/m³ with a diversity index of 1.35 (phytoplankton diversity index range from 1.0 to 3.0). These indicate that the water at Station W3 is sufficiently suitable as habitat for aquatic life forms.

Zooplankton

Four phylum of zooplankton were found: Arthropoda, Protozoa and Rotifera and Nematoda) with a total of 21 species. The dominant species was Nauplius stage in Subclass Copepoda with density of 89,000 cells/m³. Next was *Bosminopsis* sp. in group of Ostracods and *Centropyxis ecorn*is in group of Protozoans with density of 22,250 cells/m³ each. The total zooplankton count is 284,800 cells/m³ with a diversity index of 2.55 (zooplankton diversity index range from 1.0-3.0). These indicate that the water at Station W3 is sufficiently suitable as habitat for aquatic life forms.

Benthos

Two phylum of benthos was found: 2 species under Annellida and Mollusca. The dominant benthos was Class Polychaeta with density of 44 cells/m³. The total density of benthos is 66 individuals/m^2.

Station W4– The estate's wastewater drainage point

Phytoplankton

Three divisions of phytoplankton were found: Cyanophyta, Chlorophyta and Chromophyta. Four classes were found: Cyanophyceae, Chlorophyceae, Euglenophyta and Bacillariophyceae - 10 different species of these were identified. The dominant species was *Ulothrix variabilis* in Class Chlorophycaea with density of 9,150 cells/m³. Next was *Oedogonium crispum* in Class Chlorophycaea at 6,100 cells/m³. The total phytoplankton found was 39,650 cells/m³ with a diversity index of 2.20 (phytoplankton diversity index range from 1.0 to 3.0). These indicate that the water at Station W4 is sufficiently suitable as habitat for aquatic life forms.

Zooplankton

Three phylum of zooplankton were found: Arthropoda, Protozoa and and Rotifera) with a total of 10 species. The dominant species was *Centropyxis ecornis* in group of protozoans with density of 12,200 cells/m³. Next was Cyclopoids copepods and *Brachionus falcatus* in Phylum Rotifera with density of 6,100 cells/m³ each. The total zooplankton count is 45,750 cells/m³ with a diversity index of 2.15 (zooplankton diversity index range from 1.0-3.0). These indicate that the water at Station W4 is sufficiently suitable as habitat for aquatic life forms.

Benthos

Two phylum of benthos was found: 5 species under Arthopoda and Mollusca. The dominant benthos was *Brotia* sp. in Family Thiaridae with density of 330 individuals/m^2. Next was *Macrobrachium* sp. at 88 individuals/m^2. The total density of benthos is 528 individuals/m^2.

Station W5–The downstream about 500 m from the estate's wastewater drainage point

Phytoplankton

Three divisions of phytoplankton were found: Cyanophyta, Chlorophyta and Chromophyta. Three classes were found: Cyanophyceae, Chlorophyceae, and Bacillariophyceae - 9 different species of these were identified. The dominant species was *Ulothrix variabilis* in Class Chlorophyceae with density of 42,250 cells/m³. Next was *Ulothrix aequalis* in Class Chlorophyceae at 19,500 cells/m³. The total phytoplankton found was 87,750 cells/m³ with a diversity index of 1.61 (phytoplankton diversity index range from 1.0 to 3.0). These indicate that the water at Station W5 is sufficiently suitable as habitat for aquatic life forms.

Zooplankton

Three phylum of zooplankton were found: Arthropoda, Protozoa and and Rotifera) with a total of 7 species. The dominant species was *Centropyxis ecornis* and *Arcella megastoma* in group of protozoans with density of 9,750 cells/m³ each. The total zooplankton count is 42,250 cells/m³ with a diversity index of 1.84 (zooplankton diversity index range from 1.0-3.0). These indicate that the water at Station W5 is sufficiently suitable as habitat for aquatic life forms.

Benthos

Two phylum of benthos was found: 2 species under Anelida and Arthropoda. The dominant benthos was *Macrobrachium* sp. with density of 44 cells/m^3. The total density of benthos is 66 individuals/m^2.

From the aquatic ecology survey, the consultant analyzed the results to explain the difference in density of both types of planktons between the dry and rainy season. The analysis present the findings from these surface water sources into 2 groups: **(1) Khlong Kram** comprising Stations W1, W2, W4 and W5, and **(2) Sub-district Chomphon Chaophraya Municipality Pond** (W3) as follows:

- ***Dry season aquatic ecology specimen collection in Khlong Kram***: phytoplankton found in Khlong Kram were similar in variety and numbers at every stations. Number of zooplanktons gradually decline after the tie-in with Hemaraj ESIE waste water system (Stations W4 and W5)

The explanation for this is that during the dry season, there is lack of waste water from the Hemaraj ESIE waste water system discharging into Khlong Kram and the waste water presently came from the community and agricultural sector which contain nitrates and phosphates which are nutritious to phytoplankton but of no significant impact overall. However, such waste water discharge adversely impact zooplanktons – killing them or retard their reproduction.

- ***Rainy season aquatic ecology specimen collection in Khlong Kram***: phytoplankton in Khlong Kram gradually decline downstream of Hemaraj ESIE waste water tie-in (Station W4) both in variety and numbers. An increase in phytoplankton was found at Station 5, but zooplanktons still gradually decline after the Hemaraj ESIE waste water tie-in (Stations W4 and W5.

During the rainy season, water drained into Khlong Kram comprises of waste water from the industrial estate, communities and agricultural sector. It can be concluded that both phytoplankton and zooplanktons do decline downstream of the Hemaraj ESIE waste water tie-in. However, phytoplankton show sign of superior resilience compared to zooplanktons downstream of Station W5.

- ***Aquatic ecology specimen collection in Sub-district Chomphon Chaophraya Municipality Pond***: during the rainy season it was found that there were more zooplanktons than phytoplankton. This can be explained by the fact that the pond has no surface water source to contribute, so when rain falls, the water in the pond increase and thus dilute the nutrients and slow down phytoplankton's growth and reproduction.

4.3 HUMAN USE VALUES

4.3.1 Land Use

(1) Introduction

Study on existing of land use in surrounding project area is used as basic date for forecasting a change of land use in the future which is probably being impacted by the project development. In addition, environmental impact mitigation and preventive measures and environmental impact monitoring measures will be formulated in order to cope with impacts that may occur, including proper examination, later on.

(2) Method of the study

Gather data and field survey were conducted as follow:

- Gather Satellite map form Google Earth program and, topographic map with 1:50,000 from the Royal Thai Survey Department
- Gather laws and regulations related to comprehensive master plan of the city and future land use planning from Department of Public Works and Town and Count
- Plaining. Field survey for correcting land use and updating land use data in current year
- Update land use map from field survey data and make data of category and size for each land use type in the study area
- Result of land use will be used together with exiting environment data that is forecasted impact to surrounding communities such as air quality and water quality. Thus, impact on land use zone from project develoment is correctly identified.
- Assess impact from project development on land use of surrounding project area and trend of cummunity expension together with impact from project development on land use in the future
- Make mitigation measure together with regulation of land use in the future and mitigation measure to land use in surrounding project area (if have)

(3) Study Results

(a) Secondary Data

The study area within 5 km radius from the project area cover parts of Si Racha, Ban Bueng and Nong Yai Districts of Chon Buri Province and Pluak Daeng District of Rayong Province. The project area is located on Khao Kansong sub District, Si Racha District of Chon Buri Province. Presently, the Department of Public Works and Town

& Country Planning, Chon Buri and Rayong Office of Public Works and Town & Country Planning have jointly developed the framework for town & country development planning as follows:

- The Department of Public Works and Town & Country Planning and Chon Buri Office of Public Works and Town & Country Planning have jointly developed the principle city plan for Chon Buri Province as a development framework for 12 areas (updated June, 2015) as per **Table 4.3.1-1** where the land surrounding the project area has not been imposed for land use requirement by the principle city plan.
- The Department of Public Works and Town & Country Planning and Rayong Office of Public Works and Town & Country Planning have jointly developed the principle city plan for Rayong Province as a development framework for 14 areas (updated June, 2015) as per **Table 4.3.1-2** where the land surrounding the project area has not been imposed for land use requirement by the principle city plan.

(B) Field survey

Field survey on land use was conducted during 9-13 February 2014 and 25-29 May 2015, coverd 5 km redius from the project. The total area is 66,761.70 rai consist of Residential zone and building (U), Agricultural area (A) and other areas. The details area as follow (**Table 4.3.1-3** and **Figure 4.3.1-1**):

TABLE 4.3.1-1

CHON BURI PROVINCE MASTER PLAN

Type and Entitle of City Plan	Published in Royal Gazette		Legal Procedure
	Announced Date	Expired Date	
1. Chon Buri Province master plan	New master plan area		6. Post a notice with regulation within 90 days
2. Muang Chon Buri master plan (1st revision)	07 May 10	06 May 15	18. Published in Royal Gazette
3. Muang Pattaya master plan (2nd extansion)	6 Mar. 09	21 May 10	18. Published in Royal Gazette
4. Industrial zone and Laem Chabang community master plan (2nd revision)	30 Nov. 12	29 Nov 17	18. Published in Royal Gazette
5. Muang Ban Bung master plan (2nd extansion)	Under revising		3. Consideration of draft master plan meeting
6. Muang Phanat Nikhom master plan (2nd extansion)	Under revising		7. Compilation, investigation, consideration of complaint and report the result of consideration back to complainer
7. Bo Thong community master plan	New master plan area		2. Analyse master plan, consult the planning and analysis division
8. Panthong-Nong Tamlueng community master plan	2 Dec. 11	1 Dec. 16	18. Published in Royal Gazette
9. Hua Kun Jae-Nong Pai Kaew community master plan	4 Oct. 13	3 Oct 18	18. Published in Royal Gazette
10. Chao Phraya Surasak master plan	New master plan area		4. Public participation
11. Udom community Sub-district Municipality master plan	New master plan area		1. Survey and set of master plan zone
12. Pong community Sub-district Municipality master plan	New master plan area		1. Survey and set of master plan zone

Source: The Department of Public Works and Town (http://eservices.dpt.go.th), Available on 20 June 2015

TABLE 4.3.1-2

RAYONG PROVINCE MASTER PLAN

Type and Entitle of City Plan	Published in Royal Gazette		Legal Procedure
	Announced Date	Expired Date	
1. Rayong Province master plan	New master plan area		6. Post a notice with regulation within 90 days
2. Muang Rayong master plan (2nd extansion)	Under revising		3. Consideration of draft master plan meeting
3. Ban Pae community master plan (Extansion for 5 years)	07 Oct. 11	10 Oct. 16	18. Published in Royal Gazette
4. Industrial zone and Mab Ta Put community master plan (2nd extansion)	Under revising		5. Master plan committee meeting (Consideration of draft master plan)
5. Klang mater plan (2nd extansion)	Under revising		12. Review of Office of the Council of State
6. Ta Pong community master plan (2nd extansion)	Under revising		7. Compilation, investigation, consideration of complaint and report the result of consideration back to complainer
7. Ton Division community master plan	New master plan area		3. Consideration of draft master plan meeting
8. Muang Pluak Daeng master plan	New master plan area		5. Master plan committee meeting (Consideration of draft master plan)
9. Ban Kai-Mab Kha community master plan	24 Jul. 12	23 Jul. 17	18. Published in Royal Gazette
10. Thung Khwai Kin-Kong Din community master plan	30 May 12	29 May 17	18. Published in Royal Gazette
11. Pak Nam Pra Sae community master plan	New master plan area		3. Consideration of draft master plan meeting
12. Chompon Chaophraya community master plan	New master plan area		5. Master plan committee meeting (Consideration of draft master plan)
13. Ma Kam Ku community Sub-district Municipality	New master plan area		1. Survey and set of master plan zone
14. Klang-Ka Ched community Sub-district Municipality	New master plan area		1. Survey and set of master plan zone

Source: The Department of Public Works and Town (http://eservices.dpt.go.th), Available on 20 June 2015

TABLE 4.3.1-3

EXISTING LAND USE IN THE STUDY AREA

Type of Land Use	Symbol	5 km radius of the study area		
		km²	Rai	%
Residential zone and building	U			
Enterprises	U1	0.231	144.08	0.22
Housing Development/Residential Area	U2	4.657	2,910.49	4.36
Government Office/Government Corporation	U3	0.096	59.84	0.09
Academic Place	U4	0.106	66.17	0.10
Religious Place	U5	0.258	161.52	0.24
Nursing Area	U6	0.007	4.17	0.01
Industries	U7	2.130	1,331.00	1.99
Industrial Estate	U8	24.116	15,072.58	22.58
Golf Course	U9	0.241	150.80	0.23
Total		31.842	19,900.65	29.82
Agricultural area	A			
Field Crop (potato/pineapple)	A2	29.729	18,580.66	27.83
Rubber tree	A3	31.476	19,672.37	29.47
Fruit Tree (coconut, cashew)	A4	1.209	755.91	1.13
Perennial	A5	1.122	701.27	1.05
Oil palm	A6	2.499	1,561.66	2.34
Chicken Farm	A7	0.385	240.34	0.36
Total		66.420	41,512.21	62.18
other areas				
Forest	F1	0.769	480.78	0.72
Unused land	M1	6.785	4,240.75	6.34
Cemetery	M4	0.021	13.39	0.02
Reservior/Pond	W2	0.982	613.92	0.92
Total		**8.557**	**5,348.84**	**8.00**
Grand total		**106.819**	**66,761.70**	**100.000**

Source: Team consulting engineering and management Co., Ltd., February, 2014 and May, 2015

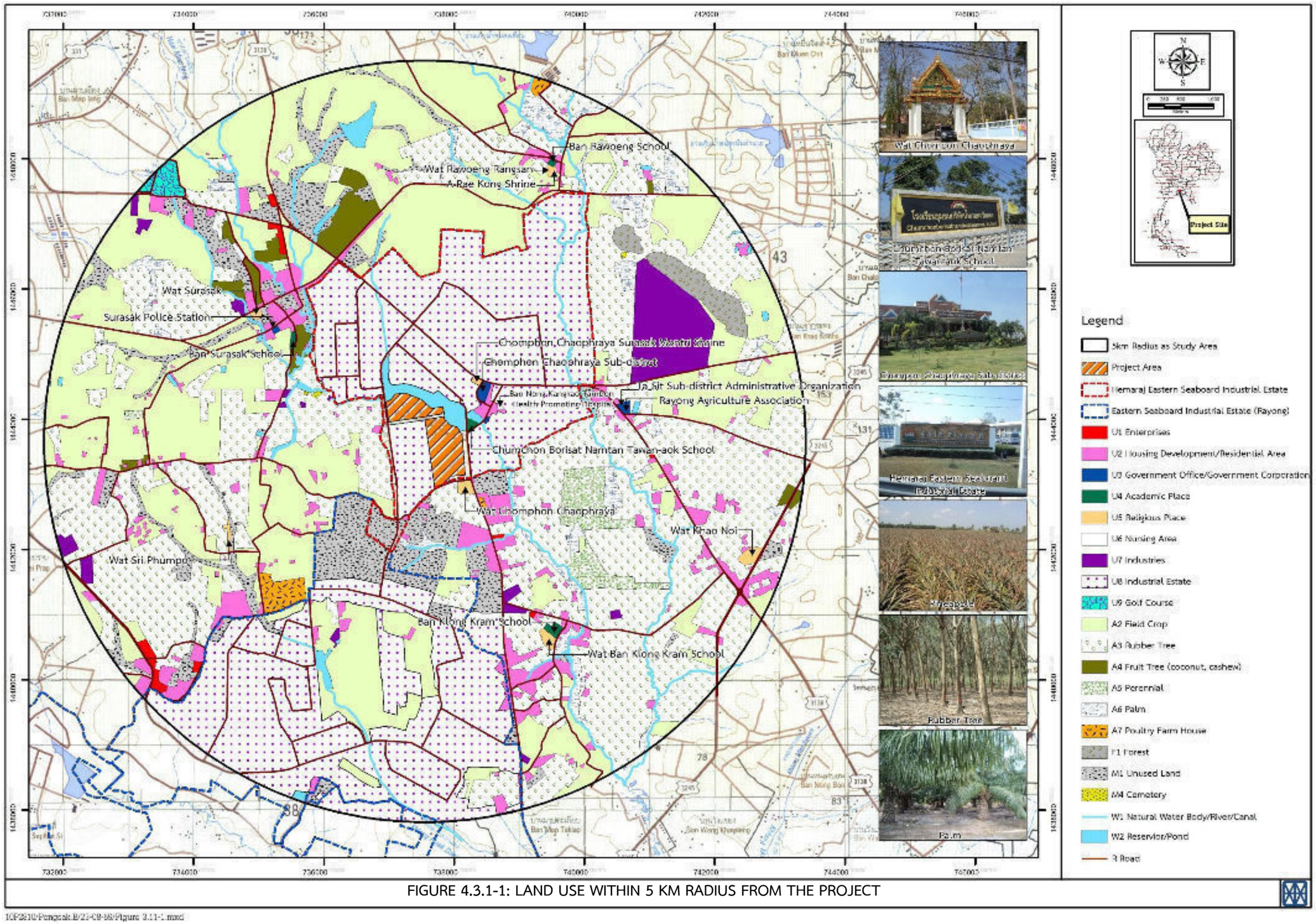


FIGURE 4.3.1-1: LAND USE WITHIN 5 KM RADIUS FROM THE PROJECT

Residential zone and building: the area was 19,900.65 rai or 29.82 % of the study area and consists of:

- Enterprises zone covered 144.08 rai. It found at junction of Highway No.3574 and Chor Bor No.3027 and at Ban Wang Kayeang community where was community market zone.
- Housing Development/Residential Area covered 2,910.49 rai. Currently, the community has expaned along with growth of the area. Most of communities were housing estates, which were found along the main road such as Highway No.3571, Ror Ngor No.0403 or near industries.
- Government Office/Government Corporation covered 59.84 rai such as Sub-district Administrative Organization, Sub-district Municipality, Bowin police station and Rayong Agriculture Association etc.
- Academic Place covered 66.17 rai. Four schools were found: Ban Ra Werng School, Ban Surasak School, Chumchon Borisat Namtan Tawan-aok School and Ban Klong Kram Shool
- Religious place covered 161.52 rai. Eight religious places were found: Wat Ra Werng, Wat Surasak, Wat Chompon Chaophraya, Chompon Chaophraya Surasak Montri Shrine, A Pae Kong Shrine, Wat Klong Kram, Wat Khao Noi and Wat Sri Phumpo
- Nursing area covered 4.17 rai. It was found only Ban Nong Kangkao Tambon Health Promoting Hospital.
- Industries covered 1,331.10 rai. They were small industiries size or warehouse.
- Industrial estate covered 15,072.58 rai. Two industrial estates were found in the study area, which were Hemaraj ESIE and Eastern Seaboard (Rayong) Industrial Estate

Golf course covered 150.80 rai, which was Pattana golf club and resort by the side of the road Chor-Bor No.3027.

Agricultural area: It was found in the most of land use type and covered with 41,512.21 rai or 62.18 % of study area. This area consists of:

- Field Crop covered 18,580.66 rai. It was mostly found field of pineapple and cassava
- Rubber tree covered 19,672.37 rai. It was found in the most of land use type in the study area.
- Fruit tree covered 755.91 rai. It was commonly found in study area, which were coconut and cashew but plot were not big.

- Perennial covered 701.27 rai. It was commonly found in study area, which were eucalyptus and others.
- Oil plam covered 1,561.66 rai. It was planted near surface water such as Kram canal and Ra Werng canal.
- Chicken Farm covered 240.34 rai.
- Forest covered 480.78 rai. It was found in Ta Sit sub-district area.

Other areas covered approximately 5,348.84 rai of 8.00% of study area. This area consists of:

- Unused land covered 4,240.75 rai
- Cemetery covered 13.39 rai
- Reservior/Pond covered 613.92 rai such as Kram canal, Ra Werng canal, Map Kradon marsh, Pluak Daeng, etc.

4.3.2 Transportation

(1) Introduction

During construction period, there will be transportation of construction materials, instruments and workers to the project area. These all activities may disturb transportation system in the project area and its vicinity. So, it is necessity to understand existing transportation situation in order to assess impacts and propose environmental impact mitigation and preventive measures for forcasting impacts in the construction period and operation period.

(2) Method of the study

- Study and compilation of secondary data related to transportation network and traffic volume in particular the route near to the project had been compiled from report of traffic volume on highway during B.E. 2553-2557, prepared by Bureau of Traffic Safety, Department of Highways, Ministry of Transport. This included data of traffic volume measurement of Division of Rural Roads 3 (Chonburi) and topographic map with 1:50,000 from the Royal Thai Survey Department B.E. 2541
- Field survey was conducted to study and gather dato of transportation route, which expected to use during the construction period and operation period. Alos, traffic volume measurement was conducted covering both working day and holiday on Ror Ngor No.0403, which would be used in the project

(3) Study Results

(3.1) Secondary Data

(a) Transportation network

The key land transportation network within the study area comprises national highways as per **Figure 4.3.2-1** and detailed as follows:

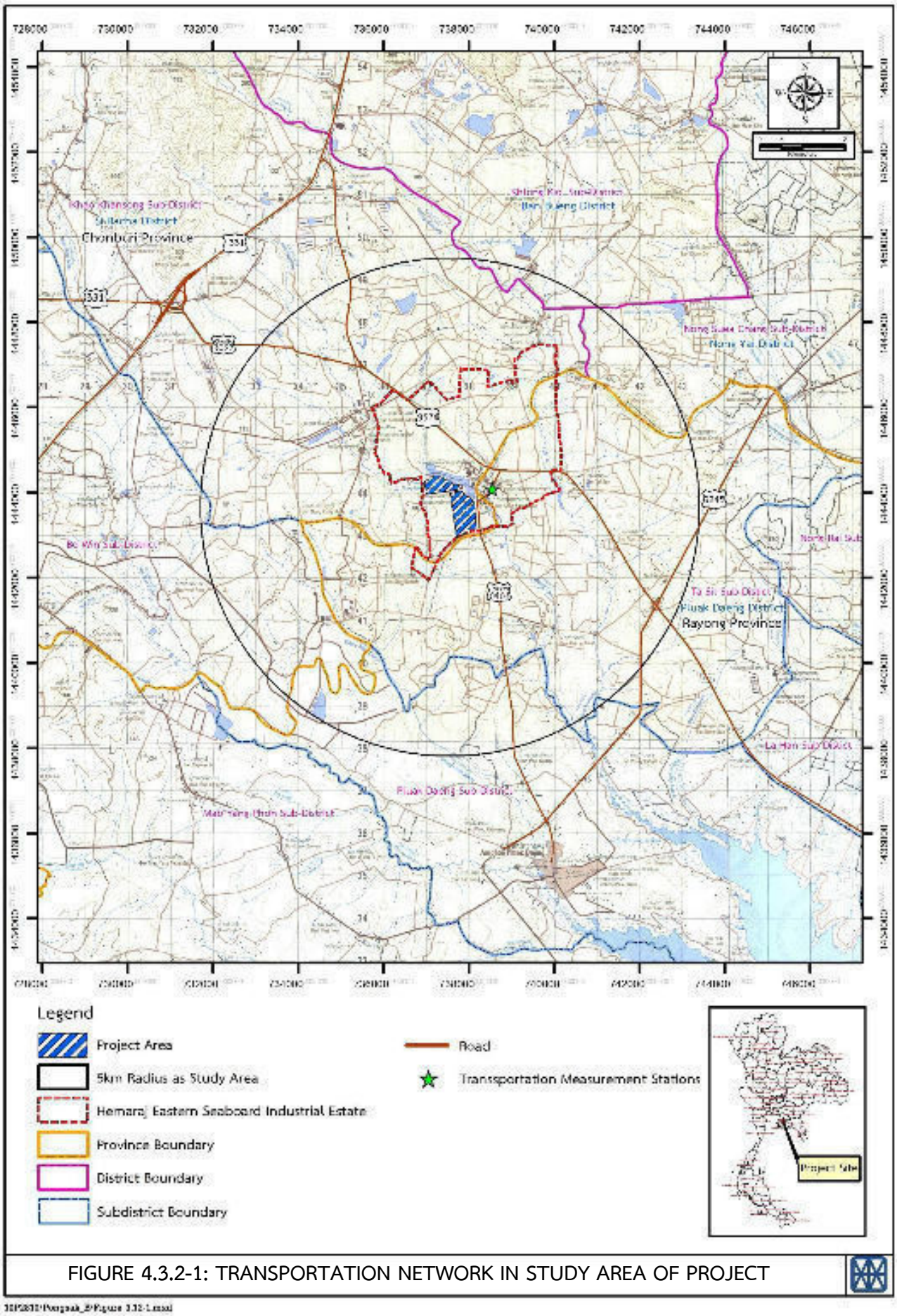


FIGURE 4.3.2-1: TRANSPORTATION NETWORK IN STUDY AREA OF PROJECT

- **Highway 331 (Phanom Sarakham-Sattahip)** is a strategically important road connecting Highway 3 at Sattahip District, Chon Buri province to Highway 304 at Phanom Sarakham District, Chachoengsao Province. Back in 2007, highway 331 was extended for a distance of approximately 17 km to connect with highway 7 (Bangkok-Chon Buri Motorway). The tarmac surfaced road is a divided highway, with a total of 4 lanes. This is the main route for logistics from Laem Chabang seaport to the project area. The road surface is generally broken with potholes and cracks due to the vast number of heavy vehicles using the road
- **Rural highway 3027 (highway 331 intersection – Ban Rawoeng)** connects between highway 331 and highway 3138 and is the gateway to Hemaraj ESIE. The 4-lane (undivided) tarmac road is in a good condition.
- **State highway 3574 (Map Pu - Rayong).** Originally the state highway 3138 was divided into 2 sections, first from Ban Bueng District of Chon Buri Province to state highway 331 and the second from state highway 331 to Rayong Municipality. Then in 2013, the second section of highway 3138 was renamed as state highway 3574 starting at Ban Map Pu Sub-district, Khao Kansong Sub-district, Si Racha District, Chon Buri Province to Mueang District, Rayong Province. Currently this road is undergoing expansion from 2 to 4 lanes (divided highway) while the road surface is still good.
- **Rural highway 0403 (Pluak Daeng – Rong Namtan)** is under the administration of Rayong Provincial Administrative Organization. It connects Chomphon Chaophraya Sub-district to Pluak Daeng District and passing the east side of Si Racha Power Plant project. It is an undivided 2-lane road while the condition is generally good.

(b) Traffic

Regarding a study on traffic, the consultant focused on likely key routes to be used during the both the construction period – transporting construction equipment, supplies and workers – and operation period of the project where supplies and employees would be transported. Secondary data collected on the state highway traffic between 2010 and 2014 by the Bureau of Highway Safety, Department of Highways using data from its traffic station located on kilometer 12+300 on state highway 331 and at kilometer 4+418 on state highway 3574. Note that traffic data for 2010-2012 from station at kilometer 25+600 on state highway 3138 is the station as current state highway 3574. As for rural highway 3027, the secondary data for 2013-2014 will be collected from the 3rd Rural Highway Bureau (Chon Buri) to be used as baseline for possible impact in the future. They are described as in **Table 4.3.2-1** and can be summarized as follows:

TABLE 4.3.2-1

TRAFFIC VOLUME MEASUREMENT ON HIGHWAY SURROUNDING OF STUDY AREA DURING B.E.2553-2557

No.	Highway No.	Traffic volume measurement station	B.E.	Traffic volume of each vehicle category (vehicles/day)								Total (Vehicles/ day)
				Passenger car	Light Bus	Heavy Bus	Light Truck	Medium Truck	Heavy Truck	Bycle/ tricycle	Motorcycle	
1	**331**	**Km. 12+300**[1/] (Noen Pha suk –Highway No.331 (Mab Eang))	2553	10,401	85	304	2,481	2,659	7,378	173	233	23,714
			2554	9,488	64	137	3,842	2,666	7,215	18	468	23,898
			2555	8,712	245	347	2,151	2,126	5,309	6	399	19,295
			2556	7,490	177	176	3,255	2,741	6,175	11	396	20,421
			2557	6,977	98	136	3,996	3,101	5,821	2	555	20,686
			Average	**8,614**	**134**	**220**	**3,145**	**2,659**	**6,380**	**42**	**410**	**21,603**
2	**3574**	**Km.4+418** [1/] (Mab Poo – Khao Kan Thong)	2553	5,459	168	232	2,633	2,372	3,874	5	256	14,999
			2554	7,729	128	237	2,780	2,956	3,394	0	280	17,504
			2555	7,045	94	626	4,064	2,567	3,635	2	506	18,539
			2556	9,247	108	282	4,465	2,542	3,889	9	709	21,251
			2557	9,283	137	446	3,174	2,746	3,991	16	985	20,778
			Average	**7,753**	**127**	**365**	**3,423**	**2,637**	**3,757**	**6**	**547**	**18,614**
3	**Chor-Bor No. 3027**	Junction of Highway No.331 (Km.85+300) – Ban Ra Werng[2/]	2556	550	50	25	100	-	25	-	650	1,400
			2557	550	50	25	100	-	25	-	650	1,400

Remark: Data of traffic volume of Highway No.3574 during B.E.2553-2555 use traffic volume data of Highway No.3138 Km.25+600 because junction of Highway No.3574 was out from Highway No.3138 since B.E.2556

Source: 1/ Report on Traffic volume of Highway B.E.2553-2557 (Department of Highways, Ministry of Transport), 2015

2/ Data of traffic volume of Division of Rural Roads 3 (Chonburi), 2015

- **Traffic volume of Highway No.331 (Km.12+300)**: The most of vehicle type was passenger car. Next was heavy truck and light truck, respectively. Total maximum vehicle was 23,898 vehicles/day in B.E.2554.
- **Traffic volume of Highway No.3574 (Km.4+418)**: The most of vehicle type was passenger car. Next was heavy truck and light truck, respectively. Total maximum vehicle was 21,251 vehicles/day in B.E.2556.
- **Traffic volume of Chor-Bor No.3027:** The most of vehicle type was motorcycle. Next was passenger car and light truck, respectively. Total maximum vehicle was 1,400 vehicles/day in B.E.2556 and 2557.

(3.2) Field Survey

Field survey was conducted during 2-3 March 2014 covering both working day and holiday from 06.01 a.m. - 18.00 p.m. It was conducted for one station at Ror Ngor No.0403 Pluak Daeng-Rong Namtao Km.0+460 where was used for equipment transportation during construction period (**Figure 4.3.2-1**). Summary of result was in **Table 4.3.2-2**. The details are as follows:

- **Traffic volume of** Ror Ngor **No.0403 Km.0+460:** On 2 March 2014 found that most of vehicle type was light truck (4 wheeled)/pickup. Next was passenger car and motorcycle, respectively. Total maximum vehicle was 577 vehicles/day during 07.01 a.m. - 08.00 a.m. On 3 March 2014 found that most of vehicle type was passenger car. Next was light truck (4 wheeled)/pickup and motorcycle, respectively. Total maximum vehicle was 1,103 vehicles/day during 07.01 a.m. - 08.00 a.m. The details are shown in **Appendix 3F.**

(3.3) Current status of Traffic volume

Expected routes of transportation of project during the construction period and operation period were from Leam Chabung port along Highway No.331 before entering to Cor-Bor No.3027, Highway No.3574 and Highway No.0403 until reaching to project area. Current status of traffic volume derived from ratio of traffic volume per carrying capacity of road (V/C ratio) as follows:

- Eight type of vehicles were multiple by each factor of Passenger Car Unit (PCU) to be Passenger Car Equivalents (PCE) as shown in **Table 4.3.2-3**. This is used as "Traffic Volume" as "V" by calculation in term of PCU/hr. Then, V/C ratio was calculated for comparing with standard of Traffic Engineering Division (Standard is not exceeded 0.8 (80 %).

Ratio of V/C can be calculated using the following fomula:

$$\text{V/C ratio} = \frac{\text{Added Traffic Volume from project + Traffic Volume in the present}}{\text{Carrying Capacity of Respective Road}}$$

TABLE 4.3.2-2

RESULT OF TRAFFIC VOLUME MEASUREMENT ON ROR NGOR NO.0403

DURING 2-3 MARCH 2014

Type of vehicle	Highway Ror Ngor No.0403 Km.0+460					
	Sunday 2 March 2014			Monday 3 March 2014		
	Bound-in	Bound-out	Total (vehecles)	Bound-in	Bound-out	Total (vehecles)
Bicycle	2	6	8	3	3	6
Motorcycle	748	679	1,427	771	899	1,670
Passenger car	690	831	1,521	828	883	1,711
LightTruck (4-wheeled)	816	753	1,569	996	1058	2,054
Medium Truck (6-wheeled)	45	69	114	296	316	612
Heavy Truck (10-wheeled)	65	64	129	96	76	172
Trailer/Semi-trailer	17	16	33	107	94	201
Light bus /van	114	141	255	290	297	587
Medium bus	1	-	1	7	2	9
Heavy bus	11	14	25	31	20	51
Others Tractor/ Crane/Sidecar trike)	22	14	36	35	20	55
Total	**2,531**	**2,587**	**5,118**	**3,460**	**3,668**	**7,128**

Source: Team consulting engineering and management Co., Ltd., 2-3 March 2014

TABLE 4.3.2-3

PASSENGER CAR EQUIVALENT FACTOR OF EACH VEHICLE

Type of vehicle	Passenger Car Equivalents Factor (PCE)
Passenger car and Taxi	1.00
Light bus	1.25
Heavy bus	2.00
Light truck	1.50
Medium truck	1.75
Heavy truck	2.00
Motorcycle	0.33
Bicycle, Tricycle	0.20

Source : Paopong, 1997 and Depart of Highway, 2001

Value of traffic carrying capacity of highway types is shown in **Table 4.3.2-4**. Bureau of Traffic Safety, Department of Highways indicated that maximum carrying capacity of multi-traffic lanes were 2,000 PCU/hr.-lane.

V/C ration was used to compare with standard for facsting traffic status in the future as shown in **Table 4.3.2-5**.

TABLE 4.3.2-4

TRAFFIC CARRYING CAPACITY AND HIGHWAY TYPES

Highway Types	Carrying Capacity of Traffic Volume (PCU/hr)
Multi-traffic lanes	2,000 (per 1 traffic lane)
Two ways road with two traffic lanes	2,000 (for both dirctions)
Three ways road with two traffic lanes	4,000 (for both dirctions)

Source : Paopong, 1997

TABLE 4.3.2-5

RANGE OF V/C RATIO FOR TRAFFIC CONDITION CLASSIFICATION

Range of V/C ratio	Classification of Traffic Condition
0.89-1.00	Severe traffic congestion
0.68-0.88	Heavy traffic congestion
0.53-0.67	Satisfactorily traffic flow
0.37-0.52	Good traffic flow
0.20-0.36	Very traffic flow

Source : Paopong, 1997

Gather traffic volome of transportation route from Report of traffic volume during B.E.2553-2557 of Department of Highways, Division of Rural Roads 3 (Chonburi) B.E.2556-2557 and traffic volume measurement from field survey which can assess traffic condition of each route in term of V/C ratio as shown in **Table 4.3.2-6**. The details are as follows.

- **Traffic volume of Highway No.331**: Total volume of vehicle in latest year (B.E.2557) was 1,275 PCU/hr. V/C ratio was 0.16. Thus, the traffic condition was very traffic flow.

- **Traffic volume of Chor-Bor No.3027**: Total volume of vehicle in latest year (B.E.2557) was 43 PCU/hr. V/C ratio was 0.01. Thus, the traffic condition was very traffic flow.
- **Traffic volume of Highway No.3574**: Total volume of vehicle in latest year (B.E.2557) was 1,174 PCU/hr. V/C ratio was 0.15. Thus, the traffic condition was very traffic flow.
- **Traffic volume of Ror Ngor No.0403**: Total volume of vehicle on Sunday 2 March 2014 was 437 PCU/hr. V/C ratio was 0.11. Thus, the traffic condition was very traffic flow. While, on Monday 3 March 2014 was 650 PCU/hr. V/C ratio was 0.16. Thus, the traffic condition was very traffic flow.

TABLE 4.3.2-6

DENSITY AND CARRYING CAPACITY OF HIGHWAY IN THE PROJECT AREA

Traffic measurement station	B.E.	Traffic volume and density					Traffic Condition
		Traffic volume			Carrying Capacity of highway (vehicles/hr.)	V/C Ratio	
		Vihecles/ day	PCU/day	PCU/hr.			
Highway No.331[1/] Measurement station at Km.12+300	2553	23,714	34,312	1,430	8,000	0.18	Very traffic flow
	2554	23,898	34,841	1,452		0.18	Very traffic flow
	2555	19,295	27,390	1,141		0.14	Very traffic flow
	2556	20,422	30,240	1,260		0.16	Very traffic flow
	2557	20,686	30,607	1,275		0.16	Very traffic flow
Chor-Bor No.3027[2/]	2556	1,400	1,027	43	8,000	0.01	Very traffic flow
	2557	1,400	1,027	43		0.01	Very traffic flow
Highway No.3574[1/] Measurement station at Km.4+418	2553	14,999	22,033	918	8,000	0.11	Very traffic flow
	2554	17,504	24,557	1,023		0.13	Very traffic flow
	2555	18,539	26,404	1,100		0.14	Very traffic flow
	2556	21,251	29,089	1,212		0.15	Very traffic flow
	2557	20,778	28,176	1,174		0.15	Very traffic flow
Ror Ngor No.0403 Measurement station at Km.0+460	2557[3/]	5,118	5,241	437	4,000	0.11	Very traffic flow
	2557[4/]	7,128	7,794	650		0.16	Very traffic flow

Remark: Data of traffic volume of Highway No.3574 during B.E.2553-2555 use traffic volume data of Highway No.3138 Km.25+600 because junction of Highway No.3574 was out from Highway No.3138 since B.E.2556

Source:
1/ Report on traffic volume of highways during B.E.2553-2557, Bureau of Traffic Safety, Department of Highways
2/ Data of traffic volume of Division of Rural Roads 3 (Chonburi)
3/ Traffic volume measurement in field survey by Team consulting engineering and management Co., Ltd., Sunday 2 March 2014
4/ Traffic volume measurement in field survey by Team consulting engineering and management Co., Ltd., Monday 3 March 2014

4.3.3 Water Utilization

(1) Introdution

Study of water use is significant since water is used at the beginning of construction until operation period. This study airms to learn about current condition of water use for consumption in the communities surrounding the project area and to learn about other purposes of water utilization such as agriculture. Data gained is used for analysis or forecasting impact on various aspects of water utilization caused by the project development of people living in the project area as well as for formulation of environmental impact mitigation and preventive measures to reduce impact and further inspection of water use of people living around the project area.

(2) Study methods

Compilation of water use information from document or related report in study area such as Provincial Waterworks Authority (www.pwa.co.th), Regional Irrigation Office 9 (www.rid9.com), Eastern Water Resources Development and Management PCL (www.eastwater.com) and report on compliance with the environmental impact prevention and mitigation and the environmental quality monitoring measure of Hemaraj ESIE during B.E.2553-2557, etc.

(3) Study results

(a) Water Resources

Information from the 9th Royal Irrigation Office (Chon Buri) revaled that Chon Buri province has 12 reservoirs with combined capacity of 196.98 Mm^3. They are Bang Phra reservoir (capacity 117.00 Mm^3), Nong Kho reservoir (capacity 21.40 Mm^3), Map Prachan reservoir (capacity 16.60 Mm^3), Huai Chaknok reservoir (capacity 7.03 Mm^3), Nong Klang Dong reservoir (capacity 7.65 Mm^3), Huai Saphan reservoir (capacity 3.84 Mm^3), Huai Khun Chit reservoir (capacity 4.80 Mm^3), Ban Bueng reservoir (capacity 10.98 Mm^3), Map Fakthong 1 reservoir (capacity 1.23 Mm^3) Map Fakthong 2 reservoir (capacity 1.98 Mm^3), Huay Tu 1 reservoir (capacity 1.50 Mm^3) and Huai Tu 2 reservoir (capacity 2.97 Mm^3).

Rayong province has 5 reservoirs with combined capacity of 542.90 Mm^3. They are Nong Pla Lai reservoir (capacity 163.75 Mm^3), Prasae reservoir (capacity 248.00 Mm^3), Dok Krai reservoir (capacity 71.40 Mm^3), Khlong Ra-ok reservoir (capacity 19.65 Mm^3) and Khlong Yai reservoir (capacity 40.10 Mm^3).

(b) Water Sources for Domestic Use

Information from the Provincial Water Authority Office, Chon Buri province, revealed that Chon Buri province has 7 PWA offices and branch offices. They are Provincial Water Authority, Area 1 Chon Buri branch (Special Class), Provincial Water Authority, Ban Bueng, Provincial Water Authority, Phanat Nikom branch, Provincial Water Authority, Si Racha branch, Provincial Water Authority, Laem Chabang and Provincial Water Authority, Pattaya branch (special class). Their combined domestic tap water production is 608,082 m^3/day. In May 2015, total water distributed was 15,305,047 m^3 for a total of 323,636 users. Rayong province has 3 Provincial Water Authority offices: Provincial Water Authority, Rayong branch, Provincial Water Authority, Ban Chang branch and Provincial Water Authority, Pak Nam Prasae branch. The total capacity is 119,512 m^3/day. In May 2015, a total of 3,681,049 m^3 were sold to 115,585 users (Provincial Water Authority, 2015) as per **Table 4.3.3-1**.

The consumptive water in the Hemaraj ESIE is produced with 3 sets of solids contact & gravity filters with a capacity of 12,000 m^3/day or 500 m^3/hr complete with a 30,000 m^3 holding tank.

(c) Water Sources for Agricultural Use

Farmers can use water from one of 12 reservoirs in Chon Buri province with a combined capacity of 196.98 Mm^3 and from 5 reservoirs in Rayong province with combined capacity of 542.90 Mm^3.

(d) Water source for industial

Eastern Water Resources Development and Management PCL or East Water was established on 12 September 1992 following the cabinet resolution. Its objective is to integrate raw water management through large scale pipeline to the industrial sector for both utility and consumption in support of the Eastern Seaboard Development Plan to promote the east coast as the country's key industrial region. Currently, East Water was converted into Company Public Limited and registed in The Stock Exchange of Thailand. It is a capital mobilization in order to development of service, meet to demand of water users. Major of stock holder are Provincial Waterworks Authority, Industrial Estate Authority of Thailand, Financial institutions both in and out country, Electricity Generating Public Co. Ltd. (Egco) and general public.

TABLE 4.3.3-1

PROVINCIAL WATER AUTHORITY CONSUMPTION WATER PRODUCTION IN CHON BURI AND RAYONG PROVINCES

Provincial Water Authority office	Distribution area	Service area (sq.km)	Water Sources	Capacity (million cubic meters/day)	Production in May 2015 (million cubic meters.)	Water Sold in May 2015 (million cubic meters.)	Users
Chon Buri Province							
Provincial Water Authority Area 1 TM = Town Municipality, SM = Sub-district Municipality SAO = Sub-district Administrative Organization							
Provincial Water Authority, Chon Buri (Special Class)	Saensuk TM, Ang Sila SM, Ban Suan SM, Khlong Tamru SM, Bang Sai SM, Chon Buri TM, Nong Mai Daeng SAO, Na Pa SAO, Nong Ri SAO, Nong Khang Khok SAO, Huai Kapi SAO, Bangsai SAO, Samet SAO, Mueang SAO, Khlong Tamru SAO	75.695	Provincial Water Authority Laem Chabang, Bang Phra reservoir, East Water	172,800	4,748,812	4,744,937	113,217
Provincial Water Authority, Ban Bueng branch	Ban Buengm TM, Hua Kunjae SM. Nong Sak, Nong Samsak SAO, Nong Bondaeng SAO, Khlong Kiew SAO, Ban Bueng SAO	30.563	Nong Irun, Ang Kaew, Nong Phaknam, Huai Mahai, Nong Ri reservoir. Provincial Water Authority, Chon Buri	23,280	655,243	653,221	18,548
Provincial Water Authority, Phanat Nikhom branch	Nong Tamlueng SM, Phanthong District, Phanat Nikhom TM, Phanat Nikom District	32.046	Bo Thong, Nong Prue, Nong Kakha, Huai Sarika reservoirs, surface water, Khlong Tha Boonme. Provincial Water Authority Chon Buri (partially).	18,600	1,124,688	1,084,084	27,781
Provincial Water Authority, Si Racha branch	Bang Phra SM, Si Racha TM, Si Racha District	11.558	-	56,000	1,718,995	1,504,239	37,826
Provincial Water Authority, Laem Chabang	Laem Chabang SM, Si Racha District, Ao Udom, SM, Si Racha District, Laem Chabang Mueng Mai Housing Estate	113.440	Nong Kho reservoir and East Water.	56,602	2,362,294	2,239,547	47,268

TABLE 4.3.3-1

PROVINCIAL WATER AUTHORITY CONSUMPTION WATER PRODUCTION IN CHON BURI AND RAYONG PROVINCES (Cont'd)

Provincial Water Authority office	Distribution area	Service area (sq.km.)	Water Sources	Capacity (million cubic meters/day)	Production in May 2015 (million cubic meters.)	Water Sold in May 2015 (million cubic meters.)	Users
Provincial Water Authority Pattaya branch (special class)	Mueang Pattaya SM, Huai Yai SM, Bang Lamueng District, Bang Lamung SM, Bang Lamung District, Na Jomthien Su-district, Village No. 12 Sattahip District, Bang Sare SM, Sattahip District, Communities outside Thessaban 4	353.320	Map Prachan, Nong Klang Dong, Huai Chak Nok, Huai Khun Chit reservoir	280,800	5,514,309	5,079,019	78,996
Rayong Province							
Provincial Water Authority, Rayong	Map Ta Phut SM, Ban Phae SM, Had Mae Pim SAO.Choeng Nern SAO, Nam Khok SAO, Tap Ma, Nern Phra SAO, Taphong SAO, Ban Khai SAO, Bang Butr SAO and communities outside Area 4. Thor. Nakhon Rayong Village, Mueang District, Ban Khai District	203.030	Beung Samnak Yai pond, Rayong river, Royal Irrigation Canal.	69,495	2,153,992	2,145,582	74,359
Provincial Water Authority, Ban Chang	Ban Chang SM in Ban Chang District, Samnak Thon SM, Bang Chang District, Ban Nern Krapork, Ban Lha, Ban Phayoon, Huai Pong Sub-district, Map Ta Phut community housing Estate, Ban Chang District	38.800	Bang Phai reservoir, East Water	43,509	1,368,815	1,348,815	34,899
Provincial Water Authority, Paknam Prasae	Pak Nam Prasae SM, Sub-district Thung Kwai Kin Sub-district, Thang Kwian Sub-district, Kongdin Sub-district, Na Yai Arm Sub-district, Kaelong SM, Thung Kwai Kin mun SM, Paknam Prasae SM, Klaeng District, Khlong Poon SAO, Thung Kwai Kin SAO, Kong Din SAOand Na Yai Arm SAO.	102.026	Khlong Phlo	6,508	201,774	186,652	6,327

Source: www.pwa.co.th 2015

Currently, East Water has invested a water pipeline network for 394.5 km in length. The new network is connected to many key water reservoirs in the eastern region such as the Nong Pla Lai, Dok Krai, Klong Yai and Prasae in Rayong Province. In Chon Buri Province, they include the Nong Kho and Bang Phra reservoirs, and also the Bang Pakong river in Chachoengsao Province. The water network is aimed to be the most modern and comprehensive water grid in Thailand, able to serve raw water to communities for utility and consumption, support tourism and industries in three Provinces: Chon Buri, Rayong and Chachoengsao. (Reference: http://www.eastwater.com, Eastern Water Resources Development and Management PCL, retrieved on 20 October2015) and support industry sector with increasing of water demand.

- **Raw water sources for East Water**

Current raw water sources that East Water have access to are Dok Krai, Nong Pla Lai, Nong Kho, Prasae reservoirs, Bang Pakong river and a few other privately-owned reservoirs. The total usable raw water is approximately 328.7 Mm^3 as described in **Table 4.3.3-2**.

- **Demand for pipeline water**

Utility and industrial water demand in Chon Buri and Rayong Provinces for the next 10 years is expected to grow continuously at a rate of 6.3 % annually. This is the results from the expansion of the industrial sector in the eastern region. The growth is also due to the migration of manufacturing bases from the central region to the eastern region in the aftermath of the big flood in 2011 and due to more power plants being built to generate another 5,000 MW. Water usage is expected to rise from the 2014 level of 298.4 Mm^3 to 395.2 Mm^3 to 548.5 Mm^3 within 5 to 10 years as detailed in **Table 4.3.3-3**.

TABLE 4.3.3-2

CURRENT WATER SOURCES AVAILABLE TO EAST WATER

Source	Province	Capacity (million cubic meters)	Water use (million cubic meters/year)
1. Dok Krai reservoir	Rayong	71.4	116
2. Nong Pla Lai reservoir	Rayong	163.75	120
3. Nong Kho reservoir	Chon Buri	21.4	16.7
4. Prasae reservoir	Rayong	248.0	40.0
5. Bang Pakong river	Chachoengsao	-	26.0
6. Private reservoirs	Chon Buri	-	10.0
Total:		**504.55**	**328.7**

Remarks: The water use from Dok Krai reservoir is greater than its capacity due to greater water volume entering throughout the year than its static capacity and is made available to East Water.

