# ADVERSE EFFECT OF ANTHROPOGENIC ACTIVITIES ON WATER QUALITY OF THE SUNGAI LEMBING

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Bachelor of Engineering (Hons) in Civil Engineering

UNIVERSITI MALAYSIA PAHANG

# Adverse Effect of Anthropogenic Activities on Water Quality of the Sungai Lembing

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A report submitted in partial fulfillment of the requirement for the award of the degree of Bachelor of Civil Engineering (Honors)

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JUNE 2015

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***Special dedication to my beloved mother, Mdm. Winzi binti Abdullah Halim and my late father, Mr. Mohd Najib bin Mat Said***

***and also to my beloved siblings for the continuous support and love.***

# ACKNOWLEDGEMENTS

I would like to thank the Faculty of Civil Engineering for giving me a chance to carry out my study and also for the funding of my final year project (PSM). I am grateful and would like to express my sincere gratitude to my supervisor Dr. Mir Sujaul Islam for his guidance and constant. I also would like to express very special thanks to my friends Izzatulhanis binti Rosli and Nurul Masliana binti Khairil Anuar for their helps and the advice that they gave when I was carrying out the study. Without their support and interest, this thesis would not have been completed properly.

My sincere thanks also extends to all lab assistants and staffs from the Environment laboratory and, UMP who have been a big help the whole time that I spend in laboratory to complete my experiment. Also, big thanks to all my friends and roommates for their continuous support and help.

I acknowledge my sincere indebtedness and gratitude to my parents for their love, dream and sacrifice throughout my life. So, a very special thanks to both of them and also to my beloved family who have been my strength to keep striving on finishing my study. Last but not least, thanks to all those who have directly or indirectly helped me in completing this thesis.

# ABSTRACT

Water quality of the Sungai Lembing in Kuantan is influenced by anthropogenic activities. This river and its tributaries is important to human as water supply, domestic uses, fisheries, tourism and recreation. The characteristics of water quality in Sungai Lembing need to specify because it may affect the water quality of the river.The objectives of this study were to assess the water quality based on National Water Quality Standard (NWQS) and Water Quality Index (WQI) Malaysia and to identify the source of pollution for sustainable management in the Sungai Lembing. Water quality of Sungai Lembing is determined based on WQI and NWQS and the samples were collected at three different points and two sampling times. The parameters were divided into two types which were in situ measurement and laboratory measurement. Based on the concentration of pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), Ammoniacal Nitrogen ($NH^-{}_3N$) and Total Suspended Solid (TSS), the surface water of the Sungai Lembing was found to be slightly polluted. It shows that the mid-stream of the river was discovered to be more polluted contrast with the down and upper stream. It was the evidence of higher anthropogenic activities at that part. In conclusion, the Sungai Lembing is slightly polluted and apparently it is not suitable for tourist spot and the authority should take action to make proper extensive of the water treatment.

# ABSTRAK

Kualiti air di Sungai Lembing dipengaruhi oleh aktiviti antropogenik. Sungai ini dan kawasan sekitarnya begitu penting untuk penduduk kerana air sungai itu digunakan untuk bekalan air, kegunaan domestik, perikanan, pelancongan dan rekreasi. Ciri-ciri air di Sungai Lembing perlu ditentukan kerana ia akan memberi kesan kepada kualiti air. Objektif kajian ini adalah untuk menilai kualiti air Sungai Lembing berdasarkan Piawaian Kebangsaan Kualiti Air (NWQS) dan Index Kualiti Air (WQI) dan juga untuk mengenal pasti punca pencemaran di Sungai Lembing untuk pengurusan berkekalan. Kualiti air Sungai Lembing ditentukan berdasarkan NWQS dan WQI dan sampel air diambil pada tiga stesen berlainan dan dua kali persempelan. Semua parameter dibahagikan kepada dua iaitu pengukuran in-situ dan pengukuran di makmal. Berdasarkan nilai pH, BOD, COD, DO, NH3-N dan TSS, air dipermukaan Sungai Lembing didapati mengalami sedikit pencemaran. Stesen 2 mempunyai nilai pencemaran yang tinggi berbanding dengan Stesen 1 dan 3. Ini membuktikan yang Stesen 2 mempunyai aktiviti antropogenik yang tinggi. Dengan mengalami sedikit pencemaran, Sungai Lembing didapati tidak sesuai untuk dijadikan sebagai tarikan pelancong dan pihak berkuasa haruslah mengambil tindakan dengan menyediakan rawatan air yang berkesan.

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| WQI | Water Quality Index |
| NWQS | National Water Quality Standard |
| DO | Dissolved Oxygen |
| BOD | Biochemical Oxygen Demand |
| COD | Chemical Oxygen Demand |
| TSS | Total Suspended Solis |
| EC | Electrical Conductivity |

# CHAPTER 1

# INTRODUCTION

## 1.0 Background of Study

Water quality involved chemical, physical, biological and radiological characteristics water. It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose. It is often used by reference to a set of standards against which compliance can be assessed. Water quality is measured by some factors, for example the concentration of dissolved oxygen, the level of the bacteria, the salinity or the turbidity. In some bodies of water, the concentration of microscopic algae and quantities of pesticides, herbicides, heavy metals, and other contaminants may also be measured to determine water quality.

Anthropogenic activities result in significantly decrease of surface water quality of aquatic systems in watersheds. Rivers in a watershed play major role in assimilating or carrying off municipal and industrial wastewater and runoff from agricultural land. River inflows contribute main pollutants to most lakes in watershed, thereby tending to induce serious ecological and sanitary problems.

More than 90% of Malaysia's water supplies are derived from surface water sources. Many river systems are moderately to grossly pollute by domestic and

Industrial wastes. In 2011, a total of 4249 water quality monitoring stations located at 464 rivers were monitored in Malaysia. Out of these, 275 (59.3%) were found to be clean, 150 (32.3%) slightly polluted and 39(8.4%) are polluted. Thus, the rivers that have been polluted is due to the anthropogenic influences such as industrial activities and agricultural activities.

As in the Sungai Lembing, Pahang, Malaysia the industries are developing fast, the surface water is increasingly contaminated due to lack of proper treatment procedures. The river water of the study area contains higher BOD, COD, TSS,Co, Cd, Cr, Pb and Cu. Therefore, monitoring and assessment of the Sungai Lembing area have to be taken to find out the present status of water quality.

On the other hand, rivers constitute the main water resources for domestic, industrial, and irrigation purposes in a watershed. Thus it is imperative to prevent and control river pollution and to have reliable information on the quality of water for effective management.

## 1.1 Problem Statement

Water is an essential requirement of human life and activities associated with industry, agriculture, and others, and it considers one of the most delicate parts of the environment. In the last few decades, the accelerated pace of industrial development and progressive growth of population caused in tremendous increase in the demand of fresh water. The quality of surface and groundwater is identified in terms of its physical, chemical, and biological parameters. The water quality of rivers is characterized by a high level of heterogeneity in time and space, because of the distinction of cover-land around. This often creates difficulties to identify water conditions and pollution sources, which is necessary to control effectively pollution in addition to construct successful strategies for minimizing of contamination resources.

Anthropogenic pollutants related to land use result in drastic deterioration of aquatic systems in watersheds. Additionally, the rivers play an important role in assimilating municipal and industrial effluent as well as runoff from agricultural land and the surrounding area in a watershed. On the other hand, rivers comprise the most important water resources for irrigation, domestic water supply, industrial, and other purposes in a watershed, thereby tending to stimulate serious hygienic and ecological problems. Consequently, prevention and controlling of river pollution and reliable evaluation of water quality are an imperative stipulation for effective management. According to, human activities in particular husbandry livestock and agriculture play an important role in contributing contamination of river water among others pollutants.

The characteristics of water in Sg. Lembing need to specify because it may affect the water quality of the river. The characteristics of the river depend on the more factors. Regarding to the previous research, it said there have more natural factors which affect the characteristics of the water. So, this study will determine some of characteristics at Sg. Lembing and the factors that will affect it.

The study of water quality is important for development our country. It also can avoid the problem which related to our human society such as health and daily activities. It also will make the quantity of aquatic life will reduced. A residential at Sg. Lembing also will face health problem because the water have been polluted by the anthropogenic activities since the rivers is the main source of water for them.

## 1.2 Objectives

The objectives of the study are:

- To assess the water quality based on natural Water Quality Standard and Water Quality Index
- To identify the source of pollution for sustainable management in the Sungai Lembing

## 1.3 Scope of the Study

The scope of work for this project:

- The study are is at Sungai Lembing located in Kuantan area
- Identify the source of the anthropogenic activities and determine the effects of the anthropogenic activities to the water quality
- For in situ measurement, parameters that involved are pH, EC, temperature, Turbidity and DO

- BOD, COD, TSS, , ammoniacal nitrogen, suphate, phosphate and heavy metals were conducted as chemical analysis.
- The lab use is Environmental Laboratory

## 1.4 Significant of the Study

The research on the water quality of the river can use to clarify anthropogenic influences on river water quality. Thus, it provides better information about factors that affect water quality. From this research also able to determine the factors that affect water quality of the river. It’s also to examine and control for any important effects of natural variables.

# CHAPTER 2

# LITERATURE REVIEW

## 2.0 Introduction

Water is a transparent liquid which structures the world's streams, lakes, seas and downpour, and is the real constituent of the liquids of living things. As an issue aggravate, a water particle contains one oxygen and two hydrogen iotas that are joined by covalent bonds. Water is a fluid at standard surrounding temperature and weight, yet it regularly exists together on Earth with its robust state, ice; and vaporous state, steam (water vapour).Water covers 71% of the Earth's surface. It is key for all known types of life. On Earth, 96.5% of the planet's water is found in oceans and seas, 1.7% in groundwater, 1.7% in glacial masses and the ice tops of Antarctica and Greenland, a little portion in other expansive water bodies, and 0.001% circulating everywhere as vapour, mists (framed of strong and fluid water particles suspended in air), and precipitation. Only 2.5% of the Earth's water is freshwater, and 98.8% of that water is in ice and groundwater. Short of what 0.3% of all freshwater is in streams, lakes, and the environment, and a considerably littler measure of the Earth's freshwater (0.003%) are contained inside organic bodies and produced products. Water on Earth moves persistently through the water cycle of vanishing and transpiration (evapotranspiration), build up, precipitation, and runoff, normally arriving at the ocean. Vanishing and transpiration help the precipitation.

over area. Water utilized as a part of the creation of a decent or administration is known as virtual water.

A report, issued in November 2009, recommends that by 2030, in some creating areas of the world, water interest will surpass supply by 50%.Water assumes a vital part on the planet economy, as it capacities as an issue for a wide assortment of concoction substances and encourages modern cooling and transportation. More or less 70% of the crisp water utilized by people goes to agriculture.

## 2.1 Anthropogenic Activities

Anthropogenic activities can be divided to its effect, its processes, objects or the materials are those that can be produce by human activities as different to those occurring in natural environments without human influences. Mostly the term used in the perspective of environmental externalities in the form of chemical or biological wastes that is produced as by-product if not intentionally human activities. For example, the scientist thought that the primary factor driving climate change is because of man-made carbon dioxide.

### 2.1.1 Anthropogenic Source

a) Industry

- Gases and dust discharge into the atmosphere
- Waste disposal practices

b) Agriculture

- The changes of forest into fields and grasslands not exclude the slash-and-burn techniques
- Distraction of surface and groundwater
- The chemicals found in fertilizer and pesticides that polluted the soil
- Unclean water

## 2.2 Water Quality

Water quality is characterized regarding the chemical, physical, and natural substance of water. The changes of the seasons and geographic areas can affect the quality of water in rivers and lakes, even when there is no pollution present. There is no single measure that constitutes good water quality. Water used for irrigation may not meet drinking water guidelines but water fit for drinking can be used for irrigation. The quality of water suitable used for industrial processes is different for recreational purposes.

The nature of surface waters is an exceptionally touchy issue. Anthropogenic impacts (urban, mechanical and farming exercises, expanding utilization of water assets) and common procedures (changes in precipitation inputs, disintegration, and weathering of crustal materials) debase surface waters and debilitate their utilization for drinking, mechanical, horticultural, diversion or other purposes. (Simeonov et al, 2003)

Water quality is measured by a few variables, for example, the amassing of broke down oxygen, microorganisms levels, the measure of salt (or saltiness), or the measure of material suspended in the water (turbidity). In a few waterways, the centralization of minute green growth and amounts of pesticides, herbicides, overwhelming metals, and different contaminants might likewise be measured to focus water quality. Albeit experimental estimations are utilized to characterize water quality, it is not a straightforward thing to say "that water is great" or "that water is terrible." So, the determination is normally made in respect to the motivation behind the water – would it say it is for drinking or to wash an auto with or for some other reason? Poor water quality can represent a wellbeing danger for individuals. Poor water quality can likewise represent a wellbeing danger for biological system

### 2.2.1 Factors affect the water quality

There are a lot of factors that can affect the quality of water. The recharge water quality, the mineralogy of soils and aquifer sediments, the residence time in the ground water flow system, and the presence of nearby saline water are all related to the natural water quality of groundwater.

Be that as it may, the essential impact on groundwater quality (and additionally surface water quality) is the defilement achieved by human action. Different dangers incorporate nitrates from dairy and other animals operations, composts and pesticides in storm water overflow, lethal chemicals in leachate from risky waste locales, and disintegration from development destinations, unpaved streets, and ranch fields. Septic tank leachate helps the debasement of numerous water bodies by including nitrate nitrogen, microorganisms, infections, and engineered organics utilized as a part of family unit cleaning items and septic tank cleaners. Modern exercises can build centralizations of metals and lethal chemicals, include suspended dregs, expand temperature, and lower broke down oxygen in the water. Gas stockpiling regions (counting administration stations) may have breaks and spills of petroleum items. Roadways help petroleum toxins spilled from vehicles and metals from fumes exhaust. More established sterile landfills, whose leachate may contain numerous distinctive chemicals at moderately high focuses, additionally represent a danger.

**Factors affect water quality**

- Dissolved oxygen
- pH
- Temperature
- Decayed organic materials
- Pesticides

## 2.3 Quality of aquatic environment

The water quality in the lake watershed has been centred around for quite a while in the overall. With the procedure of worldwide industrialization, more contamination burden has been released into the water bodies. As an issue result, lake water contamination gets to be more genuine. Individuals have attempted a ton of procedures to enhance the water quality. Some of them are powerful; the water quality gets to be better after decrease of outer burden. Before contamination lessening, there is a reason to discover the key components of contamination source. A long haul pattern appraisal for water contamination is the basic venture in discovering the element. Some certain indictors, including DO, bacterial, straightforwardness, Zooplankton, phytoplankton, metals in dregs, are considered independently or consolidated together. The examination on transient varieties is additionally connected, for instance, a regular progression. In the event that individuals could discover the supplements stream of an exceptional lake, the contamination control issue could move into key variable administration. (Yajuan Yu. et al, 2010)

## 2.4 Aquatic Pollution by Anthropogenic Chemicals

Anthropogenic chemicals have done extensive harm to oceanic environments in the past and keep on doing so today. In the U.s., around 220000 miles of 969744 miles of waterways saw in 2009 were regarded to have altogether weakened biological community administrations, because of contamination by chemicals, for example, substantial metals, particularly mercury, pesticides, smelling salts, oils and polychlorinated biphenyls (U.s. EPA, 2010). This can be utilized as a pointer for biodiversity.

