

REPORT ON THE ASSESSMENT OF WATER QUALITY IN FMU17A TANGKULAP, SG. TALIBU AND SG. PINANGAH FOREST RESERVE 2016

by

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INTRODUCTION

An environmental baseline sampling was carried out by Hydrology Unit of Forest Research Centre to characterize the water quality of 3 rivers, which drained thru the FMU17A Forest Reserve. These rivers are Sg. Tangkulap Besar, Sg Timbah and Sg. Timbangan (Table 1). This assessment is part of the study component required for the Forest Management Plan for FMU17A Forest Reserve forest development project area.

LOCATION OF STUDY AREA

A total of 3 sampling points represent the project watershed and its sub-catchment areas which predominantly drain through the project site. These sampling points are labelled W1 to W3 (Figure 1). The chemical analyses and water quality classes for all parameters tested for the sampling points in the project area are listed in Table 2.

Table 1. The location of water quality sampling points in FMU17A FR (see Map)

Sampling Point	Location	GPS location		Date of Sampling	Surrounding Condition
		Latitude	Longitude		
W1	Sg. Tangkulap Besar	05 ⁰ 27'51.3"	117 ⁰ 13'49.5"	18/04/2016	Secondary forest
W2	Sg. Timbah	05 ⁰ 25'00.8"	117 ⁰ 11'37.0"	18/04/2016	Secondary forest
W3	Sg. Timbangan	05 ⁰ 21'03.9"	117 ⁰ 12'06.1"	18/04/2016	Secondary forest

