A STUDY ON HEAVY METAL CONTAMINATION OF WELL WATER AT PASIR MAS, KELANTAN : PERSPECTIVE OF WATER QUALITY INDEX

by

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A dissertation submitted in partial fulfillment of the requirement for the Degree of Bachelor Health Sciences (Honours) (Environmental and Occupational Health)

JUNE 2015

ACKNOWLEDGEMENT

Bismillahirrahmanirrahim, in the Name of Allah, the Most Beneficent, the Most Merciful. Alhamdulillah, all praise and thanks to Allah S.W.T for giving me the strength and good health to complete this report. During this study, I have acquired a wealth of experience either bitter or sweet that is valuable and meaningful in my life as a student. The experience gained during this study may only come once in my life. Therefore, I also have acquired a wealth of information and knowledge related to my study.

I would like to express my sincere appreciation to my supervisor, Dr. Maliki Hapani for his guidance, motivate and spend his time during the period of this study. His views and tips are useful indeed in order to complete this task was entrusted.

My sincere appreciation also extends to the staffs in the Districts of Health at Pasir Mas for their cooperation and commitment until finally able to complete this research. I would like to thank to my fellow friends Afifah Abdullah, Nur Shazlina Muhammad and Nur Salshabila Afifah Zailani for their kindness and moral support during my study. Last but not least, my deepest gratitude goes to my beloved parents Abdullah Che Min and Fatimah Mohd Noor and also to my siblings for their endless love, prayers, and encouragement.

Lastly, I hope this research project can fulfil the will of the origin and purpose of this study and hopefully all the good in this world gets divine grace and blessed.

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LIST OF ABBREVIATION AND SYMBOLS

AAS	Atomic Absorption Spectrum
AP	Alor Pasir
ADD	Attention deficit disorder
ADHD	Attention deficit hyperactivity disorder
AKSB	Air Kelantan Sdn. Bhd.
BS	Bunut Susu
BOD	Biochemical Oxygen Demand
CNS	Central Nervous System
^0C	Celcius
C	Chetok
COD	Chemical Oxygen Demand
DDT	Dichlorodiphenyltrichloroethane
DOE	Department of Environment
DO	Dissolved Oxygen
EPU	Economic Planning Unit
EQA	Environment Quality Act
EQR	Environmental Quality Report
FWR	Foundation for Water Research
Fe	Ferum/Iron metal
GPS	Global Positioning System
GP	Gual Periuk
IQ	Intelligent Quotient
INWQS	Interim National Water Quality Standard

LIST OF ABBREVIATION AND SYMBOLS

JPS	Jabatan Pengairan dan Saliran
K	Kangkong
KL	Kuala Lemal
KG	Kubang Gadong
KS	Kubang Sepat
Mn	Manganese metal
Mg/l	Miligram per litre
MOH	Ministry of Health
NH_3-N	Ammonia Nitrogen
NPP	National Population Policy
OSHA	Occupational Safety & Health Act
PMS	Premenstrual Syndrome
PM	Pasir Mas
Pb	Plumbum metal
RP	Rantau Panjang
SS	Suspended Solid
USEPA	United States of Environmental Protection Agency
WHO	World Health Organization
WWF	World Wildlife Fund
WQI	Water Quality Index
Zn	Zinc metal

KAJIAN MENGENAI PENCEMRAN LOGAM BERAT DI DALAM AIR TELAGA DI KAWASAN PASIR MAS, KELANTAN : PERSPEKTIF INDEKS KUALITI AIR

ABSTRAK

Air telaga merupakan salah satu sumber air minuman di negeri Kelantan. Penilaian kualiti air telaga adalah sangat penting dalam menilai kesesuaian air ini sebagai air minuman dan tujuan domestik lain. Tujuan kajian ini adalah untuk menentukan pencemaran logam berat di dalam air telaga di kawasan Pasir Mas. Dalam kajian ini tujuh parameter seperti suhu, oksigen terlarut (DO), pH, Permintaan Oksigen Kimia (COD), Permintaan Oksigen Biokimia (BOD), Amonia Nitrogen (NH_3-N) dan Pepejal Terampai (SS) telah direkodkan. Di samping itu, logam berat seperti Zn, Fe, Mn dan Pb telah diselidik. Parameter in-situ kualiti air seperti pH, suhu and DO telah diukur dengan menggunakan Multi probe YSI mudah alih. Parameter ex-situ seperti BOD, AN, COD, dan SS dijalankan di dalam makmal. Analisis statistik menggunakan ujian *One-Way ANOVA test* menunjukkan tiada perbezaan yang signifikan antara pH, COD, BOD, Zn, Fe dan Pb di sepuluh stesen terlibat. Kepekatan Zn, Fe, Mn dan Pb masing-masing didapati berada dalam julat antara 0.02-0.08 mg/l, 0.04-0.29 mg/l, 0.09-0.76 mg/l and 0.02-0.08 mg/l. Secara keseluruhannya, Indeks Kualiti Air di kawasan Pasir Mas berada didalam kategori kelas ke III dan dianggap tercemar.

