Appendix

APPENDIX I

THIRD SCHEDULE
ENVIRONMENTAL QUALITY A 1974CT
ENVIRONMENTAL QUALITY (SEWAGE AND INDUSTRIAL EFLUENTS) REGULATIONS 1978
{Regulations 8 (1), 8 (2), 8 (3)}

Parameter Limits of Effluent Of Standards A and B

	Parameter	Unit	Standard	
			A	B
	(1)	(2)	(3)	(4)
(i)	Temperature	^{0}C	40	40
(ii)	pH value	-	6.0 - 9.0	5.5 - 9.0
(iii)	BOD, at 20 ^{0} C	mg/l	20	50
(iv)	COD	mg/l	50	100
(v)	Suspended Solids	mg/l	50	100
(vi)	Mercury	mg/l	0.005	0.05
(vii)	Cadmium	mg/l	0.01	0.02
(viii)	Chromium hexavalent	mg/l	0.05	0.05
(ix)	Arsenic	mg/l	0.05	0.10
(x)	Cyanide	mg/l	0.05	0.10
(xi)	Lead	mg/l	0.10	0.5
(xii)	Chromium trivalent	mg/l	0.20	1.0
(xiii)	Copper	mg/l	0.20	1.0
(xiv)	Manganese	mg/l	0.20	1.0
(xv)	Nickel	mg/l	0.20	1.0
(xvi)	Tin	mg/l	0.20	1.0
(xvii)	Zinc	mg/l	1.0	1.0
(xviii)	Boron	mg/l	1.0	4.0
(xix)	Iron (Fe)	mg/l	1.0	5.0
(xx)	Phenol	mg/l	0.001	1.0
(xxi)	Free Chlorine	mg/l	1.0	2.0
(xxii)	Sulphide	mg/l	0.50	0.50
(xxiii)	Oil and grease	mg/l	not detectable	10.0

APPENDIX II

Proposed Interim National Water Quality Standard for Malaysia

PARAMETERS	CLASSES					
	I	IIA	IIB	III#	IV	V
Ammoniacal Nitrogen	0.1	0.3	0.3	0.9	2.7	2.7
BOD (mg/l)	1	3	3	6	12	12
COD (mg/l)	10	25	25	50	100	100
DO (mg/l)	7	5.7	5.7	3.5	3	1
pH	6.5-8.5	6.5-9.0	6.5-9,0	5-9	5-9	-
Colour (TUC)	15	150	150	-	-	-
Elec. Conductivity (μmhos/cm)**	1000	1000	-	-	6000	-
Floatables	NV	NV	NV	-	-	-
Odour	NOO	NOO	NOO	-	-	-
Salinity (%) **	0.5	1	-	-	2	-
Taste	NOT	NOT	NOT	-	-	-
Total dissolved solid (mg/l)	500	1000	-	-	4000	-
Total Suspended Solid (mg/l)	25	50	50	150	300	300
Temperature (C)	-	Normal 2	-	Normal 2	-	-
Turbidity (NTU)	5	50	50	-	-	-
Faecal Coliform (counts/100ml)	10	100	400	5000 (20000) @	5000 (20000) @	-
Total Coliform (counts/100ml)	100	5000	5000	5000	5000	5000
AI (mg/l)	-	-	-	0.056	0.5	-
As (mg/l)	N	0.05	NR	0.045 (0.44)	0.1	+
Ba (mg/l)	N	1	NR	-	-	+
Cd (mg/l)	N	0.005	NR	0.001 (0.011**)	0.01	+
Cr (IV) (mg/l)	N	0.05	NR	0.054 (1.45)	0.1	+
Cr (III) (mg/l)	N	-	NR	- (2.53)	-	+
Cu (mg/l)	N	1	NR	0.01 (0.012*)	0.2	+
Hardness (mg/l)	N	100	NR	-	-	+
Ca (mg/l)	N	-	NR	-	-	+
Mg (mg/l)	N	0.05	NR	-	-	+
Na (mg/l)	N	-	NR	-	3 SAR	+
K (mg/l)	N	-	NR	-	-	+
Fe (mg/l)	N	0.3	NR	1	1 (Leaf) 5(Others)	+
Pb (mg/l)	N	0.05	NR	0.01 (0.014*)	5 -	+
Mn (mg/l)	N	0.1	NR	0.1	0.2	+
Hg (mg/l)	N	0.001	NR	0.0001 (0.004)	0.002	+
Ni (mg/l)	N	0.05	NR	- (0.9*)	0.2	+
Se (mg/l)	N	0.01	NR	0.037 (0.25)	0.02	+

