# Experimental Analysis On Quality Of Drinking Water in State of Perak

By

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Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Engineering (Hons)
(Chemical Engineering)

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Universiti Teknologi PETRONAS
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## CERTIFICATION OF APPROVAL

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A project dissertation submitted to the

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Approved by,

______________________

Dr. Nejat Rahmanian

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

May 2012

## CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

______________________________

Siti Hajar Bt Ali

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# ABSTRACT

The complete analysis of drinking water samples have being carried out to understand deeply on quality of water being consumed in different areas around Ipoh and Seri Iskandar districts. The drinking water samples are taken from tab water in residential area of Ipoh, Batu Gajah, Siputeh, Seri Iskandar and Tronoh where it is used for drinking purpose and also from mineral water and reverse osmosis water. The analyses of drinking water samples of different locations are conducted to determine the physical properties and chemical properties such as temperature, pH value, turbidity, conductivity and total suspended solid (TSS), total dissolved solid (TDS) and heavy metals. Heavy metals analysis is carried out to determine the concentration of different heavy metals present in the samples. There are two method of analyzing water sample which is in-situ and experimental analysis. From this study, it is shows that the entire water sample is within the safety level range set by National Drinking Water Quality Standard (NDWQS) and World Health Organization (WHO). This analysis is done to ensure the water safety level parameters according to NDWQS and also WHO.

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## LIST OF ACRONYMS AND ABBREVIATIONS

| | | |
|---|---|---|
| AAS | : | Atomic Absorption Spectroscopy |
| ICP | : | Inductively Coupled Plasma |
| TDS | : | Total Dissolved Solid |
| TSS | : | Total Suspended Solid |
| EPA | : | Environment Protection Agency |
| MNDWQS | : | Malaysian National Drinking Water Quality Standards |
| WHO | : | World Health Organization |
| RO | : | Reverse Osmosis |
| Cd | : | Cadmium |
| Pb | : | Lead |
| Cu | : | Copper |
| Hg | : | Mercury |
| As | : | Arsenic |
| Al | : | Aluminium |
| Zn | : | Zinc |
| Fe | : | Iron |
| L | : | liter |
| mg | : | miligram |
| ml | : | milliliter |

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# CHAPTER I

# INTRODUCTION

## 1. BACKGROUND STUDY

Water is the source and basic needs for all life in the world. It is well known that no one can survive without water including animals and plants. Human beings consume average 2 liters a day as drinking water. For drinking water, before it is being used, it must be treated firstly.

Water sourced from rivers will be treated before people can consume it via the tap water. Referring to Environmental Protection Agency, there is few steps involve ensuring water cleanliness in water treatment process. The first step includes is flocculation process which combines small particles into larger particles. Then, the water will be filtered to remove all its particles. After that, water undergoes ion exchange process to remove any inorganic contaminants. Then, adsorption of water in which to remove organic contaminants, unwanted coloring and taste-and-color causing compound take place. Lastly, chlorination process is carried out to disinfect the water. In some places, despite the fact that has being treated, it is still did not follow the actual standard of drinking water. Thus, the safety level of drinking water is being doubted.

Safe drinking water is water that is acceptable for humans to drink and use for other domestic purposes such as food preparation. Drinking water should contain no harmful concentrations of chemical or micro-organisms, and should ideally have a pleasant appearance, taste and odour. Water must meet certain basic requirements to make it fit for domestic uses. The most important requirement is that it must be safe to drink. Many water sources contain harmful micro-organisms or other substances in concentrations that make the water unsafe to drink. It is not possible to tell if water from a particular source has to be treated simply by visual inspection of the water.

The reason is that water may contain substances that are not visible, but can make the water unfit for drinking.

## 1.1 Water pH

The pH level of drinking water reflects the acidity or alkalinity of the water. The pH stand for potential hydrogen which is referring to the amount of hydrogen mixed with the water (APHA, 1992). The pH is measured on a scale that runs from 0-14. Seven is neutral, indicating there is no acid or alkalinity present. Normal pH is between 6.8 and 7.2. Numbers less than 7 have increasing acidity and numbers greater than 7 have increasing alkalinity. Water below 6.8 is beyond slightly acidic. This has a marked effect on the taste of the water and also indicates possible corrosion problems resulting from dissolution of metals such as copper, zinc and cadmium that can be toxic.

## 1.2 Conductivity

Conductivity is the ability to conduct electricity (EPA, 1991). Water can conduct electricity because it contains dissolved solids which carry electrical charges. For example, chloride, nitrate and sulfate carry negative charges while sodium, magnesium and calcium carry positive charges. These dissolved solids affect the water’s ability to conduct electricity. Thus, measuring the conductivity indirectly indicates the amount of total dissolved solid (TDS) in the water.

According to WHO guidelines for drinking water quality, TDS is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The measurement of specific conductivity with a conductivity probe that detects the presence of ions in water is the common method of determining TDS in water. Conductivity measurement is converted into TDS values by means of a factor that varies with type of water (WHO, 2003).

Conductivity of the water can be affected by many factors. The additional of fresh water such as rain can lowers conductivity as it has lower conductivity value (EPA, 1991). Thus, the increases in water levels dilute the mineral concentration of the water. Conversely, during low flow concentration, the dissolved solid more concentrated and therefore the conductivity is higher. Apart from that, conductivity also affected by the temperature, the conductivity is higher as the temperature increases.

## 1.3 Turbidity

Turbidity is a water quality term that refers to the cloudy appearance of water, caused by particles or "suspended matter" (EPA, 1999). There are many types of particles that may be present in water, some of which are large enough to be seen and some are not. Turbid water contains particles that are too small to be seen without magnification, but the particles produce effects that can be detected with the human eye because they scatter light. The particles that cause turbidity are about the same size as wavelengths of visible light (or smaller), described as colloidal size. Colloids are so small that they never settle, even gravity doesn't affect them. Brownian motion, which is the result of constant collisions between these particles and other, dissolved molecules, keeps the colloids suspended (EPA, 1999).

Turbid water may contain a variety of particles such as clay, silt, finely organic material, corrosion product, lime scale and debris from plants, animals and biofilms. This affects the appearance, and thus the aesthetic acceptability of the water. It is commonly high in surface waters.

Turbidity measurements performed using proprietary nephelometric instruments are expressed as Nephelometric Turbidity Units (NTU). The nephelometric apparatus is designed to measure forward scattering of light at 90° to the path of an incandescent light beam. Suspended particles present in a water sample reflect a portion of the incident light off the particle surface. The light reflected at 90° is measured by a photoelectric detector and is compared against light reflected by a reference standard. No interference exists for the turbidity test.

## 1. 4 Total Dissolves Solid (TDS) and Total Suspended Solid (TSS)

EPA describes total solids as dissolved solids plus suspended and settleable solids in water (EPA, 1991). In stream water, dissolved solids consist of calcium, chlorides, nitrate, phosphorus, iron, sulfur, and other ions particles that will pass through a filter with pores of around 2 microns (0.002 cm) in size. According to WHO guidelines for drinking water quality, TDS is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water (WHO, 2004).

Total Suspended Solids (TSS) is solids in water that cannot pass through a filter (usually with a pore size of 0.47$\mu$m) (APHA, 1992). It can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage. High concentrations of suspended solids can cause many problems for stream health and aquatic life.

## 1.5 Heavy Metals

Definition for heavy metal is referring to any metallic element that has relatively high density greater than 5 g/cm3 and is toxic or poisonous at lower concentrations (EPA, 2009). Heavy metals are natural components of the earth’s crust and a small extent; it enters bodies via food, drinking water and air.

Heavy metals can represent a common type of chemical pollution in water. They can be found naturally in bed rock and sediment or they might be introduced into water from industrial sources and household chemicals (Labunska *et al*, 2000). Heavy metals can be harmful to human live whether through direct ingestion of contaminated water or through accumulation in the tissue of other organisms eaten by humans. It is dangerous as they tend to be bioaccumulated, which means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment (S. O. Adefemi et al, 2010). Compounds are accumulated in living things any time they are taken up and stored faster than they are metabolized or excreted. Heavy metals cannot be degraded nor destroyed. There are some common heavy metals that can be found in water such as mercury (Hg), lead (Pb), cadmium (Cd), arsenic (As), copper (Cu) and aluminum (Al).

It is therefore essential to take samples and analyse the drinking water. An assessment must then be done to determine whether the water is fit to drink and to ensure the drinking water qualities consume by residential in area is followed the

Malaysian National Drinking Water Quality Standard. This is to ensure the safety level of drinking water so that it will not affect consumers' health.