The negative impact of these chemicals on organic entities is primarily because of their lethality. The lethality relies on the species and situations concerned and also the properties of the synthetic included, (for example, the mix of a few contaminations or the acridity of the water). The threat postured by a contamination is in this way hard to gage (Relya, 2005). Contamination can contrarily influence bio systems by the annihilation of biological systems, moves in environments and bioaccumulation. These impacts hurt the underpinning environments and can essentially block biological community benefits that are paramount to us, for example, giving consumable water, saving fisheries, security from surges, and keeping herbivore levels sufficiently low to forestall overconsumption of vegetation (Mayer,et al., 2010).

## 2.5 Water Pollution

Water contamination happens when a waterway is unfavourably influenced because of the expansion of a lot of materials to the water. The wellsprings of water contamination are sorted as being a point source or a non-source purpose of contamination. Point wellsprings of contamination happen when the contaminating substance is emitted specifically into the conduit. A funnel heaving harmful chemicals specifically into a waterway is a case. A non-point source happens when there is overflow of contaminations into a conduit, for example when manure from a field is conveyed into a stream by surface spill over.

### 2.5.1 Types of water pollution

- Toxic Substance - A poisonous substance is a compound toxin that is not a characteristically happening substance in oceanic environments. The best givers to harmful contamination are herbicides, pesticides and mechanical mixes.

- Natural Substance - Organic contamination happens when an overabundance of natural matter, for example, compost or sewage, enters the water. At the point when natural matter increments in a lake, the quantity of decomposers will increment. These decomposers become quickly and utilize a lot of oxygen amid their development. This prompts an exhaustion of oxygen as the deterioration procedure happens. An absence of oxygen can execute amphibian living beings. As the sea-going organic entities bite the dust, they are broken around decomposers which prompt further exhaustion of the oxygen levels. A kind of natural contamination can happen when inorganic poisons, for example, nitrogen and phosphates aggregate in sea-going biological communities. Elevated amounts of these supplements cause an excess of plants and green growth.

- Thermal Pollution -- Thermal pollution can occur when water is used as a coolant near a power or industrial plant and then is returned to the aquatic environment at a higher temperature than it was originally. Thermal pollution can lead to a decrease in the dissolved oxygen level in the water while also increasing the biological demand of aquatic organisms for oxygen.

- Biological Pollution - Ecological contamination happens when synthetic contamination, natural contamination or warm contaminations are brought on by nature as opposed to by human movement. A sample of biological contamination would be an expanded rate of siltation of a conduit after an avalanche which would build the measure of residue in spill over water.

### 2.5.2 Source of water pollution

Farming:

- Farming frequently utilizes a lot of herbicides and pesticides, both of which are lethal poisons. These substances are especially hazardous to life in waterways, streams and lakes, where harmful substances can develop over a time of time.
- Farming additionally regularly utilizes a lot of synthetic composts that are washed into the conduits and harm the water supply and the life inside it. Composts can build the measures of nitrates and phosphates in the water, which can prompt the methodology of eutrophication.

Business:

- Clearing of area can prompt disintegration of soil into the stream.
- Waste and sewage created by industry can get into the water supply, bringing substantial natural contaminations into the biological system.
- Numerous mechanical and force plants use waterways, streams and lakes to dispose of waste hotness. The ensuing high temp water can result in warm contamination.

Homes:

- Sewage produced by houses or runoff from septic tanks into close-by conduits, present natural poisons that can result in eutrophication.
- Composts, herbicides and pesticides utilized for garden consideration can spill over and pollute the conduit. Likewise with agricultural composts, home fertilizers can prompt the eutrophication of lakes and waterways.

## 2.6 Water quality parameters

A river is a framework embodying both the principle course and the tributaries, convey the restricted stream of a critical heap of matter in broke down and particulate stages from both natural and anthropogenic sources. The nature of a stream anytime reflects a few real impacts, including the lithology of the basin, atmospheric inputs, climatic conditions and anthropogenic inputs (Bricker and Jones, 1995). Then again, rivers play a significant part in absorption or transporting municipal and industrial wastewater and runoff from farming land. Civil and industrial wastewater release constitutes a steady contaminating source, while surface runoff is a regular marvel, generally influenced by atmosphere inside the basin (Singh et al., 2004). Occasional varieties in precipitation, surface runoff, interflow, groundwater stream and pumped in and surges have a solid impact on river discharge and, accordingly, on the centralization of poisons in river water (Vega et al., 1998). Hence, the successful, long haul administration of streams obliges a major understanding of hydro-morphological, substance and organic attributes.(Shrestha.S and Kazama.F, 2007)

### 2.6.1 Biochemical Oxygen Demand (BOD)

BOD alludes to the measure of oxygen that would be devoured if all the organics in one litre of water were oxidized by microorganisms and protozoa (Revelle and Revelle, 1988). It likewise incorporates the oxygen needed for the oxidation of different synthetic in the water, for example, sulphides, ferrous iron and ammonia. While a broke down oxygen test purposed is to know the amount of oxygen is accessible, while a BOD test is to know the amount of oxygen is consistently expended.

BOD is controlled by measuring the dissolved oxygen level in a freshly gathered example and contrasting it with the dissolved oxygen level in a sample that was gathered in the meantime however incubated under particular conditions for a specific number of days. The distinction in the oxygen readings between the two examples in the BOD is recorded in units of mg/L.

The primary phase in measuring BOD is to get equivalent volumes of water from the area to be tested and dilute every sample with a known volume of refined water which has been altogether shaken to safeguard oxygen immersion. After this, an oxygen meter is utilized to focus the convergence of oxygen inside one of the vials. The remaining vial is than fixed and put in murkiness and tried five days later. BOD is then dictated by subtracting the second meter perusing from the first. The scope of conceivable readings can shift significantly: water from an uncommonly clear lake may demonstrate a BOD of short of what 2 ml/L of water. Raw sewage may give readings in the hundreds and sustenance handling squanders may be in the thousands.

Microorganisms, for example, microscopic organisms are in charge of deteriorating natural waste. At the point when natural matter, for example, dead plants, leaves, grass clippings, compost, sewage, or even nourishment waste is available in a water supply, the microbes will start the procedure of breaking down this waste. At the point when this happens, a significant part of the accessible disintegrated oxygen is devoured by high-impact microorganisms, burglarizing other oceanic living beings of the oxygen they have to live. Biological Oxygen Demand (BOD) is a measure of the oxygen utilized by microorganisms to disintegrate this waste. On the off chance that there is a substantial amount of natural waste in the water supply, there will likewise be a great deal of microbes present attempting to break down this waste. For this situation, the interest for oxygen will be high (because of all the microorganisms) so the BOD level will be high. As the waste is expended or scattered through the water, BOD levels will start to decrease. Nitrates and phosphates in a waterway can help high BOD levels. Nitrates furthermore phosphates are plant supplements and can result in vegetation and green growth to become rapidly. At the point when plants become rapidly, they likewise kick the bucket rapidly. This helps the natural waste in the water, which is then disintegrated by microorganisms. This results in a high BOD level. At the point when BOD levels are high, dissolved oxygen (DO) levels diminish in light of the fact that the oxygen that is accessible in the water is generally devoured by the microbes. Since less dissolved oxygen is accessible in the water, fish and other amphibian creatures may not survive.

| BOD Level *(in ppm)* | Water Quality |
|---|---|
| 1 - 2 | **Very Good**<br>There will not be much organic waste present in the water supply. |
| 3 - 5 | **Fair: Moderately Clean** |
| 6 - 9 | **Poor: Somewhat Polluted**<br>Usually indicates organic matter is present and bacteria are decomposing this waste. |
| 100 or greater | **Very Poor: Very Polluted**<br>Contains organic waste. |

**Figure 2.1:** BOD level

### 2.6.2 Chemical Oxygen Demand (COD)

COD is utilized as an issue of what might as well be called the natural matter substance of an example that is defenceless to oxidation by a solid concoction oxidant. For examples from a particular source, COD can be connected exactly to BOD, natural carbon, or natural matter. The test is valuable for observing and control after connection has been created. Oxidation of most natural mixes is 95 to 100 percent of the hypothetical worth. Alkali, show either in the waste or freed from nitrogen-containing natural matter, is not oxidized without critical convergence of free chloride particles (nineteenth Edition, Standard Methods, 1995).

The amount of oxygen in water is important to aquatic life. Decaying matter in sewage, industrial discharges, agricultural and urban runoff uses up the dissolved oxygen in water. The COD is a measure of the amount of chemicals (mostly organics) that consume dissolved oxygen. BOD is a measure of the amount of oxygen consumed by the bacteria that are decomposing organic matter.

As of late, with the increment of contamination by releasing extensive measure of different chemicals, ox disable natural substances of diverse matter enter in the sea-going framework. BOD values alone do not give an acceptable picture of natural matter battle of the water test. Likewise, the vicinity of different toxicant in the example. Furthermore, the vicinity of different toxicants in the specimen might seriously influence the legitimacy of BOD test. Henceforth synthetic oxygen interest (COD) test is a superior assessment of natural matter which needs no modernity and is efficient. However COD that is the oxygen devoured (OC) does not separate the stable natural matter from the shaky structure, subsequently the COD worth are not straightforwardly similar to that of BOD.

### 2.6.3 Dissolved Oxygen

Dissolved oxygen (DO) is a measure of the measure of oxygen dissolved in the water (percent or milligrams of oxygen for every litre of water). Amphibian bugs and fish that live in streams need sufficient dissolved oxygen to survive and flourish. Stream waters pick up oxygen from the environment and from plants as an issue of photosynthesis (the procedures by which plants transform the vitality from the sun into carbon dioxide and water to make sustenance). Microorganisms devour oxygen amid the breakdown of natural material from both common and man-made sources. The measure of dissolved oxygen in the stream water can be influenced by a reach or components and courses of action going ahead in the waterway. In the event that more oxygen is expended than is included or delivered, dissolved oxygen levels decay and some delicate oceanic creatures may move away, debilitate or bite the dust.

Dissolved oxygen levels vary regularly and over a 24-hour period. Oxygen levels are typically most reduced just before first light and most astounding at some point in midday .Sea-going plants can impact dissolved oxygen levels in water as plants produce disintegrated oxygen amid the daytime and devour dissolved oxygen overnight (photosynthesis).

The levels additionally shift with water temperature. Icy water holds more oxygen than warm water. The release of warm water to a stream raises the water temperature and brings down the oxygen substance (see chart beneath). Sea-going creatures presented to low disintegrated oxygen focuses may be more defenceless to antagonistic impacts of different stressors, for example, ailment and harmful substances. A hourly profile of dissolved oxygen levels at an examining site is an important situated of information on the grounds that it demonstrates the change in the disintegrated oxygen levels from the low indicate just before first light the high point at some point in the midday

Dissolved oxygen is one of the prime oxidizing species included in cell digestion system and in microbiological and consumption forms. (Eduardo Silva. et al, 2014). Checking and in the long run keeping up of different physiochemical parameters, particularly pH and dissolved oxygen is viewed as essential in the vast majority of the bioprocess advancements as these elements portray the biochemical offset. By and large, both pH and dissolved oxygen controlled environment emphatically impacts the natural responses and utilized as quality parameters; e.g. wastewater treatment, cell society tests, ecological observing, clinical investigation of blood and body liquids, microbial maturation and microbial consumption process, freshness of sustenance and water. In any case the deficiencies are accounted for including, powerless to long haul float, intrusive, requires regular adjustment, and not suitable for concurrent recognition particularly for low-oxygen situations, the electrochemical systems are generally acknowledged for its robustness and unwavering quality.(Deepa.N and Balaji Ganesh A., 2014)

The centralization of dissolved oxygen in a stream is influenced by numerous elements:

- Temperature: Oxygen is all the more effortlessly disintegrated in frosty water.
- Human Activities Affecting DO:
  i. Evacuation of riparian vegetation may lower oxygen focuses because of expanded water temperature coming about because of an absence of shade and expanded suspended solids coming about because of disintegration of exposed soil.
  ii. Natural squanders and other supplement inputs from sewage and modern releases, septic tanks and rural and urban overflow can bring about diminished oxygen levels. Nutrient enters frequently prompt unnecessary algal development. At the point when the green growths kick the bucket, the natural matter is deteriorated by microbes. Bacterial disintegration expends a lot of oxygen.
  iii. Dams may represent an oxygen supply issue when they discharge waters from the base of their repositories into streams and waterways. Despite the fact that the water on the base is cooler than the warm water on top, it might be low in oxygen if a lot of natural matter has tumbled to the base and has been deteriorated by microscopic organisms.

### 2.6.4 Ammoniacal Nitrogen

Ammonia or $NH_3$: It is one of the most important pollutants in the aquatic environment because of its relatively highly toxic nature and its ubiquity in surface water systems. It is discharged in large quantities in industrial, municipal and agricultural waste waters. In aqueous solutions, ammonia assumes two chemical forms: $NH_4^+$ - ionized (less/nontoxic) and $NH_3$ - unionized (toxic).The relative concentration of ionized and unionized ammonia in a given ammonia solution are principally a function of pH, temperature and ionic strength of the aqueous solution (Fundamentals of Aquatic Toxicology, 1985): Total $NH_3$: Total ammonia is the sum of the $NH_3$ and $NH_4$.

Ammonia nitrogen (N) is available in variable focuses in numerous surface and ground water supplies. A result of microbiological movement, alkali when found in characteristic water is viewed as demonstrative of sterile contamination. Ammonia is quickly oxidized by certain microscopic organisms, in common water frameworks, to nitrite and nitrate- -a process that requires the vicinity of dissolved oxygen. Alkalis, being a wellspring of nitrogen are additionally a supplement for green growth and different types of vegetation and consequently help over-burdening of characteristic frameworks and reason contamination. In fish, ammonia speaks to the deciding result of protein digestion system and what is paramount is whether it is available in the un-ionized structure as free alkali, Nh3, which is dangerous to fish (both freshwater and marine) at >0.03 mg/L (ppm), or in the ionized structure, Nh4+, in which it is harmless. The relative centralization of each is pH and temperature subordinate. The higher the pH, the greater amount of the Nh3 will be available. Ammonia can cut oxygen move in the gills of fish, in this way bringing on prompt and long haul gill harm. Fish experiencing ammonia harming will seem slow and rise up to the top, as though panting for air. In marine situations, the safe level of $Nh_4^+$ is somewhere around 0.02 and 0.4.

### 2.6.5 Total Suspended Solid (TSS)

Total suspended solids allude to little strong particles which stay in suspension in water as an issue or because of the movement of the water. It is utilized as one pointer of water quality. It is some of the time curtailed SS, however is not to be mistaken for settle able solids, likewise contracted SS, which help the obstructing of sewer funnels. There is also a measure of total dissolved solids which refers to the solids which are present once the water has been evaporated.