Kata kunci : Air Telaga, Air Bawah Tanah, Logam Berat, Indeks Kualiti Air, Parameter Kualiti Air, Pasir Mas

A STUDY OF HEAVY METAL CONTAMINATION IN THE WELL WATER IN PASIR MAS, KELANTAN : PERSPECTIVE OF WATER QUALITY INDEX

ABSTRACT

Well water is one of the source of the drinking water in Kelantan. The assessment for well water quality is very important in evaluating the suitability of the water for drinking and other domestic purposes. The aims of this study is to determine the heavy metal contamination in the well water in Pasir Mas area. In this study seven parameter water quality such as temperature, DO, pH, COD, BOD, NH_3-N and SS were recorded. In addition, heavy metals such as Zn, Fe, Mn and Pb were investigate. In-situ measurement of water quality such as pH, temperature and DO were measured by using YSI portable Multi-probes meter. Ex-situ measurement such as BOD, AN, COD, and SS were carried out in the laboratory. Statistical analysis of One-Way ANOVA test shows that there is no significant different between pH, COD, BOD, Zn, Fe and Pb in all ten stations involved. The concentration of Zn, Fe, Mn and Pb were found in range of 0.02-0.08 mg/l, 0.04-0.29 mg/l, 0.09-0.76 mg/l and 0.02-0.08 mg/l respectively. Overall, the Water Quality Index were categorized under class III and it is considered polluted in Pasir Mas area.

Keywords : well water, groundwater, heavy metals, Water Quality Index, Water Quality Parameter, Pasir Mas

CHAPTER 1

INTRODUCTION

1.1 Introduction

Water is essential to life. It need not be spelt out exactly how important it is. Yet water pollution is one of the most serious ecological threats today.According to Saraswathy (2009), water is one of the most important basic needs of human life. Life is made up of water or water environment such as marsh, estuary, rivers, streams, lake or pond.

Water also is a source of energy for development and growth of industry. It is approximately 71% of the area of the oceans that covered the earth contained about 1370 million cubic kilometre of water. If the rivers, lakes, glaciers, north and south poles are mixed, the area will be covered by water more than 379 million square kilometre which is about 74.35% of the earth's surface (Ismail, 2004).

Conversion of land from forest to agriculture has resulted in widespread deforestation. Aside from reducing the amount of the original forest and forest biodiversity and wildlife, deforestation also contribute to soil erosion, sedimentation, slope damage and landslides in Malaysia (Ismail, 2004).

Water supply and quality of water resources will affect when continued deforestation and forest degradation in the watershed as well as affect the ability of groundwater retrieval and cause more flooding in the lowlands. In developing countries, 40% approximately used toxic compounds such as dichlorodiphenyltrichloroethane (DDT), and organophosphate (Epstein, 2014).

Groundwater is the water contained beneath the surface in rocks and soil, and is the water that accumulates underground in aquifers. It's also constitutes 97 per cent of global freshwater and is an important source of drinking-water in many regions of the world. In many parts of the world, groundwater sources are the single most important supply for the production of drinking-water, particularly in areas with limited or polluted surface water sources (World Health Organisation (WHO), 2006).

For many communities it may be the only economically viable option. This is because groundwater is typically more stable in terms of quality and better microbial quality compared to surface waters (WHO, 2006). Moreover, groundwater is one of the sources of clean water other than rain and fresh river water available in Malaysia. Furthermore, the usage of groundwater in Malaysia is still very low (Bujang *et al.*, 2011).

Then, the quality of groundwater is generally under a considerable potential of contamination especially in agriculture dominated areas with intense activities that involve the use of fertilizers and pesticides. The issue of protection of groundwater against pollution is of crucial significance (Buselli & Lu, 2001).

Contamination of groundwater often occur in places where the groundwater table is shallow and activities on going at that particular area contributes to leaching of contamination to groundwater. This normally happens in landfill area or industries especially metal plating industries where a lot of produced water is channel out into the surface water which will eventually infiltrate into the groundwater (Mahadevan & Krishnaswamy, 1984).

Less than 10% water is used and they commonly used from groundwater resources. Groundwater is used for domestic purposed in rural area where there is no piped water. However, in Kelantan,70% of water supply is from groundwater and this villagers used groundwater for cooking, drinking, washing and so on (Yunus & Mohammed, 2009).

1.2 Problem statement

Kelantan started with groundwater development since the early 1900s. It is about 65% of the groundwater is used for domestic supply, 35% for industrial supply and 5% for agricultural. In Peninsular Malaysia, about 0.2 million m^3/d of groundwater being exploited (Yunus & Mohammed, 2009).

