POTENTIAL STUDY OF BERA LAKE WATER QUALITY FOR ALTERNATIVE SOURCE OF WATER SUPPLY

NUR LYANA ADIBAH BINTI MUSHIWAN

B. ENG(HONS.) CIVIL ENGINEERING

UNIVERSITI MALAYSIA PAHANG

UNIVERSITI MALAYSIA PAHANG

DECLARATION OF THESIS AND COPYRIGHT

Author's Full Name : NUR LYANA ADIBAH BINTI MUSHIWAN

Date of Birth : 17 NOVEMBER 1995

Title : POTENTIAL STUDY OF BERA LAKE WATER QUALITY FOR ALTERNATIVE SOURCE OR WATER SUPPLY

Academic Session : SEMESTER 2017/2018

I declare that this thesis is classified as:

- ☐ CONFIDENTIAL (Contains confidential information under the Official Secret Act 1997)*
- ☐ RESTRICTED (Contains restricted information as specified by the organization where research was done)*
- ☑ OPEN ACCESS I agree that my thesis to be published as online open access (Full Text)

I acknowledge that Universiti Malaysia Pahang reserves the following rights:

1. The Thesis is the Property of Universiti Malaysia Pahang
2. The Library of Universiti Malaysia Pahang has the right to make copies of the thesis for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified by:

_______________________ (Student's Signature)

_______________________ (Supervisor's Signature)

951117-04-5450
New IC/Passport Number
Date: 25 JUNE 2018

____
Dr MIR SUJAUL ISLAM
Date: 25 JUNE 2018

NOTE : * If the thesis is CONFIDENTIAL or RESTRICTED, please attach a thesis declaration letter.

THESIS DECLARATION LETTER (OPTIONAL)

Librarian,
Perpustakaan Universiti Malaysia Pahang,
Universiti Malaysia Pahang,
Lebuhraya Tun Razak,
26300, Gambang, Kuantan.

Dear Sir,

CLASSIFICATION OF THESIS AS RESTRICTED

Please be informed that the following thesis is classified as RESTRICTED for a period of three (3) years from the date of this letter. The reasons for this classification are as listed below.

Author's Name	NUR LYANA ADIBAH BINTI MUSHIWAN
Thesis Title	POTENTIAL STUDY OF BERA LAKE WATER QUALITY FOR ALTERANTIVR SOURCE OF WATER SUPPLY
Reasons	(i)
	(ii)
	(iii)

Thank you.

Yours faithfully,

____
(Supervisor's Signature)

Date:

Stamp:

Note: This letter should be written by the supervisor, addressed to the Librarian, *Perpustakaan Universiti Malaysia Pahang* with its copy attached to the thesis.

(Please take out if not related)

SUPERVISOR'S DECLARATION

I/We* hereby declare that I/We* have checked this thesis/project* and in my/our* opinion, this thesis/project* is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering

____

(Supervisor's Signature)

Full Name :

Position :

Date :

____

(Co-supervisor's Signature)

Full Name :

Position :

Date :

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

____

(Student's Signature)

Full Name : NUR LYANA ADIBAH BINTI HJ MUSHIWAN

ID Number : AA14187

Date : 25 JUNE 2018

POTENTIAL STUDY OF BERA LAKE WATER QUALITY FOR ALTERNATIVE SOURCE OF WATER SUPPLY

NUR LYANA ADIBAH BINTI MUSHIWAN

Thesis submitted in fulfillment of the requirements
for the award of the
Bachelor Degree in Civil Engineering

Faculty of Civil Engineering and Earth Resources

UNIVERSITI MALAYSIA PAHANG

JUNE 2018

ACKNOWLEDGEMENTS

First and foremost, thanks to God Almighty for the guidance and aid in giving me the strength to finish my project "Potential Study of Bera Lake Water Quality for Alternative Source if Water Supply" to complete this thesis. A great appreciation thanks to my project supervisor, Dr Mir Sujaul Islam for the guidance, advices and knowledge throughout this study. He had taken a lot effort to give opinion and comment about my project.

Besides that, I would like to take this opportunity to express my utmost gratitude to all lecturers and technicians in the Faculty of Civil Engineering & Earth Resources who lending me a hand throughout this project development and not forgotten Puan Norazimah Binti Abdul Aziz for her advices and support in completing this project.

I also would like to express my sincere appreciation to all my friends who involve in the project development and shared their knowledge and opinion. They do not hesitate to share their opinion and idea to me in completing this project.

Finally, my sincere thankful also extends to my family for their kindness, support and encouragement from the beginning and until the end of my study. I also would like to thanks to everyone who involve in producing this project report and their contribution would never be forgotten.

ABSTRAK

Kajian ini memberi tumpuan dalam menentukan potensi kualiti air untuk alternatif sumber air. Kualiti air adalah penting sebagai sumber untuk menggambarkan sifat fizikal, biologikal dan kimia untuk mengelaskan kepada setiap kelas. Kajian ini dijalankan berdasarkan sifat parameter fizikal, biologikal, dan kimia dari Tasik Bera semasa bulan Febuari dan April 2018. Parameter fizikal adalah suhu dan jumah pepejal gantung. Kemudian, parameter kimia adalah nilai pH, bubaran oksigen (DO), permintaan oksigen biokimia (BOD), permintaan oksigen kimia (COD), nitrogen ammonia, fosforus, logam berat terpilih seperti zink, tembaga, kadmium, dan plumbum. Parameter biologikal, adalah jumlah koliform dan Escherichia coli. Air di klasifikasi berdasarkan indeks kualiti air (WQI) dan indeks kualiti air negara untuk Malaysia (NWQS). Merujuk kepada standard WQI, pengkelasan kualiti air berdasarkan jenis pengkelasan. Selepas selesai ujian makmal, dua stesen di Tasik Bera boleh di klasifikasikan kepada kelas dua. Stesen 1 dengan bacaan 79.33 adalah kelas 2, jika mahu di jadikan sumber air perlu menjalani rawatan konvensional. Stesen 2 dengan bacaan 79.24 juga berada dalam kelas 2. Ia juga perlu menjalani rawatan konvensionaljika mahu di jadikan sebagai sumber air. Secara kesimpulannya, mengenal pasti kualiti air adalah penting untuk membezakan penyesuaian penggunaan air.

ABSTRACT

This study concentrated on deciding potential of Bera Lake water quality for alternative source of water supply. Water quality is an important reference for describing the physical, chemical, and biological properties of water classification into each class. A study was conducted on physical, chemical, and biological parameter of Bera Lake on 2018 that contain water bodies at two stations with two sampling in two months of February and April 2018. Physical parameters were temperature and total suspended solids. Then, chemical parameters were pH value, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammonia nitrogen, phosphorus and selected heavy metals such as zinc, copper, cadmium and lead. For biological parameter were Total Coliform and E. Coli. The water was classified based on Water Quality Index (WQI) and National Water Quality for Malaysia (NWQS). Based on WQI standard, classifications of water quality were based on type of class. After accomplishment the laboratory test, two stations in Bera Lake can being determined classified into class 2. Station 1 with 79.33 is for class 2, if use for water supply need conventional treatment. Station 2 with 79.24 also in class 2. If want to being as water supply the conventional treatment were needed. Overall, identifying water quality is important for differentiate suitable purpose of water body. It is very important for conserving and preserve source of surface water for water supply purposes in a future.

TABLE OF CONTENT

DECLARATION		
TITLE PAGE		
ACKNOWLEDGEMENTS		**ii**
ABSTRAK		**iii**
ABSTRACT		**iv**
TABLE OF CONTENT		**v**
LIST OF TABLES		**ix**
LIST OF FIGURES		**x**
LIST OF SYMBOLS		**x**
LIST OF ABBREVIATIONS		**xii**
CHAPTER 1 INTRODUCTION		**1**
1.1	Background	1
1.2	Problem statement	2
1.3	Objectives	3
1.4	Scope of study	3
1.5	Justification of Study.	4
CHAPTER 2 LITERATURE REVIEW		**6**
2.1	General	6
2.2	Hydrological cycle of water resources	6
2.3	Water quality parameter	8
	2.3.1 Parameter of physical water quality	8

2.3.2 Parameter of chemical water quality 10

2.3.3 Parameter of biological water quality 18

2.4 Water quality standard 19

2.4.1 Water Quality Index, WQI 19

2.4.2 National Water Quality Standards for Malaysia (NWQS). 21

2.5 Alternative Water Resources 23

CHAPTER 3 METHODOLOGY 24

3.1 Introduction 24

3.1.1 Study area 24

3.1.2 Flow chart 25

3.1.3 Sample and preservation method 27

3.1.4 Experimental Procedure 28

3.1.5 Ammoniacal nitrogen (NH_4^-N) 30

3.1.6 Total Suspended Solids (TSS). 30

3.1.7 Heavy metals analysis using Atomic Absorption Spectroscopy (AAS). 31

3.1.8 E.Coli and Total Coliform Presence Test. 32

3.1.9 Water Quality Index Standard 32

3.1.10 Data analysis result 33

CHAPTER 4 RESULTS AND DISCUSSION 34

4.1 Introduction 34

4.2 Sampling and preservation 34

4.3 In-situ parameters measurement 35

4.3.1 Temperature 35

4.3.2 Determination of pH value 36

4.3.3 Dissolved oxygen 36

4.4 Laboratory analysis of water parameters 37

4.4.1 Biochemical oxygen demand 37

4.4.2 Turbidity 38

4.4.3 Chemical Oxygen Demand 39

4.4.4 Ammoniacal Nitrogen 40

4.4.5 Nitrate 40

4.4.6 Phosphorus 41

4.4.7 Total Suspended Solids 42

4.4.8 Heavy Metals Analysis 43

4.4.9 Determination of Total Coliform and E.Coli 45

4.5 Result Comparison 47

4.5.1 Water Quality Index (WQI) 47

4.5.2 National Water Quality Standard Malaysia (NWQS). 47

4.6 Bera Lake as alternative water supply 48

CHAPTER 5 CONCLUSION 50

5.1 Introduction 50

5.2 Conclusion 50

5.3 Recommendations and suggestions 51

5.3.1 Recommendations 51

5.3.2 Suggestions 51

5.3.3 Conventional Water Treatment Process 52

REFERENCES 53

LIST OF TABLES

Table 2.7	The typical use for any types of water	**14**
Table 2.9	National water quality standard for Malaysia	**20**
Table 2.10	Water classesand uses	**21**
Table 3.7	Water Quality (WQI)	**23**
Table 4.17	Average of WQI value for every station	**47**
Table 4.18	Average value of parameters tested for comarison to its classes based on National Water Quality Standard Malaysia	**48**

LIST OF FIGURES

Table 2.3	Suspended solid can settle out into sediment at bottom of water body over period of time	**10**
Table 2.4	The level of pH value of acidity and alkalinity	**11**
Table 2.5	Symbiotic relationship between bacteria and algae in a waste water	**12**
Table 2.6	The calculation of BOD	**12**
Table 2.8	Heavy metals adsorbtion process	**18**
Table 3.1	Flow chart of the study methodology	**26**
Table 3.2	Location of sample of Bera Lake	**27**
Table 4.1	Weather during sampling at Bera Lake	**34**
Table 4.2	Observation of temperature at different sampling stations	**35**
Table 4.3	pH value at different sampling stations	**36**
Table 4.4	Dissolved oxygen value at different sampling stations	**36**
Table 4.5	Biochemical oxygen demand value at different sampling stations	**37**
Table 4.6	Turbidity value at different sampling stations	**38**
Table 4.7	Chemical oxygen demand value at different sampling stations	**39**
Table 4.8	Ammonia value at different sampling stations	**40**
Table 4.9	Nitrate value at different sampling stations	**40**
Table 4.10	Phosphorus value at different sampling stations	**41**
Table 4.11	Total suspended solid value at different sampling stations	**42**
Table 4.12	Cadmium concentration value at different sampling stations	**43**
Table 4.13	Lead concentration value at different sampling stations	**44**
Table 4.14	Zinc concentration value at diffenrent sampling stations	**45**
Table 4.15	E.Coli concentration value at different sampling stations	**46**
Table 4.16	Total Coliform value at diiferent sampling stations	**46**
Table 5.1	Conventional water treatment plant process	**52**

LIST OF SYMBOLS

^oC	Temperature
mg/L	Milligram per liter
MPN	Most portable number

LIST OF ABBREVIATIONS

BOD	Biochemical oxygen demand
COD	Chemical oxygen demand
Cd	Cadmium
Cu	Copper
DO	Dissolved oxygen
NWQS	National Water Quality Standard
Pb	Lead
TSS	Toal Suspended Solid
UMP	Universiti Malaysia Pahang
WHO	World Health Organization
WQI	Water Quality Index
Zn	Zinc

CHAPTER 1

INTRODUCTION

1.1 Background

Water connects every aspect of life. It is one of important substances on earth. Clean water is essential for life, but most people in the developed world do not think much about the water. They use water for drinking, food preparation, and sanitation. Millions of people die each year, most of them children, from largely preventable diseases caused by a lack of access to clean water and proper sanitation. Access to safe water and sanitation can quickly turn problems into potential – unlocking education, work opportunities, and improved health for women, children and families across the world. Every life thing must have water to survive. No water no life in earth. Every day, 2 million tons of sewage and industrial and agricultural waste are discharged into the world's water (INSTITUTE, 2010), the equivalent of the weight of the entire human population of 6.8 billion people. Worldwide, infectious diseases such as waterborne diseases are the number one killer of children under five years old and more people die from unsafe water annually than from all forms of violence, including war (INSTITUTE, 2010). In some regions, more than 50% of native freshwater fish species are at risk of extinction, and nearly one-third of the world's amphibians are at risk of extinction (Peter B Moyle, 2010). In Earth only 3 % of Earth's is fresh water and rest of 97 % of the water consist of salt water (contributors, 2018). However the fresh water contain high demand rather than salt water.