TSS is imperative as toxins and pathogens are carried on the surface of particles. The littler the molecule measure, the more prominent the aggregate surface zone for every unit mass of molecule, along these lines the higher the contamination stack that is liable to be conveyed. Suspended solids are a marker of water quality. The measure of suspended solids shows how overcast the water is. It is for the most part utilized on waste water as it has an immediate impact on the expense of treating the water.

The utilization of an exceptionally straightforward material channel, comprising of a collapsed cotton sari, radically decreases the heap of cholera conveyed in the water, and is suitable for utilization by the extremely poor; for this situation, a fitting engineering strategy for sanitization may be included, for example, sun based water cleansing. A real special case to this speculation is arsenic tainting of groundwater, as arsenic is an intense poison which is dissolvable and hence not evacuated when suspended solids are uprooted. This makes it exceptionally hard to evacuate, and discovering an option water source is frequently the most reasonable alternative.

### 2.6.6 pH

pH is a paramount constraining substance element for amphibian life. In the event that the water in a stream is excessively acidic or essential, the H+ or OH- particle movement may upset oceanic living beings biochemical responses by either hurting or slaughtering the stream creatures. pH is communicated in a scale with extents from 1 to 14. An answer with a pH short of what 7 has more H+ movement than OH-, and is viewed as acidic. An answer with pH esteem more noteworthy than 7 has more OH- action than H+, and is viewed as essential. The pH scale is logarithmic, implying that as you go all over the scale, the qualities change in elements of ten. A one-point pH change shows the quality of the corrosive or base has expanded or diminished tenfold. Streams for the most part have a pH qualities extending somewhere around 6 and 9, contingent on the vicinity of dissolved substances that originate from bedrock, soils and different materials in the watershed. Changes in pH can change the parts of water science. Case in point, as pH builds, littler measures of alkali are required to achieve a level that is lethal to fish. As pH abatements, the centralization of metal may increment on the grounds that higher acridity expands their capacity to be disintegrated from silt into the water (1991, Streamkeeper's Field Guide: Watershed Inventory and Stream Monitoring Methods)

In a lake or pond, the water's pH is influenced by its age and the chemicals released by groups and commercial ventures. Most lakes are essential (antacid) when they are initially structured and get to be more acidic with time because of the manufacture up of natural materials. As natural substances rot, carbon dioxide ($Co_2$) structures and consolidates with water to deliver a feeble corrosive, called "carbonic" corrosive — the same stuff that is in carbonated sodas. A lot of carbonic corrosive bring down water's pH. Most fish can endure pH estimations of around 5.0 to 9.0, however genuine fishers search for waters between ph 6.5 and 8.2. The greater part of American waterways, lakes and streams fall inside this reach, however corrosive downpour has bargained numerous waterways in our surrounding.

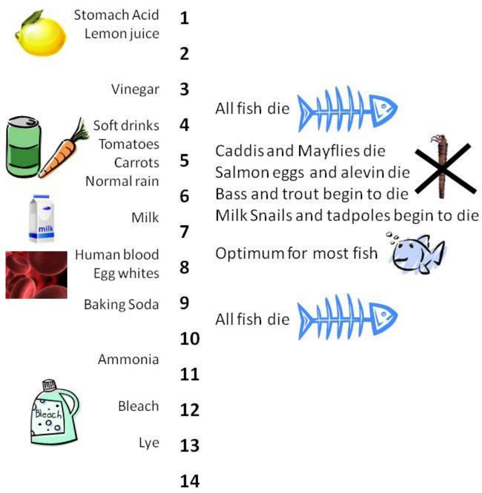



**Figure 2.2:** pH level

**<u>Factors affecting pH value</u>**

I. The concentration of carbon dioxide in the water

- Carbon dioxide ($Co_2$) enters a water body from a mixture of sources, including the climate, runoff from area, discharge from microscopic organisms in the water, and breath by amphibian creatures. This broke up $Co_2$ structures a feeble corrosive. Regular, unpolluted rainwater can be as acidic as pH 5.6, on the grounds that it assimilates $Co_2$ as it falls through the air. Since plants take in $Co_2$ amid the day and discharge it amid the night, pH levels in water can change from daytime to night

II. Geography and Soils of the watershed

- Acidic and antacid mixes can be discharged into water from distinctive sorts of rock and soil. At the point when calcite ($Caco_3$) is available, carbonates ($Hco_3$, $Co_{3-2}$) can be discharged, expanding the alkalinity of the water, which raises the ph. At the point when sulphide minerals, for example, pyrite, or "fool's gold," ($Fes_2$) are available, water and oxygen collaborate with the minerals to structure sulphuric corrosive ($H_2so_4$). This can essentially drop the pH of the water. Waste water from timberlands and bogs is regularly somewhat acidic, because of the vicinity of natural acids delivered by rotting vegetation.

III. Drainage from Mine Sites

- Digging for gold, silver, and different metals frequently includes the evacuation of sulphide minerals covered in the ground. At the point when water streams over or through sulphuric waste rock or tailings uncovered at a mine site, this water can get to be acidic from the arrangement of sulphuric corrosive. Without buffering material, for example, calcareous rocks, streams that get seepage from mine locales can have low pH levels.

Aquatic species are by all account not the only ones influenced by ph. While people have a higher resistance for pH levels (drinkable levels range from 4-11 with insignificant gastrointestinal bothering), there are still concerns pH values more prominent than 11 can result in skin and eye disturbances, as does a pH underneath 4. A pH esteem beneath 2.5 will result in irreversible harm to skin and organ linings. Lower pH levels build the danger of activated dangerous metals that can be assimilated, even by people, and levels over 8.0 can't be adequately cleaned with chlorine, bringing on other aberrant dangers.

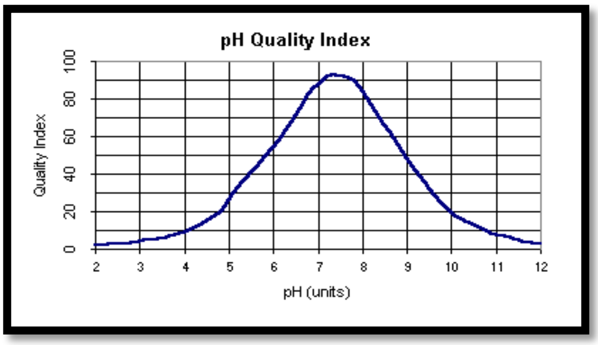



**Figure 2.3:** pH Quality Index

Indeed minor pH changes can have long haul impacts. A slight change in the pH of water can expand the solvency of phosphorus and different supplements – making them more available for plant development.

### 2.6.7 Turbidity

Turbidity is a measure of the cloudiness of water. Shadiness is brought about by suspended solids (for the most part soil particles) and tiny fish (infinitesimal plants and creatures) that are suspended in the water section. Reasonably low levels of turbidity may demonstrate a solid, well-working environment, with moderate measures of microscopic fish present to fuel the fuel the natural way of life. Be that as it may, larger amounts of turbidity represent a few issues for stream frameworks. Turbidity closes out the light required by submerged sea-going vegetation. It additionally can raise surface water temperatures above typical in light of the fact that suspended particles close to the surface encourage the retention of high temperature from daylight.

Turbid waters might likewise be low in disintegrated oxygen. High turbidity may come about because of residue bearing overflow, or supplements inputs that cause microscopic fish blossoms (1991, Streamkeeper's Field Guide: Watershed Inventory and Stream Monitoring Methods).

Material that is suspended in water permits less light to pass through the water; along these lines this builds the temperature of the water on the grounds that the suspended particles hold more hotness. Since warm water holds less dissolved oxygen than icy water, the centralization of disintegrated oxygen gets to be diminished and this influences the fish and other water life forms that need oxygen to live. In that capacity, suspended particles can stop up fish gills, that brings about decreased imperviousness to sickness, diminished development rates, and influences egg and fish larval improvement.

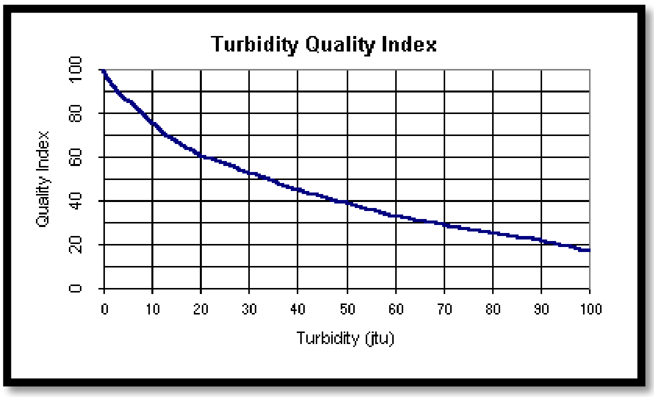



**Figure 2.4:** Turbidity Quality Index

Turbidity can be valuable as a pointer of the impacts of overflow from development, farming works on, logging exercises, storm water, and wastewater releases. Turbidity frequently builds forcefully amid a precipitation, particularly in created neighbourhoods (or urbanized watersheds) that have moderately more cleared surfaces than country neighbourhoods. The stream of storm water runoff from cleared surfaces quickly expands the disintegration rates of stream banks and waterway channels. Turbidity can likewise climb strongly amid dry climate if earth-irritating exercises (i.e. amid development) are happening in or close to a stream that does not have disintegration control rehearse set up.

Though water transparency is an imperative quality parameter that can't be disregarded, it additionally can't be consolidated into a trophic file utilizing the same calculation with respect to alternate elements. This is on the grounds that straightforwardness is the resultant of no less than three part works that focus light ingestion and disseminating: (a) water in addition to water broken down substances, (b) biomass, (c) mineral turbidity (Bukata et al., 1991a). (Vollenwieder R.A et al. 1998)

### 2.6.8 Temperature

Considered alone, water temperature can influence the metabolic rates and organic movement of sea-going organisms. As being what is indicated, it impacts the picked territories of a mixture of amphibian life. A few creatures, especially amphibian plants prosper in hotter temperatures, while a few fishes, for example, trout or salmon incline toward colder streams. Studies have demonstrated an immediate relationship between metabolic rates and water temperature. This happens as numerous cell proteins are more dynamic at higher temperatures. For most fish, a 10°c increment in water temperature will more or less twofold the rate of physiological capacity. This increment in metabolic rate can be taken care of by a few animal groups better than others. Expanded metabolic capacity can be recognized in breath rates and digestive reactions in many species. Expanded breath rates at higher temperatures lead to expanded oxygen utilization, which can be negative if rates stay raised for an augmented time of time. Moreover, temperatures over 35°c can start to denature, or breakdown, catalysts and decreasing metabolic capacity. Recent studies have highlighted that temperature played an important role in water quality change in lake system (Spearset al., 2008; Xia and Zhang, 2008; Chowdhury and Al Bakri, 2006;Christina et al., 2004; Zhang et al., 2008; Liikanen et al., 2002). In small shallow river whose inflow composes by domestic sewage and farm drainage, temperature impacts the whole water ecological system.( Lei Xua, et al. 2012)

### 2.6.9 Heavy Metal

Studies on heavy metals in rivers, lakes, fish and sediments have been a major environmental focus especially in the last decades (Ali and Fishar, 2005). Water pollution by trace metal ions is one of our most serious environmental problems. Effluents resulting from daily domestic and industrial activities may induce considerable changes in the physical and chemical properties. (Mohamed E. Goher et al, 2014). Vast amounts of dangerous chemicals particularly.

Metals are presented in sea-going frameworks as an aftereffect of the weathering of soils and rocks, from volcanic ejections, and from a mixed bag of human exercises including the mining, transforming, or utilization of metals and/or substances that contain metal contaminations. The most well-known substantial metal toxins are arsenic, cadmium, chromium, copper, nickel, lead and mercury. There are diverse sorts of wellsprings of toxins: point sources (restricted contamination), where poisons originate from single, identifiable sources. The second sort of contamination sources are nonpoint sources, where contaminations originate from scattered (and frequently hard to distinguish) sources. There are just a couple of cases of confined metal contamination, in the same way as the regular weathering of mineral bodies and the minimal metal particles originating from coal-smoldering force plants through smokestacks in air, water and soils around the industrial facility. The most well-known metal contamination in freshwater originates from mining organizations. They generally utilize a corrosive mine waste framework to discharge overwhelming metals from minerals, in light of the fact that metals are extremely solvent in a corrosive arrangement.

Substantial metals have been discharged into streams worldwide due to worldwide fast populace development and serious local exercises, and also extending modern and horticultural creation (Srebotnjak et al., 2012; Su et al., 2013; Islam et al., 2014). Waterways in urban territories have additionally been connected with water quality issues due to the act of releasing of untreated household and modern waste into the water bodies which prompts the increment in the level of metals in stream water (Khadse et al., 2008; Venugopal et al., 2009).

### 2.6.10 Electrical Conductivity (EC)

The electrical conductivity of water estimates the total amount of solids dissolved in water -TDS, which stands for Total Dissolved Solids. TDS is measured in ppm (parts per million) or in mg/l. Conductivity is a measure of the capacity of water to pass an electrical ebb and flow. Conductivity in water is influenced by the vicinity of inorganic broke up solids, for example, chloride, nitrate, sulphate, and phosphate anions (particles that convey a negative charge) or sodium, magnesium, calcium, iron, and aluminium actions (particles that convey a positive charge). Natural mixes like oil, phenol, liquor, and sugar don't direct electrical momentum exceptionally well and in this way have a low conductivity when in water. Conductivity is additionally influenced by temperature: the hotter the water, the higher the conductivity. Thus, conductivity is accounted for as conductivity at 25 degrees Celsius (25°C).

**Factors Affecting the Electrical Conductivity of Water**

- While the electrical conductivity is a decent marker of the aggregate saltiness, it still does not give any data about the particle creation in the water.
- The same electrical conductivity qualities can be measured in low quality water (e.g. water rich with Sodium, Boron and Fluorides) and in addition in great watering system water (e.g. satisfactorily treated water with suitable supplement focuses and proportions)

### 2.6.11 Phosphate

The vicinity of phosphorus is frequently rare in the all-around oxygenated lake waters and critically, the low levels of phosphorus cut off the creation of freshwater frameworks (Ricklefs, 1993).Unlike nitrogen, phosphate is held in the dirt by a perplexing arrangement of organic uptake, retention, and mineralization. Phosphates are not dangerous to individuals or creatures unless they are available in abnormal states. Digestive issues could happen from greatly elevated amounts of phosphate. The dissolvable or bio-accessible phosphate is then utilized by plants and creatures. Subsequently, the accessibility of phosphorus is a key component controlling photosynthesis.

### 2.6.12 Sulphate

Sulphur is a vital plant supplement. Aquatic creatures use sulphur and decreased fixations have an adverse impact on algal development. The most widely recognized type of sulphur in very much oxygenated waters is sulphate. A sulphur cycle exists which incorporates air sulphur dioxide (SO2), sulphate particles (SO22-) and sulphides (S-). Sulphides, particularly hydrogen sulphide (H2S), are truly solvent in water and are harmful to both people and fish. They are delivered under conditions where there is an absence of oxygen (anaerobic). As a result of their foul "spoiled egg" smell they are stayed away from by both fish and people. Sulphides framed as an aftereffect of corrosive mine spill over from coal or other mineral extraction and from mechanical sources may be oxidized to frame sulphates, which are less harmful.

