Appendix 3.1: Standard Method Employed for the Analysis

Parameters	**Method of analysis**
BOD_5	APHA 5210 B
COD	APHA 5220 B
TOC	APHA 5310 B
TS	APHA 2540 A
TSS	APHA 2540 D
TDS	APHA 2540 C
Ammoniacal-N	APHA 4500-NH3 B
Phosphate	APHA 4500-P F
Fluoride	APHA 4500-F-D
Sulfate	APHA 4500-SO42- E
pH	APHA 4500-H+B
Conductivity	APHA 2510 B
Chloride	APHA 4500-Cl- B
Metals	APHA 3120 B
Turbidity	APHA 2130
Colour	APHA 2120 E
Salinity	APHA 2520 B
Hardness	APHA 2340 C

Appendix 3.2: Calculations to derive the calorific value

Gross calorific value (H_0) of samples was determined using the following equation:

$$H_0 = \frac{C.\ \Delta T - Q}{m} \quad \text{(kJ)}$$

Where:

m = mass value of the sample,

C = constant

ΔT = the change in temperature, and

$$Q = 337C + 1442\ (H - O/8) + 93S \quad \text{(kJ/kg)}$$

Where C = mass percent of carbon

H = mass percent of hydrogen

O = mass percent of oxygen

S = mass percent of sulphur

Q is given in kilojoules per kilogram while H_0 is in kilojoules.

Appendix 3.3: Detailed percentage of waste composition in urban landfill (Kundang)

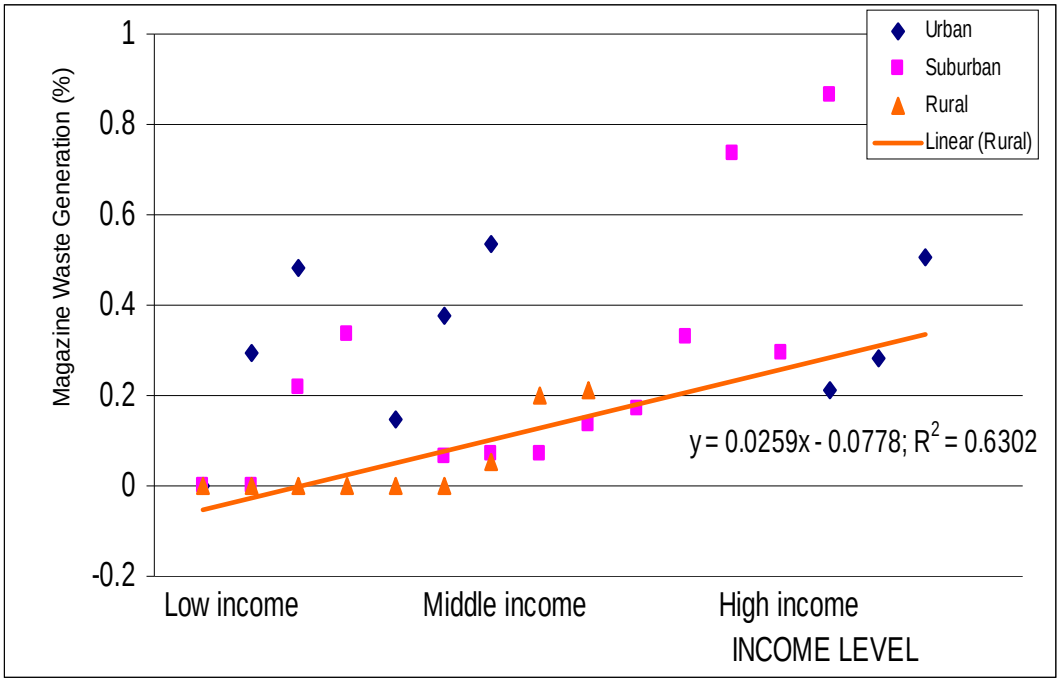
Waste types	Domestic	Commercial and institutions	Industries	Average
Food waste	46.7	65.4	31.1	47.7
Food (not-consumed)	3.75	2.69	6.22	4.22
Mixed paper	3.78	4.69	22.7	10.4
Newsprint	2.91	0.22	1.07	1.4
White paper	0.55	0	0.26	0.27
Corrugated paper	1.73	2.06	2.19	2
Plastic (rigid)	3.22	1.45	3.66	2.78
Plastic (film)	5.28	4.81	3.58	4.55
Plastic (polystyrene)	1.19	5.04	1.85	2.69
Disposable diapers	9.66	1.11	0	3.59
Textile	2.56	5.18	16.3	8.02
Rubber/ leather	0.71	0.1	1.73	0.85
Wood	0.72	2.27	0	1
Garden waste	10.1	3.7	0	4.6
Glass (clear)	1.35	0.55	0	0.63
Glass (Coloured)	0.55	0.51	0	0.35
Metal	0.53	0.01	0	0.18
Tin	1.86	0.04	8.07	3.33
Aluminium can	0.06	0.04	0.21	0.1
Other aluminium	0.05	0.02	0	0.02
Hazardous waste	1.2	0.06	0	0.42
Other organic	0.21	0	0	0.07
Other non-organic	0.97	0	0	0.32
Bulky waste	0.39	0	1.04	0.47
Total	100	100	100	100

Appendix 3.4: Detailed percentage of waste composition in sub-urban landfill (Sungai Sedu)

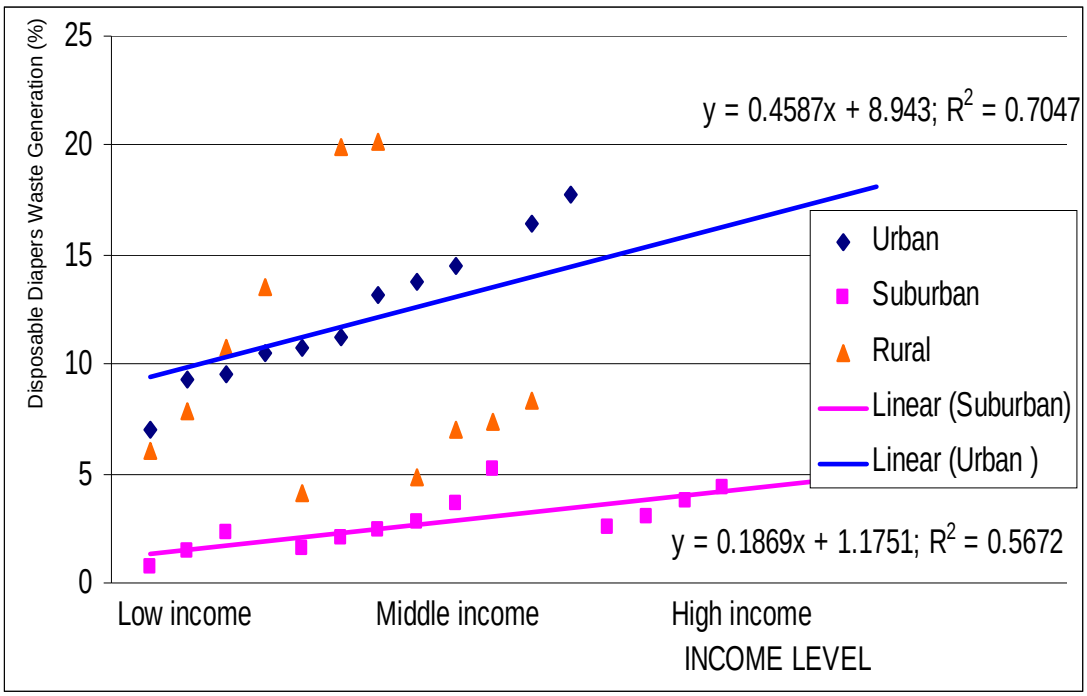
Waste types	Domestic	Commercial and institutions	Industries	Average
Food waste	28.1	18.9	3.97	17
Food (not-consumed)	0.12	0.04	0.05	0.07
Mixed paper	5.02	0.73	18.7	8.17
Newsprint	6.25	1.5	0.67	2.81
Magazine	0.93	0.12	0	0.35
White paper	0	0	0.86	0.29
Corrugated paper	4.34	18.7	2.13	8.4
Plastic (rigid)	6.73	5.19	0.62	4.18
Plastic (film)	4.37	2.13	6.76	4.42
Plastic (polystyrene)	0.96	2.1	0.24	1.1
Disposable diapers	1.99	6.74	0	2.91
Textile	1.56	1.19	2.96	1.9
Rubber/ leather	3.28	1.19	13.7	6.06
Wood	0.47	0.12	19.2	6.59
Garden waste	25.1	20	1.58	15.6
Glass (clear)	2.26	0.39	0.1	0.91
Glass (Coloured)	0.18	0.24	0.07	0.16
Metal	0.16	0	0	0.05
Tin	4.95	18	0.36	7.75
Non- metal	0.33	0	0	0.11
Aluminium can	0.12	1.28	0.4	0.6
Hazardous waste	1.14	0.16	0.12	0.47
Sand/dirt	0.47	0	26.5	9
Other organic	0	0.31	0	0.1
Other non-organic	0.21	0.7	0	0.3
Bulky waste	0.93	0.3	0.93	0.72
Total	100	100	100	100

Appendix 3.5: Detailed percentage of waste composition in rural landfill (Panchang Bedena)

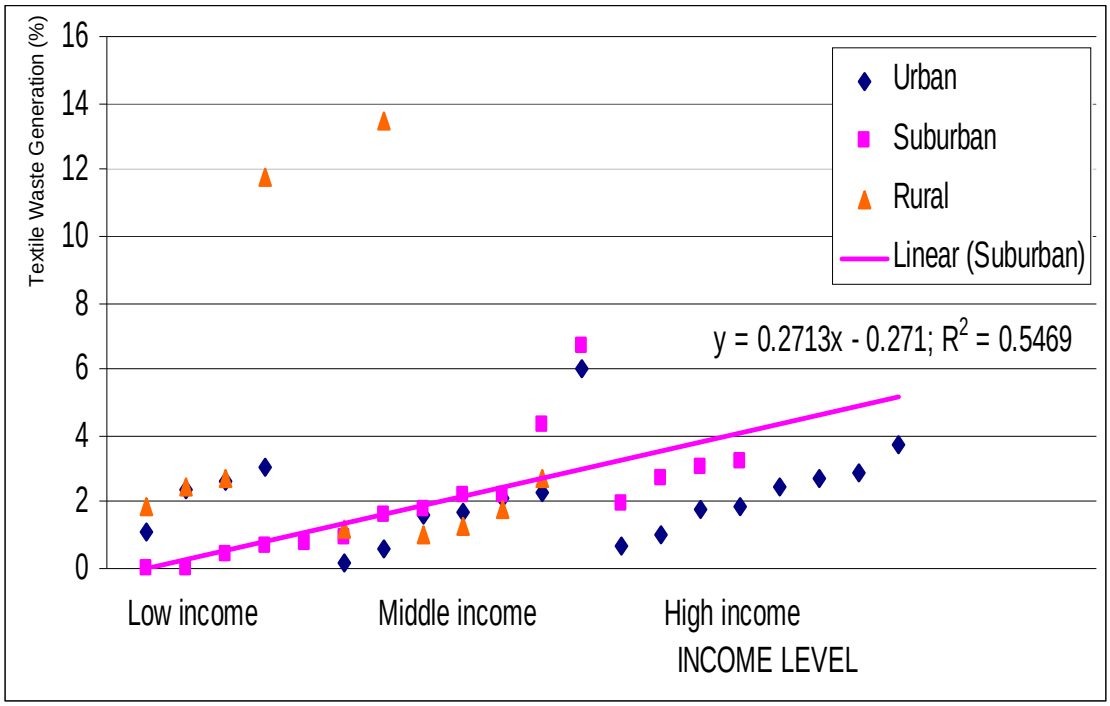
Waste types	Domestic	Commercial and institutions	Industries	Average
Food waste	35	40	1.17	25.4
Food (not-consumed)	0.1	1.568	0	0.55
Mixed paper	2.04	2.238	11.3	5.2
Newsprint	3.57	1.951	0	1.84
White paper	0.59	0.028	0.65	0.42
Corrugated paper	5.96	2.061	11.7	6.57
Plastic (rigid)	5.68	4.288	35.8	15.3
Plastic (film)	8.91	11.6	29.1	16.5
Plastic (polystyrene)	2.42	1.318	3.7	2.48
Disposable diapers	4.42	5.77	0	3.4
Textile	3.27	3.28	0.02	2.19
Rubber/ leather	1.11	0.854	0.75	0.9
Wood	1.37	0	0	0.46
Garden waste	12.4	12.16	0	8.19
Glass (clear)	0.72	1.3	0	0.67
Glass (Coloured)	0.74	0.715	0	0.48
Metal	0.35	0.019	1.66	0.68
Tin	1.48	6.08	0	2.52
Non- metal	0.04	0	0	0.01
Aluminium can	0.21	0.087	0.11	0.13
Hazardous waste	1.55	0.598	0.25	0.8
Sand/dirt	0	1.576	2.49	1.36
Other organic	7.1	0	0	2.37
Other non-organic	1.05	0.789	1.32	1.05
Bulky waste	0.18	1.727	0	0.64
Total	100	100	100	100