Source: http://www.eastwater.com, retrieved on 23 April 2015

TABLE 4.3.3-3

WATER DEMAND FORECAST FOR RAYONG AND CHON BURI PROVINCE

Service areas	Water demand (million cubic meters/year)		
	2014	2019	2024
Rayong province			
1. Rayong (Mab Taput)	185.2	238.9	296.3
2. Bowin – Pluak Daeng	29.2	52.5	120.7
Total for Rayong (1+2)	**214.4**	**291.5**	**417.0**
Chon Buri province			
3. Chon Buri	84.0	103.7	131.6
Total for Rayong and Chon Buri (1+2+3)	**298.4**	**395.2**	**548.5**

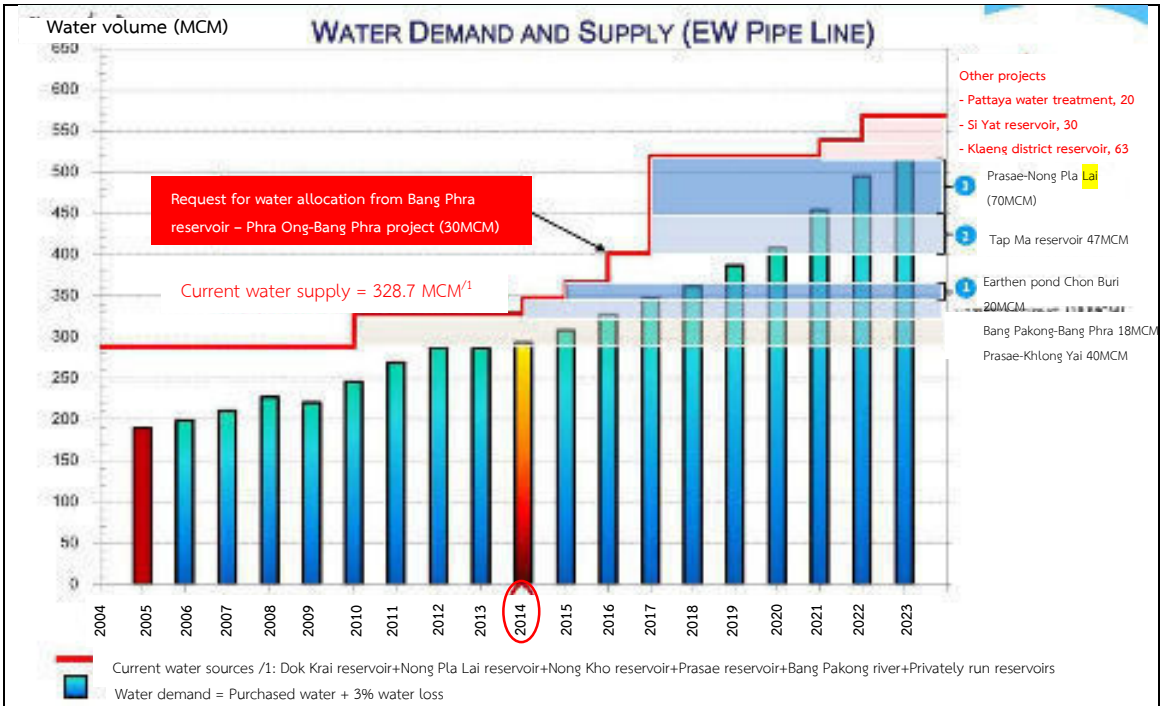
Source : http://www.eastwater.com, retrieved on 23 April 2015.

- **East Water's water sourcing plan**

Its current raw water sources is able to serve the demand through 2015 (**Figure 4.3.3-1**). However, current expansion to the pumping station at Bang Phra pumping station will increase water for the Bang Phra reservoir by another 18 Mm^3. Another 20 Mm^3 will be purchased from private reservoirs in Chon Buri province and another 30 Mm^3 from Khlong Phra Ong Chao Chaiyanuchit – Bang Phra canal. Approximately 47 Mm^3 will be available from Tab Ma pond (currently under construction) and another 70 Mm^3 will be available from the Prasae-Nong Pla Lai pipeline (also under construction). These developments will be able to satisfy water demands in the next 9-10 years. Moreover, East Water is currently conducting a feasibility study on the use of water from Pattaya City water treatment facility, Khlong Si Yat reservoir and other reservoirs in Klaeng district, Rayong province as alternative water sources and to respond to the demand in the long term.

- **Water distribution from sources to East Water users**
  - **Rayong Province area (Map Taput)**

East Water pumps out raw water from Dok Krai reservoir and Nong Pla Lai reservoir, which are on the Khlong Yai river basin, to serve its customers in Map Taput, Rayong Province. In the future, Rayong Province will also access water from Tap Ma reservoir and Prasae reservoir (via East Water's Prasae-Nong Pla Lai pipeline and Royal Irrigation Dept's Prasae-Khlong Yai pipeline) as per **Figure 4.3.3--2**. These will satisfy water demand in Rayong province including Bowin-Pluak Daen areas and even support water demand in Chon Buri Province.



Source: http://www.eastwater.com,/ธุรกิจEWG/ธุรกิจหลัก/พื้นที่ตามแนวท่อ.aspx, retrieved on 23 April 2015

FIGURE 4.3.3-1 : WATER SUPPLY PLAN FOR CHON BURI, RAYONG PROVINCES

FIGURE 4.3.3--2 : EAST WATER WATER GRID IN CHON BURI, RAYONG AND CHACHOENGSAO PROVINCES

- **Bowin-Pluak Daeng area**

Currently, East Water pumps up raw water from Nong Pla Lai reservoir for its customers in Bowin-Pluak Daeng area. In the future, the Bowin–Pluak Daeng area will also have access 70 Mm^3 of water from Prasae reservoir via East Water's Prasae-Nong Pla Lai pipeline and another 70 Mm^3 via the Royal Irrigation Department's Prasae-Khlong Yai pipeline. Total water volume accessible from Prasae reservoir will be 140 Mm^3.

- **Chon Buri Province area**

East Water uses water from Nong Kho and Bang Phra reservoirs (the latter is reserved from Bang Pakong river) and distributed to users in Chon Buri Province. In the future, Chon Buri users will have access to water distributed via Khlong Phra Ong Chai Chaiyanuchit-Bang Phra pipeline and privately operated reservoirs. This will result in more raw water access to users in Chon Buri and demand in water from Nong Pla Lai will decrease.

- **East Water raw water specifications**

The specifications of raw water from East Water's Nong Pla Lai pumping station are detailed as shown in **Table 4.3.3-4**.

- **Hemaraj Eastern Seaboard Industrial Estate Water Storage**

Currently, Hemaraj ESIE receives raw water from East Water via the Nong Pla Lai – Nong Kho pipeline and store it in a raw water pond near the water production plant on the north side of the industrial estate. The combined raw water pond and water production facility cover 60 Rai of land while the pond has a capacity of 70,000 m^3 which is sufficient even if the industrial estate is fully developed. Water produced here is distributed to all areas of the Hemaraj ESIE.

When the Sriracha power plant project is developed in the Hemaraj ESIE, they will request additional raw water from East Water at a rate of 63,000 m^3/day or 23 Mm^3/year for use in the power plant. The Hemaraj ESIE will then supply raw water by running a pipeline to feed directly the power plant's raw water holding pond with a capacity of 189,000 m^3.

- **Hemaraj Eastern Seaboard Industrial Estate Water Production**

Hemaraj ESIE has 3 units of water production equipment each with a production capacity of 12,000 m^3/day. The water produced is stored in a 30,000 m^3 holding tank but 5,601 m^3 of water is distributed each day to its clients in the industrial estate (source: Environmental Impact Prevention & Mitigation Report and Hemaraj ESIE Environmental Impact Monitoring Measures, 2014). Two more small power plants that will be developed within Hemaraj ESIE – Ta Sit 3 and Ta Sit 4 power plant projects – will each require 6,000 m^3/day more water or 12,000 m^3/day combined. Then, the Hemaraj ESIE would need to distribute approximately 17,601 m^3/day of water or just 49 % of its water production capacity.

TABLE 3.13-4

SPECIFICATIONS OF RAW WATER AT NONG PLA LAI PUMPING STATION FROM JANUARY - SEPTEMBER 2015

Parameters	Unit	Min.-Max.	Standard values
pH	-	7.30-8.34	5.0-9.0
DO	mg/l	3.52-5.92	≥4.0
BOD	mg/l	<1.0-2.6	≤2.0
COD	mg/l	10-15	-
Turbidity	NTU	2.36-8.15	-
Conductivity	us/cm	187-238	-
Colour	Pt-Co	7.38-11.53	Natural
Calcium	mg/l as $CaCO_3$	30-39	-
Magnesium	mg/l as $CaCO_3$	4-17	-
Chloride	mg/l	14-26	-
Total Ion	mg/l	0.06-0.23	-
Manganese	mg/l	0.05-0.27	≤1.0
Nitrate Nitrogen	mg/l	0.02-0.22	≤5.0
Sulfate	mg/l	10.21-22.29	-
Silica	mg/l	1.38-11.80	-
Total Suspended Solid	mg/l	3-14	-
Dissolved Solids	mg/l	120-148	-
Total Alkalinity	mg/l	50-65	-
Grease&Oil	mg/l	<2.0	-
Total Phosphate	mg/l	0.03-0.06	-
Phosphate	mg/l	0.09-0.18	-
Total Kjeldahl Nitrogen	mg/l	0.31-0.84	-
Ammonia Nitrogen	mg/l	<0.01	≤0.5
Copper	mg/l	<0.01	≤0.1
Zinc	mg/l	0.01-0.03	≤1.0
Fluoride	mg/l	0.20-0.42	-
Detergent	mg/l	<0.01	-
Carbonate Hardness	mg/l as $CaCO_3$	43-50	-
Non Carbonate Hardness	mg/l as $CaCO_3$	<1	-
Salinity	g/kg	0.06-0.08	-
TOC	mg/l	4.78-8.83	-
Arsenic	mg/l	0.0025-0.0032	≤0.01
Barium	mg/l	<0.05-0.09	-
Cadmium	mg/l	<0.02	≤0.005
Chromium (6+)	mg/l	<0.01	≤0.05
Lead	mg/l	<0.01	≤0.05
Mercury	mg/l	<0.0005	≤0.002
Nickel	mg/l	<0.01	≤0.1
Selenium	mg/l	<0.0005	-
Silver	mg/l	<0.01	-
Sodium	mg/l	15.03-20.56	-
Cyanide	mg/l	<0.001	≤0.005
Phenol	mg/l	<0.001	≤0.005
Fecal Coliform	MPN/100ml	49-490	≤4,000

Source : Eastern Water Resources Development and Management PCL, 2015

4.3.4 Electricity Use

(1) Introduction

Electricity is a basic factor for operation of any projects. This study aims to learn about the usage of electricity within the communities surrounding the project area. Data gained will be used to analyse and forecast impact from the project development towards electricity use of communities surrounding the project area including proposing mitigation measures and follow up on impact towards the electricity use of communities surrounding the project area.

(2) Study methods

Study of current condition of electricity use within the area surrounding the project area was conducted by collection of data in relation to electricity use from documents or related reports such as Provincial Electricity Authority (www.pea.co.th), Energy Regulatory Commission (www.erc.or.th), National Statistical Office (http://www.nso.go.th), etc. The results from survey of socio-economic of the project was conducted during 8-11 September 2014, will be used as basic information of electricity use in study area.

(3) Study results

(a) Electricity consumption

Study of electricity demand in study area covered in Chonburi and Rayong Provinces. The Details are as shown in (**Table 4.3.4-1**) and summarized as follows:

Trend of electricity demand of Chonburi province during 2010-2014 was increased both number of users electricity consumption**.** In 2014 found that number of electricity user was 612,280 persons and amount of electricity consumption was 10,548,236,563 Kw/hr. In 5 years found that electricity consumption was increased 6.56 per year.

Trend of electricity demand of Rayong province during 2010-2014 was increased both number of users electricity consumption**.** In 2014 found that number of electricity user was 334,112 persons and amount of electricity consumption was 8,186,299,343 Kw/hr. In 5 years found that electricity consumption was increased 5.65 per year

Project is located in Hemeraj ESIE where the total electricity demand was 389 MVA (50 KVA/1 rai). Hemeraj ESIE has prepared sub stations no less than 10 rai that is transmission station system of 115-22 kV, 600 MVA located in area of Hemeraj ESIE.

TABLE 4.3.4-1

ELECTRICITY CONSUMPTION OF CHONBURI AND RAYONG PROVINCES DURING 2010-2014

Province	Type of user	2010	2011	2012	2013	2014
Chonbu	**Number of users (person)**	**485,401**	**509,131**	**538,034**	**573,825**	**612,280**
	Electrical distribution and consumption (Kw/hr.)	**8,760,278,636**	**9,124,781,717**	**9,784,171,463**	**10,204,911,761**	**10,548,236,563**
	Demand percentage (increase/decrease)	**13.77**	**4.16**	**7.23**	**4.30**	**3.36**
	- House	1,304,521,624	1,348,378,062	1,506,530,823	1,597,172,869	1,678,399,795
	- Small business	601,108,729	625,804,504	694,905,897	765,844,488	799,467,141
	- Medium business	1,624,565,019	1,623,481,549	1,712,279,602	1,851,019,990	1,916,926,090
	- Large business	4,437,338,622	4,710,744,045	4,997,520,451	5,171,493,551	5,322,075,653
	- Others	792,744,642	816,373,557	872,934,690	819,380,863	831,367,884
Rayong	**Number of users (person)**	**270,203**	**283,067**	**296,348**	**314,626**	**334,112**
	Electrical distribution and consumption (Kw/hr.)	**8,186,299,343**	**7,805,325,106**	**8,524,603,785**	**8,758,195,178**	**9,101,211,037**
	Demand percentage (increase/decrease)	**17.03**	**-4.65**	**9.22**	**2.72**	**3.92**
	- House	598,438,695	613,370,446	673,354,481	705,811,901	744,188,478
	- Small business	179,771,929	186,173,592	202,543,304	225,547,031	242,609,760
	- Medium business	797,747,435	780,992,047	805,115,476	822,039,523	873,900,945
	- Large business	6,308,747,432	5,980,989,349	6,552,254,707	6,816,268,960	6,996,190,130
	- Others	301,593,852	243,799,672	291,335,817	188,527,763	244,321,724

Remark: Small business means business, industry, government office and offices that average maximum electricity demand in 15 minutes is lower than 30 kW.

Medium business means business, industry, government office and offices that average maximum electricity demand in 15 minutes is 30-999 kW.

Large business means business, industry, government office and offices that average maximum electricity demand in 15 minutes is more than 1,000 kW.

Others means specified business such as hotel, rental house or room, nonprofit organization, agriculture, temporary electricity use.

Source: Provincial Electrical Authority refer to National Statistical Office (http://www.nso.go.th/) available in July 2015

(b) Sufficiency of electricity

Electricity Generating Authority of Thailand is responsible for electrical managing in the country by producing and buying electricity from private power plants. The information from Ennergy Regulatory Comission, 2014 (www.erc.or.th) found that Chonburi Province has 24 power plants which sold electricity to Electricity Generating Authority of Thailand. The total production capacity was 2,410.112 MW. Amount of sell electricity in contract was 1,929.056 MW that received from 2 IPP, 6 SPP and 16 VSPP. While, Rayong province has 30 power plants which sold electricity to Electricity Generating Authority of Thailand. The total production capacity was 6,109.235 MW. Amount of sell electricity in contract was 4,706.480 MW that received from 6 IPP, 22 SPP and 2 VSPP. Chonburi and Rayong Provinces were near the source of electricity. Moreover, there were high voltage electricity stations in study area such as Pluak Daeng with pressure system of 550 kV, Bowin with pressure system of 230 kV, etc where received electricity from transmission lines connected to nationwide after that they were coverted and distributes to industrial estates and people in the area. Thus, electricity consumption is sufficient. Result from survey of socio-economic found that electricity was connected in all housholds. The troubles of using electricity in the area were outage and electrical failure that usually occurred in rainy season.

4.3.5 Drainage and Flood Control

(1) Introduction

Study on exiting of drainage and flood control in the study areas is aimed as basic data to assess environmental impact and to formulate environmental impact mitigation and preventive measures and follow up measures on environmental impact.

(2) Study methods

Secondary data wrere collected such as statistics of rain water information and water volume in water resources in surrounding areas from report of Royat Irrigation Department and related agencies. All information will be used for to assess environmental impact and to formulate environmental impact mitigation and preventive measures.

(3) Study results

The topography of the project area consists of undulating and rolling landscape with slopes of 3-16 % sloping down south towards the Gulf of Thailand. Therefore, water flow and water drainage can occur naturally by gravity. This is supported by several water ways in the area such as Khlong Kram, Khlong Rawoeng, Khlong Pluak Daeng and Huai Phai. Rainfall on the power plant site will be drained into the above streams and brooks which all flow into the Nong Pla Lai reservoir and ultimately the sea. A study of the surface soil reveals that it comprises mainly of sandy soil which can permeate very quickly and help prevent flooding.

4.3.6 Waste Management

(1) Introduction

Study on waste management in the study areas is used as basic data to assess environmental impact, formulate environmental impact mitigation and preventive measures including formulation of follow-up measures on environment impact.

(2) Study methods

Related data on waste management in the study areas were collected such as volume of garbage, waste collecting from relevant authorities. The data is used to assess impact and to formulate environmental impact mitigation and preventive measures for potential impact.

(3) Study results

(a) Solid waste and garbage management by the local administrative organizations in the study area

Local administrative organizations in the study include Bowin Sub-district Administrative Organization, Khao Khan Song Sub-district Administrative Organization, Chomphon Chao Phraya Municipality, Ta Sit Sub-district Administrative Organization, Pluak Daeng Sub-district Administrative Organization, Khlong Kiew Sub-district Administrative Organization and Nong Seua Chang Sub-district Administrative Organization. Wastes and garbage collected from the site are shipped to Clean City Co., Ltd, who is responsible for garbage disposal by means of landfill. The company has land area of 59 Rai 1 Ngarn and 10 Wah (94,810 Sqm.) located at 669 Village No. 5 Sub-district Khao Khansong Sub-district, Si Racha District, Chon Buri province. It has a disposal capacity of 300 tons/day. Meanwhile, Khlong Kiew Sub-district Administrative Organization disposes their trash by landfill within the area under its administration while Nong Seua Chang Sub-district Administrative Organization disposes its trash by dumping and incineration. Details of waste management in the local administrative organizations are detailed in **Table 4.3.6-1.**

(b) Hemaraj Eastern Seaboard Industrial Estate Waste and Trash Management

From the Hemaraj ESIE's report on environmental impact mitigation and preventive measures and environmental impact monitoring measures from July through December 2014, 19.635 tons/day of wastes and trash were produced by the estate. Out of that number, 2. 255 tons/day were general trash which were disposed of by the local administrative organizations or outsourced agencies. Approximately, 5.56 tons/day were toxic industrial wastes and 11.82 tons/day of non-toxic industrial wastes were disposed of by agencies licensed by the Department of Industrial Works.

TABLE 4.3.6-1

WASTE MANAGEMENT OF LOCAL AGENCIES IN THE STUDY AREA

Responsible agencies	Disposal location	Area	Type / number of trash trucks	Disposal method	Capacity and frequency
Bowin SAO	Disposed at the landfill of Clean City Co., Ltd at 669 Village No. 5, Sub-district Khao Khansong, Si Racha District, Chon Buri province	59 Rai 1 Ngarn and 10 Wah (94,810 Sqm	– 5 x 10 yd^3 trash truck – 2 x 4 yd^3 trash truck	Sanitary Landfill	– 30 tons/day of trash produced, collected 1-2 times per day between 02:00 a.m. to 12:00 p.m. and 06:00 a.m. to 17:00 p.m. – Disposed in Clean City landfill which has 300 tons/day capacity.
Khao Khanchong SAO			– 1 x 12 m^3 trash compactor truck		– 15 tons/day of trash but 13 tons/day of trash collected. – Disposed in Clean City landfill which has 300 tons/day capacity. – Trash trucks purchasing plan pending.
Chomphon Chaophraya Sub-district Municipality			– 1 x 12 m^3 trash compactor truck – 1 x 10 m^3 trash compactor truck		– 10 tons/day of trash produced, 10 tones/day, collected 1 time per day, 5 days a week, between 08:30 a.m. to 16:30 p.m. – Disposed in Clean City landfill which has 300 tons/day capacity.
Ta Sit SAO			– 2 x 12 m^3 trash compactor truck		– Disposed in Clean City landfill which has 300 tons/day capacity.
Pluak Daeng SAO			– 3 x 10 m^3 trash compactor truck – 1 x 4 m^3 container-type trash truck – 1 x 4 m^3 private company trash truck		– 35-38 tons/day of trash can be efficiently incinerated by a private contractors.
Khlong Kiew SAO	Khlong Kiew SAO trash disposal site is under responsibility of Hua Kunchae Sub-district Municipality	10	– 2 x 10 m^3 trash compactor truck		– 10-12 tons/day of trash produced and collected. – Landfill site at Khlong Kiew SAO is now full, soucing new site.
Nong Seua Chang SAO	SAO's landfill at Village No. 3, Ban Nong Ya Plong	10	– 1 x 12 m^3 trash compactor truck – 1 x 10 m^3 trash compactor truck	Pile on the ground and burn	– 4.57 tons/day of trash disposed of, 5 rai was used and 5 rai remains available.

Source: Summary of Bowin SAO, Khao Khan Song SAO, Chomphon Chaophraya Sub-district Municipality, Ta Sit SAO, Pluak Daeng Khlong Kiew SAO, Khlong Kiew SAO, Nong Seua Chang SAO

4.3.7 Fire Control System

(1) Introduction

Study on fire control system and fire protection of the study areas. The data is used to assess environmental impact, formulate environmental impact mitigation and preventive measures as well as follow-up measure for environmental impact.

(2) Study methods

Information of fire control system and fire protection of Hemaraj ESIE and local organizations in the study area will be collected.

(3) Study results

(3.1) Hemaraj Eastern Seaboard Industrial Estate

Hemaraj ESIE is very strict with fire protection measures, requiring development projects to be designed with provision for fire protection in compliance with the regulations of the Industrial Estate Authority of Thailand re: Standards for the Protection of Infrastructure, Utilities and Services in Industrial Estate B.E.2555. The design shall also comply with the Engineering Institute of Thailand standards and other applicable laws as per **Table 4.3.7-1** and as per following details:

- **Fire Hydrant System**

The Hemaraj ESIE fire hydrant system will operate with the consumptive water pipeline and consist of fire department connections and fire hydrants. The fire protection design is to comply with compliance with the regulations of the Industrial Estate Authority of Thailand re: Standards for the Protection of Infrastructure, Utilities and Services in Industrial Estate B.E.2555. The design shall also comply with the Engineering Institute of Thailand standards as follows.

- Fire service mains must be no less than 100 mm in diameter and the dry riser inlet must be no less than 150 mm in diameter. Each hose outlet must be of 65 mm in diameters and each fire hydrant must have two hose outlets.
- The fire hydrant must of wet barrel type.
- Hose outlets must be of quick coupling type with lid and chain.
- Maximum distance between 2 fire hydrants is 150 m.
- Water pressure at hose outlet must be no less than 1.5 bar and no more than 6.0 bar. A fire hydrant shall be no less than 0.6 m above ground level measured at hose outlet center.

TABLE 4.3.7-1

COMPARISON OF HEMARAJ EASTERN SEABOARD INDUSTRIAL ESTATE FIRE PROTECTION SYSTEM WITH STANDARDS OF THE INDUSTRIAL ESTATE AUTHORITY OF THAILAND (IEAT) AND ENGINEERING INSTITUTE OF THAILAND (EIT) (EXCLUDING INDIVIDUAL FACTORIES)

IEAT Standard	EIT Standard	Hemaraj ESIE Fire Protection System
Fire service mains of no less than 100 mm diameter	Fire service mains of no less than 100 mm diameter	Fire service mains of no less than 100 mm diameter
Water inlet no less than 150 mm diameter connecting fire service mains and fire hydrant	Water inlet no less than 150 mm diameter	Water inlet no less than 150 mm diameter connecting fire service mains and fire hydrant
No less than 2 hose outlets of 65 mm diameter per fire hydrant	No less than 2 hose outlets per fire hydrant	No less than 2 hose outlets of 65 mm diameter per fire hydrant
Wet barrel type fire hydrant	Wet barrel type fire hydrant	Wet barrel type fire hydrant
2 fire hydrants no more than 150 m apart	2 fire hydrants no more than 150 m apart	2 fire hydrants no more than 150 m apart
Water pressure at hose outlet must be no less than 1.5 bar and no more than 6.0 bar	-	Water pressure at hose outlet between 1.5-2.5 bar
-	Fire hydrant shall be no less than 0.6 m above ground level measured at hose outlet center	Fire hydrant shall be between 0.6-1.2 m above ground level measured at hose outlet center

Remarks: Certain factories may require increases in water pressure to 5.6 bar.

Source: Hemaraj Eastern Seaboard Industrial Estate, 2015.

- **Water Reserve for Fire Suppression**

Hemaraj ESIE water reserve for fire suppression comprises a raw water holding pond with 70,000 m^3 capacity and 9 water retention ponds with combined capacity of approximately 213,252 m^3. There is also a consumptive water storage tank for 30,000 m^3. The total water reserve for fire suppression is therefore

- **Fire Trucks**

Hemaraj ESIE has on standby a fire truck with 6,000 liter water capacity and fire pimp, one 4-wheeled rescue vehicle with equipment.

- **Firefighters**

Hemaraj ESIE has a team of firefighters on 24 hour standby.

- **Fire Protection Systems for Factory Buildings**

  - **Interior**

Interior of a factory building is required to be equipped with the following fire protection equipment as per building code and other applicable laws**:**

- Portable Fire Extinguisher of type appropriate to the type of fire possible in that location, with no less than 4.5 kg content each as per US Nation Fire Protection Association (NFPA) standards.
- Fire alarm system can be manually operated or automatic. When a fire occurs, the alarm will send signal to the control panel to display light to indicate the equipment and the fire location. The control panel then sets off evacuation signal for evacuation from the areas corresponding to the threat. The system comprises the following:
  - Initiating Devices including Heat Detectors and Ionization smoke Detector.
  - Control panel
  - Audible and visual warning such as bells, horns and light signals.

  - **Exterior**

Exterior of the factory buildings in the Hemaraj ESIE are required to have fire service mains shared with the consumptive water pipe with diameter of no less than 100 mm and a two-way 2.5-4-inch outlet fire hydrant every 150 m for fire service to use for fire suppression.

The Hemaraj ESIE is fully prepared for fire prevention and suppression as per the regulations of the Industrial Estate Authority of Thailand re: Infrastructure, Utilities and Services in Industrial Estates B.E.2555 and the standards of the Engineering Institute of Thailand.

(3.2) Fire Suppression Capabilities of External Organizations

If a fire on the premises is deemed uncontainable by the available resources within the Project and Hemaraj ESIE, then the estate will request support from the firefighting units in nearby local administrations organizations in Champion Chao Phraya Sub-district Municipality, Pluak Daeng Sub-district Administrative Organization in Pluak Daeng District, Rayong province, and Khao Khan Song Sub-district Administrative Organization in Si Racha District, Chon Buri province. Their fightfighting capabilities are detailed as follows:

- **Sub-district Chomphon Chao Phraya Municipality**

The firefighting unit at Sub-district Chomphon Chao Phraya Municipality is located 3.5 km from the project area and travel time is between 5-10 minutes and comprises: 4 Fire trucks and service vehicles, 2 Multipurpose water trucks with 12,000 liters water tank each, 2 Fire trucks with 6,000 liters water tank each., 1 Portable firefighting unit, 3 Fire fighters' suits with firefighter masks, 6 Firefighters, and 50 Civil defense volunteers.

- **Pluak Daeng Sub-district Administrative Organization**

The fire-fighting unit at Pluak Daeng Sub-district Administrative Organization is 13.4 km from the power plant and estimated travel time of 15-20 minutes and comprises: Multi-purpose fire truck with 12,000 liters water tank, 1 Fire truck with water cannon and 5,000 liters water tank, 1 Fire platform truck, 1 Rapid response multi-purpose vehicle, 1 surveillance vehicle, 2 Public disaster workers, 1 Permanent staff, 2 Temporary staffs, and 3 Clerks.

- **Khao Khan Song Sub-district Administrative Organization**

The fire-fighting unit at Sub-district Khao Khan Song Administrative Organization is located 8.4 km from the project area with a travel approximately 10-15 minutes and comprises: 1 Multipurpose water truck with 5,000 liters capacity, 1 Fire platform truck, 1 Fire tiller truck is being budgeted for 2017 financial year and 33 Civil defense volunteers.

(3.3) Hemaraj Eastern Seaboard Industrial Estate Emergency Plan

Hemaraj ESIE has classified emergencies and responsibilities in accordance to the Disaster Prevention and Mitigation Act B.E. 2550 which classify emergencies into 3 levels as detailed in **Appendix 20**.

4.4 QUALITY OF LIFE

4.4.1 Socio-Economics

(1) Introduction

Development of Sriracha Power Plant in Khao Khansong Sub-district, Si Racha District, Chon Buri Province is to support increasing of electricity demand with increasing of population and to maintain the electricity stability. Sriracha Power Plant is situated in the boundary of Hemaraj Eastern Seaboard Industrial Estate (Hemaraj ESIE). The project development may cause impacts on natural resources, environment and socio-economics of local communities living nearby the project. The objective of the study is to survey existing socio-economic situation of local communities which are likely to be impacted by the project development and gather people's opinion on the project development in odor to propose the environmental impact mitigation and preventive measures and environmental impact monitoring measures for environmental and socio-economic impacts.

(2) Study methods

Information used for environmental impact assessment on socio-economic is gathered from secondary data and primary data which is derived from the field survey.

(2.1) Secondary Data Collection

Review and collect a secondary data of socio-economics from documents and reports of related agencies, including:

- Population and housing statistics from the Sub-district in 2014 from Department of Provincial Administration, Ministry of Interior.
- 3-year development plan, reports on implementation and public relation document in 2014 of Sub-district Administration Organization
- Population statistics and household Kor Chor Chor 2 Kor

(2.2) Primary Data Collection

(a) Study Area

Area of primary data survey (within a 5 km radius) covers 6 Sub-districts and 1 Sub-district Municipality, which are Khao Kansong and Bowin Sub-districts, Si Racha District, Nong Suea Chang Sub-district, Nong Yai District, Klong Kio Sub-district, Ban Bueng District, Chon Buri Province, Ta Sit and Pluak Daeng Sub-districts, Chompol Chaophraya Sub-district Municipality, Pluak Daeng District, Rayong Province (**Figure 4.4.1-1**). The study area was divided into 2 sections for data analysis process: (1) communities situated nearby project area (within a 0 to 3 km radius) and (2) communities situated far from project site (within a 3 to 5 km radius) (**Table 4.4.1-1**), to obtain the clarity of community's concerns and opinions of project development.

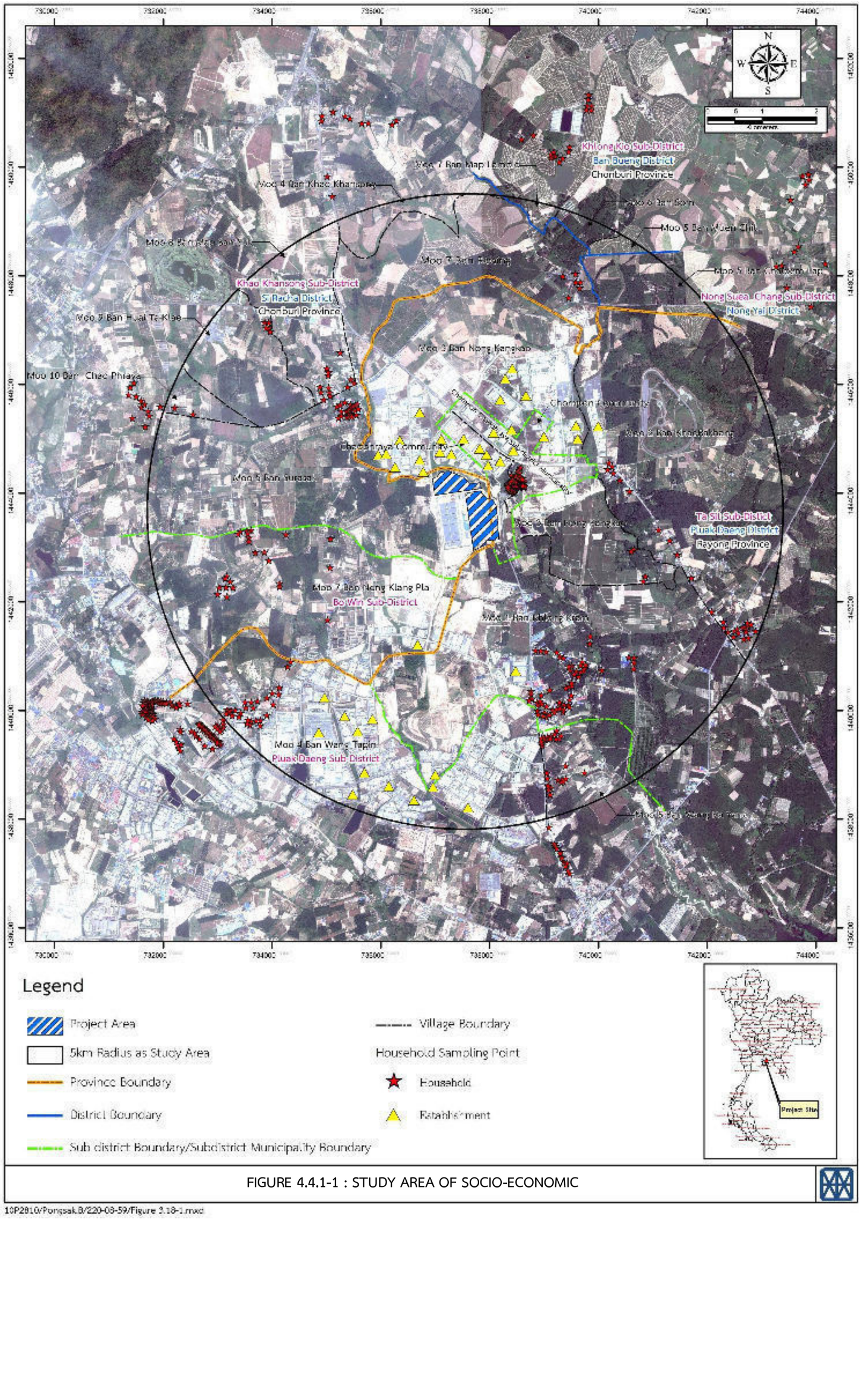


FIGURE 4.4.1-1 : STUDY AREA OF SOCIO-ECONOMIC

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TABLE 4.4.1-1

STUDY AREA OF SOCIO-ECONOMIC

Province	District	Sub-district	Moo	0 to 3 km Radius	3 to 5 km Radius
Chon Buri	Si Racha	Khao Khansong	Moo 4 Ban Khao Khansong		✓
			Moo 5 Ban Surasak	✓	
			Moo 7 Ban Rawing	✓	
			Moo 8 Ban Map San Suk	✓	
			Moo 9 Ban Huai Ta-Klao	✓	
			Moo 10 Ban Chao Phraya		✓
		Bowiin	Moo 7 Ban Nong Klang Pla	✓	
	Ban Bueng	Klong Kio	Moo 5 Ban Muen Chit		✓
			Moo 6 Ban Som		✓
			Moo 7 Ban Map Lambid		✓
	Nong Yai	Nong Suea Chang	Moo 5 Ban Chaloem Lap		✓
Rayong	Pluak Daeng	Ta Sit	Moo 1 Ban Klongkram	✓	
			Moo 2 Ban Khao Rakhang	✓	
			Moo 3 Ban Nong Kangkao	✓	
		Pluak Daeng	Moo 4 Ban Wang Tapin	✓	
			Moo 5 Ban Wang Ka Yang		✓
		Chomphon	Chompon Community	✓	
		Chao Phraya Sub-district Municipality	Chao Phraya Community	✓	
2 Provinces	**4 Districts**	**6 Sub-districts, 1 Municipality**	**16 Villages 2 Communities**		

(b) Tools

To collect primary data on socio-economics for Sriracha Power Plant project, field survey was conducted through the use of interviews and questionnaires. Interview was conducted with the target groups from different levels of government authorities. Also, there were three sets of questionnaires for the interview with three target groups, which were (1) community leaders (2) households and (3) business enterprises. The structures of questionnaires for each group (as shown in **Appendix 3G-1**) are as follows:

- **Questionnaire for different levels of government authorities** comprises the following topics:

- General information of the interviewees, job roles and duties
- Information on problems in the administration of each governmental organization or area under administration, at present
- Access to information of project, opinion on the project, opinion on the impacts, expected to arise due to the development of the project, and concerns
- Confidence regarding the management of the problems
- Ideas and suggestions for the project.

- **Questionnaire for the community leaders** comprises the following topics:
  - General information of the interviewees
  - Information of the community including the background, settlement history, religious belief, livelihood, socio-economic, and relationship between the people in the community
  - Overall living condition in the community at present, environmental problems, infrastructure, public services and utilities, problems encountered in living in the community, and ideas on the development of the community in the future.
  - Access to information of the project, opinion on the project, opinion on the impacts expected to arise due to the development of the project, and concerns
  - Involvement in monitoring the environmental impacts caused by the development of the project
  - Ideas and suggestions for the public relations of the project
  - Ideas and suggestions for the development of the project.
- **Questionnaire for the households** comprises the following topics:
  - General information about the interviewees including gender, age, status in the household, education, religious belief, native habitat and migration history
  - Socio-economic condition of the household such as the number of household members
  - Main and minor jobs of the household members, income and expenditure, livelihood problems

- Health-related information such as use of chemical substances in agriculture, illnesses afflicting people in the family, smoking, alcohol drinking, services provided by the community medical center and satisfaction and adequacy of the services
- Well-being and satisfaction with respect to the overall living condition at present such as healthcare services, the condition of the sources of drinking and non-drinking water, environmental management (waste disposal and wastewater management), and problems related to public utilities, malnutrition, and satisfy in village/community
- Access to information about the project, opinion on the project, opinion on the impacts expected to arise due to the development of the project, and concerns
- Involvement in monitoring the environmental impacts caused by the development of the project
- Ideas and suggestions for the public relations of the project
- Ideas and suggestions for the development of the project

• **Questionnaire for the business enterprises** comprises the following topics:

- General information of the interviewees including gender, age, status in the business enterprise, education, religious belief, duration of business enterprise operation
- Structures of the business enterprise such as the number of employee, characteristic of business enterprise building, utilization of the building
- Environmental conditions surrounding the business enterprise such as present environmental conditions, relevant social problems
- Access to the information of the project, opinion on the project, opinion on the impacts expected to arise due to the development of the project, and concerns
- Involvement in monitoring the environmental impacts caused by the development of the project
- Public relations, and public participation

(c) Determination of sample size and sampling method

The target groups in the socio-economic data investigation fall into four categories as follows.

(c1) Representatives from different levels of government authorities

Purposive sampling method was employed. The interview was conducted with one interviewee of the head or representative of each of the governmental organizations of different levels - namely the provincial, district, and local administrative governmental organizations involved in project implementation.

(c2) Community leaders

Purposive sampling method was employed. The interview was conducted with at local leaders in study area, including sub-district headman, village headman, assistant village headman and village committee. Interview was conducted at least 3 persons per village.

(c3) Households

The study was conducted with the households in a 5 km radius around the precincts of the project that covered 6 Sub-districts 1 Sub-district Municipality which are Khao Khansong and Bowin Sub-districts in Si Racha District in Chon Buri Province; Nong Suea Chang Sub-district in Nong Yai District in Chon Buri Province; Ta Sit, Pluak Daeng Sub-districts, and Chomphon Chao Phraya Sub-district Municipality in Pluak Daeng District, Rayong Province. Determination of the size and number of the sample groups of the households in the areas under the administration of the municipality and those under the administration of the sub-district administrative organization was based on the Civil Registration Data Base of 2014 and the calculation was conducted using the Taro Yamane formula at the confidence level of 95 % as follows:

$$n = \frac{N}{(1 + Ne^2)}$$

where n = the sample size

N = the number of all the households

E = the confidence level of 95 %, or the error level of 0.05

- **The households in the area under the administration of the sub-district administrative organization**

The number of the households in the areas under the administration of the sub-district administrative organization to be investigated was calculated through the Taro Yamane formula as follows:

$$n = \frac{17,903}{\left(1+17,903\times(0.05)^2\right)} = 391.26$$

With reference to the Civil Registration Database of 2014, in the study area there were in total 17,903 households. According to the above calculation through the Taro Yamane formula, the minimum number of 391.26 households was to be sampled and then distributed in each relevant area under the administration of sub-district administrative organization (as shown in **Table 4.4.1-2**).

- **The households in the area under the administration of the sub-district municipality**

The number of the households in the area under the administration of the sub-district municipality to be investigated was calculated through the Taro Yamane formula as follows:

$$n = \frac{344}{\left(1+344\times(0.05)^2\right)} = 184.95$$

With reference to the Civil Registration Database of 2014, in the study areas there were in total 344 households which were in the area under the administration of the sub-district municipality. According to the above calculation through the Taro Yamane formula, the minimum number of 184.95 households was to be sampled and then distributed in the area under the administration of the sub-district municipality involved (as shown in **Table 4.4.1-2**).

In gathering the samples, systematic random sampling was employed. Every other household was selected for the interview, which was conducted once per each household with the head or representative of the household, who was allowed to provide information or express their opinion freely all through the interview. All the interview process and its administration by the interviewers were under the supervision and cooperation of experienced officers from the consultant company, who provided advice on the interval in terms of distance between the location of the area of work under

the responsibility of each interviewer so as that the random interval was evenly distributed and thus equal chance of the samples being selected without bias.

(c4) Business enterprises

The study was conducted with the business enterprises within a 5 km radius around the precincts of the project. Purposive sampling was employed. The letter asking for consent for the interview, together with the project public relations documents, was sent to the enterprises, most of which, unfortunately, could not make themselves available for the representatives of the project to meet and interview their personnel. As a result, the consultant company managed to conduct socio-economic investigation of in total 41 business enterprises within a 5 km radius around the precincts of the project (16.5 % of all the 249 business enterprises).

(d) Data analysis

Based on the type of the data collected, two different approaches were employed in data analysis; (1) the secondary data acquired from relevant documents and (2) interview was conducted with the representatives from different levels of government authorities and with the representatives of relevant places of significance, the analysis was conducted descriptively. For the data acquired from the field survey through the interview with the community leaders, households, and business enterprises, statistical data analysis was employed using SPSS (Statistical Package for Social Science) to explain about related socio-economics as well as ideas and suggestions for the development of the project.

TABLE 4.4.1-2

NUMBER OF HOUSEHOLDS CLASSIFIED AS VILLAGE/COMUNITY

Province	District	Sub-district	Moo	Radius		Number of Household[1/]	Number of Sample (α = 95) (household)	Expected Sample (household)	Results (household)
				0 to 3 km	3 to 5 km				
Chon Buri	Si Racha	Khao Kansong	Moo 4 Ban Khao Khansong		✓	478	10.45	11	11
			Moo 5 Ban Surasak	✓		1,066	23.30	24	24
			Moo 7 Ban Rawing	✓		273	5.97	6	6
			Moo 8 Ban Map San Suk	✓		533	11.65	12	13
			Moo 9 Ban Houy Ta-klao	✓		221	4.83	5	5
			Moo 10 Ban Chao Phraya		✓	617	13.48	14	14
		Bowin	Moo 7 Ban Nong Klang Pla	✓		1,059	23.14	24	24
	Ban Bueng	Klong Kio	Moo 5 Ban Muen Chit		✓	211	4.61	5	5
			Moo 6 Ban Som		✓	265	5.79	6	6
			Moo 7 Ban Map Lambid		✓	446	9.75	10	10
	Nong Yai	Nong Suea Chang	Moo 5 Ban Chaloem Lap		✓	259	5.66	6	7
Rayong	Pluak Daeng	Ta Sit	Moo 1 Ban Klongkram	✓		2,887	63.09	64	64
			Moo 2 Ban Khao Rakhang	✓		1,311	28.65	29	29
			Moo 3 Ban Nong Kangkhao	✓		162	3.54	4	4
		Pluak Daeng	Moo 4 Ban Wang Tapin	✓		6,307	138.84	138	139
			Moo 5 Ban Wang Ka Yang		✓	1,808	39.51	40	40
		Total (SAO)				**17,903**	**391.26**	**398**	**401**
		Chompol Chaophraya Sub-district Municipality	Chompol Community	✓		193	103.77	104	104
			Chaophraya Community	✓		151[2/]	81.18	82	16[2/]
		Total (Sub-district Municipality)				**344**	**184.95**	**186**	**120**
Grand Total						**18,247**		**584**	**521**

Remark: 1/ Thai Population (2014), Ministry of Interior (http://stat.bora.dopa.go.th/stat/statnew/statTDD)

2/ There is no inhabitants and some have relocated (about 60 % to total households) which against reference data of Civil Registration Office (151 households – random sampling 82 households) Thus, interviews were made with all households (during field trip), totally 16 samples

(3) Study results

(3.1) Secondary Collection

(a) Results of Secondary Data Analysis (Appendix 3G-2)

(a.1) District Level Data

Chon Buri Province

Chon Buri Province covers 2,726,875 rai of land (4,363 m^2) and located in eastern region of Thailand. The boundary adjoins as follows:

North Adjacent to Chachoengsao Province

South Adjacent to Rayong Province

East Adjacent to Chachoengsao, Chantaburi and Rayong Provinces

West Adjacent to the eastern side of Thailand Gulf

The topography of Chon Buri is characterized as many features: mountainous areas, wetlands, coastal plains and small islands. Administration of Chon Buri Province is divided into 11 Sub-districts, 687 villages and 855,710 households. In terms of population registration (as of December 2014), it was reported that there were 1,421,425 in total; 696,038 men (48.97 %) and 725,387 women (51.03 %). They are mostly Buddhism (97.78 %), Christianity (0.60 %), Islam (1.56 %) and other religions (0.06 %).

Si Racha District, Chon Buri Province

Sri Racha district covers an area of 643.558 km^2 (402,223.75 rai). The area is mostly sloping hillock. Areas are suitable for agricultural (rice cultivation) and industries. West coast is adjacent to the seas and no large rivers flow through area. It is only watercourse from the mountains flow to the sea. The boundary adjoins as follows:

North Adjacent to Chon Buri and Ban Bueng Districts

East Adjacent to Nong Yai and Pluak Daeng Districts (Rayong Province)

South Adjacent to Bang Lamung District

West Adjacent to Thailand Gulf and Si Chang Island

Sri Racha District is regulated in accordance with the Act, Local Administration (B.E.2457). There are 8 Sub-districts 52 villages and 186,218 households. In terms of population registration (as of December 2014), it was reported that there are 277,291 in total; 135,306 men (48.80 %) and 141,985 women (51.20 %).

Ban Bueng District, Cho Buri Province

Ban Bueng District is located in the central of Chon Buri and covers 24,993 rai of land. The characteristic of area appears relatively flat terrain with wavy south and mountains. Creeks and rivers flow from south to north. The boundary adjoins as follows:

North Adjacent to Phanthong and Panas Nikhom Districts

East Adjacent to Bo Thong and Nong Yai Districts

South Adjacent to Nong Yai and Si Racha Districts

West Adjacent to Si Racha and Chon Buri Districts

Ban Bueng District is subdivided into 8 Sub-districts, 52 villages and 48,756 households. In terms of population Registration (as of December 2014), there are 102,318 (in total) 50,093 men (48.96 %) and 52 225 women (51.04 %).

Nong Yai District, Chon Buri Province

Nong Yai district covers an area of 415 km^2. The boundary adjoins as follows:

North Adjacent to Ban Bueng and Bo Thong Districts

East Adjacent to Bo Thong District

South Adjacent to Wangchan and Pluak Daeng Districts

West Adjacent to Si Racha and Ban Bueng Districts

Nong Yai District is divided into 5 Sub-districts, 24 villages and 8,296 households. In terms of population registration (as of December 2014), it was reported that there are 23,258 in total; 11,736 men (50.46 %) and 11,522 women (49.54 %).

Rayong Province

Rayong Province is characterized as coastal plain, which is caused by the deposition of the sedimentary basin watershed. Also, there are alternating hills and mountain slopes and wavy undulating low alternates. There are 2 mountain lines; (1) Chamao mountain situated in east. It is at 1,035 m above MSL and (2) another mountain situated in a range of center of province and long line from Mueang Rayong District to the north of province boundary. A river is briefly, which range from Chanthaburi Mountain and Ban Tad Mountain flow into the Gulf of Thailand, including the Bang Pakong, Rayong and Chanthaburi Rivers. Coastal beaches are beautiful. A few small and large islands scattered along the coast where are major tourism resources of the country.

Rayong Province is located in eastern region of the country. The area covers 3,552 km^2 of land, or about 2,220,000 rai. The boundary adjoins as follows:

North Adjacent to Nong Yai, Bo Thong, Si Racha and Chon Buri Districts

South Adjacent to Thailand Gulf (about 100 km long)

East Adjacent to Na Yay Arm and Kang Hang Meaw Districts (Chantaburi Province)

West Adjacent to Sattahip and Bang Lamung Districts (Chon Buri Province)

Rayong Province is subdivided into 8 districts: (i) Muang Rayong, (ii) Klang, (iii) Ban Khai, (iv) Bang Chang, (v) Wang Chan, (vi) Khao Cha Mao and (vii) Nikhom Pattana, comprises of 54 Sub-districts 439 villages and 181 communities. In terms of local administration, there are one provincial administrative organization, two districts municipality and 25 sub-district municipalities and 39 sub-district administrative organizations. "*Song*" is an existing native people. At present, they are all mixed and well harmonized with local people. The majority of occupation is farmer, scattered throughout the countryside. In terms of population registration (data from December 2014), it was reported that there are 674,393 in total; 332,253 men (49.27 %) and 342,140 women (50.73 %), there were 402,911 households. The majority, about 95 % are Buddhist, Islam (4 %), followed by Christianity (1 %), respectively.

Pluak Daeng District, Rayong Province

Pluak Daeng District covers an area of 329,874 rai of land or 206 km^2. The boundary adjoins as follows:

North Adjacent to Si Racha and Nong Yai District (Chon Buri Province)

East Adjacent to Wang Chan and Ban Kai Districts

South Adjacent to Ban Kai and Nikhom Pattan Districts

West Adjacent to Bang Lamung District (Chon Buri Province)

Pluak Daeng District is divided administration unit into 6 Sub-districts, 34 villages and 64,513 households. In terms of population registration (data from December 2014), it was reported that there are 54,664 people in total; 27,529 men (50.36 %) and 27,135 women (49.64 %).