Sulphates are not viewed as dangerous to plants or creatures at ordinary focuses. In people, centralizations of 500 - 750 mg/L cause a provisional diuretic impact. Nonetheless, measurements of a few thousand mg/L did not create any long haul sick impacts. At high fixations sulphates are lethal to dairy cattle. Issues brought about by sulphates are regularly identified with their capacity to frame solid acids which changes the pH. Sulphate particles additionally are included in completing and precipitation responses which influence dissolvability of metals and different substances.

# CHAPTER 3

# RESEARCH METHODOLOGY

## 3.0 STUDY AREA

Sungai Lembing is a tin mining town 42 km northwest of Kuantan in Pahang, Malaysia. It is an old mining town, which once had the biggest tin mine on earth. The town of Sungai Lembing was once viewed as the East El Dorado of Tanah Melayu. It was once a thriving town in the late 1800's with a population close to 30,000 consisting mainly family of miners, mining expatriates and local communities. This town was developed as a commercial centre for the local mining communities. As left abandoned in 1990, Sungai Lembing still remain the largest, longest, and deepest underground tin mine in the world.

A study area for this project was located in Sg. Lembing in district of Kuantan, Pahang, East Coast of Peninsular Malaysia, about 45 km from University Malaysia Pahang (UMP) and 35 km from Kuantan town. The area was selected based on the natural factors and the condition of the river. This study area also located near to Chereh Dam, which have the biggest storage dam in Malaysia.


**Figure 3.1:** Map of the study area

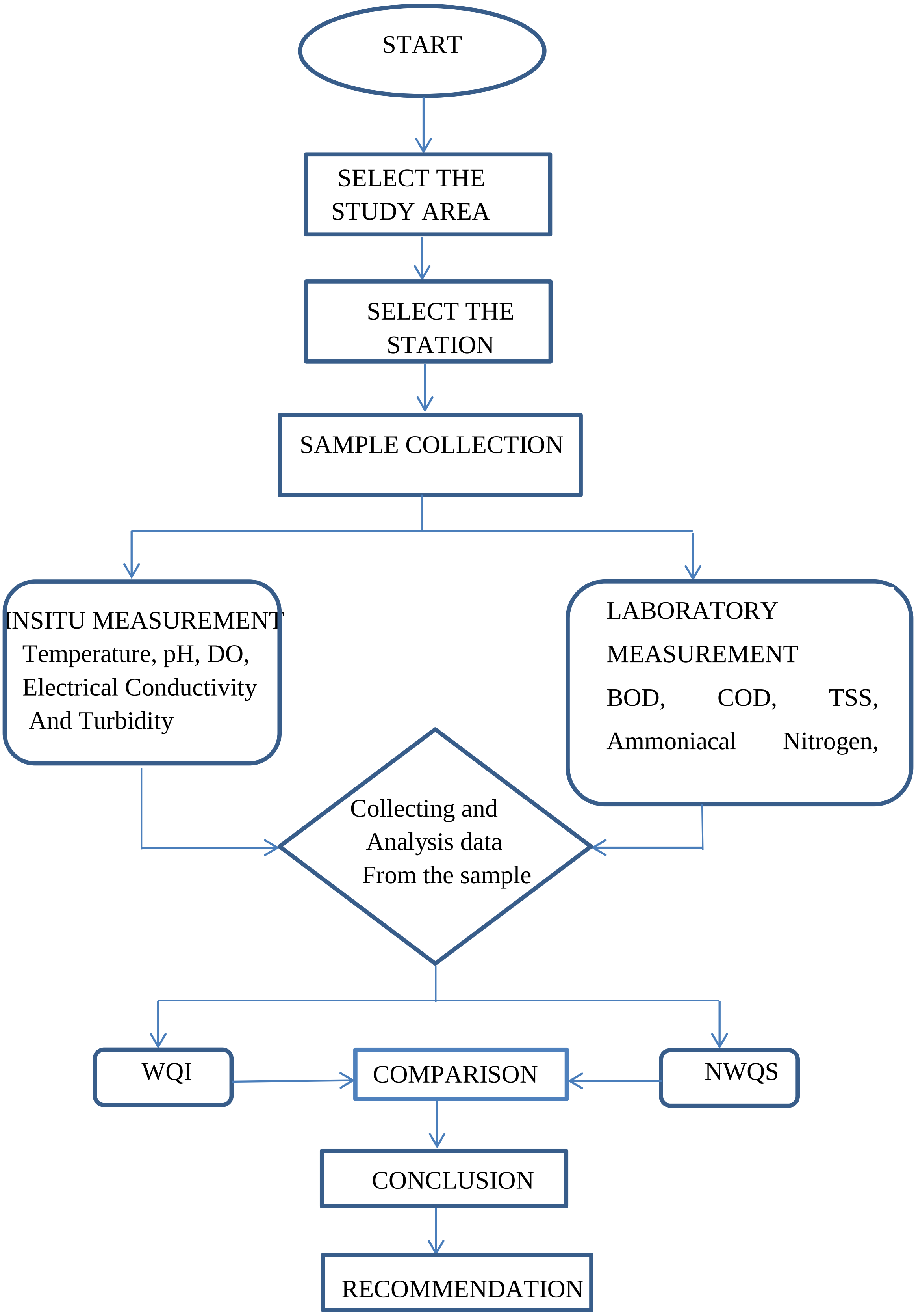
The characteristics of water in Sg. Lembing need to specify because it may affect the water quality of the river. The characteristics of the river depend on the more factors. Regarding to the previous research, it said there have more natural factors which affect the characteristics of the water. So, this study will determine some of characteristics at Sg. Lembing and the factors that will affect it.

## 3.1 Data collection

The sample will be located along the Sungai Lembing from 3 stations and 2 sampling. The sample will be used to collect data and analysis the characteristic.


**Figure 3.2:** map of the station at the study area

### 3.2 Flow Chart of Work Sequences



## 3.3 Laboratory Test and Analysis

### 3.3.1 Biological oxygen Demand (BOD)

Biochemical Oxygen Demand alludes to the measure of oxygen that would be devoured if all the organics in one litre of water were oxidized by microorganisms and protozoa (Revelle and Revelle, 1988). It likewise incorporates the oxygen needed for the oxidation of different synthetic in the water, for example, sulphides, ferrous iron and ammonia. While a broke down oxygen test purposed is to know the amount of oxygen is accessible, while a BOD test is to know the amount of oxygen is consistently expended.

Procedure

i. Prepare dilution water in a glass container by bubbling compressed air in distilled water for 30 minutes. Add 1ml each of phosphate buffer, magnesium sulphate, calcium chloride and ferric chloride for each litre of dilution water and mix through.
ii. Neutralize the sample to pH around 7.0-7.5 by using NaOH or H2SO4.
iii. Prepare dilutions in the bucket, mix the content thoroughly. Fill the water into the BOD bottles.
iv. Determine the DO content with Oxygen Meter.
v. Keep the sample of BOD in the Incubator at $30^{o}$c.
vi. Determine DO content after 5 days.

To calculate the BOD, used formula below:

$$BOD = \frac{DO_i - DO_f}{P}$$

Where P : dilution factor

$DO_i$ : initial DO of diluted waste water sample about 15 minutes after preparation

$DO_f$ : final DO of diluted waste water sample after incubation about i day

### 3.3.2 Chemical Oxygen Demand (COD)

The Chemical Oxygen Demand (COD) test measures the oxygen proportionate devoured by natural matter in an example amid solid synthetic oxidation. The solid concoction oxidation conditions are given by the reagents utilized as a part of the investigation. Potassium dichromate is utilized as the oxygen source with concentrated sulphuric corrosive added to yield a solid corrosive medium. A few reagents are included amid the situated up of the examination to drive the oxidation response to fulfilment furthermore to evacuate any conceivable impedance. Particularly, these reagents are mercuric sulphate, silver sulphate and sulfonic corrosive. Mercuric sulphate is added to uproot complex chloride particles introduce in the example. Without the mercuric sulphate the chloride particles would structure chlorine mixes in the solid corrosive media utilized as a part of the strategy. These chlorine mixes would oxidize the natural matter in the specimen, bringing about a COD worth lower than the genuine quality. Silver sulphate is included as an impetus for the oxidation of short, straight chain organics and alcohols. Once more, without the silver sulphate the COD of the specimen would be lower than the genuine quality. Sulfonic corrosive is added to uproot obstructions brought about by nitrite particles. Without sulfonic corrosive the COD of the example would quantify higher than the real esteem.

Procedure

1. Prior to completing the COD test, a series of known standards are prepared using KHP (potassium hydrogen phthalate). Most wastewater samples will fall in the high range, so standards of 100, 250, 500 and 1000 mg/L are typically prepared. COD standards can also be purchased.
2. A COD reactor/heating (150°C) block and a colorimeter are turned on so that both instruments are allowed to stabilize.
3. Pre-prepared low-range (3 - 150 ppm) or high-range (20 - 1500 ppm) vials are selected for the COD test based on expected results. Both ranges can be used if expected results are unknown.
4. One vial is marked as a “blank,” and three or four vials are marked with known standard levels. Two vials are then marked for the wastewater sample to make a

duplicate run. Note: If multiple wastewater samples are being run, at least 10% of samples are duplicated.

5. 2 mL of liquid are added to each vial. In the case of the “blank,” 2 mL of DI water are added. 2 mL of each standard are added to the corresponding vials. If the wastewater sample is tested at full strength, then 2 mL is added to the corresponding vial. If dilution is required, then serial dilutions are performed and 2 mL of the diluted sample are added to the corresponding vial.
6. Each vial is mixed well and placed into the reactor block for two hours. After two hours, the vials are removed from the block to a cooling rack for about 15 minutes.
7. The colorimeter is set and calibrated per the specific instructions for that unit (i.e., proper wavelength, blank and standards) and each vial is placed in the unit and the COD concentration read.
8. If the sample was diluted, the corresponding multiplication is made.

To calculate the COD, used formula below

$$COD = \frac{(8000\,(a-b)}{v} \times \text{Normality of FAS}$$

where a : amount of ferrous ammonium sulphate titrant added to blank,mL

b : amount of titrant added to sample, mL

v : volume of sample,mL

8000 : multiplier to express COD in mg/L of oxygen

### 3.3.3 Ammoniacal Nitrogen

Ammonia or $NH_3$: It is one of the most important pollutants in the aquatic environment because of its relatively highly toxic nature and its ubiquity in surface water systems. It is discharged in large quantities in industrial, municipal and agricultural waste waters. In aqueous solutions, ammonia assumes two chemical forms: $NH_4^+$ - ionized (less/nontoxic) and $NH_3$ - unionized (toxic).The relative concentration of ionized and unionized ammonia in given ammonia solution are principally a function of pH, temperature and ionic strength of the aqueous solution.

### 3.3.4 Heavy Metal

Metals are introduced in aquatic systems as a result of the weathering of soils and rocks, from volcanic eruptions, and from a variety of human activities involving the mining, processing, or use of metals and/or substances that contain metal pollutants. The most common heavymetal pollutants are arsenic, cadmium, chromium, copper, nickel, lead a nd mercury. Heavy metal will be measured by using Atomic Absorption Spectrometer (AAS).

The heavy metals that being studies in this research are:

- Copper ( Cu )
- Lead ( Pb )
- Zinc ( Zn )
- Iron ( Fe )

### 3.3.5 Total Suspended Solid (TSS)

Aggregate suspended solids incorporate all particles suspended in water which won't pass through a channel. Suspended solids are available in clean wastewater and numerous sorts of modern wastewater. There are likewise nonpoint wellsprings of suspended solids, for example, soil disintegration from horticultural and development locales. As levels of TSS build, a water body starts to lose its capacity to help differing qualities of aquatic life. Suspended solids assimilate heat from daylight, which expands water temperature and in this way abatements levels of broke down oxygen (hotter water holds less oxygen than cooler water). Some chilly water species, for example, trout and stoneflies, are particularly touchy to changes in broke up oxygen. Photosynthesis additionally diminishes, since less light infiltrates the water. As less oxygen is created by plants and green growth, there is a further drop in broken down oxygen levels.

Procedure

i. Preparation of the glass fiber disc; the filter disc was inserted onto the base and clamp on funnel. While vacuum is applied, the disc was washed with three successive 20 ml, distilled water. All traces of water were removed by continuing to apply vacuum after water has passed through. The funnel was removed from base and the filter was placed in the filter paper and was dry in an oven ay 103C to 105 C for one hour. Then the dish was removed from the oven, desiccate and weight.
ii. A sample volume was selected (max, of 100mL) that will yield not more than 100mg of the total suspended solids.
iii. The filter was placed on the base and clamped on funnel and applied vacuum. The filter was wetted with a small volume of distilled water to seal the filter against the base.
iv. The sample was shacked vigorously and quantitatively transferred 100ml of the sample to the filter using a large orifice, volumetric pipette. All traces of water were removed by continuing to apply vacuum after sample has passed through.
v. The pipette and funnel was rinse onto the filter with small volume of distilled water. All traces were removed by continuing to apply vacuum after sample has passed through.
vi. Carefully the disc filter was removed from the base. It was dried for at least one hour at 103 C to 105 C. Then cool in a desiccator and weight.

To calculate the TSS used formula below:

$$\text{TSS,mg/L} = \frac{(A-B) \times 1000}{C}$$

Where: A : weight of filter and dish + residue in mg

B : weight of filter and dish in mg

C : volume of sample filtered in mL

### 3.3.6 Phosphate

Phosphate test is conduct by using Ascorbic Acid Method which is in the HACH Method 490. The instrument use is DR/2500 Spectrophotometer. phosphate is held in the dirt by a perplexing arrangement of organic uptake, retention, and mineralization.

Phosphates are not dangerous to individuals or creatures unless they are available in abnormal states.

### 3.3.7 Sulphate

Sulphate test is conduct by using Sulfaver 4 Method which is in the HACH Method 680. The instrument use is DR/2500 Spectrophotometer. Aquatic creatures use sulphur and decreased fixations have an adverse impact on algal development. The most widely recognized type of sulphur in very much oxygenated waters is sulphate.

## 3.4 In-Situ Test

### 3.4.1 pH

pH is a paramount constraining substance element for amphibian life. In the event that the water in a stream is excessively acidic or essential, the H+ or OH- particle movement may upset oceanic living beings biochemical responses by either hurting or slaughtering the stream creatures. pH is communicated in a scale with extents from 1 to 14. An answer with a pH short of what 7 has more H+ movement than OH-, and is viewed as acidic. An answer with pH esteem more noteworthy than 7 has more OH- action than H+, and is viewed as essential. pH value will be recorded by using pH meter

### 3.4.2 Turbidity

Turbidity is a measure of the cloudiness of water. Shadiness is brought about by suspended solids (for the most part soil particles) and tiny fish (infinitesimal plants and creatures) that are suspended in the water section. Reasonably low levels of turbidity may demonstrate a solid, well-working environment, with moderate measures of microscopic fish present to fuel the fuel the natural way of life. Turbidity value will be recorded by using turbidity meter.

