Appendix A

Table A- 1 Stock solution and all chemical reagents list

Order	Chemical reagent name
1	Standard solution 1,000 mg/L Cd, Cu, Pb, Zn, Al, Fe and Mn (MERCK, Germany)
2	Ammonia solution (A.C.S. Reagent, J.T.Baker ,USA)
3	Acetic acid (AR grade,Analytical Science)
4	Ammonium pyrolidine dithiocarbamate (Fluka Chemika)
5	Boric acid (Merck,Germany)
6	Chloroform (AR grade,Analytical Sciences)
7	Diethylammonium diethyldithiocarbamate (MERCK, Germany)
8	Hydrochloric acid (AR grade,Riedel-dehaen,Germany)
9	Hydrofluoric acid (Grade for analysis,Merck,Germany)
10	Nitric acid (AR grade, J.T.Baker ,USA)
11	High purity argon gas (purity 99.90%: TIG,Thailand)

Table A- 2 List of apparatus

Order	List of apparatus
1	Teflon vessel (Lorran International, Canada)
2	Microwave Oven Sharp Model R-311
3	Mettler-Toledo PB3002-S DeltaRange
4	Filter holder 4.7 cm. (Nalgene, USA)
5	Inherently Hydrophilic Polysulfone filter 0.45 μm (Gelman Sciences Inc., USA)
6	Buchi B-169 vacuum-system (Switzerland)

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Table A- 3 The parameters used for Perkin Elmer AAnalyst 800

Parameter	Setting
Carrier gas	Argon
Flow rate	250 ml min^{-1}
Tube	Pyrolytically coated graphite tubes
Lamp type	EDL for Cd HCL for Cu, Pb and Zn
Current	4 mA for Cd 10 mA for Pb 15mA for Cu and Zn
Spectral bandpass	0.7 nm (low slit)
Signal measurement	Peak-area absorbance
Injection volume	40 µl for Cd 20 µl for Cu, Pb and Zn

Table A- 4 The parameters used for Perkin Elmer AAnalyst 300

Parameter	Setting
Flame type	Nitrous oxide-acetylene flame for Al Air-acetylene flame for Fe, Mn and Zn
Temparature	2955°C for Al 2300°C for Fe, Mn and Zn
Lamp type	HCL
Signal measurement	Time average
Injection volume	1.0 mL/replicate
Oxidant flow rate	6.0 L/min for Al 10.0 L/min for Fe, Mn and Zn
Slit width	0.7 nm for Zn and Al 0.2 nm for Fe and Mn
Fuel flow rate	8.5 L/min for A l 3.0 L/min Fe, Mn and Zn

Table A- 5 The parameter used for Perkin Elmer Model Optima 4300 DV

Parameter	Operating conditions
RF Power	1300 watts
Plasma gas flow rate	15 L/min
Auxiliary gas flow rate	Ar 0.2 L/min
Nebulizer gas flow rate	Ar 0.8 L/min
Sample flow rate	1.5 mL/min
Peak Algorithm	Peak area
Plasma view	Axial

Table A- 6 The position of sampling site and salinity at each sampling site during sampling

Sampling Site	Location		Salinity	
	Latitude (X)	Longitude(Y)	Wet season	Dry season
N1	627468	861405	0	0.3
N2	626027	861708	0	0.2
N3	624993	860916	0	0.2
N4	626593	860651	0	0.3
N5	628619	860937	0	0.2
N6	627907	860298	0	0.3
N7	625880	860082	0	0.4
N8	624612	859402	0	0.3
N9	627072	858798	0	0.4
N10	629199	858785	0	0.6
N11	625222	858797	0	0.4
N12	629684	860410	0	0.5
N14	624750	861779	0	0.1
N15	624619	860839	0	0.1

Table A- 6(Cont.)

Sampling Site	Location		Salinity	
	Latitude (X)	Latitude (Y)	Wet season	Dry season
N13 = S0	632828	859633	0	0.6
S1	641517	860000	2	0.7
S2	636216	858818	2	0.6
S3	632060	857078	1.9	0.6
S4	644092	853908	1.9	0.7
S5	643988	850817	2	0.7
S6	640838	849045	1.8	0.7
S7	636004	850217	1.8	0.8
S8	631883	850045	2	0.8
S9	627983	849908	1.8	0.6
S10	644093	842102	2	1.9
S11	640074	842003	2	1.3
S12	636070	841992	2.9	1.1
S13	632122	841917	2.5	0.6
S14	628914	841953	1.7	0.6
S15	631186	837528	0.4	0.6
S16	639700	837848	1.9	0.6
S17	638543	833902	4.1	2.1
S18	635975	834324	2.2	2.1
S19	634983	834273	1.8	2.1
S20	635553	830066	4.2	3.4
S21	640084	830117	6	4.6

Table A- 6(Cont.)

Sampling Site	Location		salinity	
	Latitude (X)	Latitude (Y)	Wet season	Dry season
S22	636853	826073	7.6	4.8
S23	639654	825813	9.8	5.1
S24	642942	825607	6.4	4.4
S25	639964	821983	11.5	5.2
S26	644410	817827	15.8	7.8
S27	650236	836007	1.2	4.6
S28	647565	830764	1.2	6.9
S29	653951	831870	1.2	5.8
S30	653628	825760	1	12.8
S31	652875	820030	1.2	11.5
S32	655940	811811	1.2	11.8
S33	647850	812586	0.8	12
S34	651955	810098	0.8	13.4
S35	652945	806104	0.7	14.2
S36	656710	804000	0.7	15.8

Table A- 6(Cont.)

Sampling Site	Location		Salinity	
	Latitude (X)	Latitude (Y)	Wet season	Dry season
S37	658260	799890	0.9	15.2
S38	661991	800176	1	18.3
S39	665394	799910	1	18.7
S40	664081	797983	1	22.5
S41	660212	798548	0.9	17.5
S42	656078	798166	1	13.4
S43	658457	797375	1	14.6
S44	662077	795966	1	18.6
S45	666037	795968	1	27.7
S46	668540	794635	11.2	31.8
S47	675170	796030	12.6	32.5
S48	675608	793860	28.3	32.6
S49	674191	793998	6.3	32.5
S50	671241	794089	10.2	32.1
S51	664169	794222	0.4	23.5
S52	659872	794478	0.7	13.9
S53	657984	792333	0.4	10.8
S54	661902	791206	0.6	8.8
S55	666612	791966	1.1	26
S56	673183	791899	3.2	32
S57	672272	790154	1.3	31.2
S58	668392	790909	1.1	28.5
S59	664764	790076	0.9	18.3

Appendix B

Chemical reagent preparation

Preparation of stock solutions:

The standard solution of Cd, Cu, Pb, Zn, Al, Fe and Mn was prepared by diluting 1 mL of each metal stock 1000 mg/L with each of 100 mL nanopure water to its final concentration of 10 mg/L. The stock standard solution of 10 mg/L was used to prepare a working concentration for calibration curve.

Preparation of mixing reagent:

A 2 M acetate buffer (pH≈ 4.5) prepared from ammonia and acetic acid was used in the extractions.

The extraction reagent solution contained ammonium pyrrolidinedithiocarbamate (APDC) and diethylammonium diethyldithiocarbamate (DDDC). An aqueous solution containing 1% (w/v) of each reagent was prepared in a polyethylene bottle and purified with chloroform

In order to find out the volume of mixing reagent, 300 mL of real sample was added with 200 µL of mixing reagent per time until the pH of sample about 4.5-4.7.

