STUDY OF WATER QUALITY IN SUNGAI KEREH:

ANALYSIS ON THE EFFLUENT DISCHARGED FROM KAMPUNG SELAMAT BASED ON THE REQUIREMENT STANDARD

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DECLARATION

I hereby declare that I have conducted, completed the research work and written the dissertation entitled 'Study of Water Quality in Sungai Kereh: Analysis on Effluent Discharged From Kampung Selamat Based on Requirement Standard'. I also declare that it has not been previously submitted for the award of any degree and diploma or other similar title of this for any other examining body or University.

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Witnessed by

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LIST OF ABBREVIATION

DO	Dissolved Oxygen
BOD	Biochemical Oxygen Demand
BOD5	Biochemical Oxygen Demand (after 5 days)
COD	Chemical Oxygen Demand
AN	Ammoniacal Nitrogen
TSS	Total Suspended Solids
pH	Potential of Hydrogen
WQI	Water Quality Index
SH	Slaughtering House
ETP	Effluent Treatment Plant
WHO	World Health Organization
EPA	United States Environmental Protection Agency
NWQS	National Water Quality Standard
DOE	Department of Environment
DVS	Department of Veterinary Services

Kajian Kualiti Air di Sungai Kereh: Analisis terhadap Efluen yang dilepaskan dari Kampung Selamat berdasarkan Piawaian Keperluan

ABSTRAK

Sungai Kereh yang terletak di Tasek Gelugor, Pulau Pinang telah diklasifikasikan sebagai tercemar dengan "Kelas V" dan isu ini berpunca daripada aktiviti penternakan babi di Kampung Selamat. Efluen daripada aktiviti ternakan babi itu dibuang ke longkang buatan manusia dikenali sebagai Parit Cina membawa efluen terus ke Sungai Kereh. Isu ini telah berlarutan selama 40 tahun tanpa jalan penyelesaian dan mengganggu penduduk yang tinggal berhampiran untuk memperoleh kualiti hidup yang baik akibat bau busuk yang dihasilkan. Oleh itu, kajian mengenai isu ini telah dibuat melalui penilaian kualiti efluen untuk setiap ladang dan untuk mengkaji hubungan setiap parameter dengan yang lain. Aktiviti penternakan babi yang merangkumi sisa makanan, air kencing dan najis akan mengakibatkan pengeluaran ammonia daripada efluen. Jumlah kepekatan ammonia yang tinggi seperti ditunjukkan oleh parameter nitrogen ammonia boleh menjejaskan kualiti air dalam pelbagai cara. Ia juga boleh menjejaskan parameter lain seperti pH, oksigen terlarut, permintaan oksigen biokimia (BOD), permintaan oksigen kimia (COD) dan jumlah pepejal terampai. Kepekatan setiap parameter telah ditetapkan hadnya berdasarkan piawaian efluen yang diperlukan. Untuk itu, analisis terhadap parameter yang dinyatakan dilakukan untuk kedua-dua ujian, in-situ dan makmal. Daripada analisis ini, apa yang boleh disimpulkan ialah semua nilai parameter adalah berkaita antara satu sama lain. Ia juga menyediakan maklumat berdasarkan keputusan yang diperoleh daripada sampel untuk menentukan ladang efluen babi mana yang menyebabkan bahan pencemar utama. Selain itu, sistem rumah yang dilakukan untuk aktiviti penternakan babi juga mungkin menjadi faktor yangboleh mempengaruhi isu pencemaran ini.

Study of Water Quality in Sungai Kereh: Analysis on the Effluent Discharged from Kampung Selamat Based on the Requirement Standard

ABSTRACT

Sungai Kereh that is located in Tasek Gelugor, Pulau Pinang has been classified as polluted with "Class V" and the issue is caused by the pig farming activities in Kampung Selamat. The effluent from the pig farming activities is flushed to the man-made drain known as Parit Cina that carry the effluent straight to the Sungai Kereh. The issue has been unsettled for 40 years already and has disturbed the residents who lives nearby to have a good life quality due to the bad odours. Therefore, study on this issue has been made through effluent assessment quality from each farms and to observe how every parameters related to each other. Pig farming activities that include food waste, urine, faeces and manure will result on ammonia production that are found in effluent. High amount concentration of ammonia that is indicated by parameter of ammoniacal nitrogen can affect the water quality in manyways. It can affect other parameters too such as the pH, dissolved oxygen, biochemical oxygen demand (BOD), chemical oxygen demand (COD) and total suspended solid. Theconcentration has been fixed its limit based on the requirement effluent standard. As for that, analysis on the stated parameters are done for both in-situ and laboratory test. Fromthis analysis, what can be concluded is that all of the parameters value are related to each other. The analysis also provides information based on the results obtained from the sample to determine which effluent pig farms cause the major pollutants. Moreover, house system done for pig farming activities might as well be the factor that can influencethe pollution for this issue especially on the odors production.

