CHAPTER VI

CONCLUSIONS AND RECOMMENDATION

6.1 Conclusions

(1) There are significant differences in the downward flow velocities or recharge rates in different types of unconsolidated geological unit, namely, young alluvial deposits (Qcp), low terrace deposits (Qcr) and high terrace deposits (Qcm). The results show that the top units of wells in Qcp give the recharge rates less than 10 cm/yr (the average value of 6.07 cm/yr) whereas those in Qcr give the recharge rates less than 15 cm/yr (the average value of 10.72 cm/yr) and those in Qcm give the rates of recharge rates more than 15 cm/yr (the average value of 23.13 cm/yr). The recharge rates in those wells generally decrease consecutively downward in the deep layers. The variations in recharge rate in different geological unit are related to the differences in lithology (i.e., proportion of course versus fine sediments and sorting), topography as well as elevation of the area and hydraulic gradient.

(2) The overall recharge rates of the top units of all recharge wells range from 1.62-32.81 cm/yr with an average of 14.0 cm/yr. The average value is approximately 12 % of the annual rainfall (116 cm/yr). Therefore this recharge rate can be used for efficient groundwater resources management in this basin. The sources of recharge water could be derived from both basin rim and inner area of the basin.

(3) There are also variations of the shape of temperature depth profile and geothermal gradients in those 20 wells which can be differentiated into 6 groups based on the characteristics of the profile as follows;

Group 1: There are seven wells in this group (no. 8, 11, 12, 15, 19, 42, and 30). They are located in young alluvial deposits (Qcp) and low terrace deposits (Qcr) of Mae Ping flood plain. Those wells have the concave-upward temperature-depth profile indicating the recharge zones and they show a similar thermal gradient (or slope of the curve) at normal rates of about 1.97-3.01 °C/100 m.

Group 2: There are two wells in this group (no. 2 and 24). They are located in low terrace deposits (Qcr) and high terrace deposits (Qcm) in the lower part of basin. These two wells have the concave-upward temperature-depth profiles indicating recharge zone and they show a similar thermal gradient at somewhat lower rates of about 1.28-1.36 °C/100 m.

Group 3: There are six wells in this group (no. 4, 6, 13, 14, 16 and 27). They are located in high terrace deposits (Qcm) at the rim of basin. These six wells have the concave-upward temperature-depth profiles suggesting recharge zone and they show a similar thermal gradient at normal rates of about 2.21-2.91 °C/100 m

Group 4: There are two wells in this group (no. 29 and 31). They are located in young alluvial deposits (Qcp) of central Mae Ping flood plain. These two wells have the convex-upward temperature depth profiles (opposite to the Group 1) indicating discharge zones and they show a similar thermal gradient at somewhat higher rates of about 3.45-3.50 °C/100 m. The wells are situated near the river and Lamphun city. Hence the river near these two wells could gain stream water from aquifers nearby and/or Lamphun municipal and agricultural areas may exploit excessive volume of the groundwater.

Group 5 is observed in only one well (no. 5) located in low terrace deposits (Qcr) at the lower rim of basin. The well has the convex-upward temperature-depth profile indicating a discharge zone in the lower hydrogeological units and the thermal gradient is at 3.15 °C/100 m. The discharge behaviour may be due to excessive industrial and household consumptions.

Group 6 is observed in two wells (no. 9 and 21) located in low terrace deposits (Qcr) at the rim of basin. The Well 9 has the convex-upward temperature-depth profile in the upper level but almost straight profile in the lower level suggesting a discharge zone near surface whereas the Well no. 21 has the concave-upward profile indicating a recharge zone. These two wells show the highest thermal gradients of about 4.51-5.51 C°/100 m. The abnormally high thermal gradients in these two wells could be influenced by subsurface heating. The Well no. 9 is situated near Sam Kamphang hot spring in which the area may be affected by deep active basement faults and heat source underneath. The Well no. 21 is located near basin rim which may be influenced by active depositional environment and heat source below.

(4) Almost all studied observation wells in Chiang Mai Basin generally give downward flow direction or recharge zone, except only four wells show upward flow direction or discharge zone. The Cenozoic Chiang Mai Basin is filled with unconsolidated Quaternary sediments whereby surface runoff water can refill underground aquifers fairly easy, because of hydraulic gradient. As for the wells that show discharge zone, the Well 5, Well 29 and Well 31 are located near the river and/or in the populated or agricultural areas. Hence groundwater may discharge into the river (gaining stream) and/or there may be excessive exploitation (pumping) of groundwater in the municipal or agricultural areas. The Well 9, which is located near well known San Kamphang hot spring, may be affected by heat source underneath in relation to NW-SE active basement faults parallel to the eastern basin edge and to NW-SE Mae Tha active fault zone about 10 kms toward the eastern side of the basin.

6.2 Recommendation

It is recommended that in order to obtain more reliable and accurate results and interpretation of recharge and discharge estimates in Chiang Mai Basin by using groundwater temperature data method, the following precautions should be taken into consideration.

(1) This study collects the groundwater temperature data only one time. Although, the temperature data should be theoretically constant, it would be more confident if the next study could collect groundwater temperature data in difference season to confirm the result.

(2) The interpretation of some discharge wells, especially the one that gives both recharge and discharge in the same well, is based solely on overall pumping data at particular area without knowing specific location of the pumping wells. Therefore some mis-interpretation may occur.

(3) This study has shown that the method of calculation of groundwater recharge rate and direction from groundwater temperature is acceptable. Moreover,

the method of data acquisition and interpretation is not difficult. Therefore, it is expected that this method will be widely used for the determination of groundwater recharge in the future.