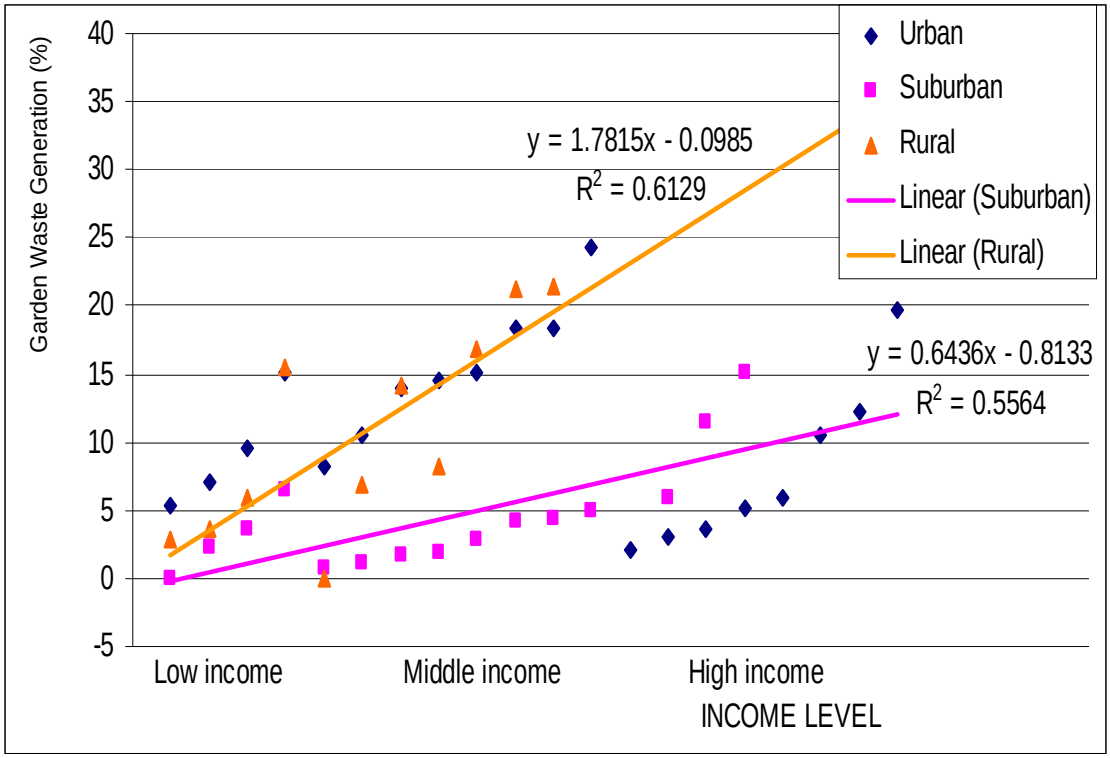
Appendix 3.6: Trends in magazine waste generation by different income groups.



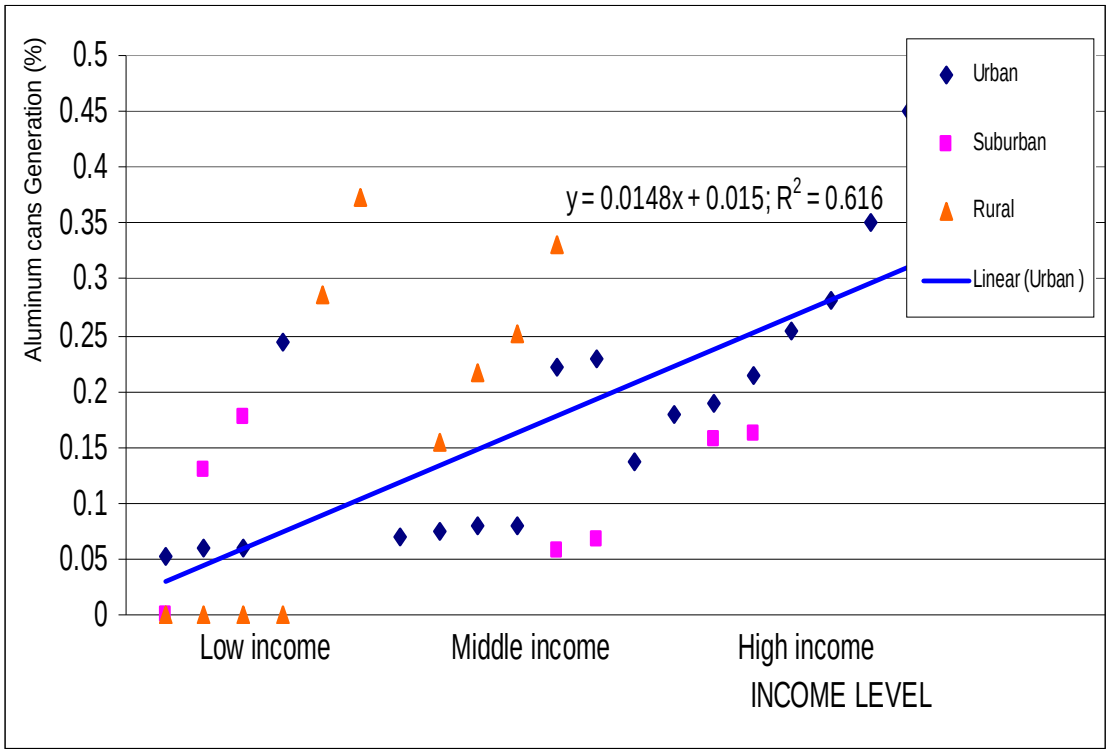
Appendix 3.7: Trends in disposable diapers waste generation by different income groups.



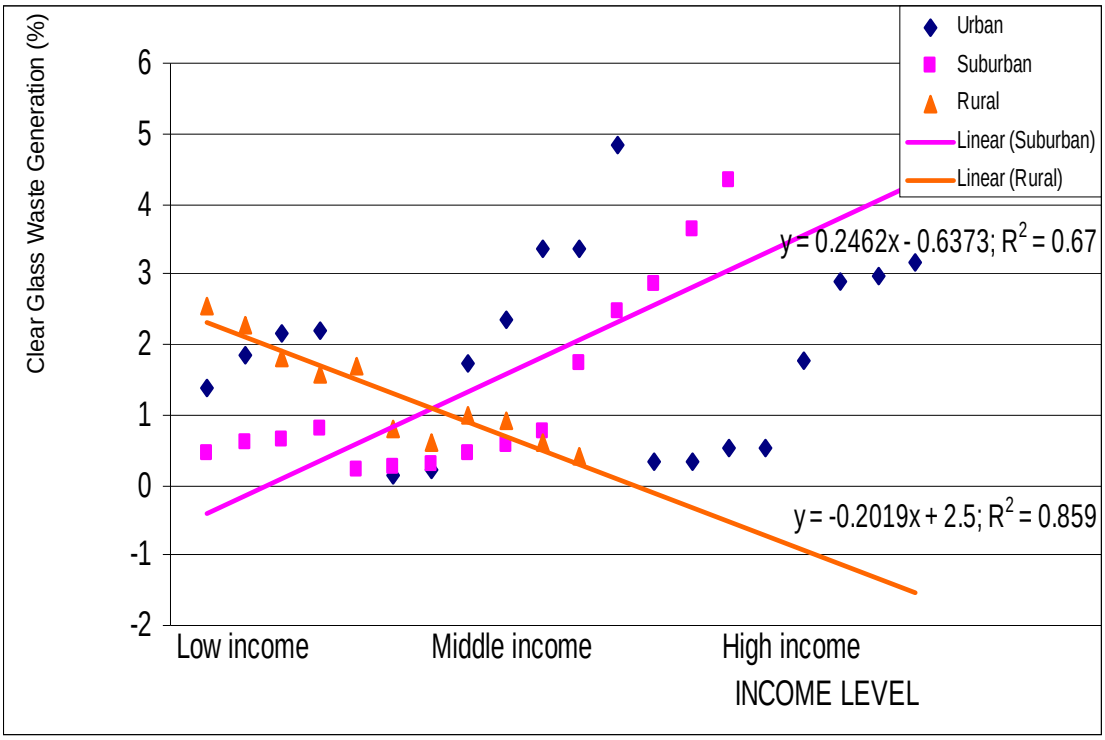
Appendix 3.8: The generation of textile waste by different income groups



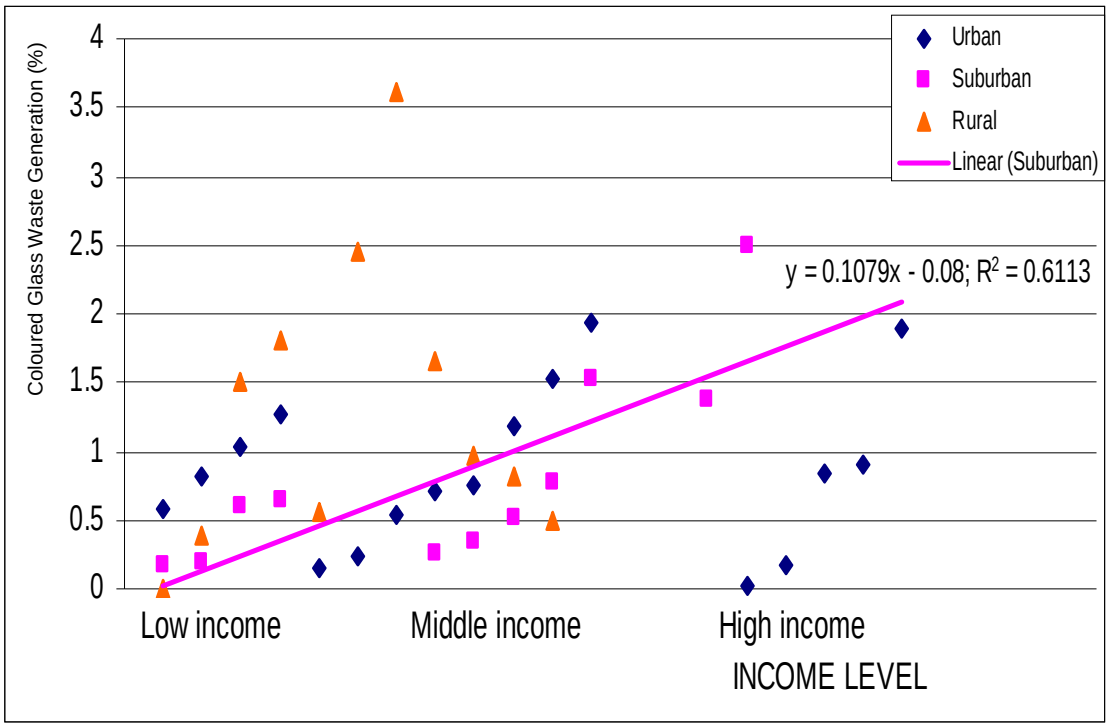
Appendix 3.9: The generation of garden waste by different income groups.



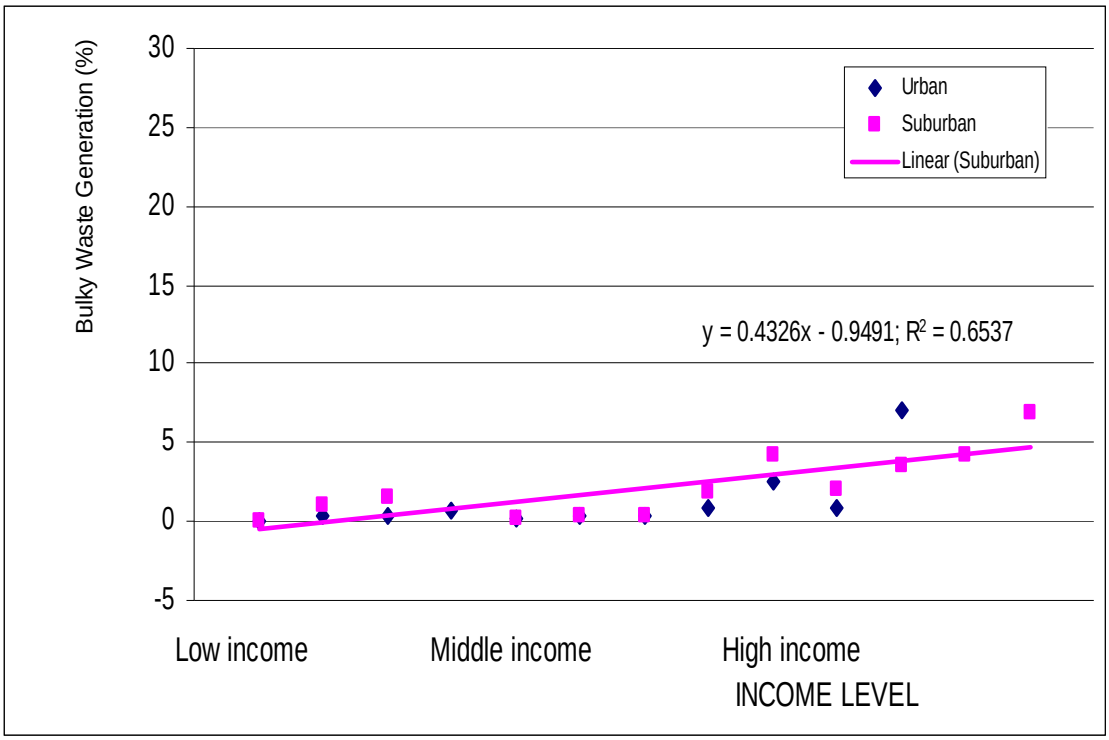
Appendix 3.10: The generation of aluminium cans by different income groups.