The followings are list of water quality which of heavy metals normally present in most waters at concentrations:

Table 1: Chemicals and its concern

| Parameter | Health Effect |
|---|---|
| Lead | At low levels of exposure to lead, the main health effect observed the nervous system; specifically, exposure to lead may have subtle effects on the intellectual development of infants and children. |
| Arsenic | This may be present in groundwater, particularly in mining areas. This can lead to arsenic poisoning and may causes damage to skin, eyes, gastrointestinal tract and liver. It may also cause cancer to the human being. |
| Cadmium | Origin includes electroplating, erosion of natural deposition, discharge from metal and plastic refineries, battery and paint waste, mining as well as sewage. It penetrated body via the food eaten and water drank. Cadmium can cause kidney disease and injures the renal, pulmonary, skeletal and testicular. In addition, is been recognized as a carcinogen. Kidney failure tends to be the fatal due to the sensitive nature of the kidneys if there is a concentration of Cadmium. |
| Copper | Cu in a very high quantity is toxic and may cause vomiting, diarrhea and loss of strength. In a long term, the toxicity can cause liver damage, kidney failure and ultimately death while the short term effect is gastrointestinal distress. |
| Zinc | This affects the taste of water. Usual cause is acidic water dissolving zinc from galvanised pipes or from appliances. |
| Iron | This affects the taste of the water and may also cause a reddish brown discolouration. It can be common in bottom waters of dams, or in mining areas. It is also can cause growth of slimes of iron-reducing bacteria that ultimately appear as black flecks in the water |
| Magnesium | This affects the taste of the water. It is bitter at high concentrations. |

## 1.2 Problem Statement

The unsafe drinking water can lead to human health problems. Recent study shows that there are cases which he quality of drinking water is not following the standard. To ensure the safety of drinking water, analysis of water samples is done to ensure their parameters are according to the Malaysian National Drinking Water Quality Standard.

## 1.3 Significant Of The Project

Drinking water is main source of water that people consume every day. It is important to ensure the drinking water consumed is safe to be drink. The neglect to this matter will affect consumers' health.

## 1.4 Objectives

1. To determine the parameters in water drinking samples from residential areas, mineral water and reverse osmosis water.

2. To compare the parameters of drinking water samples as well as the water safety level according to the parameters of Malaysian National Drinking Water Quality Standard and World Health Organization.

## 1.5 Scope of study

The drinking water samples are taken from the tab water of residential areas of Ipoh, Batu Gajah, Bandar U, Taman Maju, UTP, Siputeh, Seri Iskandar and Tronoh. The drinking water samples are also taken from mineral water and reverse osmosis water. The parameters that were analysed physical and chemical properties of water. The parameters then will be analysed and compared to the parameters in Malaysian National Drinking Water Quality Standard and World Health Organization.

# CHAPTER II

# LITERATURE REVIEW

Water pollution is a frequency of exceeding national drinking water quality standards. According to World Health Organization (WHO), the estimated number of water pollution sources for 2002 was 13,540 comprising mainly of sewage treatment plants, agro-based industries, manufacturing industries and animal farms (EQR, 2004). About 53 percent of the total number of sources was domestic sewage facilities (7,126 sources), followed by manufacturing industries (38%), pig farms (6%) and agro based industries (3%). Of the total number of effluent sources identified, Johor had the highest number (1 675) which is 29.9%, followed by Selangor (1 485) which is 26.5%, Perak (573) which is 10.2% and Perlis had the least number (14) which is 0.25% (EQR, 2004).

Recently, more people concern about the safety of their drinking water. The World Health Organization (WHO) Guidelines for Drinking-water Quality, 3rd edition (WHO 2004a, 2006) more explicitly states: "Safe drinking-water, as defined by the Guidelines, does not represent any significant risk to health over a lifetime of consumption, including different sensitivities that may occur between life stages. Safe drinking water is suitable for all usual domestic purposes, including personal hygiene."

There are many factors which are affect the drinking water to be exceed the allowable limit state by national drinking water quality standard. For example, the pH level, TDS, turbidity, conductivity and heavy metal concentration can give effect to human health if it is not following the requirement drinking water standard.

According to WHO, it was reported in a summary of a study in Australia that mortality from all categories of ischaemic heart disease and acute myocardial infarction was increased in a community with high levels of soluble solids, calcium, magnesium, sulfate, chloride, fluoride, alkalinity, total hardness, and pH when compared with one in place which levels were lower.

Apart from that, according to WHO, no recent data on health effects associated with the ingestion of TDS in drinking-water appear to exist; however, in early studies, inverse relationships were reported between TDS concentrations in drinking water with the incidence of cancer, coronary heart disease, arteriosclerotic heart disease and cardiovascular diseases. Total mortality rates were reported to be inversely correlated with TDS levels in drinking-water (WHO, 2004).

Azrina A. *et al* (2011) has reported in her study of inorganic elements in tab water, that minerals and heavy metals determined in tab water are sodium, magnesium, potassium, calcium, chromium, manganese, iron, nickel, copper, zinc, arsenic, cadmium and lead. Meanwhile, the non-metal elements were fluoride, chloride, nitrate and sulphate. Most of the inorganic elements found in the samples were below the maximum permitted levels recommended by inter-national drinking water standard limits, except for iron and manganese. Iron concentration of tap water from one of the locations was higher than the standard limit.

Thanapalasingam V. (2007) has analysed Sungai Skudai river water for heavy metals by using the Instrumental Neutron Activation Analysis (INAA) and Inductive Coupled Plasma-Mass Spectrometry (ICP-MS). The results showed that elemental concentrations of As, Pb, Hg, Cr, Cd, Cu, Ni and Zn were detected. The trend of several pollutants in the river and the statistical analysis of the results were obtained. Then trend of heavy metals in water of the Skudai River system was Zn>Cu>Ni>Cr>As>Pb>Hg>Cd.

Apart from that, the study on the determination of organic pollutants and heavy metals in sediments and water samples associated with the petrochemical complex in La Plata district Argentina had been done (Labunska *et al*, 2000). The result has shown that the area was still contaminated with the petroleum products and several heavy metals such as Cu, Pb, Hg and Zn had been detected in the sediment samples above the background levels.

Mustafa *et al*. (2006) cited on his study about the determination of trace amounts of Cr (III), Fe (III), Pb (II) and Mg (II) which good result are obtained where relative standard deviations less than 10% and recoveries were more than 95%.

Alexander V.G *et al.* (2007) shows study in Bangladesh has determined that the element concentrations such as As, Ba, Mn, Mg, and Ni used in Dhaka were lower, and Cr concentration was higher than those in the rural area. The arsenic concentration is the highest among 28 samples. Regarding health effects of As are known that one of the carcinogenic elements such like Ni and Cr. As which invaded into the body is distributed in subcutaneous layers, and occurs pigmentation.

M. Heydari et al. (2012) in their study in Kashan District, Central Iran has determined all water samples showed $SO_4^{2-}$ higher than permissible limit. Based on the findings, most of chemical parameters in Kashan District samples drinking water are low and within the WHO standards limit.

H.M. Salem *et al*. (2000) reported in his study that there are strong relationships between contaminated drinking water with heavy metals from some of the Great Cairo Cities, Egypt and chronic diseases such as renal failure, liver cirrhosis, hair loss, and chronic anemia has been identified. These diseases are apparently related to contaminant drinking water with heavy metals such as Pb, Cd, Cu, Mo, Ni, and Cr. Renal failure is related to contaminate drinking water with lead and cadmium, liver cirrhosis to copper and molybdenum, hair loss to nickel and chromium, and chronic anemia to copper and cadmium.

In November 2002, the United Nations Committee on Economic, Social and Cultural Rights asserted that access to clean and safe water goes beyond the classification of water as an economic commodity. The committee stressed the fundamental right of sufficient access to clean water for both domestic and personal use. “The human right to water is indispensable for leading a life in human dignity.” With this in mind, the clean and safe drinking water is important to be kept monitoring as it will affect the customers’ health if it is neglected.

# CHAPTER III

# RESEARCH METHODOLOGY

## 3.1 Project Flow

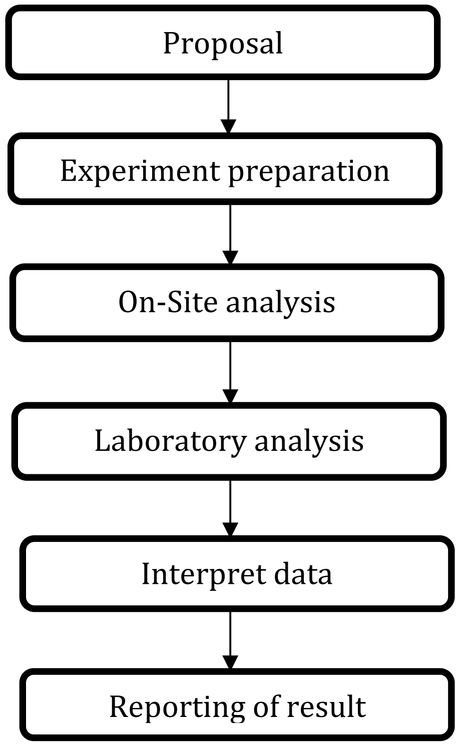



Figure1: Project Sequence Flow Chart

### 3.1.1 Taking of sample

It is important that the sample must be representative of the water on which the information is required, that the correct type and volume of sample is taken, that the correct procedure is followed for the type of sample and that the correct type of container is used.

### 3.1.2 In-Situ analysis

Samples are analyzed on-site for certain substances, using field instruments or multiparameter probe. Care must be taken when deciding on analyses to be done on-site because results are not always reliable. The substances and properties which are normally determined on-site include pH, temperature, turbidity and electrical conductivity. The reason for on-site determination for these parameters is that they are easy to measure and some of them may change as soon as the sample is taken.

#### 3.1.3 Preservation, transport and storage of water samples

This is important elements of the process of water quality analysis. The most important requirement is that the sample must be delivered as soon as possible to the laboratory for analysis, especially for microbiological analysis. It is important in all cases that the time and date be noted when the sample was taken, and that the sample be unambiguously identified with a unique name and/or number.

#### 3.1.4 Laboratory Analysis

Analysis is depends on the substance being measured as well as the type of analytical method being used by the laboratory.