According to Siti Halwani (2012), about 70% of water supply in state is derived from groundwater in Kelantan especially in Kota Bharu. In Kelantan also familiar with the largest groundwater operator in Malaysia (Ismail, 2009). The groundwater still main water supply for the districts of Kota Bharu, Tumpat, Bachok and Pasir Mas. The demand of groundwater was estimated will increase 2.5% per annum. The uses of groundwater as water supply was started in 1940's. In Kelantan, the groundwater are used for daily activities such as cooking, drinking, washing and so on.

The groundwater is significantly utilized for public water supply in Kelantan and Perlis. Moreover, Terengganu, Pahang, Sarawak and Sabah also supply the water systems with groundwater (Siti Halwani, 2012). According to Table 1.1, it shows that the usage of groundwater supply by state in Kelantan is increased compared to the other state.

Table 1.1 : Supply of groundwater by state, 2005-2009

Water entities	2005	2006	2007	2008	2009
Kelantan	**45,189**	**44,428**	**48,294**	**49,387**	**54,038**
Negeri Sembilan	325	-	-	-	-
Pahang	-	-	2,062	2,062	1,365
Perlis	2,562	2,562	2,390	3,305	3,080
Sabah	12,575	13,842	14,831	16,409	16,425
Sarawak	4,130	1,458	7	-	-
Terengganu	74	87	84	79	34
W.P Labuan	-	-	-	-	264
Total	48,150	62,387	67,661	71,242	75,206

(Source : Department of Water Supply (2005-2006) and National Water Services Commission, 2007-2009)

According to Rokiah & Hamidi (2001), the lake, river, ocean, underground water and etc. are the water sources are easy to get. Unfortunately, the quality of water that is clean and safe to use is limited. In Malaysia, the water pollution is the main of the environmental issues that disputed by all communities as the water is important element that can support organisms and ecosystems.

In year 2020, it is estimate that the water demand will increase as well as the development of industrial and agriculture sectors and the increase in population (Ismail, 2004). According to Haliza (2007), there is indirectly imbalance of supply and demand of water due to the pollution problems from land development activities and natural resources which are the opening of a new settlement, logging, urban development and housing.

Then, to meet the water requirements of the country, the surface water should be added to the groundwater supply. The water shortages forced many countries to used groundwater. The groundwater was cleaner approximately 3000 times than the surface

water. Moreover, to ensure that the water supply is not contaminated by human activities (Ismail, 2004).

In 1982, Tun Dr. Mahathir Mohamad was introduced the National Population Policy (NPP) which it stated that the contamination of groundwater affected by the increasing of population and rapid development in country as well as in Malaysia was targeting 70 million people in year 2020. As Malaysia will be more successful if they have 70 million people. Indirectly, this policy actually have an impact on the environment stages if development activities are carried out by human increasingly robust without being monitored and ignoring environmental condition (Haliza, 2007).

As mentioned water pollution is usually caused by human activities. Different human sources added to the pollution of water. There are two sorts of sources, point and nonpoint sources. Point sources discharge pollutants at specific locations through pipelines or sewers into the surface water. Nonpoint sources are sources that cannot be traced to a single site of discharge (Almasri & Kaluarachchi, 2005).

Examples of point sources are factories, sewage treatment plants, underground mines, oil wells, oil tankers and agriculture. Examples of nonpoint sources are: acid deposition from the air, traffic, pollutants that are spread through rivers and pollutants that enter the water through groundwater. Nonpoint pollution is hard to control because the perpetrators cannot be traced (Almasri & Kaluarachchi, 2005).

Most concern over groundwater contamination has centred on pollution associated with human activities. Human groundwater contamination can be related to waste disposal (private sewage disposal systems, land disposal of solid waste, municipal wastewater, wastewater impoundments, land spreading of sludge, brine disposal from the petroleum industry, mine wastes, deep-well disposal of liquid wastes, animal

feedlot wastes, radioactive wastes) or not directly related to waste disposal (accidents, certain agricultural activities, mining, acid rain, improper well construction and maintenance, road salt) (Ma *et al.*, 2009).

In Malaysia, groundwater has been explored since 70 years ago where Kelantan is the first state to utilised groundwater for public supply as stated in National Water Research Study 2000-2050 by the Economic Planning Unit (EPU). For the state of Kelantan, where groundwater is being significantly utilized for potable water supply, is the leading state and largest groundwater operator in Malaysia (Yunus & Mohammed, 2009).

Traditionally people in Kelantan have used groundwater resource as the potable use since early 1935, which taking the benefits for precious groundwater in the north region of Kelantan. Air Kelantan Sdn. Bhd. (AKSB) was handled public water supplied in Kelantan through concessionaire agreement with state government and responsible to maintained and operation groundwater supplied in the state (Mohammed Hatta, 2004).

1.3 Objective

1.3.1 General objective

The main aim of this research is to investigate the level of heavy metal content in ten stations at Pasir Mas area using two sampling method which are in-situ and ex-situ.

