# EVALUATION OF TITIWANGSA LAKE WATER QUALITY FOR AN ALTERNATIVE SOURCES OF WATER SUPPLY

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# EVALUATION OF TITIWANGSA LAKE WATER QUALITY FOR AN ALTERNATIVE SOURCES OF WATER SUPPLY

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Thesis submitted in fulfillment of the requirements
for the award of the
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# ABSTRAK

Tujuan kajian ini adalah untuk menentukan status mutu air semasa Tasik Titiwangsa dan mendapatkan klasifikasi air di tasik berdasarkan Standard Kualiti Air Negara (NWQS) dan Indeks Kualiti Air (WQI). Stesen 1 dan stesen 2 adalah dua stesen yang dipilih untuk tujuan pensampelan. Sejumlah enam belas (16) parameter dianalisis berdasarkan ujian ex-situ (dijalankan di makmal) dan ujian in-situ (dijalankan di tapak uji kaji) di mana sampel diambil pada bulan Februari dan April. Ujian in-situ termasuk suhu, pH, dan oksigen terlarut (DO) sementara ujian ex-situ termasuk jumlah mendakan (TSS), permintaan oksigen kimia (COD), permintaan oksigen biokimia (BOD), ammoniacal itrogen, nitrate, phosphorus, bakteria, Escherichia Coli (E.coli) dan logam berat seperti Cadmium (Cd), Tembaga (Cu), Zink (Zn) dan Lead (Pb). Berdasarkan analisis dan ujian yang dilakukan, Tasik Titiwangsa telah diklasifikasikan sebagai kelas IIB dimana ianya sesuai untuk aktiviti rekreasi berdasarkan Indeks Kualiti Air (WQI). Walau bagaimanapun, terdapat banyak aktiviti yang sedang dijalankan di sekitar tasik Titiwangsa seperti sukan air (kayak), aktiviti rekreasi (berkelah), pertumbuhan alga di tasik dan kawasan penjajaan makanan di sekitar Tasik Titiwangsa boleh menyumbang kepada pencemaran tasik. Tindakan terbaik harus diambil untuk melindungi tasik dari tercemar akibat kegiatan tersebut.

## ABSTRACT

The purposes of the study was to determine the current water quality status of the Titiwangsa Lake and to obtain classification of the water at the lake based on National Water Quality Standard (NWQS) and Water Quality Index (WQI). Station 1 and station 2 were the two station that were selected for the sampling purposes. Total of sixteen (16) parameter were analyzed based on ex-situ test (conduct at the laboratory) and in-situ test (conduct at the sampling site) where the sample were collected on February and April. In-situ test including temperature, pH, turbidity, and dissolved Oxygen (DO) while ex–situ test including Total Suspended Solid (TSS), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Ammoniacal Nitrogen, Nitrate, Phosphorus, Total Coliform Bacteria, Escherichia Coli (E.coli) and Heavy Metal such as Cadmium (Cd), Copper (Cu), Zinc (Zn), and Lead (Pb). Based on the analysis and test that being done, Titiwangsa Lake was classified as Class IIB which is suitable for recreational use and suitable for body contact based on Water Quality Index (WQI) that being calculated. However, there are many activities that being conducted around Titiwangsa Lake such as water sport (kayak), recreational activities (picnic), algae growth in the lake and the food court area around Titiwangsa Lake may contribute to the pollution of the lake. Best action must be taken in order to protect the lake from being polluted due to these activities.

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# LIST OF SYMBOLS

| | |
|---|---|
| °C | Celcius |
| Cd | Cadmium |
| Cu | Copper |
| mg/L | milligram per litre |
| NTU | Nephelometric Turbidity Unit |
| Pb | Plumbum |
| Zn | Zinc |

# LIST OF ABBREVIATIONS

| | |
|---|---|
| BOD | Biochemical Oxygen Demand |
| COD | Chemical Oxygen Demand |
| DO | Dissolved Oxygen |
| DoE | Department of Environment |
| TSS | Total Suspended Solid |
| NWQS | National Water Quality Standard |
| UMP | Universiti Malaysia Pahang |
| WQI | Water Quality Index |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background of the Research

Water is an important element to human life and activities associated with industry, agriculture, and others and it is considers as one of the most delicate parts of the environment. Water are covalent bonding connecting two hydrogen atoms and one oxygen atom (Fawaz Al Badaii, 2013). Water can be found everywhere including lake, stream, river, oceans, and also in nature that form as water vapours, fog, and clouds in the sky but the quality of the water differ. In other words it can be state that different places where water can be found may contain different chemical or condition (Khaled S.A Said, 2012).

Lake either contain both fresh and salt water can be found in variable size where it surrounded by land. There are millions of lakes in the world. In Malaysia, we can found two types of lake, an artificial lake and natural lake. Natural lake including Bera Lake and Chini Lake where both of it located in Pahang and in Perak, we have Chenderoh Lake. While artificial lake were Temenggor Lake in Perak, Kenyir Lake in Terengganu, Timah Tasoh Lake in Perlis, Batang Ai Lake / Logan Bunut Lake in Sarawak and Titiwangsa lake located in Kuala Lumpur (Site, 2001-2018). The lakes have different type of purposes such as recreational use, as a home to various type of protected wildlife, as a catchment area, generate the electricity and also attraction places for tourism.

Titiwangsa Lake, one of the famous artificial lake that become the heart of the city centre of Malaysia, Kuala Lumpur. Titiwangsa Lake that places within the Titiwangsa Lake Garden located just beside Jalan Tun Razak and surrounded by the famous attraction of Kuala Lumpur such as National Art Gallery, National Library and National Theatre or known as Istana Budaya. Back then when Malaysia was under British colony, mining activities were being conduct here before it was being cleaned to construct the scenic Titiwangsa Lake Garden. The total area of the garden was 95 hectares and the lake take about half of the total area of the garden (Titiwangsa Lake Garden, 2012)

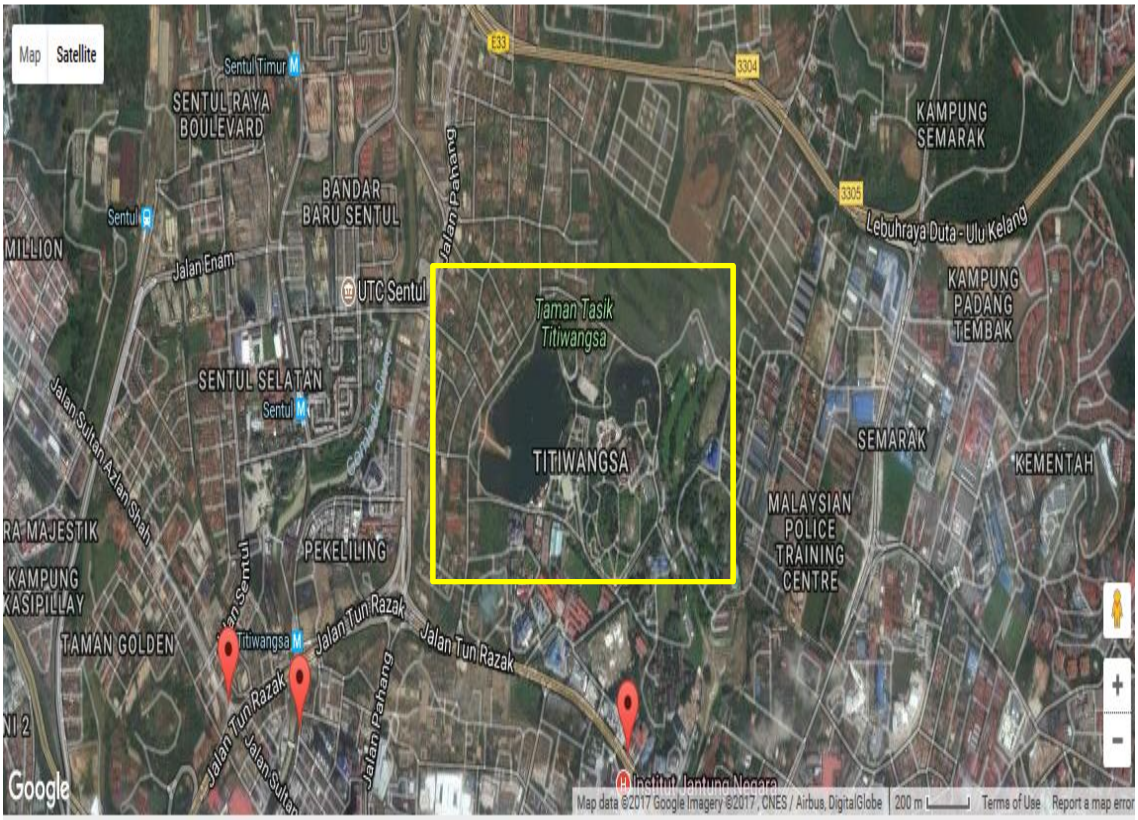


Figure 1.1 Location of the Titiwangsa Lake that located near Jalan Tun Razak
Source: (Google Maps, 2017)

Titiwangsa Lake become the main attraction for recreational activities as it were complete with the facilities such as jogging track, cycling track, kayaking, remote control car track and many other outdoor activities including event that usually being hold there such as wedding event. Despite of the activities, we can also get food or drinks around the garden (Sharifudin, 2014)

## 1.2 Problem Statement

Lake were varies in term of the uses depend on the type of the water and properties. In Malaysia, the lake can be used to generate electricity, water catchment area, source of water supply, home for a protected wildlife, and recreational uses. There are some lakes that were polluted due to the river pollution. As the river was polluted by the chemical that were discharged from the factory, it will flow through the river and this will affect the lake as there are connected to the rivers. In other states, some of them are used in different ways. For example in North America, The Great Lake was being used as a travel route for ship for carrying and trade raw material such as coal and iron ore and also source of food such as grains. Lake also was a permanent home for people called “uros”, an indigenous people that live in Lake Titicacain Andes Mountains. The lake completes with all facilities including food, water supply, and also houses where they build it using reeds (National Geographic, 1996-2018).

The study of the Titiwangsa Lake is conduct to find a solution regarding the shortage of water that happen because of the increase in number of population. According to (Malay Mail Online, 2016), Selangor will experience problem on water supply from 2017 to 2019 because of the delay of construction Langat2 Water Treatment Plant project and also the increase in number of people that migrate to Selangor area due to job opportunities.

## 1.3 Research Objective

The objective of the research are:

I. To investigate the current status of water quality in the Titiwangsa Lake catchment

II. To compare the water characteristic based on National Water Quality Standard (NWQS) and Water Quality Index (WQI) of Malaysia

## 1.4 Scope of the study

Titiwangsa Lake that located at the city of Kuala Lumpur, Malaysia was selected for the study area. Total of two (2) different sampling station are selected based on the surrounding condition where the first station located near the playground area (parasite species growth in the lake) and the second station located near the waterfall area (no parasite species growth but dry leave fall into the lake).

The data will be collected with two method. First is in-situ test where the data will be recorded at the sampling station and second is ex-situ test where the sample will be analyse in Environmental Laboratory, Faculty of Civil Engineering & Earth Resources, Universiti Malaysia Pahang. After all the test being conducted, it will be classes and compare with the National Water Quality Standard (NWQS) and Water Quality Index (WQI) of Malaysia. The result from the test will be the indicator whether the water in the lake can be used as the alternative sources of water supply or maintain it functions as the recreational activities purposes.

## 1.5 Significant of the study

Water is very crucial to all living things in the world for source of drink, source of breathing, daily life uses and others. If the water polluted, where will we get the sources of the water? That the important of awareness among people in making sure to not pollute the sources of water like rivers, streams, lake and all places where the water can be found. This is because there were some of them can be the sources of water supply after it is treated. In this research, we will investigate the current status of Titiwangsa Lake water quality and to identify whether the Titiwangsa Lake can be an alternatives source of water supply for people around Kuala Lumpur.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1.1 Introduction

Practically all of the naturally occurring elements of the Earth's crust could probably be found in natural waters. However, some of these substances would be expected to occur only in minute concentrations. In addition to the gaseous components, chemicals are found in varying quantities in natural waters include carbonates, chlorides, sulphates, phosphates and often nitrates. These anions occur in combination with cations such as calcium, sodium, potassium, magnesium and iron to form different ionisable salts (Water Center, 2012).

As a result of availability and high solubility of carbon dioxide in water, carbonates are usually the most abundant salts in fresh waters. Both the quantitative and qualitative aspects of the chemical composition of natural waters are influenced to a high degree by the geochemistry of the watershed. And in the case of lakes, influenced by the form and geology of the basin with respect to inflow and outflow. In general, the inorganic composition of the water of an open lake (that is one with effluents) through which water moves is a reflection of the nature of the influent Waters. The inorganic composition of closed lakes (those lacking significant effluents) is greatly modified by precipitation and concentration of salts as determined by evaporation. Also, lakes near the ocean coast may receive substances from sea spray and moist ocean air (Water Center, 2012).

## 2.2 Lake

Lake either contain both fresh and salt water can be found in variable size where it surrounded by land. There are millions of lakes in the world. In Malaysia, we can found two types of lake, an artificial lake and natural lake. Natural lake including Bera Lake and Chini Lake where both of it located in Pahang and in Perak, we have Chenderoh Lake. While artificial lake were Temenggor Lake in Perak, Kenyir Lake in Terengganu, Timah Tasoh Lake in Perlis, Batang Ai Lake / Logan Bunut Lake in Sarawak and Titiwangsa lake located in Kuala Lumpur. The lakes have different type of purposes such as recreational use, as a home to various type of protected wildlife, as a catchment area, generate the electricity and also attraction places for tourism. From this, we can know that they have different in water qualities that make them differ in term of the uses.