### 3.2 Location of Sampling

The drinking water samples are taken from the tab water of residential areas of Ipoh, Batu Gajah, Siputeh, Seri Iskandar, Bandar U, UTP, Taman Maju and Tronoh. Two samples is taken from mineral water and reverse osmosis water.


Figure 2: Geographical Map of the State of Perak, Malaysia

(Perak Map, 2012)


Figure 3: Location of sampling

**3.3 Procedures**

3.3.1 Collecting Sample

1. 1L of clean polyethylene bottle is wash with acid wash and deionize water
2. Tab water sample is collected by flow the water into the 1L polyethylene bottle.
3. Tab water sample is preserved by using 4ml of nitric acid, $HNO_3$
4. Close the 1L polyethylene bottle cap.
5. The sample boxes shall be sealed, and remain so until they are opened for analysis at the laboratory.
6. The sample shall be placed in a dark environment at a constant temperature (4°C). Any possibility of contamination to the samples must be avoided.

3.3.2 pH measurement by HANNA HI98130 pH meter

1. Press and hold the ⏻/ MODE button for 2 second to turn the multi parameter probe on.
2. Select the pH mode with the SET/HOLD button.
3. Submerge the electrode in the tab water to be tested.
4. The measurement should be taken when the stability symbol on the top left of the LCD disappears.
5. The pH value automatically compensated for temperature is shown on the primary LCD while the secondary LCD shows the temperature of sample.
6. Record the data.
7. To turn the meter off, press the ⏻/ MODE button while in normal measurement mode and OFF will appear before release the button.

3.3.3 Conductivity measurement by HANNA HI98130 Conductivity meter

1. Press and hold the ⏻/ MODE button probe for 2 second to turn the multi parameter on.
2. Select the conductivity mode with the SET/HOLD button.
3. Submerge the electrode in the tab water to be tested.

4. The measurement should be taken when the stability symbol on the top left of the LCD disappears.
5. The conductivity value automatically compensated for temperature is shown on the primary LCD while the secondary LCD shows the temperature of sample.
6. Record the data.
7. To turn the meter off, press the ⏻/ MODE button while in normal measurement mode and OFF will appear before release the button.

3.3.4 Turbidity by 2100P Turbid meter HACH

1. Select the operating range at ”AUTO” mode.
2. Fill a clean sample cell to the mark with the test sample and place it in the cell holder. The sample cell must be clean, dry and free of fingerprints. Wipe the outside of the cell with a lens tissue and align the dot on the sample cell with the raised mark on the spill ring around the cell holder opening. Be sure the cell is kept down completely and held in place by the spring clip. Cover the sample with the light shield.
3. The digital readout is in Nephelometric Turbidity Units (NTU).

3.3.5 Standard method for analysis of heavy metal and mineral using Flame Atomic Absorption Spectroscopy

Table 2: Detection limit for AAS

| Sr.No. | Element | Detection Limit |
|---|---|---|
| 1 | Cr | 0.1ppm |
| 2 | Mg | 0.1ppm |
| 3 | Hg | 5ppb |
| 4 | Cd | 0.1ppm |
| 5 | Pb | 0.5ppm |
| 6 | Zn | 0.1ppm |
| 7 | Fe | 0.5ppm |
| 8 | Cu | 0.1ppm |
| 9 | As | 5ppb |

3.3.5.1 Preparation of zero calibration solutions

1. Prepare zero calibration solution by dissolving 8ml pure conc. HNO3 in about 25ml double distilled water in a 1000ml volumetric flask and diluting it up to the mark by adding double distilled water.

3.3.5.2 Preparation of working solution

1. For 40ppm working standard solution, pipette 1ml of standard 1000ppm stock solution with the help of volumetric pipette into clean 25ml volumetric flask.
2. For 200ppm working standard solution, pipette 5ml of standard 1000ppm stock solution with the help of volumetric pipette into clean 25ml volumetric flask.
3. For 1000ppb working standard solution, pipette 25$\mu$l of standard 1000ppm stock solution with the help of micropipette into clean 25ml volumetric flask.
4. Make the volume up to the mark by adding zero calibration solution to prepare working standard (stock solution).

3.3.5.3 Standard Curve

1. Switch on the Atomic Absorption Spectrophotometer and operate all other step following work instructions (TEC-IPL-WI-16).
2. Aspirate the zero calibration solution and auto zero the instrument.
3. Aspirate different standard solutions in ascending order for preparation of standard calibration curve applying standard conditions for the mineral to be analyzed.

Table 3: Diluted Standard Solution for Standard Curve

| Working Standard Solution | Diluted Standard Solution |
|---|---|
| 40ppm | 0.1ppm, 0.2ppm, 0.4ppm, 0.8ppm |
| 200ppm | 0.5ppm, 1ppm, 2ppm, 4ppm |
| 1000ppb | 5ppb, 10ppb, 20ppb, 40ppb |

3.3.5.4 Sample Analysis

1. Aspirate the zero calibration solution or sample blank as blank.
2. Aspirate the sample solution to be analysed into the flame.

3.3.6 Total Suspended Solid

1. Obtain the tare weights of three aluminium dishes each containing a glass fibre filter.
2. Assemble filtering apparatus, position the filter and begin suction. Wet filter with a small volume of distilled water to seat it.
3. Pour sample into filtration apparatus. Record the total volume filtered. Rinse the graduated cylinder with small amounts of distilled water and add to filter. Start the pump.
4. Carefully remove filter from filtration apparatus and transfer it back to the aluminium dish. Pinch sides of dish in a bit to protect the filter from oven drafts. Place the aluminium dish into the 103°C oven to dry for at least one hour.
5. Transfer dish to desiccators, cool and weigh. Calculate the total suspended solids in terms of mg/L.

3.3.7 Total Dissolved Solid

According to WHO, Total Dissolved Solid can be determined by the measurement of the conductivity. Conductivity gives an indication of the concentration of the ions or total dissolved solid in the water. For domestic water, conductivity value may used to estimate the TDS concentration in mg/l by multiplying the conductivity in mS/m by a factor of 6.5.

mS/m = $\boldsymbol{\mu}$S/m x 0.1

mg/l of TDS = conductivity (mS/m) x 6.5

(WHO, 2003)

## 3.4 Apparatus and Chemicals

### 3.4.1 Chemicals

a) Nitric Acid, $HNO_3$
b) Sulfuric Acid, $H_2SO_4$
c) Hydrochloric acid, HCL
d) Conc. HNO3 (Analytical/ Reagent grade)
e) Standard stock solution (NIST traceable)
f) Buffer solution of pH 7.01 and pH 4.01 (for calibrating pH meter)
g) Tap water sample
h) Double distilled water

### 3.4.2 Apparatus

a) 1L clean polyethylene bottles
b) Label of the bottle for identification
c) Micropipette and volumetric pipette (5ml, 10ml)
d) Volumetric flask (25ml, 10ml,100 ml. 1000ml)
e) Aluminium dishes
f) Sample holders
g) Beaker (10ml, 50ml, 100ml)
h) Filter Paper (0.45 $\mu$m of cellulose nitrate membrane, 47mm)

### 3.4.3 Instruments

a) Perkin Elmer Analyst 400 Flame Atomic Absorption Spectroscopy (AAS)
b) HI 98130 HANNA Combo pH and Conductivity meter
c) 2100P Turbid meter HACH
d) Filtering apparatus

### 3.5 Gantt Chart

| No | Detail / Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Final Year Project I | | | | | | | | | Mid semester break | | | | | | | | |
| 1 | First meeting with coordinator and supervisors | | | | | | | | | | | | | | | | |
| 2 | Preliminary research work | | | | | | | | | | | | | | | | |
| 3 | Submission of Extended proposal Defence | | | | | | | | | | | | | | | | |
| 4 | Proposal Defence | | | | | | | | | | | | | | | | |
| 5 | Project Study and Designing | | | | | | | | | | | | | | | | |
| 6 | Submission of Interim Draft Report | | | | | | | | | | | | | | | | |
| 7 | Submission of Interim Report | | | | | | | | | | | | | | | | |
| Final Year Project II | | | | | | | | | | | | | | | | | |
| 1 | Data Analyzing | | | | | | | | | | | | | | | | |
| 2 | Submission of Progress Report | | | | | | | | | | | | | | | | |
| 3 | Pre-EDX | | | | | | | | | | | | | | | | |
| 4 | Submission of Draft Report | | | | | | | | | | | | | | | | |
| 5 | Submission of Dissertation (Soft Bound) | | | | | | | | | | | | | | | | |
| 6 | Submission of Technical Paper | | | | | | | | | | | | | | | | |
| 7 | Oral Presentation | | | | | | | | | | | | | | | | |
| 8 | Submission of Dissertation (Hard Bound) | | | | | | | | | | | | | | | | |

***Process*** ***Suggested Milestone***

# CHAPTER IV

# RESULT AND DISCUSSIONS

## 4.1 RESULT

The data shows in the in-situ analysis are measured three times and the averages with the standard deviation are reported.

