STUDY C... ...ANDAN,

KAUNTAN, PAHANG.

NAIMAH MARDHYYAH BINTI CHE MAT

Report submitted in partial fulfilment of

the requirements for the award of .the degree of

Bachelor of Civil Engineering

Faculty of Civil Engineering

Universiti Malaysia Pahang

JUNE 2012

ABSTRACT

Sungai (Sg.) Pandan is a one of the recreational area in Pahang where it always full with visitors from various places. Study has been carried out in order to identify the water quality and it suitability as raw drinking water of Sg. Pandan at Panching area. This water quality study was conducted to determine and to analyze some of water quality parameter that had been chosen (temperature, pH, dissolved oxygen, turbidity, total coliform, hardness, biological oxygen demand, chemical oxygen demand, nitrate and total suspended solid). All the parameters involve were compared to the Interim National Water Quality Standard (INWQS) and National Guidelines for Raw Drinking Water Quality provided by the Department of Environment (DOE). From the results, all parameters except BOD was compared to INWQS and classified as CLASS IIB. The BOD value was higher than the standard limit and classified as CLASS IV. From the results, the water can be used as a raw source after being treated.

ABSTRAK

Sebagaimana yang di ketahui, Sg. Pandan adalah sebuah kawasan rekreasi yang terletak di Panching dan is sering di kunjungi oleh ramai pengunjung samada dari dalam dan luar negara. Kajian telah dijalankan di Sg. Pandan bagi mengenalpasti tahap kualiti air dan juga kesesuaian sebagai sumber air mentah. Oleh itu, kajian ini lebih memfokus untuk mengenalpasti tahap kualiti air sungai dan kesusuaiannya sebagai sumber air mentah berdasarkan beberapa parameter yang telah dipilih untuk kajian ini (suhu, pH, oksigen terlarut (DO), kekeruhan, jumlah coliform, kekerasan, permintaan oksigen biokimia (BOD), permintaan oksigen kimia (COD), Nitrogen Nitrat dan pepejal terampai (TSS). Kesemua parameter tersebut kemudiannya dibandingkan dengan piawaian yang telah diwujudkan oleh Jabatan Alam Sekitar iaitu Kualiti Piawaian Air Kebangsaan (INWQS) dan Garis Panduan Kebangsaan bagi Kualiti Air Minuman Mentah. Daripada data yang diperoleh, semua parameter yang terlibat dibandingkan dengan standard piawai dan mematuhi piawaian KEIAS IIB kecuali BOD. Nilai BOD yang diperoleh melebihi limit yanf telah di tetapkan dan di kelaskan di dalam KELAS IV. Hasil daripada kajian yang diperoleh, air daripada Sg. Pandan boleh digunapakai sebagai sumber air mentah setelah di rawat.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVATIONS

BOD	Biologycal Oxygen Demand
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
DOE	Department of Environment
INWQS	Interim National Water Quality Standard
MANCID	Malysian National Committee for Irrigation and Drainage
MWA	Malaysian Water Associasion
MWP	Malaysian Water Partnership
NOM	Natural Organic Matter
TSS	Total Suspended Solid
USGS	U.S Geological Survey
WWF	World Wide Fund for Nature

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Earth is called the 'water planet'. More water than land covers the earth's surface. Water is made up of tiny part called atoms. Atoms join together to form molecules. A water molecule contains of one oxygen (O) and two hydrogen (H) that connected by covalent bond. It also often called as H_2O. Water can be found in nature as a liquid, a gas and a solid. Water changes from one form to another as the temperature rise and falls (Olien, 2005).

Water covers 70% of the earth surfaces and is vital for all known form of life. On Earth, 96.5% of the planet water is found in the ocean, 1.7% in groundwater, 1.7% in glacier and the ice cap, and 0.001% in the air as vapour, clouds and precipitation. Only 25% of the Earth water is freshwater and 98.8% of the water is in the ice and groundwater. Less than 0.3% of freshwater is in river, lakes and the atmosphere. Smaller amount of the Earth freshwater (0.003%) is contain within the biological bodies and manufactured products.