## 2.3 Water Quality Parameter

### 2.3.1 Physical parameter

Physical parameter is a parameter that can be touch, hear, taste, smell, and seen. The example of physical parameter is turbidity, temperature and total suspended solid (TSS).

#### 2.3.1.1 Turbidity

Turbidity is a measure of water lucidity how much the material suspended in water reduces the amount of light reaching through the water. Suspended materials involving soil particles (mud, residue, and sand), green growth, microscopic fish, organisms, and different substances (United States Environmental Agency, 2012).

In water bodies, for example, lakes, streams and reservoir, the lower depths receiving low amount of light due to the higher turbidity levels, which can restrain development of submerged aquatic plants and therefore affect the species that reliant on them, for example, fish and shellfish. Besides that, high turbidity levels can affect the capacity of fish gills to absorb dissolved oxygen (Wikipedia, 2017). Standard units for turbidity are "Nephelometric Turbidity Units" (NTU's) standardised against

Formazin solution (Department of Primary Industries, Parks, Water and Environment (Tasmania), 2017)

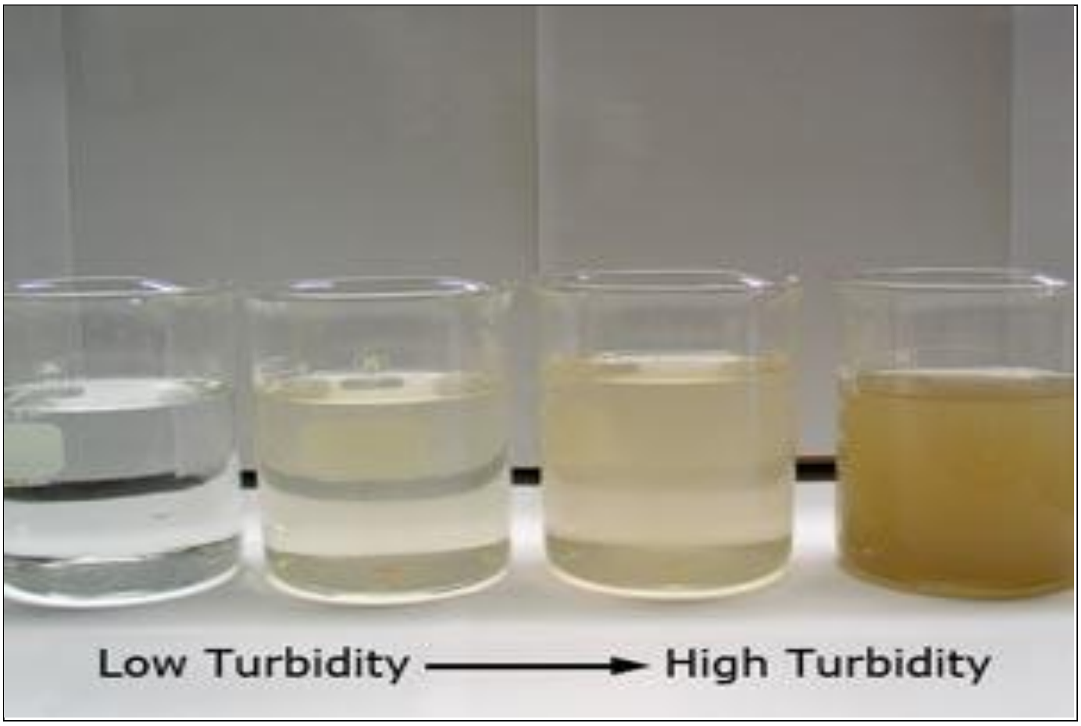


Figure 2.1 The level of turbidity from low turbidity (clear( to high turbidity (cloudy)

Source:. (Staff, 2010)

#### 2.3.1.2 Temperature

According to (Fundamentals of Environmental Measurements, 2016), water temperature is a physical property communicating how hot or frosty water is. Warmth exchange, regardless of whether from the air, daylight, another water source or warm contamination can change the temperature of water. Temperature applies a noteworthy impact on biological activity and development. Temperature oversees the sorts of life forms that can live in streams and lakes. Fish, creepy crawlies, zooplankton, phytoplankton, and other amphibian species all have a favoured temperature. As temperatures get too far above

or underneath this favoured range, the quantity of the species reduces until at last there are no more species remain (U.S. Geological Survey, 2016)

#### 2.3.1.3 Total Suspended Solid (TSS)

Total Suspended Solids (TSS) is solids in water that can be caught by a filter. TSS including a wide assortment of material, for example, sediment, rotting plant and creature matter, modern squanders, and sewage. High concentrations of suspended solids can cause numerous issues for stream wellbeing and aquatic life. As the amount of light pass through the water decrease cause the photosynthesis process slower. This is because the high TSS blocking light from entering the water. As the photosynthesis become slower will cause the amount of dissolved oxygen released into the water become lesser until the plants stop produced oxygen and caused the plant to die. Furthermore, high TSS also can affect the surface water temperature to become higher as the suspended particles that floating at the surface of water absorbs heat from the sunlight.

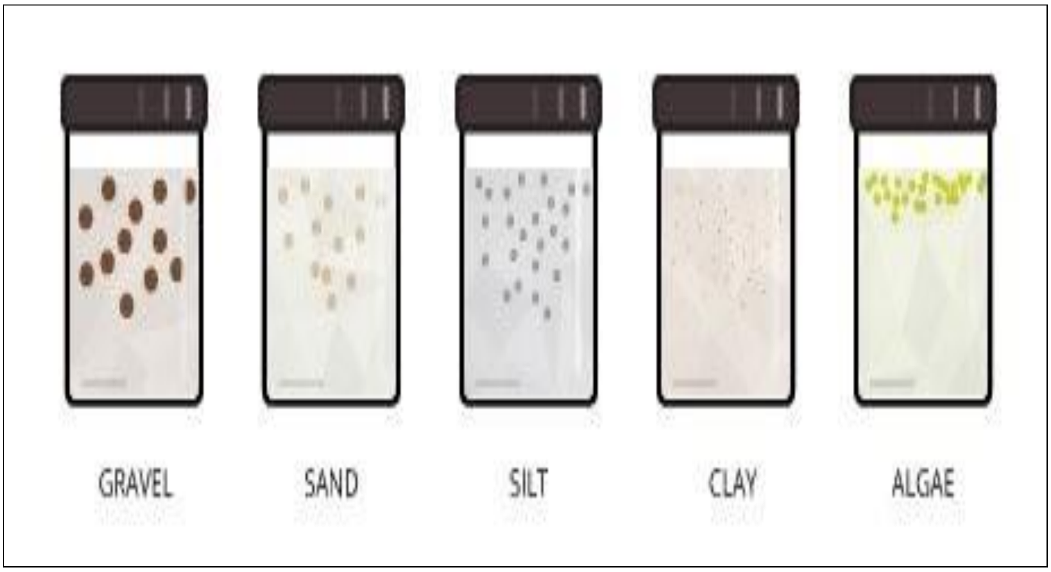


Figure 2.2 Both organic and inorganic particles of all size that contribute to the suspended solid concentration

Source: (Mousavi, 2016)

### 2.3.2 Chemical Parameter

Water is type of solvent and it has its chemical properties that will indicate the quality of the water. Chemical oxygen demand (COD), biochemical oxygen demand (BOD), dissolved oxygen (DO), pH, ammonia nitrate, and phosphate were being classified under chemical parameter. These parameters are measured to evaluate the water quality of Titiwangsa Lake based on its chemical properties.

#### 2.3.2.1 Chemical Oxygen Demand (COD)

The chemical oxygen demand, or COD, is used as a measure of the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant. For samples from a specific source, COD can be related empirically to BOD, organic carbon, or organic matter. The test is useful for monitoring and control after correlation has been established

#### 2.3.2.2 Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand (BOD) is defined as the amount of oxygen needed for the bacteria and other microorganism to decompose organic matter through aerobic process. It is most commonly expressed in milligrams of oxygen consumed per litre of sample during 5 days ($BOD_5$) of incubation at 20°C.

BOD directly affects the amount of dissolved oxygen in rivers and streams. The rate of oxygen consumption is affected by a number of variables: temperature, pH, the presence of certain kinds of microorganisms, and the type of organic and inorganic material in the water. The greater the BOD, the more rapidly oxygen is depleted in the stream. This means less oxygen is available to higher forms of aquatic life. The consequences of high BOD are the same as those for low dissolved oxygen: aquatic organisms become stressed, suffocate, and die.

Sources of BOD include topsoil, leaves and woody debris; animal manure; effluents from pulp and paper mills, wastewater treatment plants, feedlots, and food-processing plants; failing septic systems; and urban storm water runoff. BOD is affected by the same factors that affect dissolved oxygen. BOD measurement requires taking two measurements. One is measured immediately for dissolved oxygen (initial), and the second is incubated in the lab for 5 days and then tested for the amount of dissolved oxygen remaining (final). This represents the amount of oxygen consumed by microorganisms to break down the organic matter present in the sample during the incubation period.

#### 2.3.2.3 pH

Potential of hydrogen or chemically known as pH is a numeric scale that being used to indicate the acidity or basicity of an aqueous solution. As the pH indicates lower than 7, that means the acidity and the water has more free hydrogen ions. While if the water has more free hydroxyl ions, it indicates a base and the pH is more than 7 (U.S. Geological Survey, 2016). The level of the pH if too higher or lower can affect the use of water. For example, if the pH is too higher can causes a bitter taste, water pipes and water using appliances become encrusted with deposits, and it depresses the viability of the cleansing of chlorine and it will causing the requirement for extra chlorine. If the pH is lower, it will affect the metals and other substances to undergo corrosiveness (U.S. Geological Survey, 2016).

#### 2.3.2.4 Dissolved Oxygen (DO)

Dissolved oxygen can be described as the free, non-compound oxygen that exist in water or other liquid. Dissolved oxygen is one of the parameter that was very crucial in order to identify the water quality because it influence towards the organisms that live in body of water. The water quality and also the aquatic life may be affected due to the level of the dissolved oxygen that was too high or too low ("Dissolved Oxygen Measurement _ DO Meters, Sensors for Sampling and Monitoring," 2017).

#### 2.3.2.5 Ammoniacal Nitrogen

Nitrogen is an essential nutrient that is required by all plants and animals for the formation of amino acids. In its molecular form, nitrogen cannot be used by most aquatic plants; therefore it must be converted to another form. One such form is ammonia ($NH_3$). Ammonia may be taken up by plants or oxidized by bacteria into nitrate ($NO_3^-$) or nitrite ($NO_2$). Of these two forms, nitrate is usually the most important. However, it is very difficult to directly measure nitrate. A common procedure for measuring nitrate is to first measure the amount of nitrite in a sample. Then, reduce any nitrate in the sample to nitrite. Lastly, measure the combined nitrite (the initial nitrite plus the reduced nitrate) concentration. By subtracting the original nitrite concentration from the combined nitrite concentration, one can determine the amount of nitrate that was in the sample.

#### 2.3.2.6 Phosphorus

Phosphate is required by all plants and animals but if excessive phosphate in water can cause eutrophication. Eutrophication refers to an increase of nutrients in a water body. It is a natural process but when it is accelerated by natural or human causes it is an issue for concern. Many human activities have led to widespread eutrophication in rivers, streams, lakes, and oceans around the world impacting water quality and biodiversity. One example of eutrophication is algal bloom.

Algal bloom occurs naturally in minerals and rocks. The concentration reflects particular land uses and human activities. The amount of phosphate in the water is increased by the soil erosion and fertilizers.

### 2.3.3 Biological Parameter

Total coliform and Escherichia coli (E.coli) are the two parameters that are classified under biological parameter. This is to describe the presence of microbiological organism and water-borne pathogens in the water. The pathogens and microorganism that enter the lakes, rivers or oceans either naturally or because of untreated sewage will cause the illness to the human as well as animals.

#### 2.3.3.1 Total Coliform Bacteria

Total coliform or faecal coliform is a type of faecal bacteria that is one of harmless bacteria that present in water, soil and digestive system of animals. These bacteria can go through the water bodies as it can be found in large quantity whether in faeces or intestinal tracts of human and other warm-blooded animals. Pathogenic organism that can cause disease or illness can be found in water if the number of faecal coliform bacteria are large (over 200 colonies per 100 millilitres) of water sample. The example of disease or illness that affects human body effect from high faecal coliform are typhoid fever, hepatitis, gastroenteritis, dysentery, and ear infections. In order to killed the faecal coliform, the water sample that contain these bacteria can be boiled or treating it with chlorine.

#### 2.3.3.2 Escherichia coli (E.coli)

Escherichia coli or simply known as E.coli is a type of bacteria that live in human and animal's intestines. E.coli did not dangerous but actually is important especially to human intestinal tract. Although it was harmless, there are pathogenic where the E.coli can cause illness to the human intestinal tract. The illness may be cause as the bacteria being transmit through contaminate water, food, and contact with animal or person. (Centre for Disease Control and Prevention, 2015)

## 2.4 Water Quality Standard

Water Quality Standard is a programme under water quality control where the purpose is to control the amount of pollution entering the water from various sources such as wastewater treatment plants, storm sewer, industrial facilities, and others. The water quality based programme is mandated by Clean Water Act that is a technical basis to reduce runoff from rural and also urban areas. The standard involved physical, chemical, and biological parameters that are used to monitor and protect the quality of water to meet and maintain designated uses. For example swimming, recreational purpose, public water supply and aquatic live.

Two standards will be used to determine the quality of water in Titiwangsa Lake for the alternative source of water supply. The standards that will be use are Water Quality Index (WQI) and National Water Quality Standard (NWQS). The election or the use of this standard is depending on parameters tested in this study.