Appendix C

Table C- 1 The pyrolysis and atomization temperature

Step	Cd		Cu		Pb		Zn	
	Temp.	Abs	Temp.	Abs	Temp.	Abs	Temp.	Abs
Pyrolysis	300	0.4400	700	0.3733	450	0.3166	400	0.4420
	400	0.4260	800	0.399	550	0.353	500	0.4731
	500	0.4279	900	0.3987	650	0.3751	600	0.4946
	600	0.2986	1000	0.3767	750	0.3834	700	0.5029
	700	0.0121	1100	0.2784	850	0.3642	800	0.4873
			1200	0.1988	950	0.3197	900	0.2849
			1300	0.1058	1050	0.017		
Atomization	1000	0.2807	1500	0.1302	1000	0.1109	1300	0.3755
	1100	0.2962	1600	0.1643	1100	0.1683	1400	0.4477
	1200	0.3205	1700	0.1854	1200	0.2283	1500	0.4782
	1300	0.3743	1800	0.2418	1300	0.2969	1600	0.4873
	1400	0.4448	1900	0.2576	1400	0.3331	1700	0.5029
	1500	0.4373	2000	0.2929	1500	0.3642	1800	0.5012
	1600	0.4299	2100	0.2971	1600	0.3636	1900	0.5202
			2200	0.2966	1700	0.3479	2000	0.5114
			2300	0.2647	1800	0.3449		

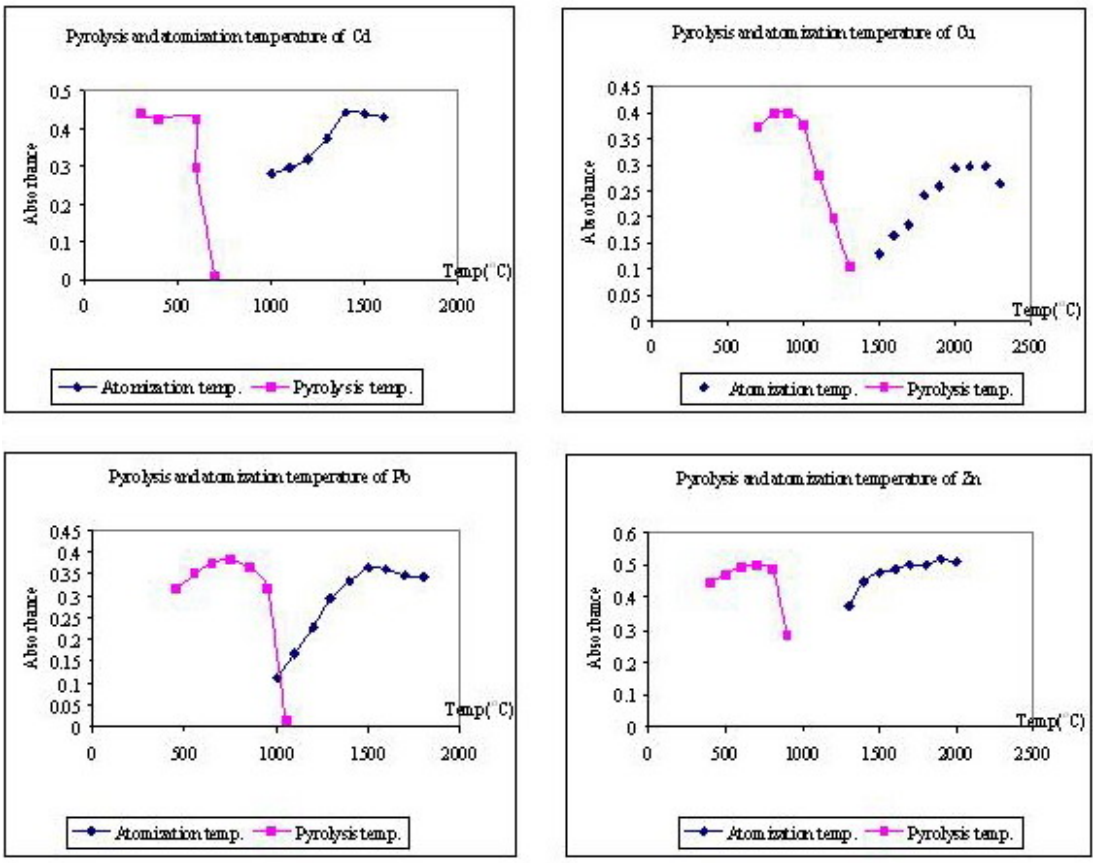

Figure C- 1 The pyrolysis and atomization curve for Cd, Cu, Pb and Zn

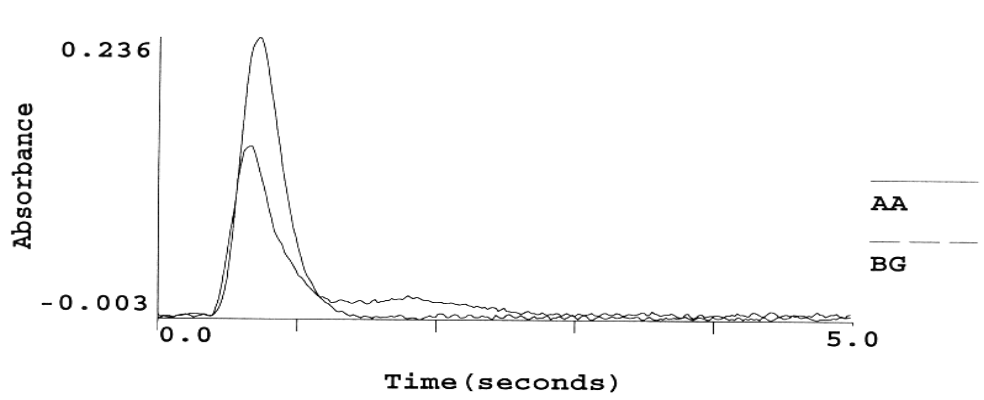

Figure C- 2(a) The absorbance of 2 ug/L of Cd at optimum pyrolysis and atomization temperature

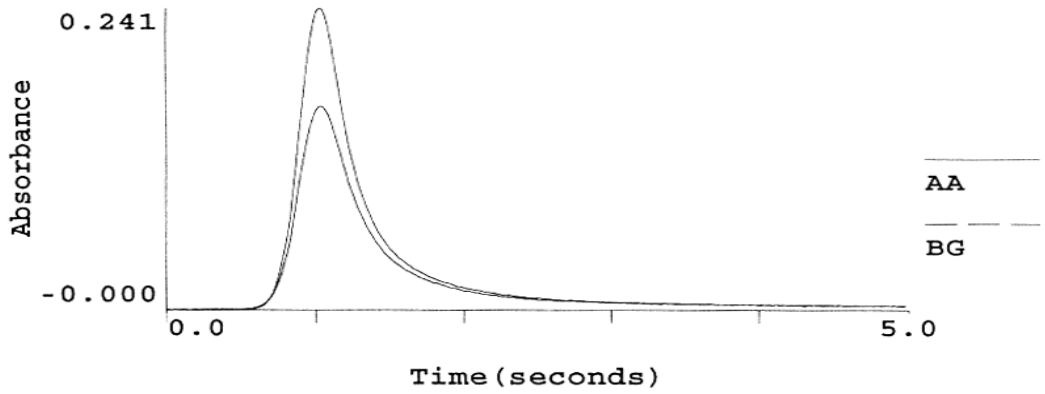

Figure C- 2 (b) The absorbance of 25 ug/L of Cu at optimum pyrolysis and atomization temperature

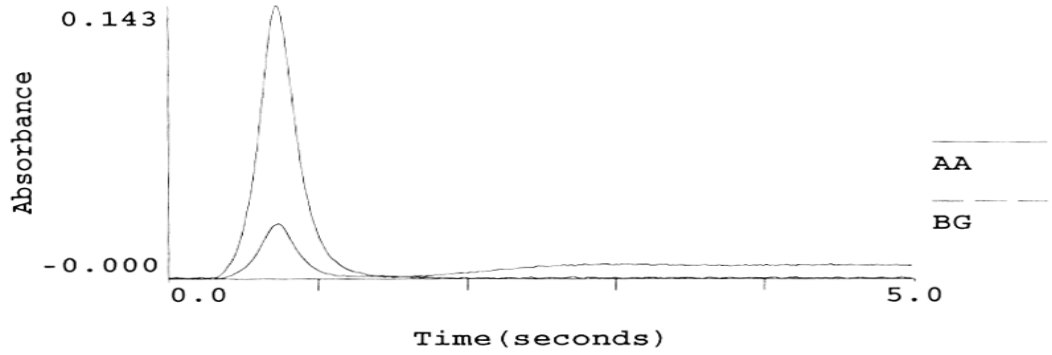

Figure C- 2(c) The absorbance of 50 ug/L of Pb at optimum pyrolysis and atomization temperature