There are many catchment area became as water resources on earth. The common catchment area are instance stream, pond, river or freshwater wetland. These catchment area basic function for agricultural use, industrial use and for generation of different types of energy like hydro electric energy. However, it is important to know the quality of water since it became from limited volume.

In Pahang, there are many issues of water quality that occured because of human activity (bauxite mining), agricultural and travel activities. There is a natural freshwater Bera Lake. It is RAMSAR site since 1994. However on past few years Bera Lake became polluted because of agricultural activities and illegal logging. 1,000 hectares of RAMSAR's permanent forest reserve in Tasik Bera, Pahang, changed status and approved for logging activity (Malaysia, 2016). Bera Lake is the water resources to Semelai community. The polluted of water became dangerous to community area.

1.2 Problem statement

Nowadays there are several problem of water quality occurred in an international area. For example on 2017, Pakistan drinking water quality is being deteriorated day by day, China had unusable drinking without treatment, Lebanese had a brown-colored area in the sea, Lake St. Clair nearly a trillion gallons of partially treated storm sewer overflow, storm water runoff mixed with sewage. From this problem occurred water can be polluted easily. A healthy water quality is good for everybody and good for future also. Malaysia, catchment area as water resources to locals but today many catchment area being polluted. There are 43 river in Malaysia being polluted (Bernama, 2016). Suspended solid pollution from land development activities. For example Langat River area. Langat River water became polluted to groundwater and soil quality because of agricultural and industrial activities. The other is Tasik Titiwangsa, got water pollution because of human activities.

In Pahang, there is a catchment area such as Lake Bera. As we know Lake Bera is the largest natural lake in Peninsular Malaysia and designated as first RAMSAR site. Even it is RAMSAR site it is water supply or water resources to Semelai community or Orang Asli Semelai. They used for daily used. Water pollution occur because of land development for establishment of oil palm, rubber tree plantations and illegal logging that affected wetlands and open waters. It is also affected to increase the sedimentation rate.

1.3 Objectives

The main objectives of this study are :

i. To identify the behavior of water quality parameter based on special variation of the study area.
ii. To identify or disclosed the suitability of the lake water quality for alternative source of water supply.

1.4 Scope of study

Bera Lake is located in southwest Pahang, Malaysia in the saddle of the main and eastern mountain ranges of Peninsular Malaysia, extending 35 km long and 20 km wide, drain into the Pahang River. Bera Lake is the largest neutral freshwater lake system. The location of Bera Lake located at water crisis problem however it is RAMSAR site. Pollution of water occured because of land development by FELDA and illegal logging.

Sampling station in this research area was located at various points according to their different depth, current flow, and surrounding activities around the lake. Besides, sampling points also based on water intake criteria. Water intake criteria consists of best available water quality, far from strong current, quantity of water demanded can be achieved at very low water flow rate, easy accessible and possess adequate space. The sample from each sampling point will be taken once since lake is not a stream flow that may show frequent changes.

The study includes physical, chemical, and biological characteristics parameters. The physical parameter consists of temperature, conductivity and total suspended solid test. Whereas chemical parameter consists of pH test, dissolve oxygen, biochemical oxygen demand, chemical oxygen demand, ammoniacal nitrogen, phosphorus, sulphate, selected test for heavy metal presence. Biological parameter consists of Absence-Presence Test, E.Coli and Total Coliforn Presence Test.

Figure 1.0 : The map of Bera Lake in peninsular Malaysia.

Source: (Farhah, 2014)

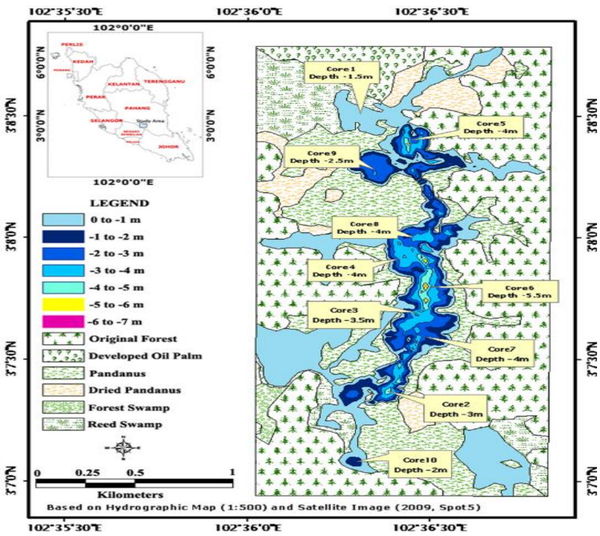

Figure 1.1: The specific location of Bera Lake.

Source: (Mohammadreza Gharibreza, 2013)

1.5 Justification of Study.

The tendency of water demand in Malaysia increase day by day from 9.543m^3/day in 1995 to 15,285m^3/day in 2010.

Critical water supply areas in Malaysia

Catchment	States	Water treatment plants located	Possible supply (million litres/day)	Critical factors
Sg. Selangor	Selangor	4	2,800	Supplies 60% of the water requirements in Selangor, KL and Putrajaya.
Sg Semenyih	Selangor	1	670	Supplies 15% of the water requirements in Selangor, KL and Putrajaya.
Sg. Langat	Selangor	6	525	Supplies 13% of the water requirements in Selangor, KL and Putrajaya.
Sg. Muda	Kedah	1	45	Source is from Kedah.
	Penang	2	941	Supplies 80% of the water requirements in Penang.
Sg. Muar	Negri Sembilan	10	46	Main raw water source for Negri Sembilan.
	Malacca	2	273	Supplies 56% of the water requirements in Malacca.
	Johor	8	164	Main source for Johor.
Sg. Johor	Johor	4 no. (Johor) 1 no. (S'pore)	797 (Johor) 1,136 (PUB S'pore)	Supply 50% of the water requirements in Johor. Main source for Singapore.

Source: National Water Services Commission (SPAN) *©The Star Graphics*

Figure 1.2: The critical water supply areas in Malaysia.

Source: (Lee, 2015)

However there are the critical water supply areas in Malaysia. The rapid growth of community area needs improvement of amenities such as water supply, electricity, transportation, environmental and drainage (N.A. Zakaria, 2004). A new development of water supply is very important to make sure there is no water pollution and new generation can get clean water.

CHAPTER 2

LITERATURE REVIEW

2.1 General

Water is very important to all living thing. About four billion people across the globe face severe water scarcity (Carrington, 2016). About 86 % of all the freshwater resources in the world are consumed in food production (Noemi Mancosu, 2015). Water demand management is now one of the main issues in the water policy agenda (Franceys, 2011). Water is the basic in environmental ecosystem. Therefore, study in water quality is very important especially on freshwater that contain lake, river and groundwater. Water quality is to identify the behaviour of microbiological, physical and chemical properties of water that determine its fitness for a specific use. This study purpose is to disclosed or identify the suitability of the lake water quality for alternative source of water supply. This study will improved the community life standard using safe water supplied from lakes.

2.2 Hydrological cycle of water resources

Water sources as a basic source for human including ecosystem. An ecosystem is a community of living organisms in conjunction with no living components of their environment like air, water and mineral soil (Wikipedia, 2018). Therefore the water connecting with the ecosystem. So the water cycling need to be considered to preserve the ecosystem. Water cycle or hydrology cycle known as the natural sequence through which water passes into the atmosphere as water vapor, precipitates to earth in liquid or solid form, and ultimately returns to the atmosphere through evaporation (Dictionary.com, 2018). Therefore rain and another forms of precipitation return to earth. The hydrological cycle consist above and below earth surface. There are a lot major reservoir in earth that consists of ice, fresh water, saline water and atmospheric water.

The physical properties of hydrological process are condensation, precipitation, percolation, surface runoff, transpiration and evaporation.

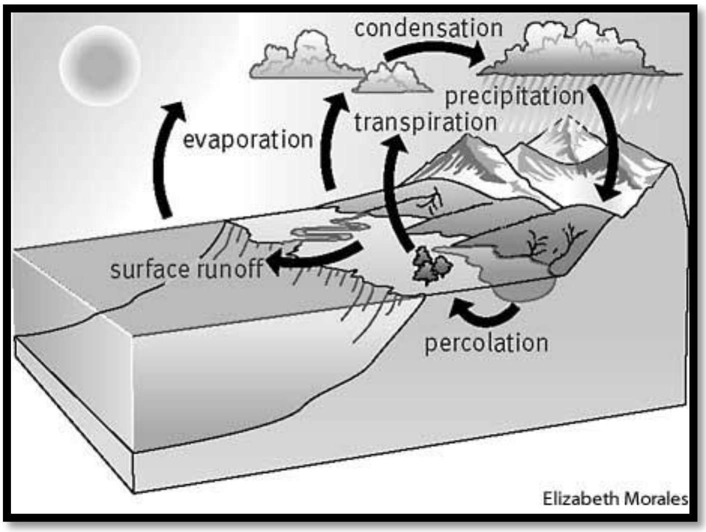

Figure 2.1 : Graphic explanation regarding overall hydrological cycle process.

Source: (Theme, 2017).

All water bodies links by hydrologic cycle in continents of ocean, and studies in different scales in local area and global extent. It is not begin at any process. The information presented below simplified described major contributing physical process of hydrological cycle.

Firstly, an evaporation process. When physical state of water changed from liquid state to gaseous state. About 600 calories of energy gram of water is exchanged during the changed of state (Organization, 2018). It can occur during water settled on vegetation, soil, rocks and snow. However human activities also being caused of evaporation process. Next, condensation process. When water vapour changes from vapour to a liquid it is condense into a small air bone particles to form dew, fog or clouds. When water vapour condense back into liquid state, the same large amount of heat (600 calories of energy per gram) was need to make it a vapour is released to environment (Organization, 2018).Then the process of precipitation. It is occur when all water particles fall from the atmosphere and reach the ground. The portion of precipitation that appears in surface streams is called runoff (Organization, 2018). It consist of contribution of component such as source runoff, subsurface runoff or ground water runoff. Next is percolation process whereas water movement though the soil by gravity and capillary forces. Then process of transpiration. It is biological process that mostly occurred in a day. Lastly, runoff process. It is flow from drainage basin or watershed appears in surface streams.

2.3 Water quality parameter

Water quality used to illustrate the quality of a tested water for describing the physical, chemical, and biological properties of water that classified them into each class with different suitable purposes. Suspended and dissolve substance in water body will being analyse to identify the water quality level. Raw water sources should be clean and free from dangerous organism and toxic elements that may affect our health. Water quality is considered the main factor controlling health and the state of disease in both man animals. The decline of water quality in rivers, lakes and groundwater has progressively become a global issue of concern (S. Behmel, 2016). Innovative measures are required to mitigate the risk of unregulated discharges including water quality monitoring, which is the standardized measurement and observation of the aquatic environment used in order to define status and trends (S. Behmel, 2016) .It is challenging of water quality monitoring in 21st century since large chemical used in everyday lives.

2.3.1 Parameter of physical water quality

Parameter of physical characteristic water quality in this study consists of temperature, conductivity and total suspended solid.

2.3.1.1 Temperature

Measurement of temperature can help detect sources of thermal pollution and suggest the size of habitat for organism that more sensitive with temperature variation. It is measured in degree Celsius or degree Fahrenheit. Water temperature is measure of heat content. Water temperature can affect the metabolic rates and biological activity organism.

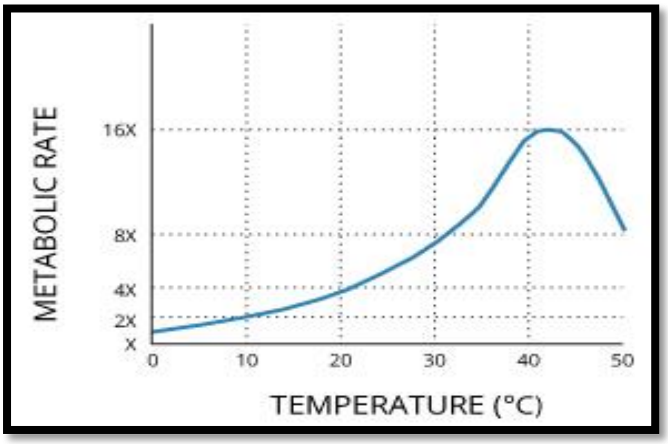

Figure 2.2: A direct relationship between metabolic rates and water temperature. As many cellular enzymes are more active at higher temperatures.

Source: (Environmental, 2016)

2.3.1.2 Total Suspended Solid

Total suspended solid are particles are larger than 2 microns found in water column. It is are made up of inorganic material, through bacteria and algae. It is including anything floated in water from sediment and sand. An organic particles from decomposing materials can contribute to TSS concentration (Environmental, 2016). It is significant factor in observing water clarity. More solid present, less clear water will be. If particles are heavier, it will settle out when they enter an area of flow or no flow of water.

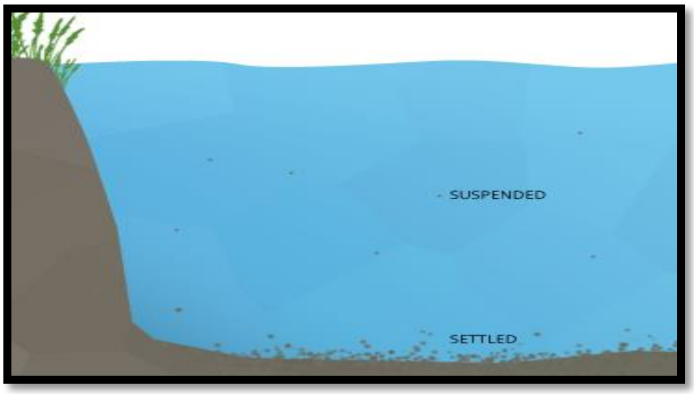

Figure 2.3 : Suspended solid can settle out into sediment at bottom of water body over period of time.