### 2.4.1 Water Quality Index (WQI)

Water quality index is a combination of multiple water quality factors into a single number by normalizing values to subjective rating curves. This index is used to measure the water quality of the rivers, lakes, and streams. WQI consists of parameters that are BOD, COD, pH, TSS, DO and Ammoniacal Nitrogen.

Table 2.1 DOE Water Quality Classification based on Water Quality Index

| SUB INDEX & WATER QUALITY INDEX | INDEX RANGE | | |
|---|---|---|---|
| | CLEAN | SLIGHTLY POLLUTED | POLLUTED |
| Biochemical Oxygen Demand(BOD) | 91 - 100 | 80 - 90 | 0 - 79 |
| Ammoniacal Nitrogen(NH3-N) | 92 - 100 | 71 - 91 | 0 - 70 |
| Suspended Solids(SS) | 76 - 100 | 70 - 75 | 0 - 69 |
| Water Quality Index(WQI) | 81 - 100 | 60 - 80 | 0 - 59 |

Source: (EQR , 2006)

### 2.4.2 National Water Quality Standard (NWQS)

National Water Quality Standard is a guidelines that being used in Malaysia by Department of Environment (DoE). The purpose of National Water Quality Standard is to measure, protect and maintain the quality of water. These standards consists of physical, chemical and biological parameters that involved BOD, COD, DO, temperature, total coliform and others parameters. These parameters have to meet the standards of every water classes. There are six classes overall. For Class I, it classifying the conservation of natural environment where the water supply practically does not need ant water treatment. For Class IIA, the conventional treatment is required for this class. For example; fisheries where this classes of water is sensitive to the aquatic species. Class IIB is meant for recreational use for body contact. Next is Class III where excessive treatment is required for livestock drinking. Class IV will be for irrigation use. Lastly is the Class V where it use to classify tone of above that have mention in Class I until Class IV (EQR , 2006).

Table 2.2 Water Classes and uses

| CLASS | USES |
| --- | --- |
| Class I | Conservation of natural environment.<br>Water Supply I - Practically no treatment necessary.<br>Fishery I - Very sensitive aquatic species. |
| Class IIA | Water Supply II - Conventional treatment.<br>Fishery II - Sensitive aquatic species. |
| Class IIB | Recreational use body contact. |
| Class III | Water Supply III - Extensive treatment required.<br>Fishery III - Common, of economic value and tolerant species; livestock drinking. |
| Class IV | Irrigation |
| Class V | None of the above. |

Source: (EQR , 2006)

# CHAPTER 3

# METHODOLOGY

## 3.1 Introduction

Methodology has crucial role in comprising the theoretical analysis of the methods and principle of the research. Methodology is not provided the solution but it set out to provide understanding regarding the method that being used and procedure or data analysis of the study (Methodology, 2017). In this chapter, the data collection of in-situ and ex-situ method will be focused in order to evaluate the Titiwangsa Lake water quality for alternative sources of water supply.

## 3.2 Study Area

Titiwangsa Lake, one of the famous artificial lake that become the heart of the city centre of Malaysia, Kuala Lumpur. Titiwangsa Lake that places within the Titiwangsa Lake Garden located just beside Jalan Tun Razak and surrounded by the famous attraction of Kuala Lumpur such as National Art Gallery, National Library and National Theatre or known as Istana Budaya. Back then when Malaysia was under British colony, mining activities were being conduct here before it was being cleaned to construct the scenic Titiwangsa Lake Garden. The total area of the garden was 95 hectares and the lake take about half of the total area of the garden (Titiwangsa Lake Garden, 2012)

Titiwangsa Lake become the main attraction for recreational activities as it were complete with the facilities such as jogging track, cycling track, kayaking, remote control car track and many other outdoor activities including event that usually being hold there such as wedding event. Despite of the activities, we can also get food or drinks around the garden (Sharifudin, 2014)

## 3.3 Methodology Flow Chart

For this research to be done accordingly following the procedure, Figure 3.1 shows the step by step approaches in conducting this research. Firstly, the study area was been selected where Titiwangsa Lake has been chosen as the location for this research. Next, two different sampling station has been chosen and the sample of water has been collected two times. After the sample has been collected, the data on the sample will be collected by doing in-situ and ex-situ test. Last but not least, the data from the test will be collected to be comparing with Water Quality Index (WQI) and National Water Quality Standard (NWQS) in order to identify the suitability of the water as an alternative source of water supply.

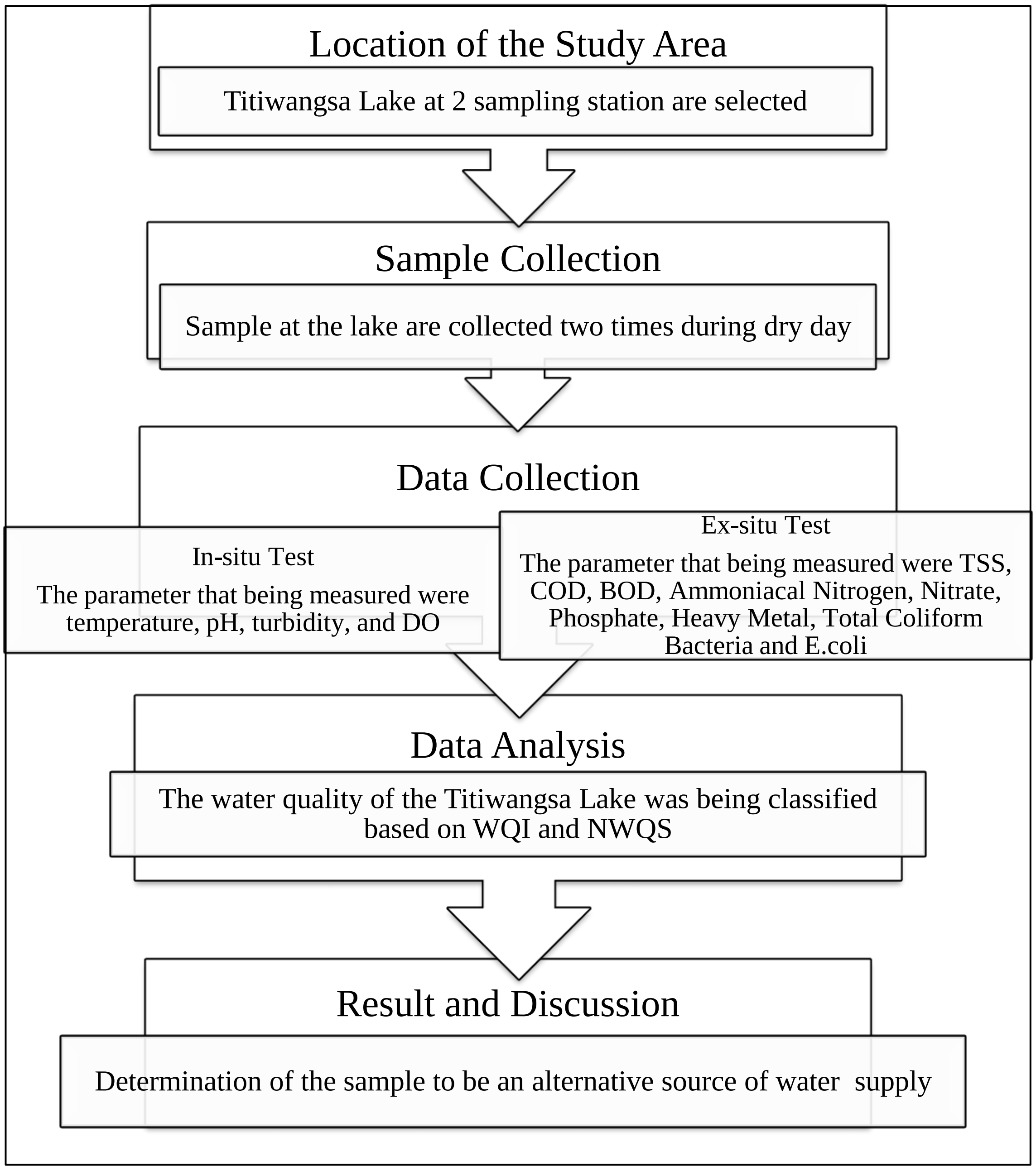


Figure 3.1 Methodology Flow Chart

### 3.4 Sampling Station

Titiwangsa Lake that became the main attraction for recreational activities especially for people lived around Kuala Lumpur is chosen as the study area for this research. There are total of two stations that being selected based on the surrounding condition of the sampling station. For station 1, the station located playground area (parasite growth inside the lake) and for the station 2, it was near to the waterfall area (no parasite growth but dry leaf fallen in the lake).

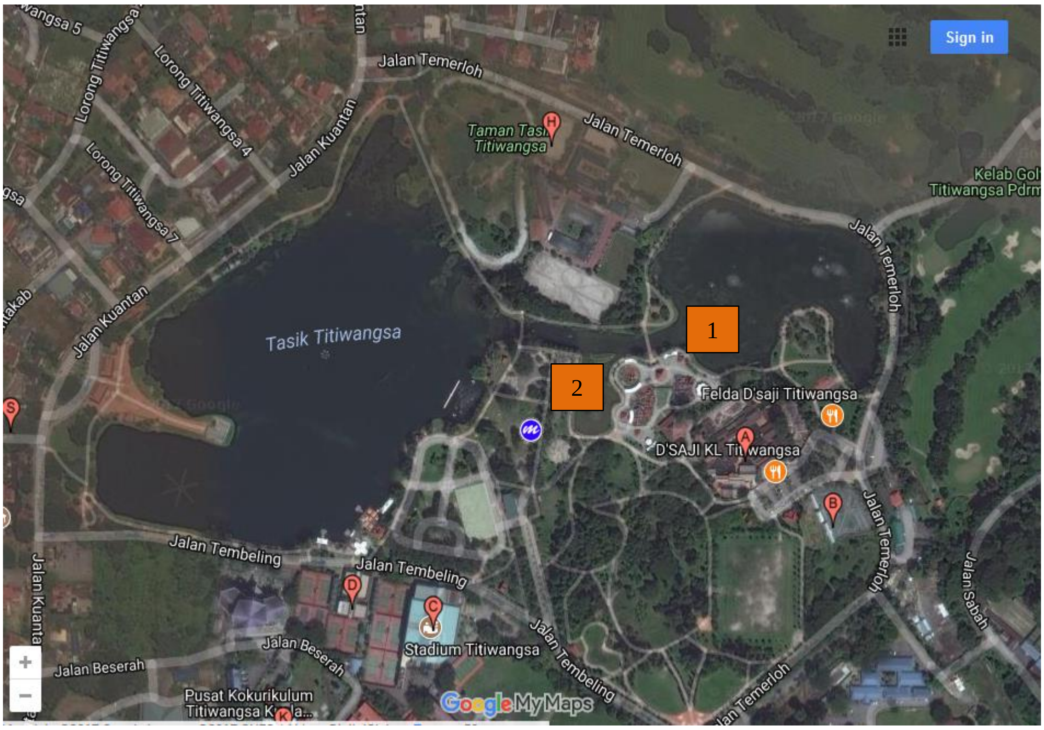


Figure 3.2 The location of the sampling station where the sample are taken

Source: (Google Map, 2017)

### 3.5 Preparation of Sampling Collection

The sample is collect at two (2) different station for two times. To differentiate the sample between the two station, the bottle (plastic type) is being labelled and for ensuring that the sample is free from impurities that may affect the result in the future, the bottle can being rinse with the sampler water itself or with distilled water.

### 3.6 Sampling Preservation

In order to preserve the sample that being taken in Titiwangsa Lake, there are different preservation method depending on the parameter that will be analysed. For BOD, TSS, and nitrate the sample need to be cool at 4 °C. Ammoniacal nitrogen, phosphorus, and COD have same preservation technique where they need to be cool at 4°C and sulphuric acid (pH < 2) need to be added. Lastly for remaining parameter, heavy metal also need to be cool at 4°C and nitric acid (pH < 2) need to be added. For

E.coli and total coliform bacteria, the sample is preserve in E.coli bottle and cool at 4°C.

## 3.7 Study Approaches

For this research, the water quality parameter can be approaches by two methods; in-situ test and ex-situ test. In-situ test is a test that being conduct outside laboratory (at the location of the study area) while ex-situ test is a test that being conduct in laboratory (laboratory testing).

### 3.7.1 In-situ data collection

The data for in-situ test can be get directly from the Handheld Multiparameter equipment as the test is being conduct at the study area. The parameter are pH, temperature, DO and turbidity. These data can be get directly as it does not use any chemical or equipment that need several procedure to be conduct.

### 3.7.2 Ex-situ data collection

Ex-situ test is being conduct in the Environmental Laboratory of Civil Engineering & Earth Resources UMP as use chemicals and equipment that follow certain procedure. The parameters including BOD, COD, TSS, ammonia nitrate, phosphorus, nitrate, heavy metal, E.coli, and total coliform bacteria.