(a.2) Socio-economic Condition

Chon Buri Province

The topography of Chon Buri Province has 5 main features: (i) undulating plains, (ii) hills, (iii) Bang Pakong River plains, (iv) steep areas and (v) small and large islands.

Undulating plains and hills can be found in the eastern region of Ban Bueng, Panas Nikhom, Nong Yai, Si Racha, Bang Lamung, Sattahip and Bo Thong Districts. It is an area of flat and steep area, similarly to xylophone. Currently, this area is mainly used in the cultivation of cassava. Coastal area is found at the mouth of Bang Pakong River to Sattahip District, where is narrow plateau and alternate with small hills at costal. Next is Bang Pakong River plains where has Klong Luang about 130 km long. The upstream is in

Ban Bueng and Bo Thong Districts and pass Panas Nikhom District and flows to meet Khlong Phan Thong before flowing into the Bang Pakong River. The rich sediment from the sediment of the Bang Pakong River has caused plains suitable for agricultural. The steep and mountainous area are located in the center and east of province from Mueang, Ban bueng, Si Racha, Nong Yai and Bo Thong Districts. Besides, Bang Pra reservoir is a main for water resource the steep mountain and in the middle. Thus, to the east of the city, water consumption in Chon Buri Province.

Chon Buri Province, situated nearby a long coastline of 160 km, dented crooked beautiful is the rock sand stretches of mangrove forests, beaches, etc., many bays of developing a marina, sheltered as well as landing warship Sattahip District. There are no less than 46 islands such as Si Chang island, Khang Kao Island, Rin Island, Phai Island, Loi Island, Lan Island, Krok Island, Sak Island, Kham Island, Samea San Island, Kram Island, etc. This area is a breeding kindergarten and rare sea turtles center, also, conserving endangered species of Thailand's species and overseas species. These islands are natural barriers to prevent waves and wind for Chon Buri Province. Thus, it is no big waves in Chon Buri Province which is different from Rayong, Chantaburi and Trad Provinces because they usually found bigger waves. Thus, Chon Buri Province is full of fishery ports and suitable for building of commercial ports such as Leam Chabung Port etc.

- **Gross Domestic Product (GDP) of Chon Buri Province**

In 2553, Chon Buri' GDP was 657,545 million baht, (source: Office of Strategic eastern provinces, 2014- 2018 (http://www.eastosm.com available on 14 February 2015), which has largely dependent on the agricultural sector, worth 638,034 million baht, consisting of industry (production) (worth 305,605 million baht), in the transport, storage and transportation (worth 55,546 million baht), in the wholesale and retail trade's (worth 38,043 million baht), in electricity, gas and water supply (worth 35,397 million baht), in the hotel and restaurant (worth 23,904 million baht), in the construction (worth of 12,761 million baht). In the agricultural sector (worth 19,511 million baht) consists of hunting and forestry (worth of 21,183 million baht) and fishery (worth of 1,068 million baht). Rate of economic expansion is 12 % of the average income per capita of 441,062 baht as No. 5 in the country, followed by Rayong, Samutsakorn, Ayutthaya and Samut Prakan Provinces.

- **Agriculture**

Agricultural areas covers 1,228,692 rai of land (45.06 % of total land of province), consists of rice, 156,072 rai (12.56 %), crops 535,818 rai (43.14 %), plant 13,132 rai (1.06 %), fruit/tree 536,489 rai (43.19 %) and flowers 641 rai (0.05 %). Important crops that has been grown the most (top 5) include cassava, sugar cane, pineapple, and rice.

- **Livestock**

There are 475,754.47 rai of land and use for growing forage planting (24,613 rai or 0.90 % of total land of province). There are 112 slaughterhouses, 1 dairy cooperative, 1 dairy livestock market, 228 stores of animal food and 9 animal food factories.

Livestock, especially chickens are fed in Chon Buri Province, in Ban Bueng, Bo Thong, Si Racha, Panas Nikhom, Mueang Chon Buri, Nong Yai, Phan Thong, Bang Lamung, Kho Chan and Sattahip, respectively. Certified farms have been granted for all egg chicken farms. Egg chicken farms are found in large, medium and small farms in Panas Nikhom, Ban Bueng, Bo Thong, Nong Yai, Phan Thong, Bang Lamung and Kho Chan Districts.

For live pigs, the major farms are located in Bo Thong, Panas Nikhom, Nong Yai, Ban Bueng, Si Racha, Kho Chan, Phan Thong and Bang Lamung Districts.

Dairy farming in Chon Buri Province is an independent party under dairy cooperative. The major sources of dairy farming are in Nong Yai, Panas Nikhom and Bo Thong Districts.

- **Fishery**

The fishing area is 61,483.22 rai, divided into three categories: marine fishery, aquaculture, and coastal fishery.

The shrimp farming is Panas Nikhom, Phan Thong, Bo Thong and Chon Buri Districts. The shrimp farming area is in the current situation in downward trend due to export problems, trade barrier, competition in the market, epidemic of shrimp. Also, the issue low price, causing temporary pause. By turning to aquaculture, with less risk, such as snapper and grouper farming has been raised.

Freshwater-fishery in Panas Nikhom, Phan Thong, Chon Buri, Bo Thong and Nong Yai Districts, catfish and tilapia and other fishes are popular.

- **Mining**

It has been found antimony, iron, barite, calcite, dolomite, feldspar (little reserve: Not worth the investment in a commercial). Antimony with mining operations located in Bo Thong sub-district. But there are little reserves as well. There was no yield at all. The current mining production continued only rock mining industry. Rock mining for construction will be divided into two types; limestone stone and granite. The construction industry has 35 places and mineral production volume of 9,951,194 metric tons (as of October 2011).

- **Industry**

Chon Buri Province is the target areas of the Eastern Seaboard Development Project in 2010: there will be 3,853 industries in total. In detail, there are 2,947 outside industrial estates and 5 within industrial estates (Hemaraj Chon Buri, Amata Nakorn, Pinthong, Pinthong (Laem Chabang) and Laem Chabang industrial estates), there are 1,231 locations in total.

- **Tourism**

The number of tourists (Comprised of tourists who come to visit and tours as defined by the Department of Tourism), Chon Buri Province is the number one of tourists most-visit place (78.1 %). Average duration of stay is approximately 2-3 days for foreign tourists, prefer to stay longer than locals.

Si Racha District, Chon Buri Province

It is identified as semi-agricultural zone and semi-industrial zone. This is likely to be developed for more industrial than agricultural due to development according to the project development in east coastal supporting by Leam Chabang port.

The main occupations is agricultural (farming and gardening) employed in industry, commerce and fishery. For the supplement occupation is animal husbandry. The major of agricultural produce are pineapple, cassava, coconut, jackfruit and orchids.

Ban Bueng District, Chon Buri Province

Ban Bueng District is located in the eastern region of Chon Buri Province, a plateau interspersed with green plants, little Bayou. Therefore, people mostly have main occupations in agricultural sectors, such as sugarcane, cassava, fruit farming and rice cultivation.

Nong Yai District, Chon Buri Province

Nong Yai District is mostly hilly plains rise a little different on the mound. Nong Yai district is not significant role in tourism like Bang Lamung, Si Racha and Sattahip Districts. Agriculture is the main occupation of the people in the virtual space. The crops include oil palm, rubber, sugar cane, mainly cassava and cashew. In addition, Bang Yai District is also an area with industrial support on agricultural production, such as palm factory, sugar factory, rubber processing factory and other types of plants in areas such as plastics processing factory and food processing factory

Rayong Province

Rayong inhabitants mostly live along/nearby the coast and rivers. Fishing and farming are the main occupations. After industrial ages, there are many in-migration workers, as a result of socio-economic change (agricultural become industrial age).

Economic Situation

According to the Rayong Provincial Office of the Comptroller General showed that the gross domestic product of Rayong Province in 2012, worth 799,627 million baht as a result of the agricultural sector is 19,887 million baht and non-agricultural sector is 779 740 million baht. Worth of products per capita equal to 1,304,896 baht/person/year as No. 1 in the country (Source: Office of Strategy Management Group Eastern Province, Rayong Province development plan in 2015-2018 (http://www.eastosm.com, 14 February 2015).

The Census latency The Office of the National Economic and Social Development found that in the 2009 with a registered population of 455,138 people, so it has a population of 1,067,233 people living in Rayong Province. In comparison, it was found that the insurer did not move out. It was found that there were 253,414 persons (23.7 % of the passive population in the province), followed by the Map Ta Put Municipality 106,101 people, which is higher than about one times the number of the registered population (90,185 people, in December 2009). Pluak Daeng and Nikhom Pattana Districts have passive population of 28,218 and 13,900 people, respectively. (Source: preliminary report study on passive population in Rayong Province; Office of the National Economic and Social Development, 962 Krung Kasem Rd, Wat Sommanat, Pom Prap Sattru Phai, Bangkok 10100; August 2010, page 16).

The projected passive population trends in Rayong Province found that passive population will be increased from 487,859 people in 2010 to 796,510 people, at least in 2017, an increase of 308,651 people (1.75 times of the number of passive population in the year 2009), with the proportion of the population latency increased steadily (Source: Office of strategy Management group eastern province, Rayong Province development plan in 2015-2018 (http://www.eastosm.com, 14 February 2015).

- **Agriculture**

The Rayong Province terrain and climate are suitable for agriculture. As a result, Rayong Province has made many important crops:

- Rubber is an important crop and is grown in most provinces because the plant is easy to grow, as well as the topographical conditions favorable for the cultivation of the province.
- Cassava is crop that is vital to the economy of the district. They are the most cultivated plants in Klang, Wang Chan and Mueang districts, respectively
- Pineapple growing ranks second in the country, after Prachuap Khiri Khan Province, it was about 20 % of productivity in the country. Most products are sold to industry, to produce pineapple can and pineapple juice.
- Durian Farm is a farm in the province of Rayong Province. Hold a long career the experience and accumulated knowledge from their ancestors with the production of durian plantations scattered in the Klang District, Muang Rayong, Khao Cha Mao, Wang Chan, and Ban Khai Districts, respectively.
- Rambutan is economical fruit, popular plant, in Rayong Province. There are a lot of fruit growing areas of the country was ranked sixth.
- Mangosteen has been referred to as "THE QUEEN OF FRUIT" fruit varieties are bred only and no mutation. The growing period is usually in between May to September and harvest in between May to July.

- **Livestock**

Trade of chickens and ducks are increased due to price incentives. Also, farmers have been promoting loans from government agencies such as the village fund and other loans. Numbers of livestock farmers are different in each district of the Rayong Province.

- **Fishery**

Rayong Province has long coastal approximately 100 km. Major occupation is sea fishery, freshwater fishery and brackish water fishery. It is approximately 1,500,000 rai of sea area and 63,080 rai for freshwater fishery. There are 2,603 fishing boats, 6 of fishing associations, 36 of association of fishery Group, 2 of fishing cooperatives and 45 of fishery ports.

- **Industry**

Rayong Province has a role as part of a project to develop the coastal area east and guidelines were developed as a center for development of new service standards research and technology and the eastern coast of the northeast to export to foreign countries by not passing Bangkok. The government has taken to prepare infrastructure completely in Map Ta Phut to be industrial estate where located in Mueang

District, Rayong Province. The area of the new industrial estate in the country is 10,000 rai; 8,000 rai for industrial. One port of deep water port cargo can receive ships of 20,000 tons and two ports of harbor transport molten material that can receive ships of 8,000 tons, where is located of important industries such as petrochemical Industry and chemical fertilizer industry in Rayong Province, has great potential in terms of industrial investment. It also has been defined by Investment Promotion Zone of the Board of Investment of Thailand in zone 3 as a resulting in the advantage of Rayong Province over the perimeter cities so the industry is developing rapidly.

Rayong Province has Industrial Estate and industrial co-operation with the private sector. Industrial zone, Community industry and Industrial Park are 23 places of total which covers approximately 40,000 rai of land with 1,944 industries and 159,824 of workers. There are various types of electronic parts such as automobile manufacturing process, agricultural products, electricity and chemical production. The total value each year is almost one third of the expenditures in the United States. (Office of Rayong Province in 2012).

The number of enterprises with highest agricultural industry is metal products industrial and transportation industries, most of the upstream sector production technology and high investment value. The Mueang District has the highest number of industrial enterprises with 638 industries, followed by Pluak Daeng District and Klang District with 457 and 287 industries, respectively.

Tourism and Service

Rayong Province is diverse coastal areas as sea beaches, islands, mountains, waterfalls, fruit orchards, including fresh seafood. There are more than 120 km long beach on Koh Samet where is a tourist attraction that has been highly appreciated tourists. Travel to Rayong Province is easy and convenient by water, land and air transportation with approximately 179 km far from Bangkok. Also, it has capability to receive many of tourists.

In 2011, there were 4,583,551 people visit to Reyong Province that were classified as guest of Thailand. 14,336,032 people and visitors foreigners of 247,519 people. The income was more than 17,891 million baht (Source: Office of Strategy Management Group Eastern Province plan Rayong (in 2015-2018) http://www.eastosm.com, 14 February 2015).

- **Natural Resources**

Rayong Province has many mineral resources. The most abundant mineral is silica sand, industry rock, granite type for construction and decoration, gneiss stone for the construction and decoration, limestone for the construction, industry minerals and others (kaolin, feldspar and gold). Moreover, it was found rare minerals accumulate along the coast and at sea.

Pluak Daeng District, Rayong Province

Most areas have a wavy slope rise and there is generally a mountain slope about 3-15 % gradient from west to east of the district. A natural stream flow, water throughout the year, into Dok Krai Reservoir, Nong Pla Lai Reservoir and Khlong Yai Reservoir. The 3 large reservoirs are the important water sources for Eastern region.

However, the implementation of the government policy to promote industrial development in the eastern coastal areas were not applied together with land use plan. As a result, many areas in Pluak Daeng District become an urban and industrial areas in the shortest time.

With little remaining of forest areas, the government has allocated land. Local farmers have changed the Khao Somsed-Rawoeng National Forest to be agricultural area. The main occupation is to grow pineapple, rubber and cassava. For the supplement occupation is contractor and trade.

(b) District and village/community in the study area within a 5 km radius of surrounding the project area (Details are shown in **Appendix 3H-2**)

The study area within a 5 km radius around the project area and covers an area of 7 local authorities in 4 districts of 2 provinces.

Local governments within the project area.

Province	District	Sub-district
Chon Buri	Si Racha	Khao Khansong Sub-district Administrative Organization
		Bowin Sub-district Administrative Organization
	Ban Bueng	Klong Kio Sub-district Administrative Organization
	Nong Yai	Nong Suea Chang Sub-district Administrative Organization
Rayong	Pluak Daeng	Ta Sit Sub-district Administrative Organization
		Pluak Daeng Sub-district Administrative Organization
		Chompol Chaophraya Sub-district Municipality

(b.1) Administrative Boundary and Population

Khao Khansong Sub-district Administrative Organization, Si Racha District, Chon Buri Province

Khao Khansong Administrative boundary covers an area of 90 km^2, or about 56,250 rai:

North: Adjacent to Khlong Ban Bueng, Chon Buri Province.

East: Adjacent to Rayong Province.

West: Adjacent to Nong Kham, Sriracha Districts, Chon Buri Province.

South: Adjacent to Bowin, Sriracha Districts, Chon Buri Province.

Khao Khansong Sub-district Administrative contains 6 villages. The whole area of Moo 5 and 7 are under Sub-district Administrative Organization and the area of Moo 4, 8, 9 and 10 are partially under the Sub-district Administrative Organization

Other local administrative organization of Khao Khansong sub-district is Chao Phraya Surasak Municipality (Source: 3-year development plan (in 2014-2016) Khao Khansong Sub-district Administrative, 2014).

Population registration (as of December 2014), it was reported that there were 5,755 in total; 2,852 men (49.56 %) and 2,903 women (50.44 %), there were 3,762 households.

Bowin Sub-district Administrative Organization, Si Racha District, Chon Buri Province

Bowin, Sub-district Administrative cover an area of 39 km^2 or 24,375 rai. The boundary adjoins as follows:

North: Adjacent to Khao Khansong Sub-district Administrative Organization, Si Racha District, Chon Buri Province

South: Adjacent to Takiantia Sub-district Administrative Organization, Bang Lamung District, Chon Buri Province

East: Adjacent to Mab Yang Porn Sub-district Administrative Organization, Pluak Daeng District, Rayong Province.

West: Adjacent to Ao Udom Sub-district Municipality, Chon Buri province

Bowin Sub-district Administrative Organization consists of 4 villages (Source: Bowin Sub-district Administrative Organization; http://www.bowin.go.th available on February 14, 2015) are Moo 3, 4, 6 and 7.

In terms of populationr (as of December 2014), it was reported that there were 16,610 people (17,084 households) in total, 8,380 men (49.56 %) and 8230 women (50.44 %).

Klong Kio Sub-district Administrative Organization, Ban Bueng District, Chon Buri Province

Klong Kio Sub-district Administrative Organization covers an area of 222.809 km^2 or 139,255.62 rai. The boundary adjoins as follows:

North: Adjacent to Ban Bueng and Nong Sang Sub-districts, Ban Bueng District

South: Adjacent to Khao Khansong Sub-district, Si Racha District.

East: Adjacent to Nong Irun Sub-district, Ban Bueng District and Nong Suea Chang Sub-district, Nong Yai District

West: Adjacent to Bang Phra Sub-district, Si Racha Dsitrict

Klong Kio Sub-district Administrative Organization consists of 9 villages. There are 2 villages under other local Administrative Organization which is Moo 1 under Hua Kun Jae Sub-district Municipality and Moo 4 under Nong Phai Kaew Sub-district Municipality (Source: 3-year development plan (in 2014-2016), Klong Kio Sub-district Administrative Organization, 2014).

In terms of Population Registration (as of December 2014), it was reported that there are 15,082 people (5,743 households) in total; 7,467 men (49.51 %) and 7,615 women (50.49 %).

Nong Suea Chang Sub-district Administrative Organization, Nong Yai Sub-district, Chon Buri Province

Nong Suea Chang Sub-district in Nong Yai District in Chon Buri Province located in the south of Nong Yai District. It covers an area of 85 km^2 (53,125 rai). The boundary adjoins as follows:

North: Adjacent to Nong Phai Kaew Sub-district, Ban Bueng District, Chon Buri Province and Hang Su Sub-district, Nong Yai District, Chon Buri Province

South: Adjacent to Nong Rai Sub-district, Pluak Daeng District, Rayong Province and Khao Sok Sub-district, Nong Yai District, Chon Buri Province

East: Adjacent to Nong Yai Sub-district, Nong Yai District, Chon Buri Province

West: Adjacent to Klong Khio Sub-district, Ban Bueng District, Khao Khansong Sub-district, Si Racha District, Chon Buri Province and Ta Sit Sub-district, Pluak Daeng District, Rayong Province

Nong Suea Chang Sub-district Administrative Organization consists of 5 villages.

In terms of population registration (as of December 2014), it was reported that there are 4,143 people (1,482 households) in total; 2,076 men (50.11 %) and 2,067 women (49.89).

Ta Sit Sub-district Administrative Organization, Pluak Daeng District, Rayong Province

Ta Sit Sub-district Administrative Organization covers an area of 96.33 km^2 or 60,206.25 rai. The boundary adjoins as follows:

North: Adjacent to Nong Suea Chang Sub-district, Nong Yai District, Chon Buri Province

South: Adjacent to Pluake Daeng District

East: Adjacent to Nong Rai and Nong Lahan Sub-districts

West: Adjacent to Khao Khansong Sub-district, Si Racha District, Chon Buri Province

Ta Sit Sub-district Administrative Organization consists of 4 villages.

Other local Administrative Organization in Ta Sit Sub-district is Chomphon Chao Phraya Sub-district Municipality where located in Moo 3 Ban Nong Kangkao (Source: 3-year development plan (in 2014-2016), Ta Sit Sub-district Administrative Organization, 2014).

In terms of population registration (data for December 2014), it was reported that there are 6,133 people (5,930 households) in total: 3,038 men (49.54 %) and 3,095 women (50.46 %).

Pluak Daeng Sub-district Administrative Organization, Pluak Daeng district, Rayong Province.

Pluak Daeng Sub-district Administrative Organization covers an area of 71.22 km^2 or 44,508.75 rai. The boundary adjoins as follows:

North: Adjacent to Ta Sit Sub-district, Pluak Daeng District, Rayong Province and Bowin Sub-district, Si Racha District, Chon Buri Province

West: Adjacent to Map Yang Phon Sub-district, Pluak Daeng District, Rayong Province

East: Adjacent to Ta Sit and Lahan Sub-districts, Pluak Daeng District, Rayong Province

South: Adjacent to Lahan, Mae Nam Khu and Map Yang Phon Sub-district, Pluak Daeng District, Rayong Province.

Pluak Daeng Sub-district Administrative Organization consists of 6 villages.

Other local Administrative Organization in Pluak Daeng Sub-district is Ban Pluak Daeng Sub-district Municipality, where located in Moo 1 Ban Pluak Daeng, covers area of 2.866 km^2 or 1,500 rai.

In terms of population registration (as of December 2014), it was reported that there are 10,741 people (16,417 households) in total: 5,484 men (51.06) and 5,257 women (48.94).

Chompol Chaophraya Sub-district Municipality, Pluak Daeng District, Rayong Province

In 1980, the Interior Ministry has notified "Establishment Sanitation of Chompon Chaophraya Sub-district, Pluak Daeng District, Rayong Province" as published in Volume 97, Part 115, 29 July 1980 by a community of Nong Khang Kao and the surrounding area, which is Moo 3 among of the four villages of Ta Sit Sub-district, Pluak Daeng District, Rayong Province, covers an area of 2.84 km^2. In 1999, the law was changed as a municipal sanitation, as announced in the Government Gazette Volume 116, Part 9A, 24 February 1999. The boundary adjoins as follows:

North Adjacent to Khao Khan Song Sub-district, Si Racha District, Chon Buri Province

East Adjacent to Lahan Sub-district, Pluak Daeng District, Rayong Province

West Adjacent to Bowin Sub-district, Si Racha District, Chon Buri Province

South Adjacent to Mae Nam Ku Sub-district, Pluak Daeng District, Rayong Province

Chompol Chaophraya Sub-district Municipality consists of 2 communities. There are Chompol and Chaophraya communities (Source: 3-year development plan (in 2014-2016) Chompol Chaophraya Sub-district Municipality, 2014).

In terms of population registration (as of December 2014), it was reported that there were 1,366 people (354 households) in total; 695 men (50.88 %) and 671 women (49.12 %).

(b.2) Occupation and Living Condition

Khao Khansong Sub-district Administrative Organization, Si Racha District, Chon Buri Province

Topography of Khao Khansong Sub-district Administrative Organization is mostly sloping mountainous area with a little scattered. The area is mostly suitable for agricultural industries.

Main occupation of the population in this district is agricultural, trade and contractors.

Business unit in Khao Khansong Sub-district Administrative Organization is 2 small petrol stations.

Establishment of masses is Aor Por Por Ror 1st batch with 39 persons.

Bowin Sub-district Administrative Organization, Si Racha District, Chon Buri Province

Bowin has various plateaus and mountain slopes with a little scattered. Most people do agricultural, industrial and gardening / farming and contract.

Khlong Kio Sub-district Administrative Organization, Ban Bueng District, Chon Buri Province

The area is a flat hill that mostly used for agricultural activities (for growing crops such as sugar cane, cassava, pineapple, rubber and others).

Sand and granite were found in Khlong Kio Sub-district Administrative Organization.

Business unit in Khlong Kio Sub-district Administrative Organization is 3 petrol and gas stations, 40 industries, 3 golf courses and 152 stores.

Nong Suea Chang Sub-district Administrative Organization, Ban Nong Yai District, Chon Buri Province

The majority of occupation in the area is agriculture; farming, gardening and livestock. The current population of the termination of a career is in agriculture into the industrial sector.

Business unit in Nong Suea Chang Sub-district Administrative Organization is as follows:

- 1 petrol and gas station
- 5 industries
- 6 agricultural production companies
- 7 other companies

Establishment of community group is as follows:

1. Women Group
2. Housewife Group
3. Youth Group
4. Pineapple Group
5. Tap Water User Group
6. Guava Group
7. Elder Group
8. Village Committee Group
9. Leader of volunteer to development community
10. Tap Water Committee Group
11. Cassava Group
12. Or Sor Mor Sub-distric
13. Friend Help Friend Group
14. Support of cremation Group

Ta Sit Sub-district Administrative Organization, Pluak Daeng District, Rayong Province

The majority of occupation in the area is agriculture (pineapple, rubber and cassava), contractor and others.

Business unit in Ta Sit Sub-district Administrative Organization is as follows:

- 1 hotel
- 102 industries
- 4 banks
- 1 coordinator center of international trade

Establishment of community group is as follows:

- Agricultural group
- Development Women of Ta Sit Sub-district group
- Development Women of Ban Nern Samran group
- Pineapple Ta Sit Sub-district group
- Cassava Ta Sit Sub-district group
- Mixed of farming and integrated farming group
- Moratorium of agricultural group
- Organic vegetable group
- Group of saving for production Moo 4
- Development of housewife group
- Village fund Moo 4

Pluak Daeng Sub-district Administrative Organization, Pluak Daeng District, Rayong Province

Pluak Daeng Sub-district is undulating hilly terrain interspersed with low hills scattered everywhere. Sandy loam soil is well drained and Nong Pla Lai Located almost in the center of the area, divide the district into two sides.

- Area of Moo 1 is a part of Ban Pluak Daeng Sub-district Municipality where is a service centers in all aspects due to the establishment of government agencies, enterprises and private sectors. It is also a place of shelter and various commercial sectors.
- Area of Moo 4 is the location of Eastern Seaboard Industrial Estate, G.K. land industrial zone, a place of shelter and various commercial sectors.

Pluak Daeng Sub-district Administrative Organization zone is rapidly commercial and service expansion, especially in Moo 1, 4, 5 and 6 due to close to community center or industrial estate.

However, the overall structure of the economy in the area of Pluak Daeng Sub-district Administrative Organization. Most people are still based on agriculture. Since, it is a traditional occupation in the community. The plants are grown mainly pineapple, rubber and cassava. Some plants are mixed. There are also fresh water fishing in Nong Pla Lai reservoir, and livestock. Second occupation is contractor and service.

Chomphon Chao Phraya Sub-district Municipality, Pluak Daeng District, Rayong Province

Land use in the municipality is mostly used as a residential / shop. There is a building the use of the upper floors are residential. The ground floor is a place of trade. These stores are located along the main road. The industry has expanded into the municipality. Besides, there are quite a few agricultural of land use.

Within the municipality, the use of agricultural land has been established in some parts. Most of agricultural land (pineapple, rubber, etc.) located outside the municipality.

Most of the industry is happening around Chomphon Chao Phraya Sub-district Municipality and the expansion of industry in the area of a municipality. Hemaraj ESIE located in municipality.

Within the municipality, the majority of occupation is contractor and commercial together in dense communities along the no. 1 municipal road. In community has shops selling necessities of living, including restaurants, grocery stores, etc.

There are people from neighboring provinces and other provinces have many immigrants make a living. Most civic tradition is such as buffalo race festival.

(b.3) Changes in the population studied.

A study of changing of population in the study area was gather information from the Department of Provincial Administration, Ministry of Interior in 2015 to see the trend changing population in the study area include Klong Kio Sub-district, Ban Bueng District; Nong Suea Chang Sub-district; Nong Yai District and Khao Khansong and Bowin Sub-districts, Si Racha District; Pluak Daeng and Ta Sit Sub-districts, Chomphon Chao Phraya Sub-district Municipality, Pluak Daeng District, Rayong Province. It was found that the population in the study area in 2009-2014 tended to increase at the average rate of 4.55 % per year. The Pluak Daeng Sub-district, Pluak Daeng District, Rayong Province rate of population change, increased the most (11.14 %) and Chomphon Chao Phraya Sub-district Municipality rate of population change decreased the most (-1.00 %), as detailed in **Table 4.4.1-3**. For the distribution of population by age and sex education in 2014 found that the population structure of the area is a constrictive Pyramid as shown in **Figure 4.4.1-2**. It was indicated that the number of births and deaths down. The ratio of male and female were equality (50.01 % and 49.99 %, respectively), mainly in the working age population (69.30 %) and population groups that rely on. (0-14 years and above 60 years) accounted for 30.70 %. The population in the study area is suitable for employment, so the project is stipulated measures to support the local people by consider hiring local people at first.

TABLE 4.4.1-3

NUMBER OF POPULATION AND CHANGE RATE WITHIN STUDY AREA

Area	Population						Change Rate (%)					
	2009	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	Average
Chon Buri Province	**1,289,590**	**1,316,293**	**1,338,656**	**1,364,002**	**1,390,354**	**1,421,425**	**2.07**	**1.70**	**1.89**	**1.93**	**2.23**	**1.97**
Ban Bueng District	97,029	97,945	98,764	100,017	100,916	102,318	0.94	0.84	1.27	0.90	1.39	1.07
Klong Kio Sub-district	14,898	14,984	14,969	14,989	15,008	15,082	0.58	-0.10	0.13	0.13	0.49	0.25
Nong Yai District	22,520	22,689	22,931	23,042	23,109	23,258	0.75	1.07	0.48	0.29	0.64	0.65
Nong Suea Chang Sub-district	4,042	4,050	4,069	4,096	4,114	4,143	0.20	0.47	0.66	0.44	0.70	0.49
Si Racha District	237,882	244,390	251,490	198,952	267,591	277,291	2.74	2.91	-20.89	34.50	3.62	4.58
Khao Khansong Sub-district	5,385	5,431	5,553	5,704	5,708	5,755	0.85	2.25	2.72	0.07	0.82	1.34
Bowin Sub-district	10,387	11,329	12,461	13,612	15,098	16,610	9.07	9.99	9.24	10.92	10.01	9.85
Rayong Province	**612,095**	**626,402**	**637,736**	**649,275**	**661,220**	**674,393**	**2.34**	**1.81**	**1.81**	**1.84**	**1.99**	**1.96**
Pluak Daeng District	41,628	45,160	47,335	49,192	51,452	54,664	8.48	4.82	3.92	4.59	6.24	5.61
Pluak Daeng Sub-district	6,347	7,214	8,309	8,925	9,625	10,741	13.66	15.18	7.41	7.84	11.59	11.14
Ta Sit Sub-district	5,405	5,439	5,684	5,968	6,039	6,133	0.63	4.50	5.00	1.19	1.56	2.58
Chomphon Chao Phraya Sub-district Municipality	1,449	1,428	1,327	1,250	1,369	1,366	-1.45	-7.07	-5.80	9.52	-0.22	-1.00
Study Area	**47,913**	**49,875**	**52,372**	**54,544**	**56,961**	**59,830**	**4.09**	**5.01**	**4.15**	**4.93**	**5.04**	**4.54**

Remark: Population information of Sub-districts and municipality in study area of the project

Source: Department of Provincial Administration, Ministry of Interior in 2015

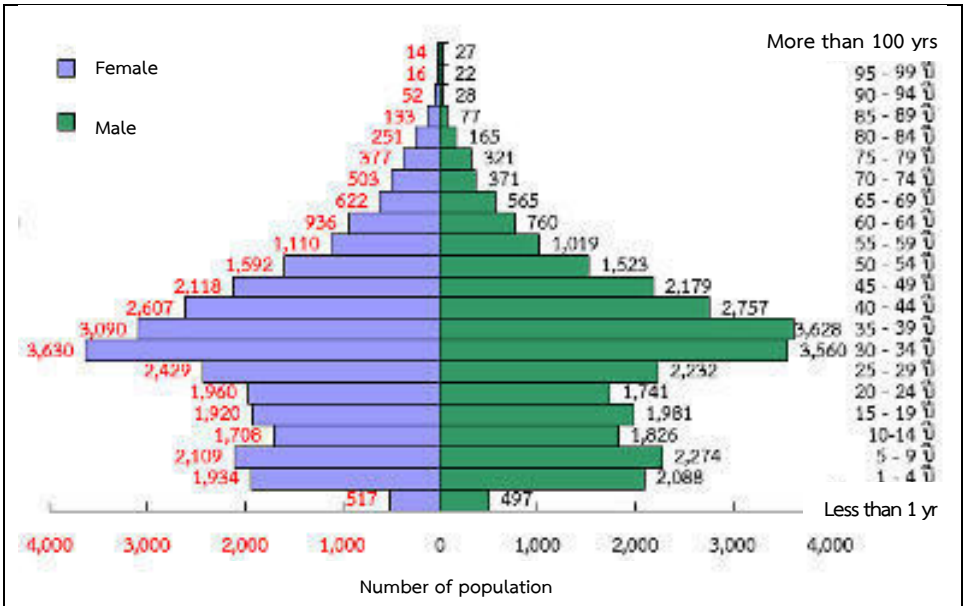


FIGURE 4.4.1-2 : PIRAMID OF POPULATION IN STUDY AREA IN 2014

Source: Department of Provincial Administration, Ministry of Interior, 2015

(3.2) Primary data collection through the field survey

The consultant conducted the field survey on 8-11 September 2014 and 3–23 February 2015; after the first meeting activity to gain opinions was organized, the details of which are as follows (as shown in **Photo 4.4.1-1**).

- 61 persons from governmental organizations
- 41 persons from business enterprises
- 52 samples community leaders, of which: (the results of the interview with the community leaders are shown in **Appendix 3G-3**).
  - 32 samples are the leaders of the communities situated within a 3 km of radius from the location of the project, including both the communities the in the areas under the administration of the sub-district administrative organization and sub-district municipality.
  - 20 samples are the leaders of the communities situated within a 3 to 5 km of radius from the location of the project, which are in the areas under the administration of the sub-district administrative organization.
  - 521 samples of households in the study area (the Taro Yamane formula is employed in determining the size of the sample groups), of which: (the results of the interview with the household sample group are shown in **Appendix 3G-4**).

GOVERNMENT AGENCY	
 Governor of Rayong Province	 Representative from Office of Natural Resources and Environment of Rayong Province
 Provincial Energy of Chon Buri Province	 Public Health, Chon Buri Province
BUSINESS ENTERPRISE	
 Nisshinbo Somboon Automotive Co., Ltd	 Curry Logistic Co.,Ltd.
 N H K Spring Co., Ltd.	 Komastsu Seiki (Thailand) Co., Ltd.

PHOTO 4.4.1-1 : TARGET GROUP INTERVIEW

COMMUNITY LEADER	
 Sub-district headman (Ta Sit Sub-district)	 Abbot (Wat Chompon Chaophraya)
 Village Headman (Moo 6 Klong Kio Sub-district)	 Village Headman (Moo 5 Khao Khansong Sub-district)
HOUSEHOLD	
 Moo 1 Ta Sit Sub-district	 Moo 7 Bowin Sub-district
 Moo 9 Khao Khansong Sub-district	 Moo 5 Nong Suea Chang Sub-district

PHOTO 4.4.1-1 : TARGET GROUP INTERVIEW (Cont'd)

- 428 samples are the households within a 3 km of radius from the location of the project, including both the communities the in the areas under the administration of the sub-district administrative organization and sub-district municipality.
- 93 samples are the households within a 3 to 5 km of radius from the location of the project, which are in the areas under the administration of the sub-district administrative organization.

(a) Results of the interview with the relevant governmental organizations

Meeting with the relevant governmental organizations was coordinated by the consultant company with the aim of providing information about the project and acquiring data on socio-economics and quality of life, the details of which are shown in **Table 4.4.1-4**. The issues raised in the interview were to be taken into account in formulating consequent measures, as shown in **Table 4.4.1-5**.

(b) Results of the interview with the business enterprises

The study was conducted with 41 business enterprises within a 5 km of radius around the precincts of the project. Illustration of the socio-economic survey can be seen in **Photo 4.4.1-1**. The results of the field survey (the results of the analysis of the interview with the business enterprise sample group, **Appendix 3G-5**) are as follows:

- **General information about the interviewees**

Gender, religious belief, age, education level, status in the business enterprise, length of employment in the business enterprise, length of establishment of the business enterprise : Of all the representatives of the business enterprises that were interviewed, 48.8 % are male and 51.2 % are female; the average age is 33.5, the youngest interviewee is 22.0 and the oldest is 51.0 years old; 97.6 % are Buddhist and 2.4 % are Christian; 80.5 % hold a Bachelor's degree and 12.2 % have a Master's degree; 29.3 % are department managers, 14.6 % are supervisors, and 56.1 % are administrative staff; the average length of employment in the business enterprise is 3.7 years, with 0.1 year as the shortest and 15.0 years as the longest length of employment in the business enterprise; the average length of establishment of the business enterprise in the industrial estate is 5.2 years, with 1.0 year as the shortest and 18.0 years as the longest length of establishment.

- **General information about the business enterprises**

Structure, type, economics, number of staff, working hours/ business hours, characteristics of the premises, utilization of the premises: as shared by the representatives of all the business enterprises, the average number of staff is 335.2, with 7.0 as the lowest and 3,000.0 as the highest number of staff; the working hours of the majority of the business enterprises are during 08.00 a.m. to 17.00 p.m., with the working hours during 07.00 a.m. to 16.00 p.m. coming second; the average number of buildings of all the business enterprises is 2.0, with 1.0 building as the lowest and 9.0 as the highest number of buildings. All the buildings are used solely for business purpose (100 %).

TABLE 4.4.1-4

LIST OF INTERVIEWEES (GOVERNMENT AGENCIES)

SECTOR	INTERVIEWEE	DATE
Administration	- Governor of Chon Buri Province	2 February 2015
	- Governor of Rayong Province	June 20, 2014
	- Lieutenant Governor of Rayong Province	3 February 2015
	- District Chief officer Si Racha	19 June 2014
	- District Chief officer Ban Bueng and Colleges	1 July 2014
	- District Chief officer Nong Yai	25 June 2014
	- Senior Deputy Governor of Pluak Daeng District	20 June 2014
	- Chief Executive of the Khao Khan Song Sub-district	25 June 2014
	- Chief Executive of the Bowin Sub-district	25 June 2014
	- Chief Executive of the District Nong Suea Chang Sub-district	26 June 2014
	- Chief Executive of the Klong Kio Sub-district	25 June 2014
	- Chief Executive of the Ta Sit Sub-district	26 June 2014
	- Chief Executive of the Pluak Daeng Sub-district	26 June 2014
	- Mayor of Chomphon Chao Phraya Sub-district	26 June 2014
Natural Resources and Environment	- Director of Office Natural Resources and Environment of Chon Buri Province	21 April 2015
	- Director of the Environment and the Office of Natural Resources and Environment of Rayong Province.	7 July 2014
Industry/Energy	- Director of the Energy Regulatory Commission District 8	10 April 2015
	- Headman of Provincial Industrial Work, Chon Buri Province	2 April 2015
	- Headman of Provincial Industrial Work, Rayong Province	7 July 2014
	- Provincial Energy of Chon Buri Province	23 June 2014
	- Provincial Energy of Rayong Province	7 July 2014
Agriculture	- Agricultural Specialist, Provincial Office of Agriculture (Si Racha District)	2 April 2015
	- District Office of Agriculture (Ban Bueng District)	7 April 2015
	- Agricultural Academician, District Office of Agriculture (Nong Yai District)	31 March 2015
	- District Office of Agriculture (Pluak Daeng District)	30 March 2015
	- Headman of Fishery Management Section, Provincial Office of Fishery	17 April 2015
	- Fishery Specialist, Provincial Office of Fishery (Rayong Province)	31 March 2015
Safety for Life and Asset	- Chief Director of Bowin Police Station	31 March 2015
	- Chief Superintendent of Pluak Daeng Police Station	20 April 2015
	- Headman of Disaster Prevention and Mitigation, Chon Buri Province	22 April 2015
	- Headman of Disaster Prevention and Mitigation, Rayong Province	30 March 2015

TABLE 4.4.1-4

LIST OF INTERVIEWEES (GOVERNMENT AGENCIES) (Cont'd)

SECTOR	INTERVIEWEE	DATE
Public Health	- Public Health Specialist, Public Health Office (Chon Buri Province)	20 April 2015
	- Nurse, Public Health Office (Rayong Province)	28 October 2014
	- Public Health Office (Si Racha District)	28 October 2014
	- Public Health Office (Ban Bueng District)	17 October 2014
	- Public Health Academician, Public Health Office (Nong Yai District)	20 October 2014
	- Public Health Office, Pluak Daeng District	21 October 2014
	- Public Health Academician, Ban Bueng Hospital	17 October 2014
	- Public Health Academician, Pluak Daeng Hospital	21 October 2014
	- Public Health Academician, Ban Tha Jam Tambon Health Promoting Hospital	20 October 2014
	- Public Health Academician, Ban Nong Bon Tambon Health Promoting Hospital	21 October 2014
	- Public Health Academician, Ban Nong Kangkao Tambon Health Promoting Hospital	20 October 2014
	- Public Health Academician, Ban Muen Chit Tambon Health Promoting Hospital	17 October 2014
	- Public Health Academician, Ban Khao Hin Tambon Health Promoting Hospital	21 October 2014
	- Director of Chaloem Phrakiartof 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambid Sub-district	17 October 2014
	- Public Health Academician, Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-district	17 October 2014
Education and Development	- Si Racha Development Center	3 April 2015
	- Ban Bueng Development Center	2 April 2015
	- Operations Community Development Academician, Office of Community Development (Nong Yai)	17 April 2015
	- Operations Community Development Academician, Office of Community Development (Pluak Daeng)	23 April 2015
	- Director of Eastern Sugar Community School	10 September 2014
	- Teacher, Klong Kram School	9 September 2014
	- Teacher, Surasak School	8 September 2014
	- Director of Ban Rawoeng School	8 September 2014
Labor and Protection	- Office of Labor (Chon Buri Province)	17 April 2015
	- Office of Labor (Rayong Province)	10 April 2015

TABLE 4.4.1-4

LIST OF INTERVIEWEES (GOVERNMENT AGENCIES) (Cont'd)

SECTOR	INTERVIEWEE	DATE
Public Utility and Public Assistance	- Deputy Director of Operations and Maintenance Committee and the Provincial Electricity Authority zone 2 (central Chon Buri)	28 April 2015
	- Manager of Water Supply, Leam Chabang Branch	7 April 2015
	- Director of Engineering Section and Colleges, Office of Irrigation 9 (Chon Buri Province)	21 April 2015
	- Director of Provincial Highway (operation 1) Chon Buri Province	12 May 2015
	- Director of Highways (Rayong District)	30 March 2015
Land and Land Use	- Director of Office of Eastern Seaboard Industrial Estate (Rayong Province)	7 April 2015

Source : TEAM Consulting Engineering and Management Co., Ltd, 2015

TABLE 4.4.1-5

SUMMARY OF THE ISSUES IN THE INTERVIEW WITH THE GOVERNMENTAL ORGANIZATIONS INVOLVED

Governmental organizations	Summary of the issues in the interview
Administrative organizations Interviewees – Governor of Chon Buri Province – Governor of Rayong Province – Deputy Governor of Rayong Province – Si Racha District Chief – Ban Bueng District Chief – Nong Yai District Chief – Senior Assistant Chief of Pluak Daeng District – Chief Executive of Khao Khansong SAO – Chief Executive of Bowin SAO – Chief Executive of Nong Suea Chang SAO – Chief Executive of Khlong Kio SAO – Chief Executive of Ta Sit SAO – Chief Executive of Pluak Daeng SAO – Chief Executive of Chomphon – Chao Phraya Sub-district Municipality	Overall opinions of the representatives from administrative authorities – There is no concern regarding environmental impacts resulting from the operation of the project, as the fuel used for electricity generation is natural gas and the project is located in the area of the industrial estate. – As at present the country is under the administration of the National Council for Peace and Order (NCPO) under martial law, when a forum for public hearing is organized, notification should be addressed to Military Circle 14. – For the public hearing, the focus should be at the sub-district and village levels, and the target groups should be evenly distributed. – Data acquired from the study on the environmental impacts arising from the operation of the project should be comparatively presented in a concrete manner. – It is suggested that the study on the environmental impacts be conducted in a straightforward manner. – It is suggested that information and news about the project be communicated and promoted to the people involved in a straightforward manner. – It is suggested that before the meeting is organized, relevant documents providing necessary information be distributed for the people in the community involved to have fundamental understanding about the project. – It is suggested that community relations be continually promoted. – It is suggested that special attention be paid to education and healthcare of the people in the area due to its remoteness from the hospital. – It is suggested that a tour be organized to visit power plants already in operation. – It is suggested that study on the environmental impacts be conducted in a comprehensive manner and the facts acquired be informed to the people involved. – There is general agreement with the Si Racha Power Plant Project in light of higher demand for electricity.

TABLE 4.4.1-5

SUMMARY OF THE ISSUES IN THE INTERVIEW WITH THE GOVERNMENTAL ORGANIZATIONS INVOLVED (Cont'd)

Governmental organizations	Summary of the issues in the interview
Natural resources and environmental organizations Interviewees – Director of Provincial Office for Natural Resources and Environment, Chon Buri Province – Director (Environment), Provincial Office for Natural Resources and Environment, Rayong Province	Overall opinions of the representatives from natural resources and environmental authorities – With natural gas as the fuel used for electricity generation, there should be strenuous control of nitrogen dioxide. – It is suggested that consideration be given to the adequacy of wastewater discharge facilities or wastewater treatment system in case of emergency in the project. – It is suggested that presentation of data to the local people be in a simple manner which is easy to understand, not in a scholarly manner. – Information and news about the project should be publicized extensively. – All the target groups should be invited to the meeting, including the non-registered population and foreign migrant workers, who are also regarded as stakeholders of the project. – Invitation to the meeting should be accompanied by a letter of invitation issued by the governmental organization involved in that part of the project. – A law should be passed stating that participating in the public hearing, the participant will not be deemed as being absent from work/ will be remunerated.
Natural resources and environmental organizations (continued)	– The project should employ new imported machines, not those second-hand, which are not fully efficient. – Special consideration should be given to adequate green areas in the project, and names of the plants in the areas should be clearly labeled. – If possible, the size of the clarifier should be increased. – If possible, the pipeline should be connected in order that the water can be utilized by the people in the area.

TABLE 4.4.1-5

SUMMARY OF THE ISSUES IN THE INTERVIEW WITH THE GOVERNMENTAL ORGANIZATIONS INVOLVED (Cont'd)

Governmental organizations	Summary of the issues in the interview
Industrial/energy organizations Interviewees – Director of Regional Office 8 of the Energy Regulatory Commission – Head of the Factory Sub-division of Chon Buri Provincial Industry Office – Head of the Factory Sub-division of Rayong Provincial Industry Office – Chief of Chon Buri Provincial Office of the Energy Ministry – Chief of Rayong Provincial Office of the Energy Ministry	Overall opinions of the representatives from industrial/energy authorities – Several environmental problems in the areas under responsibility have been reported to the authorities, such as water, air pollution and noise. – The representatives have been informed about the project by their organization and through the project's public relations. – There is concern about long-term problems. – There is concern about impacts from wastewater from the project discharged to Kram canal and its capacity to accommodate this. – During the construction period, the project and the contractor are asked to be vigilant about impact to the air quality, noise, and traffic accident. – During the operation period, the management is asked to administer the project strictly in line with the measures established. – With natural gas, which is regarded a clean energy, as the fuel used for electricity generation, the project is expected to gain acceptance from the local communities. – With natural gas as the fuel used for electricity generation, no opposition is expected. However, the project should have advocacy groups as backup. – With the location of the project in the area of the industrial estate, less impact is expected than if otherwise. – The project is expected to be administered in strict accordance with what has been promised to the communities.

TABLE 4.4.1-5

SUMMARY OF THE ISSUES IN THE INTERVIEW WITH THE GOVERNMENTAL ORGANIZATIONS INVOLVED (Cont'd)

Governmental organizations	Summary of the issues in the interview
	– Complaints about the project, after being tackled, should be reported to the Provincial Office of the Energy Ministry. – Emphasis needs to be put on the study on environmental impacts. – There is general agreement with the project, for the benefits to the industrial sectors. – There is confidence in the management of Gulf SRC Co., Ltd and the supervision of the governmental organizations involved.
Agricultural organizations Interviewees – Agricultural Technical Officer, Si Racha District Agricultural Extension Office – Chief of Ban Bueng District Agricultural Extension Office – Agricultural Technical Officer, Nong Yai District Agricultural Extension Office -Chief of Pluak Daeng District Agricultural Extension Office	Overall opinions of the representatives from agricultural authorities – The problem of increasing ambient temperature in the area nowadays adversely affects the livelihood of the local farmers. – At present the farmers in the area face the problems of pests such as mealybug, red mite, etc. and falling prices of agricultural products. – For marine fisheries, there are problems of decreased number of marine lives, fewer of which come to spawn in the area because of the degradation of the coastline. For inland fisheries, there are problems of decreased level of waters and water scarcity.
Agricultural organizations (continued) Interviewees (continued) – Head of Fishery Management Group, Chon Buri Provincial Fisheries Office -Fishery Officer (Professional Level), Rayong Provincial Fisheries Office	– At present the climate change causes adverse impacts in the Khlong Kio sub-district – increasing heat leads to drought and consequent decrease in agricultural products. – The representatives from agricultural authorities have mostly learned about the project from the consultant company's public relations, their supervisors, and from the first public hearing. – There is concern about the heat radiation incurred, which may cause the ambient temperature to rise even

TABLE 4.4.1-5

SUMMARY OF THE ISSUES IN THE INTERVIEW WITH THE GOVERNMENTAL ORGANIZATIONS INVOLVED (Cont'd)

Governmental organizations	Summary of the issues in the interview
	more and indirectly cause some adverse impacts to the local farmers, such as better growth of pests. – There is concern that there will not be adequate water for use. – There is concern about the impacts resulting from climate change, dust particles, and wastewater; which may bring about change in water quality, and as a result, adversely affect the aquaculture in the area. – It is suggested that investigation on the ambient heat be conducted both before and during the operation of the project. – It is suggested that treatment of discharged water be executed to the applicable standards, and inspection be regularly conducted. – It is suggested that support be provided to enhance the condition of the coastline in the area and construct small-size water sources for the locals; as well as support regarding the community's budget. – It is suggested that the water discharged from the cooling tower be further utilized for agriculture. For this purpose, agricultural demonstration plots may be set up so that the local communities can be well-informed of the results. – It is suggested that support in education be provided to the communities involved. – It is suggested that support be provided in environmental protection to the communities involved. – The project is expected to be administered strictly in line with the measures established. – Updated news and information should be provided to and good understanding should be constantly promoted with the communities involved.