PARAMETERS	CLASSES					
	I	IIA	IIB	III#	IV	V
Ag (mg/l)	N	0.05	NR	- (0.0002)	-	+
Sn (mg/l)	N	NR	NR	0.05	-	+
U (mg/l)	N	NR	NR	-	-	+
Zn (mg/l)	N	5	NR	- (0.35)	2	+
B (mg/l)	N	1	NR	3.4	0.75	+
Cl (mg/l)	N	200	NR	-	79	+
C12 (mg/l)	N	-	NR	0.22	-	+
CN (mg/l)	N	0.2	NR	0.0023 (0.058)	-	+
F (mg/l)	N	1	NR	- (11)	1	+
NO_3/NO_2 (mg/l)	N	7/3	NR	0.028 (0.37)	5	+
P (mg/l)	N	0.1	NR	0.1	-	+
Silica (mg/l)	N	50	NR	-	-	+
SO4 (mg/l)	N	200	NR	-	-	+
S (mg/l)	N	0.05	NR	0.001	-	+
CO2 (mg/l)	N	-	NR	-	-	+
Gross -(Bql)	N	0.1	NR	-	-	+
Gross- (Bql)	N	1	NR	-	-	+
Ra-226 (Bql)	N	+0.1	NR	-	-	+
Sr-90 (Bql)	N	+0.1	NR	-	-	+
CCE (µg/l)	N	500	NR	-	-	-
MBAS/BAS (µgl)	N	500	NR	200	NR	+
O&G (Mineral) (mg/l)	N	40;NF	NR	NL	NR	+
O&G (Emulsified edible) (µ gl)	N	7000; NF	NR	NL	NR	+
PCB (mg/l)	N	0.1	NR	0.044 (6.1)	NR	+
Phenol (µg/l)	A	10	NR	(9900)		
Aldrin/	A	0.02	NR	0.08	NR	NR
Dieldrin (µg/l)	A		NR	(0.2) 0.13	NR	NR
BHC (µg/l)	A	2	NR	(9.9)	NR	NR
Chlordane (µ g/l)	A	0.08	NR	(2.2) 0.004	NR	NR
t-DDT (µ g/l)	A	0.1	NR	(1)	NR	NR
Endosulfan (µ g/l)	A	10	NR	- (0.01)	NR	NR
Hepatachlor/	A	0.05	NR	0.06	NR	NR
Epoxide (µ g/l)	A	-	NR	(0.91)	NR	NR
Lindane (µg/l)	A	2	NR	0.38 (2.9)	NR	NR
2,4-D (µ g/l)	A	70	NR	(450)	NR	NR
2,4 5-T (µg/l)	A	10	NR	(160)	NR	NR
2,4, 5-TP (µ g/l)	A	4	NR	(850)	NR	NR
Paraquat (µ g/l)	A	10	NR	(1800)	NR	NR

Notes:

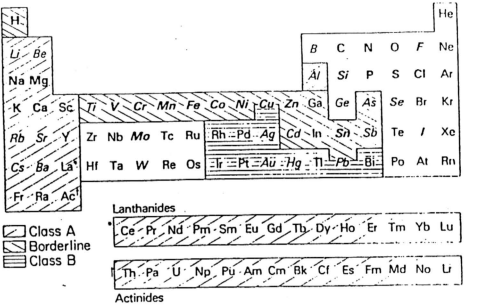
CLASS I	: Conservation of natural environment water supply I - practically no treatment necessary. Fishery I - very sensitive aquatic species
CLASS IIA	: Water Supply II - conventional treatment required Fishery II - sensitive aquatic species
CLASS IIB	: Recreational use with body contact
CLASS III	: 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
NV	: No visible floatable materials or debris
NOO	: No objectionable odour
NOT	: No objectionable taste
**	: Related parameters, only one recommended for use
@	: Maximum not to be exceeded
NR	: No recommendation
*	: At hardness 50mg/L $CaCO_3$
#	: 24-hr average and maximum (bracketed) concentrations are shown
NF	: Free from visible film, sheen, discoloration and deposits
NL	: Free from visible layer, discoloration and deposits
N	: Natural levels
+	: Levels above Class IV
A	: Absent