#### 3.7.2.1 Total Suspended Solid (TSS)

Total Suspended Solid (TSS) is the primary cause of turbidity. The most widely recognized, and exact method for measuring suspended solids is by weight. To quantify TSS, a water sample is filtered, dried, and weighed. This method is the most precise method for measuring total suspended solids; nonetheless it is likewise more troublesome and time-consuming (Fondriest Environmental Inc., 2016). The unit of these parameters are in mg/L. The test is being conducted to identify the amount of solid material that entering the Titiwangsa Lake. The procedure of the test is started by weighed the filter paper using analytical balance before it being place on top of the funnel. 100 ml sample of water is poured into the funnel and the water sample will flow through the funnel. Next, the filter paper together with the residue that remain on top of the funnel were being placed in a glass dish and dried in the oven at temperature 103°C - 105°C about 24 hour. After 24 hour, the filter paper was placed in dryer (desiccator) for 20 minutes (for better result, leaves it for a day) and weighing again. The procedure was repeated for both sample that being taken at different station.

$$\text{TSS} = \frac{(A-B)}{C}$$

Where;

A = weight of filter paper + residue (mg)

B = weight of filter paper (mg)

C = volume of sample filtered (mL)

Figure 3.3 Formula for the Total Suspended Solid (TSS)

### 3.7.2.2 Biochemical Oxygen Demand (BOD)

Biochemical Oxygen Demand (BOD) was crucial parameter in water pollution control. BOD is used as a measure of organic pollution as a basis in estimating the oxygen needed for biological processes and also as an indicator of process performance. The test being start by make buffer solution. 3 litre of distilled water is needed for one buffer and it is aerated so that the solution is well mix before it can be used. Next, 400 mL of buffer solution is mixed into 100 mL. The reading of initial DO ($DO_i$) is recorded before it was leave for five (5) days in incubator of 20°C. After five days, the final DO($DO_t$).is recorded and by using the formula in, the BOD can be calculated.

$$BOD_t = \frac{DO_i - DO_t}{P}$$

Where;

$BOD_t$ = biochemical oxygen demand, mg/L

$DO_i$ = initial DO of the diluted sample of water after preparation, mg/L

$DO_t$ = final DO of the diluted sample of water for five days, mg/L

P = dilution factor, $\frac{Volume\ of\ sample}{Volume\ of\ sample + Volume\ of\ distilled\ water}$

Figure 3.4 Calculation for Biochemical Oxygen Demand (BOD)

#### 3.7.2.3 Chemical Oxygen Demand (COD)

Chemical Oxygen Demand (COD) usually used in measuring the quantity of oxygen needed to chemically oxidize the organic compound in sample of water and convert to carbon dioxide and water. Total of three samples being prepared, one for distilled water and another two that being taken at two different sampling stations. The samples are put into the COD Reactor for about two hours. After the sample being taken out from the reactor, put it in the holder and cool down for 30 minutes. The instrument reads the bar code and then the correct test is selected to get the correct result in mg/L COD.

#### 3.7.2.4 E.coli and Total coliform bacteria

Total coliform or faecal coliform is a type of faecal bacteria that is one of harmless bacteria that present in water, soil and digestive system of animals. These bacteria can go through the water bodies as it can be found in large quantity whether in faeces or intestinal tracts of human and other warm-blooded animals. Pathogenic organism that can cause disease or illness can be found in water if the number of faecal coliform bacteria are large (over 200 colonies per 100 millilitres) of water sample.

Escherichia coli or E.coli is a type of bacteria that live in human and animal's intestines. E.coli did not dangerous but actually is important especially to human intestinal tract. Although it was harmless, there are pathogenic where the E.coli can cause illness to the human intestinal tract. The illness may be cause as the bacteria being transmit through contaminate water, food, and contact with animal or person. (Centre for Disease Control and Prevention, 2015).

For both total coliform and E.coli, the test is being conduct in the fume chamber under the light and Colilert reagent. Colilert Reagent is used for the simultaneous detection and confirmation of total coliforms and E. coli in water as it utilizes nutrient indicators that produce colour and fluorescence when metabolized by total coliforms and E. coli. The procedure for this test is preparing about 100 ml of sample and poured it into the sample bottle together with a snap-pack of Colilert reagent. Next, the bottle is closed tightly and shakes vigorously so that the mixture is well-mixed. After that, the mixture is poured into the Quantity Tray and sealed. Incubate it for 24 hours at temperature 35°C ($\pm$0.5°C). The procedure is repeated for another two sample that being taken in different sampling station. The total coliform and E.coli is determined based on the Most Probable Number (MPN). Yellow wells indicate the present of total coliforms while for fluorescent wells indicate the present of E. coli.

## 3.8 Water Quality Index (WQI)

WQI = (0.22* SlDO) + (0.19*SIBOD) + (0.16*SICOD) + (0.15*SIAN) + (0.16 * SISS) + (0.12 * SipH)

where;

SIDO = Sublndex DO (% saturation)

SIBOD = Sublndex BOD

SICOD = Sublndex COD

SIAN = Sublndex NH3-N

SISS = Sublndex SS

SipH = Sublndex pH

$0 \leq WQI \leq 100$

Figure 3.5 Formula for calculating WQI

## 3.9 Data Analysis Result

All the data that being obtained from both in-situ and ex-situ test are analyse. In order to achieve the objectives of this research, the water quality in Titiwangsa Lake is being compared with WQI and NWQS. The result will determine the suitability of the water in Titiwangsa Lake as alternative sources of water supply. The expected outcome from this research is that the Titiwangsa Lake suitable for the purpose of water sources and also daily uses. The details of all the result are discussed in next chapter (Chapter 4: Result and Discussion).

# CHAPTER 4

# RESULTS AND DISCUSSION

## 4.1 Introduction

In Chapter 3, the two methods that being used in getting the result for all sixteen (16) parameters were being discussed. There are in-situ test (pH, temperature, DO, and turbidity) and ex-situ test (TSS, BOD, COD, ammoniacal nitrogen, phosphate, nitrate, heavy metal, E.coli and total coliform bacteria. All the sample were being tested according to the parameter and the result being presented in graphs and tables that will be easier to understand.

The result will be compared between National Water Quality Standard (NWQS) and Water Quality Index (WQI) of Malaysia. The sample were being collected two times. First was dated on 11$^{th}$ February 2018 between 8am to 10am where the weather was sunny. Meanwhile for the second sample was on 2$^{nd}$ April 2018 between 4pm until 6pm and the weather was cloudy and about to raining.

## 4.2 Physical Parameter

### 4.2.1 Temperature

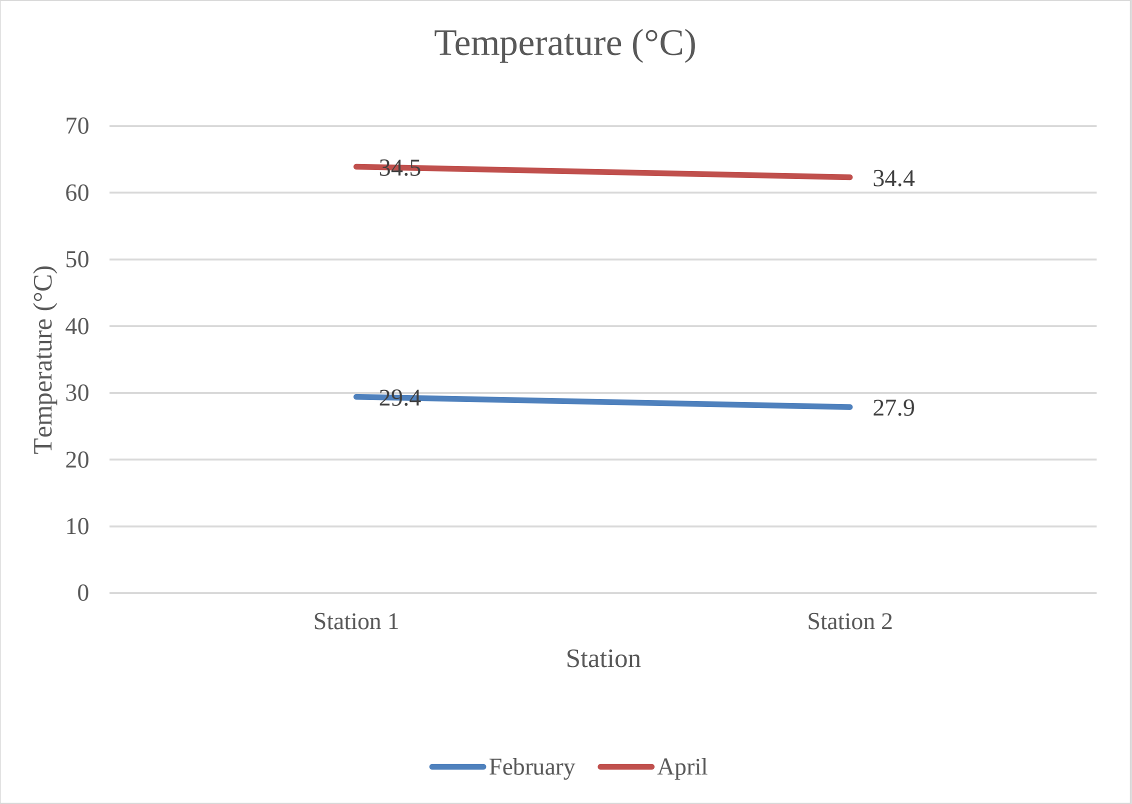


Figure 4.1 Temperature at the two different station

Temperature, a parameter where it can determine the hot and cold of a object or anything that can detect or react to the changes of the surrounding condition. Based on Figure 1, the temperature of Station 1 and Station 2 in February are in average condition neither cold nor warm as the sampler was taken in the morning. It is different in April where it was little higher and it a bit warm because the sampler was taken in the evening. The different also may because of the location of the station where for Station 1 it was exposed but for Station 2 the location is protected by the nearby tree that make it receives lower amount of sunlight.

### 4.2.2 Turbidity

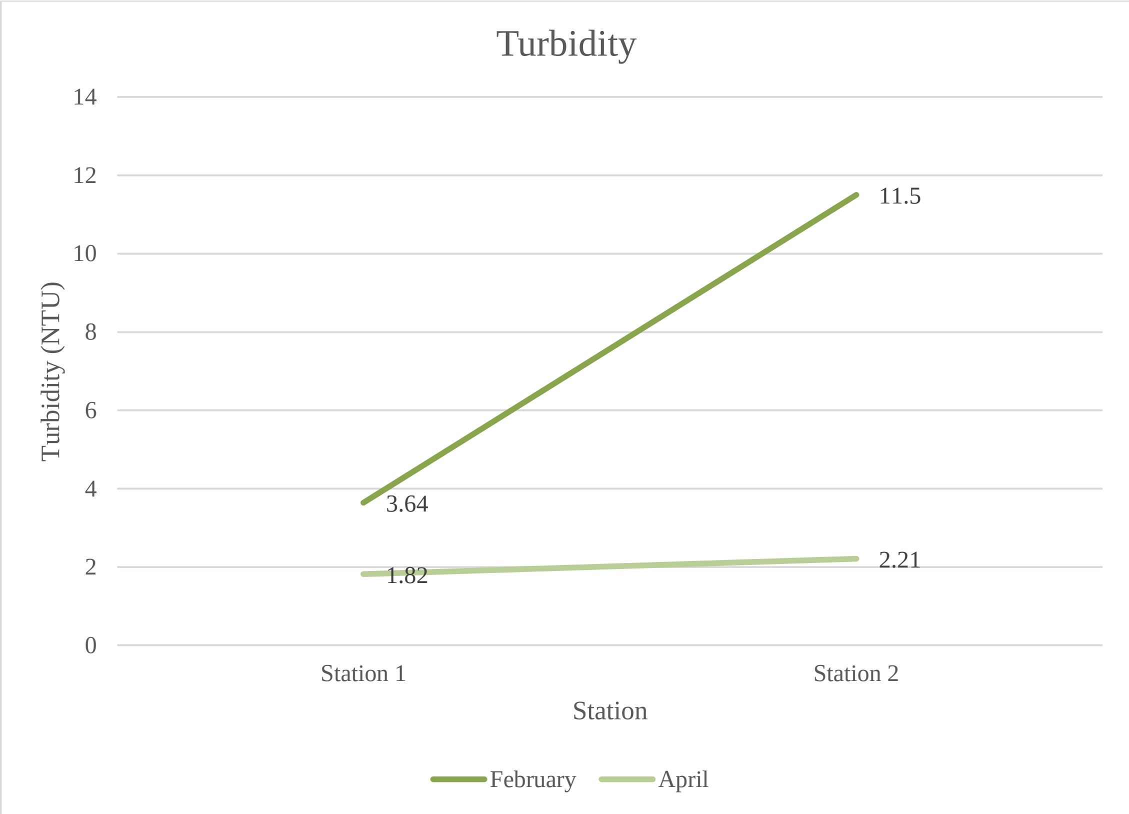


Figure 4.1 Concentration of turbidity of the two different station

By using turbidimeter at the laboratory, the result were being obtain. Figure 4.2 show different reading of the two month. At Station 2, there was huge difference between the February and April where the reading in February was higher than April. This is because when the sample being taken at the Station 2 that near the waterfall area in February, the water was in stable condition (no movement of water due to the malfunction of the waterfall) and the water was cloudy as the sediment was floating at the surface of the water. While during the second visit in April, the water were more clearer due to the functioning of the waterfall and the movement of the water due to the waterfall swipe the sediment that float at the surface of the water and thus give clearer view of the water.