TABLE 4.4.1-5

SUMMARY OF THE ISSUES IN THE INTERVIEW WITH THE GOVERNMENTAL ORGANIZATIONS INVOLVED (Cont'd)

Governmental organizations	Summary of the issues in the interview
	– Overall, there is confidence in the management of Gulf SRC Co., Ltd and the supervision of the governmental organizations involved.
Governmental organizations	**Summary of the issues in the interview**
Public health organizations Interviewees – Public Health Technical Officer, Chon Buri Public Health Office – Registered Nurse, Rayong Provincial Public Health Office – Chief of Si Racha District Public Health Office – Chief of Ban Bueng District Public Health Office – Public Health Technical Officer, Nong Yai District Public Health Office – Chief of Pluak Daeng District Public Health Office – Public Health Technical Officer, Ban Bueng Hospital – Public Health Technical Officer, Pluak Daeng Hospital – Public Health Technical Officer, Ban Tha Jam Tambon Health Promoting Hospital – Public Health Technical Officer, Ban Nong Bon Tambon Health Promoting Hospital – Public Health Technical Officer, Ban Nong Kangkao Tambon Health Promoting Hospital	Overall opinions of the representatives from public health authorities – At present the organizations have the problem of personnel shortage (nurses) and there are problems of dengue and diarrhea in the area. – They knew about the project before through the consultant company's public relations. – There are concerns about foreign migrant workers, drinking and non-drinking water, toilets, and rubbish from the workers' camps. – There is concern about heavier workload in the public health service system resulting from increasing population. – Increasing population can lead to more accident, crime and traffic. – Adverse environmental impacts caused by the project include those related to air quality, water quality, noise, rubbish (and possibly illegal waste disposal), smell, etc. – Pollution caused by the project can lead to higher morbidity. – The project is expected to have a well-managed system to deal with the influx of migrant laborers into the area during the construction period. – The traffic resulting from the project is expected to be managed in an efficient manner. – There should be support from the project on the involved communities' activities and welfare maintenance.

TABLE 4.4.1-5

SUMMARY OF THE ISSUES IN THE INTERVIEW WITH THE GOVERNMENTAL ORGANIZATIONS INVOLVED (Cont'd)

Governmental organizations	Summary of the issues in the interview
– Public Health Technical Officer, Ban Muen Chit Tambon Health Promoting Hospital – Public Health Technical Officer, Ban Khao Hin Tambon Health Promoting Hospital – Director of Chaloem Phrakiartof 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambid Sub-district – Public Health Technical Officer, Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-district	– There should be more public relations to disseminate news and information. – There should be warning construction area signs to forestall accident. – Involvement from the communities should be encouraged. – The project should have its own team of medical staff. – Safety awareness should be promoted to the project staff. – Traditional Thai medicine should be promoted. – The management is expected to maintain proper care of the project compound and workers' camps to prevent them from being the sources from which diseases can spread. – Overall, there is confidence in the management of Gulf SRC Co., Ltd and the supervision of the governmental organizations involved.
Life and property safety organizations Interviewees – Staff Inspector, Bowin Police Station – Suppression Sub-inspector, Pluak Daeng Police Station – Chief of Disaster Prevention and Mitigation, Chon Buri Provincial Office – Chief of Disaster Prevention and Mitigation, Rayong Provincial Office	Overall opinions of the representatives from life and property safety authorities – The organizations are understaffed, resulting in inadequate monitoring and there is drug problem in the communities. – The present operation problem is the organizations in the area do not have sufficient capacity to tackle the problems incurred due to lack of staff and equipment, no water source for firefighting. Moreover, the business enterprises involved did not inform the authorities immediately when the incidents occurred, but waited until the problems worsened. – Most just learned about the project for the first time when the consultant company approached them in order to collect data. – Overall, there is no concern about the project.

TABLE 4.4.1-5

SUMMARY OF THE ISSUES IN THE INTERVIEW WITH THE GOVERNMENTAL ORGANIZATIONS INVOLVED (Cont'd)

Governmental organizations	Summary of the issues in the interview
	– Concerns with respect to the construction period include problems from rubbish, dust particles, traffic (accident caused by the vehicles used for equipment and material transportation). Also, there is concern about mishaps made by system control personnel. – It is demanded that the project establish environmental impact mitigation and preventive measures for the environmental impacts possible to arise and that the measures be strictly implemented. – It is expected that the people in the vicinity of the project precincts be provided with correct and clear relevant information, and also that the funds of the power plant project be managed with integrity. – It is suggested that the safety authorities involved in the area cooperate and have joint-drill of the safety plans. – It is suggested that in the recruitment of staff for the Project, special consideration be given to the locals who can also act as mouthpieces for the Project. – Overall, there is confidence in the management of Gulf SRC Co., Ltd. and the supervision of the governmental organizations involved.
Governmental organizations	**Summary of the issues in the interview**
Education and development organizations (continued) <u>Interviewees</u> – Chief of Community Development Ban Bueng District Office – Chief of Community Development Si Racha District Office	Overall opinions of the representatives from the education and development authorities – At present there are problems of drought, traffic, rubbish smell, and unemployment (caused by being too job selective). – Most learned about the project before in their sub-district level meeting. – There are concerns about air pollution, wastewater, the quality of life of the people in the area, and foreign laborers.

TABLE 4.4.1-5

SUMMARY OF THE ISSUES IN THE INTERVIEW WITH THE GOVERNMENTAL ORGANIZATIONS INVOLVED (Cont'd)

Governmental organizations	Summary of the issues in the interview
– Technical Officer, Community Development Nong Yai District Office – Technical Officer, Community Development Pluak Daeng District Office – Director of Chumchon Borisat Namtan Tawan-aok School – Teacher of Ban Khlong Kram School – Teacher of Ban Surasak School – Director of Ban Rawoeng School	– It is anticipated that the project will cause impact on the involved communities' use of water. – It is suggested that, as profit return to the communities involved, support be provided with the emphasis of the maintenance of the mental and physical health of the people in the area. – It is suggested that assistance be provided to the people in the area in terms of the community funds – Overall, there is confidence in the management of Gulf SRC Co., Ltd and the supervision of the governmental organizations involved.
Labor protection organizations Interviewees – Chon Buri Provincial Labor Office – Rayong Provincial Labor Office	Overall opinions of the representatives from labor protection authorities – There is no labor problem at present in Chon Buri Province – The labor problem at present in Rayong Province is shortage of labor at all levels, so migrant workers are needed. – The organizations just learned about the project for the first time from the consultant company. – There is no concern about the project. – It is suggested that understanding be promoted to the people in the area and a tour to power plants already in operation be organized for the representatives from the governmental organizations involved. – It is suggested that the heat energy left from the electricity generation be exploited, possibly to the advantage of the communities nearby. – It is suggested that a study be conducted on power plants generating electricity from landfill gas, which can be used as an alternative energy.

TABLE 4.4.1-5

SUMMARY OF THE ISSUES IN THE INTERVIEW WITH THE GOVERNMENTAL ORGANIZATIONS INVOLVED (Cont'd)

Governmental organizations	Summary of the issues in the interview
	– It is suggested that consultation be made with the governmental organizations involved six months in advance in order that a joint plan can be made and the governmental organizations involved can provide assistance in seeking for the workforce with appropriate qualifications for the project. – Overall, there is confidence in the management of Gulf SRC Co., Ltd and the supervision of the governmental organizations involved.
Public utilities and services organizations <u>Interviewees</u> – Deputy Director (Operation and Maintenance), Provincial Electricity Authority Regional Office 2 (Central region, Chon Buri Province) – Manager of Waterworks Authority Laem Chabang Regional Office – Director (Engineering Division), Regional Irrigation Office 9 (Chon Buri Province) – Director (Operation), Chon Buri Highway District 1 – Director, Rayong Highway District	Overall opinions of the representatives from the public utilities and services authorities – At present the traffic surface is in a poor condition and the roads need resurfacing. – At present there is problem of traffic congestion caused by big vehicles transporting equipment and materials for the factories in the area. – Most of the representatives did not know about the project before. – The water supplied to both the local waterworks authorities and the project is from Eastern Water Resources Development and Management Public Company Limited or East Water. In this way, there is no concern over the potable water, as there is agreement with the company on water supply. – There is no concern over the project. The benefit anticipated from the project is an additional source of electricity. – There are concerns about residues in Nong Pla Rai Reservoir and the wastewater treatment system. Moreover, there is concern about opposition from the NGOs.

TABLE 4.4.1-5

SUMMARY OF THE ISSUES IN THE INTERVIEW WITH THE GOVERNMENTAL ORGANIZATIONS INVOLVED (Cont'd)

Governmental organizations	Summary of the issues in the interview
	– There are concerns about traffic congestion resulting from the transportation of machinery and about 3,000 workers for the project during the construction period. – There is concern about the amount of water needed for the project and the capacity of the water sources available to satisfy the need, which may, as a consequence, negatively affect the people in the area. – It is suggested that water quality in the project be monitored, and the people in the area be involved in the monitoring process. – It is expected that impacts that may arise because of the project be informed to the people in the area. – It is suggested that a study on environmental impacts be conducted in a comprehensive manner. – It is expected that explanation regarding the limit in the use of water is clearly communicated to the people in the area and thus better understanding is promoted. – To prevent possible confusion, differences between "discharged water" and "wastewater" must be clearly explained to the people in the area. – Standards must be set for everything. In order to generate confidence, there must be channels enabling the people in the area to check whether things are executed to the standards set. – In the meeting, in order to relieve the anxiety of the people in the area, presentation about the project must be clearly detailed. – In the meeting, the benefits to the people in the area should be pointed out in the presentation about the project. – In the meeting, the presentation about the project should be conducted in the most concrete manner possible. – It is expected that there is a good management plan for the project.

TABLE 4.4.1-5

SUMMARY OF THE ISSUES IN THE INTERVIEW WITH THE GOVERNMENTAL ORGANIZATIONS INVOLVED (Cont'd)

Governmental organizations	Summary of the issues in the interview
	– Special attention is asked to be directed to the surveillance of overloaded trucks. – Special attention is asked to be directed to environmental care in every aspect. – The project is expected to be executed strictly in accordance with the measures established. – Most are in agreement with the project. – Overall, there is confidence in the management of Gulf SRC Co., Ltd and the supervision of the governmental organizations involved.
Land and land utilization organizations Interviewees – Director of Office of Eastern Seaboard Industrial Estate (Rayong Province)	Overall opinions of the representatives from land and land utilization authorities – It is suggested that the environmental impacts arising be appropriately dealt with and the measures established be objective. – It is suggested that corporate social responsibility (CSR) activities be organized so as to reduce the anxiety on the part of the communities involved. – It is suggested that the maintenance plan of the project be made in order to generate confidence on the parts of the communities and organizations involved and the implementation be strictly in accordance with the plan.

- **Present environment in the area where the business enterprises are located, annoyance resulting from present environment, social problems** : As shared by the representatives of all the business enterprises, the main annoying problems resulting from present environment include (1) transportation problem (46.3 %) because there are more vehicles, (2) smell problem (19.5 %) coming from the factories and also from the rubbish in the area, (3) problem of soot and smoke (12.2 %) and noise problem (12.2 %) - the soot and smoke come from the factories and burning to clear the land for new cultivation in the area, while the noise problem comes from the use of machinery in the factories in the area. The environmental impacts arising are considered to be at a middle level, except for rubbish problem and dust particle problem, which are considered to be at a low level ($\overline{x}$ = 1.00 and 1.33, respectively), and for transportation problem, which is considered to be at a high level ($\overline{x}$ = 2.63). The details are shown in **Table 4.4.1-6**.

TABLE 4.4.1-6

OPINIONS ON EXISTING ENVIRONMENT CONDITION OF INTERVIEWEES (ORGANIZATIONS)

41 Interviewees:

Environmental Impacts	Number	%	Average ($\overline{X}$) *	Level of Impact
1) Fugitive Dust	3	7.3	1.33	Low
2) Soot/Smoke	5	12.2	1.40	Low
3) Odor	8	19.5	2.00	Moderate
4) Noise	5	12.2	1.60	Moderate
5) Vibration	5	4.9	2.50	Moderate
6) Unreleased flood	1	2.4	2.00	Moderate
7) Waste	1	2.4	2.00	Moderate
8) Transportation	19	46.3	2.63	High

Remark: * Interpretation of level of impact from Average ($\overline{x}$)
- Low: 1.00 ≤ ($\overline{x}$) ≤ 1.50
- Moderate: 1.51 ≤ ($\overline{x}$) ≤ 2.50
- High: 2.51 ≤ ($\overline{x}$) ≤ 3.00

Source : TEAM Consulting Engineering and Management Co., Ltd, 2014

When asked about social problems, 31.7 % of all the representatives from the business enterprises interviewed were of the opinion that there are social problems resulting from the project including mainly drugs (34.8 %), and stealing (34.8 %), as well as other problems such as overpopulation, gambling, migrant labor.

Access to information about the project : 56.1 % of all the representatives from the business enterprises interviewed learned about the implementation of the Sriracha Power Plant project in the Hemaraj ESIE before, mostly through the project officers and the project explanatory meeting; whereas 43.9 % of all the representatives did not know before about this (**Figure 4.4.1-3**).

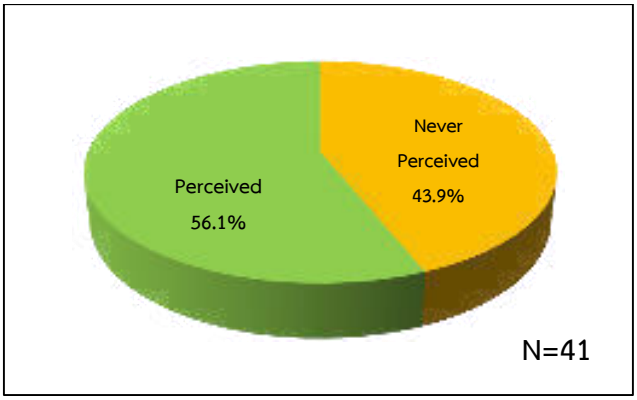


FIGURE 4.4.1-3 : PERCEPTION OF BUSINESS ENTERPRISES ABOUT PROJECT DEVELOPMENT

Anticipation of impact from project development:

The case that the data surveyed through the questionnaire are those which involve three rating scales, the presentation of the results is made by finding the average level of the interviewees' attitude* toward the issues surveyed such as environmental problems, problem about sufficiency of the public utility, and impacts from the development of the project. The formula used is

$$\bar{x} = \frac{\Sigma fx}{\Sigma f}$$

When $\bar{x}$ = average intensity

f = frequency of the number of persons affected

x = set level of involvement

Remark * Attitude is defined as the feeling of the interviewees toward a certain thing expressed by behaving in terms of liking or disliking.

To anticipate the results from the development of the project, the issues surveyed are divided into those in the construction period and operation period, as follows:

In the construction period, 41 representatives of the business enterprises were interviewed – one interviewee per one business enterprise (N = 41). 23 interviewees (56.1 %) thought that no impact was anticipated from the development of the project, while 18 interviewees (43.9 %) thought that there would be impacts from the development of the project (**Figure 4.4.1-4**).

According to the 18 interviewees who anticipated that there would be impacts from the development of the project in the construction period, the three most affected environmental problems anticipated are caused by (1) transportation (77.8 %), (2) air quality (72.2 %), and (3) noise (50.0 %), the impact level of all of which is considered moderate. The only problem anticipated the impact level of which is considered high is that caused by chemicals. The details are shown in **Table 4.4.1-7**.

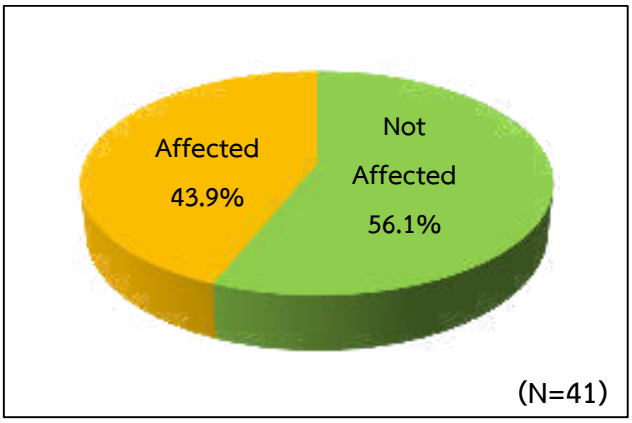


FIGURE 4.4.1-4 : ANTICIPATION OF IMPACT BY BUSINESS ENTERPRISES IN CONSTRUCTION PERIODS

TABLE 4.4.1-7

ANTICIPATION OF IMPACT BY BUSINESS ENTERPRISES IN CONSTRUCTION PERIODS

Interviewees (Expect to be affected by the project) 18 Persons (n=18)

Environmental Impacts	Number	%	Average ($\bar{x}$)*	Level of Impact
1) Air Quality	13	72.2	2.08	Moderate
2) Water Quality	5	27.8	2.00	Moderate
3) Noise	9	50.0	1.78	Moderate
4) Waste	2	11.1	2.00	Moderate
5) Chemical Agent	3	16.7	2.67	High
6) Hazardous Waste	4	22.2	2.50	Moderate
7) Transportation	14	77.8	2.14	Moderate
8) Illness	5	27.8	2.20	Moderate
9) Stress	5	27.8	2.20	Moderate
10) Accident	1	5.6	2.00	Moderate

Remark: * Interpretation of level of impact from Average ($\bar{x}$)

- Low: $1.00 \leq (\bar{x}) \leq 1.50$
- Moderate: $1.51 \leq (\bar{x}) \leq 2.50$
- High: $2.51 \leq (\bar{x}) \leq 3.00$

Source : TEAM Consulting Engineering and Management Co., Ltd, 2014

In the operation period, 41 representatives of the business enterprises were interviewed – one interviewee per one business enterprise (N = 41). 19 interviewees (46.3 %) thought that no impact was anticipated from the development of the project, while 22 interviewees (53.7 %) thought that there would be impacts from the development of the project (**Figure 4.4.1-5**).

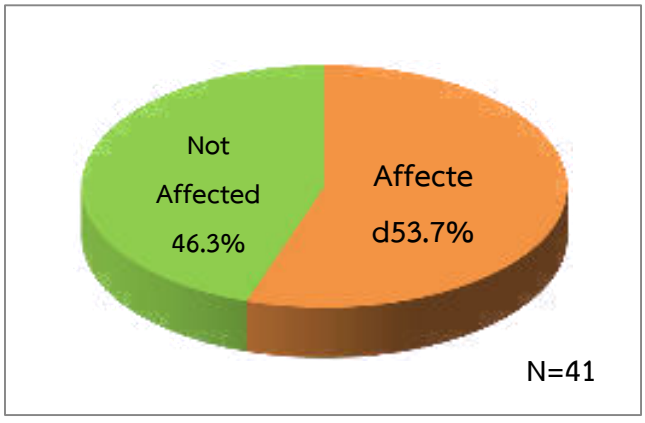


FIGURE 4.4.1-5: ANTICIPATION OF IMPACT BY BUSINESS ENTERPRISES IN CONSTRUCTION PERIOD

According to the 22 interviewees who anticipated that there would be impacts from the development of the project in the operation period, the three most affected environmental problems anticipated are caused by (1) air quality (72.7 %), (2) transportation (54.2 %), and (3) water quality (45.5 %), the impact level of all of which is considered moderate. The details are shown in **Table 4.4.1-8**.

TABLE 4.4.1-8

ANTICIPATION OF IMPACT BY BUSINESS ENTERPRISES IN OPERATION PERIOD

Interviewees (Expect to be affected by the project) 22 Persons (n=22)

Environmental Impacts	Number	% age	Average ($\bar{x}$)*	Level of Impact
1) Air Quality	16	72.7	2.38	Moderate
2) Water Quality	10	45.5	2.00	Moderate
3) Noise	8	36.4	1.63	Moderate
4) Waste	5	22.7	2.00	Moderate
5) Chemical Agent	9	40.9	1.78	Moderate
6) Hazardous Waste	5	22.7	1.80	Moderate
7) Transportation	12	54.5	2.33	Moderate
8) Illness	5	22.7	2.20	Moderate
9) Stress	4	18.2	2.50	Moderate
10) Accident	3	13.6	2.00	Moderate

Remark: * Interpretation of level of impact from Average ($\bar{x}$)
- Low: $1.00 \leq (\bar{x}) \leq 1.50$
- Moderate: $1.51 \leq (\bar{x}) \leq 2.50$
- High: $2.51 \leq (\bar{x}) \leq 3.00$

Source : TEAM Consulting Engineering and Management Co., Ltd, 2014

Concern to the development of the project: 39.0 % of the representatives of the business enterprises interviewed expressed no concern over the development of the project. 56.1 % said that they had some concerns, and 4.9 % said they were not certain. The issues of their concerns include toxic air, worse water quality, safety in the operation of the project, environmental deterioration (**Figure 4.4.1-6**).

- **Involvement in monitoring environmental impacts resulting from the project**

The representatives of the business enterprises interviewed thought that the people in the area should be involved by providing information and news that could be useful for the project, helping in disseminating information about the project to the communities, helping in monitoring environmental impacts, and also acting in compliance with the environmental impact mitigation and preventive measures against environmental impacts both in the construction period and operation period of the project.

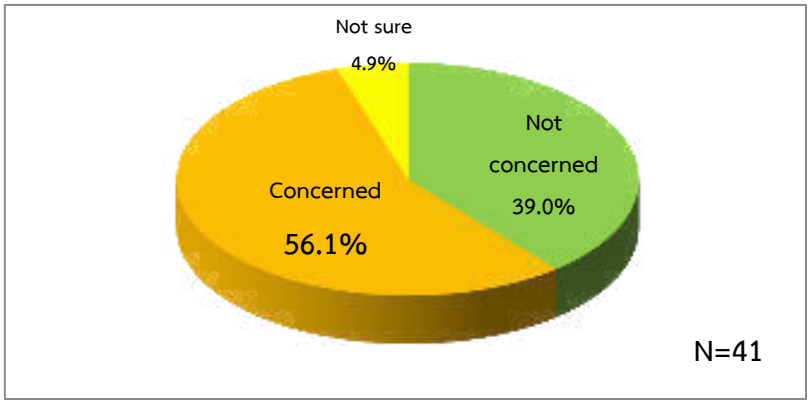


FIGURE 4.4.1-6 : CONCERNS OF BUSINESS ENTERPRISES ABOUT PROJECT DEVELOPMENT

- **Public relations, ideas, and suggestions on the operation of the project**

Opinion on the public relations of the project

: The representatives of the business enterprises interviewed thought that there should be additional public relations of the project. The information to be publicized to the people in the area involves:

- environmental impact mitigation and preventive measures against environmental impacts
- safety system in the operation of the project
- emergency prevention and control plan
- details about the project
- pros and cons of the project
- construction period/plan
- other details such as traffic management plan

Appropriate methods/channels - The representatives of the business enterprises interviewed thought that appropriate channels for public relations about the project to the local communities include informing them via e-mails and by sending letters/documents directly to the target groups, organizing explanatory meetings from time to time, posting the notice at the organizations involved. Appropriate venues for the public relations are Eastern Seaboard Industrial Estate, Chomphon Chao Phraya Sub-district Municipality, and Hemaraj ESIE. Appropriate timing is on weekdays (Monday to Friday) in the morning.

Ideas/suggestions on the operation of the project: The representatives of the business enterprises interviewed offered ideas and suggestions useful to the operation of the project as follows:

- public relations should be made on safety matters such as about the operation of the steam boiler, the use of natural gas
- public relations should be made on measures established to tackle the impacts which may arise such as dust particles/soot, wastes, smoke
- public relations should be made on the prevention and correction of the problems which may arise
- public relations should be made on the pros and cons resulting from the project
- information and news about the project should be publicized on the Internet
- information and news about the project should be publicized by having notice boards made at various intersections
- information and news about the project should be publicized by having them posted at various locations
- the industrial estates involved should provide assistance in publicizing information and news about the project
- information and news about the project should be conveyed in the manner that is easy to understand
- information and news about the project should be publicized more extensively
- power plant visit should be organized with a view to generating confidence in the project
- there is strong advocacy on the development of the project

(c) Results of the interview with the community leaders

Data gained from the interview with the community leaders were investigated by the consultant company. The official community leaders interviewed include sub-district headperson/ chairperson of the community, village headperson, village/community committees officially appointed by the authorities. For non-official community leaders, who are idea leaders well respected by the people in the community, the interview was conducted with religious leaders. In total, the interview was conducted with 52 leaders in the communities within a 5 km of radius around the precincts of the project, in the areas under the administration of 6 Sub-district Administrative Organizations and 1 Sub-district Municipality, as shown in **Table 4.4.1-9**. This can be summarized as follows: (the results of the interview are shown in **Appendix 3G-5**).

TABLE 4.4.1-9

DATA AND NUMBER OF COMMUNITY LEADER IN THE INTERVIEW

Location			Position	Expected Number of Interviewees (Person)[1/]	Actual Number of Interviewees (Person)
Province	District	Sub-district/Village			
Chon Buri	Si Racha	– Khao Khansong Sub-district (6 villages: Moo 4, 5, 7, 8, 9 and 10)	– Sub-district headman/village headman and assistance/village committee members/others – Abbot	18 2	16[2/] 2
		– Bowin Sub-district (1 village: Moo 7)	– Sub-district headman/village headman and assistance/village committee members/others – Abbot	3 1	2[2/] 1
	Ban Bueng	– Klong Kio Sub-district (3 villages: Moo 5, 6 and 7)	– Sub-district headman/village headman and assistance/village committee members/others	9	9
	Nong Yai	– Nong Suea Chang Sub-district (1 village: Moo 5)	– Sub-district headman/village headman and assistance/village committee members/others	3	3
Rayong	Pluak Daeng	– Ta Sit Sub-district (3 villages: Moo 1, 2 and 3)	– Sub-district headman/village headman and assistance/village committee members/others – Abbot	9 2	6[2/] 2
		– Pluak Daeng Sub-district (Moo 2 villages: Moo 4 and 5)	– Sub-district headman/village headman and assistance/village committee members/others	6	6

TABLE 4.4.1-9

DATA AND NUMBER OF COMMUNITY LEADER IN THE INTERVIEW (Cont'd)

Location			Position	Expected Number of Interviewees (Person)[1/]	Actual Number of Interviewees (Person)
Province	District	Sub-district/Village			
		- Chompol Chaophraya Sub-district Municipality (2 Communities)	- Sub-district headman/village headman and assistance - Abbot	6 1	4[2/] 1
Total (4 Districts 6 Sub-districts 1 Administration Municipality)				**60**	**52**

Remark: 1/ Purposive Sampling Method was employed, 3 persons/organizations or villages

2/ Field survey conducted during 8 - 11 September 2014 and 3 - 23 February 2015, some village headmen were not available for being interviewed, consequently, number of expected target group could not be all reached.

(c1) Results of the interview with the community leaders and key information providers in the study areas under the administration of both the sub-district administrative organization and the sub-district municipality within a 3 km of radius around the precincts of the project, (the results of the interview in details are shown in **Appendix 3G-3**)

1. Results of the interview with the community leaders and key information providers in the study areas under the administration of the sub-district administrative organization within a 3 km of radius around the precincts of the project

- **General information about the interviewees**

Of all the community leaders and key information providers in the study areas, 85.2 % are male and 14.8 % are female. The average age is 47.5 years old. 100.0 % are Buddhist. 22.2 % have a primary school diploma, and 22.2 % hold a Bachelor's degree. 33.3 % run their own business and 29.6 % are farmers.

- **Community Information**

The average length of establishment of the communities is 80.1 years old. 66.7 % are locals who were born or raised in the communities. 99.5 % of the people in the communities are Buddhist, 0.3 % are Muslim, and 0.2 % are Christian. The people in the communities have a variety of livelihood, with 43.43 % working as farmers and 30.2 % as employees. For the communities' economics, in the opinion of the community leaders interviewed, the great majority of the people in the communities are of medium economic standing (85.2 %) considering from factors like livelihood, living condition/ standard of living, manner of spending money. Most of the community leaders interviewed were of the opinion that relationship among the people in the community is at a very good level (85.2 %).

- **Problems of the environment and infrastructure at present**

Less than 50.0 % of the interviewees are of the opinion that there are environmental problems resulting from the project. The top three problems the interviewees think that they face most are (1) problem from dust particles/soot/smoke from vehicles and factories in the area (48.1 %), (2) problem from noise produced by a number of cars and trucks travelling past the area (25.9 %) and (3) problem from smell from the factories and landfills in the area (25.9 %). For traffic problem resulting from a number of cars during the rush hours and traffic congestion, the impact level of the environmental problem incurred is considered to be at a moderate level. At a high level are the impact of the traffic problem itself and also and that of problem from dust particles/soot/smoke ($\overline{x}$ = 2.57 and 2.54 respectively), as shown in **Table 4.4.1-10**.

TABLE 4.4.1-10

EXISTING ENVIRONMENTAL PROBLEMS AND INFRASTRUCTURE; VILLAGE HEADMAN GROUP, WITHIN A 0 TO 3 KM OF RADIUS SUB-DISTRICT ADMINISTRATIVE ORGANIZATION BOUNDARY

27 Interviewees:

Issues	Number	%	Average ($\bar{x}$) *	Level of Impact
Environmental Problems				
1) Odor	7	25.9	2.14	Moderate
2) Noise	9	33.3	2.44	Moderate
3) Dust/soot/smoke	13	48.1	2.54	High
4) Traffic	7	25.9	2.57	High
5) Waste	4	14.8	1.75	Moderate
6) Wastewater	5	18.5	2.40	Moderate
Basic Infrastructure and Public Services				
7) Electricity	6	22.2	1.50	Low
8) Tap water	8	29.6	2.13	Moderate
9) Road	7	25.9	2.29	Moderate
10) Sufficiency in Public Health Service	3	11.1	1.00	Low

Remark: * Interpretation of level of impact from Average ($\bar{x}$)
- Low: $1.00 \leq (\bar{x}) \leq 1.50$
- Moderate: $1.51 \leq (\bar{x}) \leq 2.50$
- High: $2.51 \leq (\bar{x}) \leq 3.00$

Source : TEAM Consulting Engineering and Management Co., Ltd, 2014

For problems about the infrastructure and public utilities, the problem the interviewees think affects them most is the potable water system (29.6 %) resulting from shortage of water and a lot of residues mixed in the water content. Coming second are the problems about the roads in the area caused by a high number of trucks and traffic congestion; the roads being damaged, narrow and inadequate; and lack of budget for the restoration (**Table 4.4.1-10**). The impact levels of these two problems are considered to be low to moderate ($\bar{x}$ = 1.00-2.29 respectively).

- **Top 3 problems about the living condition in the community**
  - Drug problem (85.2 %) caused mostly by teenagers (66.7 %) and people from outside the community (33.3 %). Overall, the impact of these problems is considered to be at a high level (39.1 %).

- Life and property safety problem (29.6 %) caused by teenagers (44.4 %) and people from outside the community (22.2 %). Overall, the impact of this problem is considered to be at a low level (62.5 %).
- Livelihood problem (7.4 %) resulting from the arrival of more people from other areas (50.0 %) and more non-registered population in the community (50.0 %). The impact of this problem is considered to be at a moderate level (100.0 %).

- **Opinions for community development in the future**

The community leaders and key information providers in the study area under the administration of the sub-district administrative organization are of the opinion that the emphasis of the development of their communities should be on the following areas.

- Public utilities (37.0 %) in order that the people in the area have sufficient potable water to use, improved roads/ transportation access to their community, and improved telephone network system.
- Livelihood improvement/additional income generation (29.6 %) as the people in the area have low income/want to have more income and lack work skills.
- Life quality enhancement/ social problem correction (29.6 %), especially drug problem.

- **Access to information about the project and relevant concerns**

The interview revealed that 88.9 % of all the community leaders and key information providers in the study areas under the administration of the sub-district administrative organization knew before about the project, whereas 11.1 % of them did not know before about this. For those who did, 26.1 % were informed through the officers of the relevant governmental organizations at the district or provincial level, 23.9 % through the project officers, and 23.9 % through the sub-district headperson/village headperson in their community. 3.7 % of the interviewees expressed their concern over various issues resulting from the development of the project, such as the heat from the power plant.

- **Impacts anticipated**

Impacts anticipated during the construction period

92.6 % of the community leaders anticipate no impact from the project during the construction period to their communities, while 7.4 % think there might be some impacts, the overall level of which is considered to be moderate ($\overline{x}$ = 2.00, S.D. = 0.000), as shown in **Table 4.4.1-11**. Impacts anticipated during the construction period include:

- Impact of noise from the construction activities (7.4 %), which may disturb the schools in the area. The impact level is considered to be moderate ($\overline{x}$ = 2.00, S.D. = 0.000).
- Impact of transportation network (3.7 %), which is in the form of traffic congestion. The impact level is considered to be moderate ($\overline{x}$ = 2.00, S.D. = 0.000).

TABLE 4.4.1-11

ANTICIPATION IMPACT OF COMMUNITY LEADERS WITHIN SUB-DISTRICT ADMINISTRATIVE ORGANIZATION BOUNDARY DURING CONSTRUCTION PERIOD (0 TO 3 KM RADIUS FROM PROJECT LOCATION)

N = 27

Impacts During Construction Period	Magnitude of Impacts			Number (person)	Average ($\overline{x}$)*	Standard Deviation (S.D.)	Level of Impact
	High	Moderate	Low				
Environment							
1. Noise	0	2	0	2	2.00	0.0000	Moderate
Infrastructure							
1. Transportation Network	0	1	0	1	2.00	0.0000	Moderate
Overall of impact	**0**	**3**	**0**	**3**	**2.00**	**0.0000**	**Moderate**

Remark: * Interpretation of level of impact from Average ($\overline{x}$)
- Low: 1.00 ≤ ($\overline{x}$) ≤ 1.50
- Moderate: 1.51 ≤ ($\overline{x}$) ≤ 2.50
- High: 2.51 ≤ ($\overline{x}$) ≤ 3.00

Source : TEAM Consulting Engineering and Management Co., Ltd, 2014

Impacts anticipated during the operation period

92.6 % of the community leaders anticipate no impact from the project during the operation period to their communities, while 7.4 % think there might be some impacts, the overall level of which is considered to be moderate ($\overline{x}$ = 2.00, S.D. = 0.000), as shown in **Table 4.4.1-12**. Impacts anticipated during the operation period include:

- Impact of air quality (7.4 %), which is caused by air pollution and dust particles. The impact level is considered to be moderate ($\overline{x}$ = 2.00, S.D. = 0.000).
- Impact of water quality (3.7 %), which is caused by wastewater from the operation of the project. The impact level is considered to be moderate ($\overline{x}$ = 2.00, S.D. = 0.000).

TABLE 4.4.1-12

ANTICIPATION IMPACT OF COMMUNITY LEADERS WITHIN SUB-DISTRICT ADMINISTRATIVE ORGANIZATION BOUNDARY DURING OPERATION PERIOD (0 TO 3 KM OF RADIUS FROM PROJECT LOCATION)

N = 27

Impacts During Operation Period	Magnitude of Impacts			Number (person)	Average $(\bar{x})$ *	Standard Deviation (S.D.)	Level of Impact
	High	Moderate	Low				
Environment							
1. Air Quality	0	2	0	2	2.00	0.0000	Moderate
2. Water Quality	0	1	0	1	2.00	0.0000	Moderate
Overall of impact	**0**	**3**	**0**	**3**	**2.00**	**0.0000**	**Moderate**

Remark: * Interpretation of level of impact from Average $(\bar{x})$
- Low: $1.00 \leq (\bar{x}) \leq 1.50$
- Moderate: $1.51 \leq (\bar{x}) \leq 2.50$
- High: $2.51 \leq (\bar{x}) \leq 3.00$

Source : TEAM Consulting Engineering and Management Co., Ltd, 2014

- **Public Participation**

Pre-construction period: 45.8 % of the community leaders are willing to provide information that can be useful for the project. 39.0 % are willing to help disseminate information about the project to the people in their community, while 15.3 % prefer to be involved passively by just receiving the information and news about the project.

Construction period: 35.1 % of the community leaders are willing to provide information that can be useful for the project. 31.2 % are willing to help disseminate information about the project to the people in their community, 24.7 % are willing to help follow up that the people in their community act in compliance with the measures established to decrease the impacts anticipated to arise during the construction period, while 9.1 % prefer to be involved passively by just receiving the information and news about the project.

Operation period: 34.7 % of the community leaders are willing to provide information that can be useful for the project. 30.7 % are willing to help disseminate information about the project to the people in their community, 25.3 % are willing to help follow up that the people in their community act in compliance with the measures while 9.3 % prefer to be involved passively by just receiving the information and news about the project.

- **Public relations to disseminate information of the project**

The community leaders in the study areas under the administration of the sub-district administrative organization are of the opinion that appropriate manners or approaches for public relations of the project include organizing explanatory meeting and public hearing, disseminating information through the community leaders, disseminating information through the governmental organizations involved in the area, sending letters/documents directly to the people in the area. The topics mainly of interest to the people in the area are the pros and cons resulting from the development of the project (17.1 %), details about the project (8.66 %), and benefits anticipated to the people in the area (8.66 %). In addition, the interviewees made some further suggestions on the public relations of the project. For example, a meeting should be organized and all that are involved should be invited. There should be additional public relations to promote better understanding on the part of the local people. Public relations could be made by having the PR staff go directly to the houses of the people in the area. When the construction is finished, a tour of the project premises should be organized for the public.

- **Additional ideas and suggestions on the project**

The community leaders interviewed expressed additional ideas and suggestion on the project in several aspects. For example, the community leaders should be involved in the project's environmental management to prevent impacts to the community. Activities promoting public understanding about the project, such as a tour of the project premises should be organized. In recruitment, special consideration should be given to the local people. Air quality monitoring in the local community should be conducted and the results are to be made known to the people in the area. There should be project staff appointed to provide relevant necessary knowledge to the people in the area.

2. Community leaders and key informants in the study areas under the administration of sub-district municipality within a 3 km of radius of the project

- **General information of the interviewees**

Of all the community leaders and key information providers in the study areas, 40.0 % are male and 60 % are female. The average age is 53 years old. 100.0 % are Buddhist. 40.0 % have a primary school and diploma. 60 % are merchants and 20 % run their own business.

- **Community Information**

The average length of establishment of the communities is 68.2 years old. 60.0 % are locals who were born or raised in the communities. 100 % of the people in the communities are Buddhist. The people in the communities have a variety of livelihood, with 50.0 % working as contractor followed by agriculturist, run their own

business, employee in the industry and merchant (equality at 12.5 %). For the communities' economics, in the opinion of the community leaders interviewed, people in the communities are of medium economic standing (100 %) considering from factors like livelihood, living condition/ standard of living, manner of spending money. Most of the community leaders interviewed were of the opinion that relationship among the people in the community is at a very good level (60.0 %).

- **Problems of the environment and infrastructure at present**

Top 3 of environmental problems in the opinion of interviewees are (1) problem from dust particles/soot/smoke from vehicles and factories in the area, (2) traffic problem resulting from a number of cars during the rush hours and traffic congestion (1 and 2 are equivalent at 60.0 %) and (3) wastewater at 40 % (domestic wastewater). Impact level of the environmental problem incurred is considered to be at a moderate level, except for noise, dust particles/soot/smoke are high level ($\overline{x}$ = 3.00 and 2.67 respectively), as shown in **Table 4.4.1-13**.

For problems of the infrastructure and public utilities, the problem the interviewees think affects them most is road (40.0 %) resulting from deteriorated road. Second is tap water system resulting from water turbidity containing with sediment (**Table 4.4.1-13**). The impact levels of these two problems are considered to be low to moderate ($\overline{x}$ = 1.50-2.00 respectively).

- **Top 3 problems about the living condition in the community**

  - Drug problem (80.0 %) caused mostly by teenagers (75.0 %) and local people (25.0 %). Overall, the impact of these problems is considered to be equal of high and low levels (50.0 %).
  - Occupational problem (40.0 %) caused from increasing of migrant workers (50.0 %).
  - Life and property safety problem (20.0 %) caused from occurring of steal problem (10.0 %) and impact is considered to be low levels (10.0 %).

- **Opinions for community development in the future**

The community leaders and key information providers in the study area under the administration of the sub-district municipality are of the opinion that the emphasis of the development of their communities should be on the following areas.

  - Occupation/Increase of income promoting (80.0 %) is due to people lack of knowledge for working, low income/want to increase income and want to work/have occupation.
  - Life quality enhancement / social problem correction (20.0 %), especially drug problem.
  - Public utilities (20.0 %) is due to want to improve community.

TABLE 4.4.1-13

EXISTING ENVIRONMENTAL PROBLEMS AND INFRASTRUCTURE; VILLAGE HEADMAN GROUP, WITHIN A 0 TO 3 KM OF RADIUS OF SUB-DISTRICT MUNICIPALITY ADMINISTRATIVE BOUNDARY

N = 5

Issues	Number	%	Average ($\overline{X}$) *	Level of Impact
Environmental Problems				
1) Odor	1	20.0	2.00	Moderate
2) Noise	1	20.0	3.00	High
3) Dust/soot/smoke	3	60.0	2.67	High
4) Traffic	3	60.0	2.00	Moderate
5) Waste	1	20.0	2.00	Moderate
6) Wastewater	2	40.0	2.00	Moderate
7) Unreleased flood	1	20.0	2.00	Moderate
Basic Infrastructure and Public Services				
8) Electricity	2	40.0	1.50	Low
9) Tap Water	1	20.0	2.00	Moderate
10) Road	2	40.0	2.00	Moderate

Remark: * Interpretation of level of impact from Average ($\overline{x}$)
- Low: $1.00 \leq (\overline{x}) \leq 1.50$
- Moderate: $1.51 \leq (\overline{x}) \leq 2.50$
- High: $2.51 \leq (\overline{x}) \leq 3.00$

Source: TEAM Consulting Engineering and Management Co., Ltd, 2014

- **Access to information about the project and relevant concerns**

The interview revealed that 100.0 % of all the community leaders and key information providers in the study areas under the administration of the sub-district municipality knew before about the project. 42.9 % were informed through the project staff and 28.6 % through the officers of the relevant governmental organizations at the district or provincial level. 20.0 % of the interviewees expressed their concern in issue of protection system of project.

- **Impacts anticipated**

Impacts anticipated during the construction period

60.0 % of the community leaders anticipate no impact from the project to their communities, while 40.0 % think there might be some impacts, the overall

level of which is considered to be moderate ($\overline{x}$ = 2.00, S.D. = 0.000), as shown in **Table 4.4.1-14**. Impacts anticipated during the construction period include:

- Impact of air quality (50.0 %), which caused from construction activities. The impact level is considered to be moderate ($\overline{x}$ = 2.00, S.D. = 0.000).
- Impact of water quality (50.0 %), which caused from construction activities. The impact level is considered to be moderate ($\overline{x}$ = 2.00, S.D. = 0.000).
- Impact of transportation network (100.0 %), which may impact to community due to transport through communities. The impact level is considered to be moderate ($\overline{x}$ = 2.00, S.D. = 0.000).
- Impact of road accident (50.0 %), which is considered to be moderate of impact level ($\overline{x}$ = 2.00, S.D. = 0.000).

TABLE 4.4.1-14

ANTICIPATION IMPACT WITHIN SUB-DISTRICT MUNICIPALITY ADMINISTRATIVE BOUNDARY DURING CONSTRUCTION PERIOD (0 TO 3 KM RADIUS FROM PROJECT LOCATION)

N = 5

Impacts During Operation Period	Magnitude of Impacts			Number (person)	Average ($\overline{x}$) *	Standard Deviation (S.D.)	Level of Impact
	High	Moderate	Low				
Environment							
1. Air Quality	0	1	0	1	2.00	0.0000	Moderate
2. Water Quality	0	1	0	1	2.00	0.0000	Moderate
3. Noise	0	1	0	1	2.00	0.0000	Moderate
Infrastructure							
1. Transport Network	0	2	0	2	2.00	0.0000	Moderate
Health							
1. Traffic Accident	0	1	0	1	2.00	0.0000	Moderate
Overall of impact	**0**	**6**	**0**	**6**	**2.00**	**0.0000**	**Moderate**

Remark: * Interpretation of level of impact from Average ($\overline{x}$)
- Low: $1.00 \leq (\overline{x}) \leq 1.50$
- Moderate: $1.51 \leq (\overline{x}) \leq 2.50$
- High: $2.51 \leq (\overline{x}) \leq 3.00$

Source: TEAM Consulting Engineering and Management Co., Ltd, 2014

Impacts anticipated during the operation period

60.0 % of the community leaders anticipate no impact from the project during the operation period to their communities, while 40.0 % think there might be some impacts, the overall level of which is considered to be moderate ($\overline{x}$ = 2.00, S.D. = 0.000), as shown in **Table 4.4.1-15**. Impacts anticipated during the operation period include:

- Impact of air quality (100.0 %), which is caused by air pollution and dust particles. The impact level is considered to be moderate ($\overline{x}$ = 2.00, S.D. = 0.000).
- Impact of solid waste (50.0 %), which is considered to be moderate of impact level ($\overline{x}$ = 2.00, S.D. = 0.000).
- Impact of water use (50.0 %), which caused from insufficient of water in communities. The impact level is considered to be moderate ($\overline{x}$ = 2.00, S.D. = 0.000).
- Impact of electricity (50.0 %), which caused from insufficient of electricity in communities. The impact level is considered to be moderate ($\overline{x}$ = 2.00, S.D. = 0.000).
- Impact of agriculture (50.0 %) is heat from burning in resulting of non-latex rubber. The impact level is considered to be moderate ($\overline{x}$ = 2.00, S.D. = 0.000).

TABLE 4.4.1-15

ANTICIPATION IMPACT WITHIN SUB-DISTRICT MUNICIPALITY ADMINISTRATIVE BOUNDARY DURING OPERATION PERIOD (0 TO 3 KM OF RADIUS FROM PROJECT LOCATION)

N = 5

Impacts During Operation Period	Magnitude of Impacts			Number (person)	Average ($\overline{x}$)*	Standard Deviation (S.D.)	Level of Impact
	High	Moderate	Low				
Environment							
1. Air Quality	0	2	0	2	2.00	0.0000	Moderate
2. Water Quality	0	1	0	1	2.00	0.0000	Moderate
3. Waste	0	1	0	1	2.00	0.0000	Moderate
Infrastructure							
1. Water for Domestic Usage	0	1	0	1	2.00	0.0000	Moderate
2. Electicity	0	1	0	1	2.00	0.0000	Moderate
Health							
1. Agricultural Products	0	1	0	1	2.00	0.0000	Moderate
Overall of impact	**0**	**7**	**0**	**7**	**2.00**	**0.0000**	**Moderate**

Remark: * Interpretation of level of impact from Average ($\overline{x}$)
- Low: 1.00 ≤ ($\overline{x}$) ≤ 1.50
- Moderate: 1.51 ≤ ($\overline{x}$) ≤ 2.50
- High: 2.51 ≤ ($\overline{x}$) ≤ 3.00

Source : TEAM Consulting Engineering and Management Co., Ltd, 2014

- **Public Participation**

Pre-construction period: 45.5 % of the community leaders are willing to provide information that can be useful for the project equal to willing to help disseminate information about the project to the people in their community, while 9.1 % prefer to be involved passively by just receiving the information and news about the project.

Construction period: 31.3 % of the community leaders are willing to help disseminate information about the project to the people in their community equal to willing to help follow up the act in compliance with the measures established during the construction period, while 6.3 % prefer to be involved passively by just receiving the information and news about the project.

Operation period: 33.3 % of the community leaders are willing to provide information that can be useful for the project equal to willing to help disseminate information about the project to the people in their community, 26.7 % are willing to help follow up the act in compliance with the measures established during operation period, while 6.7 % prefer to be involved passively by just receiving the information and news about the project.

- **Public relations to disseminate information of the project**

The community leaders in the study areas under the administration of the sub-district municipality are of the opinion that appropriate manners or approaches for public relations of the project include disseminating information through the community leaders, organizing explanatory meeting and public hearing, disseminating information through the governmental organizations involved in the area and sending letters/documents directly to the people in the area. The topics mainly of interest to the people in the area are the pros and cons resulting from the development of the project, mitigation measures and advantage to people (12.5 %). In addition, the interviewees made some further suggestions on public relation such as use easy language for more understanding, give more information to people, etc.

- **Additional ideas and suggestions on the project**

The community leaders interviewed expressed additional ideas and suggestion on the project in several aspects such as a tour of the project for student, keep relationship between project and community etc.

(c2) Results of the interview with the community leaders and key information providers in the study areas under the administration of the sub-district administrative organization within a 3 to 5 km of radius around the precincts of the project, (the results of the interview in details are shown in **Appendix 3G-3**)

- **General information of the interviewees**

Of all the community leaders and key information providers in the study areas, 70.0 % are male and 30.0 % are female. The average age is 47.5 years old. 100.0 % are Buddhist. 30.0 % have a primary school, senior high school/diploma, 20.0 % have high school and 15.0 % have bachelor degree. Occupation, 40.0 % are agricultural and 30.0 % run their own business.

- **Community Information**

The average length of establishment of the communities is 62.5 years old. 100.0 % are locals who were born or raised in the communities. 100 % of the people in the communities are Buddhist. 75.0 % are old communities and 10 % are semi-old communities and semi-rental house. Occupational of people in the communities have a variety of livelihood, with 43.2 % are agriculture, 34.1 are contractor, 13.6 % are merchant, etc. For the communities' economics, in the opinion of the community leaders interviewed, people in the communities are of medium economic standing (90 %) considering from factors like livelihood, living condition/ standard of living, manner of spending money. Most of the community leaders interviewed were of the opinion that relationship among the people in the community is good medium and low, respectively (75.0 %, 20.0, and 5.0 %, respectively) in consideration from joining in community activities.