Procedure

i. Allow a short warm-up period of about 5 minutes for the turbidity meter.
ii. Calibrate the turbid meter using the standard turbidity suspension.
iii. Pour the sample into the sample tube. Be careful to not let air bubble trap in the sample.

iv. Wipe the sample tube thoroughly, using clean cloth or tissue paper.
v. Read the turbidity.

### 3.4.3 Dissolved Oxygen (DO)

The dissolved oxygen examination measure the measure of vaporous oxygen broke up in water or wastewater. Oxygen is a fundamental component in all manifestations of life. Oxygen broke down in wastewater supports the development of vigorous microscopic organisms. Sufficient disintegrated oxygen is expected to permit common stream refinement procedures to move ahead and accommodate high-impact life structures in the accepting water. All different things being equivalent, the measure of oxygen that can break up in unadulterated water (the immersion point) is contrarily relative to the temperature of the water. As it were, bring down the temperature of the water; the higher the broke up oxygen level will be at immersion. Then again, the higher the temperature of the water, the bring down the broke up oxygen level will be at immersion. This is especially essential amid warm climate periods when the stream natural movement will be most noteworthy however the disintegrated oxygen immersion level will be least. DO meter will be used to recorded DO value.

### 3.4.4 Temperature

Temperature is a vital component to consider when evaluating water quality. Notwithstanding its own particular impacts, temperature impacts a few different parameters and can adjust the physical and compound properties of water. The temperature of the water will be recorded by using thermometer.

### 3.4.5 Electrical Conductivity

The electrical conductivity of the water relies on upon the water temperature: the higher the temperature, the higher the electrical conductivity would be. The electrical conductivity of water increments by 2-3% for an increment of 1 degree Celsius of water temperature. Numerous EC meters these days consequently institutionalize the readings to 25°C. While the electrical conductivity is a decent marker of the aggregate saltiness, it still does not give any data about the particle arrangement in the water.

# CHAPTER 4

# RESULT AND DISCUSSION

## 4.0 INTRODUCTION

All the data obtained using in situ measurement and lab analysis is compared to the National Water Quality Standard and Water Quality Index to evaluate the water quality of the river water of Sungai Lembing.
There is three stations and the distance between the stations is around 300 meter. The sampling process is run in two times for every station. There parameters measured according to Water Quality Standard and Water Quality Index. There is parameter that was measured in situ which is Temperature, Electrical Conductivity, pH, Dissolved Oxygen and Turbidity. For ex-situ experiment which the test is conduct in the laboratory are Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solid (TSS), Heavy Metals, Phosphate Test, Sulphate Test, and Ammonia Nitrate Test. The Heavy Metals measured are Copper (Cu), Lead (Pb), Iron (Fe) and Zinc (Zn).The data obtained is compared with water quality classes.

## 4.1 SAMPLE COLLECTION

The sampling procedure was done two times at each station during the study period. In every sampling, two sub-merged samples were drawn from different part of the station for laboratory analysis. DO test was measured in-situ while for the sample for BOD test, the water were drawn underwater and make sure while close the bottle cap there is no air inside the bottle. The sample for heavy metals test is immediately acidified at pH less than 2 by using $HNO_3$ and the cap tightly closed. As sample arrived at the laboratory, the sample will immediately put in the cool room and will be test until some period of time.

## 4.2 RSULT TEST OF THE SAMPLE WATER

### 4.2.1 TEMPERATURE

Figure 4.1 show that the different temperatures between the first sampling and the second sampling. The time measured is between 11 am to 12 pm.

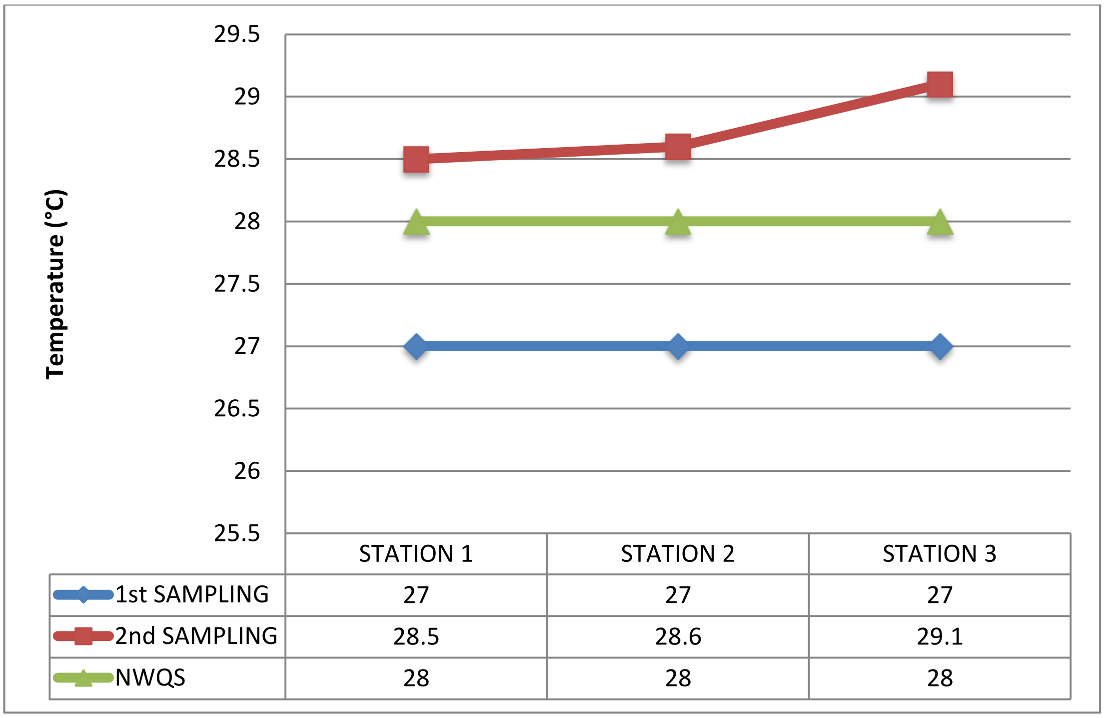



**Figure 4.1:** Temperature of water at Sungai Lembing

The first sampling is higher than the NWQS while second sampling is loer than NWQS which the standard temperature is 28$^{o}$C. The water temperature range is about between 27°C to 29.1°C In the figure 4.1 shows that on the first sampling the temperature is constant due to the time when the temperature recorded. While for the second sampling the temperature on the station 3 is slightly higher than other station because when the temperature recorded the weather is really hot and it's recorded at peak hour which is around 12 pm. Based on the NWQS its show that the temperature is between the range. The temperature is slightly higher than the standard that might be because of the weather. Other than that, high and low temperatures were influenced by the climate condition, demonstrating that the examining areas were either in clear and hot or wet and overcast conditions. Inside the both testing, the temperature was somewhat high and it's demonstrated that the climate is hot and clear. Thermal pollution also can be the reason why the temperature is high. However there is no thermal pollution source was observed near the sampling locations.

### 4.2.2 ELECTRICAL CONDUCTIVITY

Figure 4.2 shows that the values of electrical conductivity for each station for first and second sampling compare to NWQS. The value for both sampling have value that low than NWQS which is 1000 while the sampling have value ranges 26-210 only.

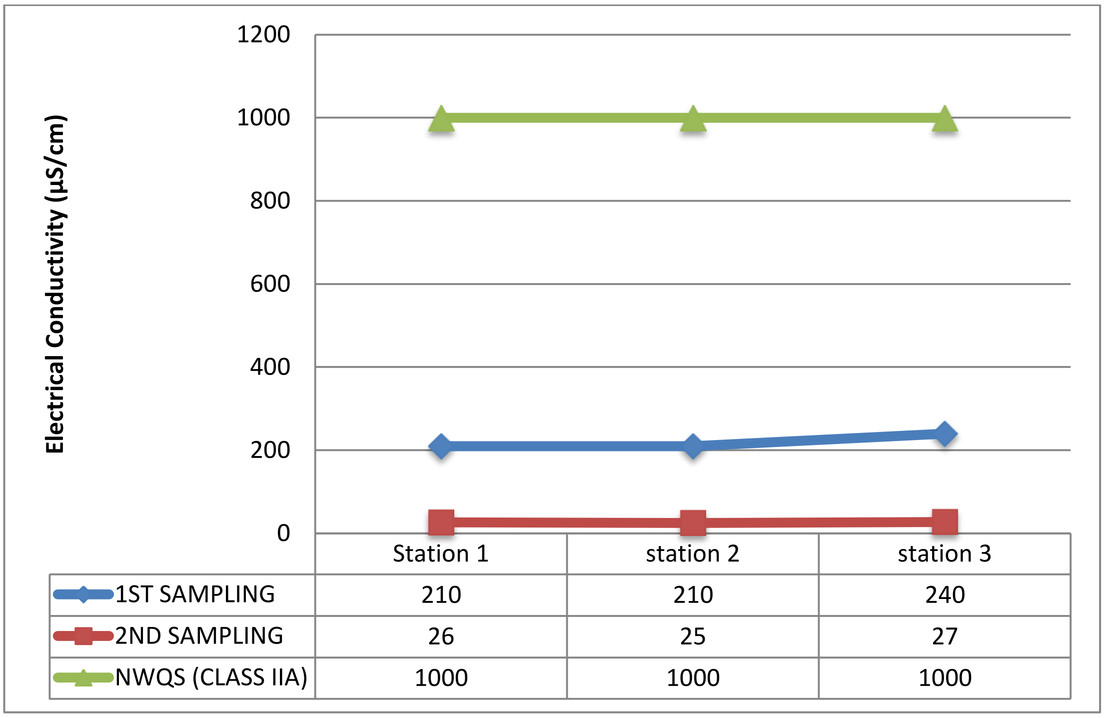
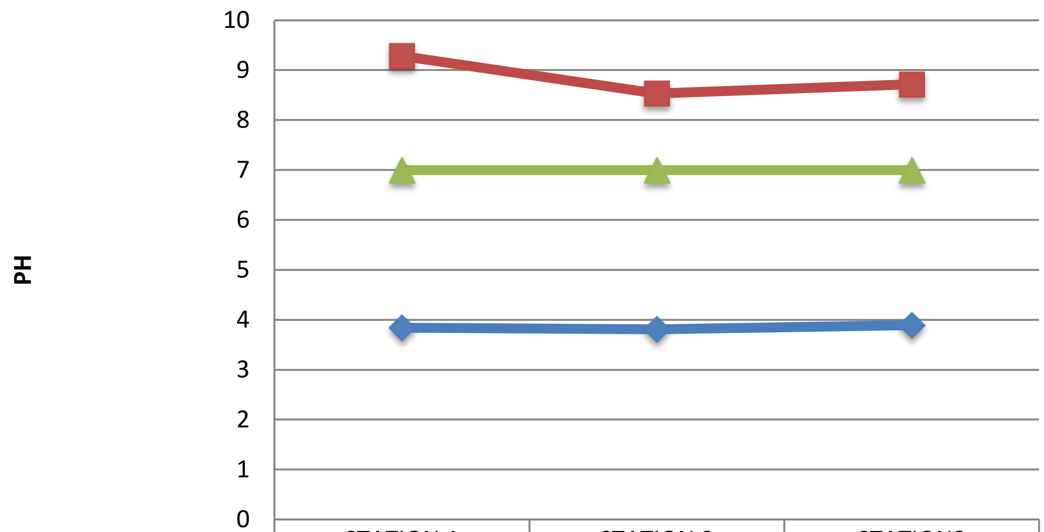



**Figure 4.2:** The conductivity value in Sungai Lembing

Conductivity in water is influenced by the vicinity of inorganic broke down solids, for example, chloride, nitrate, sulphate, and phosphate anions. The greater the amount of total dissolved solid, the greater the value of conductivity. Conductivity in streams and rivers is influenced principally by the geography of the territory through which the water streams. It's clearly shown on above that the value for both sampling is lower than NWQS. Based on the graph it's shown that second sampling has higher range value of conductivity compared to first sampling. Station 3 on the second sampling recorded the highest range value of conductivity. This is on account of station 3 indicated marginally more turbid contrasted with different stations showing higher strong extent. In addition, conductivity is likewise influenced by temperature: the hotter the water, the higher the conductivity. The conductivity of water also can be affected by the weather conditions. The hotter the water, the higher the conductivity.

### 4.2.3 pH




| | STATION 1 | STATION 2 | STATION3 |
|---|---|---|---|
| 1st SAMPLING | 3.84 | 3.81 | 3.89 |
| 2nd SAMPLING | 9.28 | 8.53 | 8.72 |
| NWQS (CLASS III) | 7 | 7 | 7 |

**Figure 4.3:** pH of Sungai Lembing

pH is an important indicator for the water quality ( A.M. Nasly, et al. 2013). The pH of water decides the solubility (sum that can be broken down in the water) and natural accessibility (sum that can be used by sea-going life) of concoction constituents, for example, supplements (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, and so forth.). Based on the graph the value for first sampling is higher than NWQS while for second sampling is value is lower than the NWQS. The pH value form the first sampling is more acidic than the second sampling. This might be because of the high level in acid rain since when taking the sample during the first sample, the site was after raining. Furthermore, the upstream of the river during the first sampling there is logging activities. While during second sampling the weather is really hot and the logging activities are already stop.

### 4.2.4 TURBIDITY

Figure 4.4 below show that the value of Turbidity recorded for first and second sampling compare to NWQS. The graph show that the value for second sampling station two have record to have the highest turbidity compare to NWQS and first sampling. The value recorded show that the value at second sampling is higher than first sampling. Higher turbidity builds water temperatures in light of the fact that suspended particles assimilate more heat. In this case, second sampling has higher value recorded. This is due to hot weather during sampling taken. The weather is hot and dry. Turbid water will seem overcast, cloudy, or generally shaded, influencing the physical look of the water. Besides that, turbidity also related to suspended solid. The higher the value of suspended solid, the higher the value of turbidity.

