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## Investigation of Groundwater Potential in Melaka District of Malaysia

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**Abstract.** The paper assesses groundwater quality and productivity in Melaka, Peninsular Malaysia. 238 data set shallow boreholes, 20 data set deep boreholes were collected and continuous pumping test data were used to determine productivity of the aquifers. 68 water samples were tested for water quality. The productivity of the wells and the characteristics of the aquifer were evaluated by pumping test using both the constant discharge rate and steps drawdown methods. The potential of shallow groundwater is low with average discharge  $< 5 \text{ m}^3/\text{hour}$ . The potential of deep groundwater is high category with average discharge  $> 20 \text{ m}^3/\text{hour}$ . The results show that 32% (538 km<sup>2</sup>) from total area of Melaka district (1650 km<sup>2</sup>) is low potential categories, 56% (922 km<sup>2</sup>) is moderate and 12% (194 km<sup>2</sup>) is high. Based on the chemical data, the quality of deep aquifer is fresh. Therefore, it is available for drinking water with minimum treatment.

### Introduction

Groundwater is a natural drinking water resource often subjected to severe human impacts. Several programs and models required preserving optimum groundwater quality, and so management of this vital natural resource has become a worldwide priority. Groundwater in Malaysia is an important resource that can supplement the increasing demand of fresh water for various uses [3]. Although the groundwater has been used for many centuries the usage is limited to the shallow unconfined aquifers using dug wells. The quality of water plays a prominent role in promoting both the standard of agricultural production and human health. Groundwater pollution depends on the inherent hydro geologic property of the site, agricultural land use and cultivation practices. Groundwater vulnerability maps, risk map, groundwater quality maps showing present scenario of contamination etc. can be used as a guide for future developments in an area, in order to minimize the impact of the projected developmental activities on the surrounding water resources. Contamination of groundwater has been observed worldwide, and it is becoming self evident that concentrated human activity will lead to groundwater contamination. There is need for a definite strategy and guidelines for all countries which would focus on specific part of a groundwater management, viz. the protection of ground water from contamination and land based management of the groundwater resources. Two major techniques for groundwater protection strategies are groundwater vulnerability assessment and groundwater quality mapping. Vulnerability of groundwater refers to the intrinsic characteristics that determine the sensitivity of the water to be adversely affected by an imposed contaminant load. Limited surface water potential in the Melaka District encourage potential groundwater investigation is needed to meet water needs for domestic and industrial purposes. In order to understand and identify the potential groundwater zones, geological, hydrogeological, geophysical, test drilling, pump testing and the hydrochemical investigations were carried out.



## Study Area

The state of Melaka situated on the west coast of Peninsular Malaysia. It is located between latitudes  $1^{\circ} 06'$  and  $2^{\circ} 30'$  N and longitudes  $101^{\circ} 58'$  and  $102^{\circ} 35'$  E (Figure 1.). Melaka has three districts, namely Alor Gajah, Melaka Tengah and Jasin. These are further divided into 81 mukims (parishes). The area of the state is approximately  $1650 \text{ km}^2$ . It has a population of 605 202 and a population density of 385 persons per  $\text{km}^2$ . The only 3% of the state is covered by forest [2].



Figure 1. Melaka District in Peninsular Malaysia as Study Area

## Investigations

### • Geology and Geo-hydrology

Melaka state has seven underlying geological formations [1].

They can be divided into four groups of lithology.

- Phyllite, schist and slate; found in the northern parts and in coastal areas.
- Shale, mudstone, phyllite, slate and hornfels; found in the central parts, in coastal areas and in smaller areas in the north.
- Sandstone and metasandstone; found in the northern areas and in smaller areas in the centre of the state.
- Schist; found in the central and southern parts of the state.

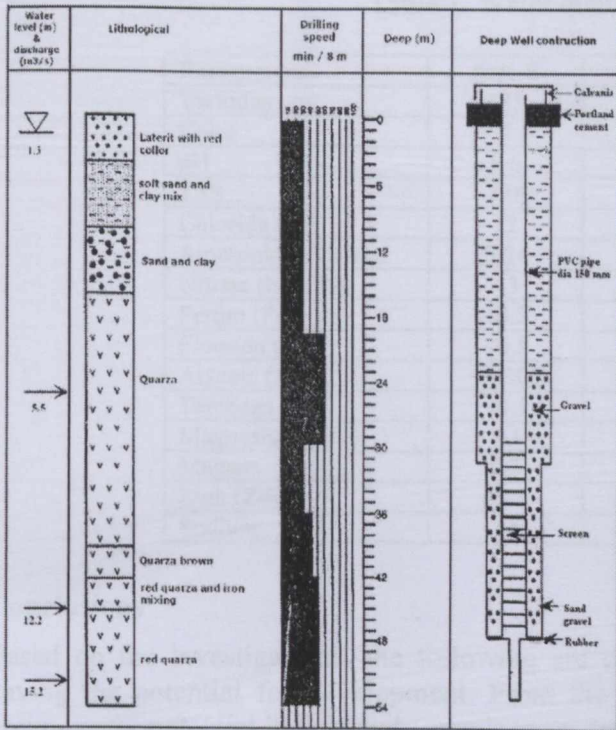
The other three formations are:

- Quaternary deposits. In these areas the local bedrock is overlain by lithologies consisting of marine and continental deposits with sand (mainly marine), clay and silt of younger age. Such deposits are found mostly in the southern region of the state
- The most abundant lithology is Acid Intrusive (undifferentiated) with igneous acidic rocks. These are mostly granitic rocks and are found mainly in the northern parts, but also extend into the southern parts of the state.
- The Triassic, characterised by lithologies consisting of interbedded sandstone, siltstone, shale, conglomerate and chert, and found in interior parts of the state

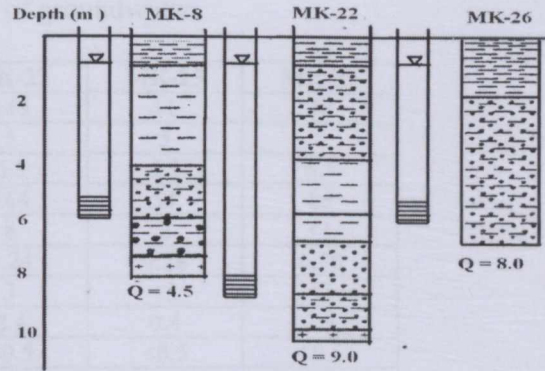
### • Test Drilling

Based on the hydrogeological and geophysical investigations, twenty locations were selected for test drilling. The lithological logs for at these test bores both from deep well and shallow well are given in Figure 2.





(a) Deep well lithology data set



(b). Shallow well lithology data set

Figure 2. Data set of lithology

Legend

- clay
  - sand a. smooth  
b. moderat  
c. rough
  - Granite stone
  - Piezometer a. tube  
b. screen  
c. water level
- Q = discharge (m<sup>3</sup>/hour)

• Pumping Test and water quality

Generally, pump tests are conducted to determine the aquifer parameters in an area in order to ascertain the potential of an aquifer [5] [6]. The capacity of groundwater in the study area was tested by drilling deep to find out the value of transmission coefficient (T) aquifer and hydraulic conductivity (K). Pumping continuously carried out for 4 hours, then waiting groundwater elevation rises. The result is 10m<sup>2</sup>/day for transmission coefficient (T) and 0.63 m/day for Hydraulic conductivity (K). Based on data analysis the potential aquifer on Melaka district can be seen in Figure 3.

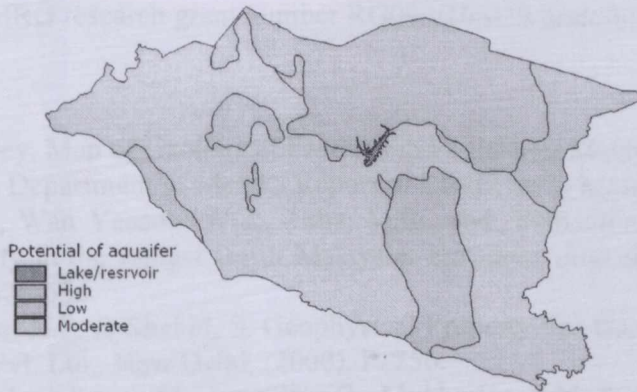


Figure 3. Potential Aquifer Map of Melaka District

Groundwater quality in the region of Central Melaka is in good condition to be used as raw water for drinking with minimum treatment because in accordance with the requirements based on the raw water quality standards by the Ministry of Health Malaysia. Groundwater quality of the study area is presented in Table 1.



Table 1. Water quality of groundwater

Parameters	MK-8	MK-22	MK-25	MK-26
Turbidity	185	148	11	18
Color	5	5	5	5
pH	6.6	6.5	5.9	6.5
TSS	328	164	54	86
Chloride (Cl)	12	8	2	<1
Ammonia (NH <sub>4</sub> -N)	0.24	0.24	0.28	0.96
Nitrate (NO <sub>3</sub> -N)	<3	3	<3	<3
Ferum (Fe)	16.2	2.4	0.4	2.4
Flourida (Fi)	<0.5	<0.5	<0.5	<0.5
Arsenic (As)	<0.005	<0.005	<0.005	<0.005
Tembaga	<0.1	<0.1	<0.1	<0.1
Magnesium (Mg)	2.1	3.9	1.0	2.1
Magana	0.3	0.5	<0.1	0.4
Zink (Zn)	<0.1	0.2	<0.1	<0.1
Sodium	14	14	4.2	5.5

### Conclusions

Based on the investigations, the following are the interpreted results in order to identify areas having the potential for development. From the geological investigations, it is evident that the groundwater potential in this study area is restricted to recent alluvial deposits such as sand, pebbles and boulders. The well inventory data revealed that the thickness of coarse sand ranges from 20 to 40 m which is the only formation holding significant quantities of water. The shallow groundwater has low potential with average discharge  $<5 \text{ m}^3/\text{hour}$  but the deep groundwater has high potential category with average discharge  $> 20 \text{ m}^3/\text{hour}$ . The results show that 32% (538 km<sup>2</sup>) from total area of Melaka district (1650 km<sup>2</sup>) is low potential categories, 56% (922 km<sup>2</sup>) is moderate and 12% (194 km<sup>2</sup>) is high. Based on the chemical data, the quality of deep aquifer is fresh. Therefore, it is available for drinking water with minimum treatment.

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