Source: (Environmental, 2016).

The remaining particles that do not settle out are called colloidal or non settle able solids (Environmental, 2016). The effect of it are adsorption site for chemicals and microorganisms, can be detrimental to health and aesthetically unpleasant.

2.3.2 Parameter of chemical water quality

The chemical properties of water quality are determination of pH value, Dissolve Oxygen, Biochemical Oxygen Demand, Chemical Oxygen Demand, and Ammoniacal nitrogen.

2.3.2.1 Determination of pH value

Hydrogen ion that contain negative logarithm, [H^+] a measure of degree is to which a solution is acidic or alkaline. An acidic is a substance that can give up hydrogen ion (H^+). A base is a substance that can accept H^+. A solution contain more acidic the greater hydrogen ion concentration and lower pH value. A pH of 7.0 indicates neutrality, a pH of lesser than 7 indicates as acidity and more than 7 indicates as alkalinity. It is to determine how well nutrients dissolve such as toxic heavy metals to be more soluble when pH lower (more acidic = high concentration) and when CO_2 dissolved in water it form carbonic acid.

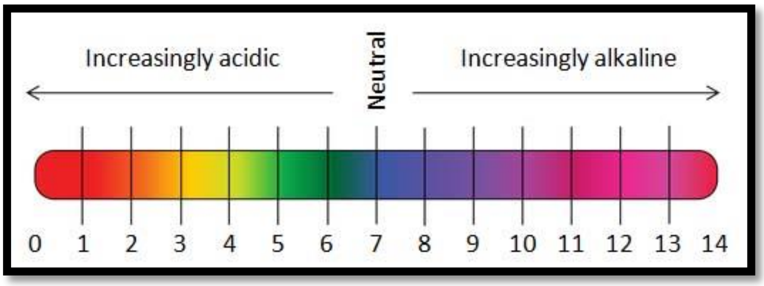

Figure 2.4: The level of pH value of acidity and alkalinity.

Source: (Horiba, 2018).

2.3.2.2 Biochemical Oxygen Demand

Biochemical Oxygen Demand (BOD) refers to the amount of oxygen that would be consumed if all the organics in one litre of water were oxidized by bacteria and protozoa. It is not a precise quantitative test, although it is widely used as an indication of the organic quality of water (Inc, 2018). Most commonly expressed in milligrams of oxygen consumed per litre of sample during 3 days (BOD_3) and 5 days (BOD_5) of incubation at 20°C. It is often used as robust surrogate of degree of organic pollution of water.

It is directly affects dissolved oxygen in rivers and streams. Rate of oxygen consumption affected by temperature, pH, presence of certain kinds of microorganisms and type of organic and inorganic material in water.

The greater of BOD, the more rapidly oxygen is depleted in the stream (Inc, 2018).That means less oxygen is available to form aquatic life. Consequences of high BOD same as those low dissolved oxygen aquatic organism. BOD sources include topsoil, leaves and woody debris, animal manure, wastewater treatment plant, food-processing plant and urban storm water runoff.

$$\text{Organic matter} + O_2 \xrightarrow{\text{microorganism}} CO_2 + H_2O + \text{new cells} \qquad 2.1$$

There are some method of BOD_5 @ 20°C:

1- A water sample containing degradable organic matter is placed in a BOD bottle.
2- If needed, add dilution water (known quantity). Dilution water is prepared by adding phosphate buffer (pH 7.2), magnesium sulphate, calcium chloride and

ferric chloride into distilled water. Aerate the dilution water to saturate it with oxygen before use.

3- Measure DO in the bottle after 15 minutes (DOi).
4- Closed the bottle and placed it in incubator for 5 days, at temperature 20°C.
5- After 5 days, measure DO in the bottle (DOt).

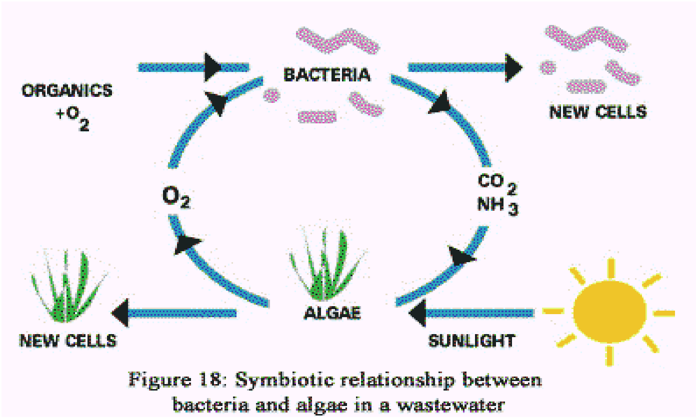

Figure 2.5 : Symbiotic relationship between bacteria and algae in a wastewater.

Source: (UNEP, 2018) .

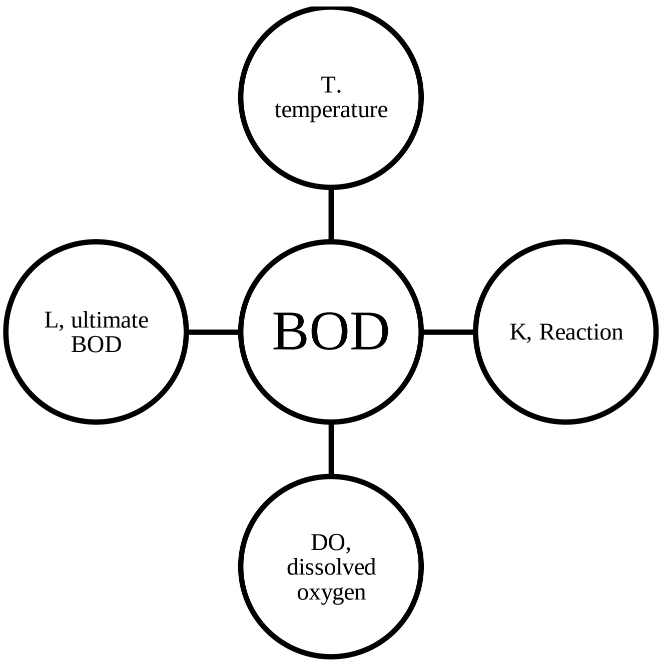

Figure 2.6: The calculation of BOD.

There are some calculation of biochemical oxygen demand:

- P, Dilution factor of BOD

$$BOD_t = \frac{DO_i - DO_t}{P} \qquad 2.2$$

Where :

BOD_t : Biochemical oxygen demand. mg/L

DO_i : initial DO of the diluted wastewater sample about 15 min after preparation, mg/L

DO_t : final DO of the diluted wastewater sample after incubation for five days, mg/L

P : dilution factor

$$P = \frac{\text{Volume of sample}}{\text{Volume of sample + Volume of dilution water}} \qquad 2.3$$

- Reaction rate

$$K = k/2.3 \qquad 2.4$$

$$L_o = \frac{BOD_t}{1-10^{-kt}} \qquad 2.5$$

$$L_o = \frac{BOD_t}{1-e^{-kt}} \qquad 2.6$$

Table 2.7: The typical K use for many types of water.

Type of water	K (base 10)
Tap water	0.04
Surface waters	0.04 – 0.1
Well-treated sewage	0.05 – 0.1
Raw sewage	0.15 – 0.3

The simply compound like sugar and starches easily utilized by microorganism that contain high K or k valued. In addition, the complex substance like phenols and cellulose are difficult to assimilate that contain low K or k valued.

For temperature part, the relation has change in reaction rate constant (K) with temperature:

$$K_T = K_{20} \times \Theta^{(T-20)} \qquad 2.7$$

Where

K_T = reaction rate constant at temperature T, per day

K_{20} = reaction rate constant at 20°C, per day

Θ = temperature coefficient = 1.047

T = temperature of biological reaction, °C

Ultimate BOD (L_0),

$${}_{T}L_0 = {}_{20}L_0\,[1+ 0.02(T-20)] \qquad 2.8$$

Where,

TL_0 = ultimate BOD at the temperature T, mg/L

$20L_0$ = ultimate BOD at 20°C, mg/L

2.3.2.3 Chemical Oxygen Demand

Chemical Oxygen Demand is quantity of oxygen needed to chemically oxidize the organic compound in sample, converted to carbon dioxide and water. It is measure the capacity of water during decomposition of organic matter and oxidation matter and oxidation inorganic chemicals such as Ammonia and nitrite (People, 2009). COD sample normally made up from waste water or of natural water by domestic or industrial. A commonly used COD is potassium dichromate ($K_2Cr_2O_7$) used in combination with boiled sulfuric acid (H_2SO_4). This chemical oxidant not specific to oxygen-consuming chemicals that organic or inorganic.

$$\text{Organic matter} + Cr_2O_7^{2-} + H^+ \longrightarrow CO + H_2O + 2Cr_3^+ \qquad 2.9$$

In addition, COD is related to biochemical oxygen demand for assaying oxygen-demanding strength of waste water. It is only measures amount of oxygen by microbial oxidation and most relevant in organic matter. However, it is important to know that COD and BOD not measure same types of oxygen consumption. For example, COD does not measure the oxygen-consuming potential associated with certain dissolved organic compounds such as acetate (People, 2009). The acetate can metabolized from microorganisms and can be detected in an assay of BOD.

Calculation of COD

$$COD = \frac{8000(a-b)}{\vee} \text{ x Normality of } Fe(NH_4)_2(SO_4)_2 \qquad 2.10$$

Where :

COD = chemical oxygen demand, mg/L.

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.

COD/BOD = 2, only for biodegradable organics

COD >> BOD, non-biodegradable organics

2.3.2.4 Presence of nutrients

In aquatic ecosystem, phosphorus and nitrogen are found in dissolved and particulate. It verifying chemical forms. Organic particulate nutrient include dead and living matter such as bacterial, plant, and animal tissue. However, dissolved organic nutrients include numerous types of biological molecules like protein that containing nitrogen and phosphorus. Dissolved inorganic forms phosphorus include orthophosphate, PO_4^{3-}.

It also forms nitrogen that present as nitrate, NO_3^-, and ammonium ion, NH_4^+. It also dissolve nitrogen gas, N_2; nitrite, NO_2^-; nitrous oxide, N_2O; and ammonia, NH_3.The availability of nutrient depends on chemical form of the nutrient and biochemical process available to organism. Phosphorus can be released through weathering, which highly depends on climate. Some inorganic materials can bind phosphorus, prevent it from moving from terrestrial sources to aquatic ecosystem. Sources of nutrient include discharges of sewage, animal waste and agriculture ecosystem (RAMP).

2.3.2.4.1 Ammonia nitrate, NH_4NO_3

Ammonia is the several forms of nitrogen exist in aquatic environments. It can cause nutrient over-enrichment of water body at elevated concentration and indirect effects on aquatic life. It can cause direct toxic effects on aquatic life. It is producing for commercial fertilizers and other industrial application. Ammonia nitrate is white crystals which is dissolved in water. Though material itself is non combustible will accelerate burning of materials. Nitrogen toxic oxides are produced in fire involving this material. Ammonium nitrate based fertilizer is grayish white solid in form of prills. It is commercially available both colourless crystalline solid (Britian, 2009).

Nitrate of ammonia explosives is a powder. It is readily explodes if heated. Difficult to explode by shock. The toxic nitrogen oxide fumes may release during combustion. Primary hazard is blast of an instatenous explosion (CAMEO Chemicals). Mostly ammonia nitrate do not continue to decompose once fire has been extinguished. However, some of it fertilizers containing small percentage of chlorides like potassium and chloride that can spread through mass to produce substatial toxic fumes. These fertilizers can sustain decomposition, known as "cigar burners" normally contain 5% to 25% nitrogen from ammonium nitrate. Up to 20% phosphate (P_2O_5) and chloride that may present small percentage (K. K. Bamzai, 2018).

2.3.2.4.2 Phosphate, PO_4

Phosphate is constituents of agricultural fertilizer, manure and organic waste in sewage and industrial effluent. It is essential element for plant life, but when to much of it in water, it can speed eutrophication whereas the reduction in dissolved oxygen in water may cause by an increase of mineral and organic nutrients of river and lakes. This has been a very serious problem in Atlanta. Whereas it coming into streams that have caused West Point Lake to become highly eutrophic "enriched" (Jörg Lewandowski, 2014).

However, the excess of phosphate create the water became cloudy and low in oxygen. Plants need phosphate to grow, but it is normally presence in surface water at rate of 0.02 parts per million. Farmers and homeowners can help prevent it from affecting water quality. By planting native vegetation and avoiding removal vegetation reduces soil erosion (Víctor Hugo Durán Zuazo, 2008).

2.3.2.5 Heavy metals

Term of heavy metal refer to any chemical element has relatively high relatively density and toxic or poisonous at low concentrations. The example of heavy metals are mercury(Hg), cadmium(Cd), chromium(Cr), lead(Pb), zinc(Zn), copper(Cu), potassium(K), magnesium(Mg) and calcium(Ca) (Lenntech, 2017). Heavy metals are natural components of Earth. It cannot be degraded or destroyed. For a small extent they can enter our bodies via food, drinking water and air. Some heavy metals such as copper, selenium and zinc are essential to maintain metabolism of human body. Although, at high concentrations they may lead to poisoning. Heavy metal poisoning could result, for instance from drinking water, high ambient air concentrations near emission or intake via food chain (Lenntech, 2017).

In addition, it is dangerous because they tend to bioaccumulate. The bioaccumulation means an increase in biological organism chemical concentration over time. Heavy metals can enter a water supply by consumer waste and industrial, or from acidic rain breaking down soils and release it into streams, lake, rivers and groundwater (Lenntech, 2017).