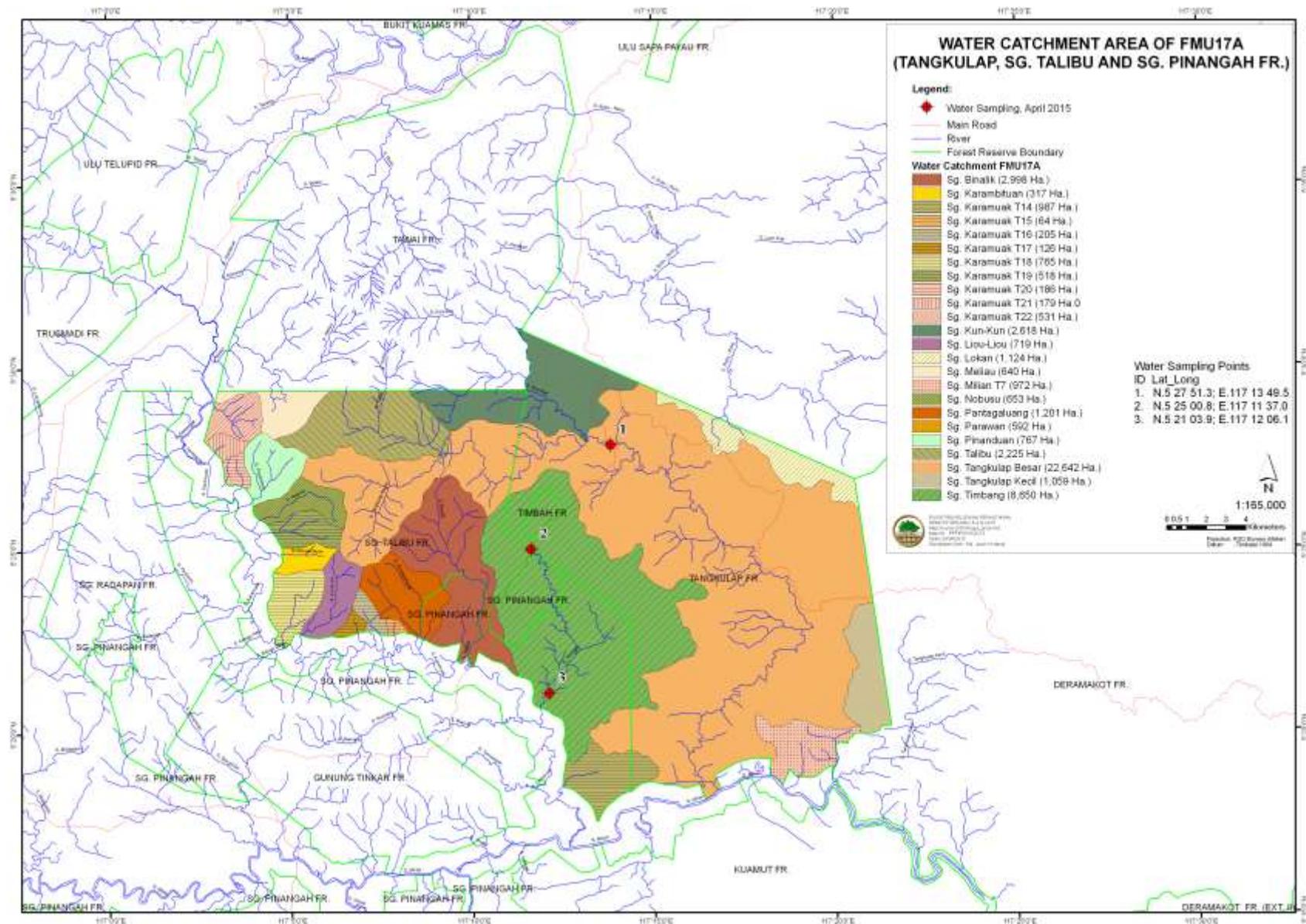


Figure 1. The location of water sampling points to assess river water quality in FMU17A Tangkulap, Sg. Talibu and Sg. Pinangah Forest Reserve.

RESULTS

Water Quality

The chemical analyses and water quality classes for all parameters tested for three sampling points in the project area are listed in Table 2.

Table 2. The results of chemical analyses and water quality classes for all parameter tested for sampling location P1, P2 and P3 in Tangkulap, Sg. Talibu and Sg. Pinangah project area . Note: Biological Oxygen Demand (BOD in mg/l), Chemical Oxygen Demand (COD in mg/l), Ammoniacal Nitrogen (AN in mg/l), Suspended Solid (SS in mg/l), Dissolved Oxygen (DO in mg/l), fecal coliform (MPN/100mL), total coliform (MPN/100mL), and oil & grease (mg/l).

Parameters Tested	Sampling Location			NWQSM *
	W1	W2	W3	
Biological Oxygen Demand (BOD in mg/l)	<1.00	4.93	<1.00	W1 & W3: Class I W2: Class IIB
Suspended Solid (SS in mg/l)	<5.00	5.00	<5.00	Class I
Chemical Oxygen Demand (COD in mg/l)	12.5	31.4	25.1	W1 & W3: Class IIA W2: Class IIB
Ammoniacal- Nitrogen (as N ₃ .N in mg/l)	<0.05	<0.05	<0.05	Class I
Dissolved Oxygen (DO in mg/l)	6.68	6.66	5.36	Class IIA
Oil & Grease (mg/l)	<1.50	<1.50	<1.50	NA
Total Coliform Count (MPN/100mL)	1100	230	220	Class I
Fecal Coliform Count (MPN/100mL)	49	17	110	W1 & W2: Class I W3: Class IIA
pH value	7.03	5.90	5.84	W1: Class I W2 & W3: Class IIA

* National Water Quality Standards for Malaysia

pH Value

The narrow concentration of hydrogen ions between pH 6 to 9 indicates the typical suitability range for the existence of most biological life. Based on the NWQSM, only sampling point W1 is under Class I. The pH level for W2 and W3 is classified within the Class III waters quality range (Table 2).

Total Suspended Solid

TSS is an indicator of the amount of land disturbance within the catchment area and relates to the erosion that took place nearby sampling area or upstream. All sampling points registered TSS levels under Class I waters under the National Water Quality Standards for Malaysia (Table 2).

Biological Oxygen Demand (BOD)

This parameter is a measure to indicate the presence of organic waste in the river. Sampling points W2 registered BOD levels within Class IIB while two (2) sampling points; W1 and W3, is classified under Class I (Table 2).

Chemical Oxygen Demand (COD)

This parameter is an indicator of organics in the water and usually used in association with BOD. W1 and W3 sampling points are in Class IIA while sampling points W2 is classified under Class IIB (Table 2).

Dissolved Oxygen (DO)

DO is an essential indicator in supporting aquatic life. It measures the amount of oxygen (O₂) that is dissolved in the water (Table 2). All sampling points registered DO levels as Class IIA under the NWQSM.

Ammoniacal- Nitrogen (as N₃-N)

This parameter is an indicator of pollution from excessive usage of ammonia rich fertilizers and often used as a measure of the health of water in natural bodies such as rivers or lakes, or in manmade water reservoirs. All sampling points registered AN levels as Class I.