- **Problems of the environment and infrastructure at present**

Top 3 of environmental problems in the opinion of interviewees are (1) problem from dust particles/soot/smoke from vehicles, factories, transportation of truck and burning of sugar cane (70.0 %), (2) noise from transportation of car and truck (35.0 %) and (3) smell problem from industry, chicken farm, and landfill (30.3 %). Most of impact level of the environmental problem incurred is considered to be at a moderate level, except for flood and traffic problems area are at high level ($\overline{x}$ = 3.00 and 2.75, respectively), while solid waste is at low level ($\overline{x}$ = 1.00), as shown in **Table 4.4.1-16**.

For problems of the infrastructure and public utilities, the problem the interviewees think affects them most is road (55.0 %) resulting from high number of truck, high traffic and narrow road. Second is tap water system resulting from insufficient water and water turbidity containing with sediment (**Table 4.4.1-16**). The impact levels of these problems are considered to be moderate level ($\overline{x}$ = 2.13-2.33 respectively).

- **Top 3 problems about the living condition in the community**

– Drug problem (75.0 %) caused mostly by teenagers (66.7 %), migrant workers (13.3 %) and remaining from alien labour. Overall, the impact of these problems is considered to be moderate low and high, respectively (40.0 %, 33.3 % and 20.0 %, respectively). Most of problems have not been solved. Some of thoes problems are controlled by police and local organization.

– Life and property safety problem (15.0 %) caused from migrant workers and teenagers (66.7 % and 33.3 %, respectively) and impact is considered to be at low equal to high levels (33.3 %). Problems have not been solved and some was controlled by police.

– Occupational problem (10.0 %) caused from increasing of migrant workers equal to no workplace (50.0 %). Most impact level is considered to be moderate equal to high levels (50.0 %) and promblems have not been solved.

TABLE 4.4.1-16

EXISTING ENVIRONMENTAL PROBLEMS AND INFRASTRUCTURE, VILLAGE HEADMAN GROUP, WITHIN A 3 TO 5 KM OF RADIUS OF SUB-DISTRICT ADMINSTRATIVE ORGANIZATION BOUNDARY

N = 20

Issues	Number	%	Average ($\bar{x}$)*	Level of Impact
Environmental Problems				
1) Odor	6	30.3	2.50	Moderate
2) Noise	7	35.0	1.86	Moderate
3) Dust/Soot/Smoke	14	70.0	2.43	Moderate
4) Traffic	4	20.0	2.75	High
5) Waste	1	5.0	1.00	Low
6) Wastewater	1	5.0	2.00	Moderate
7) Unreleased flood	1	5.0	3.00	High
Basic Infrastructure and Public Services				
8) Electricity	3	15.0	2.33	Moderate
9) Tap Water	8	40.0	2.13	Moderate
10) Road	11	55.0	2.27	Moderate

Remark: * Interpretation of level of impact from Average ($\bar{x}$)
- Low: $1.00 \leq (\bar{x}) \leq 1.50$
- Moderate: $1.51 \leq (\bar{x}) \leq 2.50$
- High: $2.51 \leq (\bar{x}) \leq 3.00$

Source : TEAM Consulting Engineering and Management Co., Ltd, 2014

- **Opinions for community development in the future**

The community leaders and key information providers in the study area under the administration of the sub-district administrative oganizations are of the opinion that the emphasis of the development of their communities should be on the following areas.

- Public utilities (40.0 %) are due to the need to travel more easily. Water and electricity are widely used. Road to improve access to services and so on.
- Occupation/Increase of income promoting (30.0 %) is due to people have low income due to the low income/add revenue, lack of knowledge for working and want to suggest occupation to establish such a group.
- Life quality enhancement / social problem correction (25.0 %) is due to increasing of passive population, environmental change, do not want drug problem, improve quality of life and want a peaceful community.
- Natural resources and environment (5.0 %) is due to increasing of industries, should care more on community and environment.

- **Access to information about the project and relevant concerns**

The interview revealed that 95.0 % of all the community leaders and key information providers in the study areas under the administration of the sub-district administrative organization knew before about the project. 26.8 % were informed through the project staff, 24.4 % through sub-district headman/village headman and 22.0 % through the officers of the relevant governmental organizations, while, 5.0 % just knew about information of project. 35.0 % of the interviewees expressed their concern in issue of air pollution, wastewater quality, environmental impact, noise impact, steam impact, etc.

- **Impacts anticipated**

Impacts anticipated during the construction period

80.0 % of the community leaders anticipate no impact from the project to their communities, while 20.0 % think there might be some impacts, the overall level of which is considered to be high ($\overline{x}$ = 2.71, S.D. = 0.4518), as shown in **Table 4.4.1-17**. Impacts anticipated during the construction period include:

- Impact of air quality (50.0 %), which caused from chemical contamination in air. The impact level is considered to be high ($\overline{x}$ = 3.00, S.D. = 0.500).
- Impact of water quality (50.0 %), which caused from construction activities. The impact level is considered to be moderate ($\overline{x}$ = 2.50, S.D. = 0.500).
- Impact of transportation network (50.0 %), which may impact to community due to transport through communities and increase of traffice. The impact level is considered to be moderate ($\overline{x}$ = 2.50, S.D. = 0.500).

- Impact of road accident (50.0 %), which is considered to be high of impact level ($\overline{x}$ = 3.00, S.D. = 0.000).

Impacts anticipated during the operation period

70.0 % of the community leaders anticipate no impact from the project during the operation period to their communities, while 30.0 % think there might be some impacts, the overall level of which is considered to be moderate ($\overline{x}$ = 2.22, S.D. = 0.4157), as shown in **Table 4.4.1-18**. Impacts anticipated during the operation period include:

- Impact of air quality (83.3 %), which is caused by air pollution, contamination of chemical in air and dust particles. The impact level is considered to be moderate ($\overline{x}$ = 2.20, S.D. = 0.4000).
- Impact of water quality (50.0 %), which caused from wastewater of project implementation. The impact level is considered to be moderate ($\overline{x}$ = 2.33, S.D. = 0.4714).
- Impact of noise (16.7 %), which caused by noise of electricity generation process. The impact level is considered to be moderate ($\overline{x}$ = 2.00, S.D. = 0.0000).

TABLE 4.4.1-17

ANTICIPATION IMPACT WITHIN SUB-DISTRICT ADMINISRATIVE ORGANIZATION BOUNDARY DURING CONSTRUCTION PERIOD (3 TO 5 KM RADIUS FROM PROJECT LOCATION)

N = 20

Impacts During Operation Period	Magnitude of Impacts			Number (person)	Average $\overline{(x)}$*	Standard Deviation (S.D.)	Level of Impact
	High	Moderate	Low				
Environment							
1. Air Quality	2	0	0	2	3.00	0.0000	High
2. Water Quality	1	1	0	2	2.50	0.5000	Moderate
Infrastructure							
1. Traffic Network	1	1	0	2	2.50	0.5000	Moderate
Health							
1. Traffic Accident	1	0	0	1	3.00	0.0000	High
Overall of impact	**5**	**2**	**0**	**7**	**2.71**	**0.4518**	**High**

Remark: * Interpretation of level of impact from Average ($\overline{x}$)
- Low: 1.00 ≤ ($\overline{x}$) ≤ 1.50
- Moderate: 1.51 ≤ ($\overline{x}$) ≤ 2.50
- High: 2.51 ≤ ($\overline{x}$) ≤ 3.00

Source : TEAM Consulting Engineering and Management Co., Ltd, 2014

TABLE 4.4.1-18

ANTICIPATION IMPACT WITHIN SUB-DISTRICT ADMINISTRATIVE ORGANIZATION BOUNDARY DURING OPERATION PERIOD (3 TO 5 KM RADIUS FROM PROJECT LOCATION)

N = 20

Impacts During Operation Period	Magnitude of Impacts			Number (person)	Average ($\bar{x}$)*	Standard Deviation (S.D.)	Level of Impact
	High	Moderate	Low				
Environment							
1. Air Quality	1	4	0	5	2.20	0.4000	Moderate
2. Water Quality	1	2	0	3	2.33	0.4714	Moderate
3. Noise	0	1	0	1	2.00	0.0000	Moderate
Overall of impact	**2**	**7**	**0**	**9**	**2.22**	**0.4157**	**Moderate**

Remark: * Interpretation of level of impact from Average ($\bar{x}$)
- Low: $1.00 \leq (\bar{x}) \leq 1.50$
- Moderate: $1.51 \leq (\bar{x}) \leq 2.50$
- High: $2.51 \leq (\bar{x}) \leq 3.00$

Source : TEAM Consulting Engineering and Management Co., Ltd, 2014

- **Public Participation**

Pre-construction period: 43.5% of the community leaders are willing to provide information that can be useful for the project equal to willing to help disseminate information about the project to the people in their community, while 10.9 % prefer to be involved passively by just receiving the information and news about the project and 2.2 % are willing to establish representative of community.

Construction period: 33.3 % of the community leaders are willing to help disseminate information about the project to the people in their community. 31.7 % are willing to provide information that can be useful for the project. 26.7 % are willing to to help follow up the act in compliance with the measures established during operation period and 8.3 % prefer to be involved passively by just receiving the information and news about the project.

Operation period: 33.9 % of the community leaders are willing to provide information that can be useful for the project. 30.5 % are willing to help disseminate information about the project to the people in their community. 27.1 % are willing to help follow up the act in compliance with the measures established during operation period, while 8.5 % prefer to be involved passively by just receiving the information and news about the project.

- **Public relations to disseminate information of the project**

The community leaders in the study areas under the administration of the sub-district administrative organization are of the opinion that appropriate manners or approaches for public relations of the project include disseminating information through the community leaders, organizing explanatory meeting and public hearing, sending letters/documents directly to the people in the area and disseminating information through the governmental organizations involved in the area. The topics mainly of interest to the people in the area are adventage to community equal to project description (12.0 %) and the pros and cons resulting from the development of the project (8.0 %). In addition, the interviewees made some further suggestions on public relation such as people should take document and questionair back for reviewing and submit to village header later, etc.

- **Additional ideas and suggestions on the project**

The community leaders interviewed expressed additional ideas and suggestion on the project in several aspects such as advantage of project to community, taking care of community, establish representative of community to get project information, increase CSR activities, should not limit number of participants, support/ develop healthcare in term of of staff, equipment and compensation to volunteer who care for the safety of the community.

(d) Results of the interview with the households

(d.1) Results of the interview with the households in the study areas under the administration of both the sub-district administrative organization and the sub-district municipality within a 3 km of radius around the precincts of the project, (the results of the interview in details are shown in Appendix 3G-4)

1. The households in the study areas under the administration of the sub-district administrative organization within a 3 km of radius around the precincts of the project

- **General information about the interviewees**

Of all the interviewees, 52.3 % are male and 47.7 % are female; the average age is 46.2 years old; 46.4 % are household leaders, 36.0 % are the spouses of the household leaders, and 6.8 % are children/sons or daughters in law of the household leaders; 32.8 % have primary school diploma, 23.1 % have junior high school diploma, and 19.2 % have senior high school diploma/ vocational college diploma; 99.0 % are Buddhist.

38.6 % of the interviewees have lived in the community since they were born, 61.4 % have moved from other provinces. Of those who have moved from other provinces, 44.4 % are originally from provinces in the northeastern region, 28.0 % are originally from provinces in the central region, and 15.9 % are originally from other provinces in the eastern region. 74.6 % decided to move here to look for work, 10.1 % because they are married to the people in the area, and 7.9 % because their parents/ relatives moved here. The average length of residence here is 19 years. When asked about their desire to move away, 92.2 % have no desire to do so because they work here/have business here/have home and family here/have lived here for a long time. 5.5 % have a plan to move away to live elsewhere because they want to move back to their hometown/ have to follow their husband/ want to look for work in other provinces in the northeastern, central, or eastern region of Thailand.

- **Information about the households' socio-economics**

The average number of the permanent household members is 4.4, with 2.2 males and 2.2 females. Most are in working age, then studying age, and old age, respectively. Working people slightly outnumber non-working people, the ratio of which is 2.4:2.0.

41.9 % of the interviewees are factory employees, 19.8 % are employees elsewhere, 18.8 % are business owners, and 8.8 % are farmers. 7.5 % of the interviewees also have part-time jobs to supplement their income such as having a business and agriculture. 95.5 % of these working interviewees have no problem in earning

their livelihood, while 3.9 % of them do owing to irregular or insufficient income. The average income of the households is 27,000 Baht and the average expenditure is 21,000 Baht. 91.9 % of the households earn enough for their expenditure, while 6.2 % of them do not and have to ask for loans or cut on their spending.

- **Healthcare services and convenience in getting the services at present**

For healthcare services, 73.1 % of the interviewees go to governmental hospital, 14.6 % to private hospital/clinic, and 4.6 % to tambon health promoting hospital/ public health center. Almost all the interviewees (99.0 %) find that healthcare services in the area are adequate. When asked about convenience in travelling to get healthcare services, 98.4 % of the interviewees find that it is convenient, while 1.3v face some difficulty in travelling to get healthcare services owing to remote location of their living place.

- **Problems about the environment and infrastructure at present**

Less than 30.0v of the interviewees are of the opinion that there are environmental problems. The top three problems the interviewees think affect them most are (1) problem from dust particles/soot/smoke from the traffic in the area (28.2 %), (2) problem from noise resulting from the traffic in the area (14.3 %), (3) problem from smell from the factories, traffic, industrial estate, and steel factories in the area. The impact level of these environmental problems is considered to be moderate ($\overline{x}$ = 2.00-2.18), as shown in **Table 4.4.1-19**.

For problems about the infrastructure and public utilities, the problem the interviewees think affect them most is about the roads (14.9 %) caused by a high number of trucks and the roads being damaged, narrow, and inadequate. Coming second is the problem about the potable water system (13.3 %) resulting from shortage of water and a lot of residues mixed in the water content. These are shown in **Table 4.4.1-19**. The impact level of most of the problems incurred is considered to be at a moderate level, except in the case of problems about the educational institute and fire station, the impact level of which is considered to be high and low, respectively ($\overline{x}$ = 3.00 and 1.00, respectively).

- **Community problems and life and property safety problems**

59.7 % of the interviewees are of the opinion that there exist community problems and life and property safety problems, which involve theft and robbery (30.4 %), drugs (22.7 %), teenage gangs/juvenile delinquency (19.8 %), and migrant labor (10.6 %).

TABLE 4.4.1-19

EXISTING ENVIRONMENTAL AND INFRASTRUCTURE PROBLEMS, HOUSEHOLDS WITHIN A 0 TO 3 KM RADIUS OF SUB-DISTRICT ADMINISTRATIVE ORGANIZATION BOUNDARY

N = 308

Impacts	Number of opinion	Percentage of opinion	Average ($\bar{x}$) of level of impact *	Interpretation of Level of Impact
Environmental Problems				
1) Odor	34	11.0	2.00	Moderate
2) Noise	44	14.3	2.18	Moderate
3) Dust/Soot/Smoke	87	28.2	2.15	Moderate
4) Traffic	20	6.5	2.10	Moderate
5) Waste	12	3.9	2.08	Moderate
6) Wastewater	4	1.3	2.00	Moderate
7) Unreleased flood	10	3.2	2.00	Moderate
Basic Infrastructure and Public Services				
8) Electricity	38	12.3	2.05	Moderate
9) Tap water	41	13.3	2.05	Moderate
10) Road	46	14.9	2.20	Moderate
11) Waste management (Disposal)	7	2.3	2.14	Moderate
12) Sufficiency in public health	2	0.6	2.00	Moderate
13) Educational institution	1	0.3	3.00	High
14) Fire station	1	0.3	1.00	Low

Remark: * Interpretation of level of impact from Average ($\bar{x}$)
- Low: $1.00 \leq (\bar{x}) \leq 1.50$
- Moderate: $1.51 \leq (\bar{x}) \leq 2.50$
- High: $2.51 \leq (\bar{x}) \leq 3.00$

Source: TEAM Consulting Engineering and Management Co., Ltd, 2014

- **Sufficiency of water sources and quality of water for household use**

87.7 % of the households interviewed have sufficient water for household use, while 9.4 % do not owing to shortage of water/ irregular supply of water during the dry season.

The main sources of water for household use are:

– Potable water (64.3 %). 72.9 % of the users find the quality of potable water satisfactory, while 22.7 % do not owing to a lot of residues in the water content.

– Groundwater (26.3 %). 79.1 % of the users find the quality of potable water satisfactory, while 16.5 % do not owing to a lot of residues in the water content.

- **Sufficiency of drinking water sources and quality of drinking water for household consumption**

97.7 % of the households interviewed have sufficient water for consumption, while 1.3 % do not, owing to there is no other source of drinking of water.

The main sources of water for consumption are:

- Bottled water/drinking water in a big size packaged jar (97.1 %). All of the consumers find the quality of the bottled water/drinking water in a big size packaged jar satisfactory.
- Groundwater (7.5 %). 76.0 % of the consumers find the quality of groundwater satisfactory, while 20.0 % do not, owing to a lot of residues in the water content.

When asked about their satisfaction with their community, 52.6 % of the households interviewed have a moderate level of satisfaction owing to peace, harmony, pleasant atmosphere and weather. 45.1 % have a high level of satisfaction because people in the community live in harmony and they have lived here since they were born or for a long time.

- **Knowledge about the project and relevant suggestions**

60.4 % of the interviewees learned about the project for the first time through the interviewer, while 39.0 % learned about the project before. Of the latter, 29.8 % were informed by the community leader (the sub-district headman/village headman), 28.7 % by their neighbor/co-worker, and 22.1 % by the project officer. Regarding concerns about the project development, 87.0 % of the interviewees have no concern about impacts resulting from the project, whereas 12.3 % expressed their concern over various issues, such as air pollution/bad air quality (30.6 %), polluted environment (10.2 %), wastewater (10.2 %), and lack of life and property safety (10.2 %). Also, it is suggested that the measures established to minimize the aforementioned impacts be strictly implemented in the management of the project.

After the first public hearing to acquire opinions on the project, another was organized, as stated in the socio-economic study plan. This involved meeting the community leaders, staging a meeting, and interviewing them. The result reveals that only a few in the sample group learn about the project before. As knowledge about the project and relevant suggestions are deemed important, it is stated in the study plan that such an activity is to be continually organized to promote understanding, acceptance, learning, and mutually-agreed modification of the project to the benefit of all those involved.

- **Impacts anticipated**

Impacts anticipated during the construction period

90.9 % of the interviewees anticipate no impact from the project during the construction peroid, while 8.8 % think there can be some impacts, the level of which is overall considered to be moderate ($\bar{x}$ = 2.02, S.D. = 0.3938), as shown in **Table 4.4.1-20**. Impacts anticipated during the construction peroid include:

- Impact of air quality (5.5 %), which is caused by air pollution, dust particles, and hotter weather. The impact level is considered to be moderate ($\bar{x}$= 2.00, S.D. = 0.4851). A mitigation measure suggested involves good management and strict control of the construction works.
- Impact of water quality (2.6 %), which is caused by wastewater/bad water quality, chemical contamination in the water, water discharged outside from the project premises, and rusty water. The impact level is considered to be moderate ($\bar{x}$= 2.13, S.D. = 0.3307). A mitigation measure suggested involves good management and strict control of the construction works.
- Impact of noise from the construction activities (1.3 %). The impact level is considered to be moderate ($\bar{x}$ = 2.00, S.D. = 0.0000). A mitigation measure suggested involves good management and strict control of the construction works.
- Impact of chemical substances (1.6 %), which are in polluted air. The impact level is considered to be moderate ($\bar{x}$ = 2.20, S.D. = 0.4000). A mitigation measure suggested involves specification of strict measures.
- Impact of water use of the communities in the area (0.6 %). High amount of water required for the construction activities may result in the communities not having enough water to use. The impact level is considered to be moderate ($\bar{x}$= 2.20, S.D. = 0.0000).
- Impact of electricity (0.6 %) – high amount of electricity required for the construction activities may result in the communities not having enough electricity to use. Also, there is already the problem of frequent power drop in the area. The impact level is considered to be moderate ($\bar{x}$ = 2.20, S.D. = 0.000). A mitigation measure suggested involves good management and strict control of the construction works.
- Impact of transportation system (0.6 %), which is caused by the traffic. The trucks used in the construction activities may cause damage to the roads in the communities. The impact level is considered to be moderate ($\bar{x}$ = 2.00, S.D. = 0.0000). Mitigation measures suggested involve repairing/ improving the condition of the roads and good administration of the construction works related.

TABLE 4.4.1-20

ANTICIPATION IMPACTS DURING CONSTRUCTION PEROID SUGGESTED BY THE HOUSEHOLDS WITHIN 0 TO 3 KM RADIUS FROM PROJECT LOCATION IN SUB-DISTRICT, ADMINISTRATIVE ORGANIZATION BOUNDARY

N = 308

Impacts during construction peroid	Number of opinion toward magnitude of Impacts			Total	Average ($\bar{x}$)*	Standard Deviation (S.D.)	Interpretation of level of Impact
	High	Moderate	Low				
Environment							
1. Air quality	2	13	2	17	2.00	0.4851	Moderate
2. Water quality	1	7	0	8	2.13	0.3307	Moderate
3. Noise	0	4	0	4	2.00	0.0000	Moderate
4. Chemical substance	1	4	0	5	2.20	0.4000	Moderate
Infrastructure							
1. Water supply	0	2	0	2	2.00	0.0000	Moderate
2. Electricity	0	2	0	2	2.00	0.0000	Moderate
3. Traffic network	0	2	0	2	2.00	0.0000	Moderate
Health							
1. Stress	0	1	0	1	2.00	0.0000	Moderate
2. Traffic accident	0	2	1	3	1.67	0.4714	Moderate
Way of Life							
1. Occupation	0	1	0	1	2.00	0.0000	Moderate
Overall Impact	**4**	**38**	**3**	**45**	**2.02**	**0.3938**	**Moderate**

Remark: * Interpretation of level of impact from Average ($\bar{x}$)
- Low: $1.00 \leq (\bar{x}) \leq 1.50$
- Moderate: $1.51 \leq (\bar{x}) \leq 2.50$
- High: $2.51 \leq (\bar{x}) \leq 3.00$

Source: TEAM Consulting Engineering and Management Co., Ltd, 2014

- Impact of stress (0.3 %), which results from anxiety about the environmental impacts. The impact level is considered to be moderate ($\bar{x}$ = 2.00, S.D. = 0.0000). Mitigation measures suggested involve providing relevant information on the consequences and preventive methods to the people in the area.
- Impact of traffic accidents (1.0 %), which results from heavier traffic. The impact level is considered to be moderate ($\bar{x}$ = 1.67, S.D. = 0.4714).
- Impact of livelihood (0.3 %), which is expected to be moderately positive, resulting from improved economy. The impact level is considered to be moderate ($\bar{x}$ = 2.00, S.D. = 0.0000).

Impacts anticipated during the operation period

89.3 % of the interviewees anticipate no impact from the project during the operation peroid, while 10.4 % think there might be some impacts, the overall level of which is considered to be moderate ($\bar{x}$ = 2.02, S.D. = 0.5812), as shown in **Table 4.4.1-21**. Impacts anticipated during the operation peroid include:

TABLE 4.4.1-21

ANTICIPATION IMPACTS DURING OPERATION PEROID SUGGESTED BY THE HOUSEHOLDS WITHIN 0 TO 3 KM RADIUS FROM PROJECT LOCATION IN SUB-DISTRICT ADMINISTRATIVE ORGANIZATION BOUNDARY

N = 308

Impacts during construction peroid	Number of opinion toward magnitude of Impacts			Total	Average ($\bar{x}$)*	Standard Deviation (S.D.)	Interpretation of level of Impact
	High	Moderate	Low				
Environment							
1. Air quality	3	14	2	19	2.05	0.5103	Moderate
2. Water quality	0	2	1	3	1.67	0.4714	Moderate
3. Noise	0	1	0	1	2.00	0.0000	Moderate
4. Chemical substance	1	3	0	4	2.25	0.4330	Moderate
Infrastructure							
1. Water supply	1	2	1	4	2.00	0.7071	Moderate
2. Electricity (Positive)	5	1	0	6	2.83	0.3727	High
3. Electricity (Negative)	1	2	0	3	2.33	0.4714	Moderate
4. Traffic network	1	0	0	1	3.00	0.0000	High
5. Public services	1	0	0	1	3.00	0.0000	High
Health							
1. Stress	0	2	0	2	2.00	0.0000	Moderate
2. Traffic accident	0	1	0	1	2.00	0.0000	Moderate
Overall impact	**13**	**28**	**4**	**45**	**2.20**	**0.5812**	**Moderate**

Remark: * Interpretation of level of impact from Average ($\bar{x}$)
- Low: $1.00 \le (\bar{x}) \le 1.50$
- Moderate: $1.51 \le (\bar{x}) \le 2.50$
- High: $2.51 \le (\bar{x}) \le 3.00$

Source: TEAM Consulting Engineering and Management Co., Ltd, 2014

- Impact of air quality (6.5 %), which is caused by air pollution, and hotter weather. The impact level is considered to be moderate ($\bar{x}$ = 2.05, S.D. = 0.5103). Mitigation measures suggested involve installing particle trapping/ air filtering devices and good administration of the project works involved.

- Impact of water quality (1.0 %), which is caused by wastewater/bad water quality. The impact level is considered to be moderate ($\bar{x}$ = 1.67, S.D. = 0.4714). A mitigation measure suggested involves good administration of the project works related.
- Impact of noise (0.3 %), which results from the project operation/ production process. The impact level is considered to be moderate ($\bar{x}$ = 2.00, S.D. = 0.0000). A mitigation measure suggested involves good administration of the project works related.
- Impact of chemical substances (1.3 %), which are in polluted air and contaminated water. The impact level is considered to be moderate ($\bar{x}$ = 2.25, S.D. = 0.4330). A mitigation measure suggested involves good administration of the project works related.
- Impact of water use of the communities in the area (1.3 %) – water required for electricity generation may result in the communities not having enough water to use. The impact level is considered to be moderate ($\bar{x}$= 2.20, S.D. = 0.7071). A mitigation measure suggested involves having water in reserve during the operation.
- Impact of electricity (1.9 %), which is expected to be highly positive as this will lead to the community's electric energy security and enable its people to have sufficient electricity to use ($\bar{x}$ = 2.83, S.D. = 0.3727). However, negative impact is also anticipated (1.0 %) as high amount of electricity required during the operation peroid may result in the communities not having enough electricity to use. In addition, electricity charges may rise. The impact level is considered to be moderate ($\bar{x}$ = 2.33, S.D. = 0.4714).
- Impact of transportation system (1.0 %), which results from modernized development and heavier traffic. The impact level is considered to be high ($\bar{x}$ = 3.00, S.D. = 0.0000). Mitigation measures suggested involve setting monitoring system during rush hours and having related project works well administered.
- Impact of public services (0.3 %). The impact level is considered to be high ($\bar{x}$ = 3.00, S.D. = 0.0000).
- Impact of stress (0.6 %), which results from anxiety about bad air quality. The impact level is considered to be moderate ($\bar{x}$ = 2.00, S.D. = 0.0000). Mitigation measures suggested involve providing relevant information on the consequences and preventive methods to the people in the area.
- Impact of traffic accidents (0.3 %), which results from heavier traffic. The impact level is considered to be moderate ($\bar{x}$ = 2.00, S.D. = 0.0000).

45.8 % of the interviewees think that the development of the project might impact their way of life resulting from their community being more modernized (18.4 %), hotter weather (15.8 %), more people from other areas coming to live in their community (13.9 %), and more jobs being generated for the local people (7.6 %).

- **Public Participation**

When the interviewees were asked about their willingness to be involved in monitoring the environmental impacts resulting from the project before and during the construction peroid and operation peroid, the findings are as follows:

Pre-construction period: 43.9 % of the interviewees are willing to provide information that can be useful for the project. 30.2 % are willing to help disseminate information about the project to the people in their community. 23.8 % are willing to receive information and news about the project.

Construction period: 41.7 % of the interviewees are willing to provide information that can be useful for the project. 30.4 % are willing to help disseminate information about the project to the people in their community. 24.6 % are willing to receive information and news about the project. 1.3 % are willing to help follow up the project to implement impact mitigation measures during construction peroid.

Operation period: 38.9 % of the interviewees are willing to provide information that can be useful for the project. 29.5 % are willing to help disseminate information about the project to the people in their community. 24.8 % are willing to receive information and news about the project. 3.6 % are willing to help follow up the project to implement impact mitigation measures during construction peroid.

- **Additional ideas and suggestions on the project**

The people in the area suppose that the project should conduct appropriate manners and approaches for public relations of the project include sending letters/documents to inform the people directly, disseminating information through the community leaders, organizing explanatory meeting and public hearing, and having notice boards made. 31.7 % of the interviewees express their opinion about the topics mainly of interest to the people in the area, which include details about the project, the pros and cons resulting from the development of the project, impact on air quality, other impacts resulting from the development of the project, safety in the operation of the project, and environmental protection measures.

14.1 % of the interviewees made some further opinions and suggestions on the public relations of the project, for example that documents giving

information about the project be extensively distributed, public relations promoting knowledge about the project be extensively conducted, and notice boards be made to publicize the project.

8.3 % of the interviewees gave some further opinions and suggestions on the development of the project, for example that good management system be set for the project, preventive measures be established for safety to the community, construction be completed within due time, activities to promote the project be organized regularly in the communities involved, etc.

2. The households in the municipality in the study area within a 3 km of radius of the project.

- **Overview of the interview.**

Most of those interviewed were male than female (48.6 % and 51.4 %, respectively), average age 50.9 years, the status of a head of household, a minor spouse of the head of household. And a son / son-in-law / daughter in law. Head of household (47.5 %, 45.8 % and 4.2 %, respectively) were completed primary education. Junior High and High School / Vocational. Respectively (45.0 %, 23.3 % and 14.2 %, respectively), and the interviewees are mostly Buddhists (97.5 %).

Respondents (67.5 %) lived in the community since the 32.5 % who moved to live in the community. Most came from other provinces in the eastern provinces in the central region. And other provinces in the Northeast (35.9 %, 33.3 % and 17.9 %, respectively) due to the move to find work, according to their parents / relatives. And married people in the area (% age of 48.7, 25.6 and 15.4, respectively), who moved into homes in the area have lived in the area for approximately 31 years, when asked about their intention to move in that provider. Most interviewees (64.2 %) do not think to move to another residence. Since this is a residential / home building is here to live long lives with the family. And career / business is located here, and the 35.8 % who think and want to move to another residence. Since being sacked / expropriation of leased. And her husband moved by the need to move to another district in Rayong Province. And other provinces in the east, respectively.

- **Economy - Society of households**

Number of household members who lived for 4.6 people are male, 2.4 and women 2.2, mostly in childhood, preschool, school-age and elderly, respectively, the proportion of those employed than those without a job a little. 2.6: 2.0 people.

Most households, workers in the industry, followed by General trade and employed persons (33.3 %, 31.7 %, 20.8 % and 5.8 %, respectively) and a main household has 5.0 % of the profession, such as General Contractors. And trade, which is 95.0 % of the professionals who are experiencing problems of occupation, but the 5.0 % achieved in the occupation. Since earning a fixed income is not enough economic income for the average household per month 27,000 baht and spending an average of 20,000 baht, 91.7 % had sufficient income to expenses, but 8.3 % that is not enough. This has solved the problem by borrowing.

- **To get the service and convenience of the service in the hospital**

Most public hospitals to receive services such as public hospitals. Health Promoting Hospital District (Rp.st.)/health centers, let disappear. And the treatment itself (% age 67.5 11.9 8.6 and 6.0, respectively), the majority (99.2 %) agreed that health facilities in the area are sufficient. When asked about the ease of travel was 99.2 % with a 0.8 % age point in the journey, not easy to travel. Since there is no car

- **Environmental problems and current infrastructure**

Environmental issues, the proportion who state that suffered environmental issues are not high. (Less than 30.0), the problem with the state that suffered the highest proportion 3 include (1) the problem of dust / soot / smoke, 25.8 % are caused due to the traffic of vehicles and roads (2). 16.7 % of odor problems that are caused due to the industry. Industrial waste pile and mill (3) noise issues, 15.8 % are caused due to the traffic of cars and factories. The impact of environmental issues at all levels in the medium ($\overline{x}$ ranged from 1.75 to 2.29), as shown in **Table 4.4.1-22**.

The problem of infrastructure and public services issues, problem with the water supply is identified as having the highest proportion (17.5 %) is caused due to the water cloudy with silt. Water does not flow / less water. A minor problem with electricity (5.8%), as shown in **Table 4.4.1-22**. Most problem are moderate level ($\overline{x}$ 1.00-2.29).

TABLE 4.4.1-22

EXISTING ENVIRONMENTAL PROBLEMS AND INFRASTRUCTURE, HOUSEHOLD GROUP, WITHIN A 0 TO 3 KM OF RADIUS OF SUB-DISTRICT MUNICIPALITY ADMINISTRATIVE BOUNDARY

N = 120

Issues	Number	%	Average ($\bar{x}$) *	Level of Impact
Environmental Problems				
1) Odor	20	16.7	2.25	Moderate
2) Noise	19	15.8	1.95	Moderate
3) Dust/Soot/Smoke	31	25.8	2.10	Moderate
4) Traffic	7	5.8	2.29	Moderate
5) Wastewater	2	1.7	2.00	Moderate
6) Unreleased flood	4	3.3	1.75	Moderate
Basic Infrastructure and Public Services				
7) Electricity	7	5.8	1.86	Moderate
8) Tap Water	21	17.5	2.29	Moderate
9) Road	1	0.8	1.00	Low
10) Sufficiency in Public Health	1	0.8	2.00	Moderate

Remark: * Interpretation of level of impact from Average ($\bar{x}$)
- Low: $1.00 \le (\bar{x}) \le 1.50$
- Moderate: $1.51 \le (\bar{x}) \le 2.50$
- High: $2.51 \le (\bar{x}) \le 3.00$

Source: TEAM Consulting Engineering and Management Co., Ltd, 2014

- **The community and the safety of life and property.**

The community and the safety of life and property (% age 65.8) Problems include drugs (29.9 %), theft, robbery (25.9 %), the mingling of youth gangs, teenagers (18.3 %) and an argument smash Brawl well (12.7 %), and so on.

- **The adequacy of water resources And the quality of water used in a household**

95.8 % of households have adequate water, but 2.5 % is not enough, because the water is not flowing. Not enough water / dry season.

The main sources used include household.

- Tap water (84.8 %), 59.4 % of tap water user agreed that water quality was found to have 32.0อ of the water turbidity and contain with sediment.
- Pond water (14.5 %), 80.0 % agreed that good quality and (15.0 %) Minor that water turbidity and contain with sediment.

- **The adequacy of water resources and the quality of the water consumed in the household.**

99.2 % of households have adequate water consumption by 0.8 อ, but there is not enough because there is no other source of water consumed. The main water sources include household water consumption.

- Water bottle / bucket (67.9 %), consumer water bottles / tanks all that bottled water / tanks with good quality.
- Water distribution from municipalities (29.1 %) and 97.4 % of that quality.
- When asked about the satisfaction of the community. There were very satisfied and 40.0 % were satisfied with mediocre as mediocre satisfaction. The need to find new housing. But careers here and are very satisfied. The area was inhabited long. The family lived in harmony, peaceful community. Here and career / employment.

- **Perceptions and opinions on the project.**

Respondents (18.3 %), information from the authorities interviewed for the first time, while 81.7 % had been aware of before. The information from friends / colleagues project staff. And community leaders (Village chief / headman) (30.8, 20.5 and 19.5 %, respectively), when asked about the concern about the development of the project found that 80.0 per cent have no anxiety. For those who have a concern about the impact (19.2 %), including air pollution / air (23.5 %), insecurity of life and property (14.7 %), water (11.8 %), etc. have been proposed the solution to the problem by allowing the project to follow strict measures to minimize such effects.

Activities to hear the interview. Defined in the study plans, economic - social. The activity was conducted after participating states. In the hearing, including the first meeting with local leaders and the platform meeting. It found that a number of the interviews were not much had been informed before the project, however, has given priority to the project informed. And public opinion Defined in the study plan by the events in this ongoing process. To understand and awareness - learning. Modify the joint project, this will be beneficial to all parties.

- **Impacts anticipated**

Impacts anticipated during the construction period

85.8 % of the interviewees anticipate no impact from the project during the construction period, while 14.2 % think there can be some impacts, the level of which is overall considered to be moderate ($\bar{x}$ = 2.16, S.D. = 0.4470), as shown in **Table 4.4.1-23**. Impacts anticipated during the construction period include:

TABLE 4.4.1-23

ANTICIPATION IMPACT WITHIN SUB-DISTRICT MUNICIPALITY ADMINISTRATIVE BOUNDARY DURING CONSTRUCTION PEROID (0 TO 3 KM OF RADIUS FROM PROJECT LOCATION)

N = 120

Impacts During Operation Peroid	Magnitude of Impacts			Number (person)	Average $\bar{x}$*	Standard Deviation (S.D.)	Level of Impact
	High	Moderate	Low				
Environment							
1. Air Quality	5	9	0	14	2.36	0.4792	Moderate
2. Water Quality	2	7	1	10	2.10	0.5385	Moderate
3. Noise	1	4	0	5	2.20	0.4000	Moderate
4. Waste	1	2	0	3	2.33	0.4714	Moderate
5. Chemical Agent	1	3	0	4	2.25	0.4330	Moderate
Infrastructure							
1. Water Supply	1	3	0	4	2.25	0.4330	Moderate
2. Electricity	0	1	0	1	2.00	0.0000	Moderate
3. Transport Network	0	2	0	2	2.00	0.0000	Moderate
Health							
1. Illness	0	2	0	2	2.00	0.0000	Moderate
2. Stress	0	1	0	1	2.00	0.0000	Moderate
3. Traffic Accident	0	5	1	6	1.83	0.3727	Moderate
4. Accidents caused by project operation	0	3	0	3	2.00	0.0000	Moderate
Socio-economy							
1. Occupation	0	1	0	1	2.00	0.0000	Moderate
2. Employment	0	1	0	1	2.00	0.0000	Moderate
3. Relationship in Community	0	5	0	5	2.00	0.0000	Moderate
4. Travelling	1	0	0	1	3.00	0.0000	High
Overall of impact	12	48	2	62	2.16	0.4470	Moderate

Remark: * Interpretation of level of impact from Average ($\bar{x}$)
- Low: $1.00 \leq (\bar{x}) \leq 1.50$
- Moderate: $1.51 \leq (\bar{x}) \leq 2.50$
- High: $2.51 \leq (\bar{x}) \leq 3.00$

Source: TEAM Consulting Engineering and Management Co., Ltd, 2014

- Impact of air quality (11.7 %) from dust and air pollution. The level of impact is moderate ($\bar{x}$ = 2.36, S.D. = 0.4792), which proposes solutions to minimize the problem by controlling the action well.
- Impact of water quality (8.3 %) from wastewater. The level of impact is moderate ($\bar{x}$ = 2.10, S.D. = 0.5385), which proposes solutions to minimize the problem by controlling the action well.
- Impact of noise (4.2 %) from pile construction of project. The level of impact is moderate ($\bar{x}$ = 2.20, S.D. = 0.4000), which proposes solutions to minimize the problem by controlling the action well.
- Impact of solid waste (2.5 %) from workers. The level of impact is moderate ($\bar{x}$ = 2.33, S.D. = 0.4714), which proposes solutions to minimize the problem by controlling the action well.
- Impact of chemicals (13.3 %) from the emissions. And leakage of chemicals. The level of impact is moderate ($\bar{x}$ = 2.25, S.D. = 0.4330), which proposes solutions to minimize the problem by controlling the action well.
- Impact of water (3.3 %) from water use in construction activities may not be enough water to community's contamination of chemical contaminants. The level of impact is moderate ($\bar{x}$ = 2.25, S.D. = 0.4330), which proposes solutions to minimize the problem by controlling the action well.
- Impact of electricity (0.8 %) from the electricity use in construction activities may cause insufficient power of community. Due to a power failure in the area are often not reported. The level of impact is moderate ($\bar{x}$ = 2.00, S.D. = 0.0000), which proposes solutions to minimize the problem by controlling the action well.
- Impact of network communications (1.7 %) from the truck traffic in the road construction activities may cause malfunctioning of the community. The level of impact is moderate ($\bar{x}$ = 2.00, S.D. = 0.0000), which has proposed a solution to the problem by repairing / improving roads damaged. And to control the action as well.
- Impact of illness (2.5 %) from the air, waste and emissions. The level of impact is moderate ($\bar{x}$ = 2.00, S.D. = 0.0000), which proposes solutions to problems with the controls tightened. Health care measures And air quality monitoring
- Impact of stress (7.5 %) due to concerns about the impact on the environment. May need relocation The level of impact is moderate ($\bar{x}$ = 2.00, S.D. =

0.0000), which has proposed a solution to the problem by clarifying the consequences and how to protect the public in understanding.

- Impact of traffic accidents (5.0 %) from vehicle speed, traffic volume, more trucks run faster. The level of impact is moderate ($\overline{x}$ = 1.83, S.D. = 0.3727), which proposes solutions to take care not to control and manage accidents during rush hour. And controls are tightened
- Impact of accidents Project (2.5 %) from the car traffic accident. The level of impact is moderate ($\overline{x}$ = 2.00, S.D. = 0.0000), which proposes solutions to problems with the controls tightened.
- Impact of occupations (0.8 %) expect to change careers. The level of impact is moderate ($\overline{x}$ = 2.00, S.D. = 0.0000).
- Impact of employment (0.8 %) expect to change careers. The level of impact is moderate ($\overline{x}$ = 2.00, S.D. = 0.0000).
- Impact of the relationship of the community (0.8 %), the degree of impact is moderate ($\overline{x}$ = 2.00, S.D. = 0.0000).
- Impact of travel (0.8 %), the impact of the high level ($\overline{x}$ = 3.00, S.D. = 0.0000).

- **Impacts anticipated during the operation period.**

Most respondents (86.7 %) is not expected to be affected during the project, while 13.3 are expected to be affected during the operation, the overall average ($\overline{x}$ = 2.21, SD. = 0.4038) (**Table 4.4.1-24**), the impact is expected to be in operation.

- Impact of air quality (10.8 %) emissions from exhaust air to heat up the dust, soot / smoke, no waste treatment before being released. The level of impact is moderate ($\overline{x}$ = 2.25, S.D. = 0.4330), which has proposed a solution to the problem by imposing protective measures and comply strictly with trap / filter before being released/controlled operation as well.
- Impact of water (6.7 %) from the sewage / wastewater discharge water quality is bad outside. No waste treatment before being released. The level of impact is moderate ($\overline{x}$ = 2.29, S.D. = 0.4518), which proposes solutions to minimize the problem by controlling the action well.
- Impact of noise (0.8 %) from the project / process level of impact is moderate ($\overline{x}$ = 2.00, SD = 0.0000), which has proposed a solution to the problem by imposing preventive measures to control and perform well.

- Impact of garbage (0.8 %) of workers / laborers. The level of impact is moderate ($\overline{x}$ = 2.00, S.D. = 0.0000), which has proposed a solution to the problem by imposing preventive measures to control the action.
- Impact of chemicals (3.3 %) from the explosion of gas emissions leakage of chemicals. The level of impact is moderate ($\overline{x}$ = 2.25, S.D. = 0.4330), which has proposed a solution to the problem by checking the safety measures to prevent the controls are tightened. and comply strictly
- Impact of water (1.7 %) use water to produce electricity. May not be enough water for the community. The level of impact is moderate ($\overline{x}$ = 2.00, S.D. = 0.0000), which has proposed a solution to the problem by imposing a measure that is better than today.
- Impact of network communications (0.8 %) increase from the boom. Traffic volumes increase, the level of impact is moderate ($\overline{x}$ = 2.00, S.D. = 0.0000), which proposes solutions to problems with the management and control system during rush hour and to control the action as well.
- Impact of illness (1.7 %) due to illness from air pollution. The level of impact is moderate ($\overline{x}$ = 2.00, S.D. = 0.0000), which has proposed a solution to the problem by following strict measures to check the health of the community.
- Impact of stress (5.8 %) due to concerns about the environmental impact of a pollution level of impact is moderate ($\overline{x}$ = 2.14, SD = 0.3499), which has proposed amendments to clarify the issue by taking care of the project. Let people know and controls are tightened
- Impact of traffic accidents (0.8 %) of car traffic accident rises. The impact of the high level ($\overline{x}$ = 3.00, S.D. = 0.0000), which proposes solutions to mitigate the problem by installing a billboard promoting the project.

TABLE 4.4.1-24

ANTICIPATION IMPACTS WITHIN SUB-DISTRICT MUNICIPALITY ADMINISTRATIVE BOUNDARY DURING OPERATION PEROID (0 TO 3 KM OF RADIUS FROM PROJECT LOCATION)

N = 120

Impacts During Operation Peroid	Magnitude of Impacts			Number (person)	Average $(\bar{x})$*	Standard Deviation (S.D.)	Level of Impact
	High	Moderate	Low				
Environment							
1. Air Quality	3	9	0	12	2.25	0.4330	Moderate
2. Water Quality	2	5	0	7	2.29	0.4518	Moderate
3. Noise	0	1	0	1	2.00	0.0000	Moderate
4. Waste	0	1	0	1	2.00	0.0000	Moderate
5. Chemical Agent	1	3	0	4	2.25	0.4330	Moderate
Infrastructure							
1. Water Supply	0	2	0	2	2.00	0.0000	Moderate
2. Transport Network	0	1	0	1	2.00	0.0000	Moderate
Health							
1. Illness	0	2	0	2	2.00	0.0000	Moderate
2. Stress	1	6	0	7	2.14	0.3499	Moderate
3. Traffic Accident	1	0	0	1	3.00	0.0000	High
Overall of impact	**8**	**31**	**0**	**39**	**2.21**	**0.4038**	**Moderate**

Remark: * Interpretation of level of impact from Average $(\bar{x})$
- Low: $1.00 \leq (\bar{x}) \leq 1.50$
- Moderate: $1.51 \leq (\bar{x}) \leq 2.50$
- High: $2.51 \leq (\bar{x}) \leq 3.00$

Source: TEAM Consulting Engineering and Management Co., Ltd, 2014

When asked to comment on lifestyle changes when developing the project, it was found that 16.7 % of those interviewed agreed that the project does not cause lifestyle changes. Because life is still the same (35.0 %), followed by any expected to be unaffected. From project development (25.0 %).

For the interview, 83.3 % agreed that the project could cause results to changes in lifestyle. Because there are strangers to live in the greater community (15.0 %), followed by community have prospered (14.0 %), heat up (13.1 %), people in the community with jobs / employment (11.2 %)

- **Public Participation**

From inquiry to voluntarily took part in monitoring the environmental impact of the project before the construction peroid and the implementation peroid.

Pre-construction: the interviewee is willing to contribute to projects that benefit the minor project will help disseminate information to the community. And welcomes information projects (44.2 %, 36.2 % and 19.6 %, respectively).

Construction peroid: the interviewee is willing to contribute to projects that benefit the minor project will help disseminate information to the community. Welcomes information project and to monitor and ensure compliance with the mitigation measures in construction (43.8 %, 36.3 %, 19.4 % and 0.5 %, respectively).

Operation peroid: the interviewee is willing to contribute to projects that benefit the minor project will help disseminate information to the community. Welcomes information project and to monitor and ensure compliance with the mitigation measures in the action (35.0 %, 41.6 %, 19.3 % and 3.0 %, respectively).

- **Comments and suggestions on the project**

People in the area that the project should take the form or the proper way for the release by a letter/notice to inform the public directly through community leaders. Clarification meeting and hearing, etc., 13.8 % of the sample expressed an opinion about the information that the public needs to know the main points are a good result - the result of a development project. Detailed Project Information Environmental impacts from project development, etc.

14.1 % had comments and suggestions to promote projects include signage, public relations project. Additional information during a public lot Details on the changes. Documents distributed to the public in the community thoroughly.

In addition, 11.6 % had comments and suggestions on the development of additional projects such event for the community on a regular basis. Measures to cover the Manage the effects that cause adverse effects on all aspects of water management should be good. Be careful in construction A good measure, and operating strictly so.

(d.2) The households in the study areas under the administration of the sub-district administrative organization within a 3 to 5 km of radius around the precincts of the project

- **General information about the interviewees**

Of all the interviewees, 41.9 % are male and 58.1 % are female; the average age is 49.1 years old; 45.2 % are household leaders, 32.3 % are the spouses of the household leaders, and 8.6 % are children/sons or daughters in law of the household leaders; 45.2 % have primary school diploma, 16.1 % have junior high school diploma equal to senior high school diploma/vocational college diploma; 100.0 % are Buddhist.

49.5 % of the interviewees have lived in the community since they were born, 50.5 % have moved from other provinces. Of those who have moved from other provinces, 53.2 % are originally from provinces in the northeastern region, 19.1 % are originally from provinces in the eastern region, and 14.9 % are originally from other provinces in the central region. 74.5 % decided to move here to look for work, 10.6 % because their parents/relatives moved here, and 6.4 % because they are married to the people in the area. The average length of residence here is 21 years. When asked about their desire to move away, 91.4 % have no desire to do so because here is their hometown, they have home and family here, they work here/have business here, etc.

8.6 % have a plan to move away to live elsewhere because they want to move back to their hometown, job finding and move to stay with their offspring in other provinces in the central and northeastern region of Thailand.

- **Information about the households' socio-economics**

The average number of the permanent household members is 4.6, with 2.2 males and 2.4 females. Most are in working age, then studying age, and pre-school child age, respectively. Ratio of working people per non-working people is 2.3 : 2.3.

31.2 % of the interviewees are factory employees, 23.7 % are employees elsewhere, 20.4 % are business owners, and 7.5 % are farmers. 17.2 % of the interviewees also have part-time jobs to supplement their income such as merchant, employees elsewhere, and agricultural.

96.8 % of these working interviewees have no problem in earning their livelihood, while 3.2 % of them have problems such as insufficient income, low economic, less customer and be cheated. The average income of the households is 21,000 Baht and the average expenditure is 17,000 Baht. 86.0 % of the households earn enough for their expenditure, while 14.0 % of them do not and have to ask for loans or cut on their spending.