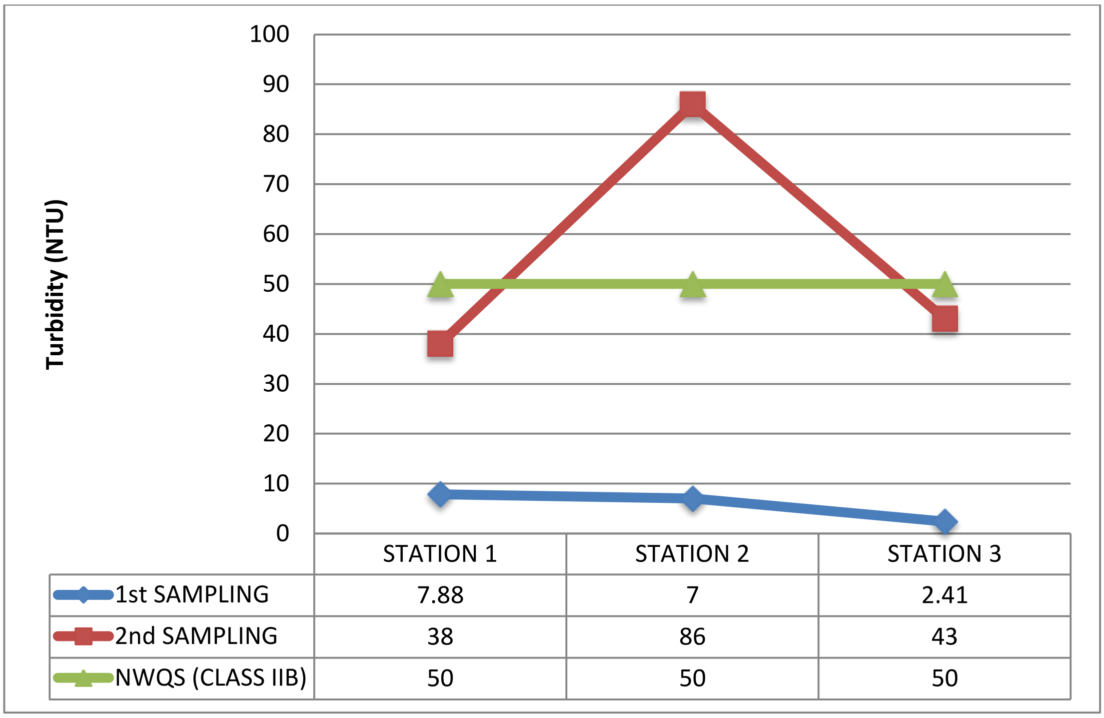



**Figure 4.4:** Turbidity value of Sungai Lembing

### 4.2.5 DISSOLVED OXYGEN (DO)

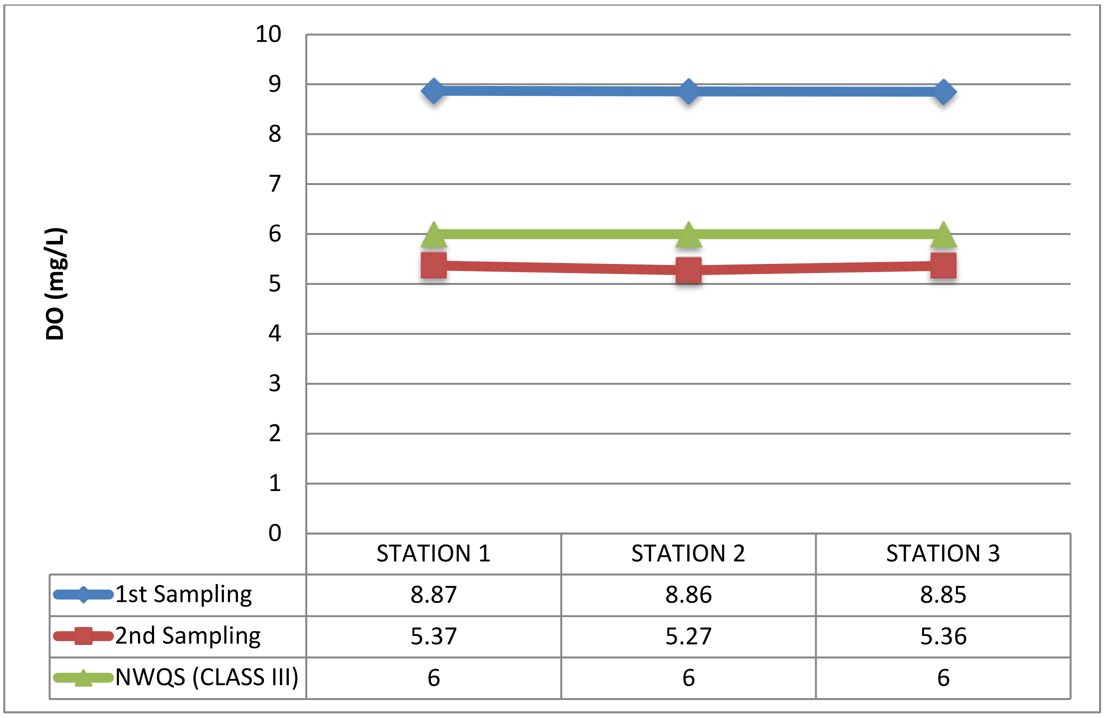



**Figure 4.5:** Value of DO compare to NWQS

The figure above show that the value of DO recorded compare to NWQS. It's shown that the value for both sampling is higher than NWQs for class III. First sampling has high value in DO. This might be because the water sample for first sampling has low in temperature. Temperature of water is related to the value of DO. When the temperature is low, the value of DO is increasing. The warmer the surface water requires less dissolved oxygen to 100% air saturation than does deeper which is cool water. Animal cannot split oxygen and only green plant can split the oxygen trough photosynthesis. Hence, when the oxygen demand is increase, the green plant will increase and it will cause higher in dissolved oxygen.

A dissolved oxygen level that is too high or too low can harm aquatic life and affect water quality. The ideal DO for many fish is 5 -7 mg/L. Most fish cannot survive if DO concentration is below than 3 mg/L. Monitoring and eventually maintaining of various physiochemical parameters, especially pH and dissolved oxygen is considered important in most of the bioprocess developments as these factors describe the biochemical balance. (N. Deepa, et.al. 2015)

### 4.2.6 BIOCHEMICAL OXYGEN DEMAND ($BOD_5$)

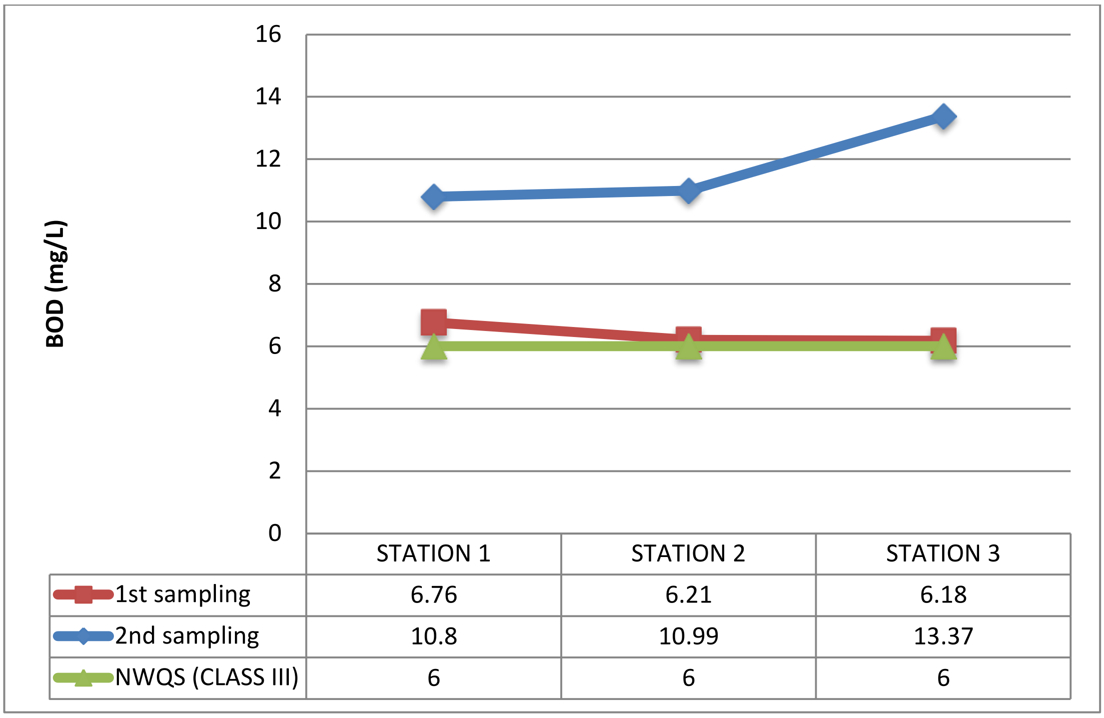



**Figure 4.6:** $BOD_5$ value compared to NWQS

The graph above show that the value of $BOD_5$ for first sampling and second sampling compared to NWQS. For NWQS class III, 6 mg/L is the standard value for water. Station 3 at second sampling show that 13.37 mg/L which the highest value among station. For all station in first sampling show that the value still in the range. For the most part, when BOD levels are high, there is a decrease in DO levels. Biochemical oxygen demand (BOD) is a widely used parameter for water biodegradability. (F.X.Simon,et.al.2011).

This is since the demand for oxygen by the microbes is high and they are taking that oxygen from the oxygen disintegrated in the water. In the event that there is no natural waste present in the water, there won't be the same number of microbes present to break down it and subsequently the BOD will have a tendency to be lower and the DO level will have a tendency to be higher. At high BOD levels, creatures, for example, full scale spineless creatures that are more tolerant of lower dissolved oxygen may show up and get to be various. Organic entities that need higher oxygen won't survive. In BOD, most labile compounds from water are almost totally consumed, while new dissolved organic compound release due to bacterial activity are more refractory to bacterial degradation.

### 4.2.7 CHEMICAL OXYGEN DEMAND (COD)

The graph below show that COD value in Sungai Lembing is lower than NWQS. The standard value 50 mg/L but the range for first and second sampling is about 2 – 16 mg/L. Higher in DO equivalent to low in COD. High COD levels decrease the amount of dissolved oxygen available. High organic inputs trigger deoxygenating. COD develop as an alternative to the lengthier BOD. It measures more than organic constituent; the organic fraction usually predominates and is the constituent of interest. If excess organics are introduced to the system, there is potential for complete depletion of dissolved oxygen. Without oxygen, the entire aquatic community is threatened. The only organisms present will be air- breathing insects and anaerobic bacteria. Organic levels decrease with distance away from the source. In a standing water body such as a lake, currents are generally not powerful enough to transport large amounts of organics. In a moving water body, the saprotrophic organisms (organisms feeding on decaying organic matter) break down the organics during transportation away from the source.

Hence, there is a decline in the oxygen demand and an increase of dissolved oxygen in the water. Community structure will gradually return to ambient with distance downstream from the source. The pollution of our water resources can have serious and wide-ranging effects on the human health, fisheries, agriculture and industry, and results in associated health and economic costs. The immediate effects of water pollution can be seen in water bodies and the animal and plant life that inhabits them. Pollution poisons and deforms fish and other animals, unbalances ecosystems and causes a reduction in biodiversity. Ultimately, these effects take their toll on human life. Chemical oxygen demand (COD) and biological oxygen demand (BOD) are two main indexes used to assess the organic pollution in aqueous systems. (P. Nipon, et.al.2014)

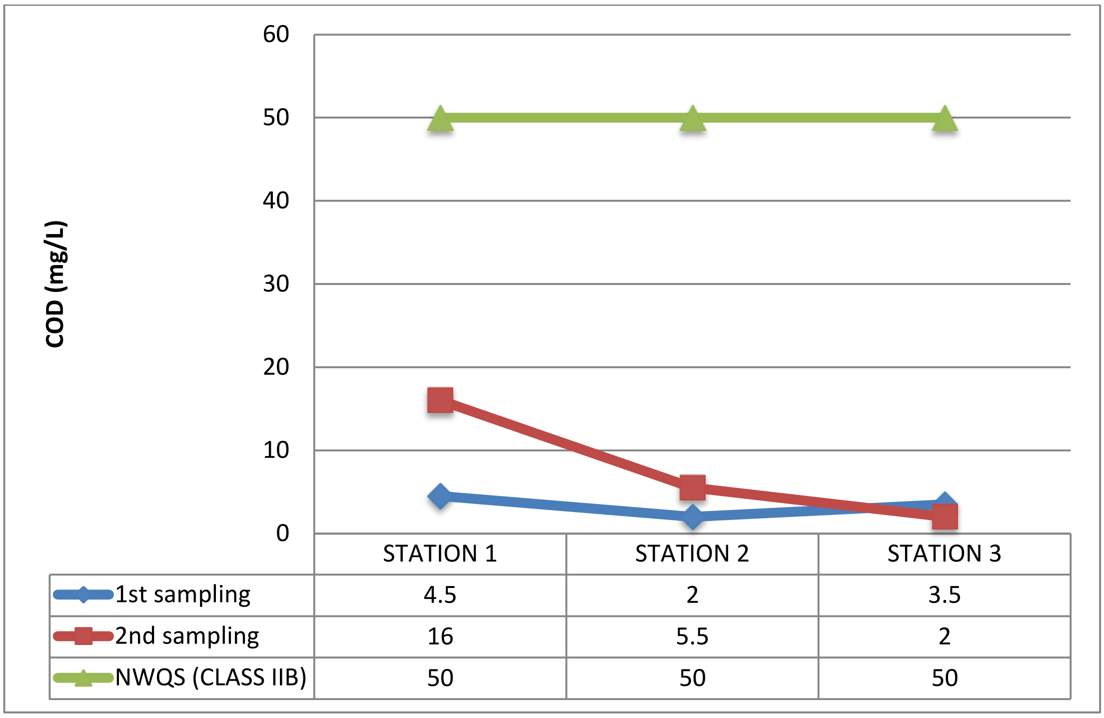



**Figure 4.7:** COD value compared to NWQS

### 4.2.8 TOTAL SUSPENDED SOLID (TSS)

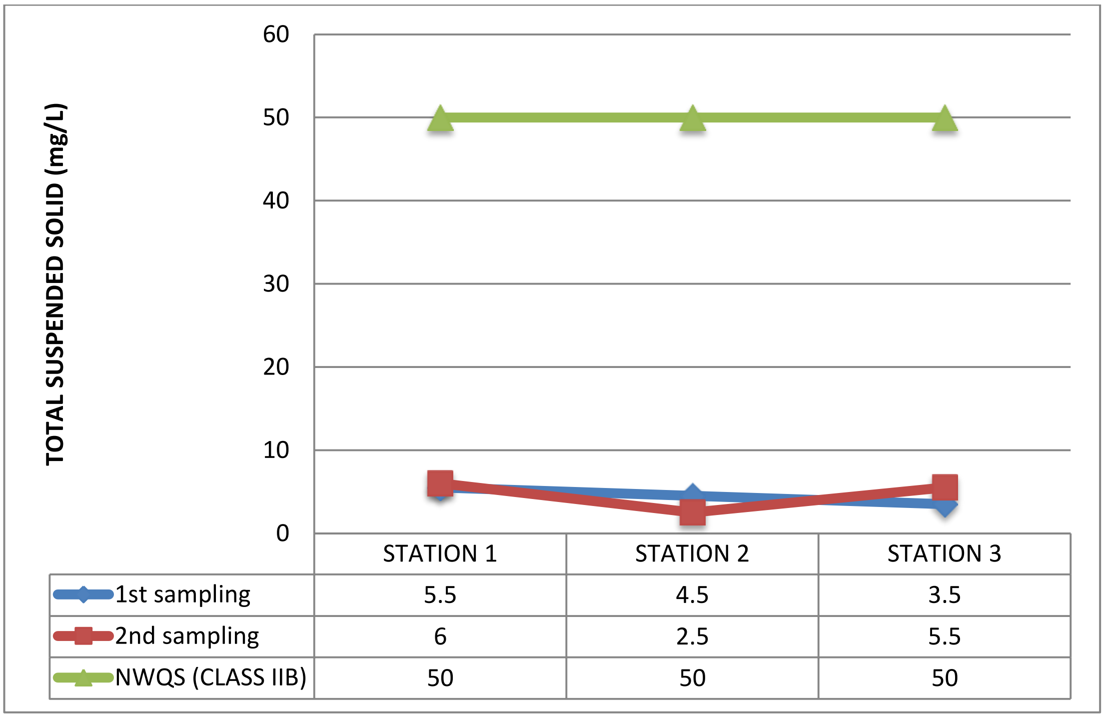



**Figure 4.8:** TSS value of Sungai Lembing compared to NWQS

The graph above show that the value of TSS for both sampling compared to NWQS. For both sampling, the TSS contain is very low compared to the standard which is 50 mg/L. The low in TSS is might be because both sampling have a low in turbidity value. TSS transported by rain runoff water are recognized as one important source of polluted sediments from urban areas (Luca Rossi,et al.2013). TSS can incorporate a wide mixed bag of material, for example, sediment, rotting plant and creature matter, modern squanders, and sewage. High concentrations of suspended solids can bring about numerous issues for stream health and amphibian life.