Oil and Grease

This parameter is aim to test whether there has been indiscriminate dumping of oil or oily waste into the water systems. All sampled showed levels of oil and grease below measurable ranges (<1.5 mg/l) and reflect near natural reference level (Table 2).

Total Coliform Count (TCC)

The term total coliform count (TCC) refers to a numerical count that generally includes both fecal and non-fecal coliforms, and the observation is used to highlight bacterial contamination of the waters. All sampling points registered TCC levels within Class I NWQSM (Table 2).

Fecal Coliform Count (FCC)

The term refers to a subset numerical count of total coliform, primarily comprising fecal coliforms bacteria that originates from the guts of warm-blooded animals and humans. The observation is used as an indicator of fecal matters. Two (2) sampling points, W1 and W2, registered FCC levels within Class I NWQSM (Table 2) while W3 sampling point registered FCC levels within Class IIA.

Synthesis of assessment

In general, the tests for water quality sampled from the various local rivers are characterised as clean water quality (Table 3). The pH for all rivers generally complied with the standards set for water under Class I and Class IIA of the NWQSM. The acceptable limit for river water pH is 6 to 9, thus the pH for all sampling points are in an acceptable limit. All rivers indicated no trace of oil and grease. There is no indication of excessive usage and harmful level of ammonium nitrate (indicator of extreme used of fertilizer), shown by Ammoniacal-Nitrogen (as N₃-N) result, which complied with the standards under Class I and Class II of NWQSM. For total suspended solid all sampling points generally complied with the standards set for water under Class I of the National Water Quality Standards for Malaysia, indicating impact of soil erosion is at the minimal level. There are indications of organic pollution in W2 sampling point as the BOD for this sampling point is under Class IIB of NQWSM and should further be investigate. The amounts of COD for W1 and W3 sampling points are under Class IIA and W2 sampling points are under Class IIB. For DO amounts all sampling points are under Class IIA of NQWSM. DO are essential for the aquatic life within the river water. A low DO level would threaten the aquatic community whereas only DO level below 2 mg/l is considered harmful for aquatic life. Based on the total coliform counts (TCC) the bacterial contamination levels in all sampling points are under Class I of NQWMS. As for fecal coliform count (FCC), the bacterial contamination

levels in two sampling points W1 and W2 are under Class I while W3 sampling points are under Class IIA. This would indicate that no indiscriminate dumping of human waste and raw sewage into the river systems. All sampled rivers are categorized as clean water and able to use for human livelihood and consumption (Table 3).

Water Quality Index (WQI)

The results of water quality index for P1 to P3 sampling points are listed in Table 3.

Table 3. The water quality index (WQI) for P1 to P3 sampling points in FMU17A FR. (Note: DO % saturation values were calculated based on dissolved oxygen saturation factor of 8.26 mgL⁻¹ at temperature 25° C).

Attributes	Sampling Point		
	W1	W2	W3
DO%	80.84	80.60	64.86
BOD	1	4.93	1
COD	12.5	31.4	21.5
SS	5	5	5
pH	7.03	5.90	5.84
NH3-NL	0.05	0.05	0.05
SIDO	90	90	71
SIBOD	96	80	96
SICOD	82	62	73
SIAN	95	95	95
SISS	95	95	95
SIpH	99	89	88
WQI	93	85	86
CLASS	I	II	II
WQ STATUS	Clean	Clean	Clean

All the river water was sampled on a clear weather and no event of rain. Based on the river water quality index, sampling points W2 and W3 falls within Class II and categorized as clean river. For sampling point W1 falls within Class I and categorized as clean river. Comparing the river water quality index from 2015, the result shows that theres improvement for W1 and W2 sampling point while slightly deteriorated for sampling point W3. Nevertheless all sampled rivers are categorized as clean water and able to use for human livelihood and consumption (Table 3).

For future undertaking, it is recommended that the management team to install signage in all river crossing areas to prevent visitors or passerby traversing from dumping waste into the watercourse. The management team should periodically brief departmental, adjacent communities and contract workers on this matter to protect the river water quality. The management also may need to carry out periodic inspection and monitoring on existing sewage and septic tanks in all office and living quarters within the FMU to prevent deterioration of the waste treatment system.