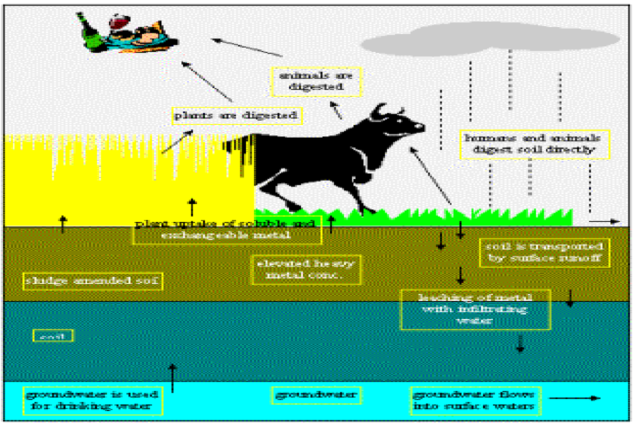

Figure 2.8: Heavy metals adsorbtion process.

Source: (Lenntech, 2017).

2.3.3 Parameter of biological water quality

Microorganism and bacteria present in the lake only can be determined by using specific apparatus and tests. In this study, a critical present of E.Coli bacteria in lake that need to be tested.

2.3.3.1 Determination of Presence of E. Coli and Total Coliform

E. Coli is short for Escherichia coli. The present of it in water is a strong indication of recent sewage or animal waste contamination (APEC WATER). In this study, Absence-Presence test is proposed to conduct in determination of presence of E. Coli. The Absence-Present test is a simple test but need reliable technique which use dry medium that provides rapid results of E. Coli. Total coliform include bacteria founded in sewage or animal contamination (APEC WATER).

2.4 Water quality standard

Aquatic organisms like fish, snails, frogs and insects are live in wate for part or all their lives. For protect human health and aquatic life , states, authorized tribes establish water quality standards. Water quality standards are described the desired condition of waterbody or level of protection or mandate how desired condition expressed or established such as water in future (EPA, 2017).

2.4.1 Water Quality Index, WQI

Firstly, WQI was developed by Horton in United Sates. Then on 1970, group of Brown developed a new WQI similar to Horton's index. Recently, many modifications have been considered for WQI (Rubio-Arias, 2012). Water quality index which is mean water quality data that summarized for report to the public in consistent manner (EPA, 2017).

There are most selected 10 commonly used water quality variables such as dissolved oxygen (DO), pH, coliforms, specific conductance, alkalinity and chloride etc that being applied in European, African and Asian countries. It is valuable and unique rate to depict water quality status that is helpful for selection of appropriate treatment technique to meet the concerned issues (Víctor Hugo Durán Zuazo, 2008).

A general WQI approach based on most common factors. There are three steps of it. Firstly, parameter selection. This is carried out by judgment of professional experts, government and agencies. The selection variables from the 5 classes which are oxygen level, eutrophication, health aspects, physical characteristic and dissolve substance. Secondly, determination of quality function for each parameter. The consideration as sub-index: sub-indices transform to non-dimensional scale. Next, sub-indices aggregation with mathematical expression. This is frequently geometric averages (Víctor Hugo Durán Zuazo, 2008). In short, an index is useful tool for communicating water quality information to the lay public. Therefore, futher analysis in this study is using Raw Water Quality Index.

Table 2.9: National Water Quality Standard for Malaysia.

Parameter	Unit	Classes				
		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	>7.0	5-7	3-5	1-3	<1
pH	mg/L	>7.0	6.0-7.0	5.0-6.0	<5.0	>5.0
Total Suspenbed Solid	mg/L	<25	25-50	50-150	150-300	>300
Water Quality Index (WQI)	mg/L	>92.7	76.5-92.7	51.9-76.5	31.0-51.9	<310

Source: EQR2006

Table 2.10: Water Classes And Uses

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

Sourse : EQR2006

2.4.2 National Water Quality Standards for Malaysia (NWQS).

PARAMETER	UNIT	CLASS					
		I	IIA	IIB	III	IV	V
Ammoniacal Nitrogen	mg/l	0.1	0.3	0.3	0.9	2.7	> 2.7
Biochemical Oxygen Demand	mg/l	1	3	3	6	12	> 12
Chemical Oxygen Demand	mg/l	10	25	25	50	100	> 100
Dissolved Oxygen	mg/l	7	5 - 7	5 – 7	3 - 5	< 3	< 1
pH	-	6.5 - 8.5	6 - 9	6 – 9	5 - 9	5 - 9	-
Colour	TCU	15	150	150	-	-	-
Electrical Conductivity*	µS/cm	1000	1000	-	-	6000	-
Floatables	-	N	N	N	-	-	-
Odour	-	N	N	N	-	-	-
Salinity	%	0.5	1	-	-	2	-
Taste	-	N	N	N	-	-	-
Total Dissolved Solid	mg/l	500	1000	-	-	4000	-
Total Suspended Solid	mg/l	25	50	50	150	300	300
Temperature	°C	-	Normal + 2 °C	-	Normal + 2 °C	-	-
Turbidity	NTU	5	50	50	-	-	-
Faecal Coliform**	count /100 ml	10	100	400	5000 (20000) a	5000 (2000) a	-
Total Coliform	count /100 ml	100	5000	5000	50000	50000	> 50000

Sourse : EQR2006

Table 2.11: Continued

Parameter	UNIT	CLASS				
		I	IIA/IIB	III*	IV	V
Al	mg/l	Natural Level or Absent	-	(0.06)	0.5	Level Above
As	mg/l		0.05	0.4(0.05)	0.1	
Ba	mg/l		1	-	-	
Cd	mg/l		0.01	0.01*(0.001)	0.01	
Cr(IV)	mg/l		0.05	1.4(0.05)	0.1	
Cr(III)	mg/l		-	2.5	-	
Cu	mg/l		0.02	-	-	
Hardness	mg/l		250	-	-	
Ca	mg/l		-	-	-	
Mg	mg/l		-	-	-	
Na	mg/l		-	-	3 SAR	
K	mg/l		-	-	-	
Fe	mg/l		1	1	1 (Leaf) 5(others)	
Pb	mg/l		0.05	0.02*(0.01)	5	
Mn	mg/l		0.1	0.1	0.2	
Hg	mg/l		0.001	0.004(0.0001)	0.002	
Ni	mg/l		0.05	0.9*	0.2	
Se	mg/l		0.01	0.25(0.04)	0.02	
Ag	mg/l		0.05	0.0002	-	
Sn	mg/l		-	0.004	-	
U	mg/l		-	-	-	
Zn	mg/l		5	0.4*	2	
B	mg/l		1	(3.4)	0.8	
Cl	mg/l		200	-	80	
Cl_2	mg/l		-	(0.02)	-	
CN	mg/l		0.02	0.06(0.02)	-	
F	mg/l		1.5	10	1	

Source: EQR2006

Water quality is considered to be suitable for a specific use as long as in the range for designated classes. NWQS serves as a good benchmarking tool for beneficial uses stipulated.

2.5 Alternative Water Resources

Individuals, businesses and all levels of government very interested in alternative water supply. The US relies mainly on surface and ground water resources (Mecsystems, 2017). There are many water resources in the world which is available on building sites. These water sources are non-potable, and greatly in quality. Normally most on-site water resources have limited application, and never suitable for human consumption (Ullah, 2017).

Alternative Water Resources (AWR) Cluster is a definition and development of diverse solutions to cope with emerging concerns in water supply sector which mainly related to increase diverge between water resources and demands over the world. The goal of cluster's is to provide a platform for discussing and collaborate together to share best practices (IWA, 2017).

CHAPTER 3

METHODOLOGY

3.1 Introduction

Bera lake is the largest natural lake in Malaysia Peninsular. It is also designated as a first RAMSAR site on 1994. However Bera Lake being the main water supply or water resources to Semelai community or Orang Asli Semelai. The location of Bera Lake located at water crisis problem because of land development by FELDA and illegal logging. Some researcher was conducted for determining soil nutrient contents in areas of developed land and correlate historical variations in nutrients eutrophication and concentration at the lake (Mohammadreza Gharibreza, 2013). So determining of potential study of Bera lake water quality for alternative source of water supply also important.

3.1.1 Study area

Bera lake and the catchment area are located in central part of Peninsular Malaysia between 2o53’00’’ and 3o10’00’’ N and longitudes 102o30’30’’ and 102o47’00’’ E. The catchment area covers about 600 km2. The original covered by primary forest although it has five Federal Land Development (FELDA) from 1970 to 1995. Around 292.86 km2 of the original forest being convert into rubber plantations. The Bera Lake catchment was design in Malaysia under the Convention of Wetlands on 1994 with FELDA district. It is being called as Buffer Zones (Mohammadreza Gharibreza, 2013).

Moreover, a map showed land use in Bera Lake area. It is prepared by geographical information system (GIS). The technique and satellite image of resolution 10m shows there is a continued agricultural development and encroachment in RAMSAR site. There is also has new oil palm and rubber plantation. The field monitor and laboratory analyses prove that the soil with catchment are ferrasols. The soil have been brownish-yellow, red and yellow colours (Mohammadreza Gharibreza, 2013).

Therefore there are two station of taking the water sample. First place at agriculture area and forest site. Agricultural area or developing area as the land use for rubber plantations. At this area, the percentage of TOC (total of carbon) being lowest. The main reason of reducing percentage of TOC are the removal of fallen leaves, tree trunks, tree stumps, root of felled palms and another organic matter while replanting. Empty fruit branches (EFB) remaining in oil palm plantations can rebuild cycle of nutrient and boost cycle of nutrient of P, N, K, and Mg levels (Comte, 2012). Therefore, the containing of nutrient in the lake, can ability three times from the original natural forested value (Mohammadreza Gharibreza, 2013). Meanwhile for forest site, has low water quality because of the lower of containing nutrient.

3.1.2 Flow chart

Figure 3.2 shows the flow chart of study methodology in determining water quality of Bera Lake. Tests that need to be run listed in the flow chart and classified into its own parameter. The aim of this project is to study the potential of lake as alternative source of water supply. The study of Bera Lake had involvement analysing data from previous research. The first step is analyse the data obtained and decides water quality parameter tests that need to be inquiry. Then, the water quality of Bera Lake need to be evaluate whether Bera Lake is safe or not to become as an alternative source as water supply. For next step, in case the result shows to Bera Lake convenient as an alternative water supply, a correct raw water treatment need to be planned in other to let on clean water supply for community demand.

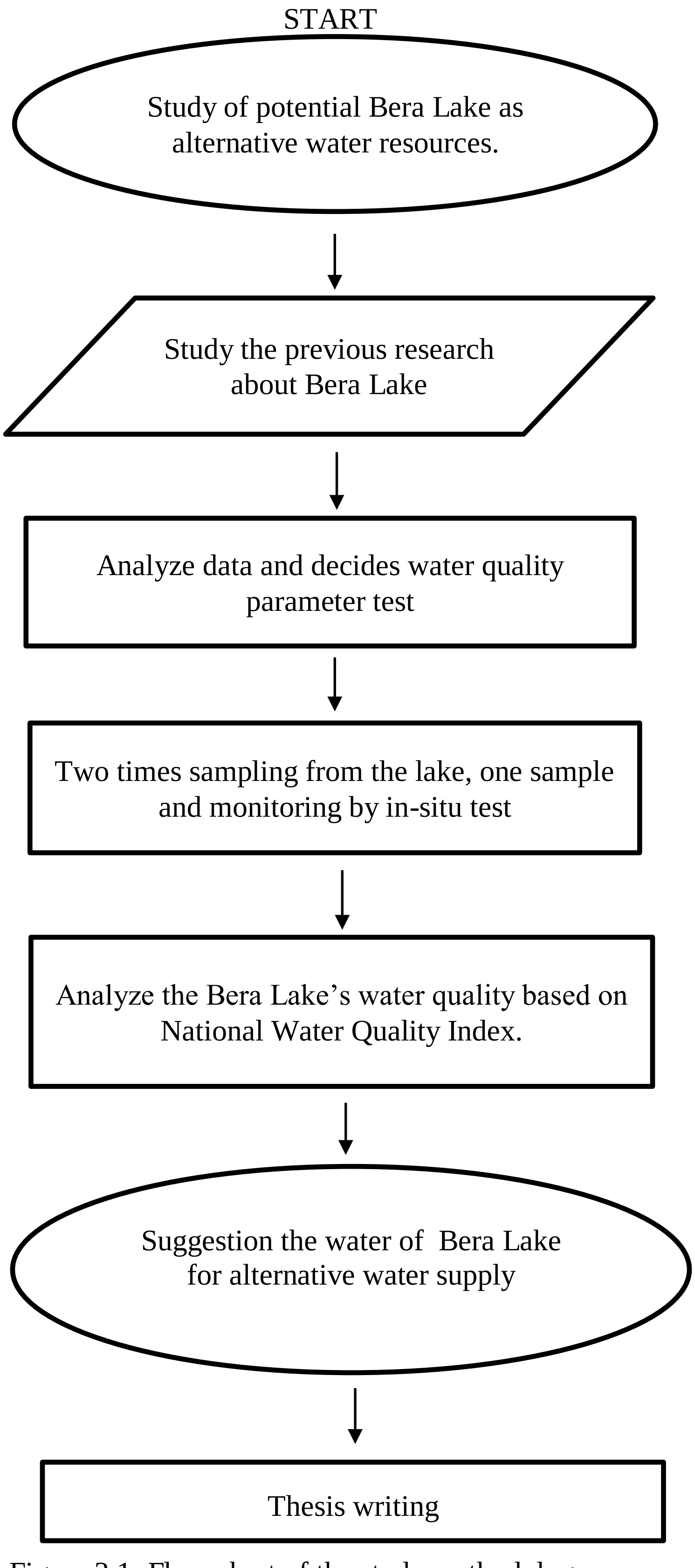

Figure 3.1: Flow chart of the study methodology.