- **Healthcare services and convenience in getting the services at present**

For healthcare services, 70.2 % of the interviewees go to governmental hospital, 19.2 % to private hospital/clinic, and 7.7 % to sub-district health promoting hospital/ public health center. Almost all the interviewees (95.7 %) find that healthcare services in the area are adequate. When asked about convenience in travelling to get healthcare services, 94.6 % of the interviewees find that it is convenient, while.3.2 % face some difficulty in travelling to get healthcare services due to remote location of their living place and deteriorated road.

- **Problems about the environment and infrastructure at present**

Less than 40.0 % of the interviewees are of the opinion that there are environmental problems resulting from the project. The top three problems the interviewees think affect them most are (1) problem from dust particles/soot/smoke from the traffic in the area (35.5 %), (2) problem from smell from the chicken farms, factories and solid waste in the area (30.1 %), (3) problem from noise resulting from the traffic of truck and industrial estate (20.4 %). Most of impact level of these environmental problems is considered to be moderate, except for wastewater and solid problems are problems are considered to be high ($\overline{x}$ = 2.80 and 2.67, respectively), as shown in **Table 4.4.1-25**.

For problems about the infrastructure and public utilities, the problem the interviewees think affect them most is tap water system (30.1 %) caused by water is not running/less water, water turbidity contain with sediment, and no access to tap water system. Coming second is road problem (17.3 %) caused by a high number of trucks and the roads being damaged. These are shown in **Table 4.4.1-25**. The impact level of the problems incurred is considered to be at a moderate level ($\overline{x}$ = 1.80-2.50).

- **Community problems and life and property safety problems**

50.5 % of the interviewees are of the opinion that there exist community problems and life and property safety problems, which involve theft and robbery (42.1 %), drugs (33.7 %), teenage gangs/juvenile delinquency (8.4 %), and quarrel (6.3 %).

TABLE 4.4.1-25

EXISTING ENVIRONMENTAL PROBLEMS AND INFRASTRUCTURE, HOUSEHOLD GROUP, WITHIN A 3 TO 5 KM OF RADIUS OF SUB-DISTRICT ADMINISTRATIVE ORGANIZATION BOUNDARY

N = 93

Issues	Number	% age	Average ($\bar{x}$)*	Level of Impact
Environmental Problems				
1) Odor	28	30.1	2.25	Moderate
2) Noise	19	20.4	2.26	Moderate
3) Dust/Soot/Smoke	33	35.5	2.15	Moderate
4) Traffic	5	5.4	2.00	Moderate
5) Waste	3	3.2	2.67	High
6) Wastewater	5	5.4	2.80	High
Basic Infrastructure and Public Services				
7) Electricity	15	16.1	1.80	Moderate
8) Tap Water	28	30.1	2.11	Moderate
9) Road	16	17.3	2.44	Moderate
10) Waste Management (Disposal)	1	1.1	2.00	Moderate
11) Sufficiency in Public Health	2	2.2	2.50	Moderate

Remark: * Interpretation of level of impact from Average ($\bar{x}$)
- Low: $1.00 \leq (\bar{x}) \leq 1.50$
- Moderate: $1.51 \leq (\bar{x}) \leq 2.50$
- High: $2.51 \leq (\bar{x}) \leq 3.00$

Source: TEAM Consulting Engineering and Management Co., Ltd, 2014

- **Sufficiency of water sources and quality of water for household use**

78.5 % of the households interviewed have sufficient water for household use, while 18.3 % do not due to water is not running and insufficient of water in dry season.

The main sources of water for household use are:

– Tap water (66.7 %), 68.1 % of the users find that quality of tap water is good, while 23.3 % do not due to water turbidity contain with sediment.

– Pond water (18.2 %), 88.9 % of the users find that quality of pond water is good, while 11.1 do not due to water turbidity contain with sediment.

- **Sufficiency of water sources and quality of drinking water in household**

96.8 % of the households interviewed have sufficient water for consumption, while 3.2 % do not due to there is no other source of drinking of water.

The main sources of water for consumption are:

- Bottled water/ drinking water in a big size packaged jar (71.6 %), all of the consumers find the quality of the bottled water/ drinking water in a big size packaged jar satisfactory.
- Tap water (11.8 %), 76.9 % of the consumers find the quality of Tap water satisfactory, while 15.4 % do not due to bad smell and water turbidity contain with sediment for 7.7 %.

When asked about their satisfaction with their community, 64.5 % of the households interviewed have a moderate level of satisfaction due to peace and harmony. 34.3 % have a high level of satisfaction because people in the community live in harmony and good environment/weather.

- **Knowledge about the project and relevant suggestions**

68.8 % of interviewees knew before about the project. 33.3 % were informed through neighborhoods/co-worker, 25.0 % through village headman and 22.2 % through staff of project. Regarding concerns about the project development, 83.9 % of the interviewees have no concern about impacts resulting from the project, whereas 16.1 % expressed their concern over various issues, such as air pollution/bad air quality (50.0 %), lack of life and property safety (25.0 %), etc. Also, it is suggested that the measures established to minimize the aforementioned impacts be strictly implemented in the management of the project.

Activities to hear the interview. Defined in the study plans, economic - social. The activity was conducted after participating states. In the hearing, including the first meeting with local leaders and the platform meeting. It found that a number of the interviews were not much had been informed before the project, however, has given priority to the project informed. And public opinion defined in the study plan by the events in this ongoing process. To understand and awareness - learning. Modify the joint project, this will be beneficial to all parties.

- **Impacts anticipated**

Impacts anticipated during the construction period

90.9 % of the interviewees anticipate no impact from the project during the construction period, while 7.5 % think there can be some impacts, the level of which is overall considered to be moderate ($\overline{x}$ = 1.80, S.D. = 0.4000), as shown in **Table 4.4.1-26**. Impacts anticipated during the construction period include:

- Impact of air quality (7.5 %), which is caused by air pollution, dust particles, and hotter weather. The impact level is considered to be moderate ($\bar{x}$ = 1.86, S.D. = 0.3499). A mitigation measure suggested involves good management and strict control of the construction works.
- Impact of water quality (2.2 %), which is caused by wastewater/bad water quality and chemical contamination in the water. The impact level is considered to be moderate ($\bar{x}$ = 1.50, S.D. = 0.5000). A mitigation measure suggested involves good management and strict control of the construction works.
- Impact of chemical substances (1.1 %), which are in polluted air. The impact level is considered to be moderate ($\bar{x}$ = 2.20, S.D. = 0.4000). A mitigation measure suggested involves good management and strict control of the construction works.

TABLE 4.4.1-26

ANTICIPATION IMPACTS WITHIN SUB-DISTRICT ADMINISTRATIVE ORGANIZATION BOUNDARY DURING CONSTRUCTION PERIOD (3 TO 5 KM RADIUS FROM PROJECT LOCATION)

N = 93

Impacts During Operation Period	Magnitude of Impacts			Number (person)	Average $(\bar{x})$*	Standard Deviation (S.D.)	Level of Impact
	High	Moderate	Low				
Environment							
1. Air Quality	0	6	1	7	1.86	0.3499	Moderate
2. Water Quality	0	1	1	2	1.50	0.5000	Low
3. Chemical Agent	0	1	0	1	2.00	0.0000	Moderate
Impact (Total)	**0**	**8**	**2**	**10**	**1.80**	**0.4000**	**Moderate**

Remark: * Interpretation of level of impact from Average ($\bar{x}$)
- Low: 1.00 ≤ ($\bar{x}$) ≤ 1.50
- Moderate: 1.51 ≤ ($\bar{x}$) ≤ 2.50
- High: 2.51 ≤ ($\bar{x}$) ≤ 3.00

Source: TEAM Consulting Engineering and Management Co., Ltd, 2014

Impacts anticipated during the operation period

90.3 % of the interviewees anticipate no impact from the project during the operation period, while 9.7 % think there might be some impacts, the overall level of which is considered to be moderate ($\bar{x}$ = 1.94, S.D. = 0.4285), as shown in **Table 4.4.1-27**. Impacts anticipated during the operation period include:

- Impact of air quality (8.6 %), which is caused by air pollution. The impact level is considered to be moderate ($\bar{x}$ = 2.00, S.D. = 0.0000). A mitigation measure suggested involves good administration of the project works related.
- Impact of noise (1.1 %), which results from the project operation/ production process. The impact level is considered to be moderate ($\bar{x}$ = 2.00, S.D. = 0.000). A mitigation measure suggested involves good administration of the project works related.
- Impact of solid waste (1.1 %), which results from project staff and from the project operation. The impact level is considered to be low ($\bar{x}$ = 3.00, S.D. = 0.000). A mitigation measure suggested involves good administration of the project works related.
- Impact of illness (1.1 %), which results from the project implementation and lead to poor health of people in community. A mitigation measure suggested to provide doctor for people in community and conduct health check-up.
- Impact of burning smell (1.1 %), which results from production process of power plant. The impact level is considered to be moderate ($\bar{x}$ = 2.00, S.D. = 0.000).

TABLE 4.4.1-27

ANTICIPATION IMPACTS WITHIN SUB-DISTRICT ADMINISTRATIVE ORGANIZATION BOUNDARY DURING OPERATION PERIOD (3 TO 5 KM RADIUS FROM PROJECT LOCATION)

N = 93

Impacts During Operation Period	Magnitude of Impacts			Number (person)	Average ($\bar{x}$)*	Standard Deviation (S.D.)	Level of Impact
	High	Moderate	Low				
Environment							
1. Air Quality	0	7	1	8	1.88	0.3307	Moderate
2. Water Quality	0	2	0	2	2.00	0.0000	Moderate
3. Noise	0	1	0	1	2.00	0.0000	Moderate
4. Waste	0	0	1	1	1.00	0.0000	Low
5. Chemical Agent	0	2	0	2	2.00	0.0000	Moderate
Health							
1. Illness	1	0	0	1	3.00	0.0000	High
2. Burnt Odor	0	1	0	1	2.00	0.0000	Moderate
Impact (Total)	**1**	**13**	**2**	**16**	**1.94**	**0.4285**	**Moderate**

Remark: * Interpretation of level of impact from Average ($\bar{x}$)
- Low: 1.00 ≤ ($\bar{x}$) ≤ 1.50
- Moderate: 1.51 ≤ ($\bar{x}$) ≤ 2.50
- High: 2.51 ≤ ($\bar{x}$) ≤ 3.00

Source: TEAM Consulting Engineering and Management Co., Ltd, 2014

When asked to comment on lifestyle changes when developing the project, it was found that 61.3 % of those interviewed agreed that the project does not cause lifestyle changes. Because living place is far from project location (73.7 %), followed by any expected to be unaffected (12.3 %), and life is still the same (3.5 %).

For the interview, 38.7 % agreed that the project could cause results to changes in lifestyle. Because project development lead to growth of community (23.1 %), followed by high development of community equal to high number of strangers live in the community (15.0 %), and people in the community with jobs / employment (12.8 %).

- **Public Participation**

When the interviewees were asked about their willingness to be involved in monitoring the environmental impacts resulting from the project before and during the construction peroid and operation peroid, the findings are as follows:

Pre-construction period: 41.2 % of the interviewees are willing to provide information that can be useful for the project. 37.2 % are willing to receive information and news about the project. 12.8 % are willing to help disseminate information about the project to the people in their community.

Construction period: 37.3 % of the interviewees are willing to provide information that can be useful for the project. 32.0 % are willing to receive information and news about the project. 16.3 % are willing to help disseminate information about the project to the people in their community. 5.9 % are willing to help follow up that the act in compliance with the measures established to decrease the impacts during the construction period.

Operation period: 34.0 % of the interviewees are willing to provide information that can be useful for the project. 31.3 % are willing to receive information and news about the project. 15.6 % are willing to help disseminate information about the project to the people in their community. 8.8 % are willing to help follow up that the act in compliance with the measures established to decrease the impacts during the operation period.

- **Additional ideas and suggestions on the project**

The people in the area think that appropriate manners and approaches for public relations of the project include disseminating information through the community leaders, sending letters/documents to inform the people directly,

organizing explanatory meeting and public hearing, and having notice boards made. 50.0 % of the interviewees express their opinion about the topics mainly of interest to the people in the area, which include the pros and cons resulting from the development of the project, details about the project, environmental protection measures, other impacts resulting from the development of the project, safety in the operation of the project, advantage to community, etc.

11.7 % of the interviewees made some further opinions and suggestions on the public relations of the project, for example having notice boards made, widely disseminate information about the project, send E-mail, and give more information.

5.3 % of the interviewees gave some further opinions and suggestions on the development of the project, for example that good management system be set for the project, preventive measures be established for safety to the community, construction be completed within due time, good environmental management, least impact to community, etc.

(d.3) Summary of overall opinions on the project

From the study results, overall opinions on the project can be summarized based on the categorization of the households into three sample groups, which are

- The households in the study areas under the administration of the sub-district administrative organization within a 0 to 3 km of radius around the precincts of the project
- The households in the sub-district municipality within a 0 to 3 km of radius around the precincts of the project
- The households in the study areas under the administration of the sub-district administrative organization within a 3 to 5 km of radius around the precincts of the project.

It can be said that although some of the interviewees still have concerns about impacts anticipated to result from the development of the project both in the construction period and operation period, the majority in all the sample groups think in the same line that the project will not impact them significantly. Overall, it is anticipated that the project will not significantly change their way of life nor impact their daily lives. More details are as follows:

Access to information about the project – On average more than 50 % of the interviewees in all the sample groups learned about the project before, except for the households in the study areas under the administration of the sub-district administrative organization within a 3 to 5 km of radius around the precincts of the project, of which only 31.2 % learned about the project before, while 68.8 % just learned about the project for the first time, as shown in **Table 4.4.1-28**. This is so because 1) the sample group live considerably far from the location of the project, resulting in many of them not being informed about the project. 2). The representatives of the households in this sample group are mostly from communities such as housing estates and rooms for rent which are newly established in response to higher demand for workforce of the industrial sectors in the area. These people have busy life tied to their fixed working hours, so when compared to other sample groups, they are less available for the public relations of information about the project. By the way, the survey interview of the sample group was conducted during the normal working hours and also after the normal working hours in the evening (18.00 a.m. to 21.00 p.m.) in order to try to make it as convenient as possible for the subjects in the sample group.

TABLE 4.4.1-28

AVERAGE PERCENTAGE OF INTERVIEWEES WHO INFORMED ABOUT PROJECT DEVELOPMENT

Sample	Sub-district Boundary			Sub-district Municipality Boundary		Remark
	Known	First time	Not Specify	Known	First time	
Community Leader						
- within a 0 to 3 km of radius	88.9	11.1	-	100.0	0.0	
- within a 3 to 5 km of radius	95.0	5.0	-	-	-	There is no Sub-district municipality within a 3 to 5 km of radius.
Household						
- within a 0 to 3 km of radius	60.4	39.0	0.6	81.7	18.3	
- within a 3 to 5 km of radius	31.2	68.8	-	-	-	There is no Sub-district municipality within a 3 to 5 km of radius.
Business Enterprise	56.1	43.9	-	-	-	Situated within Industrial Estate

Concerns about the development of the project – 80.87 % of the interviewees have no concern about the project. Those from the study areas under the administration of the sub-district administrative organization within a 0 to 3 km of radius and 3 to 5 km of radius around the precincts of the project have less anxiety than those from the study areas under the administration of the sub-district municipality within a 0 to 3 km of radius around the precincts of the project. The results clearly show that the distance between the location of the community and the project significantly affects anxiety level. The anxiety level of the communities situated nearer to the project precincts is higher than that of the communities situated farther, as shown in **Figure 4.4.1.7**. The issues that they are worried about include impacts from air pollution, lack of life and property safety, water pollution, and so on.

Impacts anticipated to arise during the construction period of the project – 85-92 % of the interviewees do not think that there will be any impact from the project during its construction period. For the interviewees who think so, the impacts anticipated include those caused by dust particles, reduced amount of water available for use in the community, noise problem, traffic congestion, traffic accident, and so on; as shown in **Figure 4.4.1.8**.

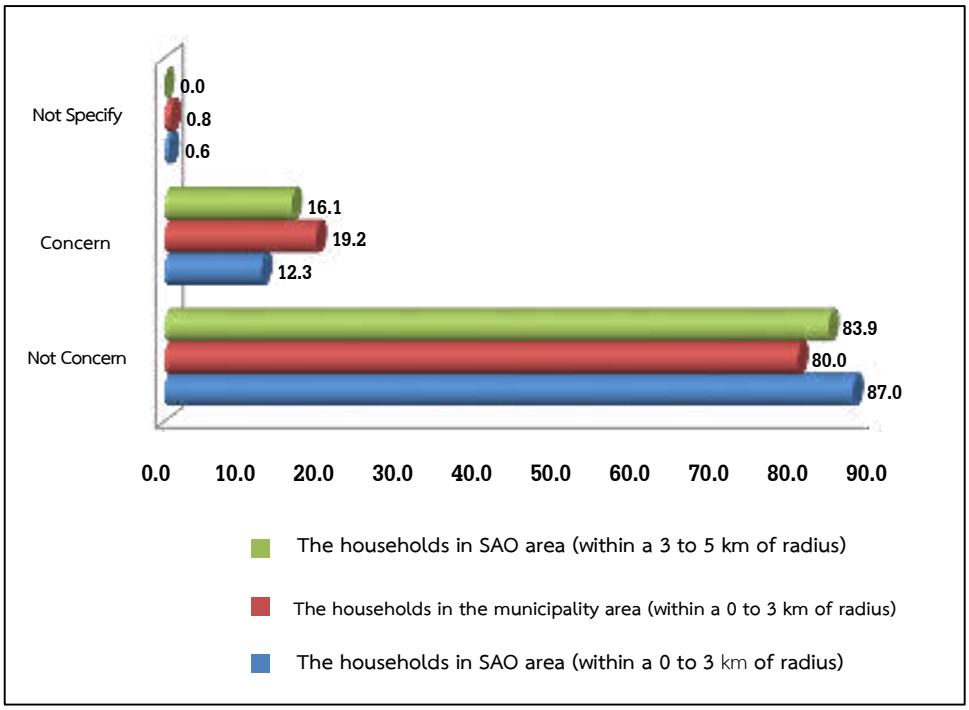


FIGURE 4.4.1-7 : CONCERNS ABOUT THE DEVELOPMENT OF THE PROJECT

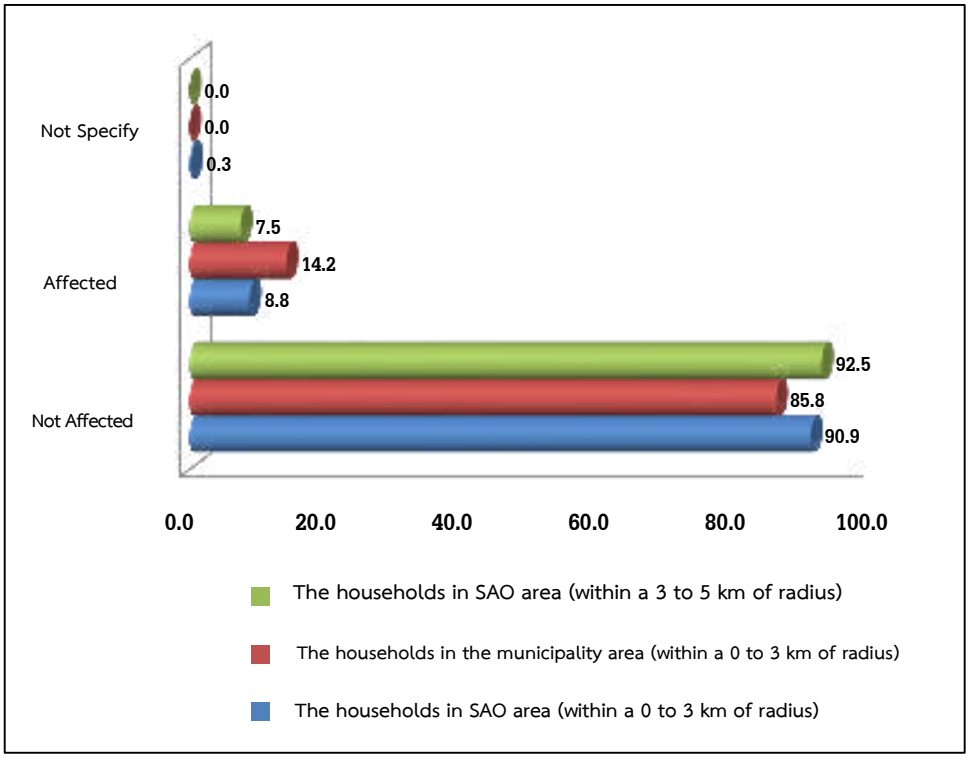


FIGURE 4.4.1-8 : IMPACTS ANTICIPATED TO ARISE DURING THE CONSTRUCTION PERIOD OF THE PROJECT

Impacts anticipated to arise during the operation period of the project – 86-90 % of the interviewees do not think that there will be any impact from the project during its operation period. For the interviewees who think so, the impacts anticipated include those involving air pollution, water quality, health problems (respiratory system problem, rash, and accumulation of chemical substances in the body). On the other hand, some positive impacts are also anticipated, such as sufficient supply of electricity, improved economy, the community being more modernized and thus more convenience for its people, and so on; as shown in **Figure 4.4.1.9**.

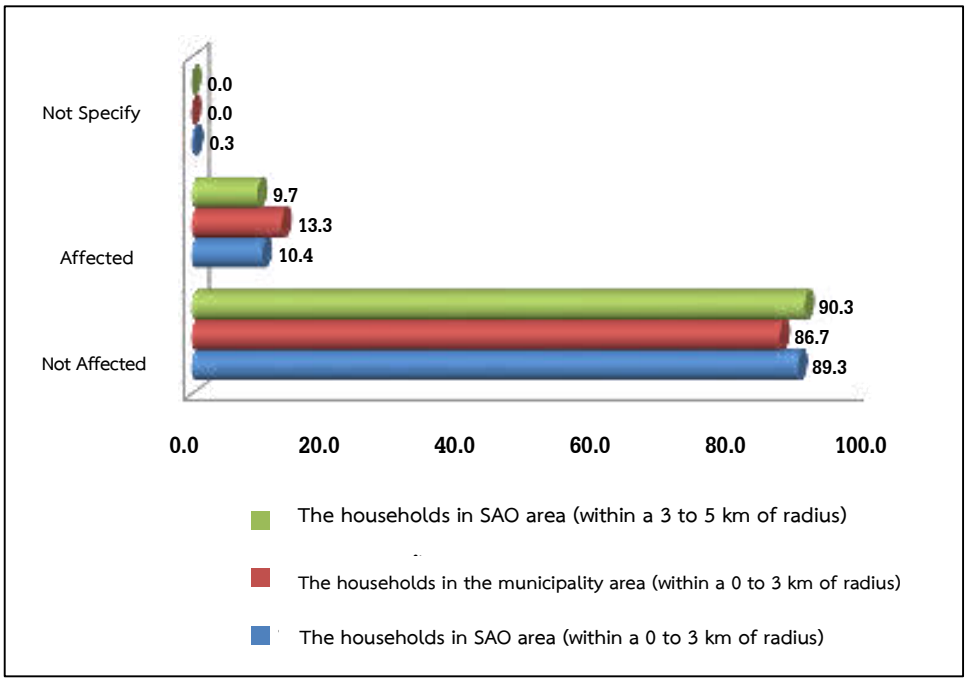


FIGURE 4.4.1-9 : IMPACTS ANTICIPATED TO ARISE DURING THE OPERATION PERIOD OF THE PROJECT

Anticipated change to the people's way of life resulting from the development of the project – 53-61 % of those from the study areas under the administration of the sub-district administrative organization within a 0 to 3 km of radius and 3 to 5 km of radius around the precincts of the project do not think that there will be any significant change to the people's way of life resulting from the development of the project, as they will still live their daily life as usual; whereas 83 % of those from the study areas under the administration of the sub-district municipality within a 0 to 3 km of radius around the precincts of the project anticipate some changes to the people's way of life. All the three sample groups; however, are in accordance that the changes possible to arise are positive, such as the community being more modernized, more job opportunities and employment for the local people in spite of more people from outside coming to live and work in the area, and improved economy in the community; as shown in **Figure 4.4.1-10**.

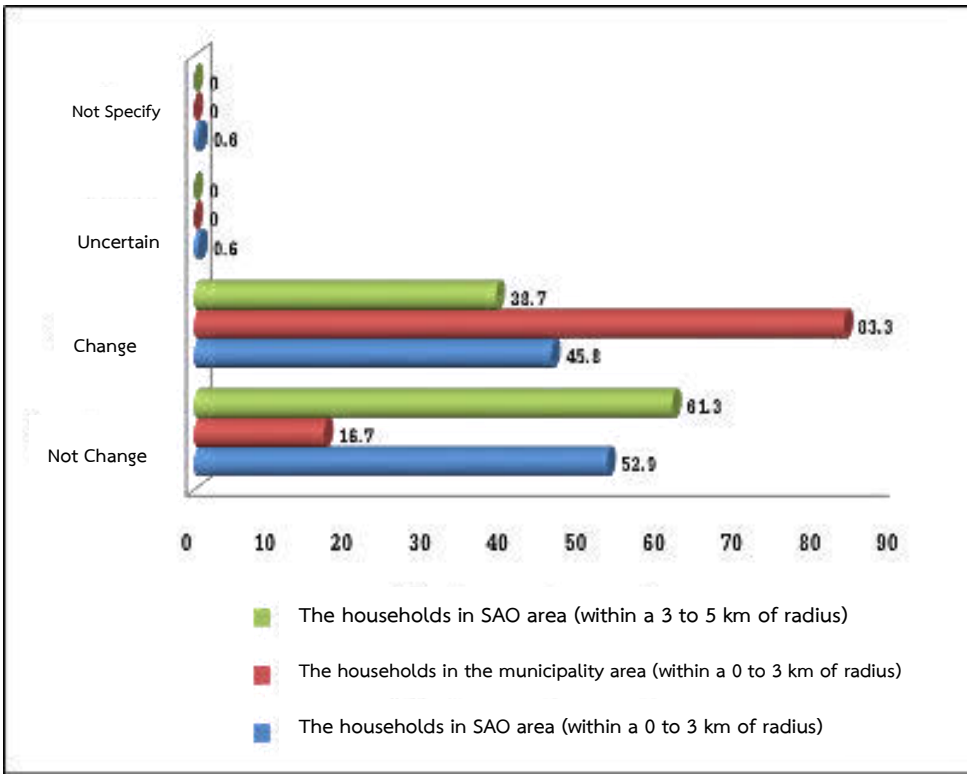


FIGURE 4.4.1-10 : ANTICIPATED CHANGE TO THE PEOPLE'S WAY OF LIFE RESULTING FROM THE DEVELOPMENT OF THE PROJECT

4.4.2 Health

(1) Introduction

The project development may cause to risk of health of local people and employees. So, it is necessary to surveillance on health impact from the project development during the construction period and operation period. The impacts of health/occupational health and safety were assessed together with propose environmental impact mitigation and preventive measures and environmental impact monitoring measures for the least impacts.

Impact assessment on health/occupational health and safety has been carried out according to Guidelines for HIA in EIA Report, Thailand (Environmental Impact Evaluation Bureau, Office of Natural Resources and Environmental Policy and Planning (ONEP), Ministry of Natural Resources and Environment, June 2008) and carried out according to the notification of Ministry of Natural Resources and Environment prescribing rule, method, regulations and EIA guideline for project may cause severe impact to communities, environmental quality and health B.E.2552 (2009), 29 December 2009). Public health in study area will be studied on public health resources and existing health status of local people together with project characteristic and others of environmental impacts. Basic healthdatasuch as health status of local people, who may impact from project and public health service, will be gathered and used for health impact assessment.

(2) Study methods

(2.1) Secondary Data Collection

- Number of annual population from public health in study area was gathered and used to studyt the tend of morbidity rate of population in study area. The study area covered 6 Sub-districts and 1 Sub-district Municipality in 4 Districts of 2 Provinces: Khao Kansong and Bowin Sub-districts in Si Racha District, Nong Suea Chang Sub-district in Nong Yai District, Khlong Kio Sub-district in Ban Bueng District, Chon Buri Province, Ta Sit Sub-district, Pluak Daeng Sub-district and Chomphon Chao Phraya Sub-district Municipality in Pluak Daeng District, Rayong Province.
- Public health service data from public health agencies in study area were gathered as follows:
  - Number of public health agency in study area in 2014
  - Public Health Officers in 2014
  - Vital statistics are comprised of death and birth rate of population in study area during 2009-2014 and population pyramid in 2014.
  - Top-ten maximum morbidity rate of disease group (follow report Ror Ngor 504), top-ten patient statistic data (follow report Ror Ngor 505) and Epidemic Diseases Surveillance data (follow report Ror Ngor 506) in study area during 2009-2013.

- Statistics of death and mortality rate per one hundred thousand population were categoried by cause of death during 2009-2013 together with road accident
- Mental Health data of people in Chon Buri and Rayong Provinces during 2009-2013
- Statistics of crime in study area during 2009-2014
- Statistics of road accident in study area during 2009-2013
- Number of medical equipment in public health in study area

(2.2) Primary Data Collection

Interview of public health officers were conducted by using questionair survey as a tool. Details from interviewing of public health officers were number of public health officers, service availibity, tend of disease, emergency service system, exiting of environment, comments and suggestion, etc.

(3) Study results

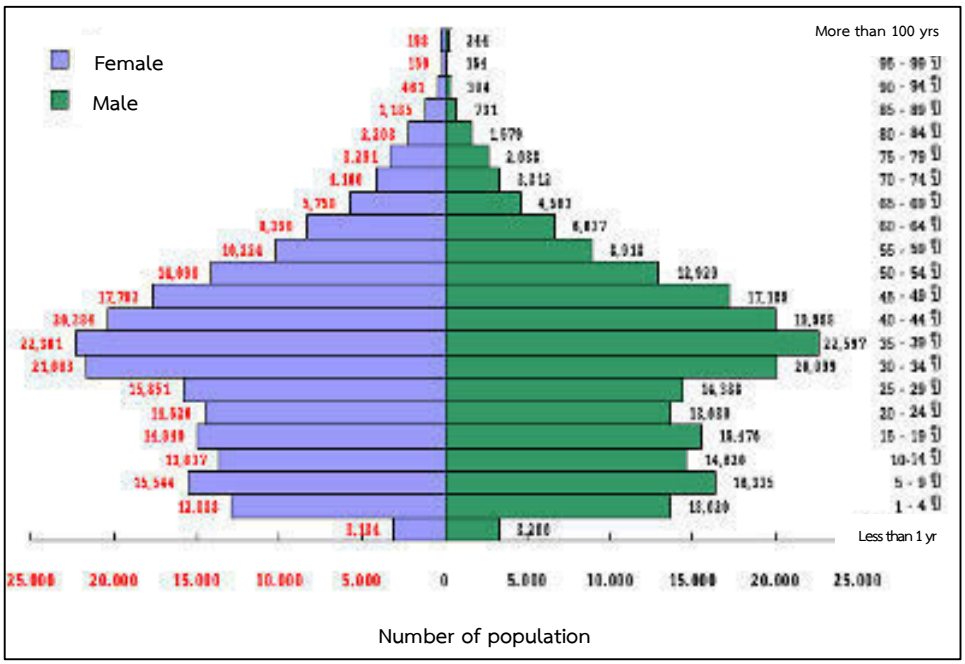
(3.1) Secondary data

(a) Population and population dispersion

Project development may cause to impact on people in study area both in the construction period and operation period especially risk population group that sensitive to health threaten (Children group 0-14 years old and elder people group more than 60 years old). Population in Si Racha, Ban Bueng and Nong Yai Districts in Chon Buri Province, Pluak Daeng District in Rayong Province that were located in study area as shown in **Figure 4.4.2-1**. The population dispersion was divided by age and gender in B.E.2557 (2014) (Population data in December 2014: the Department of Provincial Administration, Ministry of Interior, 2015). Structure of population was constrictive pyramid. It was indicated that number of births and deaths were decreased. Ratio of male and female were closed (48.91 % and 51.09 %, repectively). Large numbers of population were labor age (68.12 %) and sensitive population to threaten health (children group 0-14 years old and elder people group more than 60 years old) was 31.88 %.

(b) Public Health Resources

Project development may cause to impact on health service. Labors during the construction period are migrant workers who emigrated into the area while in operation period were employees. Impacts of migrant workers and employees of the project may cause to impact on healh service. Public health agencies in study area were Tambon Health Promoting Hospitals and hospitals. Gathered secondary data were service availibity, public health officers availibity and health status of local people. Details are described as below.



Source: Department of Provincial Admisistration, Ministry of Interior, 2015

FIGURE 4.4.2-1 : POPULATION PYRAMID OF DISTRICTS IN STUDY

(b1) Public Health Agency

Study area covered partialy of Si Racha, Ban Bueng and Nong Yai Districts in Chon Buri Province and Pluak Daeng District in Rayong Province. There were 4 public hospitals, 1 hospital belong to Red Cross Society and 4 private hospitals. Total beds were 1,320 beds as shown in **Table 4.4.2-1**. Moreover, there were 7 tambon health promoting hospitals as shown in **Table 4.4.2-2**. Number of beds of Laem Chabang Hospital was not enough for population in responsible area (bed occupancy rate at 118.51). Details are described as below:

Four Public hospitals:

- Laem Chabang Hospital (114 beds with bed occupancy rate at 118.51)
- Ban Bueng Hospital (90 beds with bed occupancy rate at 87.27)
- Nong Yai Hospital (30 beds with bed occupancy rate at 51.34)
- Pluak Daeng Hospital (30 beds with bed occupancy rate at 90.11)

One Hospital belong to Red Cross Society:

- Queen Savang Vadhana Memorial Hospital (500 beds with bed occupancy rate at 85.79)

TABLE 4.4.2-1

DETAILS OF HOSPITAL AND MEDICAL PERSONNEL IN THE STUDY AREA IN EACH DISTRICT IN B.E.2557 (2014)

Province	District	Population	Hospital	Belong to	Number of bed	Bed Occupancy Rate	Appropriate of number of bed	Doctor		Dentist		Pharmacist		Professional nurse	
								Number	Rate	Number	Rate	Number	Rate	Number	Rate
Chon Buri	Si Racha	277,291	Laem Chabang[1/]	Government	114	118.5	Crowded	22	1 : 12,605	7	1 : 39,613	14	1 : 19,807	120	1 : 2,311
			Queen Savang Vadhana Memorial Hospital2/	Red Cross Society	500	85.79	Appropriated	130	1 : 2,134	12	1 : 23,108	25	1 : 11,092	438	1 : 634
			Samitivej Srirachahospital3/	Private	150	-	-	25	1 : 11,092	6	1 : 46,216	6	1 : 46,216	82	1 : 3,382
			Phyathai Sriracha hospital[3/]	Private	251	-	-	90	1 : 3,082	11	1 : 25,209	25	1 : 11,092	304	1 :913
			Vibharam Laemchabang hospital[4/]	Private	100	-	-	6	1 : 46,216	0	-	3	1 : 92,431	20	1 : 13,865
			Piyavate Bowin hospital[5/]	Private	55	-	-	5	1 : 55,459	0	-	1	1 : 277,291	14	1 : 19,807
			Total hospital in Si Racha District		-	-	-	278	1 : 998	36	1 : 7,703	74	1 : 3,748	978	1 : 284
	Ban Bueng	102,318	Ban Bueng [6/]	Government	90	87.27	Appropriated	19	1 : 5,386	8	1 : 12,790	10	1 : 10,232	102	1 : 1,004
	Nong Yai	23,258	Nong Yai [7/]	Government	30	51.34	Over bed	3	1 : 7,753	3	1 : 7,753	2	1 : 11,629	33	1 : 705
Rayong	Pluak Daeng	54,664	Pluak Daeng [7/]	Government	30	90.11	Appropriated	6	1 : 9,111	4	1 : 13,666	6	1 : 9,111	53	1 : 1,032
Study area		**457,513**	**-**	**-**	**1,320**	**-**	**-**	**306**	**1 : 1,496**	**51**	**1 : 8,971**	**92**	**1 : 4,973**	**1,166**	**1 : 393**
National Economic and Social Development Plan				**Issue**	**-**	**-**	**-**	**9**		**8**		**8**		**8**	
				Rate	**-**	**-**	**-**	**1 : 6,000**		**1 : 6,000**		**1 : 5,200**		**1 : 900**	
Rate as per standard of World Health Organization[8/]								**1 : 5,000**		**1 : 7,500**		**-**		**1 : 500**	

Interpretation: Bed Occupancy Rate > 120 meanspatient is more than number of bed (Crowded) Bed Occupancy Rate between 80-120meansbed is sufficient to patient (Appropiated).

Bed Occupancy Rate < 80meansbed is over than number of patient (Over bed)

Remark: Bed Occupancy Ratemeans percentage total of patients occupied bed of public health in particular time

Source:
1/ Laem Chabang Hospital, 2015
2/ Queen Savang Vadhana Memorial Hospital, 2015
3/ Report on public health resources,Planning Division, Minitry of Public Health, 2015
4/ Public Health, Si Racha District, 2014
5/ Ban Bueng Hospital, 2015
6/ Nong Yai Hospital, 2015
7/ Pluak Daeng Hospital, 2015
8/ World Health Organization, 2015 (www.who.int)

TABLE 4.4.2-2

TAMBON HEALTH PROMOTING HOSPITALS IN THE STUDY AREA

No.	Name	Area of Responsibility	Sub-district	District	Patient Transfer	Distance (km.) / Time (min)[1/] of patient transfer (Approx.)
1.	Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-distrct	Moo.3, 4, 5, 7, 8, 9, 10	Khao Khansong	Si Racha	Laem Chabang Hospital	35-40
2.	Ban Khao Hin Tambon Health Promoting Hospital	Moo.4, 6, 7, 8	Bo Win	Si Racha		35-40
3.	Ban Tha Cham Tambon Health Promoting Hospital	Moo.4, 5	Nong Suea Chang	Nong Yai	Nong Yai Hospital	15-20
4.	Ban Muen Chit Tambon Health Promoting Hospital	Moo.5, 6	Khlong Kio	Ban Bueng	Ban Bueng Hospital	35-40
5.	Chaloem Phrakiartof 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district	Moo.7	Khlong Kio	Ban Bueng		20-25
6.	Ban Nong Khang Khao Tambon Health Promoting Hospital	Moo.1, 3, Chomphon Chao Phraya Sub-district Municipality	Ta Sit	Pluak Daeng	Pluak Daeng Hospital	20-25
7.	Ban Nong Bon Tambon Health Promoting Hospital	Moo.2	Ta Sit	Pluak Daeng		20-25

Source: Public Health District and Tambon Health Promoting Hospital in study area, 2015

Seven Tambon Health Promoting Hospital:

- Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-distrct
- Ban Khao Hin Tambon Health Promoting Hospital
- Ban Tha Cham Tambon Health Promoting Hospital
- Ban Muen Chit Tambon Health Promoting Hospital
- Chaloem Phrakiartof 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district
- Ban Nong Khang Khao Tambon Health Promoting Hospital
- Ban Nong Bon Tambon Health Promoting Hospital

Four Private Hospitals:

- Samitivej Sriracha hospital, 138 beds
- Phyathai Sriracha hospital, 150 beds
- Vibharam Laemchabang hospital, 100 beds
- Piyavate Bowin hospital, 55 beds

(b2) Public Health Officers

Compilation data of public health officers in study area categorized by professional career in 2014 found that all public hospitals were lack of doctor, dentist and nurse according to World Health Organization (http://www.who.int, 2558). However, when number of public health officers belong to Red Cross Society and private hospitals where are located in Si Racha District in Chon Buri Province, were included. It was found that Si Racha Distric, Chon Buri Province was lack of only doctocs. Overall of all hospitals in study area was lack of dentist. The ratio of dentist per population was 1:8,971 which was lower than standard of World Health Organization (Standard is 1:7,500) and lower than standard of the National Economic and Social Development Plan No.8 (Standard is 1:6,000). Details are shown in **Table 4.4.2-1**.

(b3) Vital statistics

Vital statistics indicated general status of public health in communities. Vital statistics are birth rate, death rate and natural increase of population rate. Summary of vital statistics (**Table 4.4.2-3**) consisted of Ban Bueng, Nong Yai and Si Racha Districts in Chon Buri Province, Pluak Daeng District in Rayong Province. Overll in the study area found that natural increase of population rate during 2009-2014 between 20.57-22.47 per one thousand population tended to increase.

TABLE 4.4.2-3

VITAL STATISTICS OF POPULATION IN STUDY AREA DURING 2009-2014

Year	Population (person)	Number of Birth (person)	Birth rateper one thousand population	Number of death (person)	Death rateper one thousand population	Increase/decrease rate of natural population per one thousand population
2009	399,059	10,947	27.43	2,060	5.16	22.27
2010	410,184	10,723	26.14	2,179	5.31	20.83
2011	420,520	11,450	27.23	2,305	5.48	21.75
2012	431,090	11,943	27.70	2,258	5.24	22.47
2013	443,068	11,651	26.30	2,535	5.72	20.57
2014	457,531	12,465	27.24	2,870	6.27	20.97

Source : Registration Database, Bureau of Registration Administration, Department of Provincial Admisistration, Ministry of Interior2009-2014 (www.dopa.go.th)

(b4) Health Status

Health status is essence to health impact assessment because it shows health status of local people in the study area before project occurring. Thus, it can be used as basic data to compare and assess health impact during the construction period and operation period. Details are as follows:

1. Cause and Morbidity Rate of Out-patient According to Report no. Ror Ngor.504

- **Hospital**

Cause and Morbidity Rate of Out-patient (Ror Ngor.504) of hospitals in study area were Laem Chabang Hospital, Queen Savang Vadhana Memorial Hospital, Nong Yai Hospital, Ban Bueng Hospital and Pluak Daeng Hospital during 2009-2013 **(Table 4.4.2-4)**. Details are summarized as follows:

Chon Buri Province

Si Racha District

- **Laem Chabang Hospital**

Major cause of morbidity of out-patient was 4 diseases: (1) endocrine, nutritional and metabolic diseases (2) diseases of the respiratory system (3) diseases of the circulatory system and (4) diseases of the digestive system. Details are shown in **Appendix 3H-1 Table 1**.

- **Queen Savang Vadhana Memorial Hospital**

Major cause of morbidity of out-patient was 4 diseases: (1) certain infectious and parasitic diseases (2) endocrine, Nutritional and metabolic diseases (3) diseases of the musculosdeletal system and connective tissue and (4) diseases of the respiratory system. Details are shown in **Appendix 3H-1 Table 2**.

TABLE 4.4.2-4

CAUSE AND MORBIDITY RATE OF OUT-PATIENT (ROR NGOR.504) OF HOSPITALS IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013

Hospital	Ranking	Cause and morbidity rate per one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Laem Chabang	1	Diseases of the respiratory system (10,981)	Endocrine, Nutritional and metabolic diseases (12,643)	Diseases of the respiratory system (10,915)	Endocrine, Nutritional and metabolic diseases (12,541)	Endocrine, Nutritional and metabolic diseases (13,541)	Endocrine, Nutritional and metabolic diseases (11,415)
	2	Endocrine, Nutritional and metabolic diseases (7,209)	Diseases of the respiratory system (11,052)	Endocrine, Nutritional and metabolic diseases (10,781)	Diseases of the respiratory system (11,288)	Diseases of the circulatory system (12,589)	Diseases of the respiratory system (10,995)
	3	Diseases of the circulatory system (6,054)	Diseases of the circulatory system (9,826)	Diseases of the digestive system (10,109)	Diseases of the digestive system (10,664)	Diseases of the respiratory system (10,748)	Diseases of the circulatory system (9,823)
Queen Savang Vadhana Memorial	1	Diseases of the respiratory system (12,510)	Certain infectious and parasitic diseases (18,909)	Certain infectious and parasitic diseases (22,338)	Endocrine, Nutritional and metabolic diseases(21,143)	Certain infectious and parasitic diseases (30,610)	Certain infectious and parasitic diseases (22,108)
	2	Endocrine, Nutritional and metabolic diseases (11,708)	Endocrine, Nutritional and metabolic diseases (18,277)	Endocrine, Nutritional and metabolic diseases (21,143)	Certain infectious and parasitic diseases (22,338)	Diseases of the musculosdeletal system and connective tissue (21,121)	Endocrine, Nutritional and metabolic diseases (19,176)
	3	Certain infectious and parasitic diseases (11,015)	Diseases of the respiratory system (16,100)	Diseases of the respiratory system (14,120)	Diseases of the musculosdeletal system and connective tissue (16,192)	Endocrine, Nutritional and metabolic diseases (17,787)	Diseases of the musculosdeletal system and connective tissue (14,864)

TABLE 4.4.2-4
CAUSE AND MORBIDITY RATE OF OUT-PATIENT (ROR NGOR.504) OF HOSPITALS IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013 (Cont'd)

Hospital	Ranking	Cause and morbidity rate per one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Nong Yai	1	Diseases of the respiratory system (40,031)	Diseases of the respiratory system (39,283)	Diseases or the digestive system (32,699)	Diseases of the respiratory system (38,760)	Diseases of the respiratory system (39,565)	Diseases of the respiratory system (39,192)
	2	Diseases of the digestive system (31,785)	Diseases of the digestive system (32,699)	Diseases of the respiratory system (39,283)	Diseases of the digestive system (35,353)	Diseases of the digestive system (36,146)	Diseases of the digestive system (35,433)
	3	Diseases of the circulatory system (27,695)	Diseases of the circulatory system (26,207)	Diseases of the circulatory system (26,207)	Diseases of the circulatory system (27,519)	Diseases of the circulatory system (29,279)	Diseases of the circulatory system (27,063)
Ban Bueng	1	Diseases of the respiratory system (31,085)	Diseases of the respiratory system (34,023)	Diseases of the respiratory system (30,682)	Diseases of the circulatory system (33,852)	Diseases of the circulatory system (35,103)	Diseases of the respiratory system (31,011)
	2	Diseases of the digestive system (23,495)	Diseases of the digestive system (25,344)	Diseases of the circulatory system (30,514)	Diseases of the respiratory system (29,671)	Diseases of the respiratory system (29,666)	Diseases of the digestive system (28,132)
	3	Diseases of the musculosdeletal system and connective tissue (16,179)	Diseases of the circulatory system (25,310)	Diseases of the digestive system (25,705)	Endocrine, Nutritional and metabolic diseases (27,178)	Endocrine, Nutritional and metabolic diseases (25,850)	Diseases of the circulatory system (24,561)
Pluak Daeng	1	Diseases of the respiratory system (46,735)	Diseases of the respiratory system (44,409)	Diseases o the respiratory system (38,897)	Diseases of the respiratory system (34,784)	Other external causes of morbidity and mortality (33,264)	Diseases of the respiratory system (38,326)
	2	Endocrine, Nutritional and metabolic diseases (30,705)	Other external causes of morbidity and mortality (33,439)	Other external causes of morbidity and mortality (34,740)	Other external causes of morbidity and mortality (33,979)	Diseases of the respiratory system (29,045)	Other external causes of morbidity and mortality (33,291)

TABLE 4.4.2-4
CAUSE AND MORBIDITY RATE OF OUT-PATIENT (ROR NGOR.504) OF HOSPITALS IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013 (Cont'd)

Hospital	Ranking	Cause and morbidity rate per one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Pluak Daeng (Cont'd)	3	Diseases of the digestive system (24,637)	Endocrine, Nutritional and metabolic diseases (25,456)	Endocrine, Nutritional and metabolic diseases (26,268)	Endocrine, Nutritional and metabolic diseases (26,506)	Diseases of the digestive system (24,675)	Endocrine, Nutritional and metabolic diseases (24,378)
Overall of study area	1	Diseases of the respiratory system (28,696)	Diseases of the respiratory system (31,363)	Diseases of the respiratory system (28,647)	Endocrine, Nutritional and metabolic diseases (33,696)	Diseases of the circulatory system (29,412)	Diseases of the respiratory system (29,010)
	2	Endocrine, Nutritional and metabolic diseases (17,320)	Endocrine, Nutritional and metabolic diseases (26,507)	Endocrine, Nutritional and metabolic diseases (28,604)	Diseases of the respiratory system (28,488)	Endocrine, Nutritional and metabolic diseases (28,662)	Endocrine, Nutritional and metabolic diseases (27,110)
	3	Diseases of the circulatory system (16,467)	Diseases of the circulatory system (23,145)	Diseases of the circulatory system (24,765)	Diseases of the circulatory system (27,765)	Diseases of the respiratory system (27,969)	Diseases of the circulatory system (24,469)

Source: Laem Chabang Hospital, Queen Savang Vadhana Memorial Hospital, Nong Yai Hospital, Ban Bueng Hospital and Pluak Daeng Hospital, 2014

Nong Yai District

- **Nong Yai Hospital**

Major cause of morbidity of out-patient was 4 diseases: (1) certain infectious and parasitic diseases (2) endocrine, Nutritional and metabolic diseases (3) diseases of the musculosdeletal system and connective tissue and (4) diseases of the respiratory system. Details are shown in **Appendix 3H-1 Table 3**.

Ban Bueng District

- **Ban Bueng Hospital**

Major cause of morbidity of out-patient was 5 diseases: (1) diseases of the respiratory system (2) diseases of the circulatory system (3) diseases of the digestive system (4) endocrine, Nutritional and metabolic diseases and (5) diseases of the musculosdeletal system and connective tissue. Details are shown in **Appendix 3H-1 Table 4**.

Rayong Province

Pluak Daeng District

- **Pluak Daeng Hospital**

Major cause of morbidity of out-patient was 4 diseases: (1) diseases of the respiratory system (2) other external causes of morbidity and mortality (3) endocrine, nutritional and metabolic diseases and (4) diseases of the digestive system. Details are shown in **Appendix 3H-1 Table 5**.