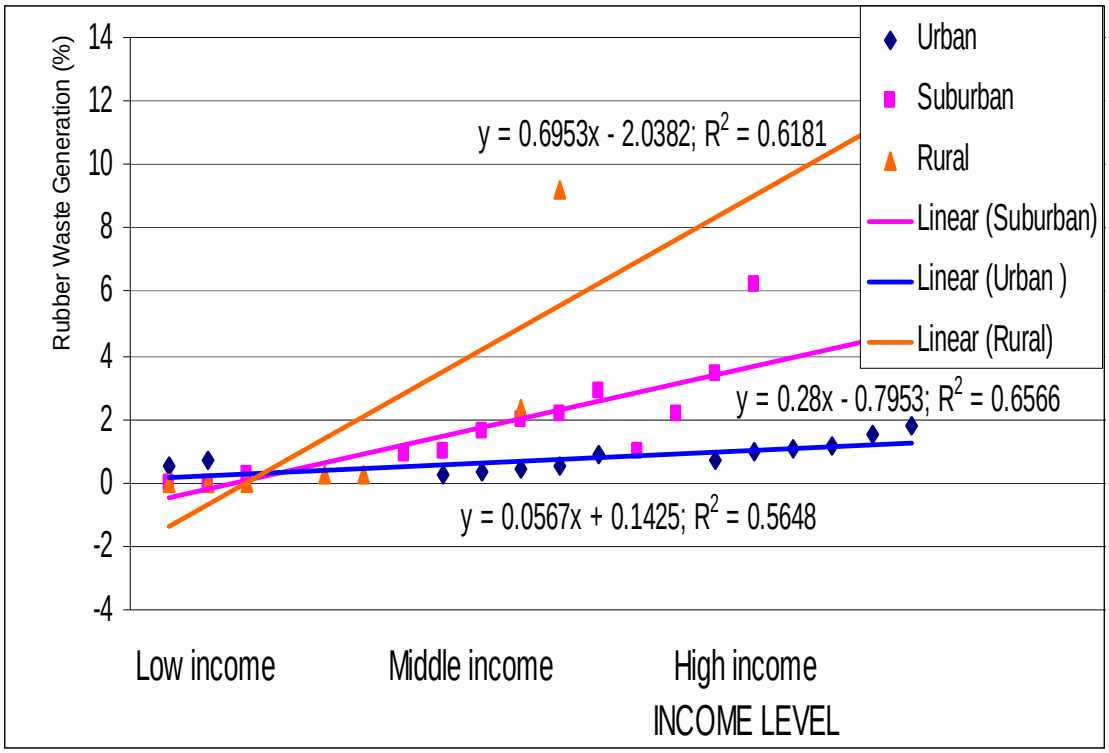
Appendix 3.11: The generation of clear glass waste by different income groups.



Appendix 3.12: The generation of coloured glass waste by different income groups.



Appendix 3.13: The generation of bulky waste by different income groups.



Appendix 3.14: The generation of rubber waste by different income groups.

Appendix 3.15: Average percentage of waste generation (wet weight) by different income groups from all three landfills (rural sub-urban and urban)

Types of waste	**Low income**	**Middle income**	**High income**
food (consume)	48.85	46.59	41.37
food (not-consume)	0.33	1.90	2.28
mixed paper	4.09	3.02	3.20
Newsprint	4.09	3.11	1.77
phone book	0.06	0.09	0.30
Magazine	0.11	0.15	0.78
white paper	0.70	1.45	0.42
corrugated paper	4.18	3.58	4.57
plastic (rigid)	3.44	4.04	4.18
plastic (bag)	7.82	2.99	4.65
plastic (polystyrene)	1.33	1.57	1.83
disposable diapers	6.88	10.66	6.75
Textile	2.43	2.62	2.17
rubber/leather	0.78	0.70	2.01
Wood	0.43	0.90	0.99
garden waste	6.03	8.99	10.31
glass (clear)	1.52	1.36	2.33
glass (colour)	0.75	0.90	0.78
metal	0.59	1.19	0.33
tin	1.10	0.75	2.19
non-metal	0.03	0.16	0.33
aluminum can	0.11	0.15	0.21
other aluminum	0.01	0.16	0.07
hazardous waste	1.62	0.64	0.55
dust/sand	0.41	0.06	0.08
other organic	0.34	0.10	0.49
other non-organic	0.97	1.20	1.78
bulky waste	1.02	0.59	3.25
Total	100	100	100

Appendix 3.16: Composition (% wet weight) of MSW generated by various income groups in urban area.

Waste types	**High income**	**Middle income**	**Low income**
Food waste	20.6 ± 12.1	24.8 ± 1.7	26.1 ± 3.8
Food (not-consumed)	4.2 ± 1.3	3.3 ± 1.0	3.5 ± 0.4
Mixed paper	3.5 ± 1.5	6.4 ± 1.2	6.3 ± 1.9
Newsprint	4.1 ± 0.3	3.8 ± 1.1	4.4 ± 0.5
Phone book	2.0 ± 0.1	0.1 ± 0.05	0.2 ± 0.1
Magazine	1.4 ± 1.6	4.6 ± 0.04	4.3 ± 2.1
White paper	1.4 ± 0.8	0.1 ± 0.03	0.3 ± 0.01
Corrugated paper	4.1 ± 1.2	4.6 ± 1.4	4.9 ± 0.1
Plastic (rigid)	4.1 ± 2.0	4.6 ± 0.8	3.5 ± 0.6
Plastic (film)	0.8 ± 0.03	0.8 ± 0.1	0.3 ± 0.1
Plastic (polystyrene)	0.5 ± 0.1	0.8 ± 0.1	1.0 ± 0.2
Disposable diapers	2.2 ± 0.1	3.6 ± 1.5	5.7 ± 0.1
Textile	3.2 ± 0.1	1.9 ± 0.4	2.2 ± 0.1
Rubber/ leather	2.0 ± 0.8	1.5 ± 1.1	2.0 ± 0.7
Garden waste	10.1 ± 2.1	7.1 ± 1.0	5.9 ± 2.3
Glass (clear)	3.4 ± 0.5	3.8 ± 0.4	4.0 ±1.1
Glass (Coloured)	3.9 ± 0.5	3.4 ± 0.7	5.4 ± 2.0
Metal	4.7 ± 0.3	2.9 ± 1.1	2.0 ± 0.4
Tin	6.2 ± 0.2	4.7 ± 0.8	6.0 ± 0.5
Non- metal	1.0± 0.7	2.4 ± 2.1	0.7 ± 0.2
Aluminium can	3.3 ± 0.1	4.2 ± 0.9	2.9 ± 0.6
Other aluminium	1.2 ± 0.7	2.8 ± 1.0	1.9 ± 1.1
Hazardous waste	2.8 ± 0.1	2.4 ± 0.2	2.2 ± 0.4
Other organic	7.3 ± 2.0	4.3 ± 1.0	3.7 ± 0.1
Bulky waste	2.0 ± 1.3	1.1 ± 0.1	0.6 ± 0.1

Appendix 3.17: Average percentages (% wet weight) of waste types generated by various income groups in the sub-urban area.

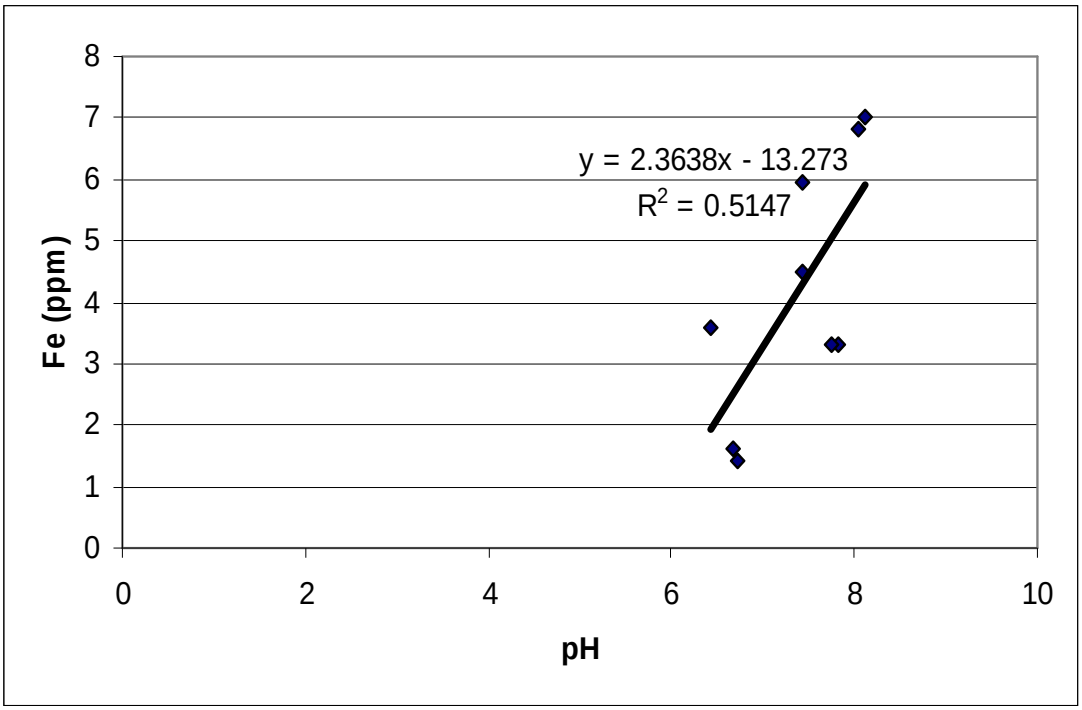
Waste types	**High income**	**Middle income**	**Low income**
Food waste	54.0 ± 9.4	60.6 ± 11.2	60.9 ± 13.4
Food (not-consumed)	1.4 ± 0.5	0.4 ± 0.1	1.0 ± 0.1
Mixed paper	2.5 ± 0.1	2.8 ± 0.2	2.7 ± 0.2
Newsprint	3.5 ± 0.3	3.3 ± 0.2	2.1 ± 0.1
White paper	1.3 ± 0.1	0.8 ± 0.2	0.1 ± 0.08
Corrugated paper	4.0 ± 0.4	4.5 ± 0.1	3.8 ± 0.4
Plastic (rigid)	3.0 ± 0.7	1.0 ± 0.3	0.5 ± 0.1
Plastic (film)	2.5 ± 0.6	2.0 ± 0.2	2.4 ± 0.5
Plastic (polystyrene)	1.4 ± 0.4	1.6 ± 0.4	0.8 ± 0.1
Disposable diapers	1.5 ± 0.7	3.0 ± 1.5	2.0 ± 1.1
Textile	1.4 ± 0.2	1.0 ± 0.1	3.0 ± 0.5
Rubber/ leather	1.4 ± 1.0	2.0 ± 1.1	2.0 ± 0.5
Garden waste	8.0 ± 2.0	1.5 ± 0.4	3.0 ± 0.9
Glass (clear)	1.4 ± 1.0	2.0 ± 0.7	1.8 ± 0.7
Glass (Coloured)	2.1 ± 0.8	3.0 ± 0.5	2.0 ± 0.4
Metal	3.0 ± 1.9	2.0 ± 0.1	1.5 ± 0.1
Tin	1.5 ± 0.6	1.0 ± 0.3	2.0 ± 0.4
Aluminium can	1.0 ± 0.6	1.0 ± 0.3	2.0 ± 0.7
Wood	2.0 ± 0.1	3.0 ± 0.2	3.0 ± 0.8
Hazardous waste	1.0 ± 0.1	0.9 ± 0.6	1.0 ± 0.3

Appendix 3.18: Average percentages (% wet weight) of waste types generated by various income groups in the rural area.