In terms of water quality, large amounts of total suspended solids will increase water temperatures and lessening DO levels. This is because of that suspended particles ingest more warmth from sun based radiation than water atoms will. This warmth is then exchanged to the encompassing water by conduction. Hotter water can't hold as highly broke down oxygen as colder water, so DO levels will drop. Moreover, the increasing of surface temperature can bring about stratification, or layering, of a waterway. At the point when water stratifies, the upper and lower layers don't blend. As deterioration and respiration regularly happen in the lower layers, they can turn out to be excessively hypoxic (low broke down oxygen levels) for organic entities to survive.

### 4.2.9 AMMONIACAL NITROGEN

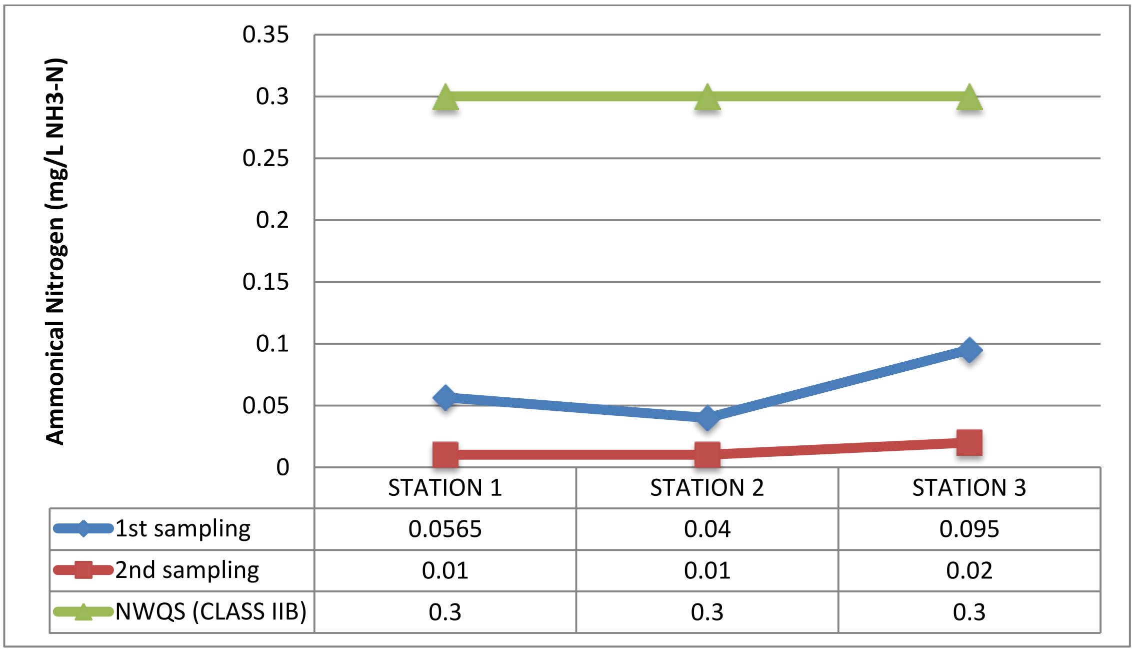



**Figure 4.9:** Ammoniacal Nitrogen value compare to NWQS

The above graph show that the value of Ammoniacal Nitrogen are low than the standard. The standard value is 0.3 mg/K NH3-N while the value of the sampling is between 0.01 to 0.09 mg/L NH3-N. If the value is more than 2.7 mg/L NH3-N, the water is dangerous because if excess of the recommended limits may harm aquatic life. Ammonia concentrations in urban wastewater are typically higher than in natural systems. (Metcalf, et al.1991). The higher the pH, the more of the NH3 will be present. Ammonia toxicity is thought to be one of the main reasons of unexplained misfortunes in fish hatcheries. Despite the fact that the ammonia particle is a supplement needed forever, abundance alkali may gather in the life form and reason adjustment of digestion system or increments in body pH. Diverse types of fish can endure distinctive levels of ammonia however in any occasion, less is better.

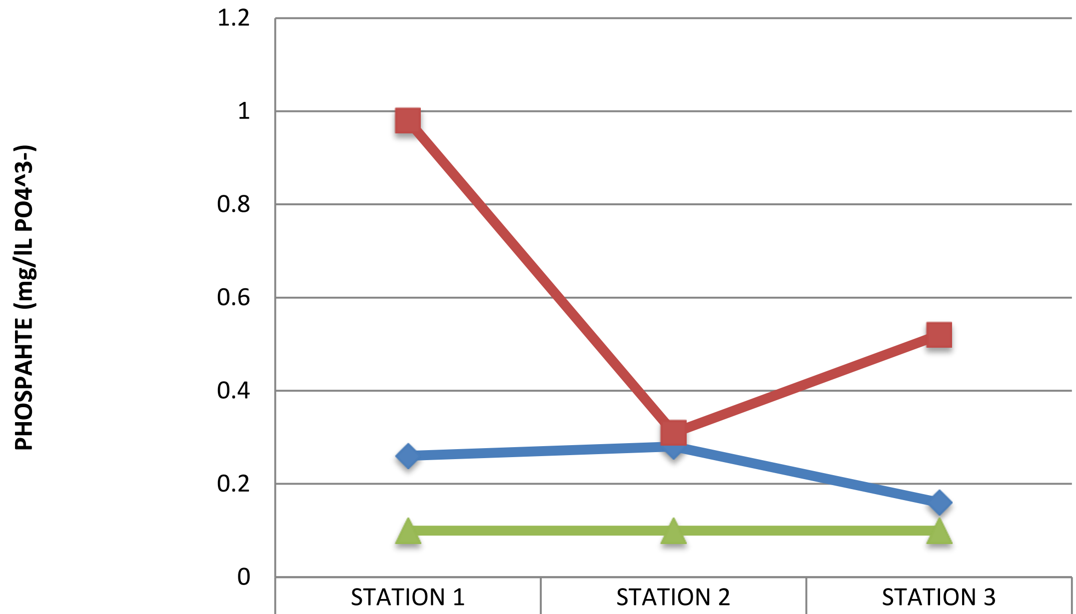
Fish may endure a loss of harmony, hyper excitability, expanded respiratory action and oxygen uptake, and expanded heart rate. At extreme ammonia levels, fish may encounter convulsion, trance like state, and demise. Elevated levels can also lead to ammonia poisoning by suppressing normal ammonia excrement from the gills. If fish are unable to excrete this metabolic waste product there is a rise in blood-ammonia levels resulting in damage to internal organs. The fish response to toxic levels would be lethargy, loss of appetite, laying on the pond bottom with clamped fins, or gasping at the water surface if the gills have been affected. Because this response is similar to the response to poor water quality, parasite infestations, and other diseases.

### 4.2.10 PHOSPATE

The graph below show that the value of phosphate in Sungai Lembing. The values have been comparing to NWQS. From the test, the value recorded for first sampling and second sampling is higher than the standard Class III in NWQS. The standard state that the value is 0.1 mg/L $PO4^{3-}$. Station 1 for the second sampling has the highest value recorded. If the value is more than 0.1 mg/L $PO4^{3-}$ , the water have an accelerated growth and consequent problems. If an excessive amount of phosphate is available in the water the green growth and weeds will develop quickly, may stifle the conduit, and go through a lot of valuable oxygen (without photosynthesis and as the green growth and plants bite the dust and are devoured by high-impact microscopic organisms.) The outcome may be the passing of numerous fish and sea-going life forms.

Rainfall can bring about shifting measures of phosphates to wash from ranch soils into close-by conduits. Phosphate will invigorate the development of tiny fish and amphibian plants which give nourishment to fish. This may bring about an increment in the fish populace and enhance the general water quality. On the other hand, if an abundance of phosphate enters the conduit, green growth, and sea-going plants will develop uncontrollably, break down the conduit and go through a lot of oxygen. This condition is known as eutrophication or over-treatment of getting waters. This fast development of oceanic vegetation in the end passes on and as it rots it uses up oxygen. This procedure thusly causes the passing of oceanic life on account of the bringing down of broke up oxygen levels.

Phosphates are not poisonous to individuals or creatures unless they are available in abnormal states. Digestive issues could happen from to a great degree abnormal amount of phosphate.



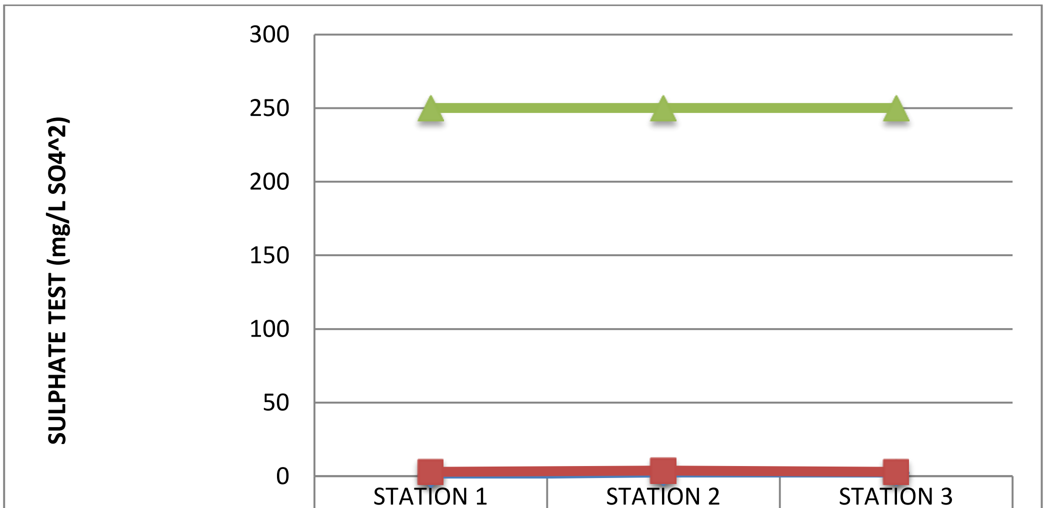

| | STATION 1 | STATION 2 | STATION 3 |
|---|---|---|---|
| 1st sampling | 0.26 | 0.28 | 0.16 |
| 2nd sampling | 0.98 | 0.31 | 0.52 |
| NWQS (CLASS III) | 0.1 | 0.1 | 0.1 |

**Figure 4.10:** Phosphate value in Sungai Lembing compare to NWQS

### 4.2.11 SULPHATE

The graph below show that the value of sulphate in Sungai Lembing. . For both sampling, the Sulphate contain in Sungai Lembing is very low compared to the standard which is 250 mg/L $SO4^{2}$. While the value is about range to 1- 3 mg/L $SO4^{2}$. Sulphate concentration of rivers have received considerable attention, due to its dominant role in anthropogenic acidification of surface waters, and the importance for understanding the role of sulphuric acid in chemical weathering of carbonate rocks and its effect on the global carbon cycle (Calmels, et al. 2007). If the sulphate concentration in a water source is less than 10 mg/l, it is an indication that the water source is fresh and unpolluted.Higher levels of sulphate in any water source can be indicative of some form of pollution.

Sulphates are not considered toxic to plants or animals at normal concentrations. In humans, concentrations of 500 - 750 mg/L cause a temporary laxative effect. However, doses of several thousand mg/L did not cause any long-term ill effects. At very high concentrations sulphates are toxic to cattle. Problems caused by sulphates are most often related to their ability to form strong acids which changes the pH. Sulphate ions also are involved in completing and precipitation reactions which affect solubility of metals and other substances.




| | STATION 1 | STATION 2 | STATION 3 |
|---|---|---|---|
| 1st sampling | 1 | 2.5 | 2.5 |
| 2nd sampling | 3 | 3.84 | 3 |
| NWQS (CLASS IIB) | 250 | 250 | 250 |

**Figures 4.11:** Sulphates contain in Sungai Lembing compare to NWQS.

### 4.2.12 HEAVY METALS

**Table 4.1:** Heavy Metals contain in Sungai Lembing

| HEAVY METALS | STATION | 1ST SAMPLING | 2ND SAMPLING |
|---|---|---|---|
| Fe | 1 | 0 | 0.007 |
| | 2 | 0.0315 | 0.045 |
| | 3 | 0.112 | 0.009 |
| Pb | 1 | 0.094 | 0.105 |
| | 2 | 0.097 | 0.09 |
| | 3 | 0.083 | 0.08 |
| Cu | 1 | 0.0165 | 0.0005 |
| | 2 | 0.015 | 0 |
| | 3 | 0.0265 | 0 |
| Zn | 1 | 0.0655 | 0.1455 |
| | 2 | 0.044 | 0.0625 |
| | 3 | 0.086 | 0.0815 |

The heavy metals that have been measured are Iron (Fe), Lead (Pb), Copper (Cu) and Zinc (Zn). Water pollutants mainly consist of heavy metals, microorganism, fertilizer and thousands of toxic organic compounds (WHO, 1999). The heavy metals measured according to the stations for every sampling. For Fe, the value recorded for station 1 is zero but after a few months the second sampling the value recorded is increasing which is 0.007 mg/L. Overall result for Fe, there is increasing in value recorded for first sampling to second sampling. Iron in water may be available in shifting amounts relying on the geographical territory and other synthetic parts of the conduit. Fe particles are the essential types of concern in the amphibian environment. Different structures may be in either natural or inorganic wastewater streams. Fe can hold on in water system of dissolved oxygen and more often than not starts from groundwater or mines that are pumped or depleted. Iron in household water supply system stains clothing and porcelain.