CHAPTER 1

INTRODUCTION

1.1 Introduction of the Study

River is one of the important water body that provide human and other living things benefits for survival purpose and economic development. It is not only used for drinking in order to stay alive and healthy, river is also the major supply for irrigation in agriculture. Moreover, waste disposal from industrial, domestic, agriculture and development also use river as the water body for them to discharge the effluent. That is the reason why river should be kept its quality because poor water quality may lead to health issue, affect the condition of environment and at worst it will disturb the development of civilization. Other than that, river also may be important for other purpose including transportation and energy resource.

Water quality can be thought as a measure of the suitability of water for a particular use based on the selected physical, chemical and biological characteristics. Normally, it is measured by several factors or scientifically known as parameters which is the concentration of dissolved oxygen, pH, the bacteria level, salinity and amount of material suspended in the water body. In some analysis of water body, the concentration of microscopic algae and quantities of pesticides, herbicides, heavy metals and other contaminants may also be measured to determine the water quality. The determination for water quality analysis is typically made relative to the purpose of water whether it is for drinking or for irrigation or maybe for some other purpose. Poor water quality can lead to health risk for people and also for the ecosystems.

Contaminated of natural water body due to the human activities can cause major problem such as pollution, climate change, health problems, bad quality of life and lack of water

resources from the water body. Water quality analysis is done for observation so that polluted water can be treated and used again so that the living things will not face the limitation issue on clean water resources. Good quality of life comes from the clean water consumption.

1.2 Significant of Study

The project involves the observation on the water quality of river that is polluted due to the farming activities. Effluent discharged from the activities is not treated properly based on standards provided. Every sector that require to discharge the waste from their place will need to have effluent treatment plant. This treatment plant is important because it is used for wastewater treatment before being discharged into the water body. The wastewater that is not undergo the complete water treatment process from the effluent form will pollute the water body and alter the natural condition of it until it is unsafe to be used not only for living things but also will ruin the ecosystems. Poor condition of water bodies are not the only indicator of environmental degradation, it also can be a threat to ecosystem. In industries factor, improper water quality may cause hazards and severe economic loss.

Water quality is very important on both environmental and economic aspects. Appropriate water quality management measures need reliable quantitative information on water quality parameter behavior. The steps of water quality analysis begin with selection of parameters and suitable methods followed with proper sampling and labelling. Then, the step proceeded with preservation and analysis of the sample. The result that obtained from the water analysis can be stated in reporting step. The parameters selected for the water analysis are based on the need for a specific use of that water. Parameters that are used in this study include pH of the water, dissolved oxygen (DO),

biochemical oxygen demand (BOD), chemical oxygen dissolved (COD), ammoniacal nitrogen (AN) and total suspended solid (TSS). All of these parameters result will be used to determine the water quality index and identify the class or grade of the river status based on the National Water Quality Standards (NWQS) in Malaysia. However, it goes differently to the effluent. The effluent discharged is based on the requirement standard for effluent either Standard A or Standard B.

1.3 Problem Statement

Water quality of Sungai Kereh in Tasek Gelugor, Pulau Pinang has been categorized as polluted and unsafe to use. Based on the class of water quality from National Water Quality Standard (NWQS), Sungai Kereh were classified as "Class V" or known as dead-river since there is no water flow (Audrey Dermawan, 2021). The main cause of this pollution to occur is due to the pig farming activities in Kampung Selamat, Tasek Gelugor. The river have been plagued by the pollution for the past four decades and it has become the main problem for the residents nearby because it has affect their quality of life. The effluent discharged from the pig farming activities not only cause bad smell, it is also change the natural condition of the Sungai Kereh until it is not safe to be used for daily life anymore.

Complaints have been made and the higher agency has taken their action to solve the problem. The action is done scientifically in order to prove that the river is polluted and the result shows that the main pollutants were from pig effluent from pig farming activities. Water quality data from DOE (2020) shows that Sungai Kereh is highly polluted with ammoniacal nitrogen concentration. However, the solution was not easy back then because there is not enough cooperation from the owners of pig farms. Many of the pig farms' owner failed to follow the right requirement standard as it supposed to.

The effluent from the pig farms are being discharged into the drain that flows through the man-made drain known as Parit Cina. This drain will carry the water straight to the Sungai Kereh and pollute the next main river.

The environmental impact of pig farming is mainly driven by the spread of waste to surrounding neighbourhood by polluting the air and water with pathogens and toxic waste particles. This has disturbed people who lives nearby Sungai Kereh to have excellent quality of life. Based on the Figure 1, it describes that upstream of Sungai Kereh is clean, until the flow water that comes from Parit Cina combined together and turned the river into black with thick layer of foam.

Figure 1.1: News about Sungai Kereh pollution

Other than that, pig farming itself can cause bad smell spreading over the village. Opened-system farming need to be upgraded to closed-system farming. From the previous research and reading, closed-system cause less pollution compared to the other one especially on the smell. Communities located near the pig farms experience negative health and environmental effects due to some factors associated with industrial pig farming. Pig waste are filled with bacteria and high amounts of ammonia. During the process of turning ammonia into nitrogen by anaerobic bacteria, the nitrogen itself can contribute to acid rain in the local areas. As for the impacts, this will cause health problem such as respiratory issue and infections.