1.3.2 Specific objectives

1. To identify the content of heavy metals that presents in the well water between different stations at Pasir Mas area.
2. To compare the heavy metals in well water with Water Quality Index Standard.
3. To identify the sources of pollution that presents in the well water

1.4 Research hypothesis

H_0 : There is no significant differences between the quality of well water in different stations in Pasir Mas.

H_A : There is significant differences between the quality of well water in different stations in Pasir Mas.

H_0 : There is no significant differences between heavy metal content of well water in different stations in Pasir Mas.

H_A : There is significant differences between heavy metal content of well water in different stations in Pasir Mas.

1.5 Research Questions

i. What are the concentration of heavy metals content in ten different stations at Pasir Mas?
ii. How does heavy metals get into drinking water?
iii. Are there any relationship between the other parameter?
iv. Are the quality of well water comply to the Water Quality Index (WQI)?
v. Are the water is safe to use and drink?

1.6 Significant of study

The concern of this is study find out whether the groundwater that from different Districts in Pasir Mas is free from contamination of heavy metal such as Ferum, Manganese, Plumbum, Zinc, Copper and Cadmium. In addition, this studies will help to provide information about contamination of heavy metal in groundwater to villager, researcher and country. Finally, it also help to provide information on current condition of water quality in the well water at Pasir Mas.

The population in district of Pasir Mas still depend on the well water sources at home. By measuring all the involved parameters, at least the current condition of the groundwater can be determined and can be compared with the WQI. The current condition of well water was very important in order to predict the safety aspect of using well water especially for domestic use in future.

This study is very important to all people in this state because all of them will having a potential to get disease from the contamination of well water as the state of Kelantan is the first country that used groundwater for drinking, washing, cooking and etc,. Moreover, according to staff from Pasir Mas District Council, the government wants Pasir Mas become second city besides Kota Bharu in Kelantan. Thus, from the development that occurred in Pasir Mas must disturb the quality of well water in this area.

CHAPTER 2

LITERATURE REVIEW

2.1 Groundwater pollution.

According to World Health Organization (WHO) (2006) groundwater pollution was any pollution that makes it not suitable for a particular purpose when it reaches an aquifer. This can be man-made, or natural including mineral and metallic deposits. The source of pollution for possible contamination basis were from municipal, industrial, agricultural and individual. Both state and federal regulations will help to inhibit pollution, and regulate or enforce the remediation practices.

According to Environment Quality Act 1974 (2011), pollution means any direct or indirect alteration of the physical, thermal, biological or radioactive properties of any part of the environment by discharging, emitting or depositing to wastes so as to affect any beneficial use adversely, to cause a condition which was hazardous or potentially hazardous to public health, safety, or welfare, or to animals, birds, wildlife, fish or aquatic life, or to plants or to cause a contravention of any condition.

Limitation, or restriction to which a licence under this act was a subject while water pollution happened when toxic substances enter water bodies including lakes, rivers, oceans and so on, getting dissolved in them, lying suspended in the water or depositing on the bed. This degrades the quality of water (World Wildlife Fund, 2014).

2.2 The source of groundwater pollution.

Groundwater pollution was emanated from the uses of land frequently by human activities. The groundwater will be at risk. Virtually any activity whereby chemical and wastes that may be released to the environment that can cause pollute to the groundwater.

The pollution of groundwater relied on its physical, chemical and biological properties that has been released into the environment within an aquifer in the same manner for groundwater moved (United State Environmental Protection Agency (USEPA), 2013). Residential, municipal, commercial, industrial, and agricultural activities can affect the groundwater quality.

Groundwater development in Peninsular Malaysia started since the early 1900s in Kelantan. At present about 65% of the groundwater was for domestic supply, 35% industrial supply and 5% for agricultural use (Yunus & Mohamad, 2009). In Malaysia, more than 90% of the freshwater resources come from groundwater. The total used of water could be approximated 10% of the volume of groundwater recharge. Table 2.1 shows the water resources in Malaysia. The table below shows the highest water resources in Malaysia was groundwater storage that has 5000 billion m^3.

Table 2.1 : The water resources in Malaysia

Water resources	Quantity (Billion m^3)
Annual rainfall	990
Surface run-off	556
Evapotranspiration	360
Groundwater recharge	64
Surface artificial storage	25
Groundwater storage	5000

(Source : Azuhan, (1999))

The present of water used in Malaysia was developed from groundwater resources was 10%. Moreover, in Kelantan more than 70% of the groundwater supplied was used by population. There were some reasons for the lack of groundwater development in Malaysia. Firstly was the failure identify the potential of groundwater resource. Next, the error or wrong concept that groundwater exploitation was not sustainable. Lack of full assessment of the resource because of the limit of budget and finally lack of strategic plan to manage the groundwater in proper way (Mohamed Hatta, 2004).