3.1.3 Sample and preservation method

Sampling station and location are determining based on the water intake criteria that consist of best available water quality at near agricultural and forest site. This is because agricultural and forest site consists of differ water quality level.

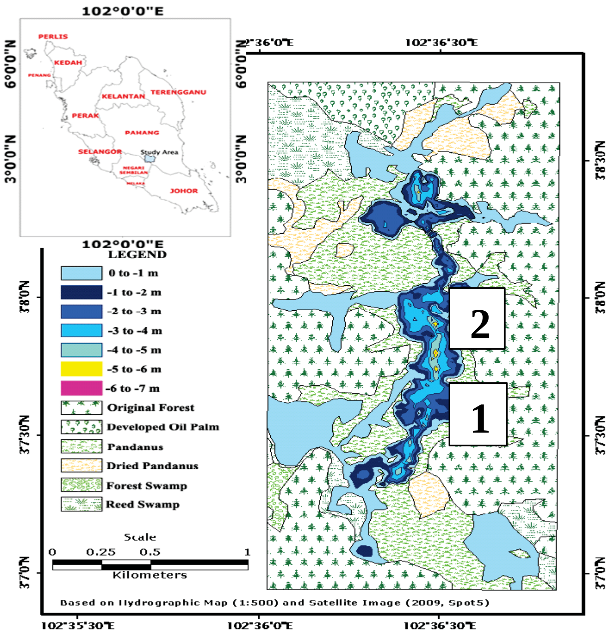

Figure 3.2: Location of sample of Bera Lake.

Station 1 located at upper east of Bera Lake. The type of soil is light to dark gray sandly mud with having 25cm thickness. There are some characterized through rich partially rotten roots, bark and stems. This location at the jetty of Bera Lake. The tourist used the boat for seeing surrounding area of Bera Lake. This activities may affect to the water quality of Bera Lake by the diesel and oil of boating activities and maybe some waste can present in the Bera Lake.

Station 2 located at east Bera lake. There are a forest surrounding this station. There is an original forest that undisturbed to form palm development. The forest is peat swamp forest that consists of grey mud, clay, silt, and sand size. There are two charcoal horizons in the first layer. The plant growth at this area are rasau, kercut, mengkuang plant. There are two charcoal horizons in second layer and other debris also present in that area.

In addition, for water sampling can being followed from previous research which is the water samples were collected using polyethylene bottles of acid wash. There are 2 bottles, one polyethylene bottle 500 ml for laboratory analysis and the other one is BOD dark glass bottle 300 ml for BOD analysis. The collected of sample in the bottle been washed to produce homogeneous medium. The samples are stored covered before laboratory analysis. Then, added the laboratory analysis for preserve samples from the infection by the surroundings. Filtering the water sample for removing the particles and kept in cold condition, 4^{o}C. Dilute acid is added to maintain the pH of water samples in acidity.

3.1.4 Experimental Procedure

This study conduct tests that can identify physical, chemical and biological parameter of Bera Lake water bodies. The physical parameter contain of temperature, conductivity and total suspended solid tests. Then, chemical parameter consists of determination of pH value, Biochemical Oxygen Demand, Chemical Oxygen Demand, presence of nutrients (ammonia nitrate, phosphate) and determining of heavy metals. The biological parameter consist only Absence-Presence Test to identifying the presence of E. Coli and Total Coliform.

3.1.4.1 Real Time In-situ Measurements

The real time in-situ using Kit-Probe instrument which is consist of turbidity, electrical conductivity, temperature, determination of pH, and dissolved oxygen tests. The result of the test can directly at site.

3.1.4.2 Dissolve Oxygen and Biochemical Oxygen Demand

The experimental test use is HACH BOD reactor. This experimental procedure start during sampling. There are two dissolved oxygen bottle which is consists of black and clear that are filled with sample water. Then, holding them for two to three minutes between surface and below water level of lake. For clear sample bottle are prepared based on directions for dissolved oxygen tests. The unit of the measurement is in mg/L.

Moreover, the black sample bottle placed in dark area and incubated for five days with 20^{o}C. The temperature almost same as room temperature. Then, after five days, determining of level of DO sample by repeating the steps four through eleven steps of

DO experimental procedure. Subtracting DO level from DO level catch from sampling site five days which is for determining BOD level.

There are some calculation of biochemical oxygen demand:

- P, Dilution factor of BOD

$$BOD_t = \frac{DO_i - DO_t}{P} \quad 3.1$$

Where :

BOD_t : Biochemical oxygen demand. mg/L

DO_i : initial DO of the diluted wastewater sample about 15 min after preparation, mg/L

DO_t : final DO of the diluted wastewater sample after incubation for five days, mg/L

P : dilution factor

$$P = \frac{\text{Volume of sample}}{\text{Volume of sample + Volume of dilution water}} \quad 3.2$$

3.1.4.3 Chemical Oxygen Demand

Chemical oxygen demand used vial method for experimental purpose. This method is for determination chemical oxygen demand in all types of water and wastewater. The experimental start with washing the tubes and caps with 20 % of H_2SO_4 before use. Then, burn up them in the muffle furnace at 500°C for one hour for contamination prevention. The sample of pipette that contain 2.5 mL in condition standard or blank into tubes. Then, 1.5 mL of digestion solution add to the tubes and mixed it frequently. Catalyst solution that contain 3.5 mL being added to the tube to all. It sipping into bottom of the tubes. Placed tightly the caps of bottle and shake the tubes for allowing dispersed layer. Tubes been placed into the oven at 150°C and keep heating for two hours. Then after two hours, the tubes need to remove from the oven and left for downturn the temperature in order to allow the sedimentation. The appliances and reagent fill connected as system start. For achieving the stable baseline, all reagents need to pump. The sample, standards and black are placed in a tray. There are some calculation of COD.

Calculation of COD

$$COD = \frac{8000(a-b)}{V} \text{ x Normality of } Fe(NH_4)_2(SO_4)_2 \quad 3.3$$

Where :

COD = chemical oxygen demand, mg/L.

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.

COD/BOD = 2, only for biodegradable organics

COD >> BOD, non-biodegradable organics

3.1.5 Ammoniacal nitrogen (NH_4^-N)

The test of ammoniacal nitrogen conducted based on the standard of HACH Method 8155 or Salicylate Method. The NH_4^-N concentration identifying using Spectrophotometer DR5000 with Ammonium Salicyte and Ammonium Cyanurate as a reagent. Positive presence of NH_4^-N can be determined by green colour. Diluted of sample before the testing since the method only relevant for Ammonia Nitrogen concentration of 0.01 – 0.50 mg/L.

3.1.6 Total Suspended Solids (TSS).

Laboratory analysis for total suspended solids begin with prepared glass fibre filter disc. Insert the filter disc onto base and clamped on funnel. When vacuum is applied, clean the disc with three consecutive 20 ml distilled water. Then, water remove by continuing to apply vacuum after water has passed through. Funnel remove from base and filtered in aluminium dish. Dried it in an oven at 103°C to 105°C for one hour. When desired, remove the dish, dehydrate and weigh.

The sample volume which is contain 200 mL as a maximum that will earn not more than 200 mg of total suspended solid. The filter is placed on base and clamped on funnel and applying the vacuum. For seal the filter with base, filter being wetted with small volume of distilled water.

Then, the samples shakes firmly, and transmit 100 mL of sample was significantly to the filter using a huge orifice, volumetric pipette. All water remove by continuing to apply vacuum after water has passed through. The funnel and pipette clean onto filter with small scale volume of distilled water. All water remove by continuing to apply vacuum after water has passed through. The disc carefully removed from the base. Drying session need at least one hour with 130°C to 150°C. Then, cool the sample in dessicator and weigh it.

There are some calculation of total suspended solid

$$\text{total suspended solids mg/L} = \frac{(A\text{-}B) \times 1000}{\text{sample volume, mL}} \qquad 3.4$$

where:

A = weight of filter + dried residue, mg, and

B = weight of filter, mg.

3.1.7 Heavy metals analysis using Atomic Absorption Spectroscopy (AAS).

Heavy metal consists of chromium (Cr), Lead (Pb), Zinc (Zn) and copper (Cu). A set of standard solution of the metals need to be prepared. If necessary to avoid clogging of burner capillary, the preparation of sample is filtering it through 0.45 micron micro-pore membrane filter. The element concentration directly read proportional to standards.

3.1.8 E.Coli and Total Coliform Presence Test.

Total Coliform and E. Coli presence test laboratory analysis procedures start with collection of 100 mL of sample in a sterile container. An aseptic technique being used for prevention contamination. For sample already disinfected, use a container that consists a dechlorinating agent. Then, add the sample for fill line of P/A bottle. The sample being incubating for 24 hours at 35 ± 0.5ºC (95 ± 0.9ºF). After 24 hours, observe the changes of colour. If there is no changes, sample being incubate for other 24 hours. If there is no changes for 48 hours, the test result being negative. Otherwise, if there is any change of colour the result is probably positive.

3.1.9 Water Quality Index Standard

Water quality index standard prepare a single number or grade for express overall water quality for a certain location and time depends on certain water quality parameters. Basically, the index in mathematically means of calculating a single value from various test. The result represent the water quality level of water basin such as river, lake, or stream. An objective of the index is for turning complex water quality data into information and used by public.

Table 3.3: Water Quality Index (WQI) Classes

Parameter	Unit	Classes				
		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					
pH	mg/L	>7.0	5-7	3-5	1-3	<1
Total Suspenbed Solid	mg/L	>7.0	6.0-7.0	5.0-6.0	<5.0	>5.0
		<25	25-50	50-150	150-300	>300
Water Quality Index (WQI)	mg/L					
		>92.7	76.5-92.7	51.9-76.5	31.0-51.9	<310

Source: EQR2006

In addition, the water quality index use scale from 0 to 100 for rating the quality of water. The values of 100 is the highest score. Since the overall WQI score is known, it can being compared with following scale for determination on how healthier water on a day. A formula shown for determine the value of Water Quality Index.

$$WQI = (0.22*SIDO) + (0.19*SIBOD) + (0.15*SIAN) + (0.16*SISS) + (0.12*SipH) + (0.16*SICOD) \quad 3.5$$

Where as;

SIDO : Sub-Index Dissolved Oxygen (%)

SIBOD : Sub-Index Biochemical Oxygen Demand

SIAN : Sub-Index Ammoniacal Nitratrogen

SISS : Sub-Index Total Suspended Solids

SipH : Sub-Index pH value

$0 \leq WQI \leq 100$

3.1.10 Data analysis result

According to the data collection, in-situ and ex-situ will being analyse. On the side for gaining the objectives of the investigation of Bera Lake water quality, the result would compared with NWQS and WQI for determine the suitability as potential water sources of water supply. The expected result can being conclude is Bera Lake is suitable for being other water supply for community. This is because, from previous research can being determine Bera Lake not suitable use for water supply. This is because, some researcher found effect of agricultural project on nutrient levels in Bera Lake that Bera Lake had being on verge considerable ecological risk with low dissolved oxygen contents, high level of nitrate and reduction of fish population. This is due of high biomass production from mature oil palm plantations.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

Every in situ measurement data and laboratory analysis can refer to Water Quality Index (WQI) in order for water classification. The sampling points are locating at various place at Bera Lake. There are two samples taken for analysing process based on their different location that has different type of sources water from land. The sampling taken two times for once in consecutive two months.

Classification of water quality parameter can divide into physical, chemical, and biological. Temperature and total suspended solid are physical water quality. For chemical water quality are pH, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, ammonia, nitrate, chromium, lead, zinc and copper. The biological parameter quality are determination of microorganism presence that consist of Escherichia Coli (E.Coli) and Total Coliform.

4.2 Sampling and preservation

Sampling were taken two times in two months, second week of February and earlier of April which recorded as dry season. Since the main purpose for this study is determine whether Bera Lake suitable or not being alternative source of water supply.

Table 4.1: Weather During Sampling at Bera Lake

Station and Time	Sunday, 11 February 2018	Monday,2 April 2018
Station 1	31.3 ^{o}C (sunny)	30.3^{0}C (sunny)
Station 2	29.9 ^{o}C (sunny)	29.9^{o}C (sunny)

Every sampling had drawn sub-merged from lake for laboratory analysis. In-situ tests were conducted at site using handling parameter and pH handling parameter. The sample which is need bacteria analysis should keep in ice and delivered in same day, or delivered straight to laboratory within six hours. BOD test should been conducted within 48 hours. For COD and Ammonia Nitrogen can hold time in 28 days and store with temperature below 4°C and had preserve with H_2SO_4 until pH reach less than two. Heavy metals can hold for 6 months with preservation HNO_3 with pH below two. The sampling taken during dry season. The chosen of sampling location are based on jetty site and agricultural site.

4.3 In-situ parameters measurement

Handling multi-parameter were calibrated based on the maintenance system. The field measurements parameters are temperature, determination of pH value, dissolve oxygen and total dissolve solid. Every parameter divided into sub section for detail, discussion and result analysis.

4.3.1 Temperature

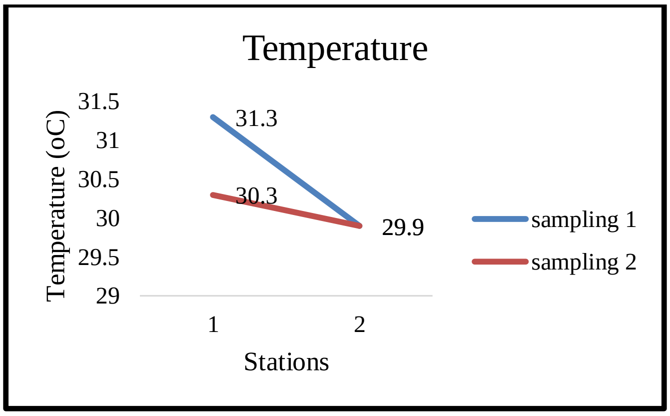

Figure 4.2 : Observation of temperature at different sampling stations.