REFERENCES

Department Of Environment Malaysia (DOE), 2011. Malaysia Environmental Quality Report 2011. <http://www.doe.gov.my/webportal/en/penerbitan-jas/>

http://www.wepa-db.net/policies/law/malaysia/eq_surface.htm

APPENDIX I METHODOLOGY

A. Sampling Method and Parameters Tested for Chemical Analyses

Grab sampling technique were used to collect water samples at proposed location as indicated in Figure 1 and Table 1. All samples were preserved accordingly and sent to Chemsain Konsultant Sdn. Bhd (an accredited laboratory) for analysis within 24 hours. Parameters measured were according to the DOE Water Quality Index (WQI) with additional physical and microbiological analysis of the samples. The parameters tested were concentration of hydrogen ion (pH), Biological Oxygen Demand (BOD in mg/l), Chemical Oxygen Demand (COD in mg/l), Ammoniacal Nitrogen (AN in mg/l), Suspended Solid (SS in mg/l), Dissolved Oxygen (DO in mg/l), fecal coliform (FCC MPN/100mL), total coliform (TCC MPN/100mL), and oil & grease (mg/l).

B. Data Analysis

Water Quality Index (WQI) was proposed by the Department of Environment Malaysia and can be used to determine the water quality status and classify the rivers based on the National Water Quality Standards for Malaysia (NWQSM). This water monitoring programme was practised in Malaysia since 1978. The NWQSM provides a convenient means of summarizing water quality data for sampled river water by classifying them into various categories, such as Class I, II, III, IV or V based on Water Quality Index (WQI) and National Water Quality Standards for Malaysia (NWQSM). Subsequently, the water quality status can be grouped into broad classes such as clean, slightly polluted or polluted.

The formulas used in the calculation of WQI is as follows:

$$\mathbf{WQI = 0.22SIDO+0.19SIBOD+0.16SICOD+0.16SISS+0.15SIAN+0.12SI\ pH \ (1)}$$

where, WQI = Water quality index; SIDO = Sub-index of DO; SIBOD = Sub-index of BOD; SICOD = Sub-index of COD; SIAN = Sub-index of AN; SISS = Sub-index of TSS; SIpH = Sub-index of pH.

Sub-index for DO (in % saturation):

$$\begin{aligned} \text{SIDO} &= 0 \text{ for} && \text{DO} < 8 && (2a) \\ &= 100 \text{ for} && \text{DO} > 92 && (2b) \\ &= -0.395 + 0.030\text{DO}^2 - 0.00020\text{DO}^3 && \text{for } 8 < \text{DO} < 92 && (2c) \end{aligned}$$

Sub-index for BOD:

$$\begin{aligned} \text{SIBOD} &= 100.4 - 4.23\text{BOD} && \text{for BOD} < 5 && (3a) \\ &= 108e^{-0.055\text{BOD}} - 0.1\text{BOD} && \text{for BOD} > 5 && (3b) \end{aligned}$$

Sub-index for COD:

$$\begin{aligned} \text{SICOD} &= -1.33\text{COD} + 99.1 && \text{for COD} < 20 && (4a) \\ &= 103e^{-0.0157\text{COD}} - 0.04\text{COD} && \text{for COD} > 20 && (4b) \end{aligned}$$

Sub-index for AN:

$$\begin{aligned} \text{SIAN} &= 100.5 - 105\text{AN} \\ &= 94e^{-0.573\text{AN}} - 5 | \text{AN} - 2 | \\ &= 0 \end{aligned}$$

$$\text{for AN} < 0.3 \quad (5a)$$

$$\text{for } 0.3 < \text{AN} < 4 \quad (5b)$$

$$\text{for AN} > 4 \quad (5c)$$

Sub-index for SS:

$$\begin{aligned} \text{SISS} &= 97.5e^{-0.00676\text{SS}} + 0.05\text{SS} \\ &= 71e^{-0.0016\text{SS}} - 0.015\text{SS} \\ &= 0 \end{aligned}$$

$$\text{for SS} < 100 \quad (6a)$$

$$\text{for } 100 < \text{SS} < 1000 \quad (6b)$$

$$\text{for SS} > 1000 \quad (6c)$$

Sub-index for pH:

$$\begin{aligned} \text{SIpH} &= 17.2 - 17.2\text{pH} + 5.02\text{pH}^2 \\ &= -242 + 95.5\text{pH} - 6.67\text{pH}^2 \\ &= -181 + 82.4\text{pH} - 6.05\text{pH}^2 \\ &= 536 - 77.0\text{pH} + 2.76\text{pH}^2 \end{aligned}$$

$$\text{for pH} < 5.5 \quad (7a)$$

$$\text{for } 5.5 < \text{pH} < 7 \quad (7b)$$

$$\text{for } 7 < \text{pH} < 8.75 \quad (7c)$$

$$\text{for pH} > 8.75 \quad (7d)$$

APPENDIX II WATER QUALITY RESULTS



CHEMSAIN KONSULTANT SDN BHD (130904-U)