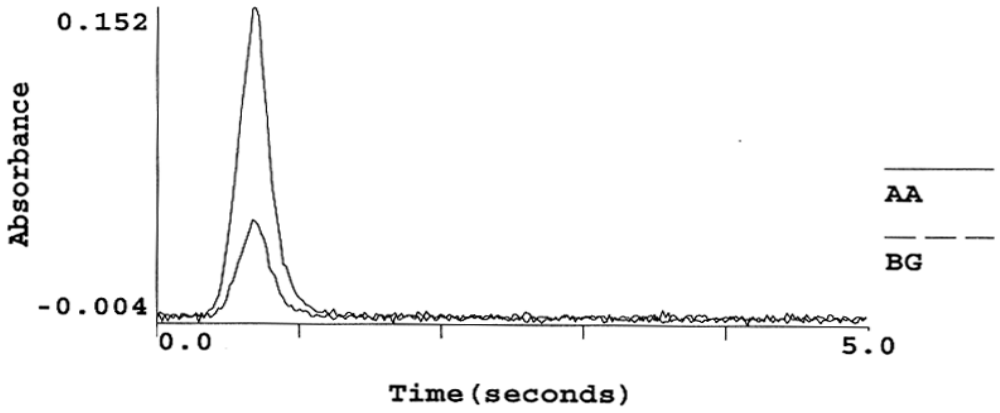

Figure C- 2 (d) The absorbance of 2 ug/L of Zn at optimum pyrolysis and atomization temperature

Table C- 2 The comparison of the absorbance of Cd, Cu, Pb and Zn with and without matrix modifier

Metal	Type of matrix modifiers	Absorbance	
		Without Modifiers	With Modifiers
Cd	0.05 mg $NH_4H_2PO_4$+0.003 mg $Mg(NO_3)_2$	0.0875	0.0977
Cu	0.003 mg $Mg(NO_3)_2$+0.005 mg Pd	0.0823	0.0825
Pb	0.05 mg $NH_4H_2PO_4$+0.003 mg $Mg(NO_3)_2$	0.1121	0.1243
Zn	0.005 mg $Mg(NO_3)$	0.1613	0.1698

Table C- 3 The absorbance of 2.0 ug/L Cd standard working solution at various matrix modifier

Matrix modifiers	Absorbance
0.05 mg $NH_4H_2PO_4$+ 0.003 mg $Mg(NO_3)_2$	0.0784
0.05 mg $NH_4H_2PO_4$	0.0825
0.003 mg $Mg(NO_3)_2$	0.0864
0.005 mg $La(NO_3)_2$	0.0875

Table C- 4 The absorbance of 50 μg/L Pb standard working solution at various types of matrix modifiers

Matrix modifiers	Absorbance
0.05 mg $NH_4H_2PO_4$+ 0.003 mg $Mg(NO_3)_2$	0.1120
0.05 mg $NH_4H_2PO_4$	0.1106
0.003 mg $Mg(NO_3)_2$	0.1098
0.005 mg $La(NO_3)_2$	0.1201

Table C- 5 The detection limit study of dissolved metal

Order	Cd (ng/L)	Cu (μg/L)	Pb (μg/L)	Zn (μg/L)	Al (μg/L)	Fe (μg/L)	Mn (μg/L)
1	0.300	0.094	0.425	0.002	13.05	-1.737	0.775
2	0.600	0.059	0.200	0.002	10.75	-1.740	0.806
3	2.100	0.035	0.225	0.003	11.58	-1.937	0.668
4	3.000	0.023	0.075	0.003	11.29	-1.799	0.714
5	1.400	0.021	0.125	0.007	6.67	-2.170	0.773
6	1.900	0.004	0.100	0.003	12.28	-1.646	0.483
7	1.400	0.018	0.100	0.003	10.73	-1.922	0.619
8	1.700	0.009	0.050	0.002	12.59	-1.779	0.722
9	2.800	0.027	0.075	0.003	10.63	-1.811	0.723
10	3.700	0.017	0.100	0.002	10.62	-1.766	0.699
Avg	1.900	0.031	0.147	0.003	11.02	-1.8307	0.698
Sd	1.000	0.026	0.106	0.001	1.672	0.1393	0.088
DL	3.100	0.077	0.319	0.004	5.017	0.4180	0.265

Table C- 6 The detection limit study of particulate metal

Order	Cd (μg/L)	Cu (μg/L)	Pb (μg/L)	Zn (μg/L)	Al (μg/L)	Fe (μg/L)	Mn (μg/L)
1	5.185	0.043	0.010	0.011	4.700	0.022	0.003
2	4.305	0.109	0.016	0.031	7.000	0.022	0.003
3	7.735	0.039	0.023	0.032	4.500	0.018	0.004
4	0.755	0.108	0.013	0.017	4.600	0.018	0.007
5	1.210	0.093	0.013	0.046	4.600	0.018	0.006
6	4.430	0.034	0.024	0.041	4.300	0.018	0.006
7	4.140	0.026	0.034	0.030	4.800	0.011	0.006
8	4.015	0.121	0.018	0.033	4.200	0.007	0.005
9	3.805	0.094	0.039	0.012	4.200	0.018	0.005
10	4.975	0.121	0.045	0.045	4.200	0.018	0.004
avg	0.081	1.577	0.473	0.598	4.710	0.017	0.005
sd	0.039	0.772	0.239	0.258	0.792	0.004	0.001
DL	0.118	2.318	0.718	0.775	2.375	0.013	0.004

Table C- 7 The %RSD study of dissolved metals

Order	Cd (µg/L)	Cu (µg/L)	Pb (µg/L)	Zn (µg/L)	Al (mg/L)	Fe (µg/L)	Mn (µg/L)
1	0.7	24.6	413.5	0.2	19.1	1.6	0.3
2	0.7	23.8	443.5	0.2	25.4	1.7	0.5
3	0.7	24.2	453.5	0.2	19.9	1.8	0.4
4	0.7	24.2	438.5	0.2	22.5	1.7	0.4
5	0.7	23.4	433.5	0.2	22.6	1.6	0.4
6	0.7	22.6	393.5	0.2	19.8	1.6	0.4
7	0.6	25.2	458.5	0.2	22.4	1.7	0.4
8	0.6	25.0	418.5	0.2	19.2	1.6	0.5
9	0.7	25.1	378.5	0.2	19.6	1.7	0.4
10	0.6	23.7	463.5	0.3	21.9	1.5	0.4
avg	0.7	24.2	429.5	0.2	21.2	1.7	0.4
sd	0.0	0.8	26.7	0.01	2.0	0.1	0.0
%RSD	6.3	3.3	6.2	4.1	9.2	4.4	10.0

Table C- 8 The %RSD study of particulate metals

Order	Cd (ng/g)	Cu (µg/g)	Pb (µg/g)	Zn (µg/g)	Al (g/Kg)	Fe (g/Kg)	Mn (g/Kg)
1	115.3	11.0	12.0	319.4	69.3	66.2	2.8
2	113.7	11.2	13.0	304.8	72.3	55.9	2.9
3	113.2	11.0	13.0	348.4	70.8	57.0	2.9
4	141.8	11.1	13.3	309.7	69.3	53.6	2.9
5	113.2	13.0	11.7	266.4	69.3	58.2	2.9
6	103.0	11.5	12.7	293.6	64.8	55.9	2.9
7	104.4	11.4	13.0	324.8	72.3	47.7	2.9
8	113.7	10.8	12.6	324.2	64.8	55.9	2.9
9	98.8	10.8	12.3	252.7	70.8	55.9	2.9
10	113.9	9.8	12.0	337.0	72.3	58.2	2.9
avg	113.1	11.2	12.6	308.1	69.3	56.5	2.9
sd	11.0	0.8	0.5	28.6	2.7	4.3	0.0
%RSD	9.7	6.8	4.1	9.3	3.8	7.7	1.2