Water pollution was caused by point and non-point sources. The definition of point source pollution was "any single identifiable source of pollution from pollutants were discharge for examples pipe, ditch, ship or factory smokestack" (Hill, 1997). Point source also include sewage treatment plant, manufacturing and agro-based industries and livestock (Hill, 1997).

According to Department of Environment (DOE) (2010), the non-point source was defined as diffused sources like agricultural activities and surface run-off. When the rain moves over through the ground, the water absorbs and assimilate any pollutant it comes into contact with.

According to DOE (2010), the registered of water pollution point source was 20,348, sewage treatment plant (10,025 : 49%) manufacturing industries (9,069: 45%), animal farms (754 : 4%) and agro-based industries (500 : 3%) as shown in Figure 2.1.

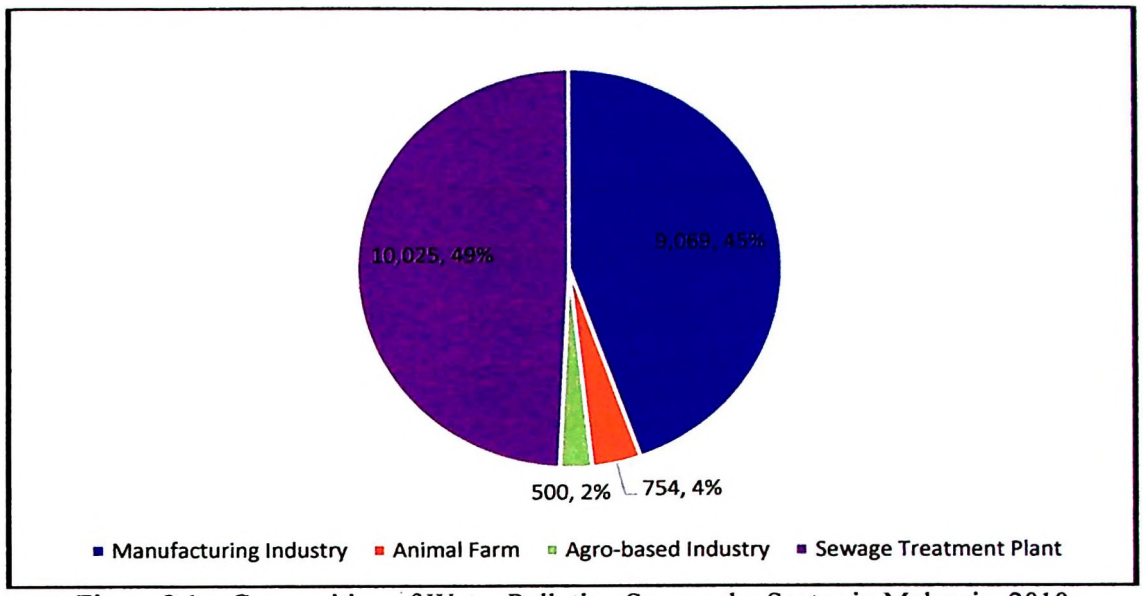

Figure 2.1 : Composition of Water Pollution Sources by Sector in Malaysia, 2010
Source : DOE, 2010

The sources for contaminations were from natural sources, septic system, improper disposal of hazardous wastes, releases and spills from chemical storage and products from petroleum, landfill and surface impoundment.

According to Thamer & Abdul (2009), the most important sources of water for irrigation was groundwater. It was susceptible to pollution. When man-made products for example gasoline, oil, road salts and chemicals get into the groundwater it can cause groundwater contamination and become not safe for human use. Materials from the land's surface such as pesticides and fertilizer will run-off through the soil to groundwater.

Furthermore, the groundwater was possible to pollute when they was near with septic tanks, underground chemical storage and leachate from landfills. The first source was from natural sources. Groundwater was very clean water and it also contain some impurities but it will not affect by human activities. The types and the concentrations

of natural impurities depend on the nature of the geological material through the groundwater moves and the quality of the recharge water (Mohamad Roslan, 2007).

Groundwater will transport through sedimentary rocks and soils that can pick up a wide range of combinations like magnesium, calcium, and chlorides. Some of aquifers have been increased in natural concentration of dissolved constituents such as arsenic, boron, and selenium. The effect of these natural sources of contamination on the groundwater quality depends on the type of contaminant and its concentrations (USEPA, 2002).

Septic systems that were improperly sited, designed, constructed, or maintained can contaminate ground water with bacteria, viruses, nitrates, detergents, oils, and chemicals (USEPA, 2013). Table 2.2 shows the cleaners that can contaminate water supply wells and interfere with natural decomposition processes in septic systems. Besides, the agriculture farm can also affect the quality of groundwater which is in agricultural farm the farmer will frequently use the fertilizers, pesticides, animal waste and herbicides (Noor Wahida *et al., 2005)*.

