

9**A STUDY ON ARTIFICIAL RECHARGE WELL AS A PART OF DRAINAGE SYSTEM AND WATER SUPPLY IN UTHM**

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ABSTRACT

Area of Parit Raja including campus of UTHM is facing flood and water shortage every year due to topographically is flat and most of the top layer of soil is occupied by clay. Based on this condition, this study is aimed to reduce the excess storm-water runoff by flowing the surface water into the ground (aquifer) through a well (perforated pipe), so that the decreasing of surface water will be able to contribute in overcoming the flood problem and the second expectation from the mechanism is to store water in the aquifer with hope that the potential of groundwater will increase.

Keywords : *Groundwater; Artificial Recharge Well; Confined Aquifer; Storm Water Control, Flat Area*

1.0 INTRODUCTION

Pair of problems in Parit Raja, especially in area of campus of UTHM is flood and water shortage. The flood (flash flood) occurred due to the drainage system is poor caused by the rate of infiltration of clay soil is low that cannot contribute to the drainage system and back water from the main-drain/river that flows back to the drainage area as the topography is flat (Fig.1.1). Even though a detention is available it is not effective to reduce the peak flow rate as the elevation gap between inflow and outflow is small (Fig.1.2). Meanwhile water shortage occurred due to the main sources of water supply are not sufficient to fulfill the water requirements as the available groundwater is limited which cannot contribute to the water supply. This lacking of groundwater could be caused by the circumstance that the top layer of soil is clay in which its permeability is small. In this kind land usually has aquifer layer (confined aquifer) in the subsurface where it can be used as water storage of excess storm-water runoff. By flowing surface water runoff into the ground (aquifer) through a well (perforated pipe) will reduce the volume of surface water runoff as well as the flood and also will increase the potential of groundwater, so that the reducing of surface water can contribute to the drainage system and the increasing of potential of groundwater can contribute to the water supply.





Fig.1.1: Flash flood in UTHM



Fig.1.2: Detention pond in UTHM campus

2.0 HYDROGEOLOGY FORMATION OF PARIT RAJA AND ITS SURROUNDING AREA

In 2008, a study on infiltration and particle size distribution has been done in the most area of UTHM campus. It was found that the rate of infiltration is in the range of 0.004 – 0.007 mm/s (Fig.2.1) and the soil classification based on particle size is between silt to fine sand (Fig.2.2).

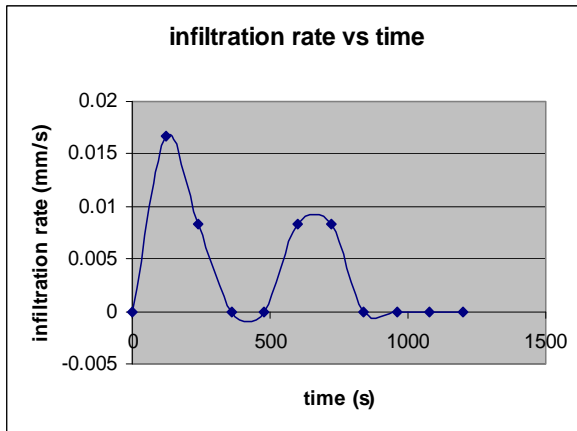


Fig.2.1: Infiltration rate of top soil of UTHM’s area

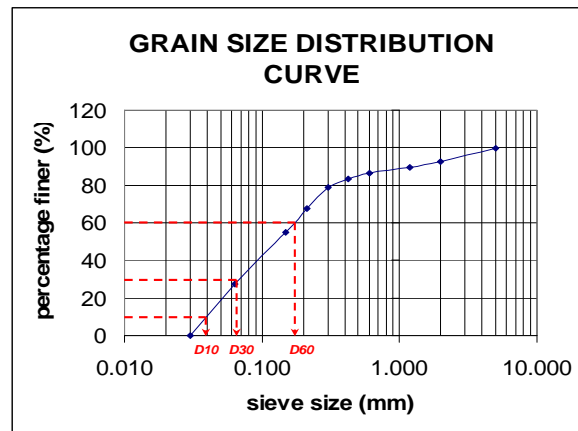


Fig.2.2: Grain size distribution of top soil of UTHM’s area

In 1986, 30 observations and 5 production wells were built in Batu Pahat and Sri Gading for ensuring the availability of groundwater, and in 2003, 2 observation wells were built as well in UTHM (Mohd Faizal, 2003). All reports showed that the groundwater containing high Calcium and Chloride (Table 2.1). It is predicted that UTHM and its surrounding area previously was a muddy and sandy coastal area, and the water containing high Calcium and Chloride due to ancient salt water intrusion at quaternary era and effects of karsts under the land surface, respectively. Granite rock (red) in Batu Pahat and seal rock (green) in Air Hitam dominates almost areas of Batu Pahat, Parit Sulong, Yong



Peng, Kuris and Parit Raja as well as in UTHM. Away from foot of hill and folded back slit of rocks became the place of water surface infiltration to the groundwater system. However, according to Mohd Faizal (2003), the real condition of deep soil is karsts (Fig.2.3), which is more potential as groundwater resources than granite and seal rocks in which the hydraulic conductivity is about 1×10^{-1} - 1×10^{-5} m/s. It is then obtained the most of top soil is occupied by yellow clay where this kind soil is not potential as aquifer layer and has low vertical hydraulic conductivity (Johnson, 1986).