Table C- 9 The %Recovery study of dissolved and particulate metals

Particulate Sample			Dissolved Sample		
Sample+spiked Cd	Conc.	Recovery (%)	Sample+spiked Cd	Conc.	Recovery (%)
Real sample	0.041		Real sample	0.31	
Sample+Cd 1 μg/L	1.01	97.74	Sample+Cd 1 μg/L	1.37	106.76
Sample+Cd 1 μg/L	0.99	95.76	Sample+Cd 1 μg/L	1.27	96.76
Sample+Cd 1 μg/L	0.86	82.08	Sample+Cd 1 μg/L	1.31	101.02
ave		91.86	ave		101.51
sd		6.96	sd		5.02
Cu	Conc.	Recovery	Cu	Conc.	Recovery
Real sample	13.40	(%)	Real sample	7.06	(%)
Sample+Cu 20 μg/L	35.59	110.92	Sample+Cu 20 μg/L	25.61	92.76
Sample+Cu 20 μg/L	36.37	114.81	Sample+Cu 20 μg/L	26.54	97.40
Sample+Cu 20 μg/L	35.07	108.33	Sample+Cu 20 μg/L	27.36	101.50
ave		111.36	ave	19.44	97.22
sd		2.66	sd	0.48	2.42
Pb	Conc.	Recovery	Pb	Conc.	Recovery
Real sample	4.04	(%)	Real sample	5.87	(%)
Sample+Pb 20 μg/L	44.04	100	Sample+Pb 20 μg/L	26.81	104.72
Sample+Pb 20 μg/L	40.22	90.45	Sample+Pb 20 μg/L	27.70	109.17
Sample+Pb 20 μg/L	41.00	92.4	Sample+Pb 20 μg/L	24.37	92.5
ave		94.28	ave		102.13
sd		4.12	sd		8.63
Zn	Conc.	Recovery	Zn	Conc.	Recovery
Real sample	0.75	(%)	Real sample	0.23	(%)
Sample+Zn 1 mg/L	1.68	93.21	Sample+Zn 1 mg/L	1.18	94.56
Sample+Zn 1 mg/L	1.80	105.13	Sample+Zn 1 mg/L	1.21	97.77
Sample+Zn 1 mg/L	1.55	80.38	Sample+Zn 1 mg/L	1.30	107.17
ave		92.91	ave		99.83
sd		10.10	sd		5.35
Al	Conc.	Recovery	Al	Conc.	Recovery
Real sample	94.87	(%)	Real sample	22.07	(%)
Sample+Al 50 μg/L	209.53	114.66	Sample+Al 50 μg/L	69.51	94.88
Sample+Al 100 μg/L	193.53	98.66	Sample+Al 100 μg/L	125.23	103.16
Sample+Al 200 μg/L	224.20	129.33	Sample+Al 200 μg/L	221.14	99.53
ave		114.22	ave	ave	99.19
sd		12.52	sd	sd	3.39
Fe	Conc.	Recovery	Fe	Conc.	Recovery
Real sample	0.72	(%)	Real sample	301.76	(%)
Sample+Fe 50 μg/L	1.75	102.63	Sample+Fe 50 μg/L	348.11	92.70
Sample+Fe 100 μg/L	1.88	116.28	Sample+Fe 100 μg/L	403.00	101.24
Sample+Fe 200 μg/L	1.66	93.53	Sample+Fe 200 μg/L	502.06	100.15
ave		104.15	ave		99.83
sd		9.35	sd		5.35

Table C- 9(Cont.)

Particulate Sample			Dissolved Sample		
Mn	Conc.	Recovery	Mn	Conc.	Recovery
Real sample	0.46	(%)	Real sample	188.50	(%)
Sample+Mn 20 µg/L	1.43	97.31	Sample+Mn 20 µg/L	206.74	91.19
Sample+Mn 40 µg/L	1.45	99.44	Sample+Mn 40 µg/L	231.80	108.26
Sample+Mn 60 µg/L	1.66	120.24	Sample+Mn 60 µg/L	246.89	97.32
ave		105.66	ave		98.92
sd		10.34	sd		7.06

Table C- 10 The dissolved metal concentrations in wet and dry season in Thale Noi

	Wet Season							Dry season						
Station	Cd ng/l	Cu ng/l	Pb ng/l	Zn ug/l	Al ug/l	Fe ug/l	Mn ug/l	Cd ng/l	Cu ng/l	Pb ug/l	Zn ug/l	Al ug/l	Fe ug/l	Mn ug/l
N1	34.8	813.1	6.2	26.5	41.2	293.6	163.4	14.7	140.1	7.4	98.3	4.2	162.6	7.6
N2	27.8	1127.9	6.2	7.4	75.9	90.4	13.3	3.3	72.8	3.9	66.6	1.8	410.8	11.1
N3	12.3	369.9	3.4	4.8	37.6	54.8	17.5	1.1	213.6	2.5	84.8	nd	113.4	157.6
N4	122.7	1034.0	5.9	61.1	19.7	26.5	20.2	23.3	531.7	26.2	59.0	7.1	77.6	15.8
N5	44.3	433.6	12.4	7.7	411.0	270.7	675.9	nd	102.4	2.3	nd	5.3	218.8	8.3
N6	23.0	657.9	3.9	42.2	79.9	165.0	81.8	nd	56.1	2.5	54.9	12.8	102.9	8.5
N7	5.4	954.5	2.2	4.3	104.5	85.8	33.3	nd	73.5	5.3	78.7	2.1	21.5	1.2
N8	53.6	577.5	6.5	6.0	156.0	187.0	34.5	nd	11.7	1.7	10.9	2.0	171.8	471.5
N9	11.8	275.8	2.8	6.4	357.3	282.8	2.1	1.2	34.7	1.5	8.7	14.6	40.1	2.4
N10	9.8	946.3	2.3	29.9	72.4	170.3	70.1	6.1	38.8	3.0	25.1	16.0	11.2	114.2
N11	331.2	730.3	4.7	6.8	86.8	198.4	80.6	nd	10.8	1.8	10.8	3.0	76.6	376.3
N12	60.8	252.6	14.7	18.8	781.4	377.2	990.4	nd	52.4	1.2	2.3	1.6	63.7	170.8
N14	11.0	228.4	1.4	7.8	38.9	35.5	67.2	nd	67.5	2.7	18.6	75.0	129.9	82.5
N15	24.2	571.6	3.6	7.6	75.0	47.8	45.9	3.0	19.9	2.3	nd	29.4	261.4	58.5

Table C- 11 The dissolved metal concentrations in wet and dry season in Inner Lake