### 4.1.1 In-Situ Analysis Results

Table 4: The measurement of temperatures and pH values of the water samples

| Sample no. | Location | Date | Time | Temp (°C) | pH value | Standard deviation |
|---|---|---|---|---|---|---|
| **1** | Bandar U | 25 Sept 2012 | 16:25 | 29.5 | 9.21 | |
| | | 09 Oct 2012 | 11:15 | 28.4 | 8.50 | |
| | | 18 Oct 2012 | 10:04 | 27.9 | 8.59 | |
| | | | | | 8.77 | ±0.32 |
| **2** | Seri Iskandar | 25 Sept 2012 | 16:45 | 28.5 | 7.35 | |
| | | 09 Oct 2012 | 11:45 | 28.7 | 7.21 | |
| | | 18 Oct 2012 | 10:20 | 27.4 | 7.39 | |
| | | | | | 7.32 | ±0.08 |
| **3** | Siputeh | 25 Sept 2012 | 15:30 | 29.3 | 8.86 | |
| | | 09 Oct 2012 | 09:30 | 27.1 | 8.53 | |
| | | 18 Oct 2012 | 16.15 | 29.4 | 8.69 | |
| | | | | | 8.69 | ±0.13 |
| **4** | Tronoh | 25 Sept 2012 | 15:42 | 28.9 | 8.87 | |
| | | 09 Oct 2012 | 09:47 | 27.3 | 8.74 | |
| | | 18 Oct 2012 | 16:30 | 29.1 | 8.66 | |
| | | | | | 8.76 | ±0.08 |
| **5** | Taman Maju | 25 Sept 2012 | 16:00 | 29.1 | 7.34 | |
| | | 09 Oct 2012 | 11:35 | 28.5 | 7.32 | |
| | | 18 Oct 2012 | 10.30 | 28.9 | 7.29 | |
| | | | | | 7.32 | ±0.02 |
| **6** | Batu Gajah | 25 Sept 2012 | 15:05 | 29.2 | 9.08 | |
| | | 09 Oct 2012 | 08:30 | 27.2 | 8.89 | |
| | | 18 Oct 2012 | 09:15 | 28.7 | 8.86 | |
| | | | | | 8.94 | ±0.09 |
| **7** | UTP | 28 Sept 2012 | 08:20 | 29.2 | 8.02 | |
| | | 09 Oct 2012 | 12:00 | 28.1 | 7.74 | |
| | | 18 Oct 2012 | 08:00 | 27.9 | 7.95 | |
| | | | | | 7.90 | ±0.11 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **8** | Ipoh | 21 Sept 2012 | 10:00 | 27.8 | 7.13 | |
| | | 11 Oct 2012 | 17.30 | 28.3 | 7.29 | |
| | | 23 Oct 2012 | 17.20 | 29.2 | 7.15 | |
| | | | | | 7.19 | ±0.07 |
| **9** | Mineral Water | 28 Sept 2012 | 08:30 | 26.8 | 7.72 | |
| | | 09 Oct 2012 | 12:10 | 27.3 | 7.69 | |
| | | 18 Oct 2012 | 08:30 | 28.5 | 7.71 | |
| | | | | | 7.71 | ±0.01 |
| **10** | R.O Water (Taman Maju) | 28 Sept 2012 | 08:45 | 27.6 | 7.02 | |
| | | 09 Oct 2012 | 11:40 | 27.7 | 7.24 | |
| | | 18 Oct 2012 | 10:35 | 28.9 | 7.29 | |
| | | | | | 7.18 | ±0.12 |

Table 5: The measurement of the conductivity of the water samples

| Sample no. | Location | Date | Time | Conductivity ($\mu$S/m) | Standard deviation |
|---|---|---|---|---|---|
| **1** | Bandar U | 25 Sept 2012 | 16:25 | 55.4 | |
| | | 09 Oct 2012 | 11:15 | 69.1 | |
| | | 18 Oct 2012 | 10:04 | 72.2 | |
| | | | | 65.57 | ±7.30 |
| **2** | Seri Iskandar | 25 Sept 2012 | 16:45 | 38.9 | |
| | | 09 Oct 2012 | 11:45 | 57.8 | |
| | | 18 Oct 2012 | 10:20 | 51.6 | |
| | | | | 49.43 | ±5.32 |
| **3** | Siputeh | 25 Sept 2012 | 15:30 | 55.4 | |
| | | 09 Oct 2012 | 09:30 | 67.2 | |
| | | 18 Oct 2012 | 16.15 | 64.5 | |
| | | | | 62.37 | ±5.05 |
| **4** | Tronoh | 25 Sept 2012 | 15:42 | 56.1 | |
| | | 09 Oct 2012 | 09:47 | 66.9 | |
| | | 18 Oct 2012 | 16:30 | 67.4 | |
| | | | | 63.46 | ±5.21 |
| **5** | Taman Maju | 25 Sept 2012 | 16:00 | 40.8 | |
| | | 09 Oct 2012 | 11:35 | 55.5 | |
| | | 18 Oct 2012 | 10.30 | 64.3 | |
| | | | | 53.53 | ±9.69 |
| **6** | Batu Gajah | 25 Sept 2012 | 15:05 | 60.8 | |
| | | 09 Oct 2012 | 08:30 | 74.5 | |
| | | 18 Oct 2012 | 09:15 | 72.2 | |
| | | | | 69.17 | ±5.99 |
| **7** | UTP | 28 Sept 2012 | 08:20 | 47.7 | |
| | | 09 Oct 2012 | 12:00 | 60.3 | |
| | | 18 Oct 2012 | 08:00 | 59.3 | |
| | | | | 55.77 | ±5.72 |
| **8** | Ipoh | 21 Sept 2012 | 10:00 | 50.6 | |
| | | 11 Oct 2012 | 17.30 | 62.9 | |
| | | 23 Oct 2012 | 17.20 | 64.3 | |
| | | | | 59.27 | ±6.15 |
| **9** | Mineral Water | 28 Sept 2012 | 08:30 | 135.4 | |
| | | 09 Oct 2012 | 12:10 | 158.9 | |
| | | 18 Oct 2012 | 08:30 | 142.7 | |
| | | | | 146.67 | ±9.82 |
| **10** | R.O Water (Taman Maju) | 28 Sept 2012 | 08:45 | 25.3 | |
| | | 09 Oct 2012 | 11:40 | 52.7 | |
| | | 18 Oct 2012 | 10:35 | 54.3 | |
| | | | | 44.10 | ±13.31 |

4.1. 2 Experimental Analysis Result

4.1.2.1 Turbidity

Table 6: The measurement of the turbidity of the water samples

| Sample no. | Location | Date | Time | Temp (°C) | Turbidity (NTU) | Standard deviation |
|---|---|---|---|---|---|---|
| **1** | Bandar U | 25 Sept 2012 | 16:25 | 29.5 | 3.98 | |
| | | 09 Oct 2012 | 11:15 | 28.4 | 2.52 | |
| | | 18 Oct 2012 | 10:04 | 27.9 | 2.87 | |
| | | | | | 3.12 | ±0.62 |
| **2** | Seri Iskandar | 25 Sept 2012 | 16:45 | 28.5 | 4.81 | |
| | | 09 Oct 2012 | 11:45 | 28.7 | 3.98 | |
| | | 18 Oct 2012 | 10:20 | 27.4 | 3.77 | |
| | | | | | 4.18 | ±0.45 |
| **3** | Siputeh | 25 Sept 2012 | 15:30 | 29.3 | 2.23 | |
| | | 09 Oct 2012 | 09:30 | 27.1 | 3.11 | |
| | | 18 Oct 2012 | 16.15 | 29.4 | 2.83 | |
| | | | | | 2.72 | ±0.37 |
| **4** | Tronoh | 25 Sept 2012 | 15:42 | 28.9 | 5.28 | |
| | | 09 Oct 2012 | 09:47 | 27.3 | 4.32 | |
| | | 18 Oct 2012 | 16:30 | 29.1 | 4.21 | |
| | | | | | 4.60 | ±0.48 |
| **5** | Taman Maju | 25 Sept 2012 | 16:00 | 29.1 | 5.14 | |
| | | 09 Oct 2012 | 11:35 | 28.5 | 3.37 | |
| | | 18 Oct 2012 | 10.30 | 28.9 | 3.65 | |
| | | | | | 4.05 | ±0.78 |
| **6** | Batu Gajah | 25 Sept 2012 | 15:05 | 29.2 | 1.74 | |
| | | 09 Oct 2012 | 08:30 | 27.2 | 2.23 | |
| | | 18 Oct 2012 | 09:15 | 28.7 | 2.19 | |
| | | | | | 2.05 | ±0.22 |
| **7** | UTP | 28 Sept 2012 | 08:20 | 29.2 | 3.13 | |
| | | 09 Oct 2012 | 12:00 | 28.1 | 2.64 | |
| | | 18 Oct 2012 | 08:00 | 27.9 | 2.78 | |
| | | | | | 2.85 | ±0.21 |
| **8** | Ipoh | 21 Sept 2012 | 10:00 | 27.8 | 1.44 | |
| | | 11 Oct 2012 | 17.30 | 28.3 | 1.02 | |
| | | 23 Oct 2012 | 17.20 | 29.2 | 1.33 | |
| | | | | | 1.26 | ±0.18 |
| **9** | Mineral Water | 28 Sept 2012 | 08:30 | 26.8 | 0.41 | |
| | | 09 Oct 2012 | 12:10 | 27.3 | 0.48 | |
| | | 18 Oct 2012 | 08:30 | 28.5 | 0.21 | |
| | | | | | 0.37 | ±0.11 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **10** | R.O Water (Taman Maju) | 28 Sept 2012 | 08:45 | 27.6 | 1.76 | |
| | | 09 Oct 2012 | 11:40 | 27.7 | 1.29 | |
| | | 18 Oct 2012 | 10:35 | 28.9 | 1.13 | |
| | | | | | 1.39 | ±0.27 |