1.4 Objectives

1) To assess the water quality status of pig farm effluent from Kampung Selamat that will be released into Sungai Kereh.
2) To analyse the correlation between the concentration of ammonia with other parameters of Water Quality Index (WQI).
3) To study the hygiene condition on both closed and opened housed system used in the pig farming activities.

1.5 Location of the Study

Location study area is focusing on pollution that occur in Sungai Kereh that is located in Tasek Gelugor, Pulau Pinang. Sungai Kereh is one of the body of water that is important to people who lives near to it. The stream is not only used for domestic purpose, however it is also used as a place where effluent is discharged.

The major industry sector that involve in waste disposal into Sungai Kereh are from factory, agriculture and domestic. The high percentage of discharge that caused by those activites come from Kampung Selamat since they have man-made drainage system that

connect the effluent from the village to flow straight to Sungai Kereh. At the upstream of this river, it will connect water from Sungai Kereh to Sungai Korok that is cleaner compared to Sungai Kereh. Both of this river then will flow the water to other main river which is Sungai Muda and Sungai Perai. Based on the Figure 1.2 below, the location can be seen how they are related to each other.

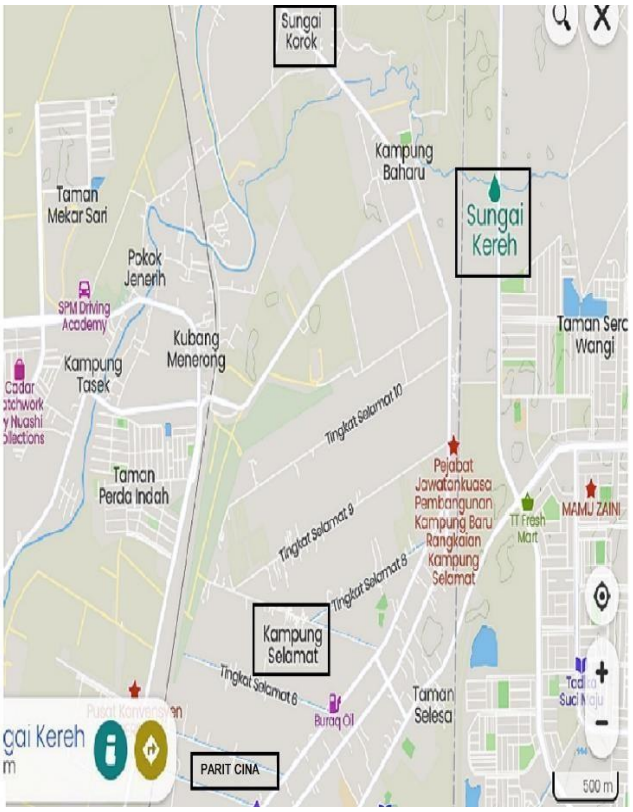

Figure 1.2: Location of Sungai Kereh, Kampung Selamat and Parit Cina

From the figure, Kampung Selamat is located near to border between Pulau Pinang and Kedah and also border to another village which is Kampung Baharu. Based on Land and District Office, pig farming is nominated as the third highest land use in Kampung Selamat with 13% or 72.43 hectares. There are about 67 lots of pig farms in Kampung Selamat that are active and most of them are still using open-system pig farming. The distribution of the pig farms in Kampung Selamat can be seen in Figure 1.5. Due to the lack of maintenance and proper treatment of wastewater on the effluent discharged, it has

caused pollution to Sungai Kereh that flushed from man-made drain known as Parit Cina in Kampung Selamat. The condition of Parit Cina and Sungai Kereh can be seen in Figure 1.3 and 1.4.

Figure 1.3: Condition of Parit Cina

Figure 1.4: Condition of Sungai Kereh (sampling point on river)

Other than that, agriculture on paddy is also considered as major activity done in Kampung Selamat, they also use water resource that come from Sungai Kereh as the irrigation. Based on the Figure 1.6, the area of paddy field is close to the Kampung Selamat. If the water resource use is polluted, this will affect the production of the paddy and harm the human's health due to the consumption.