Table 2.1: Samples of groundwater and the contents

Sample Number	Ca (ppm)	Mg (ppm)	Na (ppm)	K (ppm)	Fe (ppm)	As (ppm)	HC0 (ppm)	Cl (ppm)	S0 (ppm)	N0 (ppm)	Total Solids (ppm)	Diss. Solids (ppm)	pH
1	379	615	1699	40	4	0.001	266	7500	85	143	10.9	10.9	7.1
5	7.99	13	12.7	4.2	1.5	0.001	1	28	100	6.17	6.17	0.70	4.2
15	-	-	-	-	0.3	-	-	4850	-	-	-	-	7.5
18	324	289	1253	22.4	21.2	0.002	127	3020	54	2.4	6.72	6.61	6.65
23	11.4	25	255	25	10	0.006	118	430	20	2.0	1.61	1.03	7.0
25	-	-	-	-	0.5	-	-	8640	-	-	-	-	7.1
27	-	-	-	-	1.5	-	-	4980	-	-	-	-	7.6
28	55.8	232	1095	66.5	13.1	0.001	633	3220	86	0.34	4.08	4.27	7.0
31	293	675	3294	108	0.95	0.001	638	5230	262	7.54	27.6	17.4	6.7
32	2.39	0.95	6.6	3.3	1.1	0.001	4	30	2	3.77	0.20	0.09	4.9
34	-	-	-	-	4.0	-	-	272	-	-	-	-	7.1
J1	5.5	12	24.3	7.5	7.63	0.001	107	40	35	2.03	0.3	0.22	6.4
J2	4.2	1.4	1.5	313	6.2	0.001	24	4.0	2	2.4	0.009	0.08	6.65
J3	15.9	38	816	35	5	0.001	509	1110	54	1.71	2.76	2.4	7.25
J4	4.7	0.4	1.9	0.51	9.34	0.001	13	6	2	2.4	3.06	0.08	6.45

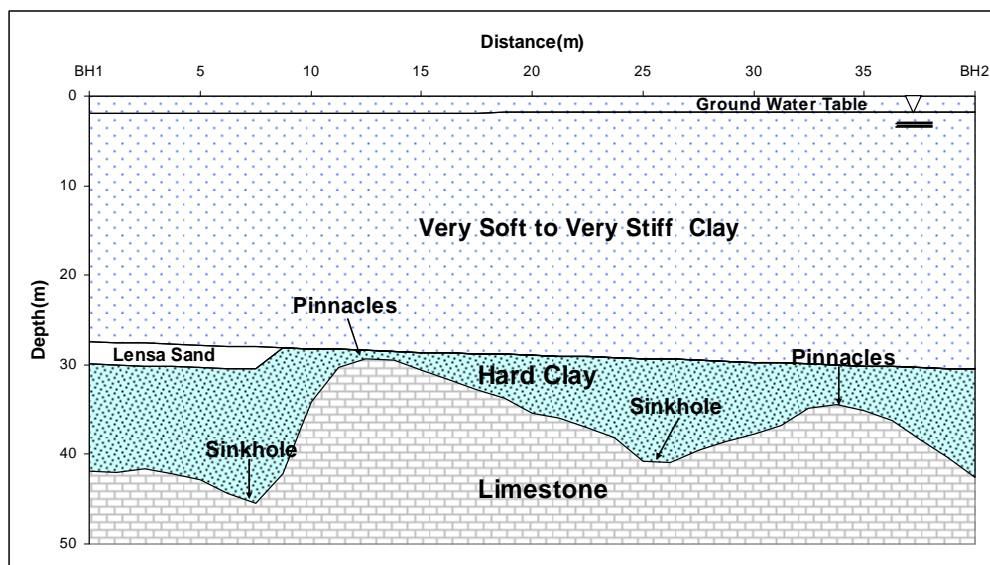


Fig. 2.3: Structure of geology in UTHM's area



3.0 RECHARGE WELLS ON GROUND WATER

Artificial recharge of groundwater increases the rate at which water infiltrates from the land surface to the groundwater system. Water can be injected by means of wells or spread on the land surface to infiltrate. Use of injection wells to recharge groundwater systems has become an accepted method of slowing or stopping overdrafts of groundwater. In water short areas, surface water may be captured in basins during spring runoff, and allowed to recharge groundwater later in the year by one of several water-spreading methods. Elsewhere, treated surface water is stored underground until needed later in the season during peak-demand periods (Olsthoorn, 1982). At Lake Manatee, Florida, for example, a 15 million-gpd (56,800 m³/day) increase in peak-capacity has been achieved by temporarily storing portable water in aquifers containing low-quality water (Water Well Journal, 1983).