4.1.2.2 Result of TSS

Table 7: The measurement of TSS of the water samples

| Sample no. | Location | Before (Empty weight) | After (dry at 103°C) | After – Before (g) | Total Suspended Solids (mg/l) |
|---|---|---|---|---|---|
| **1** | Bandar U | 1.3670 | 1.3679 | 0.0009 | 6.00 |
| **2** | Seri Iskandar | 1.3747 | 1.3749 | 0.0004 | 2.67 |
| **3** | Siputeh | 1.3732 | 1.3739 | 0.0007 | 4.67 |
| **4** | Tronoh | 1.3768 | 1.3751 | 0.0005 | 3.33 |
| **5** | Taman Maju | 1.3654 | 1.3655 | 0.0001 | 0.67 |
| **6** | Batu Gajah | 1.3708 | 1.3720 | 0.0012 | 8.00 |
| **7** | UTP | 1.3750 | 1.3752 | 0.0000 | 0.00 |
| **8** | Ipoh | 1.3684 | 1.3685 | 0.0001 | 0.67 |
| **9** | Mineral Water | 1.3767 | 1.3767 | 0.0000 | 0.00 |
| **10** | R.Osmosis Water (Taman Maju) | 1.3688 | 1.3688 | 0.0000 | 0.0 |

4.1.2.3 Results of TDS

Table 8: The measurement of TDS of the water samples

| Sample no. | Location | Conductivity ($\mu$S/m) | Conductivity (mS/m) | TDS (mg/l) |
|---|---|---|---|---|
| 1 | Bandar U | 65.57 | 6.557 | 42.6205 |
| 2 | Seri Iskandar | 49.43 | 4.943 | 32.1295 |
| 3 | Siputeh | 62.37 | 6.237 | 40.5405 |
| 4 | Tronoh | 63.46 | 6.346 | 41.249 |
| 5 | Taman Maju | 53.53 | 5.353 | 34.7945 |
| 6 | Batu Gajah | 69.17 | 6.917 | 44.9605 |
| 7 | UTP | 55.77 | 5.577 | 36.2505 |
| 8 | Ipoh | 59.27 | 5.927 | 38.5255 |
| 9 | Mineral Water | 146.67 | 14.667 | 95.3355 |
| 10 | Osmosis Water (Taman Maju) | 44.1 | 4.41 | 28.665 |

4.1.2.4 Result of heavy metals concentration (mg/l)

Table 8: The measurement of the heavy metals concentrations in the water samples

| **Sample no.** | **Location** | **Copper (Cu) Conc.** | **Magnesium (Mg) Conc.** | **Zinc (Zn) Conc.** | **Iron (Fe) Conc.** |
|---|---|---|---|---|---|
| **1** | Bandar U | 0.001 | 0.1522 | 0.004 | 0.045 |
| **2** | Seri Iskandar | 0.000 | 0.2889 | 0.005 | 0.032 |
| **3** | Siputeh | 0.001 | 0.1192 | 0.002 | 0.070 |
| **4** | Tronoh | 0.001 | 0.2138 | 0.001 | 0.067 |
| **5** | Taman Maju | 0.002 | 0.1416 | 0.002 | 0.053 |
| **6** | Batu Gajah | 0.000 | 0.5121 | 0.002 | 0.012 |
| **7** | UTP | 0.002 | 0.2113 | 0.004 | 0.048 |
| **8** | Ipoh | 0.001 | 0.3105 | 0.001 | 0.032 |
| **9** | Mineral Water | 0.000 | 0.1906 | 0.277 | 0.000 |
| **10** | Osmosis Water (Taman Maju) | 0.000 | 0.3732 | 0.008 | 0.000 |

## 4.2 DISCUSSION

### 4.2.1 National Drinking Water Quality Standard

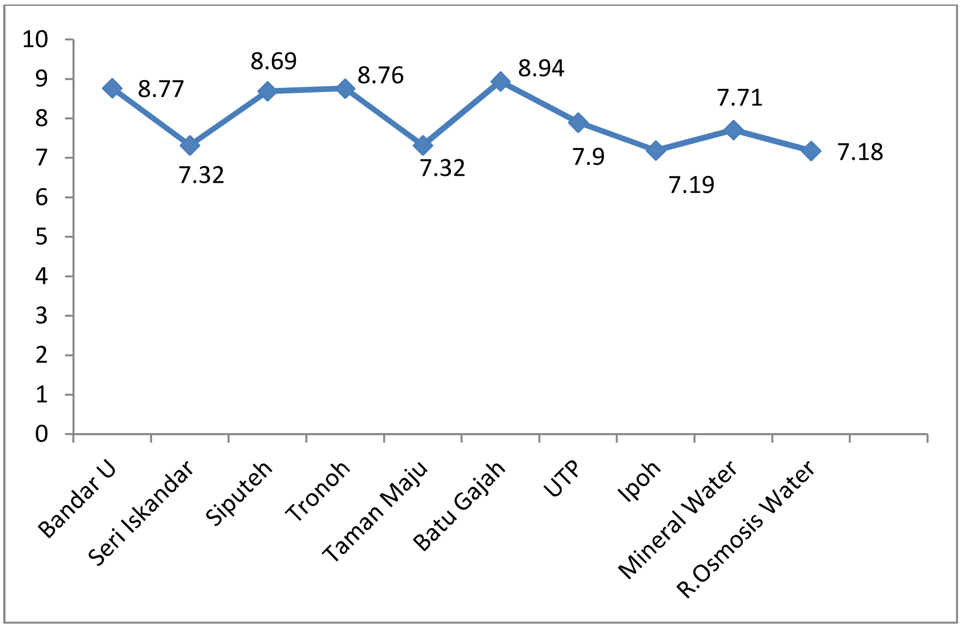
Below is the National Drinking Quality Standard and World Health Organization Standard which being compared to the results.

Table 8: National Drinking Water Quality Standard (National Drinking Water Quality Standard, 2004) and World Health Organization (WHO, 2003) Organization Standard

| PARAMETERS | UNIT | MNDWQS | WHO |
|---|---|---|---|
| pH | - | 6.5-8.5 | 6.5-8.5 |
| Elec. Conductivity | $\mu$S/m | 1000 | 1000 |
| Total Suspended Solid | mg/l | 25 | 25 |
| Total Dissolved Solid | mg/l | 500 | 500 |
| Temperature | °C | - | - |
| Turbidity | NTU | 5 | - |
| Copper | mg/l | 1.0 | 2.0 |
| Lead | mg/l | 0.05 | 0.01 |
| Magnesium | mg/l | 150 | 150 |
| Zinc | mg/l | 5 | 3 |
| Iron | mg/l | 0.3 | 0.5 |
| Mercury | mg/l | 0.001 | 0.001 |
| Arsenic | mg/l | 0.05 | 0.01 |

4.2.2 pH

Figure 4: The measured pH values of the water samples



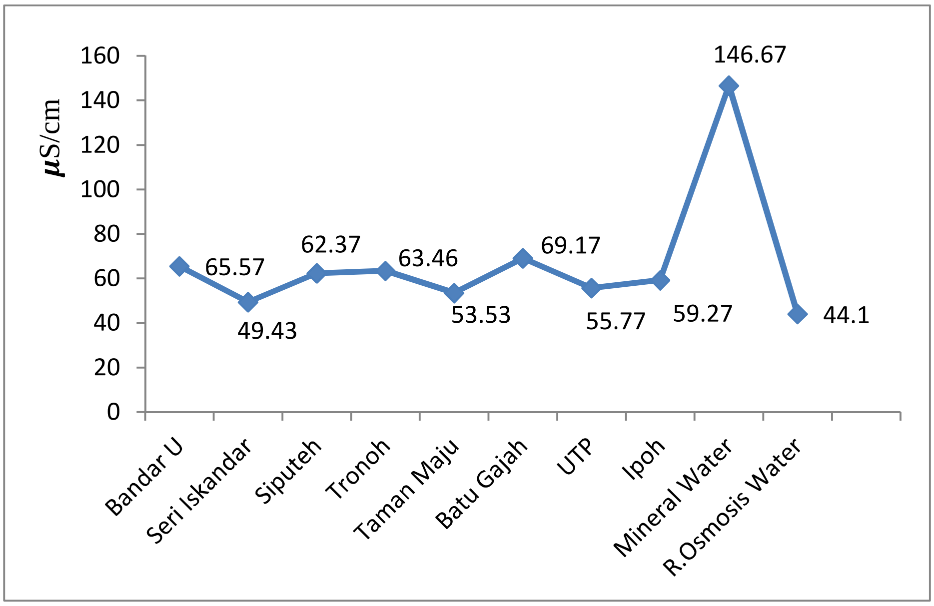

The pH values of the water samples is measured using pH meter *(model HI 98130 HANNA, Mauritius, Iramac Sdn. Bhd*). Referring to WHO standard, the pH value is a measure of measuring the alkalinity or acidity concentration in water. It is also to measure the corrosiveness of water. According to NDWQS and WHO, the standard of drinking water quality on pH base lies within the range of 6.5 to 8.5. When the pH value is below 7.0, water tends to be corrosive and can damage metal pipes carrying the water. Water is much less corrosive if the pH is between 7.0 and 8.5.

The pH value of water samples ranges from 7.19 to 8.94. Four samples of drinking water show above the standard limit. It shows the samples are indicates slightly alkaline. Sample from Ipoh has the lowest pH meanwhile sample from Batu Gajah has the highest value.