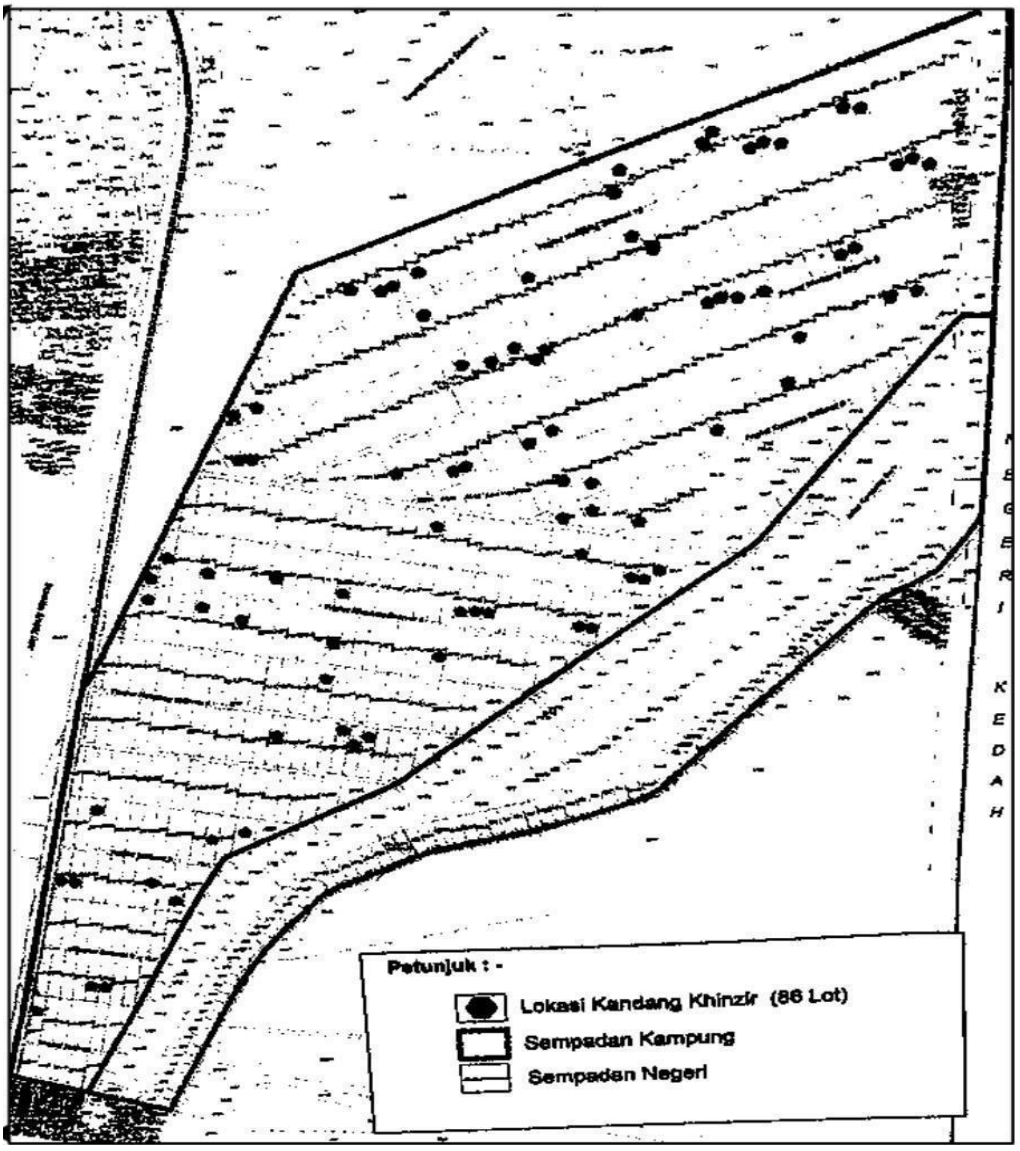

Figure 1.5: The distribution of Pig Farms location in Kampung Selamat (based on Land and District Office)

