

CHAPTER 1

INTRODUCTION

1.1 Statement of the problems

The Northern Region Industrial Estate (NRIE) is the first provincial industrial estate in Thailand. It was established in according with the Fourth and Fifth National Economic and Social Development Plans that aimed to extend the industrial development to the regions outside Bangkok. Construction of NRIE was completed in March 1985. Located in Tambon Ban Klang, Mueang District, Lamphun Province, It house more than 30,000 employees (in 2008). The types of industries operated in NRIE include electronic, heavy equipment's spare parts manufacturing, agricultural, leather, food, wood-furniture, gems, etc. Almost all of the industries used toxic chemicals such as Volatile Organic Compounds (VOCs) and heavy metals in their production systems. Waste and wastewater from these industries, should they be released or accidentally spilled, can become harmful contaminants to human and environments, such as surface water and groundwater.

The Environmental Research and Training Center (ERTC) of the Department of Environmental Quality Promotion (DEQP) conducted a detailed survey in the NRIE area and found contamination in soils and shallow groundwater system by heavy metals and VOCs, especially trichloroethylene (TCE), toluene and ethyl-methyl ketone. TCE is considered to be Group 2A carcinogen according to International Agency for Research on Cancer (IARC) and World Health Organization (WHO). The results of the detailed survey indicated that at least one or more volatile organic compounds were detected in 12 out of 30 sampled dug wells (DEQP, 2001). The VOCs concentration found in shallow groundwater in the study area did not exceed the groundwater standard, but VOCs concentration in some locations was marginally high resulting in a high risk of groundwater contamination and human health impact.

When chemicals (e.g. VOCs) in groundwater migrate away from the source zone, they spread or disperse which results in a large contaminant plume. Movement of these groundwater contaminants from sources to receptors can be predicted using groundwater flow model. In order to setup a comprehensive flow model, detailed site characterization must be conducted to obtain accurate hydrogeologic and stratigraphic information such as thickness of aquifer, correlation of aquifer and hydraulic property of aquifer.

1.2 Purposes and scopes

The purpose of this research is therefore to conduct a detailed hydrogeologic investigation of shallow aquifer in the study area and to construct hydrostratigraphic model that can be translated to a flow model used to determined groundwater flow pattern. In particular this research aims to construct hydrostratigraphic model of the shallow aquifer in the NRIE area, Lamphun Province which requires integrated information from detailed sedimentology, stratigraphy, and hydrogeology surveys. A calibrated groundwater flow model will also be setup to assess groundwater flow direction in these aquifers.

1.3 Methodology

The research methodology use several methods consist of geological surveys, geophysical (resistivity) surveys, hydrogeological surveys and groundwater modeling which are details below:

1. Collecting and reinterpreting previous geologic, hydrogeologic, and geophysical data of study area.
2. Conducting geological surveys and constructing the stratigraphic unit.
3. Conducting geophysical (resistivity) surveys and interpreting this data.
4. Conducting hydrogeological surveys to divided aquifers. This surveys include measuring water level at boreholes and dug wells in the study area and conducting aquifer test (pumping test and slug test) to obtain hydraulic properties.
5. Constructing a hydrostratigraphic model by compiling and re-interpreting all relevant information.

6. Setup a groundwater flow model using MODFLOW program, calibrate the model, and use model to determined groundwater flow pattern.

1.4 Location of the study area

The study area covers the Northern Region Industrial Estate Vicinity (NRIE) in Mueang District, Lamphun Province, northern Thailand. It is located on the southeast part of Chiang Mai basin and east of Lamphun city. This area covers an area of 49 Km² and is located between UTM Zone47N-East: 500,000-507,000 and UTM Zone47N-North: 2,050,000-2,057,000 (Figure 1.1).

1.5 Literature review

1.5.1 VOCs contamination of the study area.

Volatile Organic Compounds (VOCs) are classified as Non-Aqueous Phase Liquids (NAPLs) which are generally referred as organic fluids with low solubilities. NAPLs move at a separate pace and are often visible to the naked eye, as opposed to soluble contaminants that travel in groundwater. NAPLs have been widely used in various industries and are known to be present at numerous industrial and waste disposal sites. Due to their potential toxicity and widespread occurrence, they constitute a serious environmental problem.

The Environmental Research and Training Center of the Department of Environmental Quality Promotion (2001) found chlorinated ethylene contamination in soils and groundwater of at least 3 factories in the NRIE. These compounds include trichloroethylene; cis-1,2-dichloroethylene; trans-1,2-dichloroethylene and vinyl chloride whose concentrations were 7.22, 0.57, 0.35, and 0.32 mg/L, respectively. All of these compounds were far significantly beyond maximum contaminant levels (MCL).

The Good Governance for Social Development and the Environment Institute had funded an innovative research project on the Good Governance, Public Participation and the Decision making Process for Environmental Protection (2006). The study uncovered significant destruction of the natural resources and environment due to rapid industrial expansion. The critical problem was shallow groundwater

contamination from volatile organic chemicals used in the electronics industries in the NRIE which was in turn directly related to worker's health problems.

Singharajwarapan and others (2006) conducted a preliminary study on the assessment of shallow groundwater contamination from volatile organic compounds in the vicinity of the NRIE. The groundwater samples were taken from sixteen dug wells and it was found that twelve dug wells were contaminated with one or more types of VOCs but concentrations were below MCLs.