Overall of hospitals in study area

Major cause of morbidity of out-patient was 5 diseases: (1) diseases of the respiratory system (2) endocrine, nutritional and metabolic diseases (3) diseases of the circulatory system (4) certain infectious and parasitic diseases and (5) diseases of the digestive system as shown in **Figure 4.4.2-2**. Details are shown in **Appendix 3H-1 Table 6**.

2. Tambon Health Promoting Hospital (Health Center)

Cause and Morbidity Rate of Out-patient (Ror Ngor.504) of Tambon Health Promoting Hospital (Health Center) in study area were Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-distrct, Ban Khao Hin Tambon Health Promoting Hospital, Ban Tha Cham Tambon Health Promoting Hospital, Ban Muen Chit Tambon Health Promoting Hospital, Chaloem Phrakiartof 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district, Ban Nong Khang Khao Tambon Health Promoting Hospital and Ban Nong Bon Tambon Health Promoting Hospital during 2009-2013 **(Table 4.4.2-5)**. Details are summarized as follows:

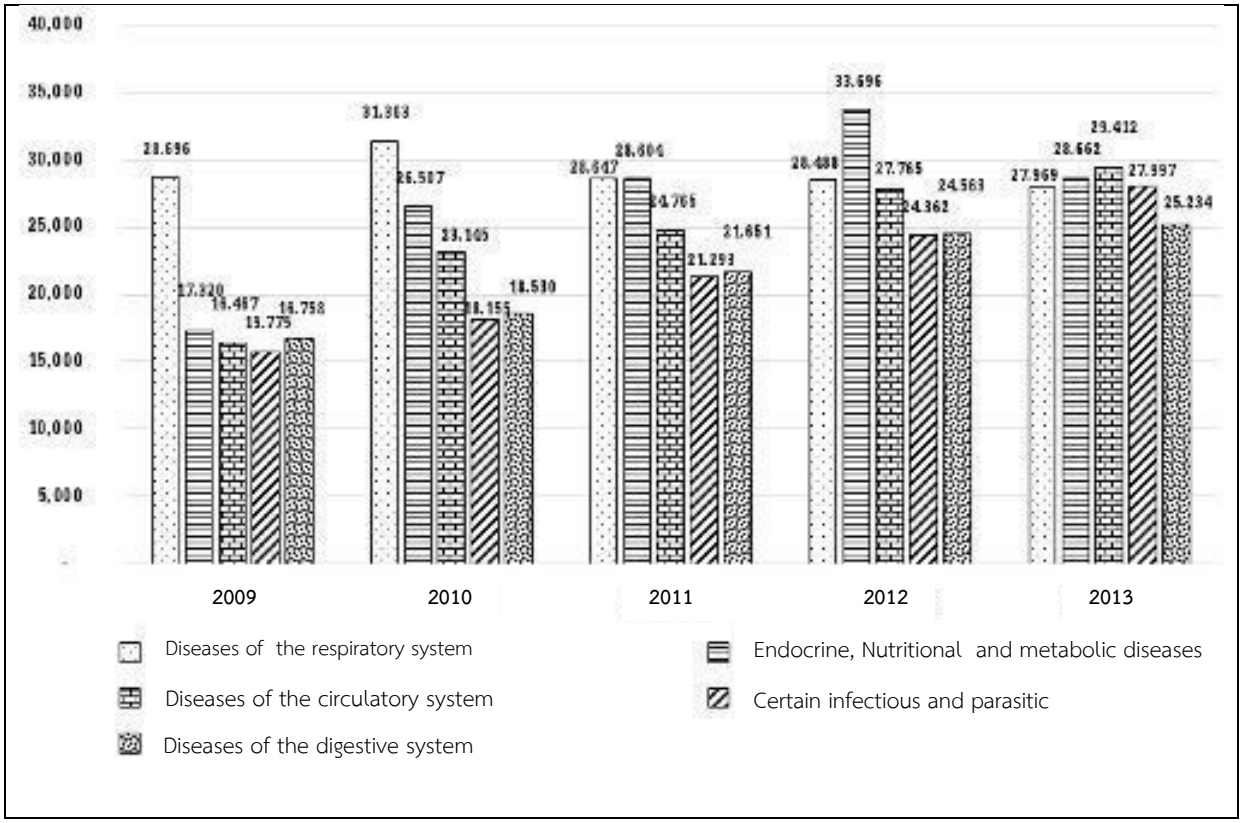


FIGURE 4.4.2-2 :CAUSE AND MORBIDITY RATE OF OUT-PATIENT (ROR NGOR.504) OF HOSPITALS IN STUDY AREA DURING 2009-2013

Chon Buri Province

Si Racha District

- **Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-district**

Major cause of morbidity of out-patient was 4 diseases: (1) symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (2) diseases of the respiratory system (3) diseases of the circulatory system and (4) diseases of the digestive system. Details are shown in **Appendix 3H-1 Table7**.

- **Ban Khao Hin Tambon Health Promoting Hospital**

Major cause of morbidity of out-patient was 5 diseases: (1) diseases of the respiratory system (2) symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (3) diseases of the circulatory system (4) diseases of the digestive system and (5) endocrine, nutritional and metabolic diseases. Details are shown in **Appendix 3H-1 Table8**.

TABLE 4.4.2-5

CAUSE AND MORBIDITY RATE OF OUT-PATIENT (ROR NGOR.504) OF TAMBON HEALTH PROMOTING HOSPITAL (HEALTH CENTER) IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013

Tambon Health Promoting Hospital/Health Center	Ranking	Cause and morbidity rate per one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-district	1	Diseases of the respiratory system (32,366)	Diseases of the respiratory system (36,680)	Diseases of the respiratory system (28,601)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (129,315)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (30,019)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (43,150)
	2	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (19,046)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (23,894)	Diseases of the circulatory system (15,108)	Diseases of the respiratory system (28,549)	Diseases of the respiratory system (20,669)	Diseases of the respiratory system (29,366)
	3	Diseases of the circulatory system (10,307)	Diseases of the circulatory system (13,445)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (13,226)	Diseases of the musculosdeletal system and connective tissue (26,814)	Diseases of the circulatory system (17,949)	Diseases of the circulatory system (15,125)

TABLE 4.4.2-5

CAUSE AND MORBIDITY RATE OF OUT-PATIENT (ROR NGOR.504) OF TAMBON HEALTH PROMOTING HOSPITALS (HEALTH CENTER) IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013 (Cont'd)

Tambon Health Promoting Hospital/Health Center	Ranking	Cause and morbidity rate per one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Ban Khao Hin Tambon Health Promoting Hospital	1	Diseases of the respiratory system (16,538)	Diseases of the respiratory system (23,190)	Diseases of the respiratory system (20,728)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (23,647)	Diseases of the respiratory system (16,067)	Diseases of the respiratory system (19,781)
	2	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (9,412)	Diseases of the circulatory system (9,637)	Diseases of the circulatory system (9,255)	Diseases of the respiratory system (22,668)	Diseases of the circulatory system (9,790)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (11,175)
	3	Diseases of the circulatory system (9,132)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (8,381)	Diseases of the digestive system (6,867)	Diseases of the circulatory system (9,990)	Endocrine, Nutritional and metabolic diseases (8,123)	Diseases of the circulatory system (9,591)
Ban Tha Cham Tambon Health Promoting Hospital	1	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (14,147)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (27,318)	Diseases of the respiratory system (32,486)	Diseases of the respiratory system (27,475)	Diseases of the respiratory system (24,219)	Diseases of he respiratory system (23,553)
	2	Diseases of the circulatory system (11,387)	Diseases of the respiratory system (22,633)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (16,305)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (21,005)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (17,798)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (19,314)
	3	Diseases of the respiratory system (10,816)	Diseases of the digestive system (5,974)	Diseases of the digestive system (8,189)	Diseases of the digestive system (14,412)	Diseases of the digestive system (11,133)	Diseases of the digestive system (8,602)

TABLE 4.4.2-5

CAUSE AND MORBIDITY RATE OF OUT-PATIENT (ROR NGOR.504) OF TAMBON HEALTH PROMOTING HOSPITALS (HEALTH CENTER) IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013 (Cont'd)

Tambon Health Promoting Hospital/Health Center	Ranking	Cause and morbidity rate per one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Ban Muen Chit Tambon Health Promoting Hospital	1	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (75,989)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (26,102)	Diseases of the respiratory system (53,898)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (89,944)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (79,661)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (61,130)
	2	Diseases of the respiratory system (43,729)	Diseases of the respiratory system (16,949)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (33,955)	Diseases of the respiratory system (66,893)	Diseases of the respiratory system (71,638)	Diseases of the respiratory system (50,621)
	3	Diseases of the digestive system (24,350)	Diseases of the digestive system (15,198)	Diseases of the musculosdeletal system and connective tissue (22,542)	Diseases of the digestive system (31,638)	Diseases of the digestive system (31,808)	Diseases of the digestive system (24,384)
Chaloem Phrakiartof 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district	1	Diseases of the respiratory system (46,359)	Diseases of the respiratory system (38,620)	Diseases of the circulatory system (32,329)	Diseases of the circulatory system (23,943)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (30,582)	Diseases of the respiratory system (30,334)
	2	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (31,496)	Diseases of the circulatory system (29,213)	Diseases of the respiratory system (29,822)	Diseases of the respiratory system (20,189)	Diseases of the respiratory system (17,679)	Diseases of the circulatory system (25,325)
	3	Diseases of the circulatory system (30,929)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (21,156)	Endocrine, Nutritional and metabolic diseases (23,096)	Endocrine, Nutritional and metabolic diseases (19,905)	Diseases of the circulatory system (10,595)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (22,420)

TABLE 4.4.2-5

CAUSE AND MORBIDITY RATE OF OUT-PATIENT (ROR NGOR.504) OF TAMBON HEALTH PROMOTING HOSPITALS (HEALTH CENTER) IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013 (Cont'd)

Tambon Health Promoting Hospital/Health Center	Ranking	Cause and morbidity rate per one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Ban Nong Khang Khao Tambon Health Promoting Hospital	1	Diseases of the respiratory system (46,494)	Diseases of the respiratory system (57,646)	Diseases of the respiratory system (66,667)	Diseases of the respiratory system (55,725)	Diseases of the digestive system (45,175)	Diseases of the respiratory system (45,641)
	2	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (38,878)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (44,343)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (42,834)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (39,502)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (27,236)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (38,529)
	3	Diseases of the circulatory system (9,309)	Diseases of the circulatory system (10,570)	Diseases of the digestive system (21,994) Diseases of the musculosdeletal system and connective tissue (21,994)	Diseases of the digestive system (25,417)	Diseases of the musculosdeletal system and connective tissue (10,566)	Diseases of the digestive system (21,826)
Ban Nong Bon Tambon Health Promoting Hospital	1	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (55,125)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (77,724)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified(111,408)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (358,398)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (264,426)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (175,034)
	2	Diseases of the digestive system (25,417)	Diseases of the digestive system (6,212)	Diseases of the respiratory system (33,801)	Diseases of the respiratory system (26,893)	Diseases of the respiratory system (34,436)	Diseases of the respiratory system (20,249)
	3	Other external causes of morbidity and mortality (4,305)	Diseases of the circulatory system (5,221)	Diseases of the digestive system (8,523)	Diseases of the musculosdeletal system and connective tissue (6,182)	Diseases of the digestive system (7,914)	Diseases of the digestive system (7,083)

TABLE 4.4.2-5

CAUSE AND MORBIDITY RATE OF OUT-PATIENT (ROR NGOR.504) OF TAMBON HEALTH PROMOTING HOSPITALS (HEALTH CENTER) IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013 (Cont'd)

Tambon Health Promoting Hospital/Health Center	Ranking	Cause and morbidity rate per one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Overall of study area	1	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (26,073)	Diseases of the respiratory system (28,655)	Diseases of the respiratory system (32,723)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (80,953)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (44,900)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (41,698)
	2	Diseases of the respiratory system (25,145)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (27,374)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (25,920)	Diseases of the respiratory system (30,333)	Diseases of the respiratory system (20,635)	Diseases of the respiratory system (27,439)
	3	Diseases of the circulatory system (10,802)	Diseases of the circulatory system (11,002)	Diseases of the circulatory system (11,411)	Diseases of the digestive system (14,701)	Diseases of the digestive system (12,519)	Diseases of the circulatory system (10,978)

Source: Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-district, Khao Hin Tambon Health Promoting Hospital, Ban Tha Cham Tambon Health Promoting Hospital, Ban Muen Chit Tambon Health Promoting Hospital, Chaloem Phrakiartof 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district, Ban Nong Khang Khao Tambon Health Promoting Hospital and Ban Nong Bon Tambon Health Promoting Hospital, 2014

Nong Yai District

- **Ban Tha Cham Tambon Health Promoting Hospital**

Major cause of morbidity of out-patient was 4 diseases: (1) diseases of the respiratory system (2) symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (3) diseases of the digestive system and (4) diseases of the circulatory system. Details are shown in **Appendix 3H-1 Table 9**.

Ban Bueng District

- **Ban Muen Chit Tambon Health Promoting Hospital**

Major cause of morbidity of out-patient was 4 diseases: (1) symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (2) diseases of the respiratory system (3) diseases of the musculosdeletal system and connective tissue and (4) diseases of the digestive system. Details are shown in **Appendix 3H-1 Table 10**.

- **Chaloem Phrakiartof 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district**

Major cause of morbidity ofout-patient was 4 diseases: (1) diseases of the respiratory system (2) diseases of the circulatory system (3) symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified and (4) endocrine, nutritional and metabolic diseases. Details are shown in **Appendix 3H-1 Table11**.

Rayong Province

Pluak Daeng District

- **Ban Nong Khang Khao Tambon Health Promoting Hospital**

Major cause of morbidity of out-patient was 5 diseases: (1) diseases of the respiratory system (2) symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (3) diseases of the digestive system (4) diseases of the musculosdeletal system and connective tissue and (5) diseases of the circulatory system. Details are shown in **Appendix 3H-1 Table 12**.

- **Ban Nong Bon Tambon Health Promoting Hospital**

Major cause of morbidity of out-patient was 5 diseases: (1) symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (2) diseases of the respiratory system (3) diseases of the digestive system (4) diseases of the musculosdeletal system and connective tissue and (5) diseases of the circulatory system. Details are shown in **Appendix 3H-1 Table 13**.

Overall of Tambon Health Promoting Hospitals (Health Center) in the study area

Major cause of morbidity of out-patient was 4 diseases : (1) symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (2) diseases of the respiratory system (3) diseases of the circulatory systemand (4) diseases of the digestive system as shown in **Figure 4.4.2-3**. Details are shown in **Appendix 3H-1 Table 14**.

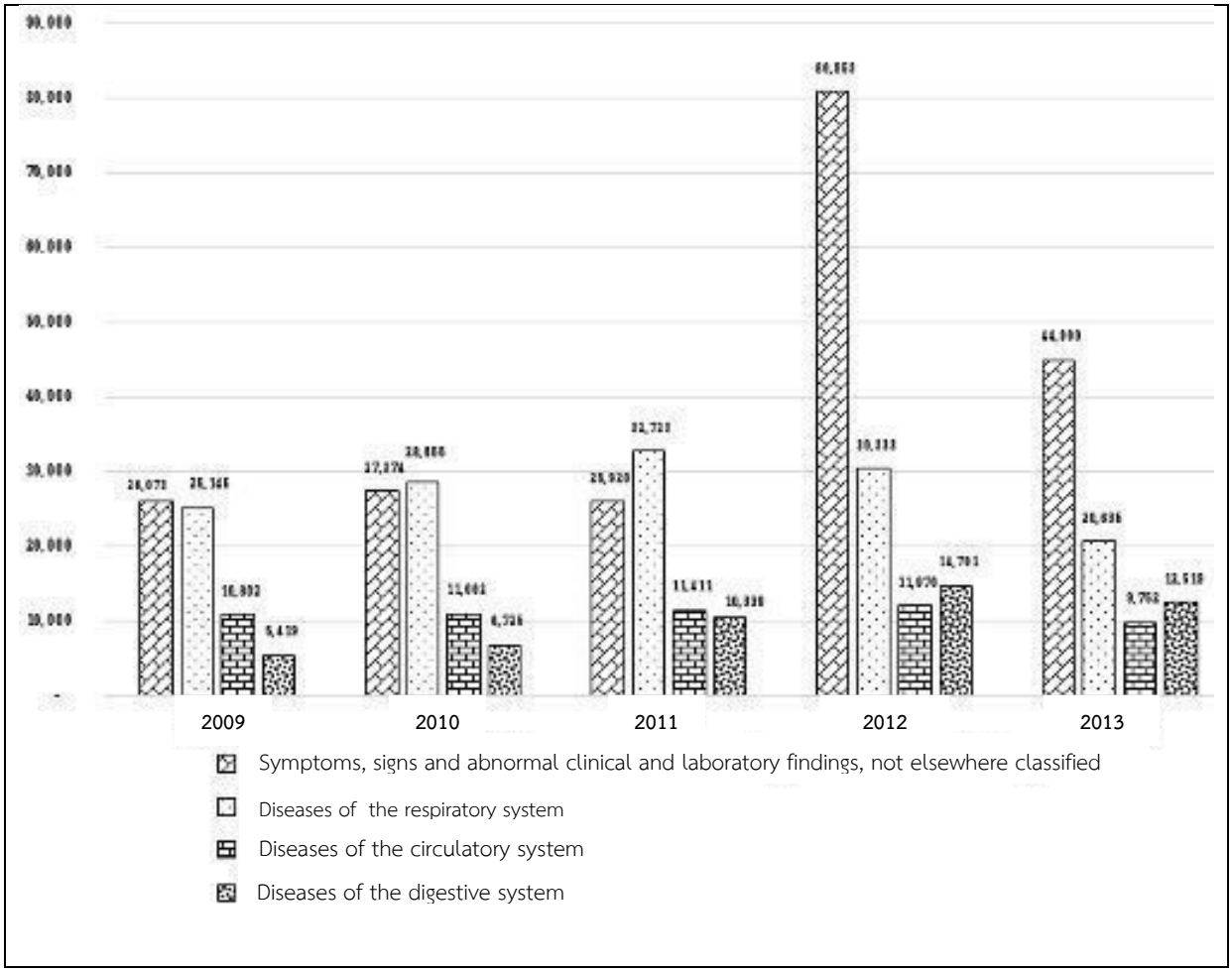


FIGURE 4.4.2-3 : CAUSE AND MORBIDITY RATE OF OUT-PATIENT (ROR NGOR.504) OF TAMBON HEALTH PROMOTING HOSPITALS (HEALTH CENTER) IN STUDY AREA DURING 2009-2013

3. Cause and Morbidity Rate of Patient According to Report no. According to Report no. Ror Ngor. 505

- **Hospital**

Cause and morbidity rate of patient (Ror Ngor.505) of hospitals in study area were Laem Chabang Hospital, Queen Savang Vadhana Memorial Hospital, Nong Yai Hospital, Ban Bueng Hospital and Pluak Daeng Hospital during 2009-2013 **(Table 4.4.2-6)**. Details are summarized as follows:

Chon Buri Province

Si Racha District

- **Laem Chabang Hospital**

Major cause of morbidity of patient was 4 diseases: (1) endocrine, nutritional and metabolic diseases (2) single spontaneous delivery (3) complication of pregnancy, labour, delivery, puerperium and other obstestric conditions, not elsewhere classified and (4) diseases of the blood and blood forming organs and certain disorders involving the immune mechanism. Details are shown in **Appendix 3H-2 Table 1**.

- **Queen Savang Vadhana Memorial Hospital**

Major cause of morbidity of patient was 4 diseases: (1) complication of pregnancy, labour, delivery, puerperium and other obstestric conditions, not elsewhere classified (2) single spontaneous delivery (3) motocycle rider injured in transport accident and (4) other disorders originating in the perinatal period. Details are shown in **Appendix 3H-2 Table 2**.

Nong Yai District

- **Nong Yai Hospital**

Major cause of morbidity of patient was 4 diseases: (1) endocrine, nutritional and metabolic diseases (2) single spontaneous delivery (3) high blood pressure and (4) complication of pregnancy, labour, delivery, puerperium and other obstestric conditions, not elsewhere classified. Details are shown in **Appendix 3H-2 Table 3**.

Ban Bueng District

- **Ban Bueng Hospital**

Major cause of morbidity of patient was 5 diseases: (1) complication of pregnancy, labour, delivery, puerperium and other obstestric conditions, not elsewhere classified (2) endocrine, nutritional and metabolic diseases (3) single spontaneous delivery (4) other diseases of the digestive system and (5) symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified. Details are shown in **Appendix 3H-2 Table 4**.

TABLE 4.4.2-6

CAUSE AND MORBIDITY RATE OF PATIENT (ROR NGOR.505) OF HOSPITALS IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013

Hospitals	Ranking	Cause and morbidity rate per one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Laem Chabang	1	Endocrine, Nutritional and metabolic diseases (551)	Endocrine, Nutritional and metabolic diseases (597)	Endocrine, Nutritional and metabolic diseases (613)	Endocrine, Nutritional and metabolic diseases (678)	Endocrine, Nutritional and metabolic diseases (794)	Endocrine, Nutritional and metabolic diseases (650)
	2	Single spontaneous delivery (404)	Single spontaneous delivery (392)	Single spontaneous delivery (409)	Single spontaneous delivery (496)	Single spontaneous delivery (451)	Single spontaneous delivery (432)
	3	Complication of pregnancy (348)	Complication of pregnancy (302)	Diseases of the circulatory system (297)	Complication of pregnancy (353)	Diseases of the circulatory system (357)	Complication of pregnancy (317)
Queen Savang Vadhana Memorial	1	Complication of pregnancy (2,046)	Complication of pregnancy (1,848)	Complication of pregnancy (1,666)	Complication of pregnancy (1,855)	Complication of pregnancy (1,953)	Complication of pregnancy (1,873)
	2	Single spontaneous delivery (755)	Single spontaneous delivery (819)	Single spontaneous delivery (745)	Single spontaneous delivery (883)	Single spontaneous delivery (672)	Single spontaneous delivery (774)
	3	Other land transport accidents and sequelae of all transport accidents (485)	Other land transport accidents and sequelae of all transport accidents (459)	Other land transport accidents and sequelae of all transport accidents (453)	Other external causes of accident injury (456)	Other land transport accidents and sequelae of all transport accidents (463)	Other land transport accidents and sequelae of all transport accidents (461)

TABLE 4.4.2-6

CAUSE AND MORBIDITY RATE OF PATIENT (ROR NGOR.505) OF HOSPITALSIN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013 (Cont'd)

Hospitals	Ranking	Cause and morbidity rateper one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Nong Yai	1	Endocrine, Nutritional and metabolic diseases (1,514)	Endocrine, Nutritional and metabolic diseases (1,618)	Endocrine, Nutritional and metabolic diseases (1,544)	Endocrine, Nutritional and metabolic diseases (1,072)	Endocrine, Nutritional and metabolic diseases (1,571)	Endocrine, Nutritional and metabolic diseases (1,463)
	2	Single spontaneous delivery (875)	Single spontaneous delivery (1,018)	High blood pressure (1,060)	Single spontaneous delivery (907)	Single spontaneous delivery (1,246)	Single spontaneous delivery (981)
	3	High blood pressure (813)	High blood pressure (899)	Single spontaneous delivery (855)	Complication of pregnancy (777)	High blood pressure (1,017)	High blood pressure (850)
Ban Bueng	1	Complication of pregnancy (1,808)	Complication of pregnancy (1,764)	Complication of pregnancy (1,689)	Complication of pregnancy (2,093)	Complication of pregnancy (2,250)	Complication of pregnancy (1,923)
	2	Endocrine, Nutritional and metabolic diseases (1,217)	Endocrine, Nutritional and metabolic diseases (1,647)	Endocrine, Nutritional and metabolic diseases (1,492)	Endocrine, Nutritional and metabolic diseases (1,468)	Endocrine, Nutritional and metabolic diseases (1,352)	Endocrine, Nutritional and metabolic diseases (1,435)
	3	Diseases of the digestive system (1,125)	Diseases of the digestive system (1,107)	Single spontaneous delivery (1,015)	Single spontaneous delivery (1,237)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (1,016)	Single spontaneous delivery (1,070)

TABLE 4.4.2-6

CAUSE AND MORBIDITY RATE OF PATIENT (ROR NGOR.505) OF HOSPITALSIN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013 (Cont'd)

Hospitals	Ranking	Cause and morbidity rateper one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Pluak Daeng	1	Other intestinal infections diseases (1,125)	Endocrine, Nutritional and metabolic diseases (2,000)	Endocrine, Nutritional and metabolic diseases (1,861)	Single spontaneous delivery (1,510)	Single spontaneous delivery (1,481)	Endocrine, Nutritional and metabolic diseases (1,511)
	2	Endocrine, Nutritional and metabolic diseases (1,217)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (1,331)	Single spontaneous delivery (1,287)	Endocrine, Nutritional and metabolic diseases (1,372)	Endocrine, Nutritional and metabolic diseases (1,096)	Single spontaneous delivery (1,335)
	3	Single spontaneous delivery (875)	Other intestinal infections diseases (1,227)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (1,166)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (919)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (686)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (1,044)
Overall of study area	1	Complication of pregnancy(2,044)	Complication of pregnancy(1,879)	Complication of pregnancy(1,706)	Complication of pregnancy(1,991)	Complication of pregnancy(2,074)	Complication of pregnancy(1,940)
	2	Single spontaneous delivery (1,186)	Single spontaneous delivery (1,212)	Single spontaneous delivery (1,176)	Single spontaneous delivery (1,405)	Single spontaneous delivery (1,201)	Single spontaneous delivery (1,237)
	3	Endocrine, Nutritional and metabolic diseases (915)	Endocrine, Nutritional and metabolic diseases (1,167)	Endocrine, Nutritional and metabolic diseases (1,087)	Endocrine, Nutritional and metabolic diseases (1,037)	Endocrine, Nutritional and metabolic diseases (1,080)	Endocrine, Nutritional and metabolic diseases (1,058)

Source: Laem Chabang Hospital, Queen Savang Vadhana Memorial Hospital, Nong Yai Hospital, Ban Bueng Hospital and Pluak Daeng Hospital, 2014

Rayong Province

Pluak Daeng District

- **Pluak Daeng Hospital**

Major cause of morbidity of patient was 4 diseases: (1) endocrine, nutritional and metabolic diseases (2) single spontaneous delivery (3) symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified and (4) other intestinal infections diseases. Details are shown in **Appendix 3H-2 Table5**.

Overall of hospital in study area

Major cause of morbidity of patient was 3 diseases: (1) complication of pregnancy, labour, delivery, puerperium and other obstestric conditions, not elsewhere classified (2) single spontaneous delivery and (3) endocrine, nutritional and metabolic diseasesas as shown in **Figure 4.4.2-4.** Details are shown in **Appendix 3H-2 Table 6.**

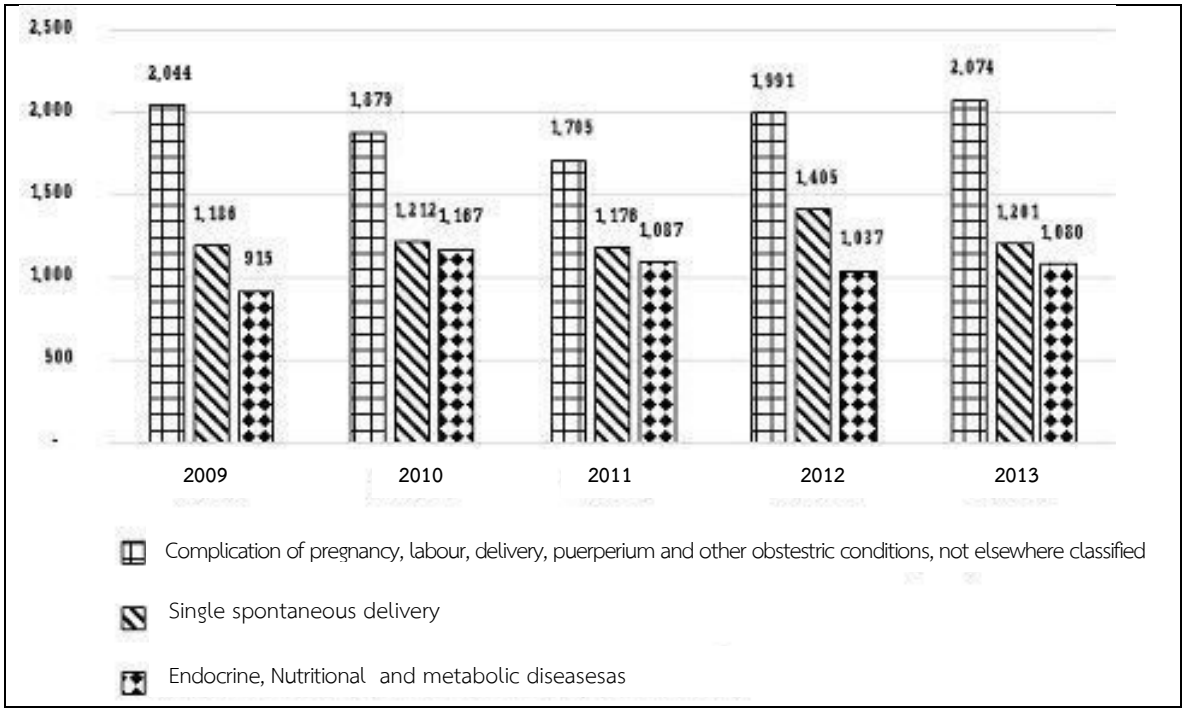


FIGURE 4.4.2-4 : CAUSE AND MORBIDITY RATE OF PATIENT (ROR NGOR.505) OF HOSPITALS IN STUDY AREA DURING 2009-2013

4. Cause and Morbidity Rate of Epidemic Diseases Surveillance According to Report no. Ror Ngor. 506

- **Hospital**

Cause and morbidity rate of epidemic diseases surveillance (Ror Ngor. 506) of hospitals in study area were Laem Chabang Hospital, Queen Savang Vadhana Memorial Hospital, Nong Yai Hospital, Ban Bueng Hospital and Pluak Daeng Hospital during 2009-2013 **(Table 4.4.2-7)**. Details are summarized as follows:

Chon Buri Province

Si Racha District

- **Laem Chabang Hospital**

Major cause of morbidity ofepidemic diseases surveillance was 5 diseases: (1) diarrhoea (2) pyrexia of unknown origin (3) influenza (4) pneumonia and (5) hemorrhagic conjunctivitis. Details are shown in **Appendix 3H-3 Table 1**.

- **Queen Savang Vadhana Memorial Hospital**

Major cause of morbidity ofepidemic diseases surveillance was 4 diseases: (1) diarrhoea (2) pneumonia (3) dengue fever and (4) tuberculosis. Details are shown in **Appendix 3H-3 Table 2**.

Nong Yai District

- **Nong Yai Hospital**

Major cause of morbidity ofepidemic diseases surveillance was 7 diseases : (1) diarrhoea (2) hemorrhagic conjunctivitis (3) pneumonia (4) food poisoning (5) chickenpox (6) mumps and (7) influenza. Details are shown in **Appendix 3H-3 Table 3**.

Ban Bueng District

- **Ban Bueng Hospital**

Major cause of morbidity ofepidemic diseases surveillance was 6 diseases: (1) diarrhoea (2) influenza (3) hemorrhagic conjunctivitis (4) pneumonia (5) chickenpox and (6) dengue haemorrhagic. Details are shown in **Appendix 3H-3 Table 4**.

Rayong Province

Pluak DaengDistrict

- **Pluak Daeng Hospital**

Major cause of morbidity ofepidemic diseases surveillance was 5 diseases:(1) diarrhoea (2) pyrexia of unknown origin (3) pneumonia (4) chickenpox and (5) tuberculosis. Details are shown in **Appendix 3H-3 Table 5.**

Overall of hospitals in study area

Major cause of morbidity ofepidemic diseases surveillance was 6 diseases: (1) diarrhoea (2) pneumonia (3) pyrexia of unknown origin (4) influenza (5) chickenpox and (6) hemorrhagic conjunctivitis as shown in **Figure 4.4.2-5**. Details are shown in **Appendix 3H-3 Table 6**.

TABLE 4.4.2-7

CAUSE AND MORBIDITY RATE OF EPIDEMIC DISEASES SURVEILLANCE (ROR NGOR. 506) OF HOSPITAL IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013

Hospital	Ranking	Cause and morbidity rateper one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Laem Chabang	1	Diarrhoea (1,116)	Diarrhoea (1,147)	Diarrhoea (1,234)	Diarrhoea (1,005)	Diarrhoea (1,150)	Diarrhoea (1,130)
	2	Pyrexia of unknown origin (207)	Influenza (416)	Pyrexia of unknown origin (322)	Pyrexia of unknown origin (302)	Pneumonia (253)	Pyrexia of unknown origin (290)
	3	Hemorrhagic conjunctivitis (193)	Pyrexia of unknown origin (365)	Influenza (100)	Pneumonia (141)	Pyrexia of unknown origin (259)	Influenza (135)
Queen Savang Vadhana Memorial	1	Diarrhoea (1,789)	Diarrhoea (2,785)	Diarrhoea (2,328)	Diarrhoea (2,267)	Diarrhoea (792)	Diarrhoea (1,976)
	2	Pneumonia (247)	Pneumonia (323)	Dengue fever (177)	Pneumonia (192)	Pneumonia (293)	Pneumonia (244)
	3	Tuberculosis (160)	Dengue fever (166)	Pneumonia (163)	Dengue fever (190)	Dengue fever (272)	Dengue fever (176)
Nong Yai	1	Hemorrhagic conjunctivitis (466)	Hemorrhagic conjunctivitis (390)	Diarrhoea (1,107)	Diarrhoea (957)	Hemorrhagic conjunctivitis (545)	Diarrhoea (609)
	2	Diarrhoea (338)	Diarrhoea (318)	Hemorrhagic conjunctivitis (415)	Hemorrhagic conjunctivitis (594)	Diarrhoea (291)	Hemorrhagic conjunctivitis (485)
	3	Influenza (83)	Food Poisoning (110)	Chickenpox (183) Mumps (183)	Pneumonia (255)	Food Poisoning (141)	Pneumonia (104)

TABLE 4.4.2-7

CAUSE AND MORBIDITY RATE OF EPIDEMIC DISEASES SURVEILLANCE (ROR NGOR. 506) OF HOSPITAL IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013 (Cont'd)

Hospital	Ranking	Cause and morbidity rateper one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Ban Bueng	1	Diarrhoea (4,172)	Diarrhoea (2,967)	Diarrhoea (2,425)	Diarrhoea (3,127)	Diarrhoea (2,208)	Diarrhoea (2,975)
	2	Hemorrhagic conjunctivitis (1,081)	Influenza (1,236)	Pneumonia (258)	Pneumonia (225)	Dengue haemorrhagic (161)	Hemorrhagic conjunctivitis (378)
	3	Influenza (415)	Pneumonia (239)	Chickenpox (227)	Influenza (95)	Chickenpox (117)	Influenza (289)
Pluak Daeng	1	Diarrhoea (7,594)	Diarrhoea (2,812)	Diarrhoea (4,974)	Diarrhoea (5,754)	Diarrhoea (3,208)	Diarrhoea (4,798)
	2	Pyrexia of unknown origin (907)	Pyrexia of unknown origin (253)	Pyrexia of unknown origin (843)	Pyrexia of unknown origin (1,191)	Pyrexia of unknown origin (1,353)	Pyrexia of unknown origin (925)
	3	Chickenpox (667)	Tuberculosis (117)	Tuberculosis (338)	Pneumonia (269)	Pneumonia (424)	Pneumonia (287)
Overall in study area	1	Diarrhoea (3,725)	Diarrhoea (3,553)	Diarrhoea (3,530)	Diarrhoea (3,602)	Diarrhoea (2,169)	Diarrhoea (3,229)
	2	Hemorrhagic conjunctivitis (455)	Influenza (654)	Pyrexia of unknown origin (327)	Pyrexia of unknown origin (338)	Pneumonia (433)	Pneumonia (313)
	3	Chickenpox (314)	Pneumonia (331)	Pneumonia (245)	Pneumonia (326)	Pyrexia of unknown origin(323)	Pyrexia of unknown origin(309)

Source: Laem Chabang Hospital, Queen Savang Vadhana Memorial Hospital, Nong Yai Hospital, Ban Bueng Hospital and Pluak Daeng Hospital, 2014

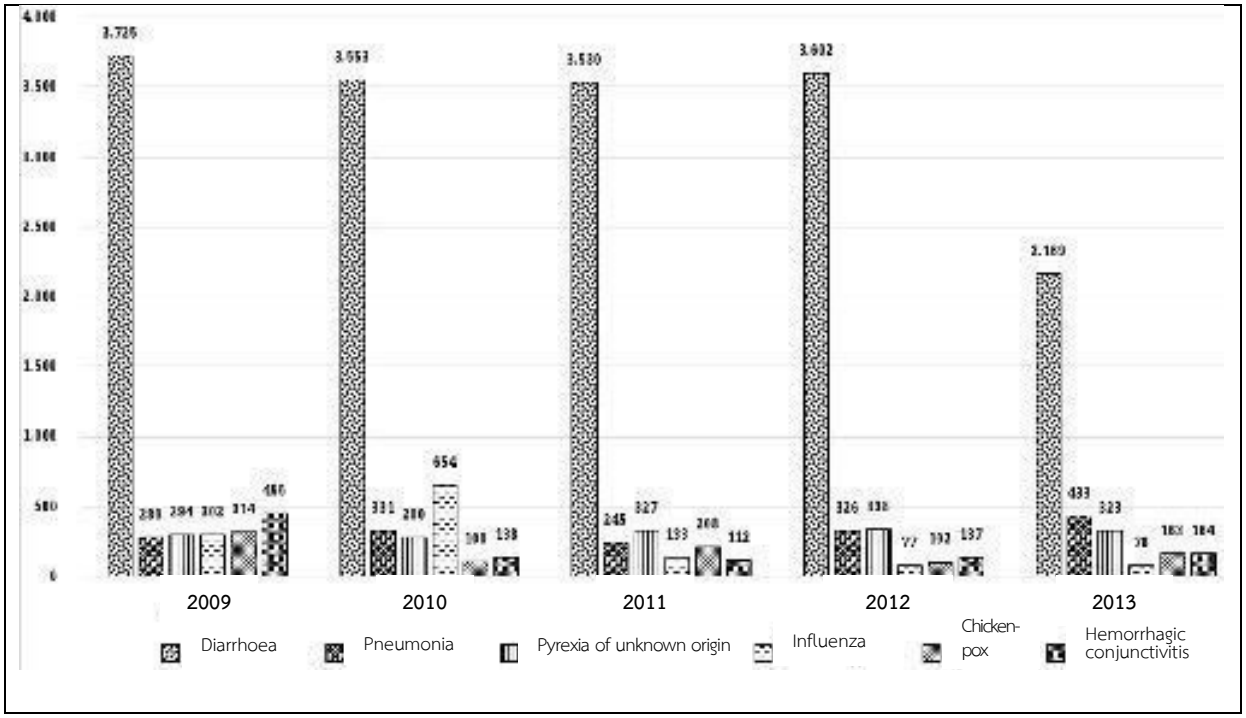


FIGURE 4.4.2-5 : CAUSE AND MORBIDITY RATE OF EPIDEMIC DISEASES SURVEILLANCE (ROR NGOR. 506) OF HOSPITALS IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013

5. Tambon Health Promoting Hospital (Health Center)

Cause and morbidity rate of epidemic diseases surveillance (Ror Ngor. 506) of Tambon Health Promoting Hospital (Health Center) in study area were Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-distrct, Ban Khao Hin Tambon Health Promoting Hospital, Ban Tha Cham Tambon Health Promoting Hospital, Ban Muen Chit Tambon Health Promoting Hospital, Chaloem Phrakiart of 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district, Ban Nong Khang Khao Tambon Health Promoting Hospital and Ban Nong Bon Tambon Health Promoting Hospital during 2009-2013 **(Table 4.4.2-8)**. Details are summarized as follows:

Chon Buri Province

Si Racha District

- **Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-district**

Major cause of morbidity ofepidemic diseases surveillance was 4 diseases: (1) diarrhoea (2) food poisoning (3) tuberculosis and (4) chickenpox. Details are shown in **Appendix 3H-3 Table 7**.

TABLE 4.4.2-8

CAUSE AND MORBIDITY RATE OF EPIDEMIC DISEASES SURVEILLANCE (ROR NGOR. 506) OF TAMBON HEALTH PROMOTING HOSPITAL (HEALTH CENTER) IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013

Tambon Health Promoting Hospital/Health Center	Ranking	Cause and morbidity rateper one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-district	1	Diarrhoea (220)	Diarrhoea (188)	Diarrhoea (392)	Diarrhoea (281)	Diarrhoea (313)	Diarrhoea (279)
	2	Food Poisoning (78)	Food Poisoning (94)	Food Poisoning (204)	Food Poisoning (203)	Food Poisoning (156)	Food Poisoning (147)
	3	Tuberculosis (47)	Tuberculosis (31) Chickenpox (31)	Tuberculosis (110)	Tuberculosis (141)	Chickenpox (94)	Tuberculosis (75)
Khao Hin Tambon Health Promoting Hospital	1	Chickenpox (203	Hemorrhagic conjunctivitis (256)	Hemorrhagic conjunctivitis (619)	Hemorrhagic conjunctivitis (420)	Hemorrhagic conjunctivitis (379)	Hemorrhagic conjunctivitis (351)
	2	Food Poisoning (19) Gonorrhoea (19)	Chickenpox (124)	Mumps (96)	Chickenpox (81)	Chickenpox (100)	Chickenpox (104)
	3	Herpes zoster (10) Measle with complication (10)	Food Poisoning (53)	Chickenpox (32) Diarrhoea (32)	Diarrhoea (59)	Diarrhoea (73)	Diarrhoea (37)
Ban Tha Cham Tambon Health Promoting Hospital	1	Diarrhoea (174)	Food Poisoning (223)	Diarrhoea (543)	Diarrhoea (123)	Dengue fever (244)	Diarrhoea (168)
	2	Pyrexia of unknown origin (124)	Hemorrhagic conjunctivitis (25)	Hemorrhagic conjunctivitis (173)	Hand Foot Mouth disease (98)	Hemorrhagic conjunctivitis (195)	Food Poisoning (89)
	3	-	-	Food Poisoning (74)	Food Poisoning (25) Hemorrhagic conjunctivitis (25)	Chickenpox (171) Dengue haemorrhagic (171)	Hemorrhagic conjunctivitis (84)

TABLE 4.4.2-8

CAUSE AND MORBIDITY RATE OF EPIDEMIC DISEASES SURVEILLANCE (ROR NGOR. 506) OF TAMBON HEALTH PROMOTING HOSPITAL (HEALTH CENTER) IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013 (Cont'd)

Tambon Health Promoting Hospital/Health Center	Ranking	Cause and morbidity rateper one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Ban Muen Chit Tambon Health Promoting	1	Hemorrhagic conjunctivitis (2,316)	Pyrexia of unknown origin (791)	Diarrhoea (452)	Diarrhoea (2,994)	Diarrhoea (2,429)	Diarrhoea (1,277)
	2	Diarrhoea (508) Chickenpox (508)	Hemorrhagic conjunctivitis (734)	Hemorrhagic conjunctivitis (226)	Hand Foot Mouth disease (113)	Hemorrhagic conjunctivitis (282)	Hemorrhagic conjunctivitis (723)
	3	-	Chickenpox (113)	Pyrexia of unknown origin (113) Chickenpox (113)	Hemorrhagic conjunctivitis (56) Chickenpox (56)	Food Poisoning (113)	Pyrexia of unknown origin (181)
Chaloem Phrakiartof 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district	1	Diarrhoea (1,737)	Diarrhoea (546)	Diarrhoea (381)	Diarrhoea (1,104)	Diarrhoea (886)	Diarrhoea (923)
	2	Hemorrhagic conjunctivitis (134)	Hemorrhagic conjunctivitis (64) Chickenpox (64)	Chickenpox (95)	Hemorrhagic conjunctivitis (379)	Hemorrhagic conjunctivitis (569)	Hemorrhagic conjunctivitis (237)
	3	Chickenpox (100)	Dengue haemorrhagic (32)	Hemorrhagic conjunctivitis (32)	Chickenpox (126) Dengue haemorrhagic (126)	Chickenpox (63) Dengue haemorrhagic (63)	Chickenpox (90)
Ban Nong Khang Khao Tambon Health Promoting Hospital	1	Diarrhoea (3,506)	Diarrhoea (5,465)	Diarrhoea (3,866)	Diarrhoea (4,350)	Diarrhoea (2,113)	Diarrhoea (3,855)
	2	Hemorrhagic conjunctivitis (919)	Pyrexia of unknown origin (1,366)	Pyrexia of unknown origin (1,037)	Dysentery (705)	Dysentery (1,479)	Pyrexia of unknown origin (617)
	3	Pyrexia of unknown origin (701)	Hemorrhagic conjunctivitis (192)	Chickenpox (283)	Food Poisoning (235)	-	Dysentery (442)

TABLE 4.4.2-8

CAUSE AND MORBIDITY RATE OF EPIDEMIC DISEASES SURVEILLANCE (ROR NGOR. 506) OF TAMBON HEALTH PROMOTING HOSPITAL (HEALTH CENTER) IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013 (Cont'd)

Tambon Health Promoting Hospital/Health Center	Ranking	Cause and morbidity rateper one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Ban Nong Bon Tambon Health Promoting Hospital	1	Diarrhoea (4,305)	Diarrhoea (3,989)	Diarrhoea (3,917)	Diarrhoea (4,353)	Diarrhoea (3,123)	Diarrhoea (3,939)
	2	Pyrexia of unknown origin (2,637)	Pyrexia of unknown origin (2,999)	Pyrexia of unknown origin (3,626)	Pyrexia of unknown origin (2,628)	Pyrexia of unknown origin (2,329)	Pyrexia of unknown origin (2,843)
	3	Food Poisoning (457)	Food Poisoning (643)	Food Poisoning (953)	Food Poisoning (850)	Food Poisoning (741)	Food Poisoning (731)
Overall of study area	1	Diarrhoea (1,004)	Diarrhoea (1,127)	Diarrhoea (1,036)	Diarrhoea (1,180)	Diarrhoea (732)	Diarrhoea (1,012)
	2	Pyrexia of unknown origin (395)	Pyrexia of unknown origin (530)	Pyrexia of unknown origin (511)	Pyrexia of unknown origin (275)	Pyrexia of unknown origin (244)	Pyrexia of unknown origin (387)
	3	Hemorrhagic conjunctivitis (243)	Hemorrhagic conjunctivitis (185)	Hemorrhagic conjunctivitis (282)	Hemorrhagic conjunctivitis (172)	Hemorrhagic conjunctivitis (197)	Hemorrhagic conjunctivitis (215)

Source: Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-district, Khao Hin Tambon Health Promoting Hospital, Ban Tha Cham Tambon Health Promoting Hospital, Ban Muen Chit Tambon Health Promoting Hospital, Chaloem Phrakiartof 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district, Ban Nong Khang Khao Tambon Health Promoting Hospital and Ban Nong Bon Tambon Health Promoting Hospital, 2014

Remark: - is no patient.

- **Khao Hin Tambon Health Promoting Hospital**

Major cause of morbidity ofepidemic diseases surveillance was 8 diseases: (1) hemorrhagic conjunctivitis (2) chickenpox (Tend to decrease) (3) diarrhoea (4) mumps (5) herpes zoster (6) food poisoning (7) gonorrhoea and (8) measle with complication. Details are shown in **Appendix 3H-3 Table 8**.

Nong Yai District

- **Ban Tha Cham Tambon Health Promoting Hospital**

Major cause of morbidity ofepidemic diseases surveillance was 8 diseases: (1) diarrhoea (2) food poisoning (3) hemorrhagic conjunctivitis (4) pyrexia of unknown origin (5) dengue fever (6) hand foot mouth (7) chickenpox and (8) dengue haemorrhagic. Details are shown in **Appendix 3H-3 Table 9**.

Ban Bueng District

- **Ban Muen Chit Tambon Health Promoting Hospital**

Major cause of morbidity ofepidemic diseases surveillance was 6 diseases: (1) diarrhoea (2) hemorrhagic conjunctivitis (3) pyrexia of unknown origin (4) chickenpox (5) food poisoning and (6) hand foot mouth. Details are shown in **Appendix 3H-3 Table 10**.

- **Chaloem Phrakiart of 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district**

Major cause of morbidity ofepidemic diseases surveillance was 4 diseases: (1) diarrhoea (2) hemorrhagic conjunctivitis (3) chickenpox and (4) dengue haemorrhagic. Details are shown in **Appendix 3H-3 Table 11**.

Rayong Province

Pluak Daeng District

- **Ban Nong Khang Khao Tambon Health Promoting Hospital**

Major cause of morbidity ofepidemic diseases surveillance was 6 diseases: (1) diarrhoea (2) pyrexia of unknown origin (3) dysentery (4) hemorrhagic conjunctivitis (5) chickenpox and (6) food poisoning. Details are shown in **Appendix 3H-3 Table 12**.

- **Ban Nong Bon Tambon Health Promoting Hospital**

Major cause of morbidity ofepidemic diseases surveillance was 3 diseases: (1) diarrhoea (2) pyrexia of unknown origin and (3) food poisoning. Details are shown in **Appendix 3H-3 Table 13**.

Overall of Tambon Health Promoting Hospital (Health Center) in study area

Major cause of morbidity ofepidemic diseases surveillance was 3 diseases: (1) diarrhoea (2) pyrexia of unknown origin and (3) hemorrhagic conjunctivitis as shown in **Figure 4.4.2-6**. Details are shown in **Appendix 3H-3 Table 14**.