Figure 1.6: Flow of effluent from Kampung Selamat to Sungai Kereh

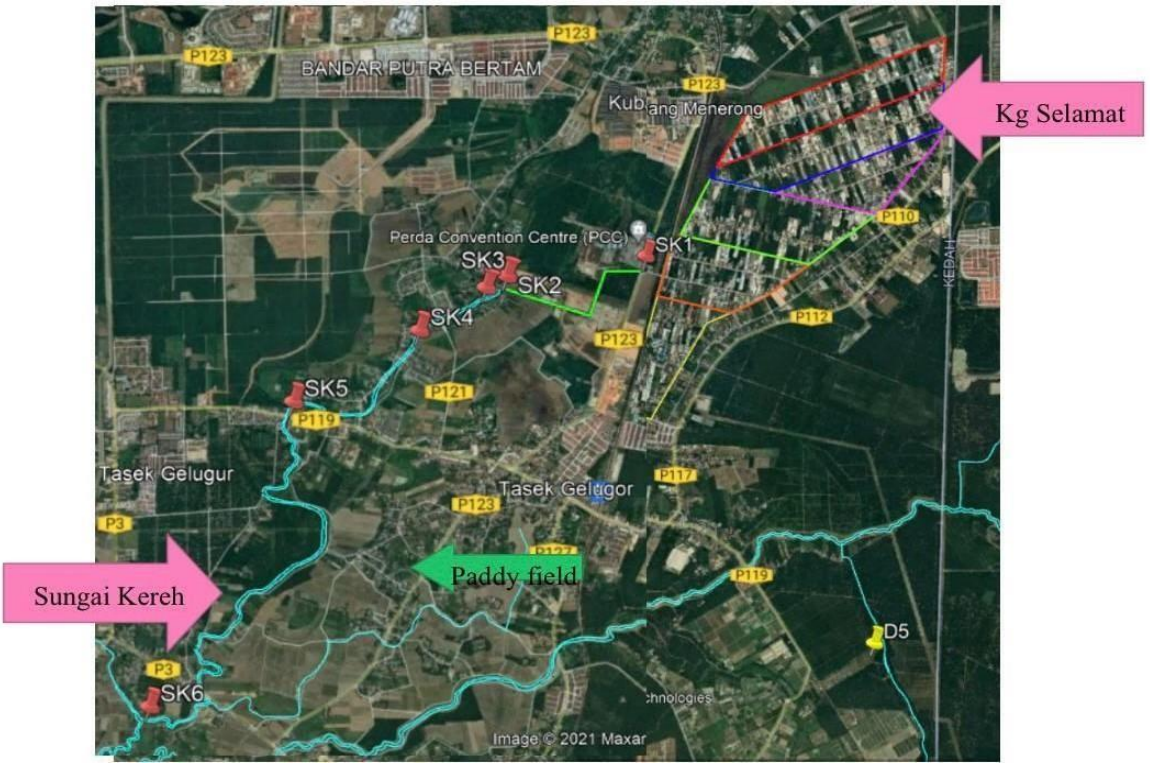

Figure 1.7: Map of Sungai Kereh

1.7 Scope of Study

1) The study was focusing on water quality status of pig farm effluent that is discharged into man-made drain, Parit Cina that carry the effluent flow straight to Sungai Kereh.
2) The laboratory test is done based on fundamental parameter such as pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammoniacal nitrogen (AN) and total suspended solids (TSS) to analyse the source of pollution.
3) The study is done to prove that the pollution that occur in Sungai Kereh is mainly occur due to pig farming activities.
4) From the research, odour problems can be reduced based on the house systems used in pig farming activities.
5) To understand the correlation between the main pollutants and to the other parameters of Water Quality Index (WQI).

CHAPTER 2

LITERATURE REVIEW

2.1 Water Quality Analysis

2.1.1 Introduction on water quality

Water is perhaps the most precious natural resources after air. Even though the surface of Earth is majorly consist of water, however there is only certain part is usable that makes this resource is limited. Therefore, this precious resource needed to be used correctly. Water is used for many different purpose not only for survival purpose but also for our daily life usage. It is essential requirement of human life and activities associated with industry, agriculture and others and considered as the most delicate part of the environment (Das et al, 2003). That is the reason why water quality are required to be analysed first before use depend on its suitability. Water quality need to be monitored regularly to determine its condition whether it is safe or not based on its improvement after water treatment process. Poor condition of water body can lead to water pollution, water scarcity and environmental degradation which may harm the ecosystem surrounding.

Water quality can be defined as the chemical, physical and biological characteristics of water usually respect to its suitability of designated use. After so many years of research, water quality standards are put in place to ensure the suitability of efficient use of water for designated purpose. Water quality analysis is to measure the required parameters of water, following standard methods, to check whether they are in accordance with the standard (Roy et al, 2018). Water quality has four classification which has been termed as potable water, palatable water, contaminated (polluted) and infected water. Potable water class of water means it is safe to drink, pleasant to taste and ready to use for

domestic purpose. For palatable water, it is considered that the presence of chemical inside do not cause threat to human health. The contaminated or polluted water means that the water contain unwanted physical, chemical and biological or radiological substance that is unsuitable for daily usage purpose. Lastly, for the infected water it gives meaning of water that is contaminated with pathogenic organism.

Objectives of water quality analysis is mainly for monitoring including, to check the water quality is in compliance with the standards, to monitor the efficiency of the system that works for water quality maintenance, to check for upgrades and improvement on the existing system, plus to monitor whether it is compliance with the rules and regulation set for daily usage and industry purpose.

2.1.2 Type of Water Bodies

There is wide diversity of water bodies on Earth, some being ancient and others very recent. More than half of the Earth's surface is covered with water. As a means of reference, and for understanding similarities and differences between systems, a classification of water bodies are required. Example of water bodies generally are ocean, river, streams, lake and pond. Water bodies are areas of water, for both salt and fresh or large and small which are distinct from one another in various ways. The largest water bodies are oceans, while the smallest are brooks or streams. Smaller accumulations of water such as puddles or swimming pools that are not usually referred to as bodies of water in the geographical sense. Below are the details about different types of water bodies and its characteristics:

a. Ocean

   It is large water bodies that are made up of salt. It separates continents from one another. Ocean is important for providing food through the many fish species that

populate the oceans and important for transportation via ships. It is also useful to human in many ways as they are a rich with source of mineral and they provide energy and valuable fuels like petroleum.

b. Seas

It is smaller bodies of water than oceans but still considered as large water bodies, partly enclosed by a land mass and connected to an ocean. Same as ocean, it is a rich source of food providing us with various kinds of sea food and work as channel transportation.

c. Lake

A body of water completely encapsulated by land. Lake can be either salt or freshwater. Salty lakes are due to a lot of evaporation taking place.

d. Rivers

Large flowing water bodies that typically end in an ocean or sea. Rivers are freshwater bodies of water that usually originate in in mountains or areas of high elevation. Then, the water from that area are added to by smaller bodies of water such as creeks or streams and as well as by rainfall.

e. Streams

Can be intermittent or permanent and can be on the surface of the Earth, underground or even within an ocean.

f. Bay

It is a water body that is enclosed by land, with wide mouth opening of land where the water is surrounded by land on three sides and joined to the sea on the fourth side.