1.5.2 Groundwater modeling of the study area

The Department of Environmental Quality Promotion (2004) conducted a detailed investigation of the contaminated site nearby NRIE. The study included geologic, sedimentological, hydrogeologic investigations, and groundwater modeling of the area. It was found that shallow groundwater generally flowed from east to west passing the NRIE and eventually reached the Mae Kuang River.

Metrix Associates Co., Ltd. (2004) constructed groundwater flow model in the area of the Northern Region Industrial Estate, Lamphun Province. The purpose of their study was to determine the groundwater flow field in both shallow and deep aquifers. The simulations were divided into three cases depending on the degree of water usage. In the first case where groundwater usage is zero, groundwater flow was assumed to be under natural conditions where flow fields were controlled solely on the boundary conditions. It was found that shallow groundwater flowed from east to west toward Mae Kuang river whereas deep aquifer showed the same trend but was not affected by the Mae Kuang river. In the second case, normal groundwater usage was considered and it was found that there was a large cone of depression in the northern part of the study area. In the third case, groundwater usage increased by three folds and larger cone of depression were found in the north and south of the NRIE.

Saenton et al. (2007) used detailed hydrogeologic information of the Northern Region Industrial Estate to construct a steady-state groundwater flow model and a solute transport model to assess the size of the contaminant plume and damage to groundwater resource. They used trichloroethylene (TCE) as a contaminant of concern and simulated contaminant transport for 30 years. However such model was only for demonstrative purpose because several model parameters, especially the

solute transport model, were not determined or evaluated from field tests. The results could only be used to approximate the extent of the contaminant plume.

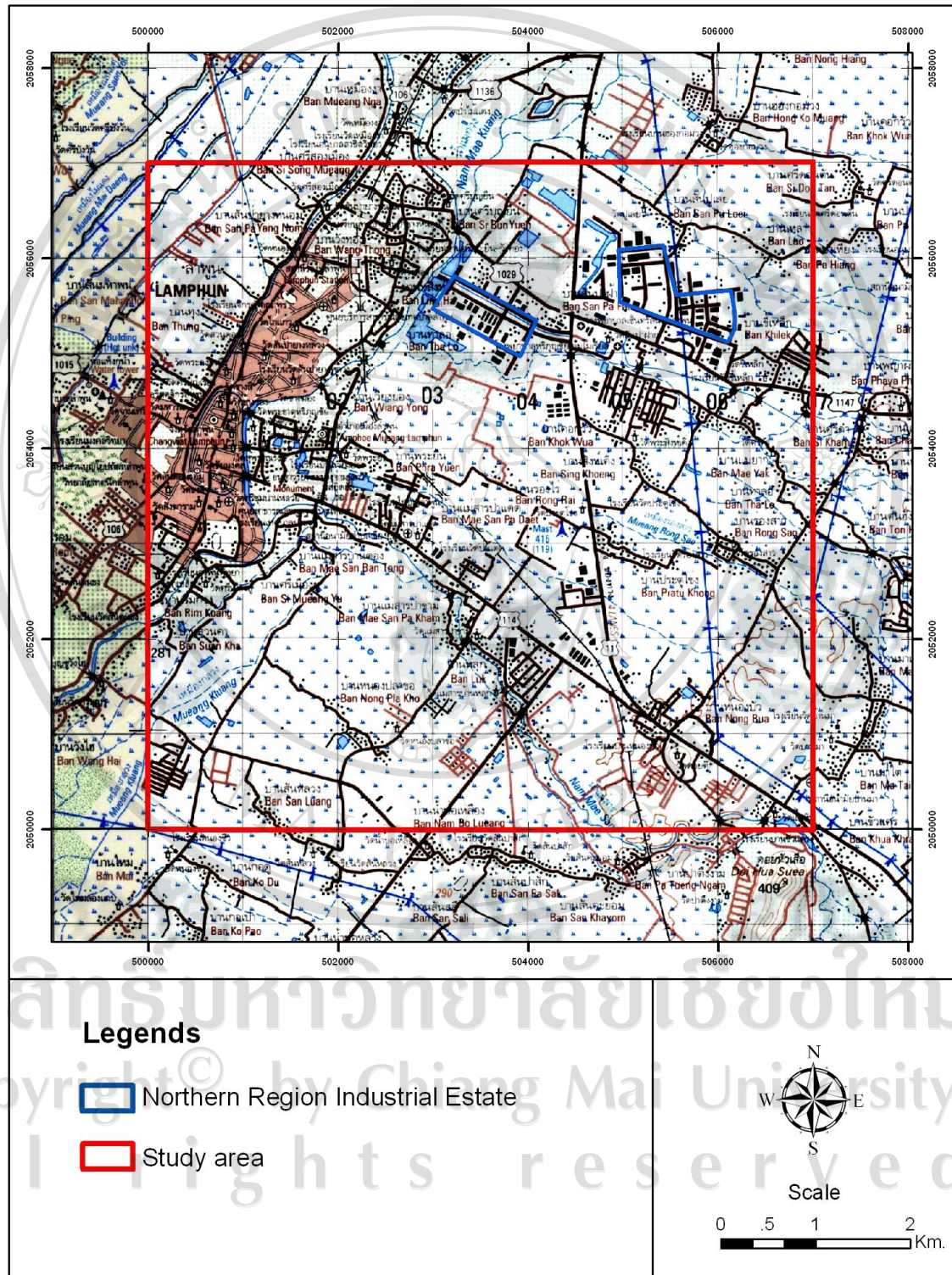


Figure 1.1 Study area (modified from Royal Thai Survey Department, 1996).