APPENDIX III

Seaweed Biomass Collection Site

APPENDIX IV

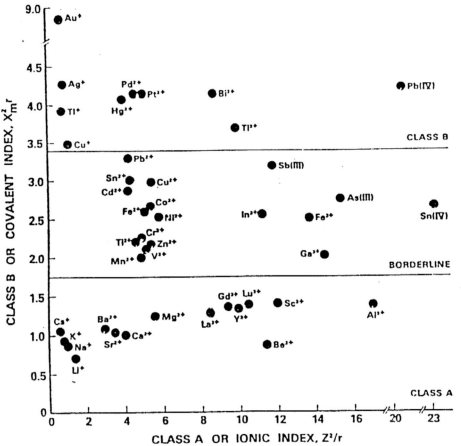
Metal Classification According to Nieboer and Richardson (1980)



The periodic table of elements showing the disposition of the Class A, Class B and borderline metals and metalloid ions.

APPENDIX V

A Separation of Metal Ions and Metalloid Ions based upon Covalent Indices against Ionic Indices, according to Nieboer and Richardson (1980)



X_m = metal-ion electronegativity

r = metal ionic radius

Z = formal charge

APPENDIX VI

APPENDIX VI a: COPPER ADSORPTION

Table 1: Cu (II) adsorption with increasing initial copper concentration

C_i mg/L	C_{eq} mg/L	$C_i - C_{eq}$ mg/L	q_{eq} mg/g	q_{eq} mmol/g	C_{eq} mM
49.703	3.236	46.467	23.23	0.37	0.05
105.706	8.222	97.484	48.74	0.77	0.13
144.939	28.232	116.707	58.35	0.92	0.44
192.337	61.284	131.0528	65.53	1.03	0.96
245.073	118.682	126.391	63.20	0.99	1.87
294.850	145.876	148.974	74.49	1.17	2.30
417.990	250.693	167.297	83.65	1.32	3.95

TABLE 2: Computation of C_{eq} from initial concentrations and control experiments (metal free and biomass free)

C_i mg/L	C_f mg/L	C_{fM-} mg/L	C_{fM-A-} Mg/L	$C_f - C_{fM-} - C_{fM-A-} = Ceq$, mg/L
49.703	3.305	0.0464	0.0224	3.236
105.706	8.290	0.0464	0.0224	8.221
144.939	28.301	0.0464	0.0224	28.232
192.337	61.353	0.0464	0.0224	61.284
245.073	118.751	0.0464	0.0224	118.682
294.850	145.945	0.0464	0.0224	145.876
417.990	250.762	0.0464	0.0224	250.693

APPENDIX VI a –continued.

Note:

$$q_{eq} = \frac{V(C_i - C_{eq})}{M}$$

V=0.05L, M=0.1g, Gram atomic wt. of Cu = 63.54g

C_i = initial sample concentration, C_{eq} = equilibrium concentration

q_{eq} = adsorption at equilibrium per gram dry wt of biomass

C_f = final concentration of sample (at end of experiment ie at 40hrs)
C_{bM-} = concentration of metal free control

C_{bM-A-} = concentration of metal and biomass free control

Table 3: pH change for Cu (II) adsorption

C_i, Initial Copper concn,	Initial pH	Final pH
49.703 mg/l 0.78mM	5.06	5.62
105.706 mg/l 1.66 mM	5.03	5.02
144.939 mg/l 2.28mM	5.09	4.54
192.337 mg/l 3.03 mM	5.07	4.42
245.073 mg/l 3.86 mM	5.02	4.29
294.850 mg/l 4.64 mM	4.99	4.19
417.990 mg/l 6.58 mM	4.98	4.12