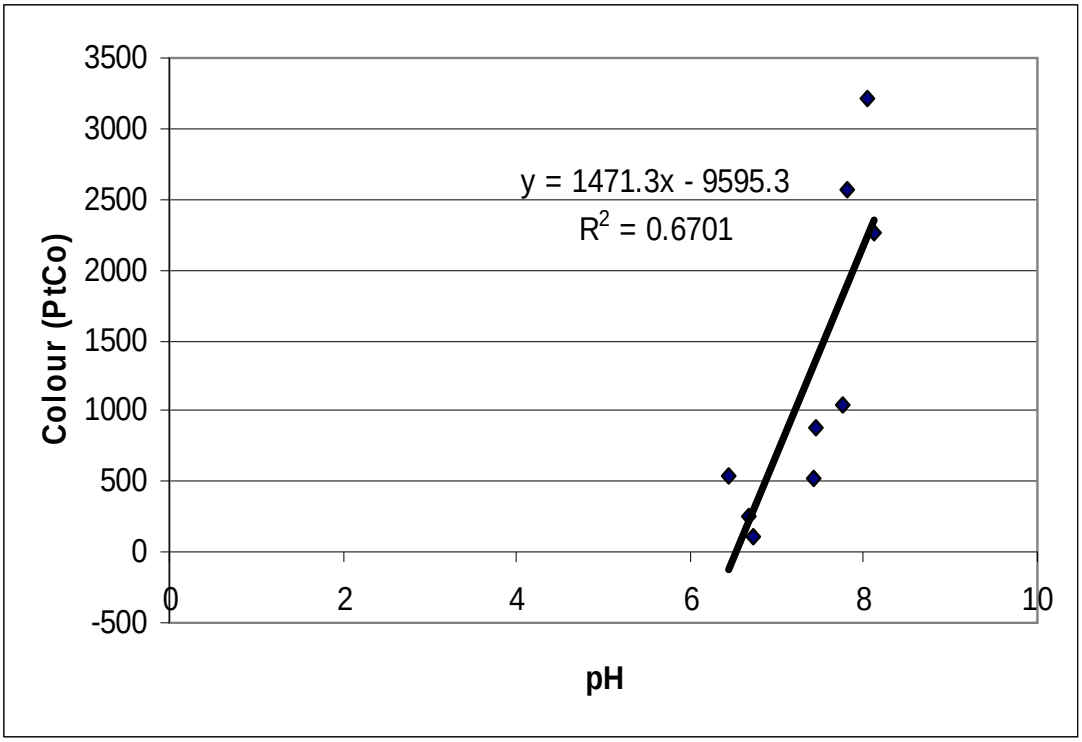
Waste types	**High income**	**Middle income**	**Low income**
Food waste	52.0 ± 6.0	53.0 ± 3.7	49.0 ± 4.1
Food (not-consumed)	3.0 ± 0.4	7.0 ± 4.3	8.0 ± 3.9
Mixed paper	3.0 ± 0.3	3.0 ± 1.1	5.0 ± 2.0
Newsprint	3.0 ± 1.2	4.0 ± 1.5	3.2 ± 1.3
White paper	1.0 ± 0.5	0.5 ± 0.3	0.1 ± 0.05
Corrugated paper	3.0 ± 0.7	5.0 ± 2.4	2.7 ± 0.2
Plastic (rigid)	2.0 ± 0.6	1.9 ± 0.6	2.1 ± 1.5
Plastic (film)	2.5 ± 0.5	3.0 ± 0.5	3.8 ± 0.6
Plastic (polystyrene)	1.5 ± 0.1	1.4 ± 0.4	1.3 ± 1.0
Disposable diapers	6.0 ± 0.5	5.0 ± 0.9	3.4 ± 1.6
Textile	1.8 ± 1.1	1.1 ± 0.4	1.5 ± 0.3
Rubber/ leather	1.3 ± 0.2	0.5 ± 0.1	0.9 ± 0.1
Garden waste	4.0 ± 2.3	2.2 ± 0.3	1.8 ± 0.4
Glass (clear)	0.9 ± 0.5	1.1 ± 0.9	1.8 ± 1.1
Glass (Coloured)	1.5 ± 0.1	1.3 ± 0.1	0.9 ± 0.3
Metal	3.9 ± 0.5	1.2 ± 0.4	3.5 ± 1.5
Tin	1.9 ± 0.4	2.1 ± 1.6	2.7 ± 2.3
Aluminium can	1.7 ± 0.4	0.8 ± 0.3	0.1 ± 0.08
Other aluminium	2.1 ± 0.1	0.2 ± 0.1	0.4 ± 0.1
Hazardous waste	0.9 ± 0.3	0.7 ± 0.4	0.5 ± 0.2
Bulky waste	3.0 ± 2.5	5.0 ± 2.1	7.3 ± 4.5

Appendix 3.19: Leachate characteristics from nine disposal sites in Selangor.

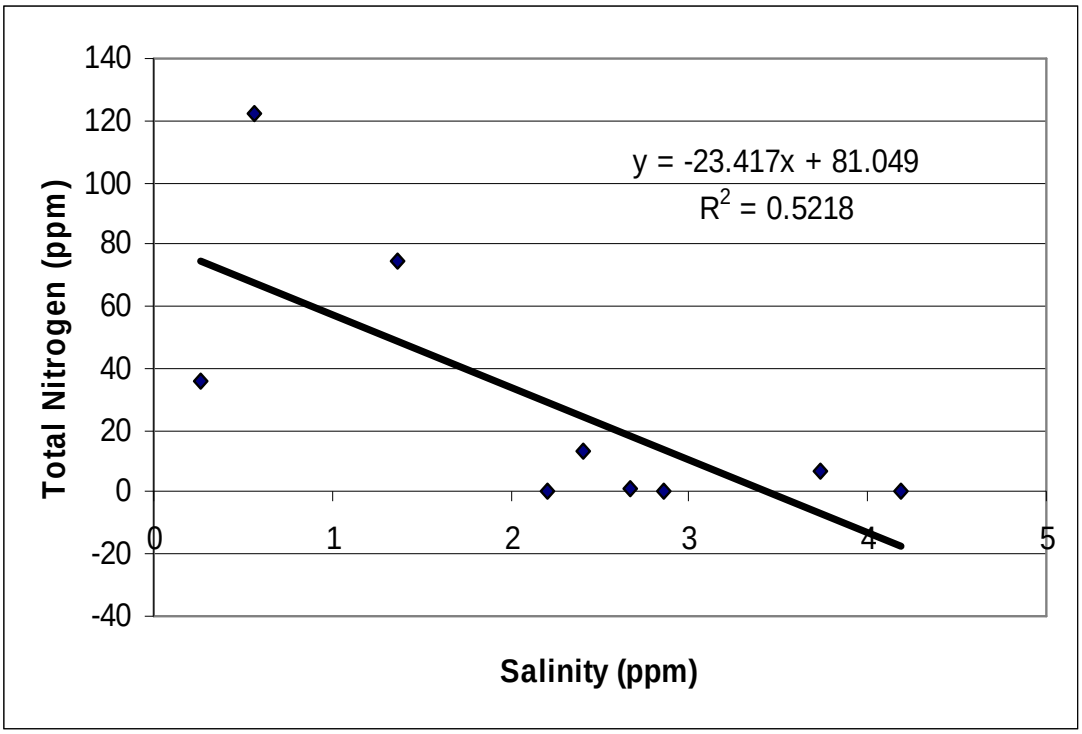
	Units	Sungai Besar	Kundang	Kpg Hang Tuah	Sg Sedu	Ampar Tenang	Kerling	Bukit Beruntung	Hulu Yam Bharu	Sungai Kembong
pH	-	8.04	7.43	7.44	6.72	8.12	7.82	7.75	6.68	6.44
Conductivity	mS/cm	15.4	86.33	73.67	33.46	171.4	11.33	1.17	16.94	551.67
Salinity	‰	2.21	2.86	2.67	3.73	2.41	4.19	0.56	1.36	0.26
Alkalinity	mg/l	636	273.7	391.3	56.33	947	62.67	122	524	48.97
Chloride	mg/l	872	278	343.33	136.67	326.73	264.6	215.67	114	325
Sulfite	mg/l	39	4.3	3.37	1.9	13.33	3.7	2	0.67	0.7
Iron	mg/l	6.8	4.5	5.97	1.43	7	3.33	3.33	1.63	3.6
turbidity	FAU	367	58.33	611.3	13.23	182.33	73.33	25.67	30	87.9
Hardness	mg/l	236	429.33	340.3	135573	175867	160167	62.67	282933	4285.41
Colour	mg/l	3218	530	882.2	107.33	2261.33	2558.33	1040.27	248.33	546.59
Total Phosphorous	mg/l	145	147	139	156	145	162	117	143	125
Total Nitrogen	mg/l	0.33	0.33	0.99	6.92	13.05	0.57	122.63	74.45	35.98
TOC	mg/l	274	2481.3	3726.74	49.1	1544.0	3267.41	1972.4	4511.51	579.32
COD	mg/l	3220	6232	4950	169.3	2530.91	7688.52	3730.24	9029.72	1272.67
BOD	mg/l	626	27.5	12.53	22.27	110.67	65.33	23.47	77.33	188.33
Total Solid	mg/l	26.81	0.39	1.09	0.21	3.81	5.13	3.91	5.47	3.37
TSS	mg/l	0.71	0.06	0.4	0.09	0.08	0.25	0.2	1.57	0.04



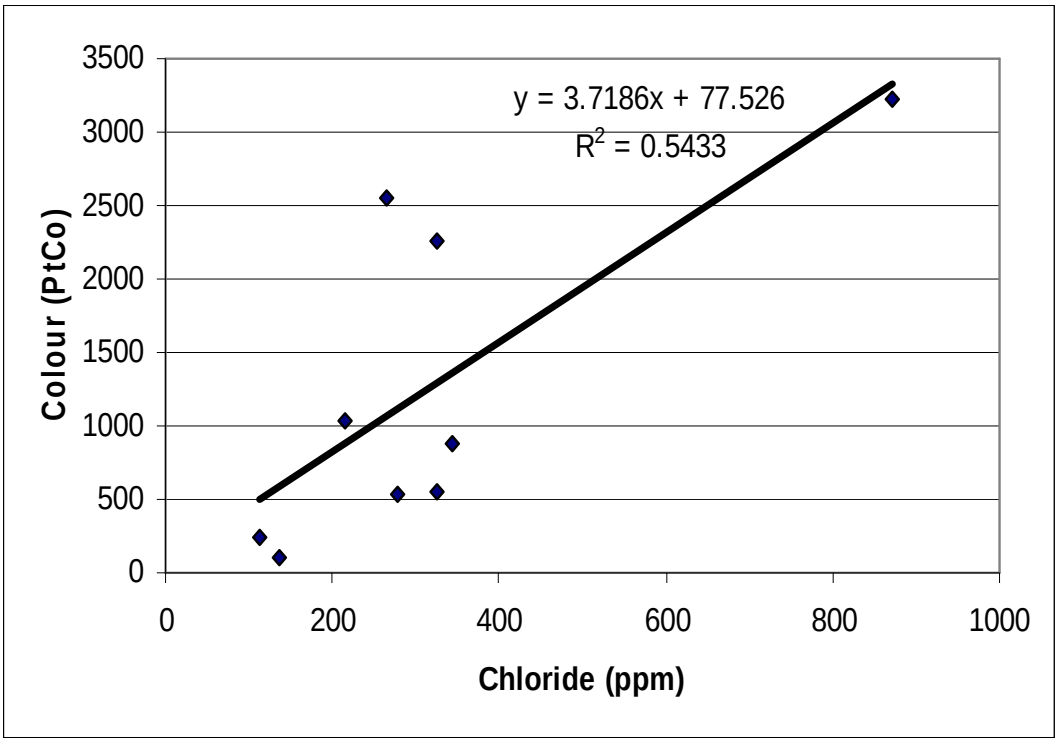
Appendix 3.20: Linear correlation between pH and Fe in leachate



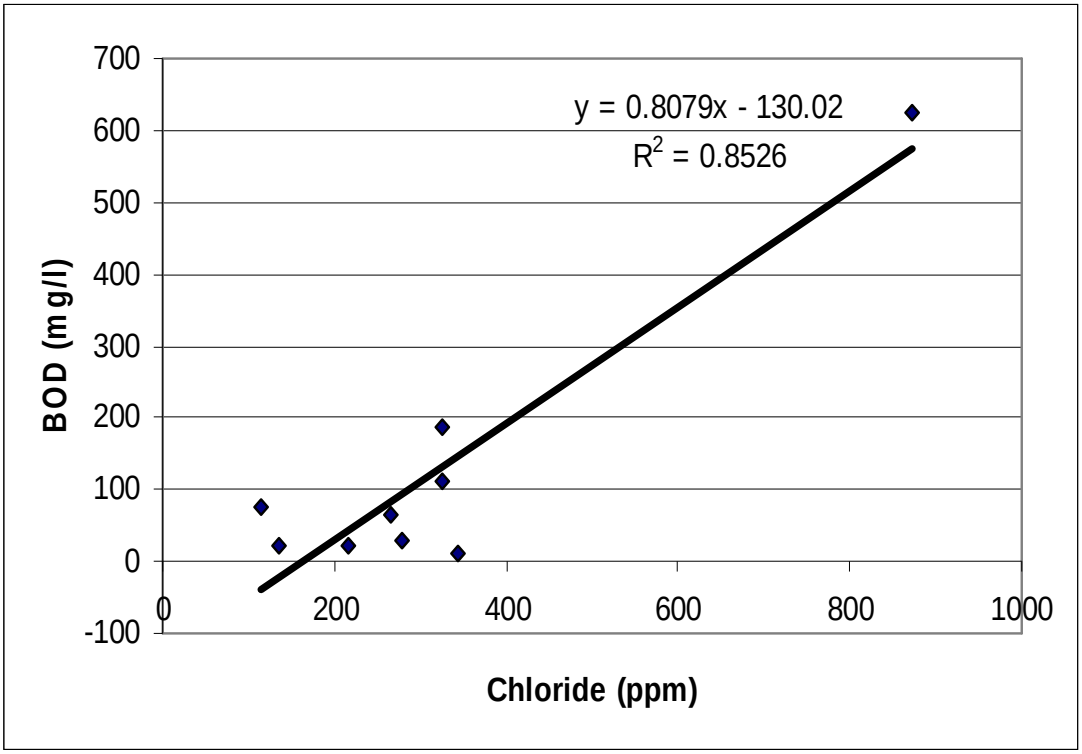
Appendix 3.21: Linear correlation between pH and colour of leachate