	Wet Season							Dry season						
	Cd ng/l	Cu ng/l	Pb ng/l	Zn ug/l	Al ug/l	Fe ug/l	Mn ug/l	Cd ng/l	Cu ng/l	Pb ug/l	Zn ug/l	Al ug/l	Fe ug/l	Mn ug/l
N13	52.5	nd	7.9	28.3	798.2	335.7	1374.7	2.5	56.2	2.0	26.8	14.5	15.2	339.9
S1	135.3	2770.8	2.9	14.7	58.9	72.2	144.7	0.0	240.6	0.9	4.1	9.6	3.7	71.9
S2	130.2	6.2	0.3	6.1	12.8	3.1	1051.1	1.4	138.1	3.2	1.6	1.1	1.4	30.3
S3	16.9	364.4	2.0	9.7	27.9	18.5	1244.0	27.9	214.5	4.1	57.1	11.7	5.6	80.8
S4	60.4	558.7	1.4	15.9	10.2	3.1	1.3	4.3	121.2	2.2	23.5	15.9	4.2	1.1
S5	33.5	554.4	0.8	8.0	76.2	41.7	9.8	22.2	490.7	3.3	4.5	16.2	4.1	12.1
S6	30.7	322.2	1.4	40.5	18.5	9.8	13.4	1.2	61.8	1.0	11.9	5.3	2.2	0.6
S7	24.0	461.2	2.1	8.9	21.3	5.1	44.6	nd	431.3	0.8	0.9	0.5	0.7	1.0
S8	23.6	285.2	0.4	0.7	6.4	3.3	231.2	11.5	769.9	3.3	73.7	8.6	3.8	4.3
S9	39.8	670.5	1.9	1.9	36.5	6.1	328.3	nd	171.2	1.1	49.8	14.1	8.0	9.5
S10	56.7	319.5	0.6	33.0	21.0	8.7	2.2	21.7	326.5	3.9	52.6	1.9	0.9	715.6
S11	7222.3	781.3	6.0	19.3	1.8	5.8	3.4	nd	68.4	0.6	1.3	3.6	1.1	195.2
S12	nd	nd	nd	21.2	4.9	11.4	4.2	5.2	117.5	3.1	52.3	10.1	5.3	445.2
S13	51.4	428.7	0.2	14.5	7.9	69.0	10.6	nd	734.8	1.7	4.5	9.3	3.9	86.9
S14	237.2	2125.7	6.8	21.1	1.7	5.3	142.1	3.7	307.9	2.6	54.7	20.5	7.4	10.9
S15	15.0	556.3	1.7	15.9	80.3	8.2	0.7	29.3	355.1	5.7	11.2	35.8	15.2	23.6
S16	32.6	523.3	1.7	2.1	11.6	11.4	0.5	1.1	421.9	1.8	19.1	7.6	1.8	3.0
S17	27.4	nd	0.2	10.3	18.2	1.0	18.0	21.5	254.3	2.4	9.2	0.3	1.5	435.3
S18	13.1	626.4	0.7	8.1	1.2	5.3	2.2	21.6	436.1	1.4	10.6	115.4	19.8	203.2
S19	8.4	291.9	0.7	9.4	5.0	6.7	9.7	20.5	149.4	5.5	13.0	51.6	0.2	185.6
S20	17.9	437.1	0.2	nd	1.1	8.3	0.7	21.0	105.9	1.8	13.4	9.3	3.3	206.1
S21	4.0	207.4	1.5	10.2	7.9	16.2	0.4	33.3	574.1	20.6	7.7	6.3	2.9	592.3

Table C- 12 The dissolved metal concentrations in wet and dry season in Middle Lake

	Wet Season							Dry season						
	Cd ng/l	Cu ng/l	Pb ng/l	Zn ug/l	Al ug/l	Fe ug/l	Mn ug/l	Cd ng/l	Cu ng/l	Pb ug/l	Zn ug/l	Al ug/l	Fe ug/l	Mn ug/l
S 22	10.0	683.0	1.2	10.1	7.6	33.7	0.6	0.0	254.7	2.3	11.4	5.8	2.2	73.4
S 23	9.7	343.2	0.5	10.4	6.9	11.4	1.1	24.4	392.5	4.8	12.3	15.6	9.3	182.7
S 24	12.9	469.4	0.2	10.5	5.6	2.1	63.0	25.8	285.8	nd	62.9	14.2	3.4	111.4
S 25	137.7	710.2	0.6	14.0	10.2	2.7	5.6	5.3	277.2	1.8	20.5	1.6	6.7	213.0
S 26	14.0	949.0	0.5	14.8	15.9	9.6	1.3	2.9	141.8	3.0	29.1	1.1	46.1	91.3
S 27	2.1	251.9	1.0	16.7	12.4	2.8	1.2	13.1	249.4	2.3	16.4	4.4	8.2	2.8
S 28	23.3	567.7	3.1	0.9	56.1	23.8	8.0	14.6	156.4	1.9	87.8	14.2	2.6	0.7
S 29	0.6	297.0	1.0	0.0	6.2	1.8	2.4	318.4	954.6	69.1	146.0	45.2	85.7	79.1
S 30	24.7	647.9	7.1	5.8	35.8	19.5	7.4	10.3	268.5	0.4	19.9	11.9	33.9	57.7
S 31	0.0	356.5	1.3	0.0	9.1	1.4	21.9	16.6	135.4	1.2	42.9	5.8	26.1	74.2
S 32	1633.6	1979.5	24.5	63.5	21.8	8.8	2.9	7.3	58.4	nd	16.9	5.4	13.6	0.3
S 33	12.3	651.2	5.0	23.1	277.1	107.4	18.6	8.3	197.5	1.0	23.6	8.1	43.8	6.8
S 34	16.5	459.9	3.1	47.9	53.0	21.0	2.5	nd	135.4	0.3	12.8	9.2	47.5	0.1
S 35	32.9	522.0	2.4	18.2	62.3	24.8	4.7	5.3	99.7	0.9	11.4	8.5	34.6	0.6
S 36	14.3	543.5	2.4	8.3	64.8	27.7	2.0	4.5	63.5	0.4	4.0	7.2	0.6	71.6

Table C- 13 The dissolved metal concentrations in wet and dry season in Outer Lake

	Wet Season							Dry season						
	Cd ng/l	Cu ng/l	Pb ng/l	Zn ug/l	Al ug/l	Fe ug/l	Mn ug/l	Cd ng/l	Cu ng/l	Pb ug/l	Zn ug/l	Al ug/l	Fe ug/l	Mn ug/l
S 37	2.8	588.5	1.5	4.3	190.9	74.5	12.2	2.2	1488.3	0.7	25.2	20.5	2.9	99.2
S 38	4.0	538.8	10.4	1.5	445.7	341.4	15.9	8.0	229.4	1.8	25.6	38.0	7.8	22.4
S 39	7.2	324.3	5.9	12.3	316.0	213.0	9.3	12.9	225.5	0.2	15.8	15.8	0.2	11.2
S 40	83.4	693.9	9.1	43.7	143.5	752.8	4.1	39.5	1104.1	16.0	64.5	34.9	9.6	5.8
S 41	47.8	497.6	3.1	26.4	38.2	9.4	0.1	7.4	135.5	0.6	6.0	232.7	13.6	52.8
S 42	70.0	601.7	3.6	0.6	15.7	49.4	0.6	0.0	185.4	0.2	28.6	0.0	1.7	93.8
S 43	32.1	500.9	3.0	22.3	35.2	6.5	0.1	13.2	243.6	0.5	15.9	11.6	2.9	25.3
S 44	75.8	1036.3	4.7	26.8	119.0	38.0	0.7	20.2	1139.0	3.1	25.1	23.4	5.5	5.5
S 45	270.0	1301.9	8.3	34.8	156.7	53.2	1.5	15.6	317.0	2.2	18.3	1103.3	445.8	4.7
S 46	19.1	1067.8	0.7	24.5	31.0	1.8	0.1	11.5	185.3	1.0	37.3	6.6	0.7	1.2
S 47	12.0	3017.7	1.4	22.9	48.7	15.0	0.7	11.2	152.0	nd	7.5	62.9	6.2	3.1
S 48	26.7	739.3	0.5	16.8	27.9	13.6	4.5	9.3	131.8	nd	28.6	10.0	2.0	1.1
S 49	2.6	720.4	0.3	21.5	12.6	5.9	0.4	11.0	200.7	1.0	46.5	13.2	27.9	1.5
S 50	5.2	802.4	1.8	14.9	0.3	8.2	0.1	14.1	254.1	0.1	25.6	3.7	2.6	2.7
S 51	109.0	2589.6	16.8	15.5	48.0	22.3	0.2	23.1	880.7	4.9	13.3	653.5	245.8	3.4
S 52	32.2	1884.8	6.6	27.5	20.1	4.4	0.2	2.2	151.2	1.1	9.0	13.5	0.9	0.7
S 53	6.0	1624.9	3.3	21.0	63.6	39.5	0.4	1.6	193.9	0.2	29.4	41.8	4.6	8.6
S 54	3.9	877.4	4.1	18.2	37.7	29.7	0.3	0.0	184.4	0.4	10.2	11.5	5.2	118.5
S 55	3.0	192.6	1.5	16.5	29.8	9.9	0.1	12.1	93.8	0.1	18.2	13.4	5.9	1.7
S 56	0.7	291.0	1.3	15.5	2.6	1.6	0.1	13.7	121.5	1.3	11.0	1.6	1.4	1.1
S 57	9.0	1394.5	4.2	21.0	17.9	6.1	0.3	nd	95.8	nd	10.5	25.2	4.5	2.3
S 58	19.9	844.2	13.4	20.9	18.1	5.4	0.2	nd	172.3	4.2	12.5	259.6	138.2	5.7
S 59	60.9	1107.9	5.2	16.2	17.6	7.9	nd	2.7	187.9	0.6	3.6	13.1	3.6	22.9