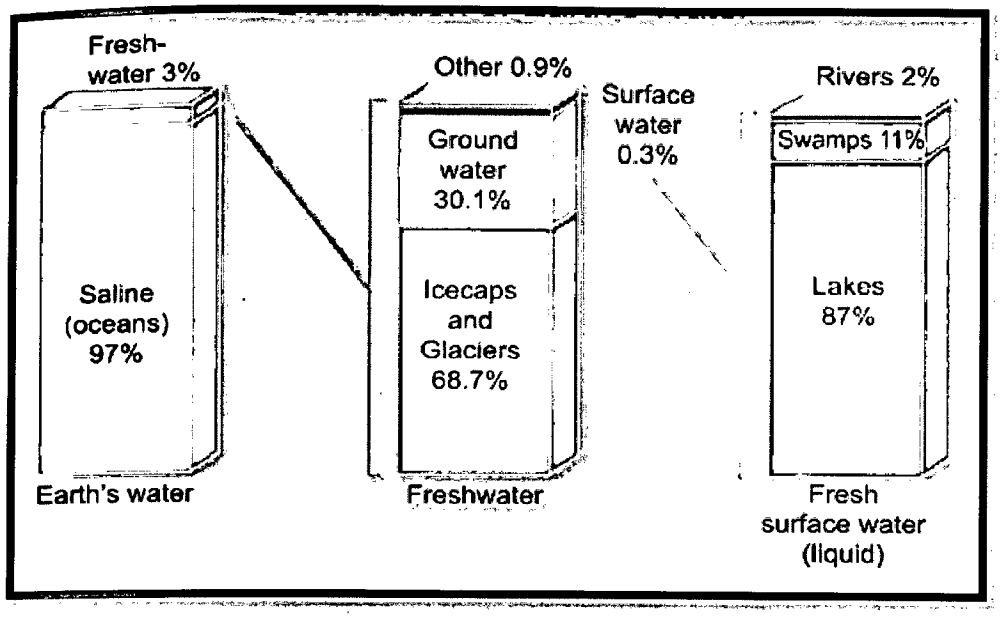

Figure 1.1: Distribution of Earth's water (Source: Gleick, 1993)

Similar to Earth, human body also mostly made up by water. The human body is contains of 69% of water, brain is 85%, bones 35%, blood 83% and liver 95% of water (McCauley, 2008). Water is the most essential elements to good health as it is necessary for the digestion and absorption of food, helps to maintain the body muscles, supplies oxygen and nutrients to the body cells, and rids the body waste and serve as the natural air conditioning system. A human can survive for a month or more without any food but can only last for a week or so without drinking water.

The most important usage of water is for drinking. Nowadays, people are more concern about the quality of water they drink. Although 70% of Earth is covers with water, but only 1% of the Earth water is available for the drinking water source. Only freshwater is suitable for drinking water purpose. Although many freshwater sources are utilize by humans, some of it are contain with pathogens or disease vectors and cause health problem if the water did not meet the certain standard or quality guidelines.

1.2 Problem Statement

Malaysia is one of the countries that situated at the equator line experience the tropical weather. Water resources in Malaysia are abundant and available throughout the year. They are estimated at 580 km^3 per year that equivalent to 3000 cubic metre and year. In year 1995, total water withdrawal was estimated at 12.5 km^3 or less than 3% of available water resources. 76% of the water was used for agriculture, 11% for the municipal water supply and 13% for industries. Therefore, less than 1% of the available water resources are used for drinking water supply.

Water crisis had been the main issues in Malaysia. The constant growth in the metropolitan area has increases its water needs. During year 1998, the water crisis has occurred that involved three dam that were the main source for the Kuala Lumpur and Selangor area. The dam that involved was Ampang intake, Klang Gates dam and Semenyih Dam. The water levels in the three reservoirs were dropped simultaneously. The crisis occur due to drought that caused by El Nino. The latest news on water crisis was said that Klang Valley would face water crisis at 2014. According to Malaysian Water Association (MWA), Malaysian will face the water problem during the early 2014 due to the habit of wasting and overused water. The average of water consumed by each Malaysian was about 280 litres daily, which is very alarming compared with Singapore's 155 litres, the Philippines' 175 litres and Indonesia's 130 litres per person per day (New Straits Times, 2011).