### 4.2.3 Total Suspended Solid

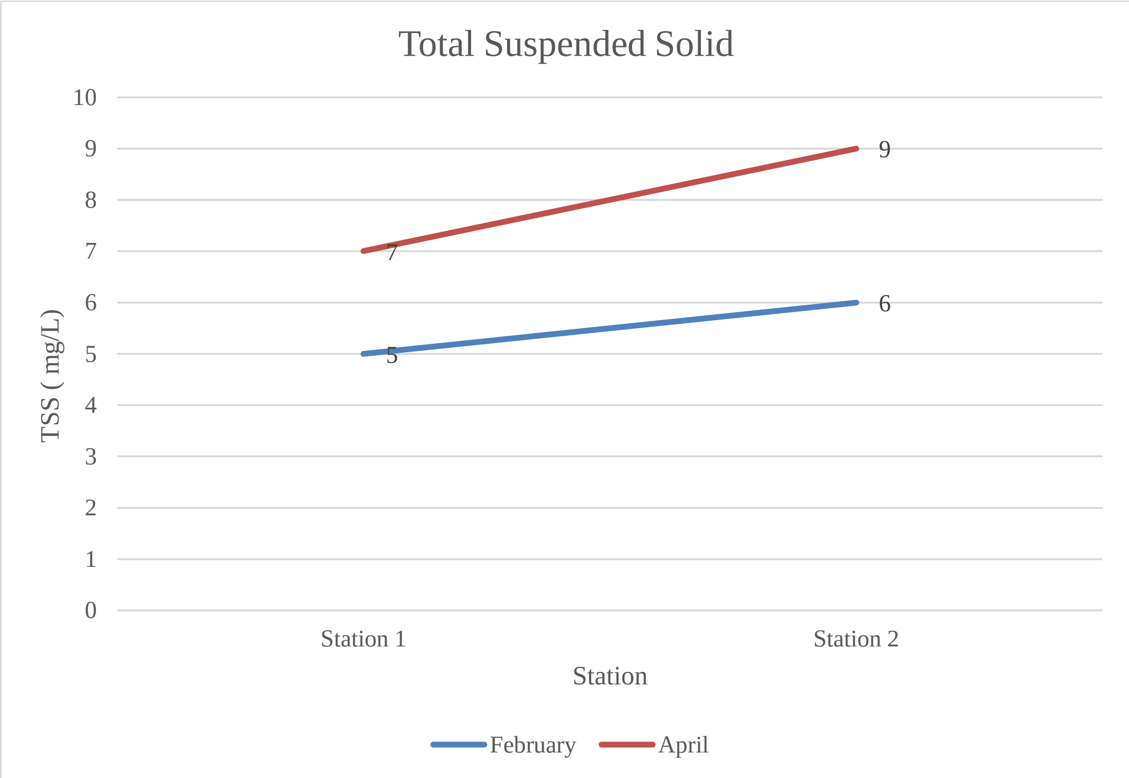


Figure 4.2 Concentration of TSS at two different station

Total suspended solid is analysed to measure the suspended solid in the water and the solid can be either organic or inorganic particles. Clay and silt are example of inorganic particles that can be found mostly in water. Based on Figure 4.3, it can be concluded that Station 2 show the highest value of suspended solids compare to Station 1. The suspended solids includes all particles that contain in water but cannot pass through filter. The presence of the suspended solid varies depends on the activities and runoff around the Ttitiwangsa Lake.

## 4.3 Chemical Parameter

### 4.3.1 Biochemical Oxygen Demand (BOD)

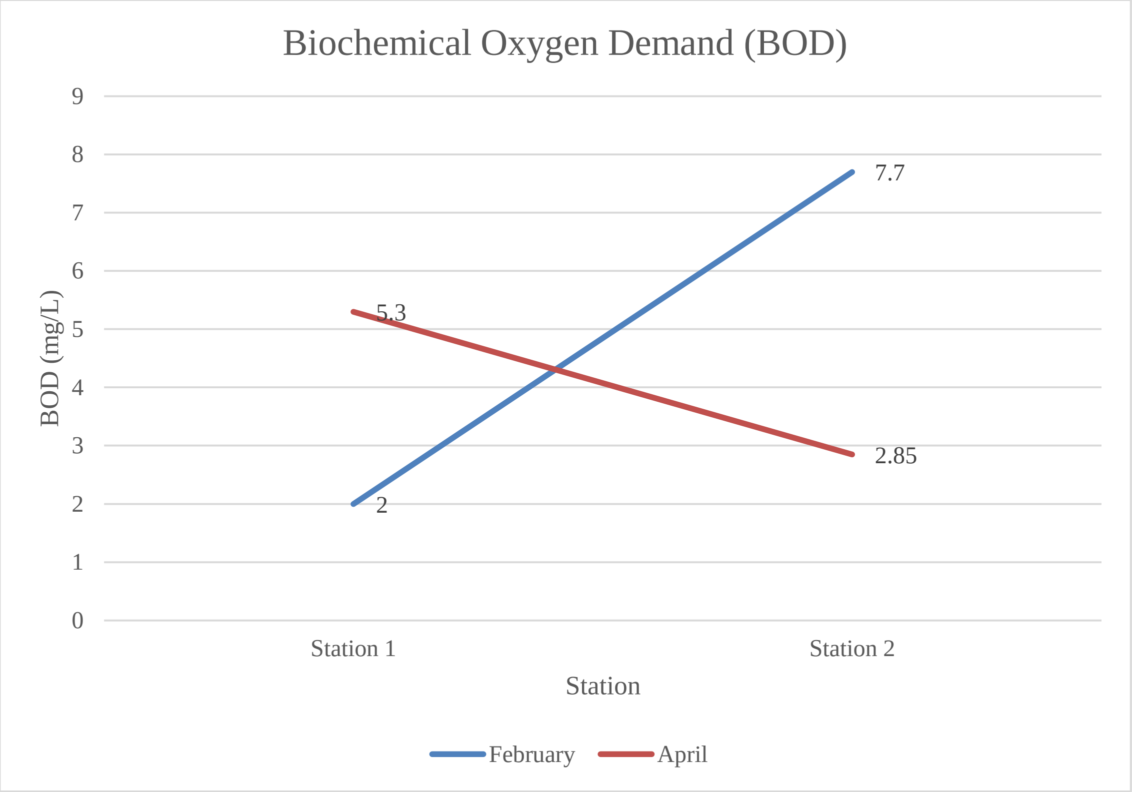


Figure 4.3 Biochemical Oxygen Demand at two different station

Biochemical oxygen demand can be define as the amount of oxygen consumed by the bacteria and other microorganism to decompose organic matter through aerobic condition at specified temperature. If the reading of BOD is high, it shows that the organic matter was high in the water. Based on Figure 4.4, Station 2 shows higher BOD reading in month of February but decreases in month of April. Different with Station 1 where the BOD reading in month of February is lower than the month of April.

### 4.3.2 Chemical Oxygen Demand (COD)

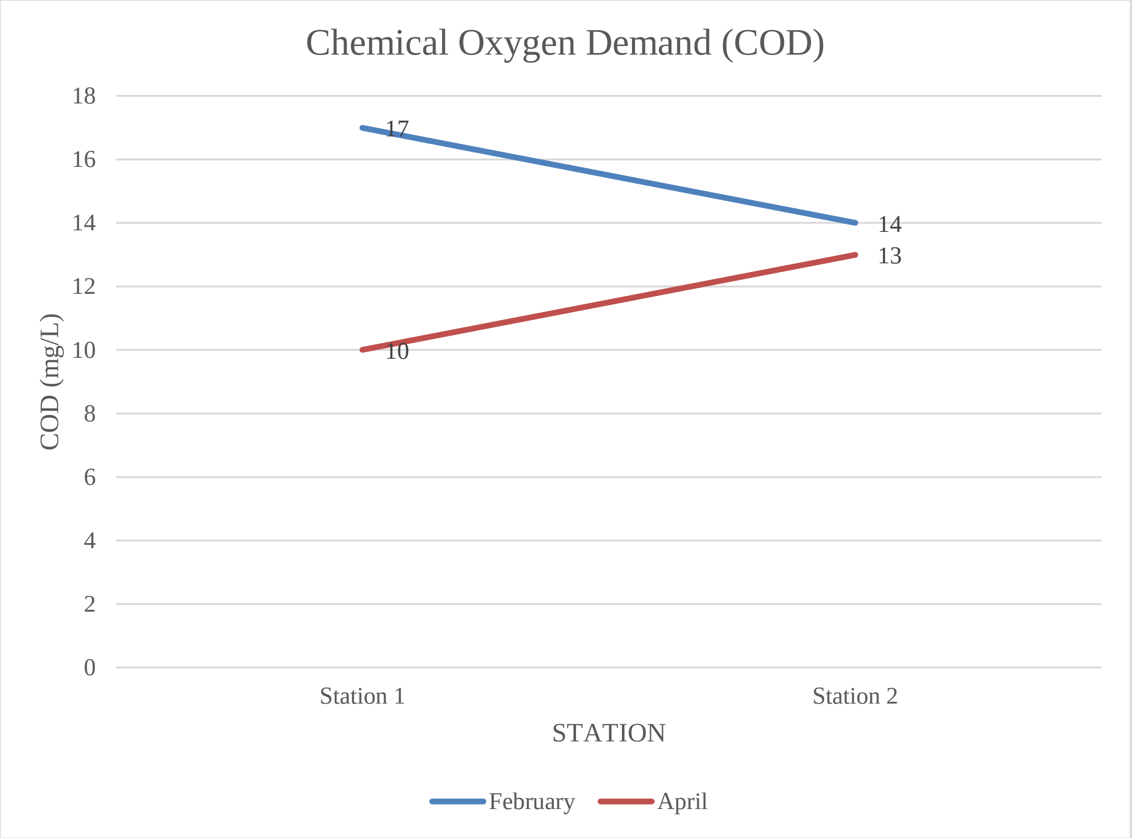


Figure 4.4 Chemical Oxygen Demand at two different station

Chemical Oxygen Demand (COD) is one of the parameter that can determine the level of pollution in the water according to chemical characteristics. From the Figure 4.5 above, the highest COD value was recorded at Station 1 in month of February but it decline in month of April. Same situation happen to Station 2 where the COD value decreased from 14 mg/L in month of February to 13 mg/L in month of April.

#### 4.3.3 pH

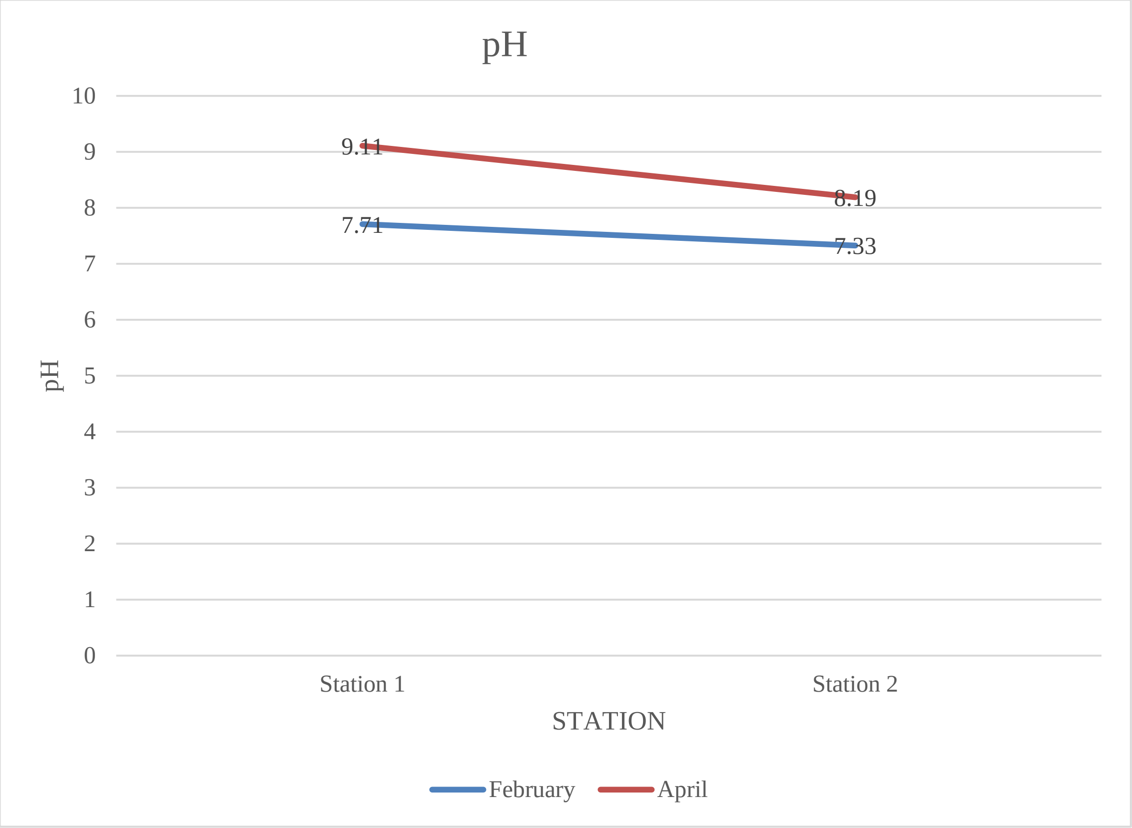


Figure 4.5 pH value at two different station

The pH value for the two station are both alkaline where the pH were above 7 and is suitable for the recreational purposes based on the WQI that range from 6-9. Based on Figure 4.6, the pH value were both increasing for both station from month of February to month of April. Although the pH were bit higher but the lake fall into Class IIB where it suitable for recreational activities purposes.

