CHAPTER 6

DISCUSSION AND CONCLUSION

The purpose of this research is 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 accurately assess the groundwater flow pattern.

The study area covered an area of 49 square kilometers around the Northern Region Industrial Estate Vicinity (NRIE) in Mueang District, Lamphun Province, northern Thailand. Topographic features are mostly flatland, the average elevation range from 285 to 300 meters above mean sea level. The Mae Kuang River is the main drainage that flows southwestward through central part of the study area.

Surface geologic settings consisted of low terrace deposits and alluvial deposits. Low terrace deposits (Qtl) are distributed along the eastern area. These are composed of sand, silt, clay, gravel and latteritic rocks of Pleistocene age. Alluvial deposits (Qa) are deposit along the flood plain of the Mae Kuang River, covering the central and western portions of the area. These sediments are composed of sandy gravel, sand, silt, clay, and mud of Holocene age. The structural geology of the study area was effected by faults that are parallel to the Mae Tha fault at the eastern part of Chiang Mai basin, a major fault in the study area approximately 5 km long laing northwest-southeast trending and north-south to northeast-southwest trending at southern part of the area. Subsurface geologic settings were delineated by 56 Lithologic logs data. Three sequences are proposed as Sequence I of depth 0-20 meters, Sequence II of depth 20-45 meters, and Sequence III of depth 45-100 meters. Each sequence generally consists of clay, sand and gravel with difference detailed properties.

The hydrostratigraphic model was constructed by hydrostratigraphic units and groundwater dynamic. This model can be characterized into three main aquifers (fourteen layers), aquifer I of depth 0-20 meter, aquifer II of depth 20-45 meter, and aquifer III of depth 45-100 meter. All aquifer are unconfined and semiconfined aquifers. They are mainly clay or sandy clay that has interbedded sand or gravel layers. The groundwater dynamic consists of hydraulic properties and groundwater flow pattern. The horizontal hydraulic conductivity of the aquifer I, aquifer II, aquifer III ranges from 2.6 to 11.5, 0.049 to 6.9, and 1.11 to 9.7 meters per day, respectively. The specific yield and storage coefficients of these three aquifer units range from 5.75 $\times 10^{-7}$ to 2.45×10^{-3}, 8.76×10^{-4} to 1.63×10^{-3}, and 1.72×10^{-3} to 6.79×10^{-3}, respectively. The transmissivity of the three aquifer range from 31.2 to 138.0 square meters per day, 0.39 to 55.2 square meters per day, and 8.88 to 77.6 square meters per day, respectively. The groundwater flow pattern in both shallow and deep aquifers direct toward the western and northwestern parts of the study area with some of the flow lines direct toward the north. It should be noted that the groundwater flow directions of study area were directed to Mae Kuang River.

The groundwater quality data shows that the shallow groundwaters are not suitable for use as a drinking water supply according to the regulated standards in the following categories: turbidity, hardness, total dissolved solids, anions contents (chloride, fluoride, nitrate, and sulfate) and iron and manganese contents. The deeper aquifers at some locations were not potable due to the same reason mentioned above. Nevertheless, the contamination of heavy metals was not detected except for some samples where zinc content was high but still lower than the standards. The hydrochemical farcies of shallow groundwater are sodium-calcium-bicarbonate facies and the deep groundwater are sodium-calcium-bicarbonate-chloride facies. Volatile Organic Compounds (VOCs) evaluation indicated that at least one or more volatile organic compounds in the aforementioned list were detected in 12 out of 30 dug wells and 18 out of 30 groundwater wells. Although VOCs concentrations in groundwater did not exceed maximum contaminant levels of the groundwater standard but some VOCs concentration is obviously high.

The groundwater flow model was processed by Visual MODFLOW® version 4.2 program. It was used to simulate three dimensional groundwater flows for aquifer systems under steady state simulation. This conceptual model defined by hydrostritigraphic model. The model is composing of three aquifers (fourteen layers). The study developed the conceptual model of groundwater flow and assigned model parameters (horizontal hydraulic conductivity, vertical hydraulic conductivity, and recharge) based on the existing hydrogeologic data and previous study. The steady-state model was calibrated using the groundwater conditions of January, 2010. The normalized root mean square (RMS) between simulated head and observed head is approximately 12.27 percent.

The groundwater flow patterns from steady-state simulation were direct toward the western and northwestern parts of the study area. Simulated and shallow aquifer groundwater flow pattern are similar. Sensitivity analysis was conducted and showed that the horizontal hydraulic conductivity (K_h) is the most sensitive parameter while the least sensitive parameter is recharge.

In this study, the most important information required for setting up a groundwater flow model is hydrostratigraphic model because it directly affects on the reliability of the model. This groundwater flow model can be translating a solute transport model for simulate transportation of VOCs. The solute transport model can indicated both quantity and distribution of VOCs contamination.