There were many other alternative for water sources such as well and river. Stream and river with or without impounding reservoirs contribute 98% of the total water used in Malaysia. River flows are irregular and to secure safe yield from surface water source, storage facilities were constructed. Currently there are 47 single purpose and 16 multipurpose dams with a total storage capacity of 25 billion m^3 (Malaysian Water Partnership (MWP) and the Malaysian National Committee for Irrigation and Drainage (MANCID).

Although river is the main surface water supply in Malaysia, but it was heavily polluted by the industries and human itself. According to World Wide Fund for Nature (WWF) Malaysia, river pollution is one of the largest threats in Malaysia. Rivers that contaminated by sewage contain high levels of organic pollutants and they become breeding grounds for harmful bacteria and viruses that may cause either mass die-offs or reduced resistance to diseases and loss of reproductive ability of fish and other aquatic organisms. Sewage pollution also causes outbreaks of water borne diseases such as cholera, typhoid and hepatitis A that are detrimental to human. Due to the heavily polluted river, there were possibilities that Malaysia will face a clean water shortage problem in the future. According to a study done by the Department of Environment (DOE) on 116 rivers nationwide, 10% of these rivers are heavily polluted or dead, 67% are polluted and only 27% are healthy (Bernama, 2006).

1.3 Objectives of Study

To conduct a study, the aim or the ultimate objective of the study should be specified so that the study can be done thoroughly according to its aim. Several objectives have been set which are:

i. To determine the water quality at Sg. Pandan, Panching.
ii. To identify its suitability

1.4 Scope of Study

The study took place in Sg. Pandan, Panching, Kuantan, Pahang. Sg. Pandan also known as Panching Waterfall is a recreational area that located 25km from the centre of the town of Kuantan. Various facilities available at this recreational forest including car park, food stalls, toilets, mosque, family field day, camping sites, rest huts, a swimming-pool bath and a suspension bridge for visitors to feel and see the beautiful rolling facing the waterfall. Other activities also can be done at the Panching Waterfall including bathing, picnic and play, also exercise activities such

as jungle trekking, camping, and family day. All the information and data that required for the testing were based on water sampling, laboratory work and observation.