Lots 2 & 7, Lorong Suria, Off Lorong Buah Duku 1, Taman Perindustrian Suria,
Jalan Kolombong, 88450 Kota Kinabalu, Sabah, Malaysia.

Tel: +60-88-389671 / 381278 Fax: +60-88-381280

Email: laboratory.kk@chemsain.com



TEST REPORT

* NOT FOR ADVERTISEMENT PURPOSES *

Customer	: Jabatan Perhutanan Sabah PPP Sepilok, PS 1407, 90715 Sandakan, Sabah.	Lab No.	: CK/CL405/1355/16
		Type (No.) of Sample	: River Water (5)
		Date Received	: 19 th April 2016
		Date of Report	: 26 th April 2016
Attn	: Ms. Noor Azmizah Bt. Andaman	Service Order	: -

Lab No.:	1355-1	
Parameter(s)	Sg. Tangkulp Date: 18/04/16 Time: 5.25 pm	Test Method
pH Value @ 25°C	7.03	APHA 4500H ⁺ B, 2012
Biochemical Oxygen Demand in 5 days @ 20°C, mg/L	<1.00	APHA 5210 B & 4500-O G, 2012
Suspended Solids, mg/L	<5.00	APHA 2540 D, 2012
Dissolved Oxygen, mg/L	6.68	APHA 4500-O G, 2012
Oil & Grease, mg/L	<1.50	APHA 5520 B, 2012
Chemical Oxygen Demand, mg/L	12.5	APHA 5220 C, 2012
Ammoniacal-Nitrogen (as NH ₃ -N), mg/L	<0.05	APHA 4500 NH ₃ F, 2012

Lab No.:	1355-2	
Parameter(s)	Sg. Timbangah Date: 18/04/16 Time: 3.30 pm	Test Method
pH Value @ 25°C	5.90	APHA 4500H ⁺ B, 2012
Biochemical Oxygen Demand in 5 days @ 20°C, mg/L	4.93	APHA 5210 B & 4500-O G, 2012
Suspended Solids, mg/L	5.00	APHA 2540 D, 2012
Dissolved Oxygen, mg/L	6.66	APHA 4500-O G, 2012
Oil & Grease, mg/L	<1.50	APHA 5520 B, 2012
Chemical Oxygen Demand, mg/L	31.4	APHA 5220 C, 2012
Ammoniacal-Nitrogen (as NH ₃ -N), mg/L	<0.05	APHA 4500 NH ₃ F, 2012

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 2) The above result(s) are based on sample(s) as received.
 3) The result(s) relates to the sample(s) tested.



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TEST REPORT

* NOT FOR ADVERTISEMENT PURPOSES *

Lab No.: CK/CL405/1355/16

Lab No.:	1355-4	
Parameter(s)	Sg. Timbangah Ulu Date: 18/04/16 Time: 4.15 pm	Test Method
pH Value @ 25°C	5.84	APHA 4500H ⁺ B, 2012
Biochemical Oxygen Demand in 5 days @ 20°C, mg/L	<1.00	APHA 5210 B & 4500-O G, 2012
Suspended Solids, mg/L	<5.00	APHA 2540 D, 2012
Dissolved Oxygen, mg/L	5.36	APHA 4500-O G, 2012
Oil & Grease, mg/L	<1.50	APHA 5520 B, 2012
Chemical Oxygen Demand, mg/L	25.1	APHA 5220 C, 2012
Ammoniacal-Nitrogen (as NH ₃ -N), mg/L	<0.05	APHA 4500 NH ₃ F, 2012