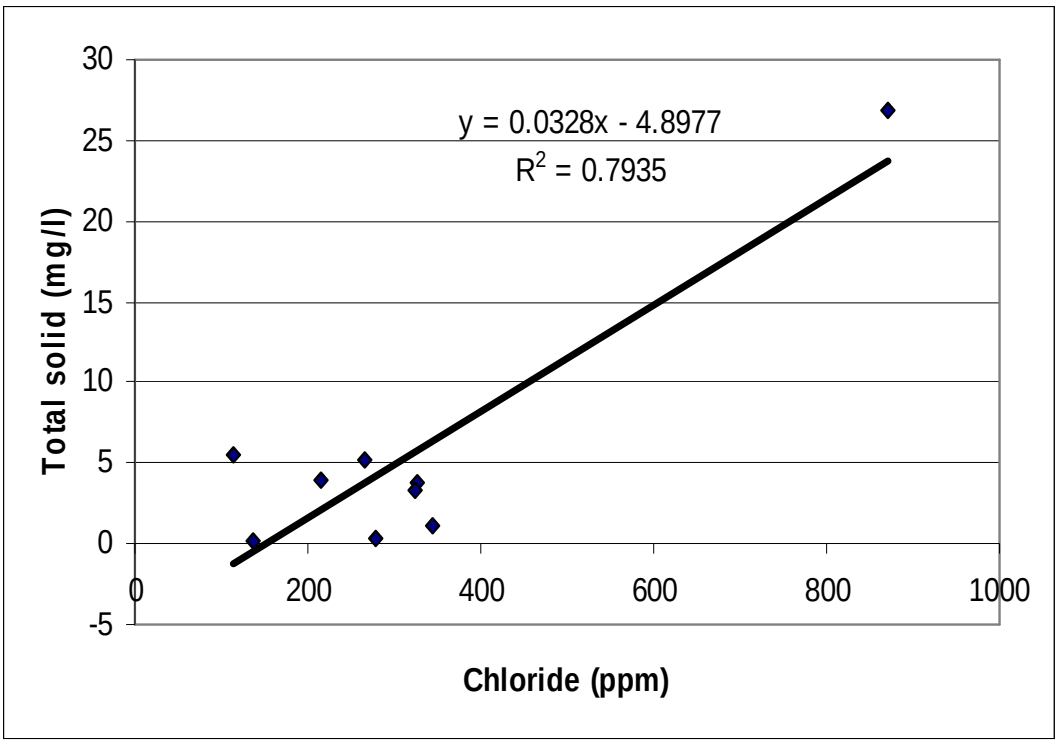
Appendix 3.22: Linear correlation between total nitrogen and salinity of leachate



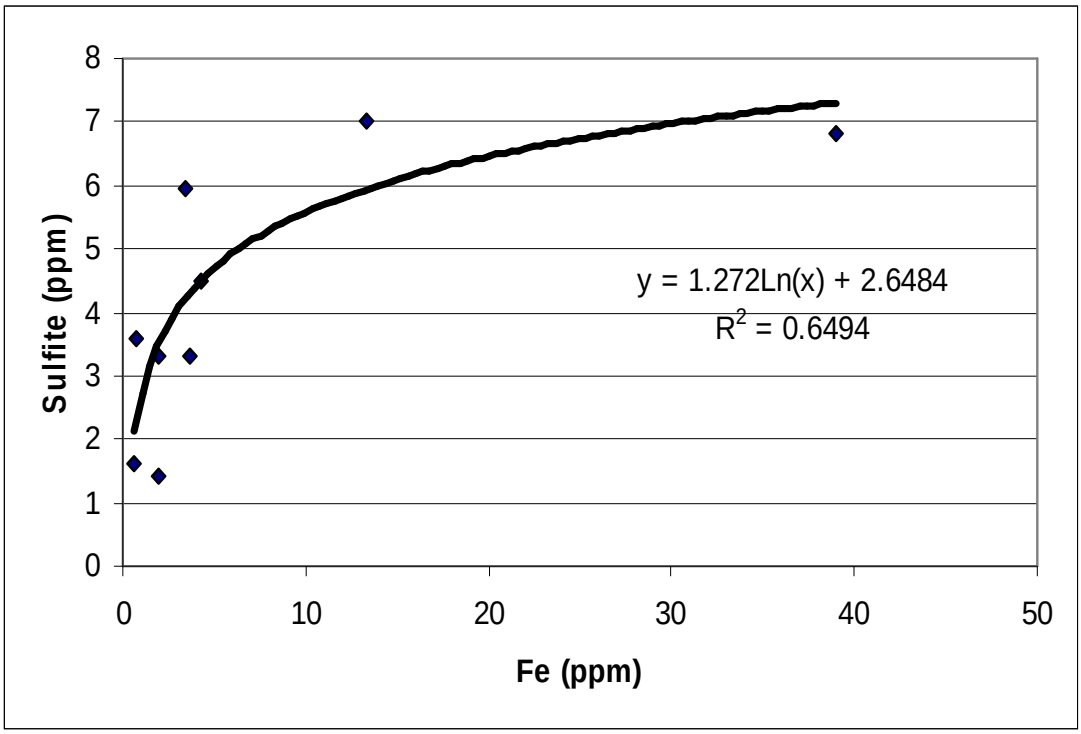
Appendix 3.23: Linear correlation between chloride and colour of leachate



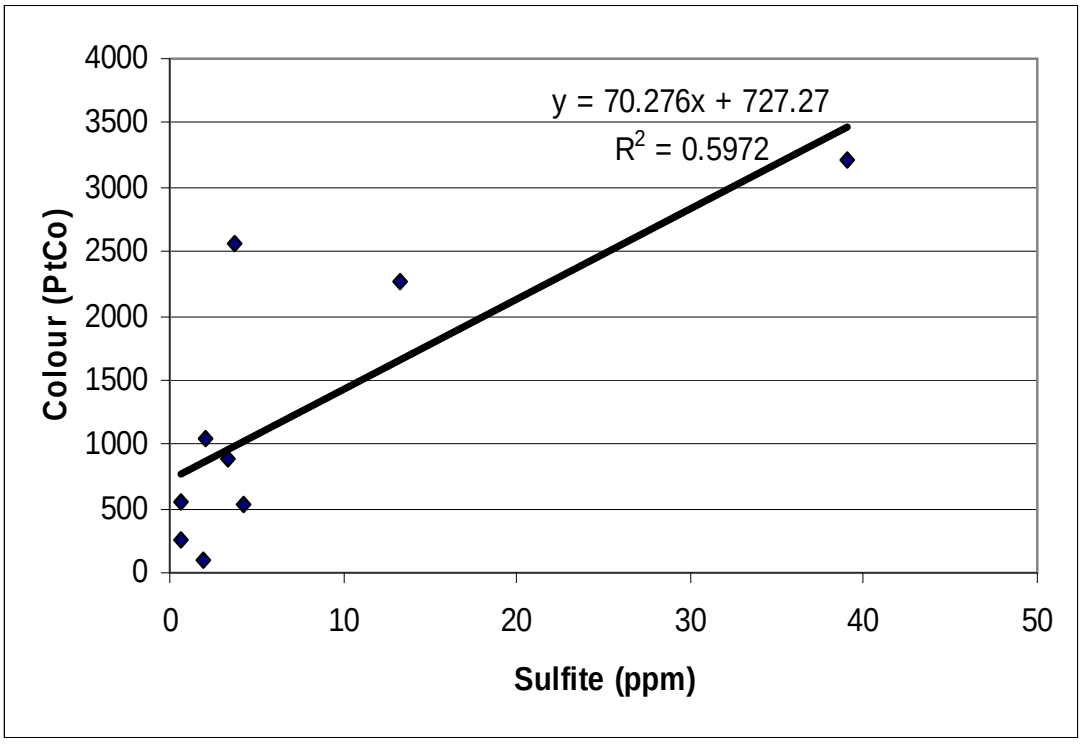
Appendix 3.24: Linear correlation between chloride and BOD of leachate



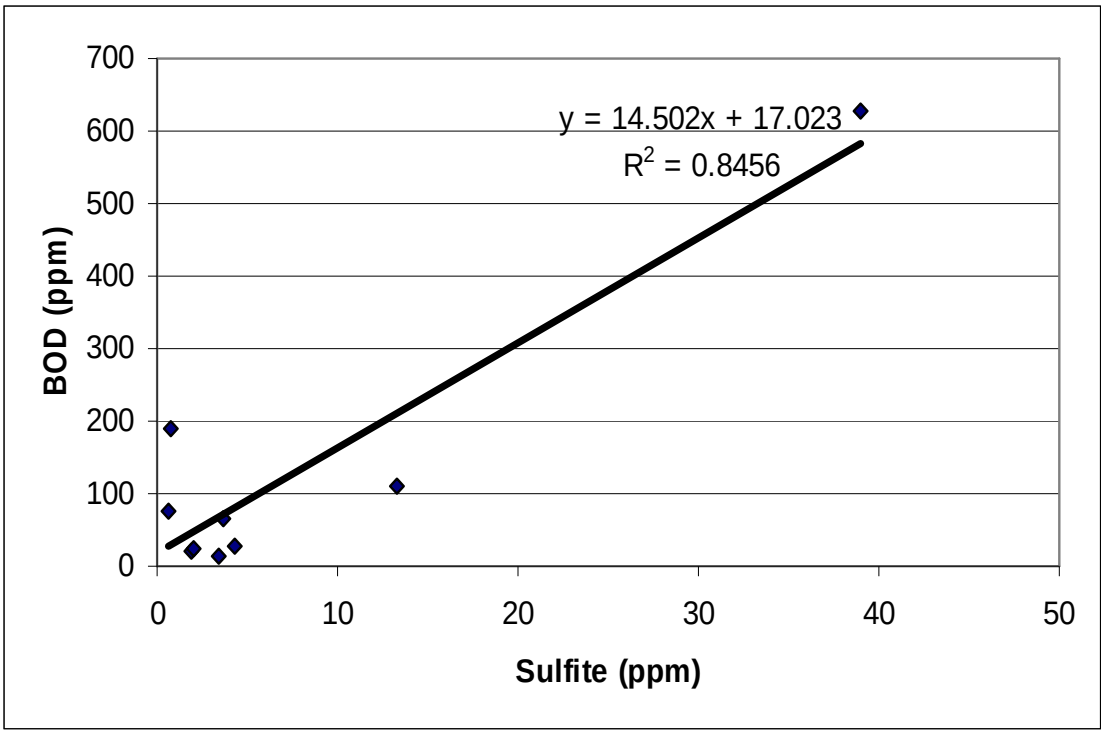
Appendix 3.25: Linear correlation between chloride and total solid in leachate



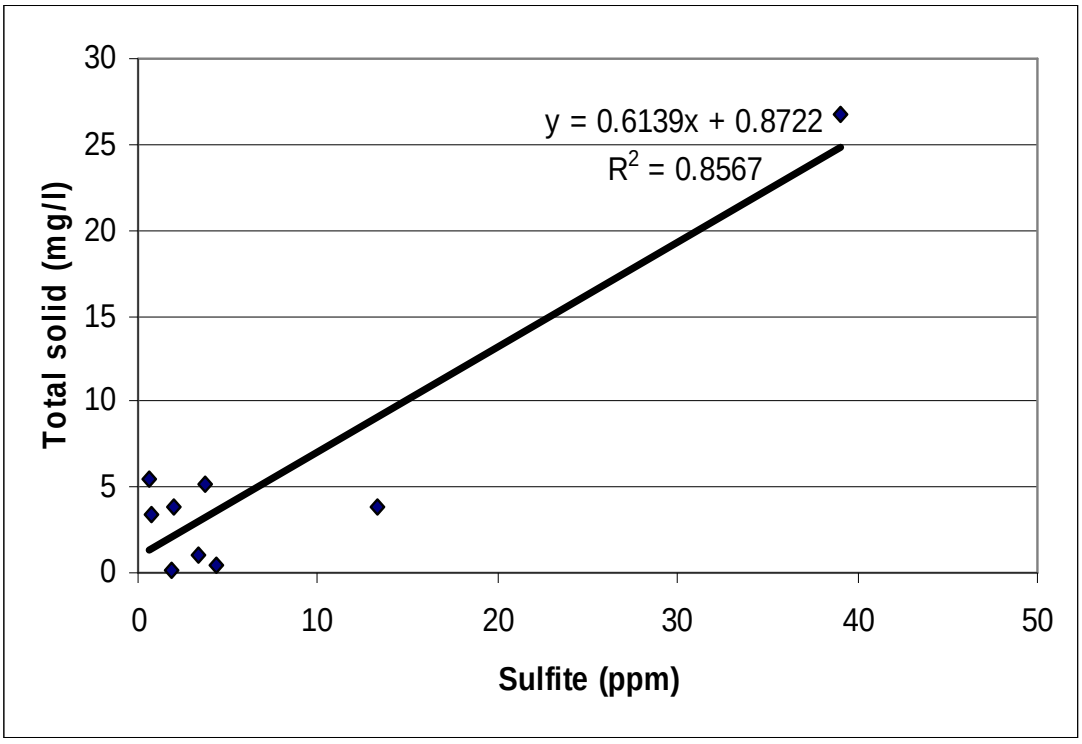
Appendix 3.26: Correlation between sulfite and Fe of leachate