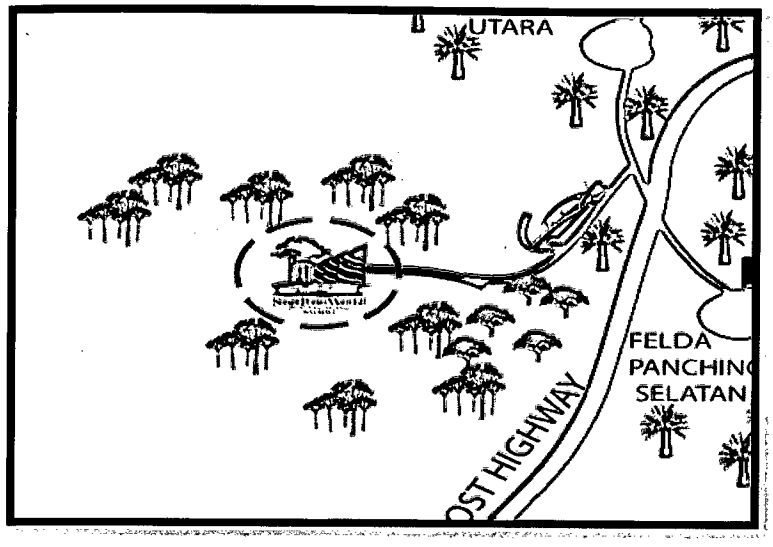

Figure 1.2: Panching illustrated map

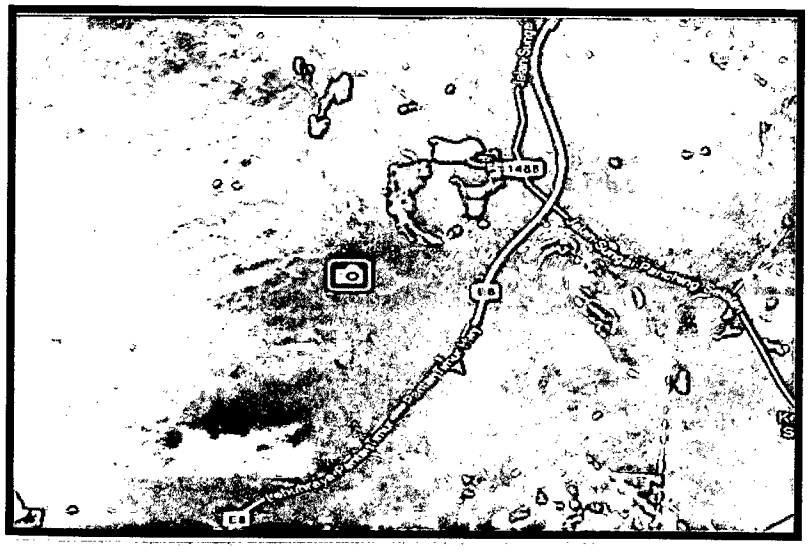

Figure 1.3: Panching location map

1.5 Significant of Study

The significant of study from a case study of water quality at Sg. Pandan, Panching, Kuantan, Pahang is to identify the quality of the water in order to determine its suitability as raw water source.

1.6 Expected Outcome

The expected outcomes from this study are able to determine the water quality of at Sungai Pandan, Panching and also able to identify either the water is safe to be used as raw drinking water source.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, all the information regarding the thesis are briefly discuss and supported with appropriate article review which compromises articles from journals, reference book, e-book and related articles. The topics that discuss in this chapter are hydrological cycles, the river and the water quality.

2.2 Hydrological Cycle

Water is a vital source of life and for centuries, sustainable water management has been daily practise in many cultures, resulting in a delicate balance between water resources and human society. Water also is a source of inspiration, source of power (Reijerkerk and Schelwald-Van der Kley, 2009).

Water covers about 70% of the earth. Clouds form when rises into the air vapour. Waterfalls as rain or snow. Its move and change as part of the water cycle (Olien, 2005). Earth water is always in movement and the natural water cycles also known as hydrological cycles. Its describe the continuous movement of water on, above and below the surface of the Earth. Water can change state among liquid, vapour and ice at various places in the water cycle.

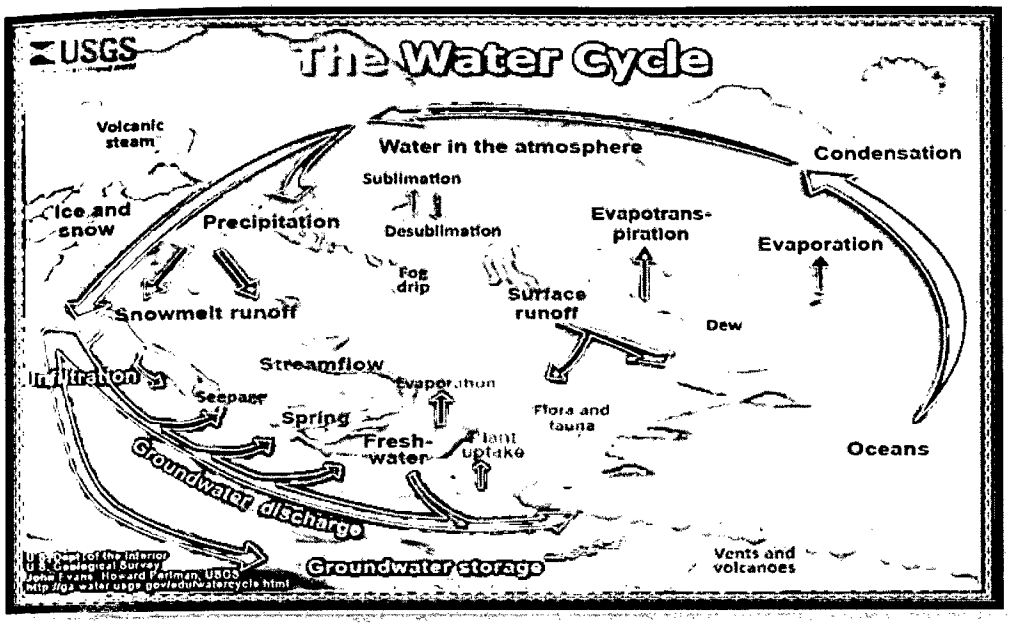

Figure 2.1: Hydrological cycles (Source: USGS)