The value of pH usually has no direct impact on water consumers; however, it is one of the most important operational water-quality parameters. Thus, careful attention to pH control is necessary especially in water treatment to ensure satisfactory water clarification and disinfection. For effective disinfection with chlorine, the pH should preferably be less than 8. The pH of the water entering the distribution system must be controlled to minimize the corrosion of water mains and pipes in household water systems. It can result in the contamination of drinking-water and in adverse effects on its taste, odour, and appearance.

### 4.2.3 Conductivity

Figure 5: The measured conductivity values of the water samples




The conductivity of the water samples is measured using conductivity meter (*model HI 98130 HANNA, Mauritius, Iramac Sdn. Bhd*). Conductivity is the ability to conduct electricity and water can conduct electricity as it contains dissolved solids that carry charges. For example, chloride, nitrate and sulfate carry negative charges while sodium carries positive charges. These dissolved solid affect the ability of water to conduct electricity. Thus, indirectly measuring of conductivity indicates the amounts of total dissolved solid in water. Electrical conductivity is measured in microsiemens per centimeter (uS/cm).

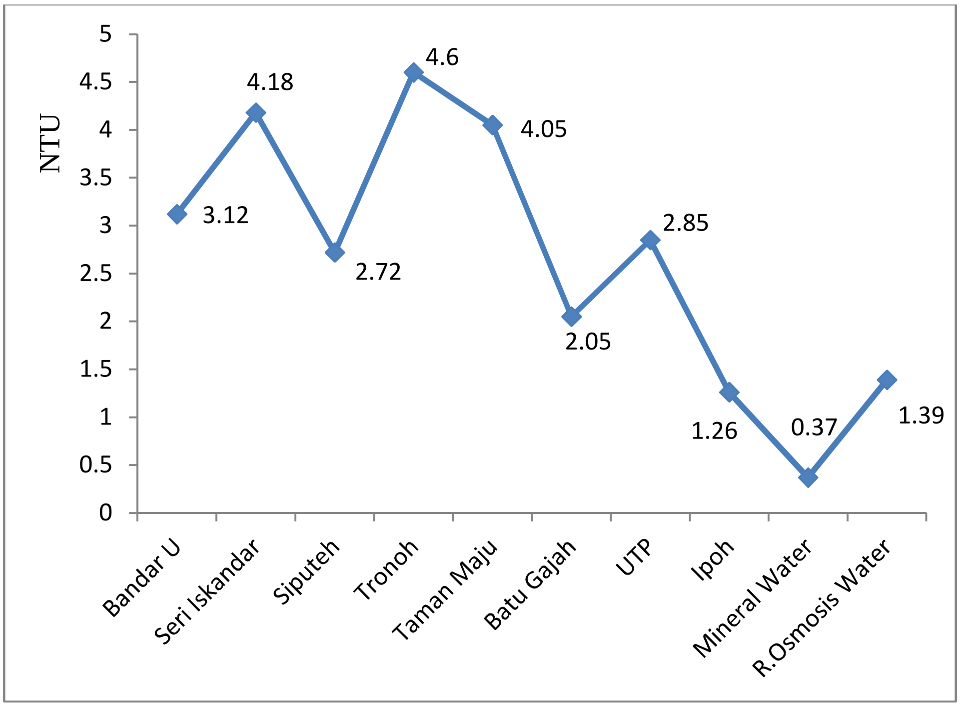
According to NDWQS and WHO, the maximum allowable of conductivity is 1000 $\mu$S/cm. From the above figure, it is shows that the mean conductivity of the sample is found to be 66.93$\mu$S/cm. The maximum value of the conductivity value is 146.67$\mu$S/cm which is mineral water sample. This sample has the highest value of conductivity because it contain higher mineral and dissolved solid. Reverse osmosis water found to be has the lowest value which is 44.1$\mu$S/cm. It can be explained as reverse osmosis is one of the water treatments used to remove dissolve solid. Thus, it is right for the conductivity in the reverse osmosis sample is to be low.

The range of good drinking water for humans is within the range 0-1000$\mu$S/cm. Within this range, there is no organic pollution and also not having too much of clay materials. It is also suitable for all livestock (Anwar. K *et al*, 2011). For the range between 2500- 10,000$\mu$S/cm, the water is not recommended for human consumption and irrigation. The conductivity of over 10,000$\mu$S/cm is not suitable for human consumption and irrigation as it contains unacceptable concentrations of particular ions.

From the above result, it shows that all samples are within the allowable limits. Thus, it can be said that the conductivity of water samples is in the range of good drinking water.

### 4.2.4 Turbidity

Figure 6: The measured turbidity of the water samples

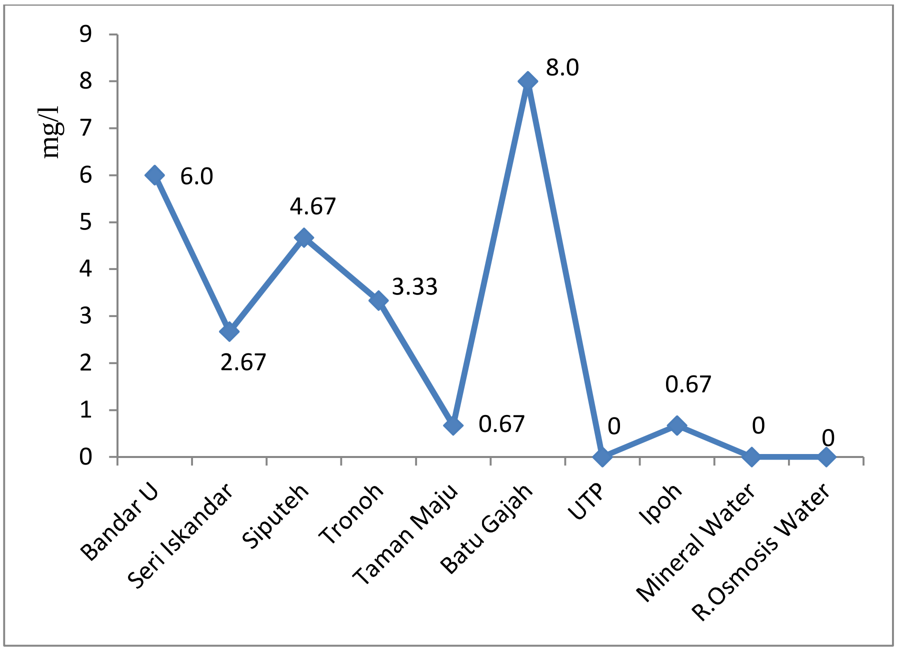


The turbidity of the water samples is measured using turbidity meter (*model 2100PTurbidimeter HACH, Colombia USA, Arachem (M) Sdn Bhd*). Measuring turbidity is important because its effect both the acceptability of water to consumers. The standard allowable turbidity limit set by NDWQS is must not exceeding 5 NTU. Turbidity is determined as soon as possible after the sample is taken.

The results in above figure reflect that the mean turbidity for the samples is 2.66NTU. All the samples are within the standard value of turbidity. The highest value of turbidity is sample from Tronoh which is 4.6NTU meanwhile the lowest is sample from mineral water which is 0.37NTU. Mineral water has the lowest turbidity as it is the cleanest water taken from nature. There are few samples which have higher value of turbidity but still in the allowable limit. It is found because the turbidity is not determined directly after the sample is taken. The turbidity measurement is taken out at the laboratory and the samples have been cool to 4°C to minimize the microbiological decomposition of solid. It is slightly affect the actual measurement of turbidity value.

### 4.2.5 TSS

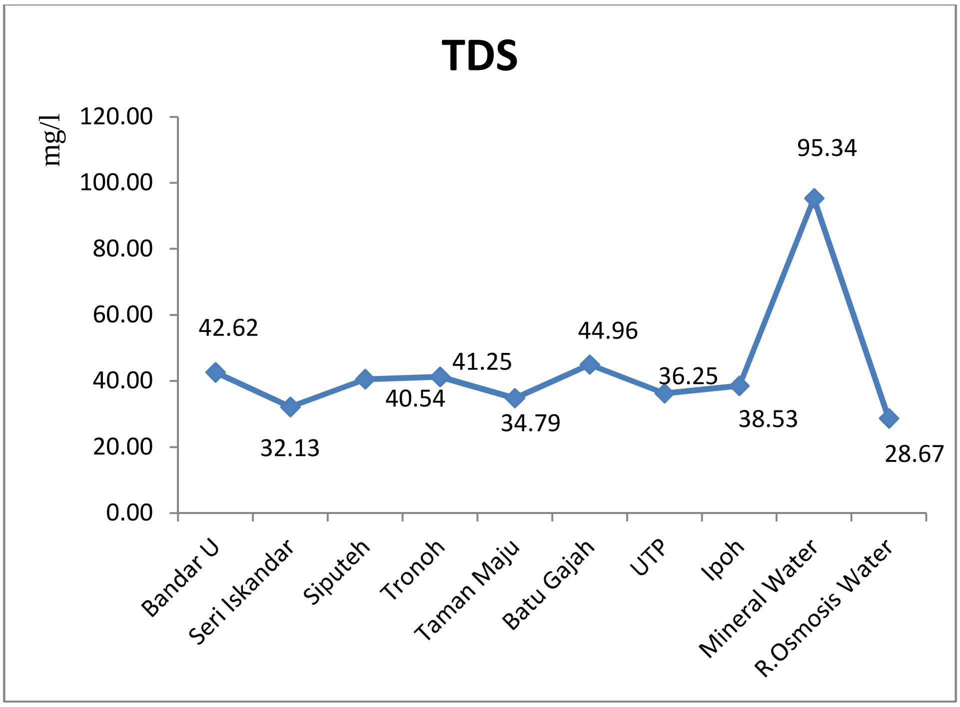
Figure 7: The measured TSS of the water samples



Total Suspended Solid set by NDWQS and WHO is at 25mg/l. From the above figure, all the samples are within the permissible standard value. It is found that in three samples, there no suspended solid in the sample. It shows that the samples are clean from any suspended particles such as silt, clay and inorganic particles. The TSS mean for all samples is 2.6 mg/l. The highest value of TSS is from Batu Gajah which is 8mg/l. All samples show lower value of TSS because each house where the samples are taken is used filter at water pipe nozzle. Thus, it prevents the suspended solid from having in their water.