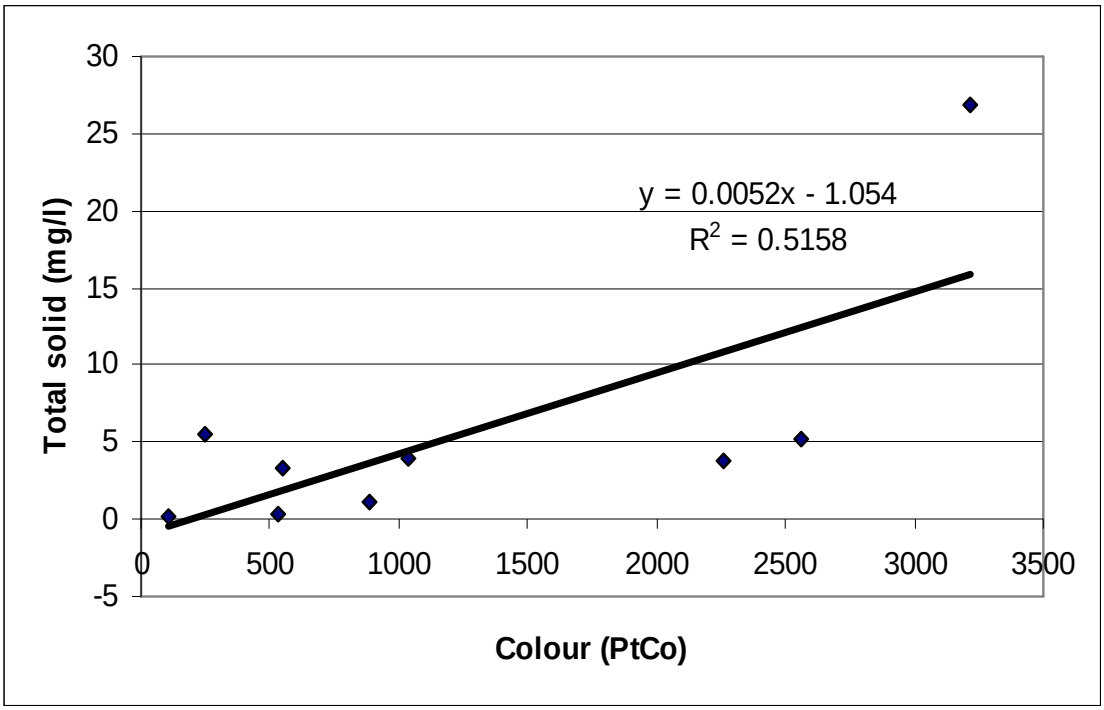
Appendix 3.27: Linear correlation between sulfite and colour of leachate



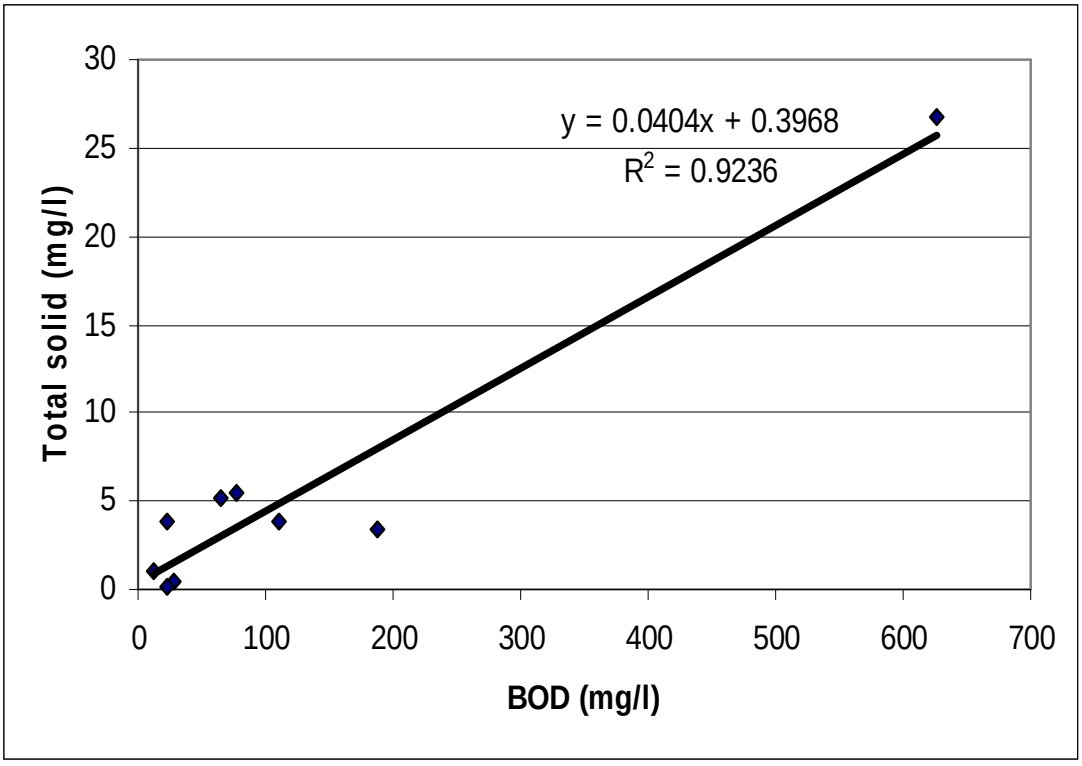
Appendix 3.28: Linear correlation between sulfite and BOD of leachate



Appendix 3.29: Linear correlation between sulfite and total solid of leachate



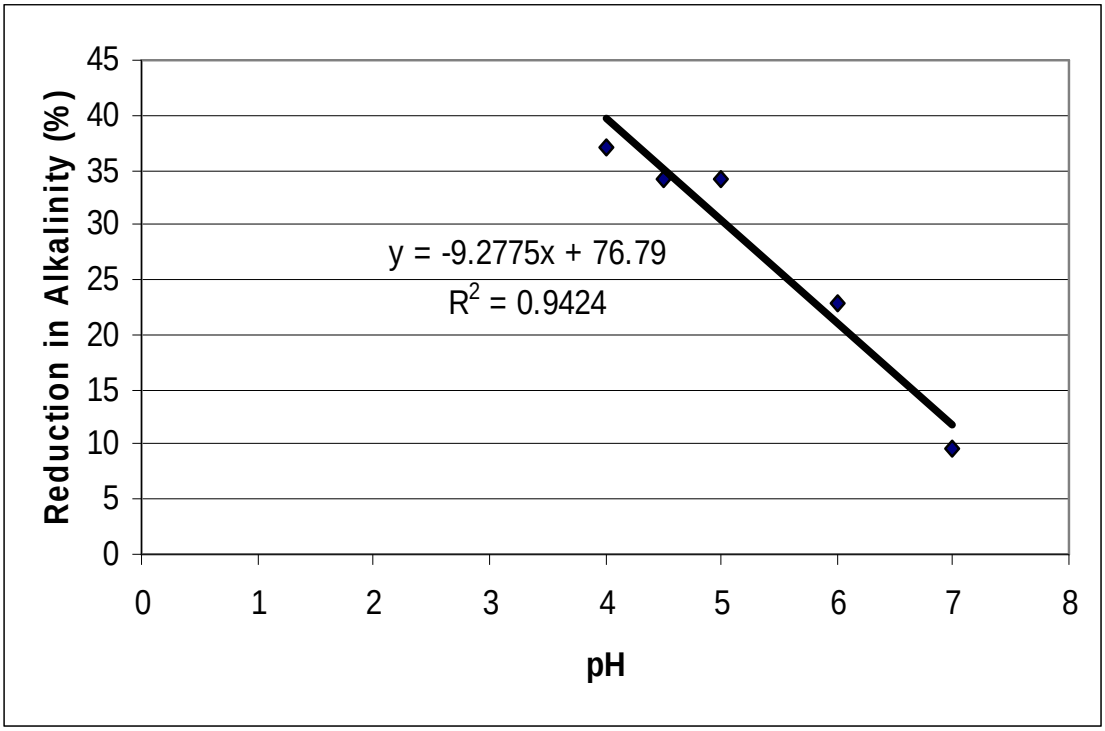
Appendix 3.30: Linear correlation between total solid and colour of leachate



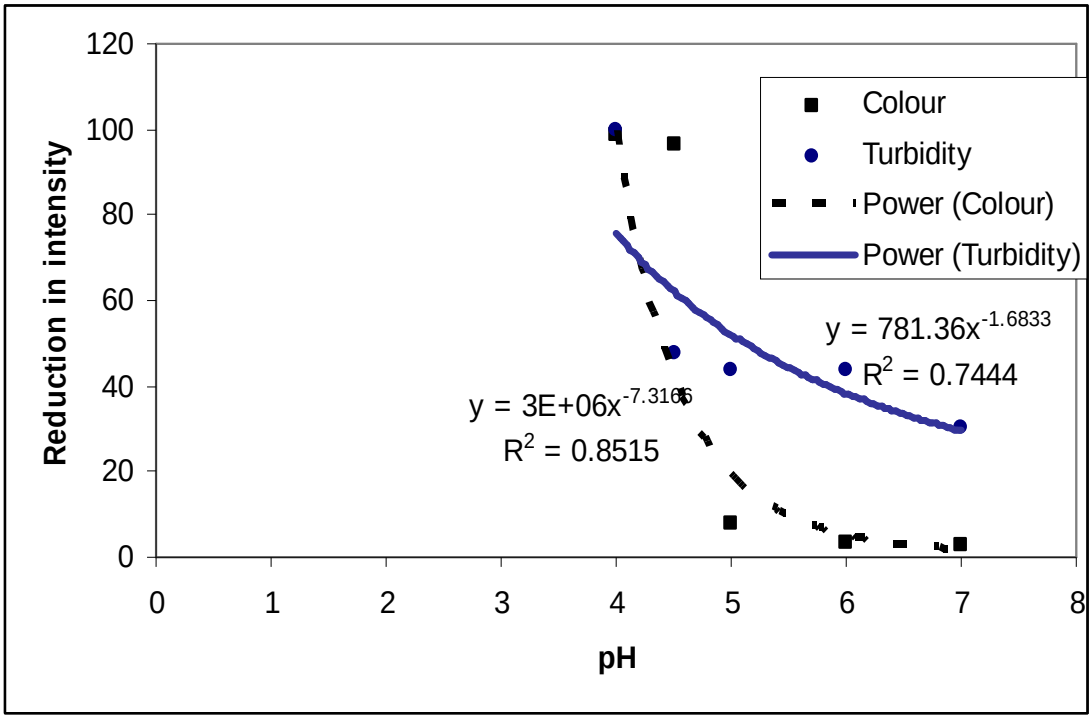
Appendix 3.31: Linear correlation between total solid and BOD of leachate

Appendix 3.32: Percentage of reduction in leachate treated with different concentration of $FeCl_3$

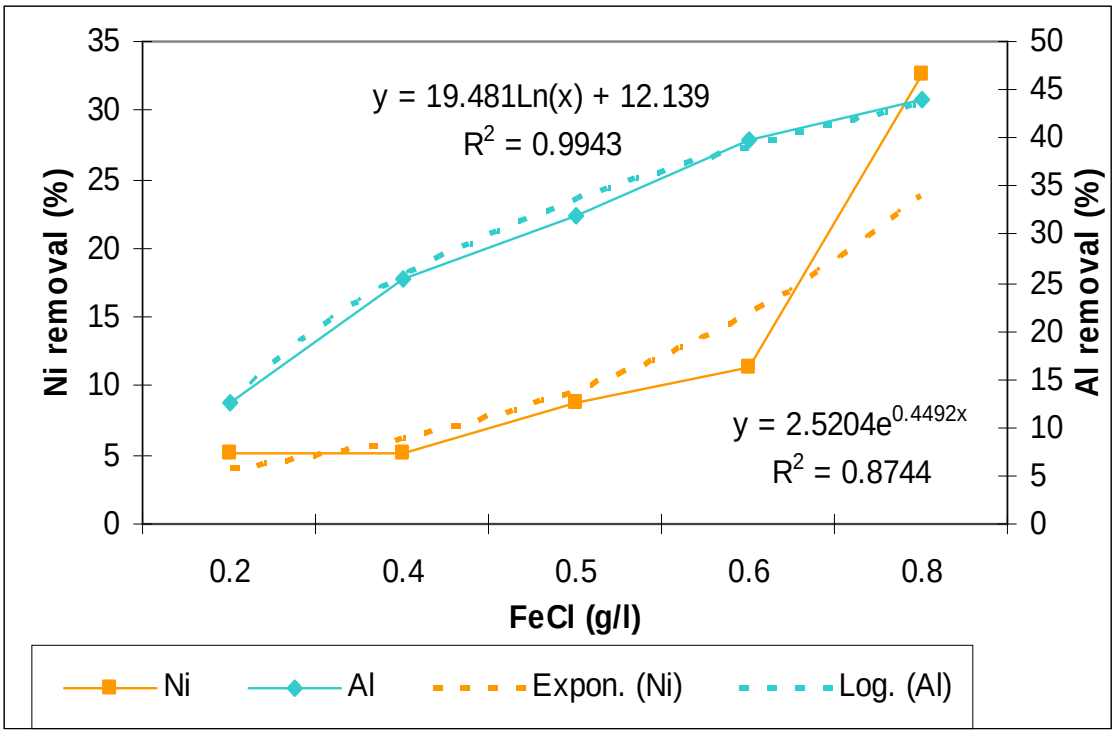
Concentration of $FeCl_3$ (mg/l)	**Reduction in pollution intensity (%)**				
	0.4	**0.8**	**1.0**	**1.2**	**1.6**
BOD	6.59899	7.40404	9.79798	10.70707	11.51515
COD	0.399449	1.170799	1.955923	4.710744	6.61157
TS	17.35849	19.24528	21.50943	26.79245	49.43396
pH	0.58651	0.879765	1.11437	1.173021	1.759531
TDS	5.081109	5.782313	11.19833	21.20094	21.78179
salinity	0	2.777778	11.11111	16.66667	22.22222
Conductivity	4.5	6.785714	13	18.8961	22.4026
Total P	30.06742	28.79775	34.89888	49.38202	69.46629
Hardness	4.761905	25.39683	17.46032	23.80952	28.57143
Alkalinity	18.80342	23.07692	28.20513	23.07692	36.75214
Sulfite	16.66667	33.33333	33.33333	50	33.33333
Colour	3.448276	10.91954	11.49425	13.7931	18.3908
Turbidity	23.07692	23.07692	30.76923	38.46154	38.46154
TSS	12.5	12.5	12.5	12.5	12.5
Ammoniacal -N	10.83333	16.89394	30.15152	42.00758	50.22727
Chloride	-3.84615	-7.69231	-30.7692	-42.3077	-59.6154
Cu	18.48958	31.51042	50.39063	52.86458	82.03125
Zn	17.41294	20.39801	28.35821	31.8408	43.78109
Ni	5.100956	5.207226	8.714134	11.37088	32.62487
Co	7	9.5	13.5	19	35.5
Fe	-5.33333	-6.66667	-9.77778	-30.2222	-43.5556
Mn	3.61991	14.02715	21.26697	25.33937	38.91403
Cr	18.46154	25.84615	29.23077	30.69231	33.15385
Ca	14.15929	18.0531	29.18584	40.88496	47.61062
Mg	7.327586	9.482759	9.482759	13.36207	36.2069
Cd	23.80952	26.53061	26.53061	28.57143	73.40136
Ba	37.6054	75.71669	57.16695	67.95953	77.90894
Pb	3.333333	8	14	64.33333	76.13333
Al	12.60997	25.5132	31.96481	39.8827	43.98827
V	2.453988	11.04294	22.69939	33.74233	41.16564
Se	12.86432	25.02513	30.95477	40.20101	-50744.2
Sr	92.02614	95.48203	93.23529	94.50163	95.0817
Li	3.981265	1.17096	3.278689	7.494145	34.66042