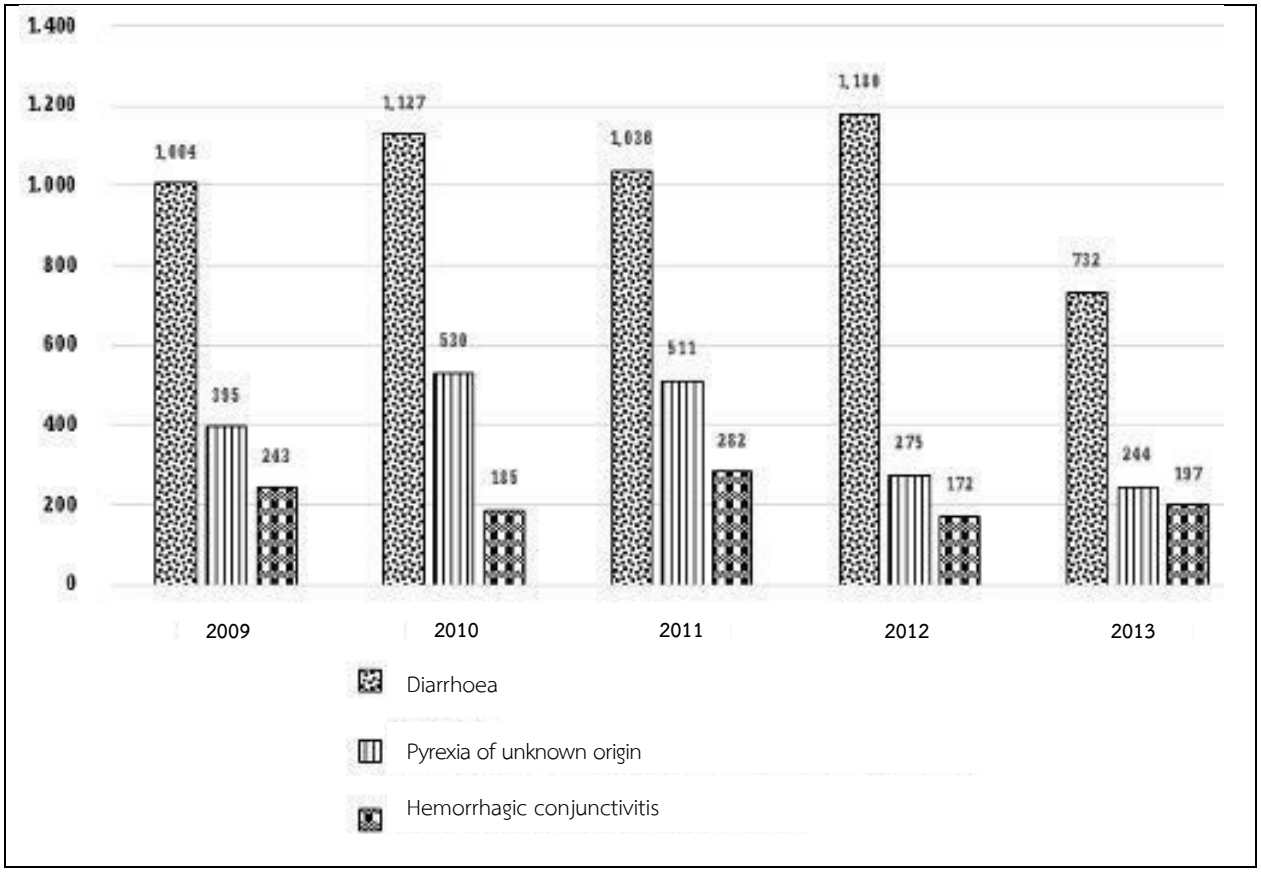


FIGURE 4.4.2-6: CAUSE AND MORBIDITY RATE OF EPIDEMIC DISEASES SURVEILLANCE (ROR NGOR. 506) OF TAMBON HEALTH PROMOTING HOSPITALS (HEALTH CENTER) IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013

6. Cause of Death and Mortality Rate

- **Hospital**

Cause of death and mortality rate of hospitals in study area were Laem Chabang Hospital, Queen Savang Vadhana Memorial Hospital, Ban Bueng Hospital and Pluak Daeng Hospital during 2009-2013 **(Table 4.4.2-9)**. Details are summarized as follows:

Chon Buri Province

Si Racha District

- **Laem Chabang Hospital**

Major cause of death and mortality was 4 causes: (1) Others such as senility etc. (2) cancer (3) pneumonitis and other of pulmonary diseases and (4) heart diseases. Details are shown in **Appendix 3H-4 Table 1**.

- **Queen Savang Vadhana Memorial Hospital**

Major cause of death and mortality was 6 causes: (1) others such as senility etc. (2) cancer (3) accidents and poisonings (4) heart diseases (5) high blood pressure and stroke and (6) pneumonitis and other of pulmonary diseases. Details are shown in **Appendix 3H-4 Table 2**.

Ban Bueng District

- **Ban Bueng Hospital**

Major cause of death and mortality was 4 causes: (1) Others such as senility etc. (2) accidents and poisonings (3) cancer and (4) Injure from suicide, killed and others. Details are shown in **Appendix 3H-4 Table 3**.

Rayong Province

Pluak Daeng District

- **Pluak Daeng Hospital**

Major cause of death and mortality was 3 causes: (1) Others such as senility etc. (2) accidents and poisonings and (3) heart diseases. Details are shown in **Appendix 3H-4 Table 4**.

Overall of hospitals in study area

Major cause of death and mortality was 4 causes:(1) Others such as senility etc. (2) accidents and poisonings (3) cancer and (4) heart diseases. Details are shown in **Appendix 3H-4 Table 5**.

TABLE 4.4.2-9

CAUSE OF DEATH AND MORTALITY RATE OF HOSPITALS IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013

Hospital	Ranking	Cause and morbidity rate per one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Laem Chabang	1	cancer (7)	Others such as senility (8)	Others such as senility (23)	Others such as senility (20)	Others such as senility (13)	Others such as senility (14)
	2	Others such as senility (7)	cancer (6)	cancer (6)	cancer (5)	cancer (6)	cancer (6)
	3	heart diseases(5)	heart diseases(1)	pulmonary diseases (2)	pulmonary diseases (3) nephropathy (3)	pulmonary diseases (5)	pulmonary diseases (3)
Queen Savang Vadhana Memorial	1	Others such as senility (66)	Others such as senility (113)	Others such as senility (82)	heart diseases (60)	heart diseases (59)	Others such as senility (72)
	2	cancer (34)	cancer (33) High blood pressureand stroke(33)	High blood pressureand stroke (39)	Others such as senility(54)	cancer (55)	cancer (41)
	3	pulmonary diseases (25)	accidents and poisonings (26)	cancer (34)	cancer (48)	Others such as senility(47)	accidents and poisonings (25)
Ban Bueng	1	Others such as senility (76)	accidents and poisonings (90)	Others such as senility(92)	accidents and poisonings (91)	accidents and poisonings (96)	Others such as senility (85)
	2	accidents and poisonings (69)	Others such as senility (87)	accidents and poisonings (70)	Others such as senility (88)	Others such as senility (83)	accidents and poisonings (83)
	3	cancer (30)	Suicide/killed (20)	Suicide/killed (23)	cancer (29)	cancer (20)	cancer (20)

TABLE 4.4.2-9

CAUSE OF DEATH AND MORTALITY RATE OF HOSPITALS IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013

(Cont'd)

Hospital	Ranking	Cause and morbidity rate per one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Pluak Daeng	1	Others such as senility (178)	Others such as senility (193)	Others such as senility (40)	Others such as senility (26)	Others such as senility (54)	Others such as senility (94)
	2	accidents and poisonings (53)	accidents and poisonings (38)	accidents and poisonings (34)	accidents and poisonings (24)	accidents and poisonings (35)	accidents and poisonings (36)
	3	heart diseases (38)	heart diseases (31)	heart diseases (13)	heart diseases (10)	heart diseases (16)	heart diseases (21)
Overall of study area	1	Others such as senility (86)	Others such as senility (121)	Others such as senility (94)	Others such as senility (72)	Others such as senility (65)	Others such as senility (87)
	2	cancer (35)	accidents and poisonings (43)	accidents and poisonings (36)	heart diseases(45)	accidents and poisonings (51)	accidents and poisonings (41)
	3	accidents and poisonings (33)	cancer (27)	cancer (28)	cancer (41)	heart diseases (44)	cancer (35)

Remark: 1/ Cause of death and mortality of Nong Yai District was not included because the information has not received yet.

Source: Laem Chabang Hospital, Queen Savang Vadhana Memorial Hospital, Nong Yai Hospital, Ban Bueng Hospital and Pluak Daeng Hospital, 2014

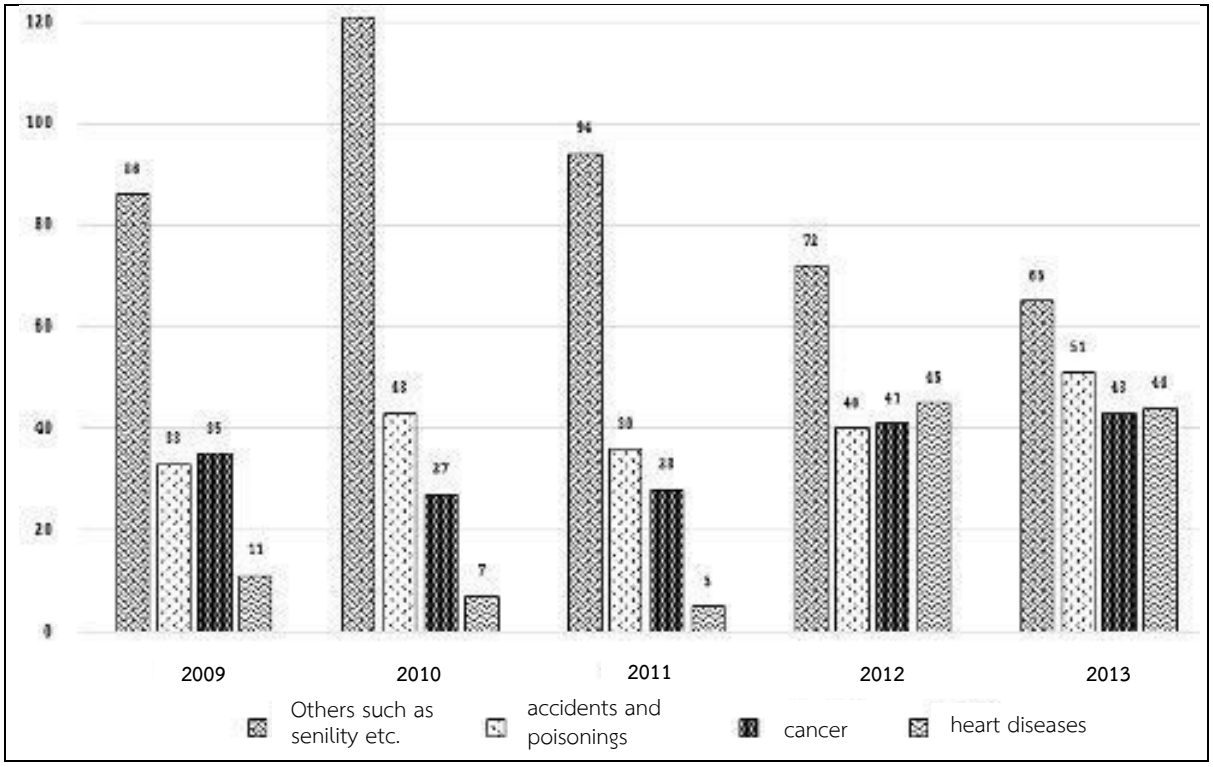


FIGURE 4.4.2-7 :CAUSE OF DEATH AND MORTALITY RATEOF HOSPITALS IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013

7. Tambon Health Promoting Hospital (Health Center)

Cause of death and mortality rateof Tambon Health Promoting Hospital (Health Center) in study area were Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-distrct, Ban Khao Hin Tambon Health Promoting Hospital, Ban Tha Cham Tambon Health Promoting Hospital, Ban Muen Chit Tambon Health Promoting Hospital, Chaloem Phrakiart of 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district, Ban Nong Khang Khao Tambon Health Promoting Hospital and Ban Nong Bon Tambon Health Promoting Hospital during 2009-2013 **(Table 4.4.2-10)**. Details are summarized as follows:

Chon Buri Province

Si Racha District

- **Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-distrct**

Major cause of death and mortality was 8 causes: (1) heart diseases (2) accidents and poisonings (3) nephritis, hemodialysis disability and nephropathy (4) cancer (5) others such as senility etc. (6) pneumonitis and other of pulmonary diseases (7) high blood pressure and stroke and (8) diseases of the liver and pancreas. Details are shown in **Appendix 3H-4 Table 6**.

TABLE 4.4.2-10

CAUSE OF DEATH AND MORTALITY RATEOF TAMBON HEALTH PROMOTING HOSPITAL (HEALTH CENTER)IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013

Tambon Health Promoting Hospital/Health Center	Ranking	Cause and morbidity rate per one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-district	1	heart diseases (94)	heart diseases (110)	heart diseases (78)	Others such as senility (63)	accidents and poisonings (47)	heart diseases (314)
	2	accidents and poisonings (78)	accidents and poisonings (63)	accidents and poisonings (31) pulmonary diseases (31)	accidents and poisonings (47)	heart diseases (16) cancer (16) nephropathy (16)	accidents and poisonings (267)
	3	nephropathy (47)	High blood pressure/stroke (31)	cancer (16)	liver diseases (31)	-	nephropathy (94)
Khao Hin Tambon Health Promoting Hospital	1	heart diseases (29)	heart diseases (9) High blood pressure/stroke (9) immunodeficiency (9) Others such as senility (9)	Others such as senility (9)	heart diseases (29)	heart diseases (7) cancer (7)	heart diseases (14)
	2	cancer (19)	-	-	Others such as senility (15)	-	Others such as senility (8)
	3	-	-	-	High blood pressure/stroke (7) Tuberculosis (7)	-	cancer (5)
Ban Tha Cham Tambon Health Promoting Hospital	1	Others such as senility (50)	pulmonary diseases (74)	High blood pressure/stroke (148)	cancer (49) Others such as senility (49)	Others such as senility (98)	Others such as senility (59)
	2	heart diseases (25) cancer (25) High blood pressure/stroke (25)	Others such as senility (50)	pulmonary diseases (49) Others such as senility (49)	High blood pressure/stroke (25)	accidents and poisonings (73) pulmonary diseases (73)	High blood pressure/stroke (49)
	3	-	accidents and poisonings (25) liver diseases (25)	accidents and poisonings (25) cancer (25)	-	High blood pressure/stroke(49)	pulmonary diseases (39)

TABLE 4.4.2-10

CAUSE OF DEATH AND MORTALITY RATEOF TAMBON HEALTH PROMOTING HOSPITAL (HEALTH CENTER)IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013 (Cont'd)

Tambon Health Promoting Hospital/Health Center	Ranking	Cause and morbidity rate per one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Ban Muen Chit Tambon Health Promoting	1	accidents and poisonings (56) cancer (56) pulmonary diseases (56)	heart diseases (56)	heart diseases (56)	cancer (56) pulmonary diseases (56)	heart diseases(34) pulmonary diseases (34)	heart diseases (68) pulmonary diseases (68)
	2	-	-	pulmonary diseases (56) Others such as senility (56)	-	cancer (23)	cancer (45)
	3	-	-	-	-	accidents and poisonings (56) Others such as senility (56)	accidents and poisonings (23) Others such as senility (23)
Chaloem Phrakiartof 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district	1	heart diseases (267)	heart diseases (96)	heart diseases (190)	heart diseases (126)	heart diseases (253)	heart diseases (186)
	2	Others such as senility (67)	Others such as senility (32)	Others such as senility (63)	Others such as senility (95)	accidents and poisonings (95)	Others such as senility (58)
	3	accidents and poisonings (33) cancer (33)	-	accidents and poisonings (32) cancer (32)	accidents and poisonings (63)	Others such as senility(32)	accidents and poisonings (45)
Ban Nong Khang Khao Tambon Health Promoting Hospital	1	heart diseases (97)	pulmonary diseases (72)	High blood pressure/stroke (141)	cancer (94)	-	High blood pressure/stroke (43) Others such as senility (43)
	2	cancer (48)	heart diseases (48) High blood pressure/stroke (48) Others such as senility (48)	Others such as senility (94)	Others such as senility(47)	-	heart diseases (38)
	3	High blood pressure/stroke (24) Diseases of the liver and pancreas (24) Others such as senility (24)	cancer (24) nephropathy (24) Tuberculosis (24)	heart diseases (47)	liver diseases (24)	-	cancer (33)

TABLE 4.4.2-10

CAUSE OF DEATH AND MORTALITY RATEOF TAMBON HEALTH PROMOTING HOSPITAL (HEALTH CENTER)IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013 (Cont'd)

Tambon Health Promoting Hospital/Health Center	Ranking	Cause and morbidity rate per one hundred thousand population					
		2009	2010	2011	2012	2013	Total of 5 years
Ban Nong Bon Tambon Health Promoting Hospital	1	accidents and poisonings (81)	accidents and poisonings (27) cancer (27) High blood pressure/stroke (27) pulmonary diseases (27)	pulmonary diseases(79)	accidents and poisonings (52) High blood pressure/stroke (52) pulmonary diseases (52) Others such as senility (52)	heart diseases (106)	accidents and poisonings (48)
	2	cancer (54)	-	accidents and poisonings (53)	-	Others such as senility(53)	pulmonary diseases(37)
	3	High blood pressure/stroke (27) Suicide/killed (27) pulmonary diseases (27)	-	nephropathy (26)	-	accidents and poisonings (26) cancer (26) , Tuberculosis (26) High blood pressure/stroke (26) Suicide/killed (26)	High blood pressure/stroke (26)
Overall of study area	1	heart diseases (66)	heart diseases (41)	heart diseases (42)	Others such as senility (40)	heart diseases (47)	heart diseases (52)
	2	cancer (33)	pulmonary diseases (20)	High blood pressure/stroke (34)	heart diseases (24)	accidents and poisonings (29)	Others such as senility (25)
	3	accidents and poisonings (30)	accidents and poisonings (17) High blood pressure/stroke (17) Others such as senility (17)	Others such as senility (31)	cancer (22)	Others such as senility(21)	cancer (15)

Source: Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-district, Khao Hin Tambon Health Promoting Hospital, Ban Tha Cham Tambon Health Promoting Hospital, Ban Muen Chit Tambon Health Promoting Hospital, Chaloem Phrakiartof 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district, Ban Nong Khang Khao Tambon Health Promoting Hospital and Ban Nong Bon Tambon Health Promoting Hospital, 2014

Remark: - isno patient.

- **Khao Hin Tambon Health Promoting Hospital**

Major cause of death and mortality was 6 causes: (1) heart diseases (tend to decrease) (2) others such as senility etc. (tend to decrease) (3) cancer (tend to decrease) (4) high blood pressure and stroke (tend to stable) (5) tuberculosis (tend to increase) and (6) immunodeficiency (tend to stable). Details are shown in **Appendix 3H-4 Table 7**.

Nong Yai District

- **Ban Tha Cham Tambon Health Promoting Hospital**

Major cause of death and mortality was 7 causes: (1) others such as senility etc. (2) high blood pressure and stroke (3) pneumonitis and other of pulmonary diseases (4) accidents and poisonings (5) cancer (6) heart diseases and (7) diseases of the liver and pancreas. Details are shown in **Appendix 3H-4 Table 8**.

Ban Bueng District

- **Ban Muen Chit Tambon Health Promoting Hospita**

Major cause of death and mortality was 5 causes: (1) heart diseases (2) pneumonitis and other of pulmonary diseases (3) cancer (4) accidents and poisonings and (5) others such as senility etc. Details are shown in **Appendix 3H-4 Table 9.**

- **Chaloem Phrakiartof 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district**

Major cause of death and mortality was 4causes: (1) heart diseases (2) others such as senility etc. (3) accidents and poisonings and (4) cancer. Details are shown in **Appendix 3H-4 Table 10.**

Rayong Province

Pluak Daeng District

- **Ban Nong Khang Khao Tambon Health Promoting Hospital**

Major cause of death and mortality was 8 causes: (1) high blood pressure and stroke (2) Others such as senility etc. (3) heart diseases (4) cancer (5) diseases of the liver and pancreas (6) pneumonitis and other of pulmonary diseases (7) nephritis, hemodialysis disability and nephropathy and (8) tuberculosis. Details are shown in **Appendix 3H-4 Table 11**.

- **Ban Nong Bon Tambon Health Promoting Hospital**

Major cause of death and mortality was 9 causes: (1) accidents and poisonings (2) pneumonitis and other of pulmonary diseases (3) high blood pressure and stroke (4) heart diseases (5) cancer (6) others such as senility etc. (7) Injure from suicide, killed and others (8) nephritis, hemodialysis disability and nephropathy and (9) tuberculosis. Details are shown in **Appendix 3H-4 Table 12**.

Overall of Tambon Health Promoting Hospital (Health Center) in study area

Major cause of death and mortality was 6 causes: (1) heart diseases (2) Others such as senility etc. (3) cancer (4) accidents and poisonings (5) high blood pressure and stroke and (6) pneumonitis and other of pulmonary diseases as shown in **Figure 4.4.2-8**. Details are shown in **Appendix 3H-4 Table 13**.

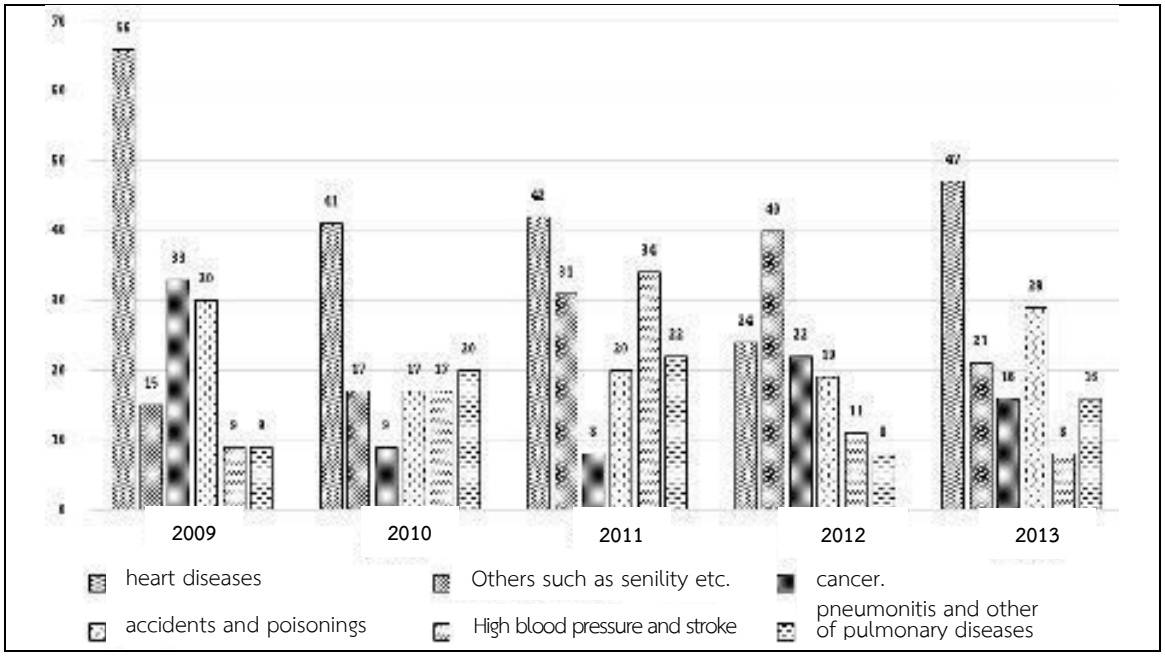


FIGURE 4.4.2-8 : CAUSE OF DEATH AND MORTALITYOF TAMBON HEALTH PROMOTING HOSPITAL (HEALTH CENTER) IN STUDY AREA PER ONE HUNDRED THOUSAND POPULATION DURING 2009-2013

8. Cause and Morbidity Rate of Mental Health

The compilation data of mental health from Department of Mental Health, Minitry of Public Health found that the project development may cause to mental health of local people such as anxiety, stress, etc. Long period of the construction period and operation period may cause to accumulate of mental health problem. Thus, it is necessary to study and assess impact on mental health. Detail of morbidity rate per one hundred thousand population of Chon Buri and Rayong Province during 2009-2013 is shown in **Table 4.4.2-11** and **Table 4.4.2-12**.

TABLE 4.4.2-11

RATE OF MENTAL HEALTH MORBIDITY OF CHON BURI PROVINCE DURING 2009-2013

Year	Morbidity rate per one hundred thousand population										
	Mental disorder	Anxiety diorder	Depression	Mental retardation	Epilepsy	Drug addictor	Other mental health problems	Parasuicide or suicide		Autistic	Total
								Completed	In-completed		
2009	351.27	392.77	122.09	7.50	221.91	178.37	115.06	8.68	79.73	4.85	**1,482.21**
2010	273.53	245.83	82.20	41.52	252.12	175.99	197.78	8.14	76.52	4.76	**1,358.39**
2011	416.13	561.59	254.32	52.88	425.24	207.24	252.21	6.93	48.74	1.88	**2,227.16**
2012	387.10	492.40	360.46	44.62	422.92	1,453.83	336.19	5.92	47.21	18.06	**3,568.71**
2013	288.99	296.83	242.31	37.18	446.94	295.61	594.67	5.03	56.89	27.62	**2,292.08**
Avg. 5 years	**343.40**	**397.88**	**212.28**	**36.74**	**353.83**	**462.21**	**299.18**	**6.94**	**61.82**	**11.43**	**2,185.71**

Source: Mental health center region 1-19, Information center, Planning Division, Department of Mental Health, Minitry of Public Health, 2015

TABLE 4.4.2-12

RATE OF MENTAL HEALTH MORBIDITY OF RAYONG PROVINCE DURING 2009-2013

Year	Morbidity rate per one hundred thousand population										
	Mental disorder	Anxiety diorder	Depression	Mental retardation	Epilepsy	Drug addictor	Other mental health problems	Parasuicide or suicide		Autistic	Total
								Completed	In-completed		
2009	199.25	461.38	332.30	12.71	8.91	3.63	8.75	16.01	102.84	1.82	**1,147.60**
2010	206.22	291.16	430.04	11.47	148.73	21.64	99.31	9.85	71.38	2.26	**1,292.05**
2011	423.85	480.80	240.01	36.70	300.76	66.61	323.70	13.45	77.36	0.79	**1,964.03**
2012	433.41	464.33	268.68	31.70	310.80	46.93	643.51	12.28	69.93	52.52	**2,334.09**
2013	958.68	569.70	562.90	63.52	274.04	62.16	1,166.18	8.17	44.92	65.49	**3,775.75**
Avg. 5 years	**444.28**	**453.47**	**366.79**	**31.22**	**208.65**	**40.19**	**448.29**	**11.95**	**73.29**	**24.58**	**2,102.70**

Source: Mental health center region 1-19, Information center, Planning Division, Department of Mental Health, Minitry of Public Health, 2015

- **Rate of Mental Health Morbidity**

Chon Buri Province

Rate of Mental Health Morbidity was 9 categories : Mental disorder, anxiety disorder, depression, mental retardation, epilepsy, drug addictor, other mental health problems, parasuicide or suicide and autistic. It was found that rate of mental health morbidity per one hundred thousand during 2009-2013 was between 1,358.39-3,568.71. The maximum rate mental health morbidity per one hundred thousand was 3,568.71 in 2013. Major of mental health in the area was mental disorder, other mental health problems and anxiety disorder, respectively.

Rayong Province

Rate of Mental Health Morbidity was 9 categories : mental disorder, anxiety disorder, depression, mental retardation, epilepsy, drug addictor, other mental health problems, parasuicide or suicide and autistic. It was found that rate of mental health morbidity per one hundred thousand during 2009-2013 was between 1,147.6 - 3,775.75. The maximum rate mental health morbidity per one hundred thousand was 3,775.75 in 2013. Major of mental health in the area was other mental health problems, mental disorder and anxiety disorder, respectively.

- **Rate of completed suicide**

Chon Buri Province

Completed suicide rate tended to increase. Rate of completed suicide per one hundred thousand was between 5.03-8.68 while in-completed suicide rate tended to decrease.

Rayong Province

Completed suicide rate tended to increase. Rate of completed suicide per one hundred thousand was between 8.17-16.01 while in-completed suicide rate tended to decrease.

(b5) Number of Medical Equipment

Medical equipment of public health agencies in study area is necessary due to project may transfer patient to public health agencies in case of emergency or servere accidents. Thus, medical equipment data is used as basic data to assess health impact. Medical equipment data is gathered from Information health resources, Minitry of Public Health. Queen Savang Vadhana Memorial Hospital and private hospitals, were Laem Chabang International Hospital, Samitivej Si Racha hospital and Phyathai Si Racha hospital, had equipments that can diagnose fine disorder such as MRI, CT Scan, etc. Tambon Health Promoting Hospital (Health Center) was potential to first aid and transfer to government hospital by ambulance. Details of medical equipment of public health agencies in study area is shown in **Table 4.4.2-13**.

TABLE 4.4.2-13

NUMBER OF MEDICAL EQUIPMENT OF PUBLIC HEALTH AGENCIES IN STUDY AREA

No.	Public Health Agency	Number of Medical Equipment						
		CT Scan	MRI	ESWL machine	Laser	Ultrasound	Dialysis machine	Ambulance
Public hospitals								
1	Laem Chabang Hospital	-	-	-	-	3	-	4
2	Nong Yai Hospital	-	-	-	-	1	-	4
3	Ban Bueng Hospital	-	-	-	-	3	6	6
4	Pluak Daeng Hospital	-	-	-	-	1	-	4
Belong to Red Cross Society								
1	Queen Savang Vadhana Memorial Hospital	1	1	1	-	8	15	6
Private Hospitals								
1	Laem Chabang International Hospital	1	-	1	-	1	-	2
2	Samitivej Srirachahospital	1	1	-	3	5	20	7
3	Phyathai Sriracha hospital	1	1	-	-	18	17	6
4	Vibharam Laemchabang hospital	1	-	1	-	1	-	2
5	Piyavate Bowin hospital	*	*	*	*	*	*	*
Tambon Health Promoting Hospital/health center								
1	Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-district	-	-	-	-	-	-	1
2	Ban Khao Hin Tambon Health Promoting Hospital	-	-	-	-	-	-	-
3	Ban Tha Cham Tambon Health Promoting Hospital	-	-	-	-	-	-	2
4	Ban Muen Chit Tambon Health Promoting Hospital	-	-	-	-	-	-	1
5	Chaloem Phrakiartof 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district	-	-	-	-	-	-	1
6	Ban Nong Khang Khao Tambon Health Promoting Hospital	-	-	-	-	-	-	1
7	Ban Nong Bon Tambon Health Promoting Hospital	-	-	-	-	-	-	-

Remark: * is no data.

Source: Information health resources, Minitry of Public Health, 2014 (http://gishealth.moph.go.th/healthmap/gmap.php#result)

(c) Accident and Safety

- **Statistics of Crime**

Safety data is necessary for project development, it is used for health assessment particularly during the construction period because migrant workers emigrate into the area which may impact to safety of area. Thus, gather of safety data is necessary and imply on safety of communities in the study area. Data were gathered from Laem Chabang Police Station, Nong Kham Police Station, Bowin Police Station, Khlong Kio Police Station, Nong Yai Police Station and Pluak Daeng Police Station, found that major case wascrimes committed against the state such asfirearm, gambling and drug, while next was crimes against properties (theft, robbery and gang-robbery) and homicide, battery and rape case (premeditated murder or involuntary manslaughter, attempted murder and battery), respectively. Details are shown in **Table 4.4.2-14**.

- **Statistics on Road Accident**

In the construction period and operation period need to use vihecles for transportation. Materials and workers transportaitions were in construction while chemical and employees transportaitions were in operation period. Increasing of traffic volume may cause high accident. Thus, it is necessary to gather statistics on road accident to use as basic data for health assessment. Statistics on road accident were gathered from Accident Information Center. In 5 years (2010-2014) road accidents in study area consisted of Ban Bueng, Si Racha and Nong Yai Districts in Chon Buri Province and Pluak Daeng District in Rayong Province, found that total road accidents were 20,434 times, 22,269 injured, 177 death and 82 disabled, respectively. Details are shown in **Table 4.4.2-15**.

(3.2) Collection of primary data on public health

Data on health care and public health were surveyed using in-depth interview with 18 health care officers of the public health organizations in the study area, the details of which are provided in **Table 4.4.2.16**. The survey was conducted on 17– 28 October 2014 and 20 April 2015, the illustration of which is shown in **Photo 4.4.2-1**. With deliberation, the outline of the questionnaire, with respect to the topics to be covered, was designed with a view to acquiring primary data to be further used in health impact analysis. (The questionnaire for in-depth interview with public health officers is shown in **Appendix 3H-5**.)

TABLE 4.4.2-14

STATISTICS OF NOTIFIED AND ARRESTED IN 5 CRIME TYPES DURING 2009-2014

Police Station	Type of Crimde	Statistics of notified and arrested in 5 crime types											
		2009		2010		2011		2012		2013		2014	
		Notified (Case)	Arrested (Case)	Notified (Case)	Arrested (Case)	Notified (Case)	Arrested (Case)	Notified (Case)	Arrested (Case)	Notified (Case)	Arrested (Case)	Notified (Case)	Arrested (Case)
Laem Chabung	1. Serious offence and awful crimes[1]	7	6	6	4	11	6	9	8	9	6	5	4
	2. Homicide, battery and rape case[2]	47	28	24	9	30	16	18	14	21	17	19	12
	3. Crimes against properties[3]	252	60	245	76	220	88	145	84	115	79	83	73
	4. Interesting case[4]	198	13	180	12	125	8	78	21	58	18	33	26
	5. Crimes committed against the state[5]	700	984	705	986	862	1,356	1,037	1,341	1,340	1,486	1,337	1,606
Nong Kham	1. Serious offence and awful crimes[1]	*	*	4	2	6	4	11	11	9	7	9	8
	2. Homicide, battery and rapecase[2]	*	*	28	12	30	15	29	17	27	13	36	30
	3. Crimes against properties[3]	*	*	88	52	91	54	128	87	127	94	123	71
	4. Interesting case[4]	*	*	49	15	36	10	56	24	69	36	64	23
	5. Crimes committed against the state[5]	*	*	956	1,065	1,420	1,595	1,919	1,786	1,199	1,234	2,659	3,050
Bowin	1. Serious offence and awful crimes[1]	8	1	9	7	5	3	5	2	1	1	9	7
	2. Homicide, battery and rapecase[2]	21	6	18	4	20	11	19	5	16	8	18	11
	3. Crimes against properties[3]	126	19	96	10	77	45	81	31	62	27	58	33
	4. Interesting case[4]	86	6	51	4	24	3	36	6	28	3	31	5
	5. Crimes committed against the state[5]	143	207	50	60	649	806	428	550	700	767	759	961
Khlong Kio	1. Serious offence and awful crimes[1]	1	0	5	4	2	2	1	0	1	0	2	2
	2. Homicide, battery and rapecase[2]	9	3	7	4	5	2	8	5	18	13	4	3
	3. Crimes against properties[3]	8	0	17	6	22	10	23	9	43	17	14	9
	4. Interesting case[4]	3	0	3	2	6	1	5	3	10	4	0	0
	5. Crimes committed against the state[5]	64	79	80	97	136	154	188	232	286	354	170	181

TABLE 4.4.2-14

STATISTICS OF NOTIFIED AND ARRESTED IN 5 CRIME TYPES DURING 2009-2014 (Cont'd)

Police Station	Type of Crimde	Statistics of notified and arrested in 5 crime types											
		2009		2010		2011		2012		2013		2014	
		Notified (Case)	Arrested (Case)	Notified (Case)	Arrested (Case)	Notified (Case)	Arrested (Case)	Notified (Case)	Arrested (Case)	Notified (Case)	Arrested (Case)	Notified (Case)	Arrested (Case)
Nong Yai	1. Serious offence and awful crimes[1]	5	3	4	4	4	2	4	4	1	1	1	1
	2. Homicide, battery and rapecase[2]	18	9	10	10	10	5	9	8	6	5	4	4
	3. Crimes against properties[3]	22	15	20	11	16	13	11	6	5	3	19	17
	4. Interesting case[4]	4	1	9	1	5	0	3	0	3	0	4	4
	5. Crimes committed against the state[5]	230	284	253	309	255	296	294	376	526	610	553	600
Pluak Daeng	1. Serious offence and awful crimes[1]	5	1	9	6	9	7	10	8	6	3	9	7
	2. Homicide, battery and rapecase[2]	33	15	34	15	21	14	19	16	28	17	43	38
	3. Crimes against properties[3]	145	52	173	57	108	76	178	83	109	72	113	93
	4. Interesting case[4]	25	4	8	1	24	7	97	16	45	18	50	27
	5. Crimes committed against the state[5]	544	906	510	688	785	956	950	1,030	645	757	858	1,224

Remark: 1 is premeditated murder, gang-robbery,robbery, kidnap andarson.

2 is premeditated murder or involuntary manslaughter,attempted murder, battery and rape.

3 is theft/snatching/blackmail/robbery/gang-robbery/malicious damage, extortion and receiving stolen property.

4 is steal (Motorcycle/car/cattle/agricultural tools), robbing bus or taxi, rape and kill, kidnap, defraud and embezzle.

5 is firearm,gambling anddrug

* is no data.

Number of offender is arrested in case of crimes committed against the state.

Source: Laem Chabang Police Station, Nong Kham Police Station, Bowin Police Station, Khlong Kio Police Station, Nong Yai Police Station and Pluak Daeng Police Station, 2015

TABLE 4.4.2-15

STATISTICS ON ROAD ACCIDENT DURING 2010-2014

Province	District	No. of accident (time)	Statistics on Road Accident (person)														
			2010			2011			2012			2013			2014		
			Disabled	Injured	Death	Disabled	Injured	Death	Disabled	Injured	Death	Disabled	Injured	Death	Disabled	Injured	Death
Chon Buri	Ban Bueng	2,741	5	457	17	2	669	17	4	718	17	12	668	29	4	627	29
	Si Racha	15,328	13	2,624	69	13	3,459	79	6	3,305	101	17	3,737	86	11	3,492	106
	Nong Yai	256	-	40	1	1	86	3	1	61	6	-	67	2	2	40	3
Rayong	Pluak Daeng	2,109	5	392	20	3	413	27	-	415	27	4	540	33	2	459	39
Total		**20,434**	**-**	**3,513**	**107**	**19**	**4,627**	**126**	**11**	**4,499**	**151**	**33**	**5,012**	**150**	**19**	**4,618**	**177**

Source: Accident Information Center (http://ts2.thairsc.com) , 2558

TABLE 4.4.2-16

LIST OF PUBLIC HEALTH ORGANIZATIONS IN THE STUDY AREA

No.	Organizations	Position	In Charged Duration (Year)
1	Public Health, Rayong Province	Registered Nurse	21
2	Public Health, Chon Buri Province[1/]	Public health Technical Officer	19
3	Public Health, Si Racha District	Chief of Medical District	2
4	Public Health, Nong Yai District	Public health Technical Officer	1
5	Public Health, Ban Bueng District	Chief of Medical District	9
6	Public Health, Pluak Daeng District	Chief of Medical District	17
7	Laem Chabang Hospital	Chief of Development Strategy	22
8	Queen Savang Vadhana Memorial Hospital	Head of Administration Building and environment	11
9	Nong Yai Hospital	Director	18
10	Ban Bueng Hospital	Public health Technical Officer	4
11	Pluak Daeng Hospital	Medical Technologist	24
12	Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-district	Public health Technical Officer	2
13	Ban Khao Hin Tambon Health Promoting Hospital	Public Health Officer	12
14	Ban Tha Cham Tambon Health Promoting Hospital	Public health Technical Officer	10
15	Ban Muen Chit Tambon Health Promoting Hospital	Public health Technical Officer	3
16	Chaloem Phrakiartof 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district	Director	10
17	Ban Nong Khang Khao Tambon Health Promoting Hospital	Public Health Officer	20
18	Ban Nong Bon Tambon Health Promoting Hospital	Public health Technical Officer	20

Source: Result of interview during 17 -28 October 2014 and

[1/]20 April 2015 by TEAM Consulting Engneering and Manaement Co., Ltd.

	
Chief of Medical District Public Health, Si Racha District	Chief of Development Strategy Laem Chabang Hospital
	
Public health Technical Officer Chaloem Phrakiart 60 years Nawamin Maharachini Health Center, Khao Khansong Sub-district	Public Health Officer Ban Khao Hin Tambon Health Promoting Hospital
	
Director Nong Yai Hospital	Chief of Medical District Public Health, Ban Bueng District

PHOTO 4.4.2-1: EXAMPLE PICTURE OF MEETING WITH REPRESENTATIVE OF PUBLIC HEALTH AGENCY IN STUDY AREA

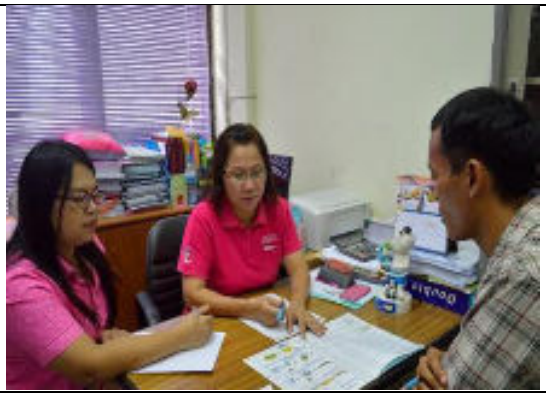
	
Public health Technical Officer Ban Bueng Hospital	Director Chaloem Phrakiartof 50th Anniversary Celebrations of His Majest's Accession to the throne Health Center, Map Lambit Sub-district
	
Registered Nurse Public Health, Rayong Province	Chief of Medical District Public Health, Pluak Daeng District
	
Medical Technologist Pluak Daeng Hospital	Public Health Officer Ban Nong Khang Khao Tambon Health Promoting Hospital

PHOTO 4.4.2-1: EXAMPLE PICTURE OF MEETING WITH REPRESENTATIVE OF PUBLIC HEALTH AGENCY IN STUDY AREA (Cont'd)

Study results

The results of the survey to collect public health data are shown in **Appendix 3H-6** and the illustration of the meeting activity with representatives from the public health organizations in the study area is shown in **Photo 3.19-1**. The findings can be summarized as follows:

- **Sufficiency of medical personnel and equipment**

According to the interview survey, 94.4 % of the public health officers interviewed think that there is shortage of medical personnel such as registered nurses, dental health officers andpublic health officers, etc. 77.8 % think that there is shortage of medical equipment such as dental equipment, respirators, wound carekits, etc.

- **Change in health determining factors**

People's illness caused by the current environment

According to the interview survey, 72.2 % of the public health officers interviewed think that people's illness is an impact resulting from the current environmental condition, which involves air quality, water quality, rubbish, for example.

Health promotion plans or activities

The public health organizations in the study area have plans or activities to promote good health such as providing checking-up and screening of certain health conditions, disseminating health-related knowledge, promoting exercise behavior, etc.

Daily life behaviors that can increase health-related risks

Certain behaviors of the people in the area that pose risk to their health and can endanger their lives include inappropriate eating behavior, drinking, violation of traffic regulations, smoking and drug abuse.

Social problems and crimes

According to the interview survey, 72.2 % of the public health officers interviewed think that in the study areasthere are social problems and crimes involving theft/robbery, drug abuse, violence, and teenage pregnancy.

Pros and cons, concerns, and suggestions about the project during the construction period

According to the interview survey, 94.4 % of the public health officers interviewed think that the positive impact resulting from the project during its construction period is improved socio-economic standing. At the same time, nevertheless, most of the interviewees (88.9 %) have some concerns about impacts caused by the project to people'shealth, environment, society, traffic, etc. The population groups anticipated to be affected are the people in the study area (51.7 %); children, senior citizens, pregnant women, chronic patients (27.6 %); and construction workers (17.2 %). Moreover, 72.2 % of

the healthcare officers interviewed expressed further concern about their possibly more workload resulting from the project during its construction period. With respect to these concerns, they made some suggestions about the project as follows:

- That relevant preventive measures be established and the impacts be continually monitored.
- That public relations to disseminate information and promote understanding about the project be continually made and channel for public opinion about the project be provided .
- That there should be warning construction area signs to forestall accident.
- That budget be allocated from the electricity development funds to support public health and medical services in the area.
- That social security card be issued for all the project staff to prevent the problem concerningright to medical careand reduce the problem of medical expenses in the area, and health checkup be arranged for all the project staff to prevent spread of diseases.
- That activities to promote health be continually organized and health-related support be continually provided to the areas involved.
- That it must be stipulated that the construction works can be done only during the day.
- That the sanitary system in the workers' camps be hygienically maintained.

Pros and cons, concerns, and suggestions about the project during the operation period

According to the interview survey, 77.8 % of the public health officers interviewed think that the positive impacts resulting from the project during its operation period is improved socio-economic standing. At the same time, nevertheless, 77.8 % of the interviewees have some concerns about impacts caused by the project to people's health, environment, traffic, society, safety, etc. The population groups anticipated to be affected are the people in the study area (46.7 %); children, senior citizens, pregnant women, chronic patients (30.0 %); and the project staff (23.3 %). Moreover, 52.9 % of the healthcare officers interviewed expressed further concern about their possibly more workload resulting from the project during its operation period, and 64.7 % think that there can be some change to their way of life. With respect to these concerns, they made some suggestions about the project as follows;

- That relevant control and treatment systems must be set to minimize the pollution caused by the project.

- That budget be allocated from the electricity development funds to support public health and medical services in the area.
- That activities to promote health be continually organized and health-related support be continually provided to the areas involved.
- That public relations to disseminate information and promote understanding about the project be continually made and public opinion about the project be encouraged, to generate confidence in the project on the part of the people in the area.
- That knowledge on details, production process, and impacts of the project be provided to public healthofficers in the area.
- That relevant preventive measures be established and the impacts be continually monitored.
- That there should be promotion of healthcareamong the staff such as through provision of knowledge about healthy eating behavior, campaign on alcohol abstention, campaign promoting exercise behavior, etc.
- That there must be regular maintenance of the machinery used in the project.
- That there should be basic first aid unit within the project.
- That there should be cooperation with other factories in the Industrial Estate in maintenance of the wellbeing of the communities.
- That there should be officers specifically appointed to follow up and deal with possible impacts caused to agricultural production in the area.
- That the emergency plan drill should be conducted regularly.
- That in the appointment of community development committee, local people in the community should be selected.
- That a visit to the project premises be organized for the public.
- That opportunity be open for the public to investigate the operation of the project.
- That there should be proper management of water for use in the project in order that there is no impact to water for household use in the area.

- **Capacity to accommodate admissions due to emergency accidents happening in the area**

According to the interview with the public health officers in the area, the hospitals and the sub-district healthcare centers can accommodate emergency patients with the average treatment time of 27 minutes per patient.

4.4.3 Archaeology and Historical Treasure

(1) Introduction

The project development may exhaust impact to archaeology and historical treasure. So, it is necessary to conduct a study on position, location and current condition of historical archaeology and treasure in vicinity areas of the project in order that the impact will be assessed and defined mitigation measure for reducing the impact at low level.

(2) Study methods

- Gather secondary data of position and location of archaeology and historical treasure from map with scale of 1:50,000 and sattlelite picture with scale of 1:50,000 provided by the Royal Thai Survey Department and compile related secondary data and documents.
- Conduct field survey to observe current condition of archaeology and historical treasure in vicinity areas around the project areas.
- Analyze both primary and secondary data to assess current condition of the archaeology and historical treasure in the project areas and related areas includes problems and impacts which may occur during the construction period and operation period.
- Propose environmental impact mitigation and preventive measures, that were expected to impact on archaeology and historical treasure.

(3) Study results

No archeological site nor historical artifact is found in the field survey conducted in the radius of 5 km around the precincts of the project. There are five religious places in the area.

- Wat Rawoeng Rangsan - situated in Moo. 7, Khao Khansong Sub-district, Si Racha District, Chon Buri Province, approximately 4.15 km away to the north from the location of the project
- Wat Sri Phum Pho - situated in Moo. 7, Bowin Sub-district, Si Racha District, Chon Buri Province, approximately 2.99 km away to the southwest from the location of the project
- Wat Chom Phon Chao Phraya - situated in Chom Phon Chao Phraya Sub District Municipality, Pluak Daeng District, Rayong Province, approximately 220 m away to the south from the location of the project
- Wat Khlong Kram T - situated in Moo. 1, Ta Sit Sub-district, Pluak Daeng District, Rayong Province, approximately 2.77 km away to the southeast from the location of the project

- Shrine of His Highness Prince Surasak Montri – situated next to Chom Phon Chao Phra Ya Sub District Municipal Office on the west side, approximately 830 m away to the north from the location of the project
- Shrine of the Chinese God Pae Kong - situated in the community behind Chom Phon Chao Phraya Sub District Municipal Office, Pluak Daeng District, Rayong Province, approximately 580 m away to the north from the location of the project.

4.4.4 Asthetics and Tourism

(1) Introduction

Existing of tourism placein the study area of project are historical treasure, natural and aesthetic man-made tourism place. The result of the field survey is used for assessing impact on aesthetics and tourism place and defining the environmental impact mitigation and preventive measures and environmental impact monitoring measures of expected impact from the project.

(2) Study methods

Compilation data of tourism places in Si Racha, Ban Bueng and Nong Yai Districts in Chon Buri Province, Pluak Daeng District in Rayong Province as follows:

- Collect secondary data of tourism place of Si Racha, Nong Yai Districts Chon Buri Province and Pluak Daeng Distric, Rayong Province from document of related agencies namely Tourism Authority of Thailand, Chon Buri and Rayong Tourist Center, document and report of tourism such as Ao.So.Tho., Travel to Thailand Book, etc.
- Conduct field survey in order to observe current condition of tourism place in adjacent areas around the project areas
- Bring collected data from documents, reports and field survey for assessing current condition of tourism place and aesthetic of the project areas and related areas including problems and impact occurring during the construction period and operation period of the project

(3) Study results

Boasting several natural tourist attractions, Chon Buri Province and Rayong Province attract a lot of tourists each year. Most of the hotels and restaurants are located in prime touristic areas, especially those along the beach. From the survey to collect data on tourism, there is neither natural nor historic tourist attraction in the study area, which is approximately 30 km away from Si Racha District and approximately 9 km away from Pluak Daeng District.