Table C- 14 The particulate metal concentrations in wet and dry season in Thale noi

	Wet Season							Dry season						
Station	Cd ug/l	Cu ug/l	Pb ug/l	Zn ug/l	Al mg/l	Fe mg/l	Mn mg/l	Cd ug/l	Cu ug/l	Pb ug/l	Zn ug/l	Al mg/l	Fe mg/l	Mn mg/l
N1	0.3	27.1	21.6	29.5	42.2	297.3	1.3	nd	0.2	1.6	9.1	0.0	8.0	nd
N2	0.1	21.4	44.2	26.7	100.0	172.6	0.2	nd	2.7	1.7	9.0	0.0	17.2	0.3
N3	0.1	10.4	14.2	7.9	20.0	118.1	1.3	0.0	7.2	25.2	20.9	0.0	88.7	0.4
N4	0.1	7.3	15.7	22.4	20.0	73.9	0.4	nd	0.4	17.7	4.0	6.2	2.9	0.0
N5	0.1	0.9	5.1	5.3	nd	24.5	nd	0.1	1.1	3.9	8.3	135.3	12.5	0.0
N6	0.2	24.0	31.9	44.8	108.9	185.6	1.3	nd	1.0	15.0	5.0	nd	3.5	0.2
N7	0.2	36.6	26.0	600.4	91.1	76.5	1.8	0.1	2.7	3.8	7.1	5.7	1.1	0.3
N8	0.1	2.6	5.2	5.9	nd	14.2	3.8	0.1	1.2	21.4	8.4	5.9	16.2	1.5
N9	0.1	0.6	7.3	9.6	6.7	32.3	3.9	0.2	2.4	16.8	7.1	12.3	5.7	3.4
N10	0.2	22.7	16.6	20.5	55.6	94.7	1.1	nd	2.7	6.2	13.5	58.8	14.1	0.0
N11	0.1	3.3	4.7	3.3	70.0	15.1	2.3	nd	9.2	12.5	25.9	178.9	45.9	0.1
N12	0.1	nd	4.1	3.3	nd	6.5	nd	nd	2.6	27.9	8.8	6.7	37.5	nd
N14	0.1	6.6	13.8	14.3	nd	53.1	1.1	0.1	8.8	8.8	29.0	33.3	108.8	0.8
N15	0.2	38.5	67.4	39.0	46.7	118.1	3.1	0.1	66.1	38.6	12.1	68.8	61.4	1.2

Table C- 15 The particulate metal concentrations in wet and dry season in Inner Lake

	Wet Season							Dry season						
	Cd ug/l	Cu ug/l	Pb ug/l	Zn ug/l	Al mg/l	Fe mg/l	Mn mg/l	Cd ug/l	Cu ug/l	Pb ug/l	Zn ug/l	Al mg/l	Fe mg/l	Mn mg/l
N13	0.1	nd	6.0	11.0	nd	27.1	nd	0.1	0.9	22.0	3.3	0.0	3.7	0.6
S1	0.5	99.0	7.6	71.3	50.0	24.4	5.3	nd	8.9	25.5	19.0	4.0	24.5	2.2
S2	0.6	49.0	9.3	66.3	40.0	17.4	6.8	0.2	27.9	72.8	100.6	10.7	61.8	3.6
S3	0.8	75.3	15.7	121.6	100.0	96.1	7.4	nd	42.6	22.5	38.5	137.3	18.1	0.5
S4	0.4	47.2	19.8	108.7	20.0	95.3	8.3	0.2	61.7	45.5	75.6	317.3	45.1	4.8
S5	0.2	29.9	11.6	47.6	5.7	48.3	4.5	0.1	33.1	28.2	51.3	104.0	26.2	5.8
S6	0.2	48.3	8.8	31.4	24.6	30.4	4.5	0.1	10.6	17.7	30.9	210.7	16.4	2.9
S7	0.3	8.9	2.6	0.1	66.7	14.2	2.4	0.1	68.0	14.1	44.4	124.0	10.0	4.4
S8	0.5	40.6	7.3	61.6	60.0	17.3	6.0	0.3	68.0	32.8	63.6	70.7	36.5	3.2
S9	0.3	19.2	6.0	41.2	33.3	29.0	3.4	nd	12.6	12.6	31.8	50.7	15.7	0.2
S10	0.4	332.7	9.5	180.8	60.0	29.0	2.1	nd	10.6	11.2	11.8	124.0	6.9	1.6
S11	0.3	341.7	16.2	467.2	93.3	0.2	2.5	0.5	13.4	11.7	5.4	57.3	11.8	4.4
S12	0.3	90.7	12.2	49.5	60.0	32.9	2.8	0.1	14.9	12.0	3.4	30.7	6.6	1.1
S13	0.3	18.2	5.6	16.4	13.3	13.4	3.1	0.1	18.9	25.0	8.7	57.3	26.0	4.8
S14	0.3	67.5	32.1	35.5	26.7	68.0	5.8	0.1	37.5	20.6	4.1	37.3	15.9	0.0
S15	0.4	33.5	34.7	54.2	13.3	87.5	2.3	nd	4.2	8.6	9.2	104.3	4.7	-0.2
S16	0.5	82.8	21.9	28.3	233.3	40.7	2.5	0.2	35.9	38.7	57.4	84.0	37.3	4.7
S17	0.3	70.7	12.9	217.3	100.0	87.5	3.0	0.1	18.1	23.4	37.0	2.7	18.1	1.6
S18	0.3	18.8	nd	97.9	93.3	64.1	2.2	0.3	21.8	31.5	48.9	122.7	17.6	2.5
S19	0.2	8.1	2.2	256.6	40.0	68.0	3.0	0.2	13.7	54.1	52.1	156.0	18.4	2.2
S20	0.4	5.9	0.4	157.8	1006.7	64.1	3.6	0.2	8.6	41.5	80.2	149.3	9.8	0.5
S21	0.3	22.7	22.1	704.6	153.3	110.8	5.5	0.0	22.6	54.6	118.4	916.0	9.6	0.6

Table C- 16 The particulate metal concentrations in wet and dry season in Middle Lake