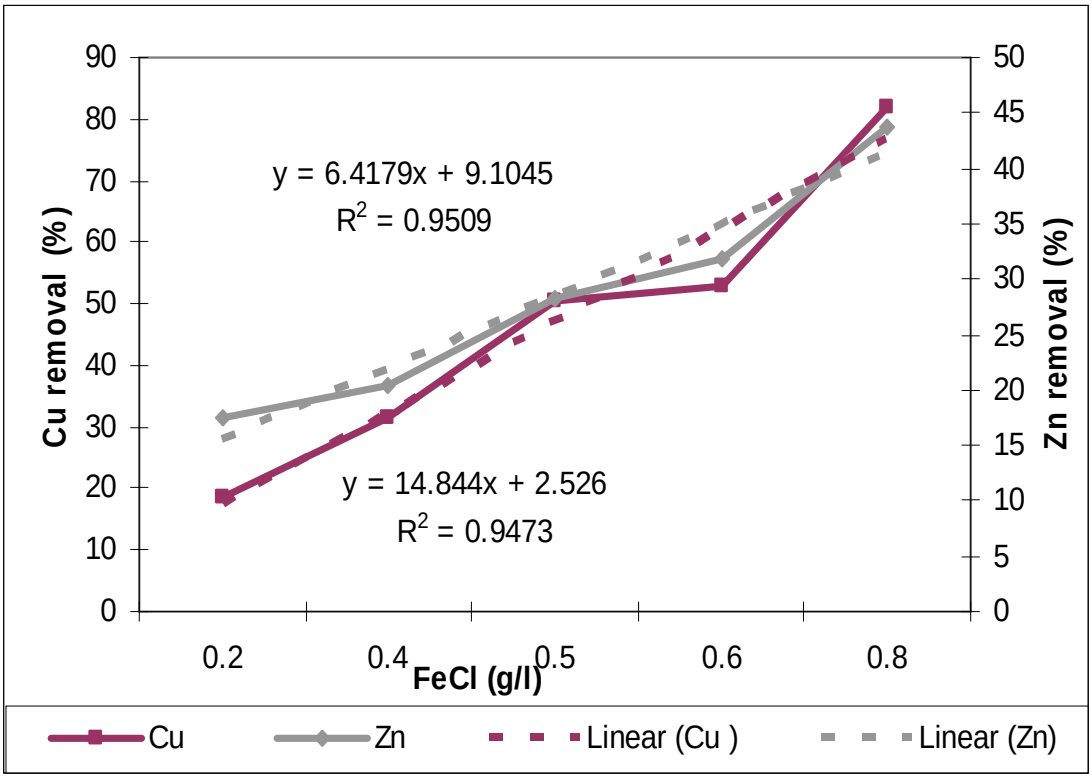
Appendix 3.33: Linear correlation between pH and reduction in alkalinity



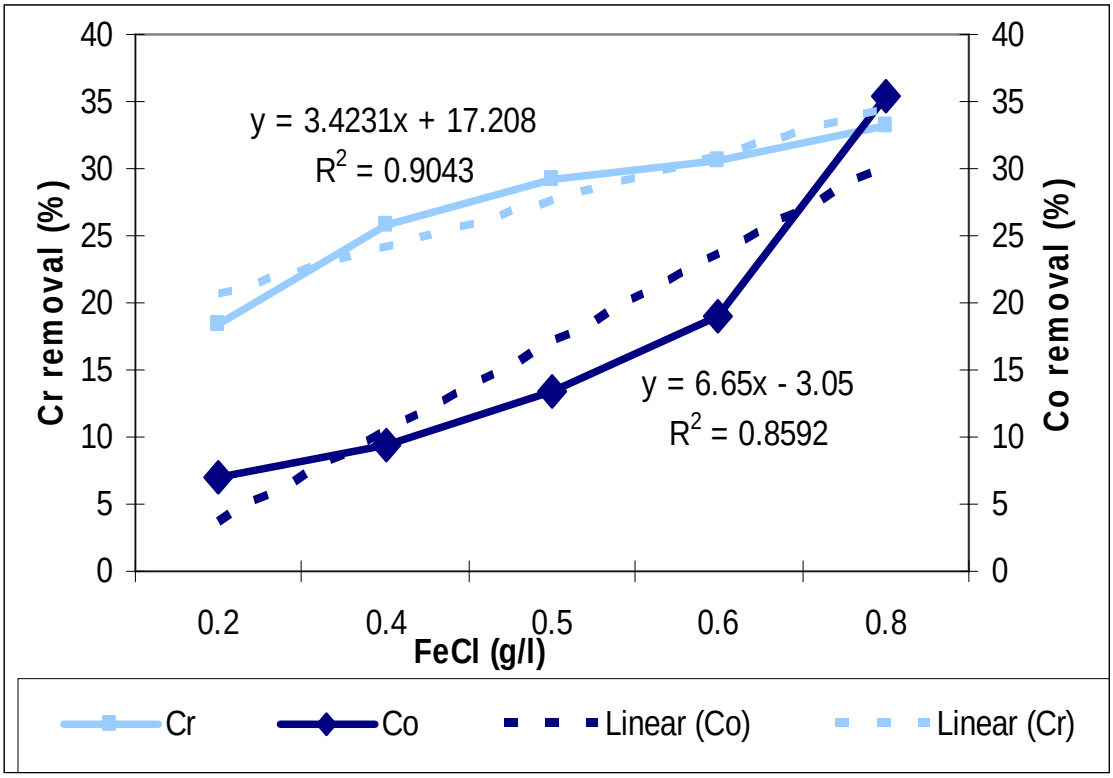
Appendix 3.34: Exponential correlation between pH and reduction in colour and turbidity



Appendix 3.35: Correlation between Ni and Al removal with concentration of $FeCl_3$.



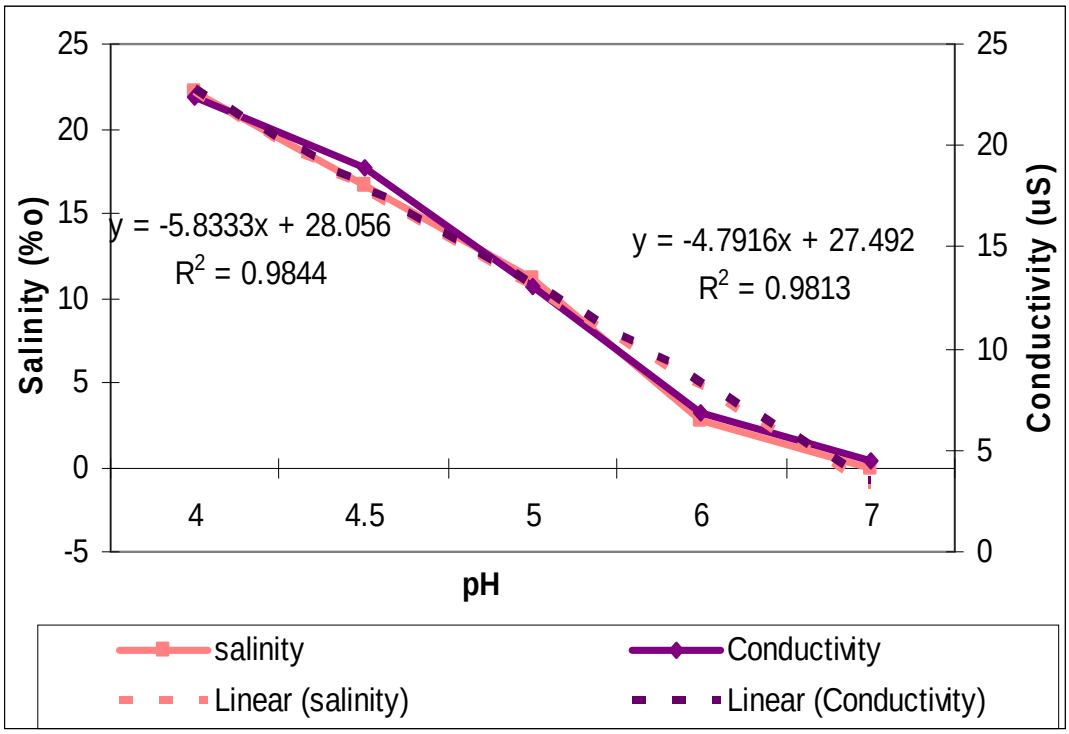
Appendix 3.36: Correlation between Cu and Zn removal with concentration of $FeCl_3$.



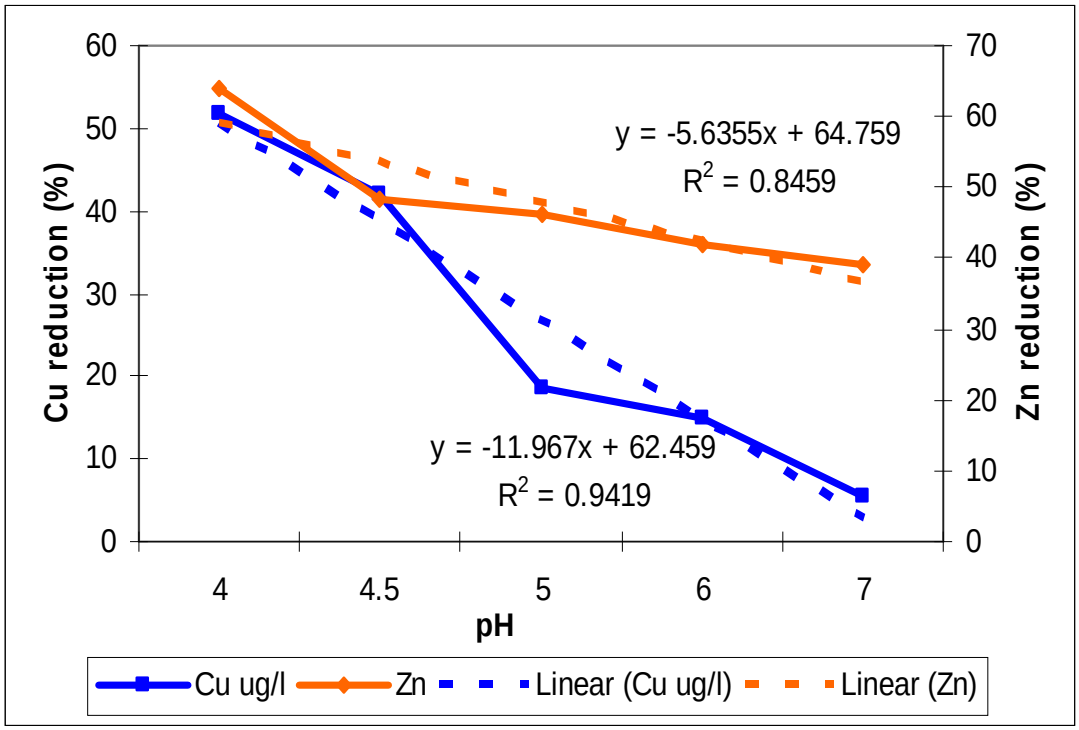
Appendix 3.37: Correlation between Co and Cr removal with concentration of $FeCl_3$.