### 4.3.4 Dissolved Oxygen

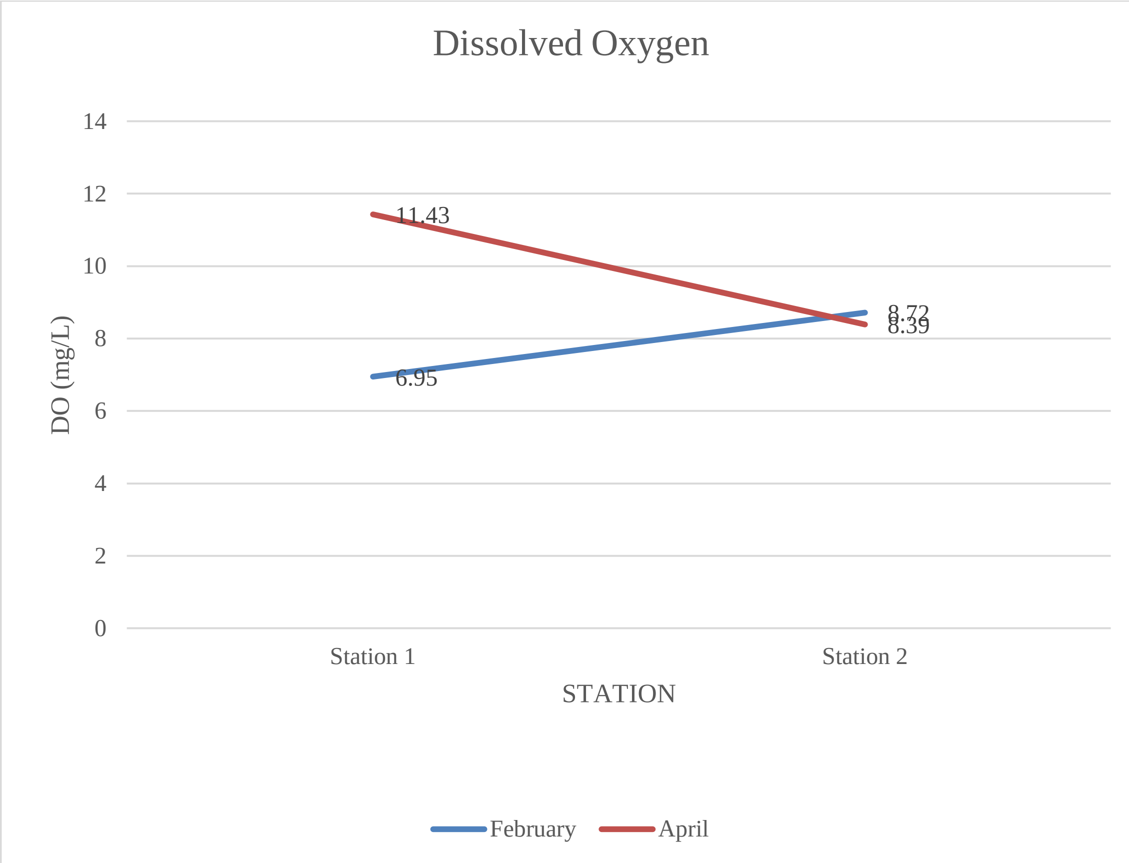


Figure 4.6 Dissolved oxygen presence at two different station

Figure 4.7 shows the saturation of dissolved oxygen of Titiwangsa Lake at two different station. The DO reading was taken at the surface of the water. Since the water was in stable condition, the Handheld Multiparameter equipment need to be move little bit as to record the DO reading as DO reading cannot be measured in static condition. Based on the graph above, the highest DO reading was recorded in month of April at Station 1 with 11.43 mg/L and the lowest reading was 6.95 mg/L at Station 1.

### 4.3.5 Ammoniacal Nitrogen

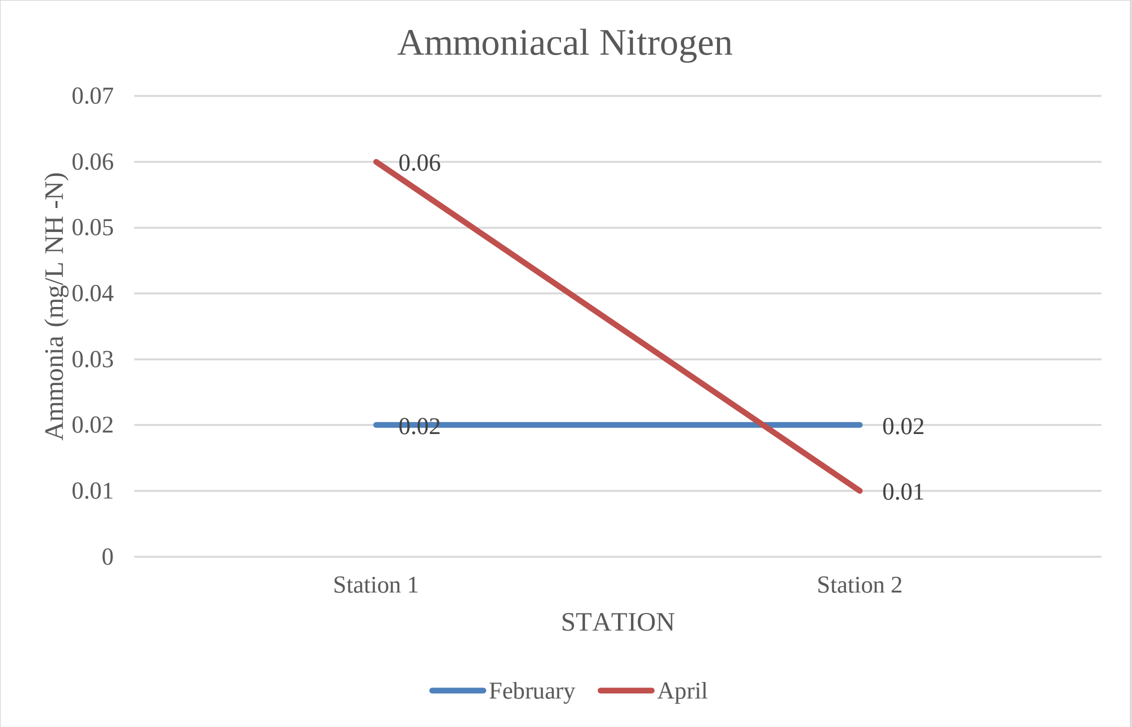


Figure 4.7 Ammoniacal nitrogen prsence at two different station

The highest amount of ammoniacal nitrogen may cause toxic effect to aquatic life that live in the lake. From Figure 4.8, the highest reading was 0.06 mg/L and the lowest is 0.01 mg/L. The higher reading of ammoniacal nitrogen indicate that it was presence in the lake. This can be prove with the experiment that being conducted where the sample turns to colourless green.

### 4.3.6 Nitrate

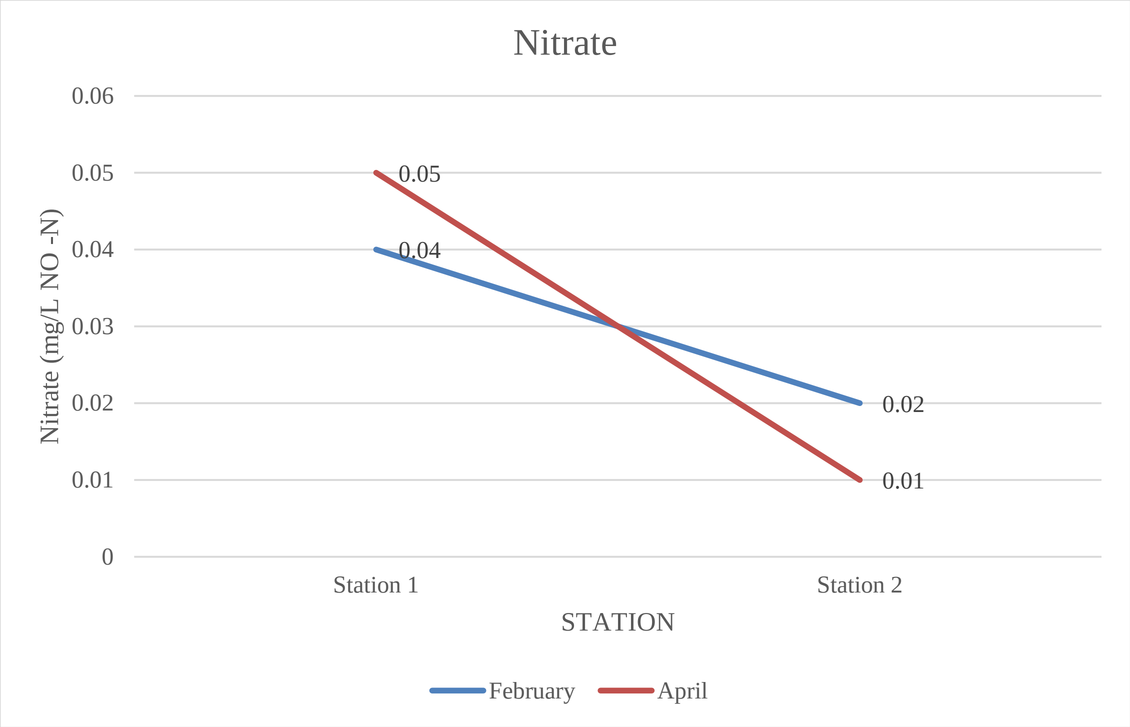


Figure 4.8 Nitrate presence at two diffrerent station

Station 1 recorded the highest nitrate presence with amount of 0.05 mg/L in month of April, a little bit higher than the reading recorded in moth of February. Station 2 recorded the lowest reading of nitrate with 0.01 mg/L. The higher reading of nitrate indicates that nitrate was presence in the lake as the sampler turns colourless pink during the experiment.

### 4.3.7 Phosphorus

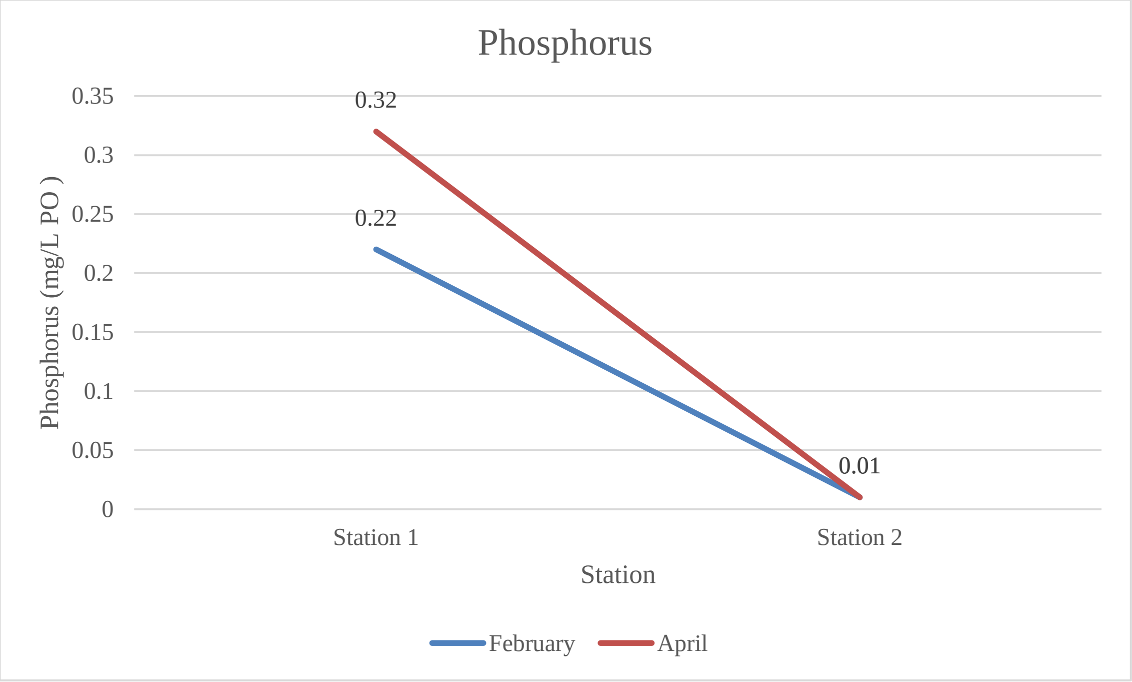


Figure 4.9 Phosphorus concentration at two different station

The highest amount of phosphorus can be found at Station 1 with amount of 0.22 mg/L and 0.32 mg/L within the two month of sample being taken. This can be prove as the sample at Station 1 turns colourless dark blue that indicates the present of phosphorus in the lake.

### 4.4 Heavy Metal

Total of four (4) heavy metal were being tested. There are Cadmium (Cd), Lead (Pb), Copper (Cu) and Zinc (Zn). Between these four heavy metal, zinc has been identified as the higher amount that being identified in the Titiwangsa Lake with amount of 0.353 mg/L at Station 1 in month of April. Between these four metal, Cadmium (Cd) shows negative reading where this indicates that there are no Cadmium (Cd) that being found in the Titiwangsa Lake.