g. Waterfall

It is water that falling from a certain height that formed when a river flows over an edge of hard rocks and falls from a great height.

h. Wetland

An area of land that is saturated with water either permanently or seasonally. Wetlands can be freshwater, brackish (partly salty) and saline (very salty). It becomes important because it has function of filtering water, as when the water moves through a wetland, the sediments and pollutants stick in the wetland and making the water cleaner. Other than that, it also help reduce flooding and prevent shoreline erosion. Wetland can be both naturally and man-made. Man-mad wetland is made for the water management purpose in urban areas. There are several type of wetland which is marshes, swamps, bogs and fens.

i. Estuary

It is an area where a freshwater from river or stream meets the ocean (sea water). In estuary, the saline water mixes with the freshwater from river and resulting in new form of water which is known as brackish water. Water level and salinity rise and fall by tides. During the rainy season, rivers may flood the estuary with freshwater while on the other hand, during storm season, storm surges and other ocean waves may flood the estuary with saltwater. Example geographical features of estuary are reefs, island, mud and sand that act as barriers from ocean waves and wind.

2.1.3 Uses of Water in Daily Life

In general, water is important to all living things in order for them to survive. As the water is used with different purpose, therefore the quality of water need to be monitored whether it safe or not for others to use. Poor water body condition not only may harm human's

health, it also will cause environmental degradation that can be a threat for the ecosystem. The reason why water body is important in our daily life is as stated below.

1) Drinking water and disposal of waste

   Living things on Earth are dependent on water in order for them to complete their cycle of life as the water is essential component of cells. The main source of water consumption back then is river, lake and pond. Waste is discharged into water bodies nearby from agriculture activities.

2) Water and human transport

   In previous century, water is means as a transport at that time. They use simply-crafted or boats to migrate from one location to another. When the cities and towns developed near rivers, transport was needed for carry loads for import and export important goods. Normally, they will use cargoes as the transportation.

3) Providing human foods from water

   Water bodies contain sources of foods such as aquatic life either plants and animals or vertebrates and invertebrates. People who lives near to the rivers and seas commonly depend on sea foods as their source of energy other than from farming and natural resources.

4) Irrigation of crops

   Fresh water from water bodies are necessary for irrigation purpose for crops. They use water from rivers, lakes, impoundments and containers to irrigate the water to the crops since enough of water are vital. As for the details, irrigation use channels and dikes to duct water to crops that sometimes maintained under water.

5) Generate power by using water sources

   Moving water provides important source of energy that can be harnessed to start the machinery and generate power other purpose. The principle used for

generating power from water is the use of turbines. Large rivers dammed and water passing through pipes to generators, often with considerable drop in vertical water level to ensure maximum power output. Other way is by using hydroelectric for a significant amount of power. However, this method involve burning fossils or from nuclear reaction. Another method is by using sea to generate power, it uses tidal cycle and action of waves but nowadays this process for the following method are expensive to develop, produce and maintain the system for generating power.

6) Recreational purpose

Water bodies like river, beach and pond become the attraction for recreational purpose. As long as the quality of the water safe from harmful pollutants, then people are free to use it without causing the pollution.

2.2 Parameters in Water Quality Analysis

2.2.1 Relationship between water quality analysis and parameters

Water quality analysis is test that is done chemically, physically and biologically based on its characteristics and suitability depend on the situation and environment. The standard for this analysis is put on place of water for designated purpose. Water quality analysis purpose is to measure the required parameters of water, by following the standard methods to check whether they are in accordance with the standard on different purpose and sector. If the water quality extend the standard compliance set by National Water Quality Standard (NWQS), therefore the water bodies is harmful for use and need to be treated. The parameters for water quality analysis are selected based on according to the need for a specific use of that water.

Water has lots of importance that has been used in many ways. For example, the parameters used to analyse water for drinking is based on standard set by NWQS which is pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammoniacal nitrogen (AN) and total suspended solid. However for irrigation purpose, parameter that involve in its water quality analysis are pH, conductivity, sodium (Na) and potassium (K), nutrients and specific compounds are used in order to analyse whether the irrigated water extend the standard compliance or not. For industrial, it is different a little bit as it depend on the specific requirement. Industry discharge its waste into the water bodies near to them from effluent treatment plant. Every sector need to build their effluent treatment plant before dispose it into the water body to remove harmful pollutants. This way will keep water quality on the water body clean and remain on class I which is safe to be used. Normally, industry will dispose chemical substance that contain heavy material that may affect the quality of water body and kill the aquatic life. Thus, the analysis that is done in this kind of condition require specific parameter based on materials or chemicals dispose into the river, seas or lakes. Next, domestic consumption that comes from household operations are necessary to undergo water treatment process to remove particles, natural organic matter, oil and gas and sediments before discharge to be used again either for drinking, agriculture, industry and domestic.