### 4.2.6 TDS

Figure 8: The measured TDS of the water samples




The standard or allowable value of TDS set by NDWQS and WHO is 500mg/l. From the above figure, the highest TDS value is mineral water which is 95.54mg/l and the lowest TDS is RO water which is 28.67mg/l. The sample from mineral water is having higher TDS because it contains higher dissolved solid and minerals. The lowest TDS value from RO water can be explain as reverse osmosis treatment is a process of removing dissolved solid in water. Thus, it is right for RO water to have lowest value of TDS. The mean value of TDS for all samples is 66.93mg/l. It is shows that the value of TDS in all sample is within the allowable value set by NDWQS.

### 4.2.7 Heavy Metal Concentration

Figure 9: The measured Cu concentration of the water samples

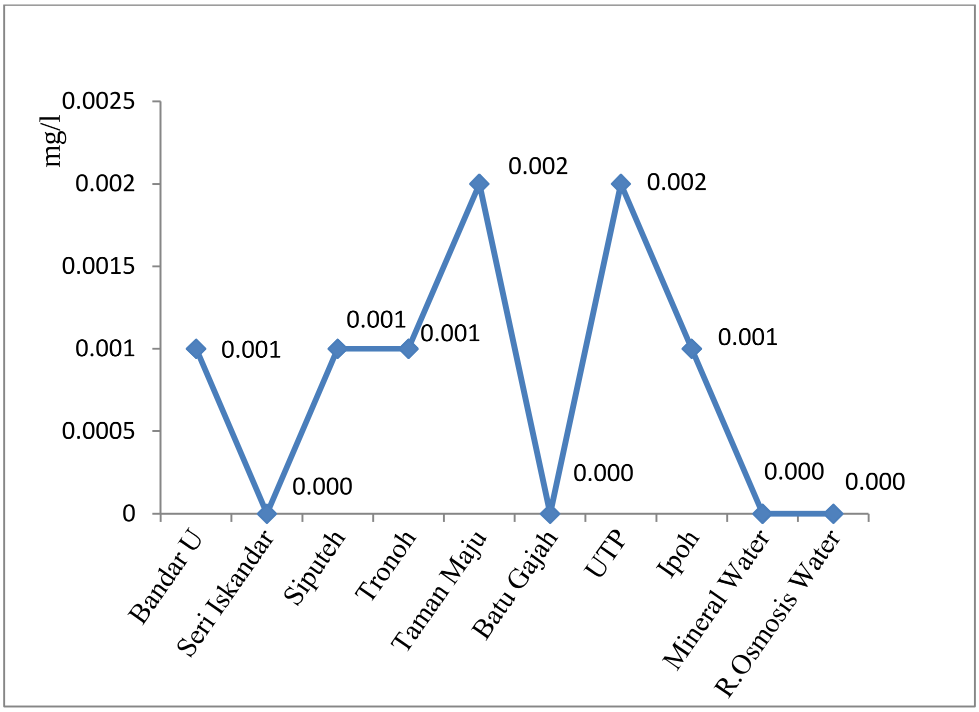



Figure 10: The measured Zn concentration of the water samples

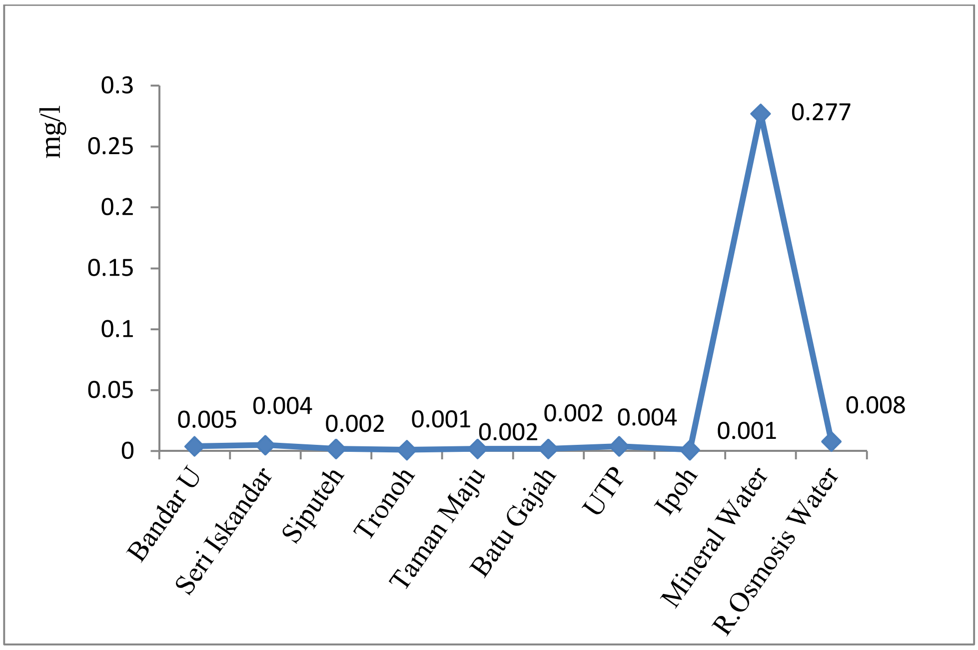


Figure 11: The measured Mg concentration of the water samples

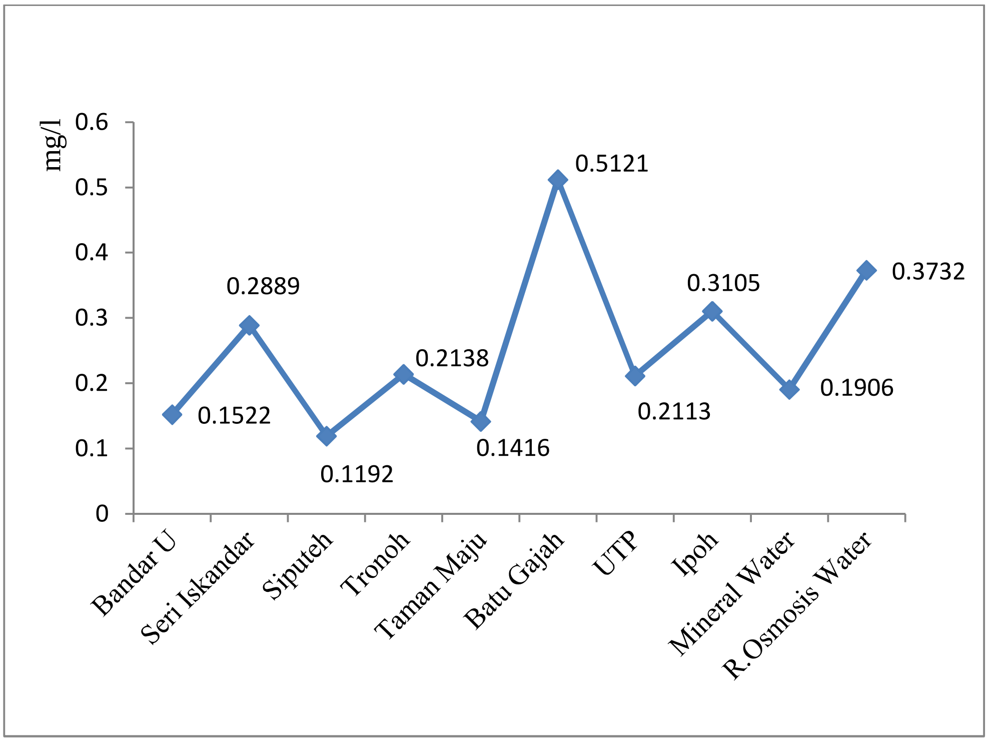
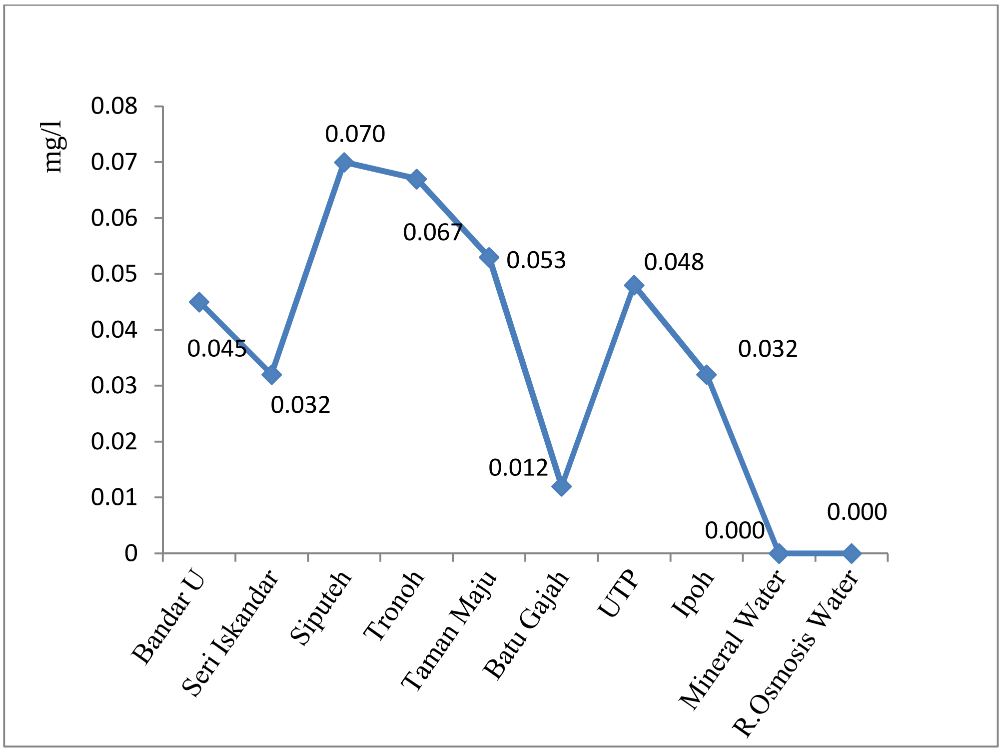