There were numerous and varied of agricultural contamination sources including spillage of fertilizers and pesticides during handling, runoff from the loading and washing of pesticide sprayers or other application equipment, using chemicals uphill from or within a few hundred feet of a well. Many farmers to be lost income land when their agricultural land was lack sufficient drainage. So to make the land more productive, the farmers need to install drainage wells or drain tiles (USEPA, 2002).

Table 2.2 : Typical Sources of Potential Groundwater Contamination by Land Use Category

Category	Contaminant Source	
Agriculture	Animal burial areas Animal feedlots Fertilizer storage/use	Irrigation sites Manure spreading areas Pesticides storage/use
Commercial	Airports Auto repair shop Boat yards Construction areas Car washes Cemeteries Dry cleaners Gas stations Golf courses	Jewelry/metal plating Laundromats Medical institutions Paint shop Photography establishments Railroads tracks and yards Research laboratories Scrap and junkyards Storage tanks
Industrial	Asphalt plants Chemical manufacture/storage Electronics manufacture Electroplaters Foundries/metal fabricator Machine/ metal working shops Mining and mine drainage	Petroleum production/storage Pipelines Septage lagoons and sludge Storage tanks Toxic and hazardous spills Wells (operating/abandoned) Wood preserving facilities
Residential	Fuel oil Furniture stripping/refinishing Household hazardous products Household lawns	Septic systems, cesspools Sewer liner Swimming pool (chemical storage)
Other	Hazardous waste landfills Municipal incinerators Municipal landfills Municipal sewer lines Open burning sites	Recycling/reduction facilities Road de-icing operations Road maintenance depots Storm water drains/basins Transfer stations

(Sources : USEPA (1991))

If the storage of agriculture chemical near to the groundwater like open and abandoned well, sink hole or surface depression where the water like to accumulate will cause contamination to occur. This happened when the chemicals were stored unprotected from rain or wind when the stores was near to the groundwater flows from the direction of chemical storage to the well water (USEPA, 2002).

2.3 Effect of the groundwater pollution

The results of contaminated ground water or degraded surface water were very serious. For example, estuaries that have been impacted by high nitrogen from ground water sources have lost critical shellfish habitats. In terms of water supply, in some instances, ground water contamination is so severe that the water supply must be abandoned as a source of drinking water. Follow-up water quality monitoring is often required for many years. Health side effects depend on the type of chemicals that have been released into the ecosystem.

2.3.1 Heavy metals

Any metallic chemical that had relatively high density and was toxic or poisonous even at low temperature called as heavy metals. These happened as the natural components of the Earth's crust. Heavy metals have higher specific gravity at least 5 times specific gravity of water for example 1 at 4°C (39°F) (Momodu & Anyakora, 2010).

Heavy metals also important for the body to functions effectively which was it only need to consume for small quantity for example iron, copper, manganese and zinc etc. Moreover, these heavy metals called as trace element. These elements commonly found in fruits, vegetables, can food and it also commercially available in multivitamin products.

These element cannot be vanished by body. These elements enter our body through food that we eat, drinking water and air that we inhaled. Unfortunately, these heavy metals cannot be traced by sight, smell or taste but it can be traced only in laboratory by using Atomic Absorption Spectrum (AAS) (Deepali & Joshi, 2014).

When these elements enter in the body and not metabolized, it will accumulate in the soft tissues and can cause toxic to human body. They will enter the human body via food, air, water, absorption via skin when they contact with human in manufacturing, industrial, agricultural and so on. Exposed to industrial was one of the factors for common route of exposure for adults while ingestion was a common route exposure for children (Roberts, 1999).

2.3.1.1 Cadmium (Cd)

Examples for heavy metals were cadmium (Cd), copper (Cu), iron (Fe), manganese (Mn), lead (Pb) and zinc (Zn). Firstly was cadmium which was a by-product of the mining and smelting of lead and zinc. It is used in nickel-cadmium batteries, PVC plastics, and paint pigments. It occurs mostly in association with zinc and gets into water from corrosion of zinc-coated ("galvanized") pipes and fittings. Its target organs are the liver, placenta, kidneys, lungs, brain, and bones (Deepali & Joshi, 2014).

Cadmium was known as human carcinogen. It was found that smoker has higher Cd level than non-smoker. It also cause damage to the lungs. Ingesting of very high Cd it can irrates the stomach and lead to diarrhea and vomit. For lon term exposure it can lead to build up the kidney lung damage,and fragile bones (Martin & Griswold, 2009).

2.3.1.2 Copper (Cu)

Copper was a mineral and it can found in organ meats, seafood, seeds, nuts, cereal, grain products and products from cocoa. In human body, the placed that stores copper were in bones and muscles. If the amount of Cu was higher, it can cause toxic to the tissues in human body.

It also can cause diarrhea, vomiting, loss of strength and cirrchosis of liver (serious exposure). High level of copper may lead to chronic anemia when the drinking water was pollute with this elements (Acharya, 2008).