	Wet Season							Dry season						
	Cd ug/l	Cu ug/l	Pb ug/l	Zn ug/l	Al mg/l	Fe mg/l	Mn mg/l	Cd ug/l	Cu ug/l	Pb ug/l	Zn ug/l	Al mg/l	Fe mg/l	Mn mg/l
S 22	0.3	15.2	13.5	336.4	16.0	86.3	9.3	0.1	7.5	61.5	25.9	76.0	15.2	1.0
S 23	0.2	14.3	4.3	294.3	33.3	75.8	8.7	nd	9.8	56.5	28.2	56.0	12.7	1.8
S 24	0.2	26.2	9.8	413.3	266.7	92.9	3.1	0.0	3.4	52.3	23.6	122.7	11.3	1.6
S 25	0.3	9.4	8.7	250.9	260.0	75.8	0.5	0.1	6.0	27.1	14.7	69.3	10.8	0.3
S 26	0.2	6.5	0.8	126.5	42.4	45.2	0.3	nd	20.7	25.8	23.4	69.3	10.5	1.4
S 27	0.3	1537.6	60.3	341.0	2.9	201.9	0.9	nd	3.4	23.7	13.6	69.3	10.3	0.5
S 28	0.2	110.6	44.3	325.1	282.9	158.5	3.4	0.3	nd	23.9	27.2	62.7	11.0	1.9
S 29	0.2	1853.0	35.7	284.9	212.5	147.4	1.6	0.0	11.5	35.2	36.1	62.7	15.0	2.8
S 30	0.3	235.5	62.7	329.9	385.7	195.2	1.9	0.0	34.2	31.4	21.7	89.3	13.0	1.3
S 31	0.1	51.8	22.4	189.4	50.7	101.1	1.6	nd	6.4	35.5	20.7	102.7	14.0	3.6
S 32	0.2	17.1	35.3	305.3	56.0	138.5	2.5	nd	25.4	61.2	40.7	96.0	21.1	5.2
S 33	0.2	17.3	27.8	78.2	211.4	8.3	2.5	nd	3.4	17.6	11.3	89.3	8.3	3.8
S 34	0.1	21.3	14.9	45.2	102.2	4.9	1.8	nd	6.3	9.3	8.5	122.7	5.4	3.4
S 35	0.1	74.4	9.4	27.4	150.0	4.2	1.3	0.1	4.5	12.0	12.2	56.0	5.4	2.5
S 36	0.2	206.0	21.8	70.2	565.0	67.5	2.2	0.1	3.7	26.4	16.8	42.7	10.3	2.9

Table C- 17 The particulate metal concentrations in wet and dry season in Outer Lake

	Wet Season							Dry season						
	Cd ug/l	Cu ug/l	Pb ug/l	Zn ug/l	Al mg/l	Fe mg/l	Mn mg/l	Cd ug/l	Cu ug/l	Pb ug/l	Zn ug/l	Al mg/l	Fe mg/l	Mn mg/l
S 37	0.6	357.1	169.5	273.4	217.8	271.3	5.0	0.7	7.7	14.8	46.1	20.0	7.8	0.8
S 38	0.3	192.3	98.6	183.1	417.8	104.7	4.0	0.4	35.1	32.0	41.3	46.7	19.9	6.4
S 39	0.2	97.5	64.5	220.6	595.0	153.3	2.8	0.6	10.8	23.4	26.9	46.7	14.2	4.3
S 40	0.3	86.1	80.4	255.9	450.0	186.9	2.5	0.2	4.8	28.3	7.3	33.3	6.4	1.3
S 41	0.4	86.6	103.4	270.0	502.2	203.8	3.2	0.0	6.0	21.6	28.9	40.0	7.1	1.9
S 42	0.4	66.9	96.8	266.2	565.0	205.9	3.0	nd	2.2	50.8	4.8	46.7	6.6	0.3
S 43	0.3	31.3	79.7	163.8	590.0	140.5	2.8	nd	2.9	15.0	51.0	46.7	4.9	1.1
S 44	0.3	112.9	31.2	1662.6	255.0	173.7	1.9	0.1	4.6	39.2	10.1	53.3	6.1	3.0
S 45	0.3	34.4	81.3	265.0	204.4	198.6	2.2	0.0	5.2	44.8	10.2	80.0	13.5	0.6
S 46	0.2	140.8	39.4	109.0	190.0	65.6	1.3	0.6	26.3	65.8	136.4	253.3	55.4	1.7
S 47	0.2	117.1	18.4	253.5	265.0	50.5	1.1	0.1	9.7	54.4	28.6	106.7	18.9	1.0
S 48	0.3	129.7	23.8	145.3	266.7	72.5	1.5	0.2	13.0	66.0	36.1	80.0	7.6	0.3
S 49	0.3	22.2	26.8	89.9	1160.0	68.5	1.3	0.1	9.7	66.2	32.7	106.7	19.9	0.5
S 50	0.1	107.4	12.2	533.5	173.3	76.5	0.3	0.3	27.7	58.1	50.5	860.0	40.4	0.9
S 51	0.8	125.7	290.7	349.7	705.0	461.5	4.1	0.0	4.6	20.2	2.3	160.0	8.8	1.8
S 52	0.2	27.0	62.4	226.1	93.3	159.6	1.3	nd	4.7	22.9	2.0	66.7	9.8	1.5
S 53	0.6	38.7	156.2	335.4	390.0	319.8	3.2	nd	10.0	38.6	28.7	80.0	18.6	1.9
S 54	1.0	531.7	16.6	365.9	11.4	562.5	0.4	0.2	6.3	22.5	24.9	106.7	15.9	1.5
S 55	0.3	52.0	96.3	261.2	400.0	175.1	2.7	0.2	8.8	29.3	28.3	93.3	23.8	0.5
S 56	0.2	56.5	48.9	148.5	375.0	59.3	1.9	0.3	17.4	85.5	38.5	113.3	32.8	1.1
S 57	0.2	27.8	35.1	117.9	285.0	70.5	1.3	0.2	25.4	45.8	50.6	186.7	49.8	1.6
S 58	0.4	279.3	59.8	209.6	365.7	6.9	2.1	0.0	8.8	27.9	34.7	280.0	30.9	0.7
S 59	0.6	57.5	78.9	414.6	105.0	382.9	2.4	nd	9.4	46.0	485.7	126.7	23.0	1.4

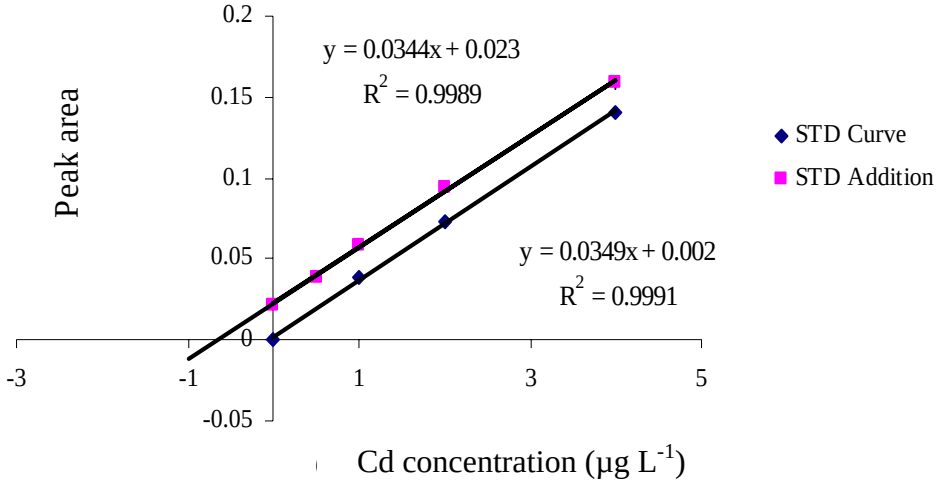

Figure C- 3(a) Comparison between calibration curve and standard addition curve of Cd

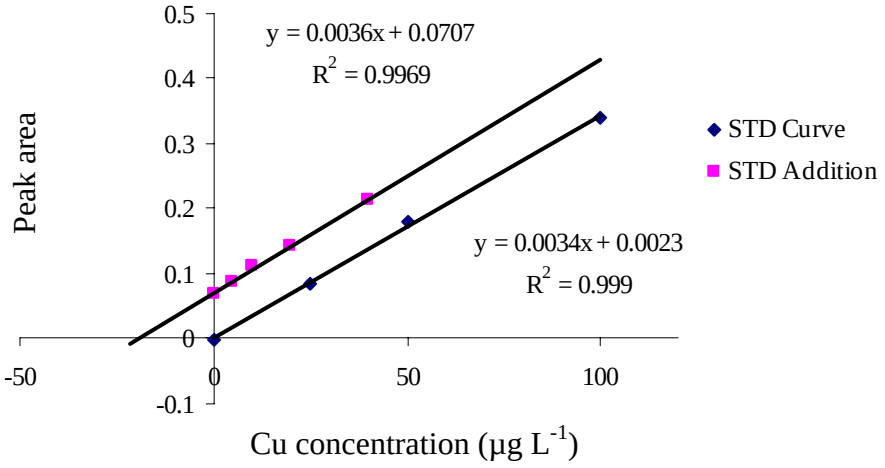

Figure C-3(b) Comparison between calibration curve and standard addition curve of Cu.