2.2.2 Parameters for water quality analysis

Parameters in water quality analysis used to analyse the presence of the pollutants and to determine the percentage of oxygen in the water. Generally, the parameters are classified into physical, chemical and biological. However, there is also addition to the parameter classification into toxic metals, radiological and also organic or nutrient demand. This classification is separated based on its condition, method and result. As for the example,

the physical parameter means that the result from the observation can be done physically with part of human body or by using some equipment without involve chemical substance. For the chemical type, it involves chemical that may need us to do lab test to get the result for the analysis. Biological parameter involve living things either microorganism or plant such as algae, protozoa, plankton and bacteria. The classification can be seen in the Table 2.1 below.

Table 2.1: Classification of parameters for water quality analysis

Physical	Chemical	Biological
1. pH 2. Temperature 3. Colour 4. Taste and Odour 5. Turbidity 6. Conductivity 7. Total Suspended Solid (TSS) 8. Total Dissolved Solid (TDS)	1. Hardness 2. Calcium 3. Magnesium 4. Sulphate 5. Nitrate 6. Fluoride 7. Alkalinity 8. Phosphate 9. Nitrate 10. Nitrite	1. Algae 2. Plankton 3. Protozoa 4. Bacteria

Toxic Metals	Organic and Nutrient Demand	Radiological
1. Zinc 2. Mercury 3. Lead 4. Copper 5. Iron	1. Biochemical Oxygen Demand (BOD) 2. Chemical Oxygen Demand (COD) 3. Oil and grease	1. Alpha Emitter 2. Beta Emitter

Water Quality Index standard has been set differently for every country due to the different environment and season (World Health Organization [WHO], 2004). As in Malaysia, as long as it do not involve heavy materials, unfamiliar chemical substance or radioactive source, then the parameter that will be used for water quality analysis is pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammoniacal nitrogen (AN) and total suspended solid (TSS).

Those six fundamental parameters is important since it is the basic thing to confirm the water quality analysis. Normally, industrial zone that near to the water body will be investigated first its environment and chemical or heavy material used so that the parameter for their water quality analysis can be added to keep water body nearby safe and clean. In Malaysia, these are the parameters that are commonly used:

1) pH (potential Hydrogen)

   pH stands for potential of hydrogen. In water quality, pH is the first measurement that should be taken. The pH of water is measured with test kit which will tell us whether it is basic or acidic based on the value shown on the kit. For acidic water, it is invariably comprised of more hydrogen ions. On the other hand, basic water

contains more of hydroxyl ions. Generally, range for pH level is between 0-14. If the reading shown is 7, then the water is neutral. For reading below than 7 then it is acidic while if the reading shown is above 7 it is basic. Pure water has neutral pH, however it can change due to the rainfall because it is slightly acidic which around 5.6. Water is considered safe to drink if it is in range (6.5 to 8.5). The pH of water cannot be too low or high because it might affect the condition of water and the aquatic life.

2) Dissolved Oxygen (DO)

This is one of the fundamental parameter used in this analysis since it helps us to determine how polluted the water body is. If the water has high concentration dissolved oxygen, it means that the water quality is excellent. Dissolved oxygen refer to the solubility of oxygen in the water. The actual amount of dissolved oxygen varies depend on the pressure, temperature and the salinity of the water (Vijay S. Kale et al, 2016). It also related to another parameter known as biochemical oxygen demand (BOD)and chemical oxygen demand (COD) due to its relation to oxygen consumption on the water sample.

3) Biochemical Oxygen Demand (BOD)

Aquatic life and microorganism in the water body use organic substances for food. They consume oxygen when metabolize the organic material. The organics are broken down into simpler compound such as water or water vapor (H_2O) and carbon dioxide (CO_2) and then microbes use the energy released for growth and reproduction. Example of microbes are bacteria, algae, viruses and protozoa (S. Joanneau et al, 2014). If oxygen used is not continuously replaced by the natural or artificial mean in the water, the dissolved oxygen concentration will reduce

as the microbes decompose the organic materials. The need of oxygen is called the biochemical oxygen demand (BOD). The more organic material present in the water, the higher the BOD used by the microbes will be. BOD is used as a measure of the power of sewage, which means the strong sewage has high BOD while weak sewage has low BOD. The complete of decomposition of organic material takes time under certain circumstances (Tchobanoglous et al, 2003). The quantity of oxygen used in specified volume of water to fully decompose or stabilize all biodegradable organic substances is called the ultimate BOD and BOD_L. BOD is at time 0 and no oxygen is consumed so the BOD is equal to 0, however it is going to increase as the time goes. Meanwhile, BODL is the reading when the organic material has been done decomposed.

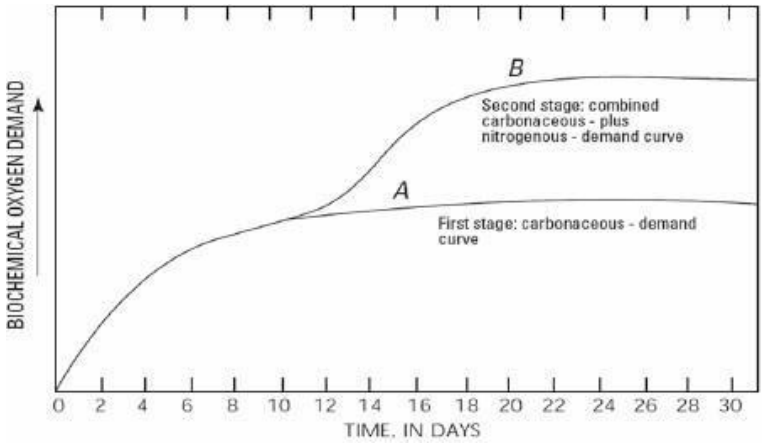

Figure 2.1: Example of BOD curve (Sawyer and McCarty et al, 1978)