When the corroded copper comes off inside the pipes, the water will turn blue to green in colour and appears in the water as residue. This only occurs in small percentage of cases. When the amount of copper excessed, the tissues will stimulate biogenic amines, neurotransmitters that relate to depression, anxiety, mood swing and schizophrenia (Deepali & Joshi, 2014).

2.3.1.3 Ferum (Fe)

According to Ghulman (2008), iron was malleable and silver-grey metal and it was believed to be the most abundant by mass (34.6%) made up the Earth and the concentration of iron in the different layer of Earth range from high at the inner core about 5% in the outer layer. Iron mainly occur in ferrous or ferric state in the water. In surface water, iron commonly present in ferric state.

Iron also used in all metals and produce 95% of metal tonnage in worldwide. Iron also used in food container to body of cars, screwdrivers, washing machine, paper staplers and etc. Iron also important in living things for human and micro-organisms (Deepali & Joshi, 2014). When humans lack of iron it can cause anaemia. Daily intake of iron from man and woman for normal diet were 7 mg and 11 mg respectively.

Next, iron also can cause conjunctivitis, choroiditis and retinitis and if contact it will remain in the tissues. When excessive inhaled the iron oxide fumes or dusts it can cause siderosis which was it can disrupt the development of benign pneumoconiosis. It also may affect the organs including liver, cardiovascular system and kidney. Besides, this elements will be found in groundwater as it is abundance in the earth crust. Usually, the iron will form ferric oxide in the groundwater in concentration less than 500 μg/L (Oyeku and Eludoyin, 2010).

2.3.1.4 Manganese (Mn)

Manganese was natural metals and will be found in variety of rocks. Manganese also important in human body to consume it to makes the body function efficiently. It always found in nuts, legumes, seeds, tea, whole grains and green vegetables. Manganese also can be medicine to people. It was used for osteoporosis, anaemia and premenstrual syndrome (PMS). Besides, iron, steel and power plants, coke oven and dust from mining operation released through the air (Deepali & Joshi, 2014).

Manganese (Mn) will enter to the water and soil from disposal, natural deposit or airborne sources. It also naturally exist in the groundwater, lakes and river. The villagers that used pesticides such as maneb and mancozeb can be exposed to excess

level of manganese. Exposure of Mn can cause long-term affect like emotional disturbance and slow body movement in some individuals (Martin & Griswold, 2009).

This two symptoms was a disease called manganism. This disease happened because amount of manganese in part of brain exceed from normal. Unfortunately, the part of the brain that injured from manganese was function to control body movements. When exposed to high in manganese whether consume or in airborne can affect the motor skills for human including when want to balanced holding one's hand, performing fast hand movements and to maintain the balanced of the body (Deepali & Joshi, 2014).

It also cause respiratory problems and sexual dysfunction when exposed too high with Mn. During pregnancy, the Mn always present in the mother body to develop a fetus and Mn was needed for growth and good health in children. When our body cannot remove the excess of Mn, it will cause problems in nervous system (Dvorak & Skipton, 2014).

2.3.1.5 Lead (Pb)

Lead was one of the horror mineral as it can act with violence, it also can cause lowered intelligent quotient (IQ), attention deficit disorder (ADD), attention deficit hyperactivity disorder (ADHD) and many neurological problems. It always found and used in pipes, drains and material solder for a decade. Year by year, the industry yield 2.5 million tons of lead all around the world. Most of it used for batteries, old house paint, lubricants, medications, cosmetics (lipstick and etc.), inks and so on. In United

states, common sources for lead exposure come from toys, cosmetics and glazed pottery (Martin & Griswold, 2009).

It also was proved that lead toxicity can cause symptoms from hundreds of symptoms from anaemia to death. Workers that exposed to lead dust can exposed to entire family because the dust will adsorb to his shirt and shoes while his taking this to his house. In consumer products, automobile components to specialty paint, hair dryer and candy also consists of lead (WHO, 2011).

According to Roberts (1999), a houses that built before 1940 was consists of lead (painted surface). Moreover, PVC products also contained lead and it can cause to chronic exposure from weather, flake, chalk and dust. In old house had a lead water pipes which was contaminate the drinking water. The cases of paediatric heavy metal poisoning increase because of lead. The bones, brain, blood, kidney and thyroid gland were target organs for lead. This metals that we take will excrete via urine.

According to Hanaa (2000), the research for lead toxicity were numerous as it was hazardous to human body and it can cause death or permanent damaged to the central nervous system (CNS), kidneys and brains.

2.3.1.6 Zinc (Zn)

Zinc was play main vital role in the metabolic and physiological process of organisms. Human health also need zinc for boosting the immune system, treat cold and recurrent ear infection and prevent low infection for respiratory. According to Rajkovic *et al.*

(2008), Zinc also used to prevent malaria or other disease that can caused by parasites. When the concentration of Zn was increases it will became toxic to organisms.