Page 2 of 3

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TEST REPORT

* NOT FOR ADVERTISEMENT PURPOSES *

Customer :	Jabatan Perhutanan Sabah PPP Sepilok, PS1407, 90715 Sandakan, Sabah.	Lab No. :	CK/ML405/1356/16
		Type (No.) of Sample :	River Water (5)
		Date Received :	19 th April 2016
		Date of Report :	27 th April 2016
Attn :	Ms. Noor Azmizah Bt Andaman	Service Order :	-

Lab No.:	1356-3		Test Method
Parameter	Sg. Timbangah Date: 18/04/16 Time: 3.30 pm		
Total Coliform Count MPN/100mL, 35±0.5°C/48 h	2.3 x 10 ²		APHA 9221B, 2012
Fecal Coliform Count MPN/100mL, 44.5±0.2°C/24 h	17		APHA 9221E, 2005

Lab No.:	1356-4	1356-5	Test Method
Parameter	Sg. Tangkulap Date: 18/04/16 Time: 5.25 pm	Sg. Timbangah Ulu Date: 18/04/16 Time: 4.15 pm	
Total Coliform Count MPN/100mL, 35±0.5°C/48 h	1.1 x 10 ³	2.2 x 10 ²	APHA 9221B, 2012
Fecal Coliform Count MPN/100mL, 44.5±0.2°C/24 h	49	1.1 x 10 ²	APHA 9221E, 2005


ANIS IDAYU BINTI ZAKARIA
B. Sc. (Hons.)
FOOD TECHNOLOGIST



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3) The result(s) relates to the sample(s) tested.

APPENDIX III

- i. National Water Quality Standards For Malaysia
- ii. Water Classes And Uses
- iii. DOE Water Quality Classification Based On Water Quality Index
- iv. DOE Water Quality Index Classification
- v. WQI Formula And Calculation

Source from: Department Of Environment Malaysia (DOE), 2011. Malaysia Environmental Quality Report 2011. <http://www.doe.gov.my/webportal/en/penerbitan-jas/>

APPENDIX III (i)

ANNEX

NATIONAL WATER QUALITY STANDARDS FOR MALAYSIA

PARAMETER	UNIT	CLASS				
		I	IIA/IIIB	III*	IV	V
Al	mg/l	▲	-	(0.06)	0.5	▲
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	-	0.2	
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)	L E V E L S	
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	A B O V E	
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		
NO ₂	mg/l	0.4	0.4 (0.03)	-		
NO ₃	mg/l	7	-	5		
P	mg/l	0.2	0.1	-		
Silica	mg/l	50	-	-		
SO ₄	mg/l	250	-	-		
S	mg/l	0.05	(0.001)	-		
CO ₂	mg/l	-	-	-	I V	
Gross-α	Bq/l	0.1	-	-		
Gross-β	Bq/l	1	-	-		
Ra-226	Bq/l	< 0.1	-	-		
Sr-90	Bq/l	< 1	-	-		
CCE	µg/l	500	-	-		
MBAS/BAS	µg/l	500	5000 (200)	-		
O & G (Mineral)	µg/l	40; N	N	-		
O & G (Emulsified Edible)	µg/l	7000; N	N	-		
PCB	µg/l	0.1	6 (0.05)	-		
Phenol	µg/l	10	-	-		
Aldrin/Dieldrin	µg/l	0.02	0.2 (0.01)	-		
BHC	µg/l	2	9 (0.1)	-		
Chlordane	µg/l	0.08	2 (0.02)	-		
t-DDT	µg/l	0.1	(1)	-		
Endosulfan	µg/l	10	-	-		
Heptachlor/Epoxide	µg/l	0.05	0.9 (0.06)	-		
Lindane	µg/l	2	3 (0.4)	-		
2,4-D	µg/l	70	450	-		
2,4,5-T	µg/l	10	160	-		
2,4,5-TP	µg/l	4	850	-		
Paraquat	µg/l	10	1800	-		

Notes :

* = At hardness 50 mg/l CaCO₃

= Maximum (unbracketed) and 24-hour average (bracketed) concentrations

N = Free from visible film sheen, discoloration and deposits

APPENDIX III (i & ii)

NATIONAL WATER QUALITY STANDARDS FOR MALAYSIA

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)*	5000 (20000)*	-
Total Coliform	count/100 ml	100	5000	5000	50000	50000	> 50000

Notes:

- N : No visible floatable materials or debris, no objectional odour or no objectional taste
- * : Related parameters, only one recommended for use
- ** : Geometric mean
- a : Maximum not to be exceeded

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 required. Fishery II – Sensitive aquatic species.
Class IIB	Recreational use with 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.