*** Raw and Computed Data presented in Tables 1-3 are mean of duplicate samples analysed.**

APPENDIX VI b: LEAD ADSORPTION

TABLE 1: Lead adsorption with increasing initial concentrations of lead

C_i of Pb mg/L	C_{eq} mg/L	C_i-C_{eq} mg/L	$q_{eq} = \frac{V(C_i-C_{eq})}{M}$ mg/L	q_{eq} mmol/g	C_{eq} mM
54.452	0.291	54.162	27.08	0.13	1.4 $x10^{-3}$
220.539	1.6901	218.849	109.42	0.53	8.16 $x10^{-3}$
431.929	8.183	423.746	211.87	1.02	39.49 $x10^{-3}$
553.278	31.582	521.696	260.85	1.26	152.42 $x10^{-3}$
599.205	87.797	511.408	255.704	1.23	424.73 $x10^{-3}$
625.854	59.759	566.095	283.047	1.37	288.42 x10-3
762.107	252.322	509.785	254.893	1.23	1217.76 $x10^{-3}$
993.251	480.965	512.286	256.143	1.24	2321.26 $x10^{-3}$
1462.822	1028.794	434.028	217.014	1.05	4965.22 $x10^{-3}$

Note
V = 0.05 L, M = 0.1g
Gram atomic wt. of Pb = 207.2g
C_{eq} was obtained by deducting control blanks from initial Pb concentration C_i

C_i = initial sample concentration, C_{eq} = equilibrium concentration

q_{eq} = adsorption at equilibrium per gram dry wt of biomass

*** Raw and Computed Data presented in Tables 1-3 are mean of duplicate samples analysed.**

APPENDIX VI b continued

Table 2: Computation of C_{eq} from initial concentration C_i and control experiments (metal free and biomass free)

C_i mg/L	C_f mg/L	C_{fM-} mg/L	C_{fM-A-} mg/L	C_f-C_{fM-} -C_{fM-A-} = C_{eq}
54.452	0.422	0.008	0.123	0.291
220.539	1.821	0.008	0.123	1.690
431.929	8.314	0.008	0.123	8.183
553.278	31.822	0.159	0.081	31.582
599.205	85.446	0.159	0.081	87.797
625.854	59.999	0.159	0.081	59.760
762.107	252.562	0.159	0.081	252.322
993.251	481.205	0.159	0.081	480.965
1462.822	1029.034	0.159	0.081	1028.794

C_f = final concentration of sample (at end of experiment ie at 40hrs)

C_{fM-} = concentration of metal free control

C_{fM-A-} = concentration of metal and biomass free control

Table 3: pH change during Pb (II) adsorption

C_i,	Initial pH	Final pH
54.452 mg/L 0.26 mM	5.05	6.97
220.539 mg/L 1.06 mM	5.01	6.35
431.929 mg/L 2.08 mM	4.98	4.84
553.278 mg/L 2.67 mM	4.85	4.57
599.205 mg/L 2.89 mg/L	4.85	4.46
625.854 mg/L 3.02 mM	5.06	4.45
762.107 mg/L 3.68 mM	5.18	4.13
993.251 mg/L 4.79 mM	5.22	4.16
1462.822 mg/L 7.06 mM	5.17	4.06

APPENDIX VI c: COPPER (II) BIOSORPTION AS A FUNCTION OF INITIAL MOLAR RATIOS OF COPPER (II) TO LEAD (II)

Table 1: Copper (II) biosorption as a fuction of initial molar ratios of copper (II) to lead (II)

Cu:Pb	C_i mg/L	C_{eq} mg/L	$C_i - C_{eq}$ mg/L	$q_{eq} = \frac{V(C_i - C_{eq})}{M}$ mg/g	q_{eq} mmol/g	C_{eq} mM
1:0	53.75 0.85 mM	5.26	48.49	48.49	0.763	0.083
1:1	53.30 0.84 mM	23.72	29.58	29.58	0.466	0.37
1:2	53.37 0.84mM	39.87	13.50	13.5	0.213	0.63
1:5	50.54 0.795mM	48.29	2.26	2.26	0.036	0.76
1:10	50.53 0.795Mm	48.28	2.25	2.25	0.035	0.76