Figure 4.2 shows the trend of temperature of two stations during sampling. The temperature shows high reading since the sampling taken during dry and hot season. The water temperature ranges from 29.9°C to 31.3°C. The water temperature is measure of heat content of the water mass and influences the growth rate and survivability of aquatic life (NAHRIM, 2018). Based on Figure 4.2, the temperature shows station 1 and 2. Station 1 taken at jetty area which is has boat and oily place with 31.3°C. Meanwhile, for station 2 the sample taken at agricultural area with 29.9°C. From figure 4.2, clearly shows the fluctuated drop of temperature from one station to another station.

4.3.2 Determination of pH value

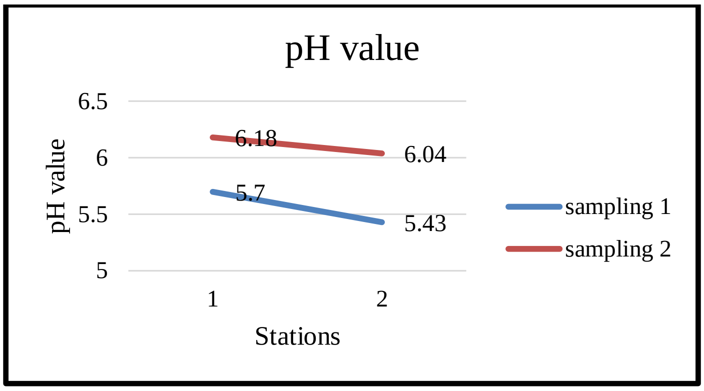

Figure 4.3: pH value at different sampling stations

Figure 4.3 show the pH value of Bera lake at two differ sampling points. The pH value shown the value lower than 7 is acidic condition. For station 1, this acidic condition due to jetty place that contain oily place which is can affected the pH value of the lake. Meanwhile for station 2, the acidic condition based on agricultural area that contain plant. The pH value does not state a big differ between two station. However for second sampling, pH value for Bera Lake towards alkalinity. This can be seen from the result of pH value turns to 6.10 and 6.04. This is can be observe from the situation on that day hot and dry season and less rainy day in a month.

4.3.3 Dissolved oxygen

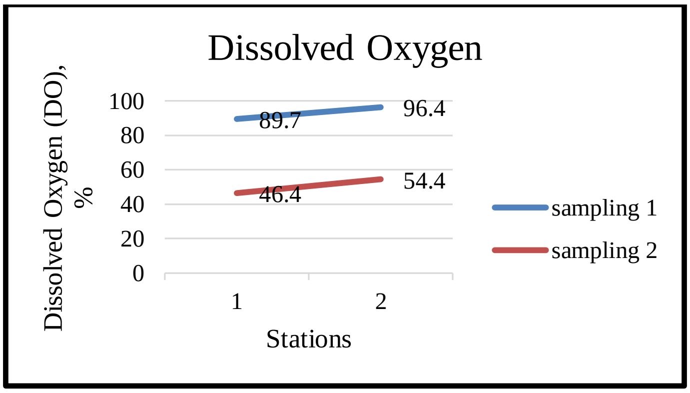

Figure 4.4: Dissolved Oxygen value at different sampling stations

Figure 4.4 illustrate the degree of saturation of dissolved oxygen of Bera Lake at two different sampling points. Dissolved oxygen in Bera lake indicated trend and range.

DO reading shows various based on their depths that resulted different pressure. In this analysing, DO reading was taken on surface water suited for it purpose of study for water supply. Changes of dissolved oxygen can be presented by two components which are the water temperature and hydrological regimes seasonal photosynthesis activity of phytoplankton. The reading of DO are stagnant for sampling 1 and 2. The low dissolved oxygen caused by the presence of microbes such as fungi and bacteria that use DO for decompose them.

4.4 Laboratory analysis of water parameters

Analyse the parameters at laboratory are biochemical oxygen demand, chemical oxygen demand, Ammoniacal Nitrogen (NH_4^-N), turbidity, total suspended solid, phosphate, chromium, lead, copper, zinc, E.Coli and Total Coliform.

4.4.1 Biochemical oxygen demand

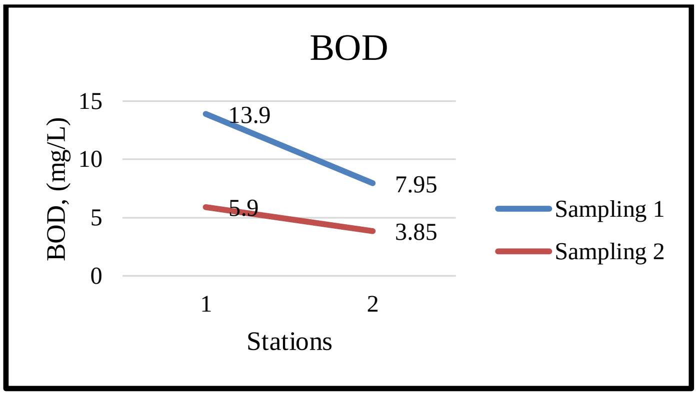

Figure 4.5: Biochemical Oxygen Demand at Different Sampling Stations

Biochemical Oxygen Demand (BOD) refers to the amount of oxygen that would be consumed if all the organics in one litre of water were oxidized by bacteria and protozoa. Large BOD indicated high organic matter and generate by waste that consist of chemical capable of suppressing microbiological growth. Station 1 on first sampling shows the highest value of BOD with 13.9 mg/L concentration. This happening due to station 1 located at jetty area with high water level during first sampling. BOD cannot be measured any polluted matter however they can stabilize the organic matter which is can being decomposed and measured total oxygen that important by bacteria and other microorganism in water. The sources of effluent can defined through the BOD test. Station 2 second sampling shows the lowest value of BOD concentration with 3.85 mg/L.

The lower observation of BOD reading shown less contaminated after all it contain higher contains of DO. The reading of BOD reading are vice versa to DO reading based on the oxygen that is available in water being consume from bacteria and other microorganism.

4.4.2 Turbidity

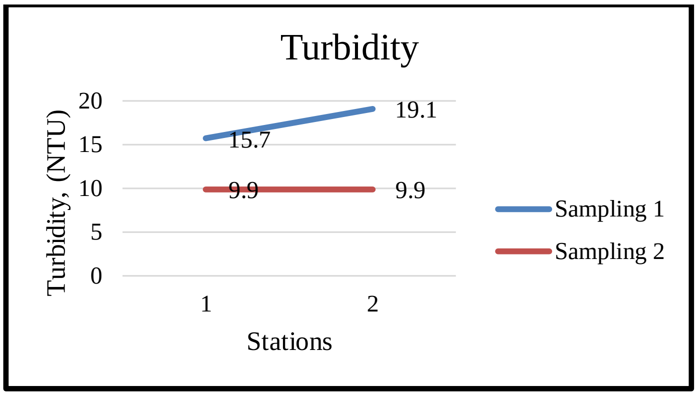

Figure 4.6: Turbidity at different sampling stations

Turbidity is a measure of relative clarity of liquid. It is an optical characteristics of water and an expression of amount of light through the water sample. The higher intensity of scattered light, the higher the turbidity. Turbidity makes water cloudy or opaque. High concentrations of particulate matter affect light penetration and productivity, recreational values, and habitat quality, and cause lakes to fill in faster (USGS, 2016). According to figure 4.6, sampling one on station 1 and station 2 had large reading of turbidity compared to sampling two have same reading of turbidity. Sampling 1 had cloudy colour compared to sampling 2.

4.4.3 Chemical Oxygen Demand

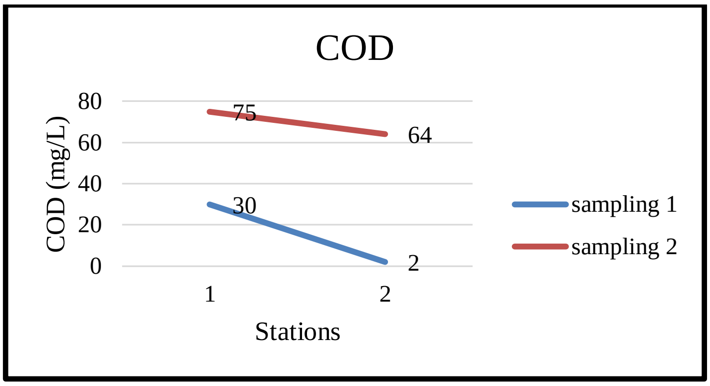

Figure 4.7: Chemical Oxygen Demand at Different Sampling Stations

Chemical Oxygen Demand is quantity of oxygen needed to chemically oxidize the organic compound in sample, converted to carbon dioxide and water. It is measure the capacity of water during decomposition of organic matter and oxidation matter and oxidation inorganic chemicals such as Ammonia and nitrite. COD sample normally made up from waste water or of natural water by domestic or industrial. COD is water quality parameter that can determine the level of pollution in water according chemical characteristics and express the amount of oxygen required for oxidize organic matter chemically through a strong oxidant such as dichromate and sulphuric acid. The values of COD can be affected from various factor. The high value of COD can increase affected by high density of population and urbanization. Station 1 sampling one shown the highest COD reading with 75 mg/L due to high quantity of oxygen required to oxidize all organic material into water and carbon dioxide. This is due to location of station 1 sampling at jetty and oily surface of Bera Lake. Besides that, the amount of organic and reduced matter that present in water or likely known as amount of oxygen that needed for decompose organic matter chemically.

4.4.4 Ammoniacal Nitrogen

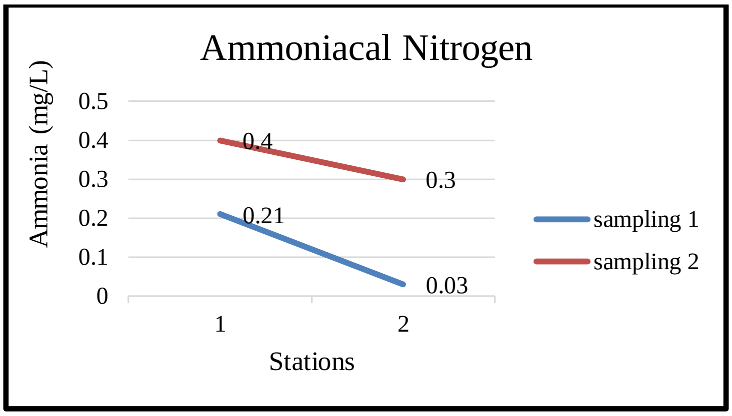

Figure 4.8: Ammonia at different sampling stations

Ammonia is a colourless gas with distinct odor. It occurs naturally throughout the environment in air, soil and water also in plants and animals including humans (ChemicalSafetyFActs.org, 2018). According to figure 4.8, Bera Lake belongs to class 2 based on Water Quality Index (WQI) regarding the presence of Ammonia. Station 2 in first sampling shows the highest value of ammonia concentration with 0.4 mg/L. Ammonia has high toxic in the surface of water. Station 2 shows the biggest contaminated due to its usage of land like agricultural that maybe contribute of Ammonia. Overall, first sampling second station has highest value of ammonia compared to others.

4.4.5 Nitrate

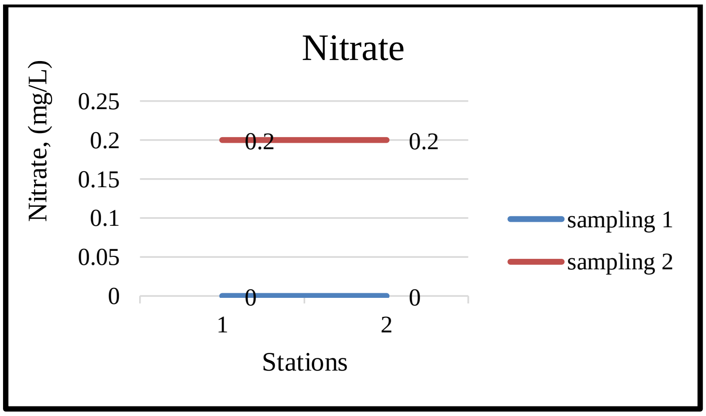

Figure 4.9: Nitrate at different sampling stations

Nitrate (NO_3^-) is a common contaminant of drinking water when it present in excessively large concentrations leads to serious health problem. It is also reported in animals and again due to MHb formation in blood with consequent asphyxiation (Walter K. Dodds, 2010). According to figure 4.9, Bera Lake shows the first sampling there is an absent of nitrate belongs to first station and second station with value of 0 mg/L. For second sampling shows a value of fist station and second station with 0.2 mg/L.

4.4.6 Phosphorus

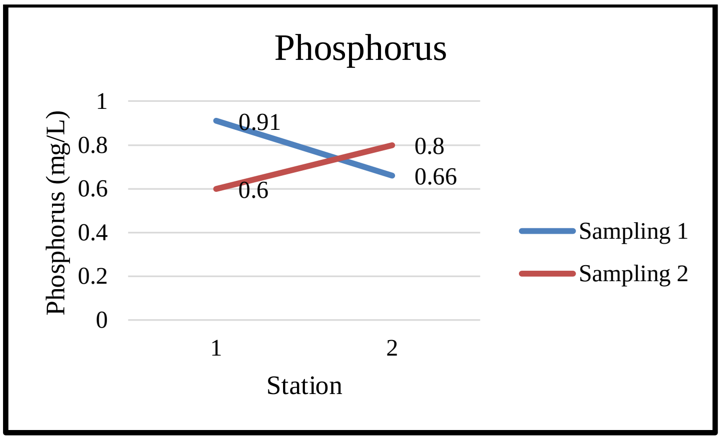

Figure 4.10: Phosphorus at different sampling stations

Phosphorus is an essential for life. Phosphates (compounds containing the phosphate ion, PO_4^{3-}) are a component of DNA, RNA, ATP, and phospholipids. Elemental phosphorus was first isolated from human urine, and bone ash was an important early phosphate source. Phosphate mines contain fossils because phosphate is present in the fossilized deposits of animal remains and excreta. Low phosphate levels are an important limit to growth in some aquatic systems (Wikipedia, 2018). Based on figure 4.10, station one had highest reading with 0.91 mg/L for first sampling rather than second sampling had lowest reading with 0.6 mg/L. However for station 2, first sampling had low reading with 0.66 mg/L rather than second sampling slight high with 0.8 mg/L.