DOE WATER QUALITY CLASSIFICATION BASED ON WATER QUALITY INDEX

SUB INDEX & WATER QUALITY INDEX	INDEX RANGE		
	CLEAN	SLIGHTLY POLLUTED	POLLUTED
Biochemical Oxygen Demand (BOD)	91 - 100	80 - 90	0 - 79
Ammoniacal Nitrogen (NH ₃ -N)	92 - 100	71 - 91	0 - 70
Suspended Solids (SS)	76 - 100	70 - 75	0 - 69
Water Quality Index (WQI)	81 - 100	60 - 80	0 - 59

DOE WATER QUALITY INDEX CLASSIFICATION

PARAMETER	UNIT	CLASS				
		I	II	III	IV	V
Ammoniacal Nitrogen	mg/l	< 0.1	0.1 - 0.3	0.3 - 0.9	0.9 - 2.7	> 2.7
Biochemical Oxygen Demand	mg/l	< 1	1 - 3	3 - 6	6 - 12	> 12
Chemical Oxygen Demand	mg/l	< 10	10 - 25	25 - 50	50 - 100	> 100
Dissolved Oxygen	mg/l	> 7	5 - 7	3 - 5	1 - 3	< 1
pH	-	> 7.0	6.0 - 7.0	5.0 - 6.0	< 5.0	> 5.0
Total Suspended Solid	mg/l	< 25	25 - 50	50 - 150	150 - 300	> 300
Water Quality Index (WQI)		> 92.7	76.5 - 92.7	51.9 - 76.5	31.0 - 51.9	< 31.0

WQI FORMULA AND CALCULATION

FORMULA

$$WQI = (0.22 * SIDO) + (0.19 * SIBOD) + (0.16 * SICOD) + (0.15 * SIAN) + (0.16 * SISS) + (0.12 * SIpH)$$

where;

SIDO = Subindex DO (% saturation)

SIBOD = Subindex BOD

SICOD = Subindex COD

SIAN = Subindex NH₃-N

SISS = Subindex SS

SIpH = Subindex pH

0 ≤ WQI ≤ 100

BEST FIT EQUATIONS FOR THE ESTIMATION OF VARIOUS SUBINDEX VALUES

Subindex for DO (in % saturation)

$$\begin{aligned} SIDO &= 0 && \text{for } x \leq 8 \\ SIDO &= 100 && \text{for } x \geq 92 \\ SIDO &= -0.395 + 0.030x^2 - 0.00020x^3 && \text{for } 8 < x < 92 \end{aligned}$$

Subindex for BOD

$$\begin{aligned} SIBOD &= 100.4 - 4.23x && \text{for } x \leq 5 \\ SIBOD &= 108 * \exp(-0.055x) - 0.1x && \text{for } x > 5 \end{aligned}$$

Subindex for COD

$$\begin{aligned} SICOD &= -1.33x + 99.1 && \text{for } x \leq 20 \\ SICOD &= 103 * \exp(-0.0157x) - 0.04x && \text{for } x > 20 \end{aligned}$$

Subindex for NH₃-N

$$\begin{aligned} SIAN &= 100.5 - 105x && \text{for } x \leq 0.3 \\ SIAN &= 94 * \exp(-0.573x) - 5 * |x - 2| && \text{for } 0.3 < x < 4 \\ SIAN &= 0 && \text{for } x \geq 4 \end{aligned}$$

Subindex for SS

$$\begin{aligned} SISS &= 97.5 * \exp(-0.00676x) + 0.05x && \text{for } x \leq 100 \\ SISS &= 71 * \exp(-0.0061x) - 0.015x && \text{for } 100 < x < 1000 \\ SISS &= 0 && \text{for } x \geq 1000 \end{aligned}$$

Subindex for pH

$$\begin{aligned} SIpH &= 17.2 - 17.2x + 5.02x^2 && \text{for } x < 5.5 \\ SIpH &= -242 + 95.5x - 6.67x^2 && \text{for } 5.5 \leq x < 7 \\ SIpH &= -181 + 82.4x - 6.05x^2 && \text{for } 7 \leq x < 8.75 \\ SIpH &= 536 - 77.0x + 2.76x^2 && \text{for } x \geq 8.75 \end{aligned}$$

Note:

* means multiply with