2.4 Water Quality Standard

The Department of Environment initiated the development of Receiving Water Quality criteria for Malaysia in 1985 which aimed at developing a water quality management approach for the long term water quality of the nation's water resources. The Environment Quality (Sewerage and Industrial Effluents) Regulations 1979 set out two standards of effluent quality, Standard A and B.

Effluent that discharged upstream of a water supply intake should meet Standard A, while effluent that discharged downstream has to meet Standard B. Effluent from sewage treatment plants need to be sampled at regular intervals and tested to ensure that it meets the required standards. Tests were carried out as part of a monitoring programme to ensure the efficient operation of treatment processes (EQA 1974, 2011).

In Malaysia studies focused on the water quality of the river than groundwater because of the lack of awareness of the importance of clean groundwater. Unfortunately the data for groundwater was very little in Malaysia. Nowadays, the groundwater was one of the sources that can be used including cooking, washing, drinking and so on. In Malaysia, there already have standard that we need to follow and fix some criteria to be mainly live on groundwater.

For the purposes, Ministry of Health (MOH) set the present for the pollution of heavy metals in water drinking as shown in Table 2.3. Moreover the value of parameter were

classified through Water Quality Index- Department of Environment (DOE) shows in Table 2.4, 2.5 and 2.6 respectively.

Table 2.3 : Treated and Raw Water Quality Guidelines

No.	Parameters	Unit	Treated Water	Raw Water
	GROUP 1			
1	Total Coliform	MPN	Absent	5000
2	E.Coli	-	Absent	-
3	Turbidity	NTU	5	1000
4	Colour	TCU	15	300
5	pH	unit	6.5 – 9.0	5.5 – 9.0
6	Residue Chlorine	mg/L	0.2 – 5.0	-
7	Total Chlorine	mg/L	1	-
	GROUP 2			
8	Total Dissolved Solids	mg/L	1000	1500
9	Biological Oxygen Demand	mg/L	-	6
10	Chemical Oxygen Demand	mg/L	-	10
11	Total Organic Carbon	mg/L	-	-
12	Chloride	mg/L	250	250
13	Anionic Detergent MBAS	mg/L	-	1
14	Ammonia	mg/L	1.5	1.5
15	Nitrate	mg/L	10	10
16	Iron	mg/L	0.3	1
17	Fluoride	mg/L	0.4 – 0.6	1.5
18	Hardness	mg/L	500	500
19	Aluminium	mg/L	0.2	-
20	Manganese	mg/L	0.1	0.2
	GROUP 3			
21	Mercury	mg/L	0.001	0.001
22	Cadmium	mg/L	0.003	0.003
23	Arsenic	mg/L	0.01	0.01
24	Cyanide	mg/L	0.07	0.07
25	Lead	mg/L	0.01	0.05
26	Chromium	mg/L	0.05	0.05
27	Copper	mg/L	1	1
28	Zinc	mg/L	3	3
29	Sodium	mg/L	200	200
30	Sulphate	mg/L	250	250

(Source : Ministry of Health (MOH), 2010)

Table 2.4 : Water Quality Index classification

Parameter	Unit	Class				
		I	II	III	IV	V
NH_3-N	mg/l	< 0.1	0.1 – 0.3	0.3 – 0.9	0.9 – 2.7	>2.7
BOD	mg/l	< 1	1 – 3	3 - 6	6 - 12	>12
COD	mg/l	< 10	10 – 25	25 - 50	50 - 100	>100
DO	mg/l	> 7	5 – 7	3 - 5	1 - 3	<1
pH	-	> 7	6 – 7	5 - 6	<5	>5
TSS	mg/l	< 25	25 - 50	50 - 150	150 - 300	> 300
WQI	-	<92.7	76.5 – 92.7	51.9 – 76.5	31.0 – 51.9	>31

(Source : Environmental Quality Report (EQR), 2006)

Table 2.5 : Water Classes and Uses

Class	Uses
I	Conservation of natural environment Water supply I – Practically no treatment necessary Fishery I – Very sensitive aquatic species
IIA IIB	Water supply II – Conventional treatment Fishery II – Sensitive aquatic species Recreational use body contact
III	Water Supply III – Extensive treatment required Fishery III – Common of economic value and tolerant species, livestock and drinking
IV	Irrigation
V	None of the above

(Source : EQR, 2006)

Table 2.6 : DOE Water Quality Classification based on WQI

Sub Index and Water Quality Index	Index Range		
	Clean	Slightly Polluted	Polluted
BOD	91 - 100	80 - 90	0 – 79
NH_3-N	92 - 100	71 - 91	0 - 70
SS	76 - 100	70 - 75	0 - 69
WQI	81 - 100	60 - 80	0 - 59

(Source : EQR, 2006)