4.4.7 Total Suspended Solids

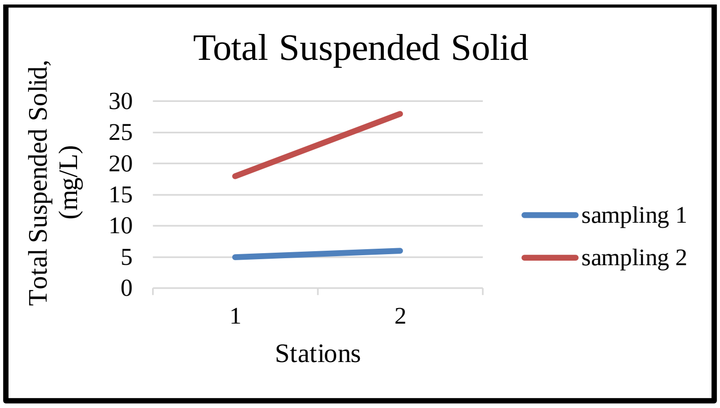

Figure 4.11: Total Suspended Solid at different sampling stations

Total suspended solid are particles are larger than 2 microns found in water column. It is are made up of inorganic material, through bacteria and algae. It is including anything floated in water from sediment and sand. An organic particles from decomposing materials can contribute to TSS concentration (Environmental, 2016). It is significant factor in observing water clarity. More solid present, less clear water will be. If particles are heavier, it will settle out when they enter an area of flow or no flow of water. Figure 4.11 illustrate that Bera Lake had various concentration of total suspended solid in first station and second station of two sampling. A presented of solid depends on activities surrounding in Bera Lake. TSS has being included in all particles suspended in water which is not passing through a filter.

4.4.8 Heavy Metals Analysis

4.4.8.1 Cadmium

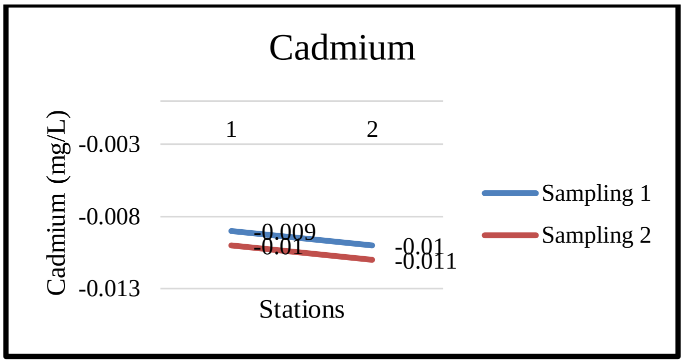

Figure 4.12: Cadmium Concentration at Different Sampling Stations

Cadmium is used in metal alloys and pigments for paints, cement, paper, rubber, and other materials. Low-level exposure can irritate the skin and cause ulceration. Long-term exposure can cause kidney and liver damage, and damage too circulatory and nerve tissue. Cadmium often accumulates in aquatic life, adding to the danger of eating fish that may have been exposed to high levels of chromium (BV, 2018). From figure 4.12, there are many concentration of Cadmium at each station and sampling. Different surroundings activities and stream location of each station affect the result of Cadmium presence. Largest reading of cadmium metals were -0.010 mg/L at station 2 first sampling and station 1 second sampling. This happened due to non-point sources of pollutant since the amount of cadmium is not stagnant at the two station.

4.4.8.2 Lead

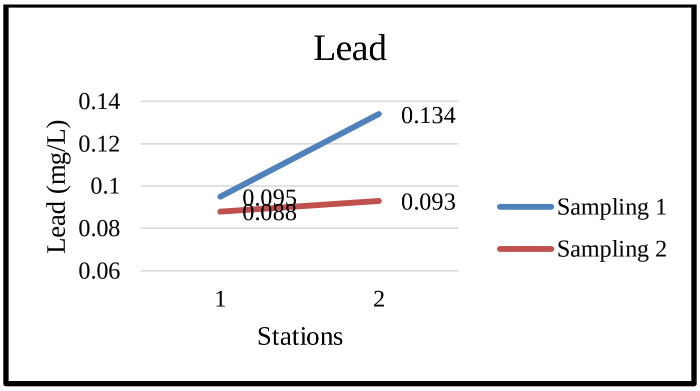

Figure 4.13: Lead Concentration at different sampling stations

Lead is among the most recycled non-ferrous metals and its secondary production has therefore grown steadily in spite of declining lead prices. Its physical and chemical properties are applied in the manufacturing, construction and chemical industries. It is easily shaped and is malleable and ductile. There are eight broad categories of use: batteries, petrol additives (no longer allowed in the EU), rolled and extruded products, alloys, pigments and compounds, cable sheathing, shot and ammunition (BV, 2018). Figure 4.13 shown the result of lead experiment on laboratory testing in each testing. The highest lead concentration where found on station 2 first sampling with 0.134 mg/L even station 2 is an agricultural area compare with station 1 is jetty area that does not have agricultural area.

4.4.8.3 Copper

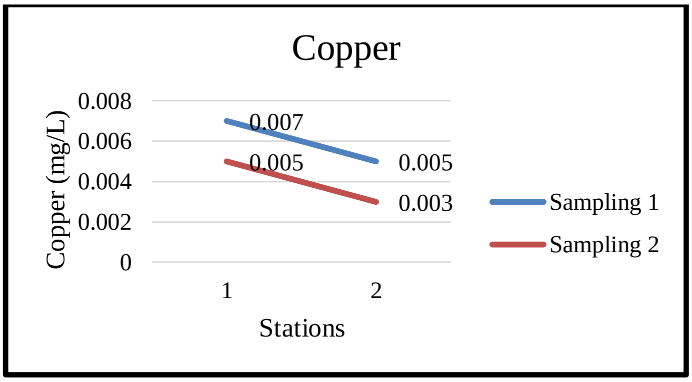

Figure 4.11: Copper Concentration at different sampling station

Presence of copper concentration at Bera Lake are very low. Copper is an essential substance to human life, but in high doses it can cause anemia, liver and kidney damage, and stomach and intestinal irritation. People with Wilson's disease are at greater risk for health effects from overexposure to copper. Copper normally occurs in drinking water from copper pipes, as well as from additives designed to control algal growth (BV, 2018). There no larger different between two stations and sampling of copper concentration. The existence of copper metals slightly high at station 1 with 0.007mg/L on first sampling due to jetty area and oily surface.

4.4.8.4 Zinc

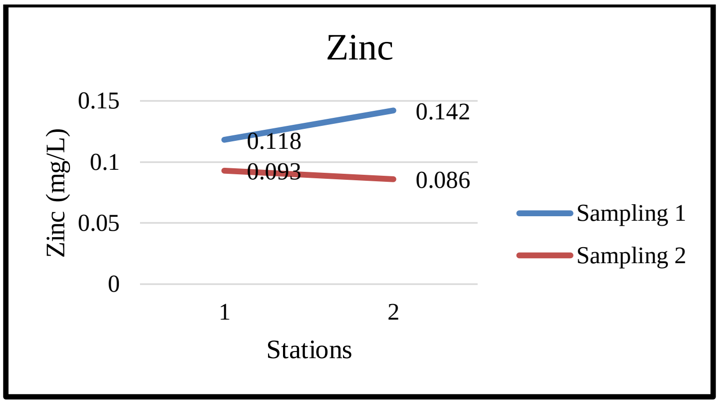

Figure 4.14: Zinc Concentration at different sampling stations

Zinc is usually can found in fertilizers that may leach in water. As we can see in figure 4.14, first sampling in second station has highest concentration with 0.142 mg/L compared to first station first sampling with 0.118 mg/L. Highest concentration found in station 2 due to wide agricultural activities in the Bera Lake. First sampling shows gradually increases concentration of zinc from station 1 to station 2. For second sampling shows the concentration of zinc has gradually decrease from station 1 to station 2.

4.4.9 Determination of Total Coliform and E.Coli

Present of bacteria and microorganism in lake can only be determine by use a specific experiment. For this research, a critical present of Toral Coliform and E.Coli bacteria in the lake need to be tested.

4.4.9.1 E.Coli

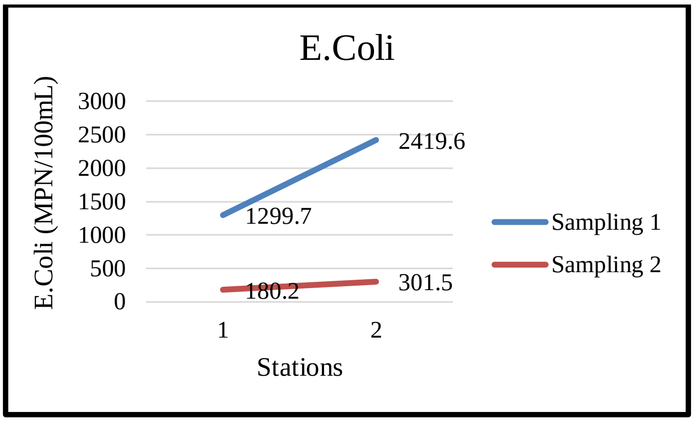

Figure 4.15: E.Coli Presence at Different Sampling Stations

Based on figure 4.15 first sampling shows the critical presence of E.Coli at station 1 and station 2 with 1299.7 MPN/100mL and >2419.6 MPN/100mL. The present of E.Coli in the lake play as major of ecology process and happening and every niche of environmentally. It is use for release and decompose nutrient for aquatic life and terrestrial systems. Small propotion of microorganism may effect to human as human disease.

4.4.9.2 Total Coliform

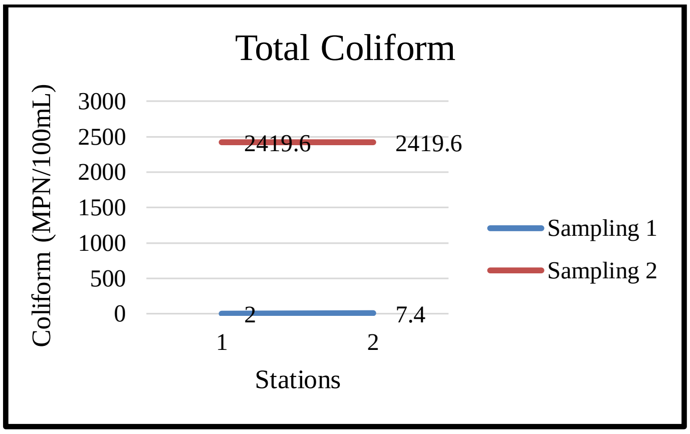

Figure 4.16: Total Coliform Presence at Different Sampling Stations

From figure 4.16, the highest of Total Coliform presence at first station and second station during first sampling with >2419.6MPN/100mL. The total coliform include bacteria that can be founded in soil , water that present on the water surface and in human or animal waste. Pathogens that can harm water supplies come from humans or animal faeces. The presence of Total Coliform shows high different during two sampling.

4.5 Result Comparison

4.5.1 Water Quality Index (WQI)

Based on standard quality of water in Malaysia, the Water Quality Index (WQI) where will classifying the surface of water in Class I, II, III, IV and V.

Table 4.17: Average of WQI value for every station

Station	Average WQI	Class
1	79.33	II
2	79.24	II

According table 4.17, the average result of surface water of Bera Lake for every station during two sampling. Sampling of Bera Lake were tested by six parameter for identifying WQI. The parameters were pH, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, ammonia nitrate and total suspended solid. The testing of six parameters were conducted in Environmental Laboratory Universiti Malaysia Pahang (UMP) and others parameter on site during take a sample.

Bera Lake were in observation of PERHILITAN (protection of wildlife and national parks department). From table 4.2 shown, station 1 have high water range with 79.33. This result can being conclude that station 1 is the best water quality of water body compared to station 2 has 79.24 only. However, station 1 and station 2 are in class II. In order for suggestion, the two station is suitable as alternative water supply, it is very important for suitability of water intake. As we know, water intake criteria must have the best available water quality, must far from strong current, has quantity of water demanded that must achieved at very low flow rate, and easy for accessing .

4.5.2 National Water Quality Standard Malaysia (NWQS).

This study consist alternative water supply for daily purposes especially during critical surrounding. So it is important to determine whether the parameters is acceptable by referring this guidelines. The parameters were includes pH value, Total Coliform, Biochemical Oxygen Demand, Chemical Oxygen Demand, Ammoniacal Nitrogen, Dissolved oxygen, Total Suspended Solid, Heavy metals which are includes Lead, Cadmium, Copper, and Zinc.