From the Figure 2.1 (Sawyer and McCarty et al, 1978), the first stage is the BOD which is the first day sample is taken its measurement of BOD, the level BOD is low which means that the oxygen consumed by the microbes to decompose organic material is less. However, the BODL increases after days because the oxygen consumed by the microbes also increases. This activity is depend on surrounding factor such as temperature, moisture and pressure.

4) Chemical Oxygen Demand (COD)

This type of parameter measures all organics including biodegradable and non-biodegradable substances. COD indicate the amount of oxygen required to chemically break down pollutants, while BOD indicates the amount of oxygen required to break down organic pollutants biologically with microorganisms. This parameter is used to determine concentration of oxidising pollutants in the wastewater, to analyse effectiveness of water treatment solution, to determine the effect of wastewater disposal on the environment and act as an index for water quality index analyse. It is a chemical test using strong oxidizing chemicals such as potassium dichromate, sulphuric acid and heat. The result can be obtained in about 2 hours. Normally, the result in COD is higher than value of BOD.

5) Ammoniacal Nitrogen (AN)

A parameter that is used to measure the amount of ammonia, which is a toxic pollutant that is often found in landfill and also in the waste products. Other than that, it can be used in water quality analysis to measure the health of water in natural bodies from lakes, river, pond, estuary and wetland or even in man-made water reservoir. Ammonia is poisonous to human and may destroy the environment of the ecosystems. High concentration of ammonia and nitrogen can deteriorate water bodies and can affect aquatic life in there. Animal waste from farming activities is the major source of ammoniacal nitrogen pollution in the water bodies.

6) Total Suspended Solid (TSS)

Can be defined as the amount of solids in water that can be trapped by filters. This parameter include wide variety of material such as silt, decaying plant and animal matter, industrial wastes and sewage. High concentration of TSS may lead to

serious health problem and damage to aquatic life. TSS with high value can block light from reaching submerged vegetation. When the light passing through the water is reduced then the rate of photosynthesis may also decrease. Rate of photosynthesis may affect the amount of dissolved oxygen in the water. Low rate of photosynthesis therefore it may reduce the amount of dissolved oxygen absorbed in the water. The plants in the water body failed to produce oxygen due to less sunlight absorption thus it will die too. As the plants decomposed, the microbes may use up the oxygen from the water. This will create oxygen demand to aquatic life as the fish and other aquatic life also need oxygen to live (Mitchell and Stapp et al, 1992). High TSS can often mean higher concentration of bacteria, nutrients, pesticides and metals.

7) Hardness

   Occurs when the water contains high mineral levels. If left not being treated then the dissolved minerals in the water create scale deposits on hot water pipes. Hardness in water is mainly caused by the presence of magnesium and calcium ions which can enter water from rock and soil. Normally, groundwater has more hardness than the surface water.

2.3 Water Quality Index (WQI)

2.3.1 Introduction to Water Quality Index (WQI)

Water quality requirements differ depending on the proposed used of water. The requirement should be agreed with the water quality standards which are put down by the governmental agency and represent the legislation requirements. In general, there are three types of standards which are in stream, potable water and wastewater effluent. Each of it has its own criteria by using the same methods of measurement (Tchobanoglous et

al, 1985). The World Health Organization (WHO) has established the minimum standards for drinking water that all countries are recommended to meet (World Health Organization [WHO], 1996).

WQI provides a single number that expresses the overall water quality, at certain location and time based on parameters used depend on the type of pollutants detected. The main objective of WQI is to turn complex water quality data into information that is understandable and usable by the public. A number of indices have been developed to summarize water quality data in an easily expressible and easily understood format. WQI is basically a mathematical means of calculating single value from multiple test results. It is first developed by Horton (Horton R.K et al, 1965) and he presented a mathematical method of calculating a single value to represent water quality from multiple water quality parameters. The index represents the level of quality of water body such as lake, river or stream by using some of the regularly used water parameters including Biochemical Oxygen Demand (BOD), pH, turbidity, dissolved oxygen and conductivity (Kankal et al, 2012). WQI is based on the measurement of different water quality parameters thus providing a mechanism for presenting a cumulatively derived numerical expression for defining water quality (Miller W.W. et al, 1986). Water quality index reduces water quality data to common scale or format and combine the data taken from different parameters into a single number in accordance with suitable method or model of computation. Every parameters will be set its limit and standard for both surface water and groundwater.

Despite of the benefits attributed to the WQI, however it is besieged with some challenges (Yilmaz Ilcaga et al, 2007). One of the limitation of WQI are, it is not an absolute measure degree of pollution or the actual water quality. This is because pollution occur due to different pollutants and it depends on parameters used to determine the cause of it. Other