For the table above, it's clearly show that there is higher Pb ions in Sungai Lembing. For station 1, the value is increasing for a few months, while for Station 2 and 3 the value is decreasing. This because on the second sampling the water is hot and the area is dry while for first sampling the water is cold and the area is wet. Lead in nature emerges from both natural and anthropogenic sources. Exposure can happen through drinking water, sustenance, air, soil and dust from old paint containing lead. Lead pollution in water systems has seriously influenced the quality of life, especially in developing country. (N.S.Safaa. 2013)

Cu in Sungai Lembing is decreasing in second sampling. For second sampling station 2 and 3 the Cu is zero. While the first sampling station 2 and 3 have value about 0.1-0.2 mg/L. When copper ends up in soil it strongly attaches to organic matter and minerals. As a result it does not travel very far after release and it hardly ever enters groundwater. In surface water copper can travel great distances, either suspended on sludge particles or as free ions

For Zn the value is low for first sampling and also for second sampling. Zinc is normally present in water. zinc was not credited a water danger class, on the grounds that it is not viewed as a hazard. This however just concerns basic zinc. Some zinc mixes, for example, zinc arsenate and zinc cyanide, may be greatly hazardous. Zinc is a dietary mineral for people and creatures. Still, overdoses might adversely impact human and creature wellbeing and more than a certain limit focus, zinc may even be dangerous. Harmfulness is low for people and creatures, yet phytotoxicity may not be underestimating.

Heavy metals can be found easily in water environments because of natural sources and those due to the anthropogenic causes. Heavy metals are the most important pollutants which affect water, soil, and air quality. Especially presence of heavy metal creates permanent affects to living organisms that participate in the food chain which can cause many diseases, including cancer. Determination of heavy metals should be established for all water environments to understand the most probable source if natural or anthropogenic. Thus, identify and eliminate sources of pollutants are vital works can be done meticulously because of burden of pollution of aquatic ecosystems. A large part of heavy metal gets into the water and goes deep because of the molecular weight which resulted pollution of sediment mix in rivers. Many creatures that inhabit the rivers are suffered by these metals, as a part of the absorption of these organisms in food chain. (S.Sehabat, et.al.2014)

## 4.3 WATER QUALITY CLASSIFICATION

Based on the result from the experiment, all the data and value have been used to calculate the WQI classification for each station. the data for parameter DO, BOD, COD, TSS, pH and Ammonical Nitrogen have used to calculated the classification. After the calculation, the table below show the result of water quality classification for each station.

**Table 4.2:** Water Classification of Sungai Lembing

| Sta. | DO | BOD | COD | $NH^{-}_{3}N$ | TSS | Ph | WQI Value | Class | Status |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 65.76 | 85.47 | 90.06 | 94.07 | 97.45 | 66.42 | III | Slightly Polluted |
| 2 | 0 | 66.44 | 94.11 | 90.54 | 95.4 | 93.32 | 67.72 | III | Slightly Polluted |
| 3 | 0 | 62.11 | 95.44 | 88.67 | 94.8 | 94.97 | 66.94 | III | Slightly Polluted |

The results show that all the station has been slightly polluted. The WQI value for each station is between the ranges 66 to 67. Based on the WQI the clean water is 81 – 100. While for the polluted water the value is 0-59. Between all the three stations, stations 2 have the highest value which is 67.72. This might be because of at the station 2 there is an evidence of higher anthropogenic activities at that part. Stations 2 have a residential area where the water discharges from every house will trough a drain and to the river. But for BOD itself, the water is polluted. The polluted range is 0-79. All stations for BOD, the water is polluted compared to clean range 91-100. In term of Ammoniacal Nitrogen, the water is slightly polluted for all three stations. But based on TSS the water is clean. That mean, the water do not have higher suspended solid. After calculated using formula, the water of Sungai Lembing is in Class III which is slightly polluted.

# CHAPTER 5

# CONCLUSION AND RECOMMENDATION

## 5.0 CONCLUSION

Water Quality of Sungai Lembing has been known trough tests that were conduct for each parameter. The entire test such as BOD, COD, TSS, pH and Ammoniacal Nitrogen has been successfully conducted to be able to calculate the WQI classification. Beside that's, all the result has been compared to NWQS to show the class of the water and the standard.

As a conclusion, the water of Sungai Lembing is under Class III which is the water is slightly polluted. Class III waters are essentially transitional between the satisfactory Class II and the unsatisfactory Classes IV. It is considered prudent, however, that these slightly polluted waters should also be classified as unsatisfactory in the analyses set out in this report because of the potential risk to game fish populations of nocturnal dissolved oxygen (DO) depletion which may occur in such waters, particularly in times of low flow and elevated temperature.

Sungai Lembing is one of the tourist attractions. Besides, it is also the main source of income for people near Sungai Lembing. But because of the polluted water of Sungai Lembing, this might be become a problem to the tourism part. With the water at Class III, Sungai Lembing is not suitable for tourist to come. Meanwhile, the tourism developments also become the reason why the water is polluted. Intensive tourism development in the state is causing the contamination of its aquifers, which in turn, impact on the marine ecosystems. Without acknowledging nonetheless that it is vital to all living beings, great care must be taken.

The main pollutant is the wastewater generated by the hotel infrastructure and urban growth. The biggest problem to overcome is the resistance by citizens and by the private sector that do only the minimum necessary to meet the requirements of the law, but they forget to act to preserve the environment and to protect the limited water supplies that benefit everyone.

## 5.1 RECOMMENDATION

A series of experiments on the water sample was successfully done. There are some recommendations proposed to improve the quality of water at Sungai Lembing. First, the extensive water treatment should be applied. Water may be treated differently in different communities depending on the quality of the water that enters the treatment plant. Typically, surface water requires more treatment and filtration than ground water because lakes, rivers, and streams contain more sediment and pollutants and are more likely to be contaminated than ground water. The water treatment may slightly different based on the locations but the basic principles is the same which is coagulation and flocculation, sedimentation, filtration, and disinfection.

Second, the authorities should make a good sustainable management plan in order for the future generations to learn and to control the quality of the water. The government should make sure the law must be reaffirmed. These laws are usually directed at industries, hospitals, schools and market areas on how to dispose, treat and manage sewage. The laws might help to minimize the water pollution.

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# APPENDIX A

## STUDY AREA

**Figure A1:** Station 1 on First Sampling

**Figure A2:** Station 1 on Second Sampling

**Figure A3:** Station 2 on First Sampling

**Figure A4:** Station 2 on Second Sampling

**Figure A5:** Station 3 on First Sampling

**Figure A6:** Station 3 on Second Sampling

# APPENDIX B

## SAMPLING COLLECTION

**Figue B1:** Water Sample Collection First Sampling

**Figure B2:** Water Sample Collection Second Collection

## APPENDIX C

## IN-SITU MEASUREMENT

**Figure C1:** In-situ Measurement First Sampling

**Figure C2:** In-Situ Measurement Second Sampling

# APPENDIX D

## EX-SITU MEASUREMENT

**Figure D1:** BOD Test

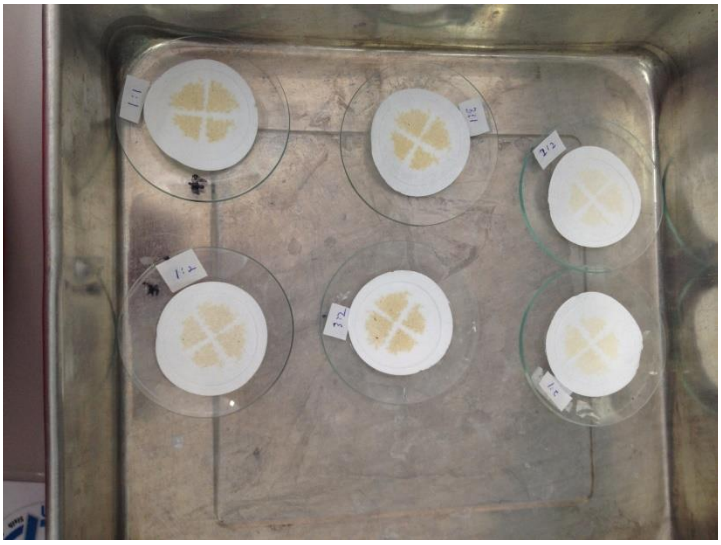

Figure D2: TSS Test

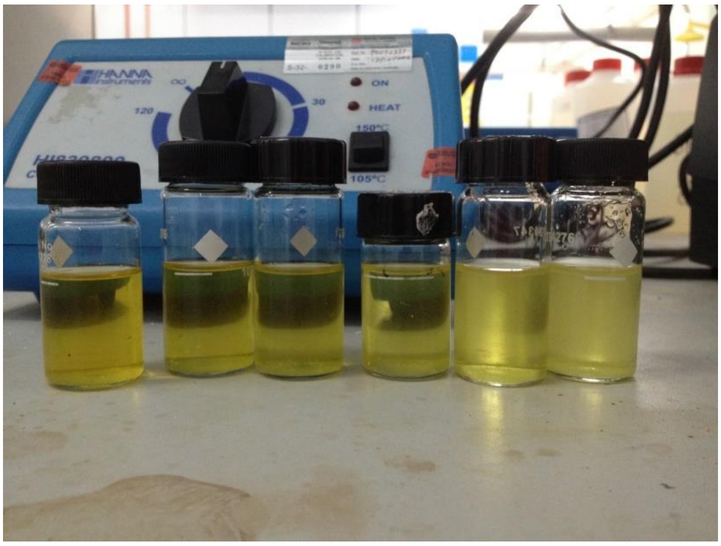


Figure D3: Ammoniacal Nitrogen Test

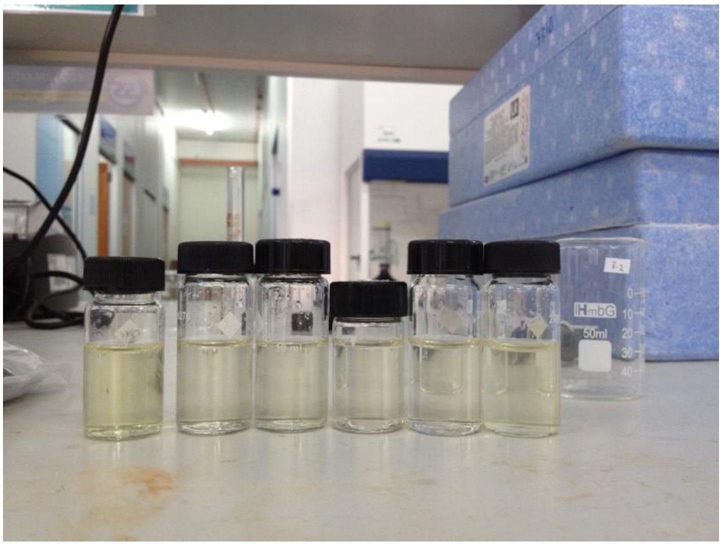


Figure D4: Phosphate Test

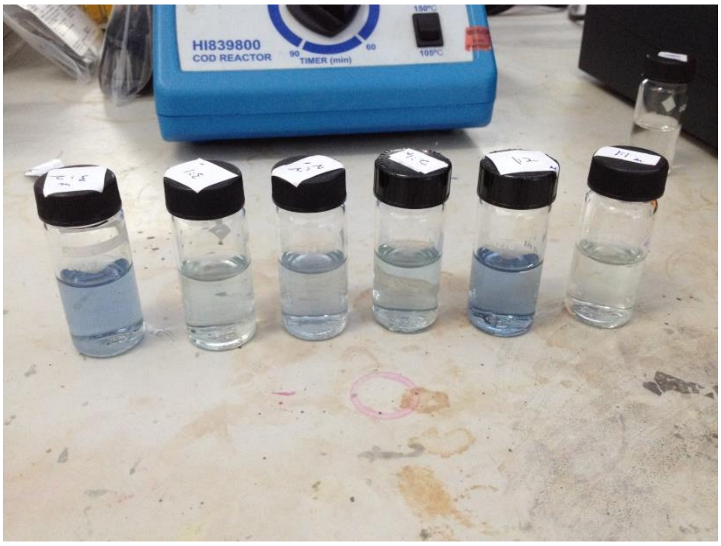


Figure D5: Sulphate Test


Figure D6: COD Test

Figure D7: Heavy Metals Test

## APPENDIX E

## WATER QUALITY INDEX TABLE

Table E1: DOE Water Quality Index Classification

| PARAMETER | UNIT | CLASS | | | | |
|---|---|---|---|---|---|---|
| | | I | II | III | IV | V |
| Ammoniacal Nitrogen | mg/l | < 0.1 | 0.1 - 0.3 | 0.3 - 0.9 | 0.9 - 2.7 | > 2.7 |
| Biochemical Oxygen Demand | mg/l | < 1 | 1 - 3 | 3 - 6 | 6 - 12 | > 12 |
| Chemical Oxygen Demand | mg/l | < 10 | 10 - 25 | 25 - 50 | 50 - 100 | > 100 |
| Dissolved Oxygen | mg/l | > 7 | 5 - 7 | 3 - 5 | 1 - 3 | < 1 |
| pH | - | > 7 | 6 - 7 | 5 - 6 | < 5 | > 5 |
| Total Suspenbed Solid | mg/l | < 25 | 25 - 50 | 50 - 150 | 150 - 300 | > 300 |
| Water Quality Index (WQI) | - | < 92.7 | 76.5 - 92.7 | 51.9 - 76.5 | 31.0 - 51.9 | > 31.0 |

Table E2: 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 |

Table E3: 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. |

Table E4: Best Fit Equations for the Estimation of Various Sub index Values

| **SUB-INDEX** | **CALCULATION** | **RANGES** |
|---|---|---|
| DO | SIDO = 0<br>SIDO = 100<br>SIDO = -0.395 + 0.030x2 - 0.00020x3 | for x ≤8<br>for x ≤92<br>for 8 < x < 92 |
| BOD | SIDOD = 100.4 - 4.23x<br>SIDOD = 108* exp(-0.055x) - 0.1x | for x ≤ 5<br>for x > 5 |
| COD | SICOD = -1.33x + 99.1<br>SICOD = 103* exp(-0.0157x) - 0.04x | for x ≤ 20<br>for x > 20 |
| NH3-N | SIAN = 100.5 - 105x<br>SIAN = 94* exp(-0.573x) - 5* I x - 2 I<br>SIAN = 0 | for x ≤ 0.3<br>for 0.3 < x < 4<br>for x ≥ 4 |
| TSS | SISS = 97.5* exp(-0.00676x) + 0.05x<br>SISS = 71* exp(-0.0061x) + 0.015x<br>SISS = 0 | for x ≤ 100<br>for 100 < x < 1000<br>for x ≥ 1000 |
| PH | SlpH = 17.02 - 17.2x + 5.02x2<br>SlpH = -242 + 95.5x - 6.67x2<br>SlpH = -181 + 82.4x - 6.05x2<br>SlpH = 536 - 77.0x + 2.76x2 | for x < 5.5<br>for 5.5 ≤ x < 7<br>for 7 ≤ x < 8.75<br>for x ≥ 8.75 |
| **WQI = (0.22* SlDO) + (0.19*SIBOD) + (0.16*SICOD) + (0.15*SIAN) + (0.16 * SISS) + (0.12 * SipH)** | | |