Highland forests are usually high rainfall area. Precipitation or rain is formed in the highland resulting from the condensation of moisture in the atmosphere. Scientific evidence shows that forest at elevation above 1500m also have the ability to strip the moisture from the wind-blown dust. This function is important especially during low rainfall periods. Forests in the highlands have been likened to a giant sponge that absorbs and accumulates rainwater intercepted by vegetation and the forest floor. Highland forests release water continuously into streams and rivers that flow downstream to coastal areas where they merge with the sea. The sun's energy causes water from the sea and other water bodies to evaporate into water vapour that forms clouds (WWF-Malaysia).

According to WWF-Malaysia, freshwater is perhaps the most crucial resource for humans and all other living creatures on earth. Malaysia receives abundant rainfall averaging 3,000mm annually that contributes to an estimated annual water resource of some 900 billion cubic metres.

2.3 River

River is a natural watercourse usually freshwater, flowing towards an ocean, a lake, a sea or another river. Rivers are part of the hydrological cycle. Water within the rivers is generally collected by the precipitation through a drainage basin from surface runoff and other sources. A river is also surface water that finds its way over land from a higher altitude to lower altitude due to the gravity (USGS).

According to WWF-Malaysia, beside of being the main water source, rivers also contribute to our life in numerous ways. Rivers provide food resources and also the livehood of riverine communities are significantly depending on rivers. Rivers also provide the important habitat and serve as feeding and breeding ground for a wide range or riverine biodiversity that lives in the river. The phrase 'river of life' is not just a word. It has been essential to not only human but also to all life on earth (USGS).

The highland forests are often referred to as natural 'water towers'. This is because most rivers originate from there and a significant amount of water from rainfall is captured and accumulated by these forests. In fact, a large proportion of the river volume originates in the highlands. Among the eight prominent mountain ranges forming Peninsular Malaysia's highland landscapes, the Main Range is the longest and most contiguous. It stretches some 500km across five states - Kelantan, Perak, Pahang, Selangor and Negeri Sembilan. The Main Range is the peninsula's most important catchment area since many of the major rivers supplying freshwater in these five states originate from its forest base. In the East Malaysian states of Sabah and Sarawak, there are at least 18 mountain ranges and isolated mountain areas, all of which perform important roles in providing sources of freshwater supply (WWF-Malaysia).

According to WWF-Malaysia, about 97% of raw water supply for agricultural, domestic and industrial needs are derived from surface water sources primarily rivers. Malaysia has 189 river basins - 89 in Peninsular Malaysia, 78 in

Sabah and 22 in Sarawak. All the rivers originate and flow from the highlands. The highland forests and wetlands (including forested wetlands and water bodies such as river systems) constitute key freshwater ecosystems in the country that deliver a multitude of benefits, from providing natural resources, gene pools, and habitats for flora and fauna, to enabling water purification and flood control.

Although river is the largest source for freshwater, it still cannot avoid the river from being polluted. River pollution is one of the largest threats to the river. The sources of pollution come from domestic and industrial sewerage, effluents from livestock farms, manufacturing and agro-based industries, suspended solids from mining, housing and road construction, logging and clearing of forest and heavy metals from factories (WWF-Malaysia).

Rivers that contaminated by sewage contain high levels of organic pollutants and they become the breeding grounds for harmful bacteria and viruses that may cause either mass die-offs or reduced resistance to diseases and loss of reproductive ability of fish and other aquatic organisms. Sewage pollution also causes outbreaks of water borne diseases such as cholera, typhoid and hepatitis A that are detrimental to human (WWF-Malaysia).

2.4 Water Quality

Water quality refers to the physical, chemical and biological characteristics of water. Water is regarded as high quality when it is safe to drink, that is when it is dissolved and suspended constituents are below the harmful level. It is most frequently used as reference to a set of standard that can be assessed. The most standard water quality used is as reference relate to the health of ecosystem, the safety of human contact and drinking water.