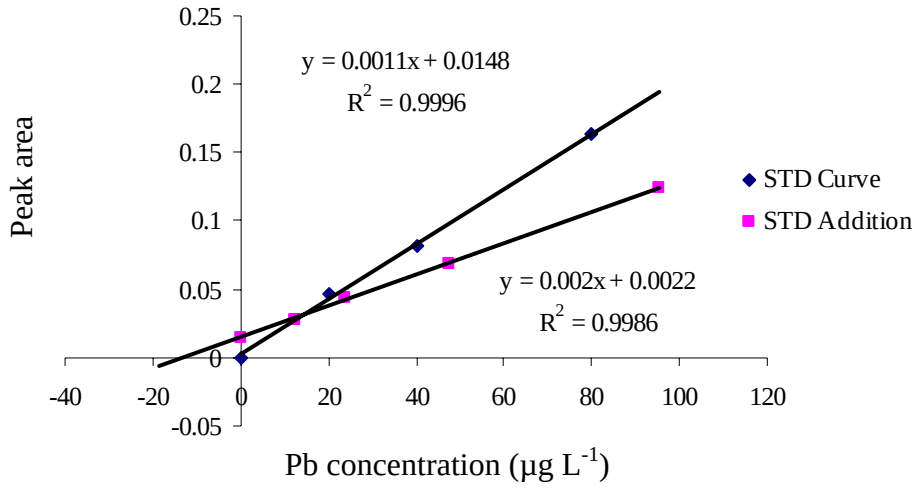

Figure C-3(c) Comparison between calibration curve and standard addition curve of Pb

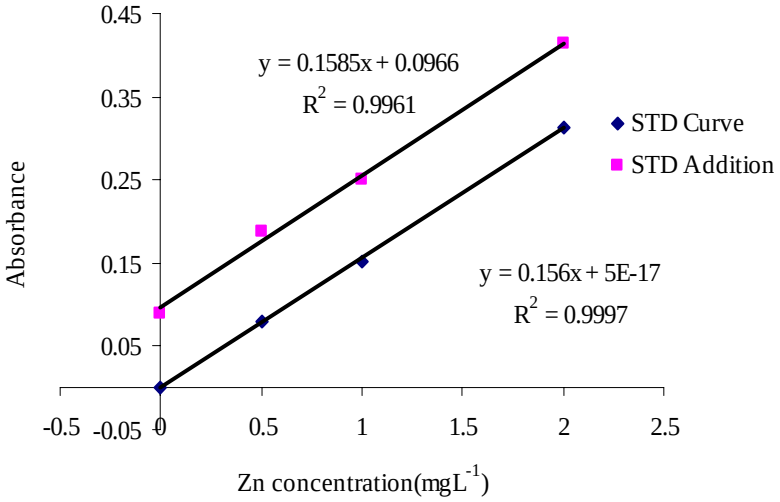

Figure C-3(d) Comparison between calibration curve and standard addition curve of Zn

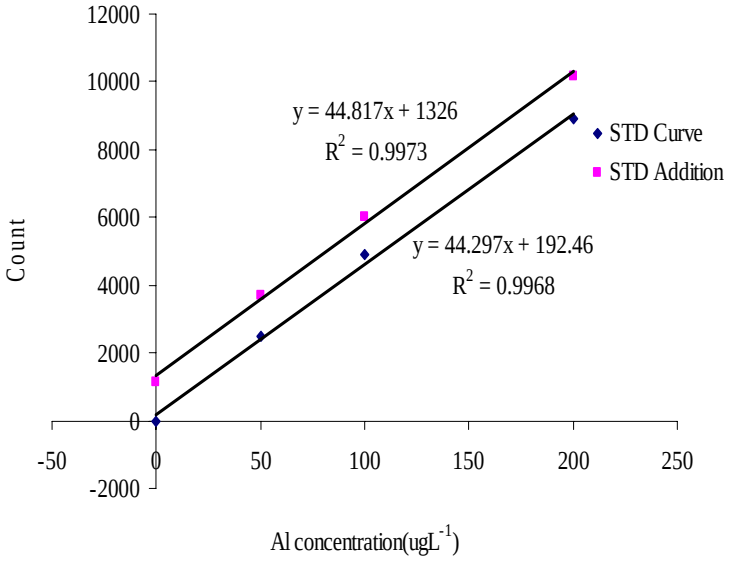

Figure C- 3(e) Comparison between calibration curve and standard addition curve of Al

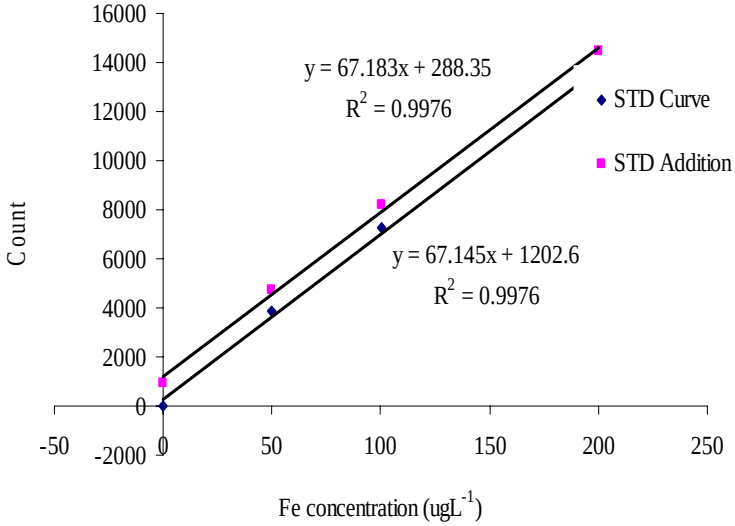

Figure C-3(f) Comparison between calibration curve and standard addition curve of Fe.

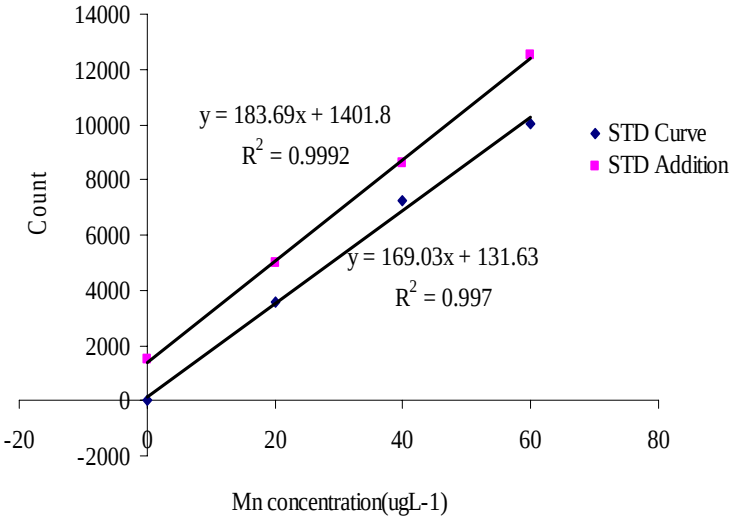

Figure C-3(g) Comparison between calibration curve and standard addition curve of Mn.