Injection tubing forms an important part of the design for recharge wells. The injection tube must terminate below the static water level in blank casing and must be designed so that positive pressure exists along its entire length. Back pressure valves should be installed to eliminate negative pressures in the injection tube. Another important criterion is that the injection tube should provide for full flow to eliminate the possibility of air entrainment.

The equation describing the cone for various discharges can be derived by using the same assumptions applied to a pumping well. For a confined aquifer with water being recharged into a well completely open to the aquifer at a rate Q, the following equation is applicable:

$$Q = \frac{Kb(h_w - H_0)}{528 \log(r_0/r_w)}$$

$$Q = \frac{Kb(h_w - H_0)}{0.366 \log(r_0/r_w)}$$

Where:

Q = rate of injection, in gpm

K = hydraulic conductivity, in gpd/ft²

b = aquifer thickness, in ft

h_w = head above the bottom of aquifer while recharging, in ft

H_0 = head above the bottom of aquifer when no pumping is taking place, in ft

r_0 = radius of influence, in ft

r_w = radius of injection well, in ft

Where:

Q = rate of injection, in m³/day

K = hydraulic conductivity, in m/day

b = aquifer thickness, in m

h_w = head above the bottom of aquifer while recharging, in m

H_0 = head above the bottom of aquifer when no pumping is taking place, in m

r_0 = radius of influence, in m

r_w = radius of injection well, in m

And for a recharge well penetrating an unconfined aquifer, the following equation is applicable:

$$Q = \frac{K(h_w^2 - H_0^2)}{1055 \log(r_0/r_w)}$$

$$Q = \frac{K(h_w^2 - H_0^2)}{0.733 \log(r_0/r_w)}$$



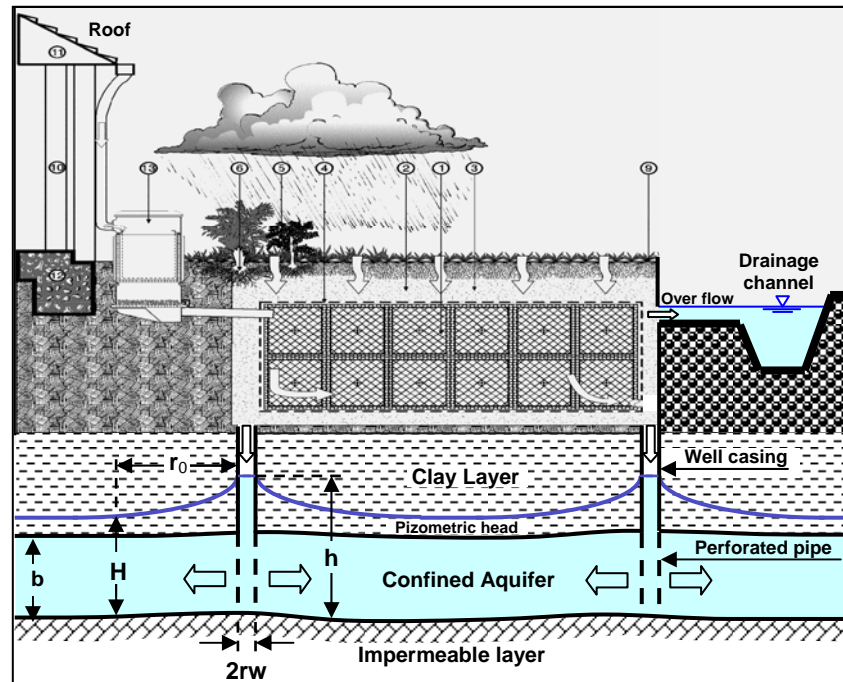


Fig.3.1: Drain system using artificial recharge well (perforated pipe) on groundwater

4.0 DISCUSSION

Study on top and sub soil in UTHM's area has shown that most area is occupied by almost clay in which the rate of infiltration is low (0.004 – 0.007 mm/s); meanwhile the base rock of 25m to 40m depth is occupied by karsts, which gives value of RQD 38%. It means that this area has confined aquifer and the karst is the material of aquifer which has high fractured as much as 62% where it will be the storage of water. Another geology structure such as cavity and sinkholes are occurred in karsts, which shows the potentials of quality. The bad quality of water surface can be treated naturally through treatment of acid and alkali (karsts rock) and clearing of turbidity by sand layer filter. While Chloride water can be treated by using membrane filter. Hence, it is possible and required to make a deep study on hydro-geology of UTHM's area and to determine whether the confined aquifer is available and feasible to store water for use as artificial recharge on groundwater (Fig.3.1). Hopefully, this method may able to cover problems of water in Parit Raja and its surrounding area such as lacking of quantity and quality of water supply and flooding during storm season. By discharging surface water into the ground will increase the potential of groundwater and also will reduce the volume of water in the drainage area, so then the system will be able to control the storm water and also enhance the potential of groundwater to be able to contribute to the water supply.



5.0 CONCLUSION

According to the existing data of soil as written in Chapter 2 (two) and the discussion in Chapter 4 (four), it is sure that most of the land surface has low infiltration rate and it is possible to implement artificial recharge well on groundwater in UTHM's area as the aquifer is there.

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