Figure 12: The measured Fe concentration of the water samples



The heavy metals analysis for the water samples is analyst using Flame Atomic Absorption Spectrometer (*Perkin Elmer Aanalyst 400, California USA*). From the figure of Cu, Zn, Fe and Mg concentrations, all the samples show the result below the allowable limit of heavy metals set by NDWQS and WHO.

From figure 9, all samples show no concentration of copper inside the sample. Although the sample shows value about 0.001 to 0.002 mg/l, the relative standard deviation of the samples shows higher than 5%. This indicates that the data show the value for noise interference only and not the concentration level of Cu in the samples. If the relative standard deviation show below than 5%, it indicate that there are less error in analyzing result and the result can be accepted. Thus, there are no copper concentrations in all samples. The limit of Cu concentration set by NDWQS is 1.0mg/l and WHO is 2mg/l.

From figure 10, the highest values of Zn concentration are from sample 9 which is mineral water 0.277mg/l. Apart from this sample, all samples show low values of concentration. The result for Zn concentration in sample no 10 and no 5 shows relative standard deviation below than 5%. This indicates that there are small amount of Zn concentration in the samples. Other than these samples, all show relative standard deviation higher than 5% which indicate no Zn concentration in samples. The Zn concentration's limit set by NDWQS is 5.0mg/l and WHO is 3mg/l. All samples are within the standard value of Zn concentration.

From figure 11, the mean Mg concentration of the samples is 0.2516mg/l. The highest concentration of Mg is in Batu Gajah sample which is 0.5121mg/l. the lowest concentration is in Siputeh water sample which is 0.1192mg/l. From the result, it shows that the concentrations in all water samples are below the allowable Mg concentration set by NDWQS and WHO which is 150mg/l.

From figure 12, the highest value for Fe concentration is showed by sample 3, Siputeh which is 0.07mg/l. The mean Fe concentration for all samples is 0.0359mg/l. The result for samples no 9, 10 and 6 show relative standard deviation higher than 5%. These indicate the data is noise interference and cannot be consider as the exact value for Fe concentration. Apart from these samples, all show relative standard deviation less than 5% which the data can be indicate the right concentration of Fe in the water samples.  The allowable limit set by the NDWQS is 0.3mg/l and WHO is 0.5mg/l. Thus, all samples are within the limit.

The analyses of heavy metals for Mercury, Arsenic and Lead also have been done using AAS. Unfortunately, the result shows error which the AAS cannot read the concentration of these heavy metals in the samples. This is due to the very low concentration of heavy metals in the water samples which below the range of the detection limit of AAS. Thus, from the result reported above, it is right to say that the heavy metals concentrations for all samples are within the limit set by NDWQS.

# CHAPTER V

# CONCLUSION

This study shows that the pH concentration for almost water samples is within the range of NDWQ and WHO standard except a few samples that show slightly alkaline. For the conductivity, turbidity, TDS and TSS, the water samples are also within the allowable standard set by NDWQS and WHO, and it is in the range of safe drinking water conditions. The concentrations of heavy metals (Cu, Fe, Zn, and Mg) are below the allowable limit. The water samples are analyzed in order to ensure its parameter value is following drinking water standard. Thus, it can be said that the entire water sample is within the safety level range set by NDWQS and WHO.

## RECOMMENDATIONS

1. For analyzing of heavy metals, it is recommended using other equipment such as Inductively Coupled Plasma as it can detect the concentration in very low concentration up to higher concentration. It is also can detect many different metals element at a time. It is differ from AAS that only can detect one metal at a time.

2. It is recommended to further this study in determine others heavy metals such as cyanide, chromium, silver and etc besides the heavy metals that have been analyze to measure their concentration in the water.

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# APPENDIX I

1.1 The procedure for Total Suspended Solid

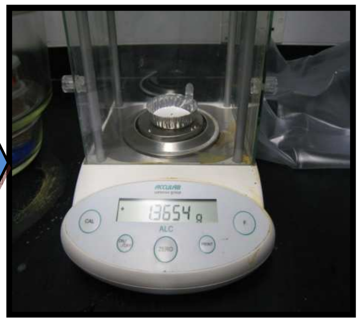
Obtain the weight of empty filter paper and dish

Place filter paper (47mm) on the apparatus

Put samples and start the pump

Dry the filter paper with the dish in the oven at 103°C for an hour

Place in the desiccator



Weight the filter paper and record

# APPENDIX II

1.2 The procedure for analyzing heavy metals using AAS

Prepare the samples and the standard solutions

Run the analysis using Flame AAS

Take the data

1.3 The procedure for measuring turbidity

Put water sample in the standard turbidity bottle

Place the bottle in the turbid meter

Press enter to read the measurement and record the data.

# APPENDIX III

1.4 WHO's drinking water standards 1993

WHO's Guidelines for Drinking-water Quality, set up in Geneva, 1993 are the international reference point for standard setting and drinking-water safety.

| **Element/ substance** | **Symbol/ formula** | **Normally found in fresh water/surface water/ground water** | **Health based guideline by the WHO** |
|---|---|---|---|
| Aluminium | Al | | 0,2 mg/l |
| Antimony | Sb | < 4 μg/l | 0.005 mg/l |
| Arsenic | As | | 0,01 mg/l |
| Barium | Ba | | 0,3 mg/l |
| Boron | B | < 1 mg/l | 0,3 mg/l |
| Cadmium | Cd | < 1 μg/l | 0,003 mg/l |
| Chloride | Cl | | 250 mg/l |
| Chromium | $Cr^{+3}$, $Cr^{+6}$ | < 2 μg/l | 0,05 mg/l |
| Copper | Cu | | 2 mg/l |
| Cyanide | $CN^-$ | | 0,07 mg/l |
| Fluoride | F | < 1,5 mg/l (up to 10) | 1,5 mg/l |
| Lead | Pb | | 0,01 mg/l |
| Manganese | Mn | | 0,5 mg/l |
| Mercury | Hg | < 0,5 μg/l | 0,001 mg/l |
| Nickel | Ni | < 0,02 mg/l | 0,02 mg/l |
| Sodium | Na | < 20 mg/l | 200 mg/l |
| Sulfate | $SO_4$ | | 500 mg/l |
| Zinc | Zn | | 3mg/l |

# APPENDIX IV

1.5 NATIONAL WATER QUALITY STANDARDS FOR MALAYSIA

| PARAMETERS | UNIT | CLASSES | | | | | |
|---|---|---|---|---|---|---|---|
| | | I | IIA | IIB | III | IV | V |
| Ammoniacal Nitrogen | mg/l | 0.1 | 0.3 | 0.3 | 0.9 | 2.7 | ›2.7 |
| BOD | mg/l | 1 | 3 | 3 | 6 | 12 | ›12 |
| COD | mg/l | 10 | 25 | 25 | 50 | 100 | ›100 |
| DO | mg/l | 7 | 5-7 | 5-7 | 3-5 | ‹3 | ‹1 |
| pH | | 6.5-8.5 | 6-9 | 6-9 | 5-9 | 5-9 | - |
| Colour | TCU | 15 | 150 | 150 | - | - | - |
| Elec. Conductivity* | umhos/cm | 1000 | 1000 | - | - | 6000 | - |
| Salinity (%) | % | 0.5 | 1 | - | - | 2 | - |
| Total Dissolved Solid | mg/l | 500 | 1000 | - | - | 4000 | - |
| Total Suspended Solid | mg/l | 25 | 50 | 50 | 150 | 300 | 300 |
| Temperature (C) | °C | - | Normal +2°C | [] @ | Normal +2°C | - | - |
| Turbidity (NTU) | NTU | 5 | 50 | 50 | - | - | - |
| Faecal Coliform ** | counts/100mL | 10 | 100 | 400 | 5000 (20000)[a] | 5000 (20000)[a] | - |
| Total Coliform | counts/100mL | 100 | 5000 | 5000 | 50000 | 50000 | ›50000 |

| Notes | | |
|---|---|---|
| N | : | No visible floatable materials or debris or No objectionable odour, or No objectionable taste |
| * | : | Related parameters, only one recommended for use |
| ** | : | Geometric mean |
| A | : | maximum not to be exceeded |