Note:
V= 0.05 L, M=0.05 g
Gram atomic wt. of Cu = 63.54 g, Gram atomic wt of Pb=207.2 g
C_{eq} was obtained after deducting values of control blanks from final sample concentration
C_i = initial sample concentration, C_{eq} = equilibrium concentration

q_{eq}= adsorption at equilibrium per gram dry wt of biomass

*** Raw and Computed Data presented in tables 1-3 are mean of duplicate samples analysed**

TABLE 2: Computation of C_{eq} for Cu(II) from initial concentrations and control experiments (metal free and biomass free)

C_i mg/L	C_f mg/L	C_{fM-} mg/L	C_{fM-A-} mg/L	$C_f - C_{fM-} - C_{fM-A-} = C_{eq}$, mg/L
53.746	5.272	0.0148	-0.0003	5.257
53.296	23.734	0.0148	-0.0003	23.719
53.374	39.888	0.0148	-0.0003	39.873
50.544	48.303	0.0148	-0.0003	48.289
50.531	48.295	0.0148	-0.0003	48.280

C_f = final concentration of sample (at end of experiment ie at 40hrs)

C_{fM-} = concentration of metal free control

Cf_{M-A-} = concentration of metal and biomass free control

TABLE 3: pH change during Copper (II) as a function of initial molar ratios of Copper (II) to Lead (II).

Cu:Pb	Initial pH	Final Ph
1:0	5.03	4.96
1:1	5.07	4.49
1:2	4.94	4.17
1:5	4.91	4.14
1:10	4.97	4.11

APPENDIX VI d: LEAD (II) BIOSORPTION AS A FUNCTION OF INITIAL MOLAR RATIOS OF LEAD (II) TO COPPER (II)

Table 1: Lead (II) biosorption as a function of initial molar ratios of lead (II) to copper (II)

Pb:Cu	C_i of Pb mg/L	Ceq mg/L	C_i-C_{eq} mg/L	q_{eq}= V(C_i-Ceq) M mg/g	q_{eq} mmol/g	C_{eq} mM
1:0	52.205	0.304	51.902	51.9	0.25	1.47 x 10^{-3}
1:1	52.693	0.196	52.497	52.5	0.25	0.946 x 10^{-3}
1:2	53.153	0.218	52.935	52.9	0.26	1.05 x 10^{-3}
1:5	52.828	0.764	52.064	52.1	0.25	3.69 x 10^{-3}
1:10	53.171	2.147	51.024	51.02	0.25	10.36 x 10^{-3}

*** Raw and Computed Data presented in tables 1-3 are mean of duplicate samples analysed**

Appendix VI d continued

Table 2: Computation of C_{eq} for Pb from initial concentrations and control experiments (metal free and biomass free)

C_i mg/L	C_f mg/L	C_{fM-} mg/L-	C_{fM-A-} mg/L	$C_f - C_{fM-} - C_{fM-A-} = C_{eq}$, mg/L
52.205	0.322	0.018	-0.006	0.304
52.693	0.215	0.018	-0.006	0.196
53.153	0.236	0.018	-0.006	0.218
52.828	0.782	0.018	-0.006	0.764
53.171	2.166	0.018	-0.006	2.147

V=0.05L, M=0.05g Gram atomic wt : Pb=207.2g, Cu=63.54g

C_{eq} was obtained after deducting the control blank values from the final sample concentration .
C_i = initial sample concentration, Ceq = equilibrium concentration

q_{eq} = adsorption at equilibrium per gram dry wt of biomass

C_f = final concentration of sample (at end of experiment ie at 40hrs)
C_{fM-} = concentration of metal free control
C_{fM-A-} = concentration of metal and biomass free control

Table: 3 pH change during lead (II) biosorption as a function os initial molar ratios of lead (II) to copper (II)

Pb: Cu	Initial pH	Final pH
1:0	5.3	6.4
1:1	5.2	5.9
1:2	5.2	5.4
1:5	5.1	4.5
1:10	5.1	4.3