According to the Department of Environment (DOE), 60% of the river in Malaysia was found to be clean, 35% slightly polluted and 5% polluted. As in previous year of monitoring, the major pollutants detected were Biochemical Oxygen

Demand (BOD), Ammoniacal Nitrogen NH_3-N and suspended solid (SS). According to the DOE also, High BOD in the river water can be contributed to the untreated or partially treated sewage.

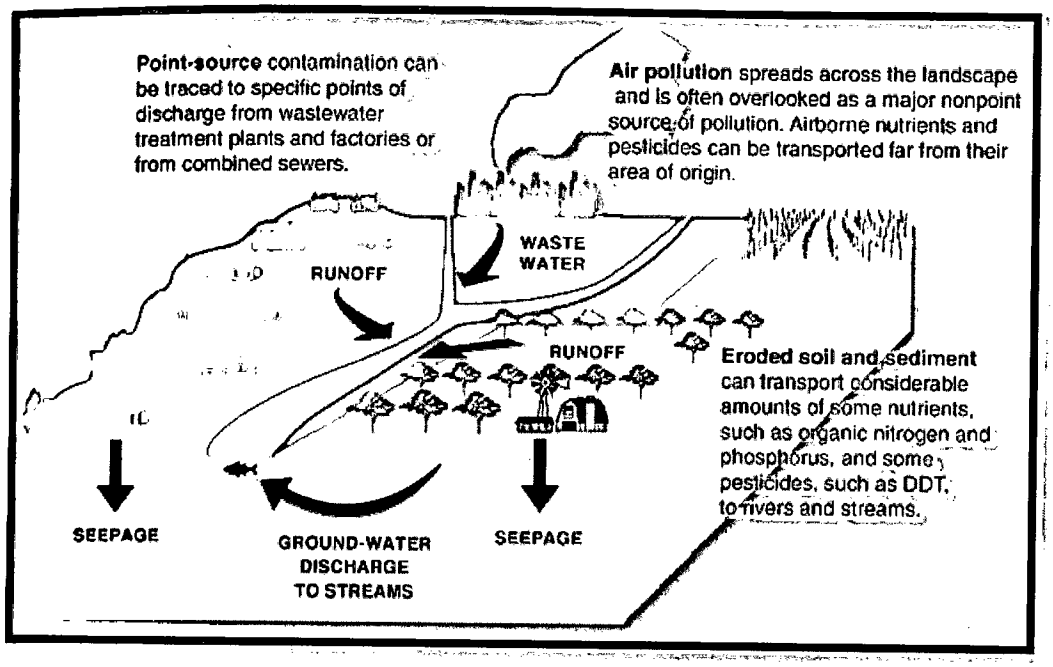

Figure 2.2: Assessment of occurrence that can harm water quality (Source: USGS)

The picture above shows the assessment of chemical occurrence that can harm water quality. The chemical such as pesticides and nutrients in water resources required recognition of complicated interconnection among surface water and ground water, atmospheric contribution, human activities, natural landscape features, and aquatic health.

2.4.1 Water Quality Parameter

Water quality is the physical, chemical and biological characteristic of water. The water quality parameter can be divided into three main groups or characteristics that are physical assessment, chemical assessment and biological assessment.

There are ten parameters choose for this study. The parameters involved are temperature, pH, turbidity, dissolved oxygen (DO), total coliform, hardness, total suspended solid (TSS), chemical oxygen demand (COD), biological oxygen demand (BOD) and nitrogen-nitrate (NO_3^-).

2.4.2 In-Situ Parameter

The In-Situ parameters that has been choose for this study are temperature, pH, dissolve oxygen (DO) and turbidity,

2.4.2.1 Temperature

The temperature of surface water in temperate climates is generally within the range zero to 30 ^{o}C; only occasionally does it exceed 40 ^{o}C. Water temperature depends on many factors such as climatic zone, altitude, air temperature, seasons of the year, the ratio of the water's surface area compared to its depth, input of discharge, flow rate and others.

2.4.2.2 pH

pH is known as measure of the hydrogen ion concentration; pH of 7.0 indicates a neutral solution, pH values smaller than 7.0 indicate acidity, pH values larger than 7.0 indicate alkalinity. Water generally becomes more corrosive with decreasing pH; however, excessively alkaline water also may be corrosive (USEPA, 1994). Surface water usually have pH values between 6.5 and 8.5, and only rarely are outside the range from 4 to 9.the drainage waters from forests and marshes are usually acidic because of the presence of humid and fulvic acids. River waters are usually more alkaline because of the presence of carbonates and hydrogen carbonates.