#### 4.4.1 Cadmium (Cd)

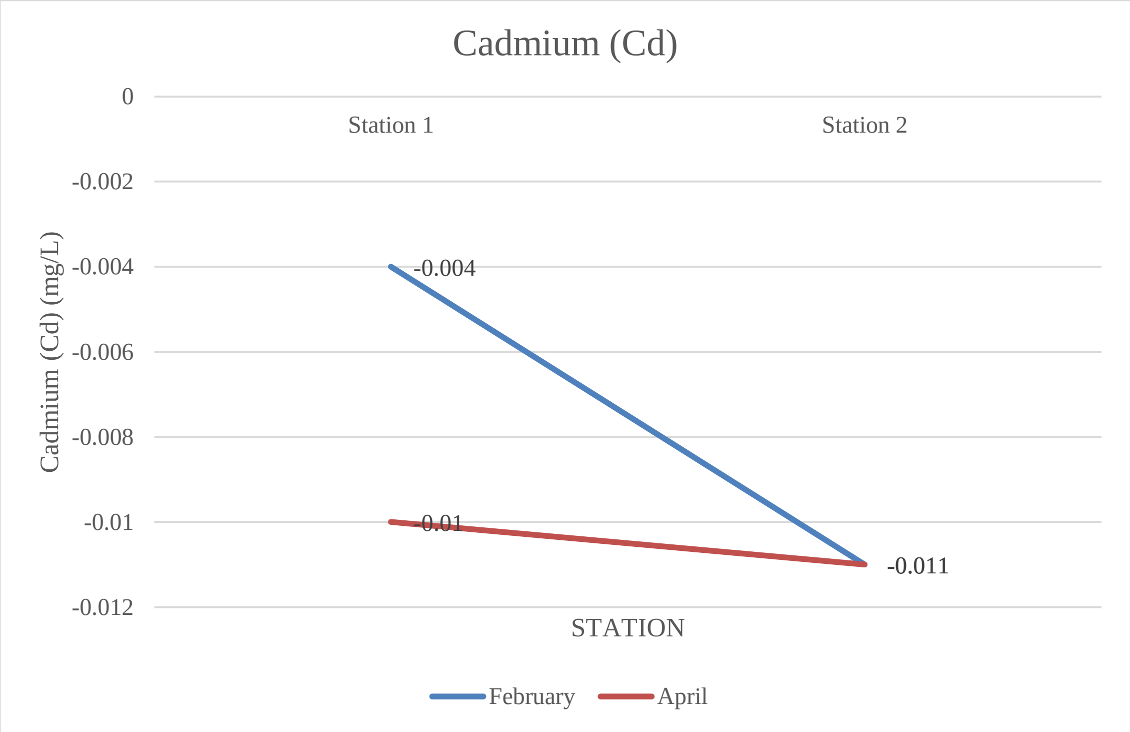


Figure 4.10 Cadmium concentration at two different station

### 4.4.2 Copper (Cu)

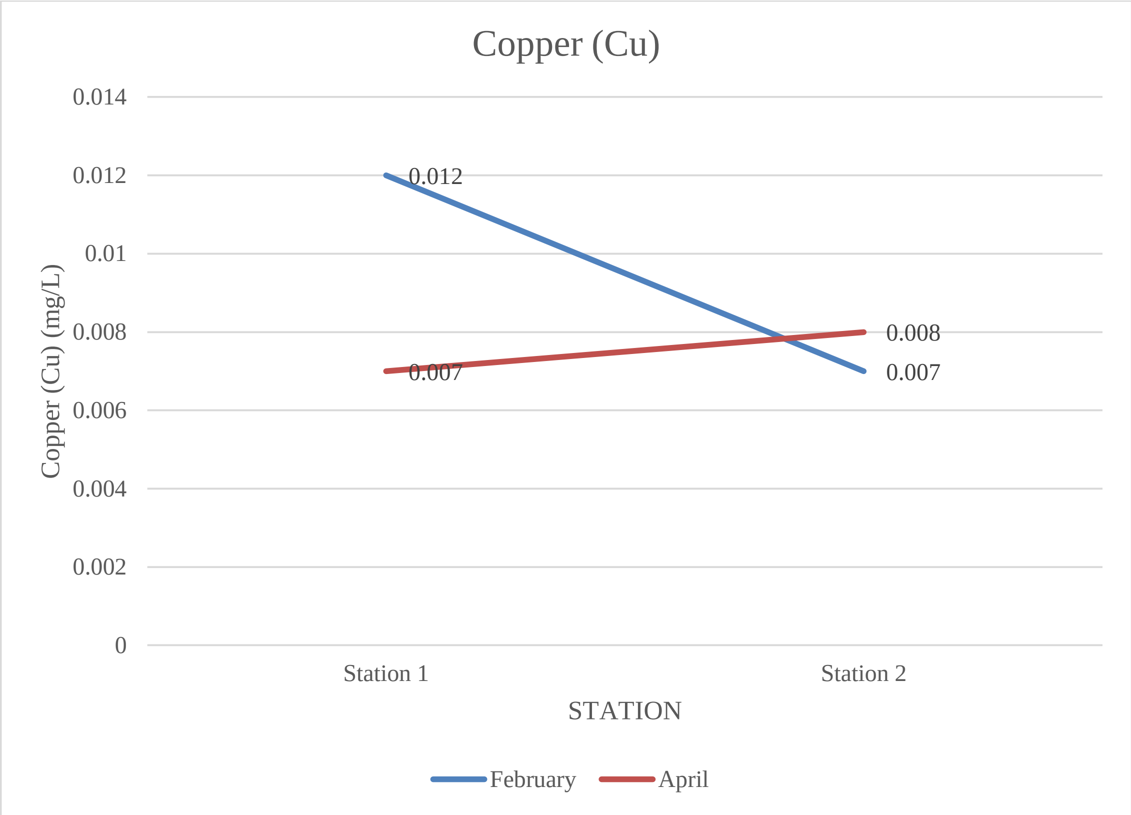


Figure 4.11 Copper concentration at two different station

### 4.4.3 Zinc (Zn)

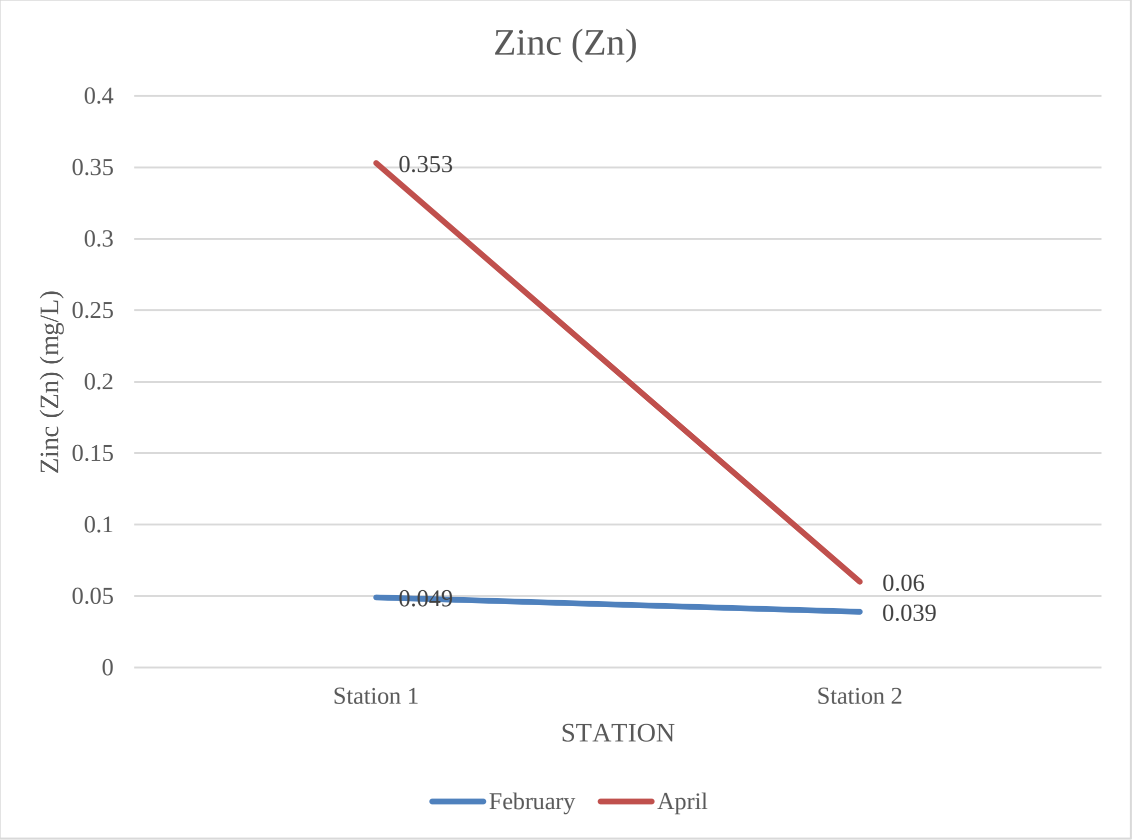


Figure 4.12 Zinc concentration at two different station

### 4.4.4 Lead (Pb)

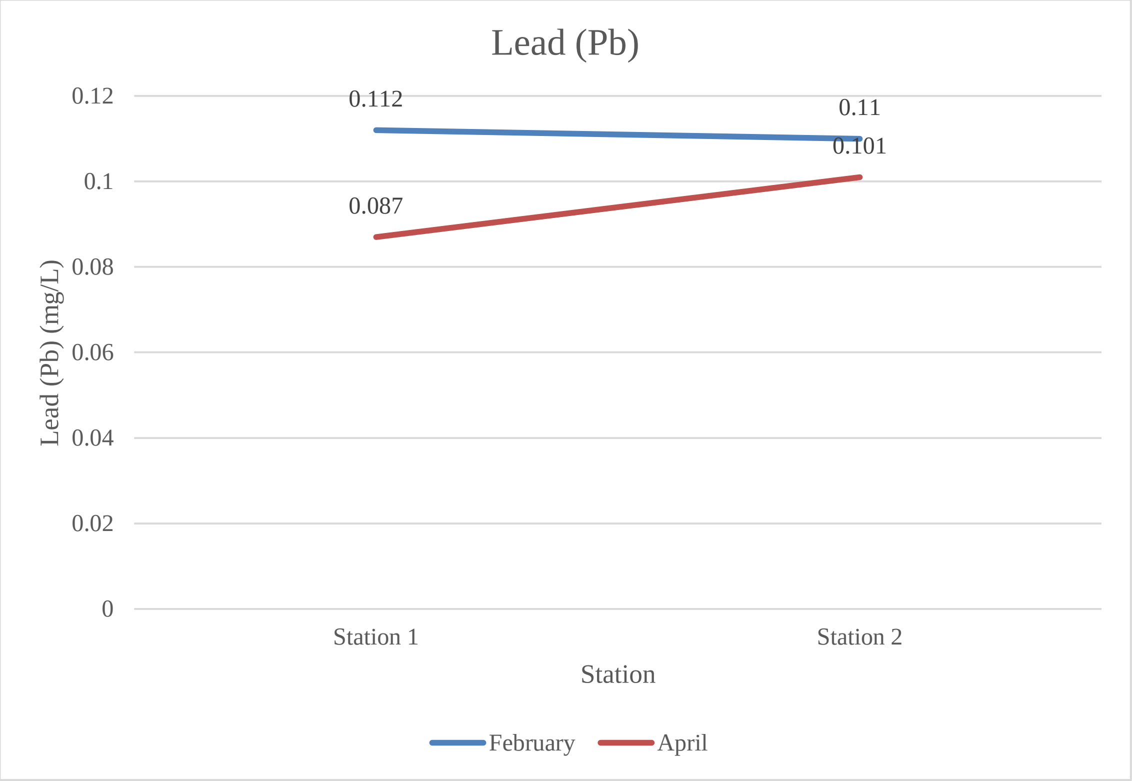


Figure 4.13 Lead concentration at two different station

### 4.5 Biological Parameter

### 4.5.1 Total Coliform Bacteria

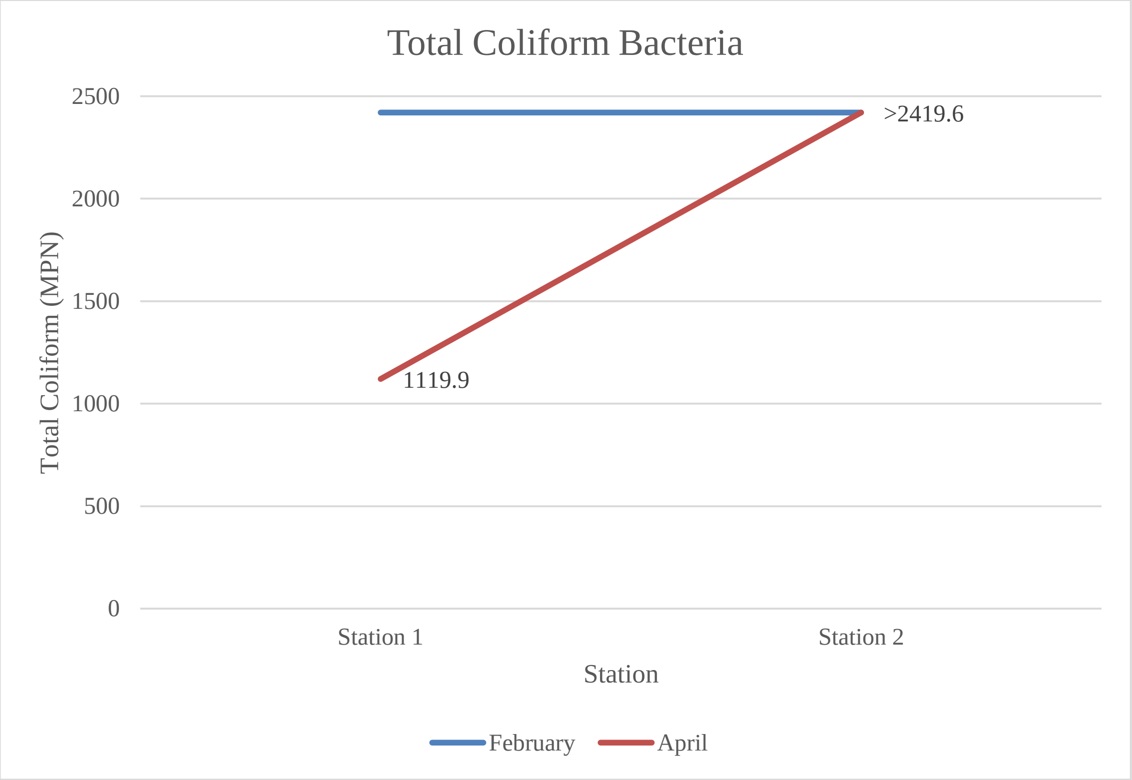


Figure 4.14 Total coliform bacteria presence at two different station

Based on Figure 4.15, Station 2 recorded the highest total coliform for both month with >2419.6 MPN. Total coliform included the bacteria that founded in the soil, water, human or animal faeces. Based on National Water Quality Standard (NWQS), total coliform that found in Titiwangsa Lake was being classes in Class IIB.