Table 4.18: Average value of parameters tested for comparison to its classes based on National Water Quality Standard Malaysia

No	Parameters	Average Value	National Quality (NWQS)	Water Standard
1	pH value	5.84	II	
2	Total Coliform	1212.15 MPN/100mL	II	
3	Biochemical Oxygen Demand	7.9 mg/L	III	
4	Chemical Oxygen Demand	42.75 mg/L	II	
5	Ammoniacal Nitrogen	0.035 mg/L	I	
6	Dissolved oxygen	7.17 mg/L	I	
7	Total Suspended Solid	14.25 mg/L	I	
8	Lead	0.1025 mg/L	IIA	
9	Cadmium	-0.01 mg/L	II	
10	Copper	0.005 mg/L	IIA	
11	Zinc	0.1098 mg/L	III	

Table 4.3 shows Bera Lake parameters tested classes referring to National Water Quality Standard. Most of the parameters shows belongs to class II such as pH value, total coliform, chemical oxygen demand, lead, cadmium, and copper. For class II need conventional treatment for being water supply usage. However, biochemical oxygen demand and zinc are belongs to class III. For class III, extensive treatment are required for being water supply usage. Then, future study are needed in dominate the pollutant from entire surface water body.

4.6 Bera Lake as alternative water supply

A main purposes of studying alternative water supply is essentially in providing sufficient water sources during critical condition and identifying whether safely use for Orang Asli Semelai community. Alternative water supply can support secure water supply. Based on the research, alternative water source comes from surface water which is the lake.

Based on Water Quality Index, in overall two stations belongs to class II only. Class II can being as water supply but need to use conventional water treatment plant. So it can being use for future generation and Orang Asli Semelai.

CHAPTER 5

CONCLUSION

5.1 Introduction

Main objective of this study were focusing on identifying the behaviour of water quality parameter based on special variation and for identifying or disclosed the significance of the lake water quality for alternative source of water supply. In this chapter, the discussion on results obtained can being simplified and recommend. The water quality test for Bera lake successfully done and met the main of an objective.

The main objectives in this study had being achieves by analyse the water quality parameter of Bera lake that contain of temperature and total suspended solid. Dissolved oxygen, pH value, turbidity, total dissolved solid, biochemical oxygen demand, chemical oxygen demand, ammoniacal nitrogen, cadmium, lead, zinc, and copper for chemical water quality. Biological parameter are determining of microorganism presence that have Escherichia Coli (E.Coli) and Total Coliform. The result were analysing and classified based on Water Quality Index (WQI) and National Water Quality Standard Guidelines.

5.2 Conclusion

In this research, classifying Bera lake are referring on Water Quality Index and National Water Quality standard. Water Quality Index shown the combination of pH value, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, ammoniacal nitrogen and total suspended solid had being classified into class I and class II where as these classes are suitable rather than class IV and V which are not compatible as water supply. For National Water Quality Index of Bera lake can being classified into class I, II and III. The parameter were being tested and compared are Total Coliform, pH value, Biochemical oxygen demand, chemical oxygen demand, ammoniacal nitrogen, dissolved oxygen, total suspended solid, heavy metals such as lead, cadmium, copper, and zinc.

Two sample were taken from Bera lake for two times sampling. The sampling were chosen based on the location of stations by surrounding area activities. The chosen site were selected before sampling activities started. Station 1 with 79.33 and station 2 with 79.24 were classified on class II. The large area were covering with compatibility with water intake criteria that characterize including in chosen most suitable as alternative water supply. In same time, in order to provide safe water supply, the raw water sources need to undergo conventional water treatment.

5.3 Recommendations and suggestions

5.3.1 Recommendations

After succeeding conducting the experimental of Bera lake, there are a few recommendation that can be determine in further study for resolving the problem in order to get more accurate data for this research. These an idea of recommendation will assets in develop and maintain water quality of Bera lake.

i. The suggested recommendation is to study other parameter rather than already stated in this research such as nickel, mercury and cadmium according to National Water Quality Standard.

ii. The number of sampling need to be increase so the more probability to be drawn had better quality of surface water resources. Possibility of study source pollutants were increasing in order to had good water quality in Bera lake.

iii. The sampling need to be more than two times so the result will getting are more accurate for effluent quality and outcomes.

5.3.2 Suggestions

In overall, Bera lake has good water bodies quality. Then, it is suitable for being as alternative and use by Orang Asli Semelai. Further research in controlling pollutant form entire surface watering in needed. The activities of fishing and boating at Bera lake are the main of activities for seeing the surrounding of area.

5.3.3 Conventional Water Treatment Process

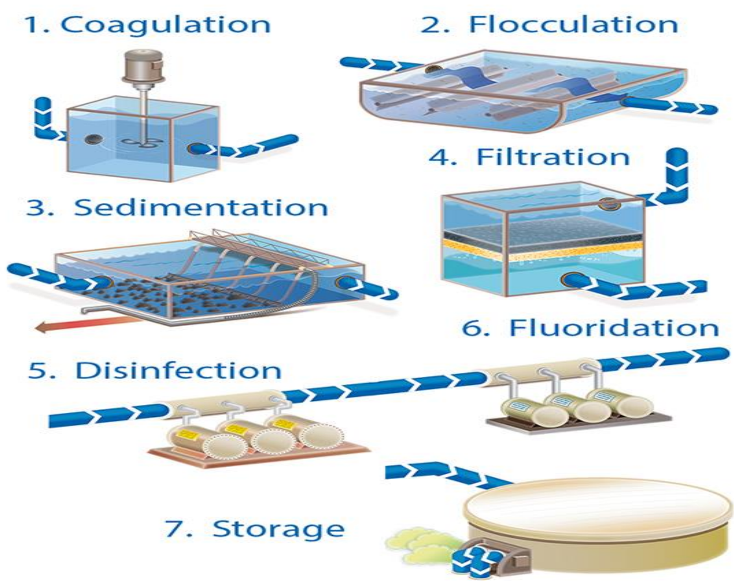

Figure 5.1: Conventional Water Treatment Plant Process

Source: (GPO, 2018)

In Malaysia normally use conventional method. For many years, combination process of mixing, flocculation, sedimentation, filtration and chlorine disinfection shown formed traditional water treatment plant design (Opflow, 2016). Conventional water treatment also needed for water pollution treated, whereas the pollution came from human waste, agricultural waste, industry or other pollution. There are substance will being removed during drinking water treatment process such as suspended solids, algae, bacteria, viruses, fungi, and minerals like iron, manganese and sulphur. The other chemical pollutant is fertilizers.

REFERENCES

Bernama. (25 May, 2016). *43 polluted rivers, mostly in urban area- Wan Junaidi*. Retrieved from New Straits Times: https://www.nst.com.my/news/2016/05/147753/43-polluted-rivers-mostly-urban-areas-wan-junaidi

Britian, C. G. (5 May, 2009). C. Graham Brittain. pp. 1-2.

BV, L. (2018). *Water Treatment*. Retrieved from Lenntech: https://www.lenntech.com/processes/heavy/heavy-metals/heavy-metals.htm

Carrington, D. (February, 2016). *Four billion people face severe water scarcity, new research finds.* Yemeni: The Guardian.

ChemicalSafetyFActs.org. (2018). *Ammonia*. Retrieved from Chemical SafetyFActs.org: https://www.chemicalsafetyfacts.org/ammonia/

Comte, I. (2012). Agricultural Practices in Oil PAlm PLantations and their impact on hydrological changes nutrient fluxes and water quality in Indonesia. *Advances in Agronmy*, 71-124.

contributors, W. (11 May, 2018). *Water distribution on Earth*. Retrieved from Wikipedia: https://en.wikipedia.org/w/index.php?title=Special:CiteThisPage&page=Water_distribution_on_Earth&id=840712594

Dictionary.com. (2018). *hydrologic cycle*. Retrieved from Dictionary.com: http://www.dictionary.com/browse/water--cycle

Environmental. (2016). *Water Temperature*. Retrieved from Fundamental of Environmental Measurement: https://www.fondriest.com/environmental-measurements/parameters/water-quality/water-temperature/

Environmental, F. (2017). *Fondriest of Environmental Measurement* . Retrieved from fondriest.com: https://www.fondriest.com/environmental-measurements/references/

EPA. (19 Jan, 2017). What are Water QUality Standards.

Farhah, A. (2014). *Effect Myth of Lake Chini towards People* . Retrieved from The Legend of Tasik Chini: http://adziatulfarhah.blogspot.my/2014/04/

Franceys, R. &. (June, 2011). Consumer Involvement in Water Services Regulation. *Utilities Policy*, 61-70.

GPO, S. W. (2018). *COnventional water treatment plants*. Retrieved from SAWater: https://www.sawater.com.au/community-and-environment/our-water-and-sewerage-systems/water-treatment/conventional-water-treatment-plants

Horiba. (2018). *What is pH?* Retrieved from PT Cahayatiara Mustika Scientific Indonesia: http://www.cmsi-id.com/blog/chemical-info/4-what-is-ph/

Inc, Y. (2018). *Biochemcial Oxygen Demand-BOD*. Retrieved from YSI: https://www.ysi.com/parameters/biochemical-oxygen-demand-bod

INSTITUTE, P. (22 March, 2010). *WORLD WATER QUALITY FACTS AND STATISTICS*. Retrieved from WORLD WATER QUALITY FACTS AND STATISTICS: https://www.pacinst.org/wp-content/uploads/2013/02/water_quality_facts_and_stats3.pdf

IWA. (2017). *Best Practices Resources Recovery from Water* . Retrieved from watershare: https://www.watershare.eu/projects/best-resources-from-water/

Jörg Lewandowski, K. M. (23 October, 2014). Groundwater – the disregarded component in lake water and nutrient budgets. *Part 2: effects of groundwater on nutrients*, pp. 622-623.

K. K. Bamzai, N. K. (2018). Synthesis, Characterization, and Thermal Decomposition of Pure and Dysprosium Doped Yttrium Phosphate System. *Materials*, 1-8.

Lee, P. (2015). *Dirty water major cause of disruption.* Petaling Jaya: The Star Online.

Lenntech. (2017). Heavy metals.

Malaysia, B. (10 December, 2016). *No approval given for logging at Tasik Bera Ramsar site*. Retrieved from Astro Awani: http://english.astroawani.com/malaysia-news/no-approval-given-logging-tasik-bera-ramsar-site-125160

Mecsystems. (26 February, 2017). *Woda-Sci Green tech Sump COntrols*. Retrieved from https://www.wodasci.com/alternative-water-supply/

Mohammadreza Gharibreza, J. K. (MArch, 2013). Historical variations of Bera Lake (Malaysia) sediments geochemistry using radioisotopes and sediment quality indices. *Journal of Radioanalytical and Nuclear Chemistry* , 1715-1730.

N.A. Zakaria, A. A. (2004). MSMA- A New Urban Stormwater Management Manual for Malaysia. *International Conference on HydroEngineering* (pp. 1-11). Brisbane, Australia: Advances in Hydro-Science and- Engineering.

NAHRIM, N. H. (28 APRIL, 2018). *Institut Penyelidikan Hidraulik Kebangsaan Malaysia*. Retrieved from NATIONAL LAKE WATER QUALITY CRITERIA AND STANDARDS: http://www.nahrim.gov.my/ms/penerbitan/senaraipenerbitan/1195-national-lake-water-quality-criteria-and-standards.html

Noemi Mancosu, R. L. (2015). Water Scarcity and Future Challenges for Food Production. *Water*, 975-992.

Opflow. (October, 2016). *COnventional Water Treatment Processes: Traditional Methods Stand the Test of Time*. Retrieved from How Water Works: https://www.awwa.org/Portals/0/files/resources/water%20knowledge/how%20water%20works/ConventionalWaterTreatmentProcessesPart1.pdf

Organization, N. (2018). *Description of the Hydrologic Cycle*. Retrieved from Northwest River Forecast Center: https://www.nwrfc.noaa.gov/info/water_cycle/hydrology.cgi

People, T. L. (October, 2009). *COD or Chemical Oxygen Demand definition*. Retrieved from The Laboratory People: http://camblab.info/wp/index.php/272/

Peter B Moyle, j. V. (November, 2010). *Rapid decline of California's native inland fishes.* Retrieved from Center for watershed Sciences: https://watershed.ucdavis.edu/pdf/Moyle%20CA%20fish%20status-WP.pdf

Rubio-Arias, H. (2012). An Overall Water Quality Index (WQi) for a Man-MadeAquatic Reservoir in Mexico. *Environemental Research and Public Health*, 1687-1698.

S. Behmel, M. D. (2016). Waterquality monitoring stratgies - A review and future perspectives. *Science of the Total Environment*, 1312-1329.

Theme, M. (29 March, 2017). *Finding the Best Deionized Water Definition*. Retrieved from Demineralized Water: http://d-m-w.com/finding-the-best-deionized-water-definition/

Ullah, R. (2017). *Water Resource*. Retrieved from Challenges of Managing Natural Resourcs in West Sumatra Indonesia: https://www.sciencedirect.com/topics/earth-and-planetary-sciences/water-resource

UNEP. (2018). *Newsletter and Technical Publications <International Source Book On Environmentally Sound Technologies for astewater and Stormwater Management>*. Retrieved from United Nations Environment Programme: http://www.unep.or.jp/ietc/Publications/TechPublications/TechPub-15/2-4/4-2-3.asp

USGS. (2 December, 2016). *Turbidity*. Retrieved from The USGS Water Science School: https://water.usgs.gov/edu/turbidity.html

Víctor Hugo Durán Zuazo, C. R. (1 Jan, 2008). Soil-erosion and runoff prevention by plant covers. A. pp. 1-23.

Walter K. Dodds, M. R. (2010). *Movement of Light, Heat and Chemicals in Water*. Retrieved from Science Direct: https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/nitrate

Wikipedia. (29 April, 2018). Retrieved from https://en.wikipedia.org/w/index.php?title=Special:CiteThisPage&page=Phosphorus&id=838817932

Wikipedia. (21 May, 2018). *Ecosystem*. Retrieved from Wikipedia: https://en.wikipedia.org/w/index.php?title=Special:CiteThisPage&page=Ecosystem&id=842289744

APPENDICES