2.4.2.3 Dissolved Oxygen (DO)

Dissolved oxygen (DO) is of fundamental importance for all chemical and biochemical processes which take place in natural waters. It is indispensable for the life of fish and other aquatic organisms. Oxygen saturation is a relative measure of the amount of oxygen that is dissolved or carried in a given medium. It can be measured with a dissolved oxygen probe such as an oxygen sensor or an optode in liquid media, usually water (Jan R. Dojlido, Gerard A. Best,1993).

2.4.2.4 Turbidity

Turbidity in water is caused by the presence of suspended matter which scatters and absorbs the incoming light. The suspended matter can be of various sizes, from colloidal dispersions to large particles. The turbidity may be caused by various substances such as mineral and soil particles produced by erosion, bottom sediments resuspended by the water current, suspended solids discharged to rivers in domestic sewage, waste water and storm water, and excessive algal growths in the water as a result of the presence of nutrients and sunlight.

2.4.3 Laboratory Parameter

As for the laboratory testing, the parameter that has been choose for the study are total coliform, E.coli, hardness, total suspended solid (TSS), chemical oxygen demand (COD), biological oxygen demand (BOD) and nitrate-nitrogen (NO_3^-).

2.4.3.1 Total Coliform

Total coliform bacteria are commonly found in the environment (e.g. soil or vegetation) and are generally harmless. If only total coliform bacteria are detected in drinking water, the source is probably environmental, and fecal contamination is not

likely. However, if environmental contamination can enter the system, there may be a way for other pathogens to enter the system. Therefore, it is important to determine the source and resolve the problem.

2.3.2.2 E.coli

Subgroup of fecal caliform. Most E.coli are harmless and found in great quantities in the intestines of people and warm-blooded animals. The presence of E.coli in a drinking water sample almost always indicates recent fecal contamination.

2.4.3.3 Hardness

Water's hardness is determined by the concentration of multivalent cations in the water. Multivalent cations are cations (positively charged metal complexes) with a charge greater than 1+. Usually, the cations had the charged of 2+. Common cations found in hard water include Ca^{2+} and Mg^{2+}. These ions enter a water supply by leaching from minerals within aquifer. The following equilibrium reaction describes the dissolving or formation of calcium carbonate scales:

$$CaCo_3 + CO_2 + H_2O \leftrightarrow Ca^{2+} + 2HCO_3^-$$

2.4.3.4 Total Suspended Solid (TSS)

Total suspended solid (TSS) is a water quality parameter and an indication of the amount of erosion that took place nearby or upstream. The series of sediment-induced changes that can occur in a water body may change the composition of an aquatic community. The TSS of water samples is determined by pouring a carefully measured volume of water through a pre-weighed filter of a specified pore size.

2.4.3.5 Chemical Oxygen Demand (COD)

Chemical oxygen demand (COD) measurement is to measure the amount of organic compounds in water. The method used for COD measuring is HACH Method 8000. The test was conducted by using the spectrophotometer and measured in mg/L, which indicates the mass of oxygen consumed per litre of solution.

2.4.3.6 Biological Oxygen Demand (BOD)

Biological oxygen demand (BOD) is the amount of dissolved oxygen needed by aerobic biological organism in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period. The BOD was measured in mg/L.

2.4.3.7 Nitrogen-Nitrate (NO_3^-)

Nitrate (NO_3) is a naturally occurring form of nitrogen found in soil. Nitrogen is essential to all life. The formation of nitrates is an integral part of the nitrogen cycle in our environment. In moderate amounts, nitrate is a harmless constituent of food and water. Plants use nitrates from the soil to satisfy nutrient requirements and may accumulate nitrate in their leaves and stems. Due to its high mobility, nitrate also can leach into groundwater. If people or animals drink water high in nitrate, it may cause methemoglobinemia, an illness found especially in infants.

2.5 Water Quality Standard

The water quality standard can be divided into two different standards as the surface water and the drinking water standard are both used two different standard. For the surface water standard will be based on the Interim National Water Quality