### 4.5.2 Escherichia coli (E.coli)

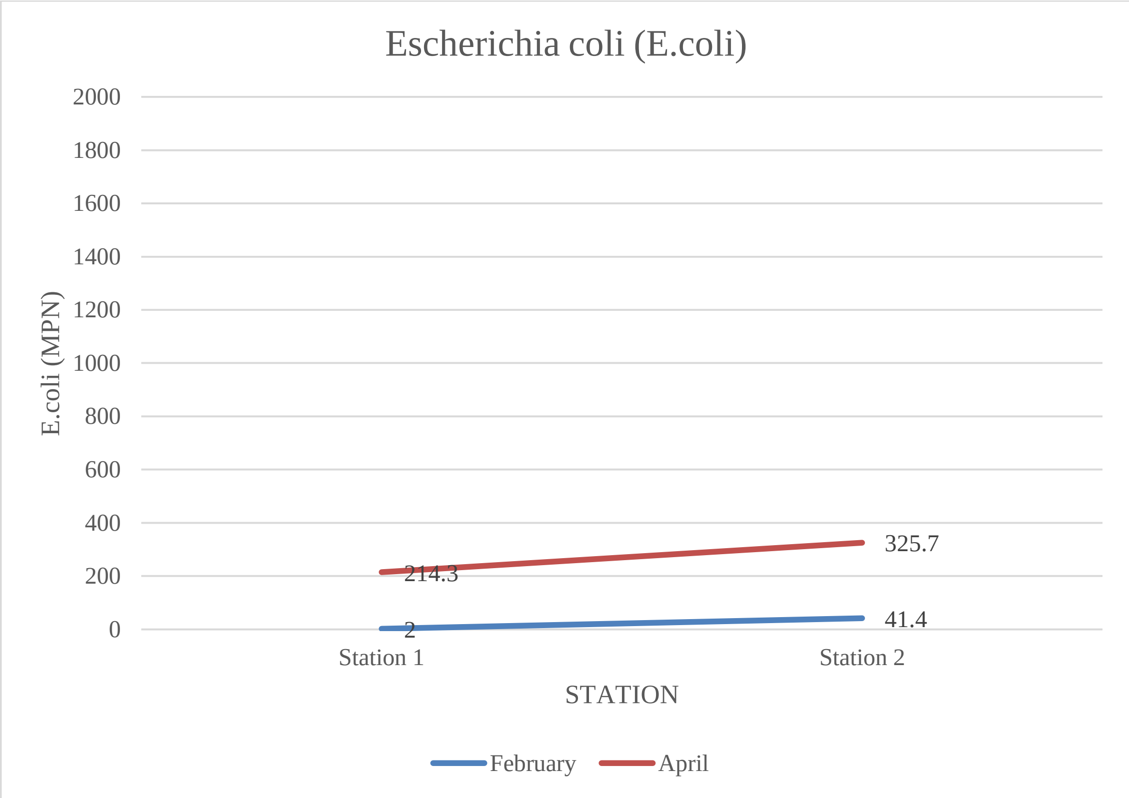


Figure 4.15 E.coli presence at two different station

E.coli functioning in releasing and decompose nutrients needed by the aquatic life that live in the lake. Based on Figure 4.16, Station 2 recorded the highest reading (325.7 MPN) of E.coli in month of April and the graph also show the increasing of E.coli from month of February to April for both station. Although the reading is highest but lowest reading of E.coli can contribute to human disease.

## 4.6 Water Quality Index Calculation

| Sampler | Station | Calculation | Class |
|---|---|---|---|
| 1ST Sampler (February) | 1 | (0.22 x 96.53) + (0.19 x 91.94) + (0.16 x 76.49) + (0.15 x 98.4) + (0.16 x 95.1) + (0.12 x 94.67) | 92.98<br>IIB |
| | 2 | (0.22 x 100) + (0.19 x 69.94) + (0.16 x 80.48) + (0.15 x 98.4) + (0.16 x 93.92) + (0.12 x 97.93) | 89.70<br>IIB |
| 2ND Sampler (April) | 1 | (0.22 x 100) + (0.19 x 80.16) + (0.16 x 85.8) + (0.15 x 94.2) + (0.16 x 93.34) + (0.12 x 63.59) | 87.65<br>IIB |
| | 2 | (0.22 x 100) + (0.19 x 88.34) + (0.16 x 81.81) + (0.15 x 99.45) + (0.16 x 92.19) + (0.12 x 83.49) | 91.56<br>IIB |

Figure 4.16 Calculation of WQI for Titiwangsa Lake

## 4.7 Summary Classification baesd on National Water Quality Index (NWQS)

| Parameter | Class |
|---|---|
| Ammoniacal Nitrogen | I |
| BOD | IIA / IIB |
| COD | IIA / IIB |
| DO | IIA / IIB |
| pH | IIA / IIB |
| TSS | I |
| Turbidity | I |
| Total Coliform | IIA / IIB |

Figure 4.17 Classification of parameter based on NWQS

### 4.8 Comparison based on WQI & NWQS

| Parameter | WQI (Class) | NWQS (Class) |
|---|---|---|
| DO | I | IIA / IIB |
| BOD | II | IIA / IIB |
| COD | II | IIA / IIB |
| Ammoniacal Nitrogen | I | I |
| Suspended Solid | I | I |
| pH | I | IIA / IIB |

Figure 4.18 Characteristic of water were compared based on WQI & NWQS

# CHAPTER 5

# CONCLUSION & RECOMMENDATIONS

## 5.1 Conclusion

As a conclusion, Titiwangsa Lake has been the heart of the city of Kuala Lumpur where it was the main attraction among people as one of the recreational park in Malaysia. In ensuring the comfortability and safety for the people that visit the lake every day, all safety measure and precautions around the lake should be taken care especially the water quality. Because of that, the research has been conduct in identifying the class of the water in the lake and the result has been discussed in Chapter 4.

All sixteen parameter has been analysed in laboratory and the result can being Classes into five (5) Class (I, IIA, IIB, III, IV, & VI) based on National Water Quality Standard (NWQS) and Water Quality Index (WQI). Overall, the parameter indicates that the lake has been fall into Class IIB that suitable for recreational purposes and thus it meets the requirements for a lake that suitable for recreational activities purposes. Rather than that, there are several disadvantages that may arise from the recreational activities that being happen in the Titiwangsa Lake. To ensuring that the quality of the water in the lake do not being disturbs, several actions should be taken as to avoid problems occur in the future.

## 5.2 Recommendations

Every day, Titiwangsa Lake will be visits by number of people that want to jogging, fishing, picnic, attending event and other but these activities can bring disturbance in terms of the comfortability and cleanliness towards the park. Therefore, there are some suggestion in maintaining the functions of the Titiwangsa Lake as a recreational park.

a) Increase the number of dustbin and place at location where people can easy to find. This is because there are people that like to throw the rubbish into the lake as they cannot find the dustbin and this will affect the quality of the water in the lake.

b) Place officer (2-3 people) as they can supervise the activities that being conduct around the lake especially if there was event that being conducted. This will help in arresting people that cannot obey the rule.

c) Limiting fishing activities around the Titiwangsa Lake. This is to ensure that they do not use inappropriate way to fishing such as using net or others that can disturb the aquatic live and change the quality of the water in the lake.

d) Cleaning works towards the lake should be done weekly. It can be seen that rubbish and dry leaf (from the tree) can be found in the lake. This is to ensure the lake can give comfortable and scenery view to the visitors.

### 5.2.1 Law Reinforcement

Stricter the law among the visitor helping in avoiding any damages that may happen to the lake. Firstly, increase the number of board that advertise the important of lake towards the human and aquatic life. With this way, it give conscience to people in thinking the implication that may happen if the lake are not being manage and clean properly. Next, monitoring and supervising the activities that being conducted around the lake. This is to avoid any illegal activities or misused of facilities that being provided there such as vandalism. Fines should be applied to those who do not obey the law and rule of the lake.

### 5.2.2 Lake Protection

Besides river and ponds, lake also need protection and proper management from the responsible parties as lake also one of the sources of water. This is to protect and maintain the quality of the water as the recreational purposes. The lake need to be clean at least once a week in order to keeping the lake clean and give comfortable view towards the visitors that came. Rather than that, fishing activities especially need to be the main focus. Excessive fishing activities may danger the aquatic species that live in the lake and disturbing their habitat.

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# APPENDIX A


Figure 1 Station 1 (February)

Figure 2 Station 1 (April)

Figure 3 Station 2 (February)

Figure 4 Station 2 (April)

Figure 5 Station 2 view

Figure 6 Parasite growth in the lake

# APPENDIX B

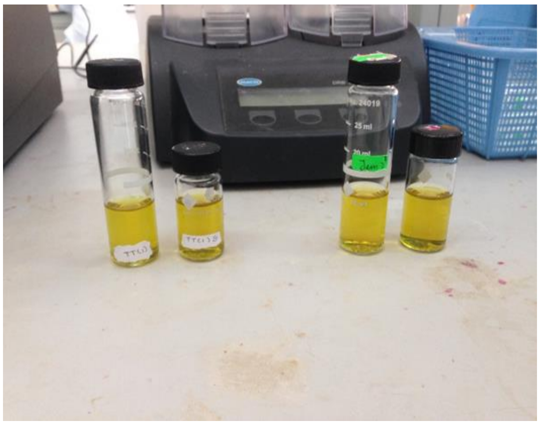


Figure 7 Ammoniacal Nitrogen (February)

Figure 8 Ammoniacal Nitrogen (April)

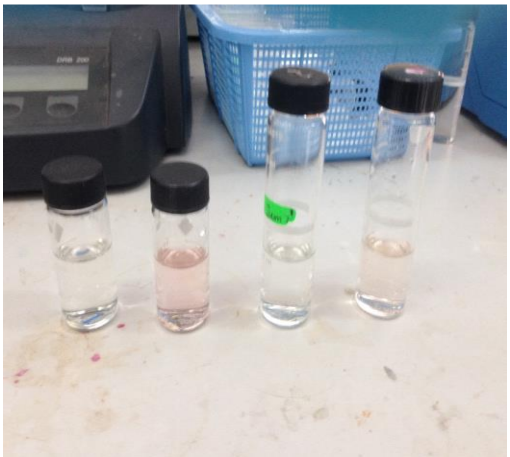


Figure 9 Nitrate (February)

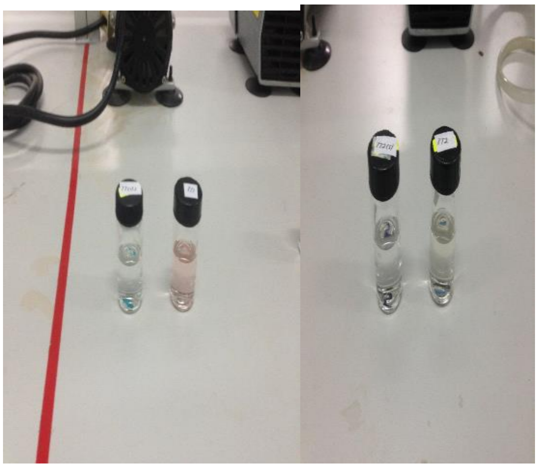


Figure 10 Nitrate (April)

Figure 11 Phosphorus (February)

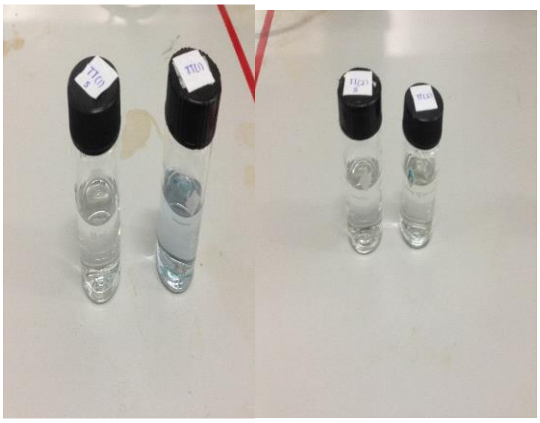
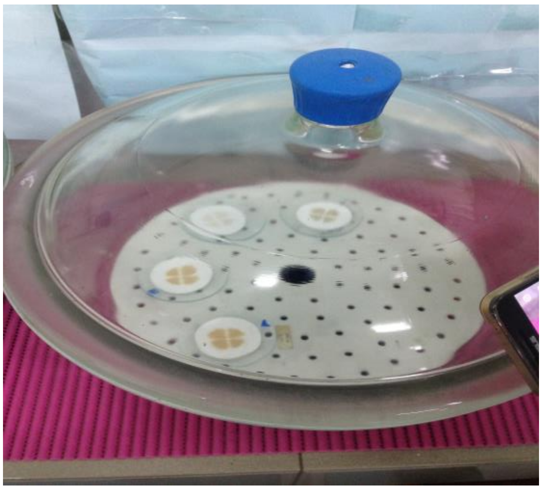


Figure 12 Phosphorus (April)



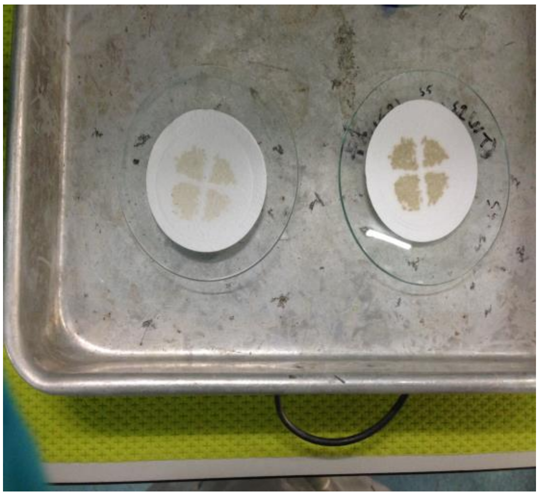


Figure 13 and 14 Total Suspended Solid test


Figure 15 COD Reactor Apparatus

Figure 16 Laboratory Partner