Appendix 3.38: Percentage of reduction in leachate treated with $FeCl_3$ at different pH

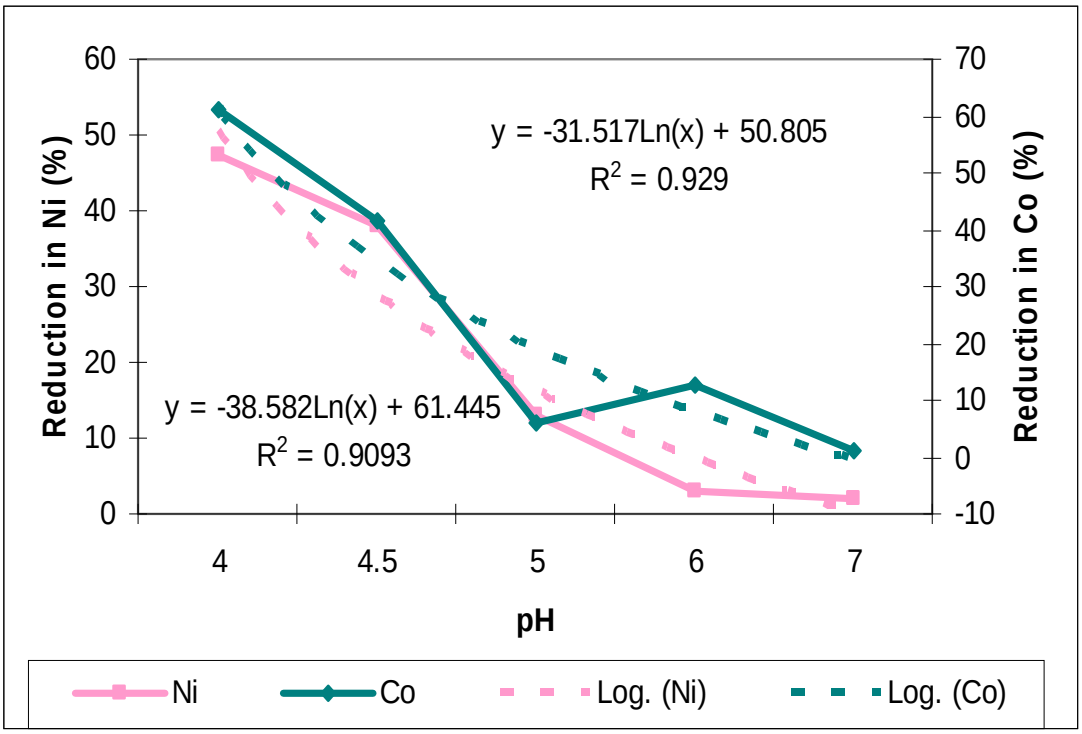
pH of $FeCl_3$ system	Reduction in pollution intensity (%)				
	4.0	**4.5**	**5.0**	**6.0**	**7.0**
BOD	11.8	10.8	10.8	7.5	7.5
COD	58.9	61.2	19.8	21.0	14.7
TS	-185.7	-79.1	-90.2	-132.8	15.6
TDS	38.5	36.2	26.3	6.4	2.2
salinity	22.2	16.7	11.1	2.8	0.0
Conductivity	22.4	18.9	13.0	6.8	4.5
Total P	76.7	69.0	33.4	23.4	18.0
Hardness	32.4	25.7	21.3	15.7	7.4
Alkalinity	37.1	34.3	34.3	22.9	9.5
Sulfite	30.0	30.0	20.0	20.0	10.0
Colour	98.7	96.5	8.0	3.4	2.7
Turbidity	100.0	47.8	43.5	43.5	30.5
TSS	100.0	59.7	39.4	39.4	39.4
Ammoniacal -N	27.4	16.8	18.4	-811.2	0.0
Chloride	-37.5	-8.3	-841.7	-4.2	-2.1
Cu ug/l	51.8	42.1	18.4	15.0	5.5
Zn	63.9	48.3	46.3	41.9	38.9
Ni	47.4	37.8	12.9	2.9	2.1
Co	61.0	41.5	6.2	12.8	1.0
Fe	-68.8	-42.3	-27.2	-20.1	-9.1
Mn	47.1	42.9	31.0	15.2	5.7
Cr	47.7	46.4	20.7	19.7	17.7
Ca	35.3	23.9	14.9	10.7	3.3
Mg	11.5	11.1	11.1	10.2	3.8
Cd	74.9	64.1	63.6	41.5	22.5
Ba	4.3	15.4	43.2	54.8	80.3
Pb	57.7	67.6	76.4	86.6	90.4
Al	56.0	48.1	39.9	24.8	6.1
V	50.9	41.3	31.4	37.2	33.3
Se	82.2	66.0	53.8	25.8	5.6
Ag	73.1	84.3	58.2	17.5	25.0
Sr	49.1	19.1	13.7	10.7	3.1
Li	1.4	2.6	-2.9	4.8	2.9



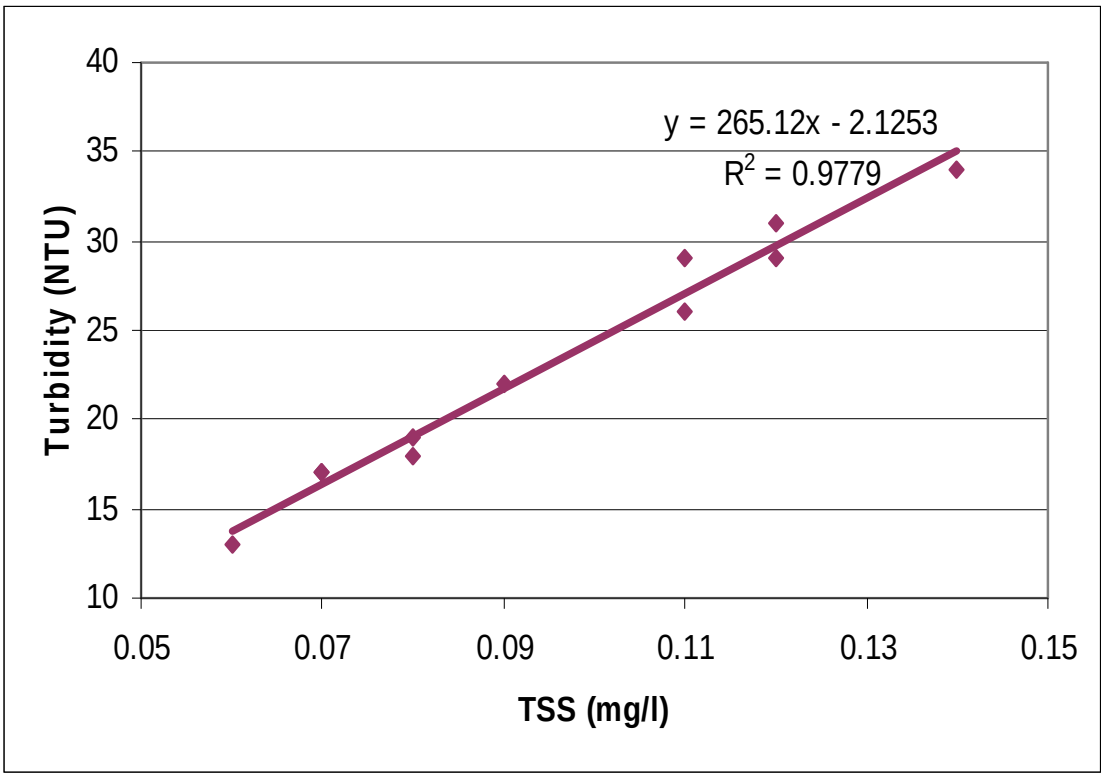
Appendix 3.39: Correlation between pH of $FeCl_3$ and salinity and conductivity.



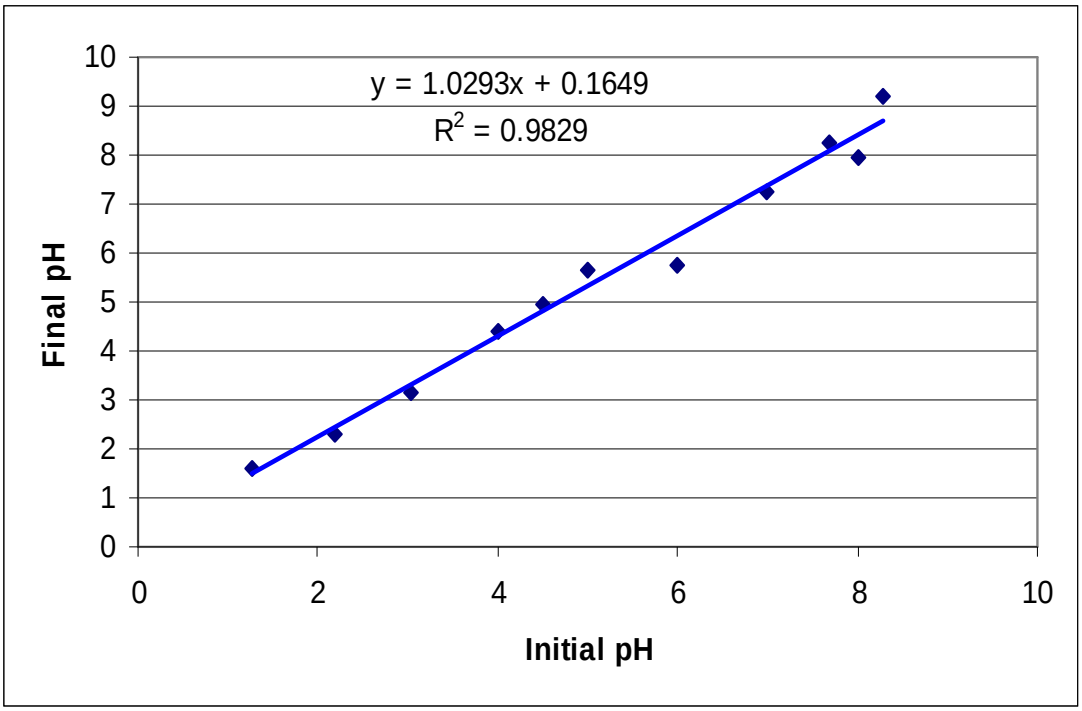
Appendix 3.40: Correlation between pH of $FeCl_3$ and Cu and Zn.



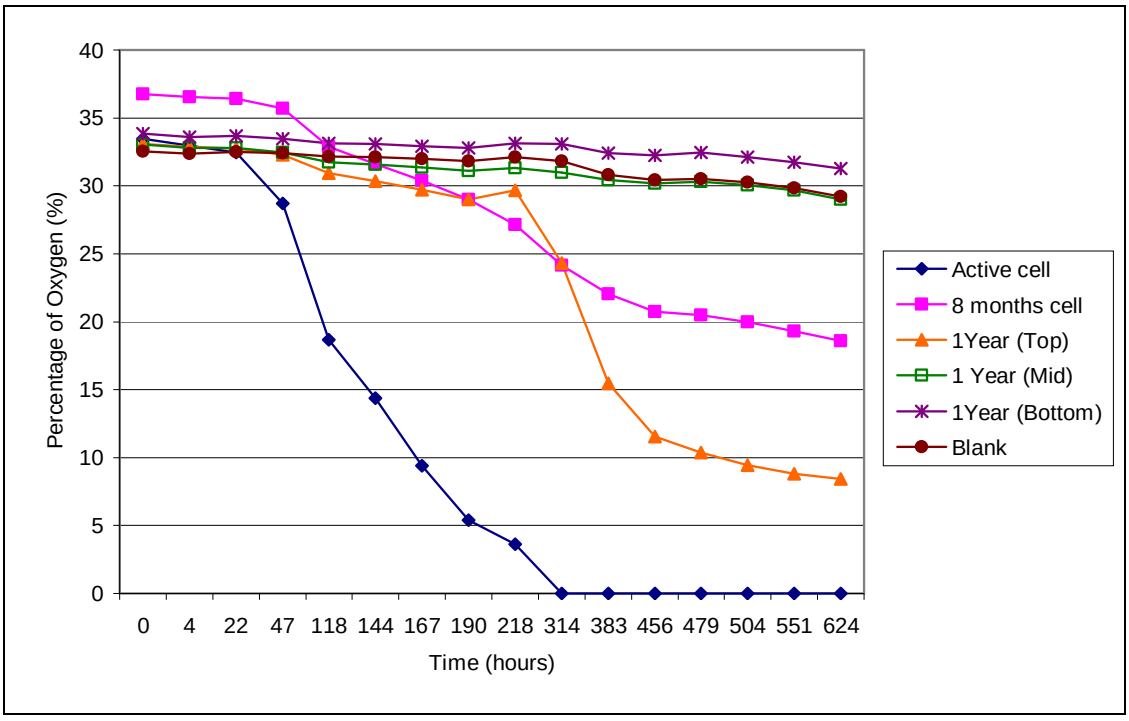
Appendix 3.41: Correlation between pH of $FeCl_3$ and Ni and Co.



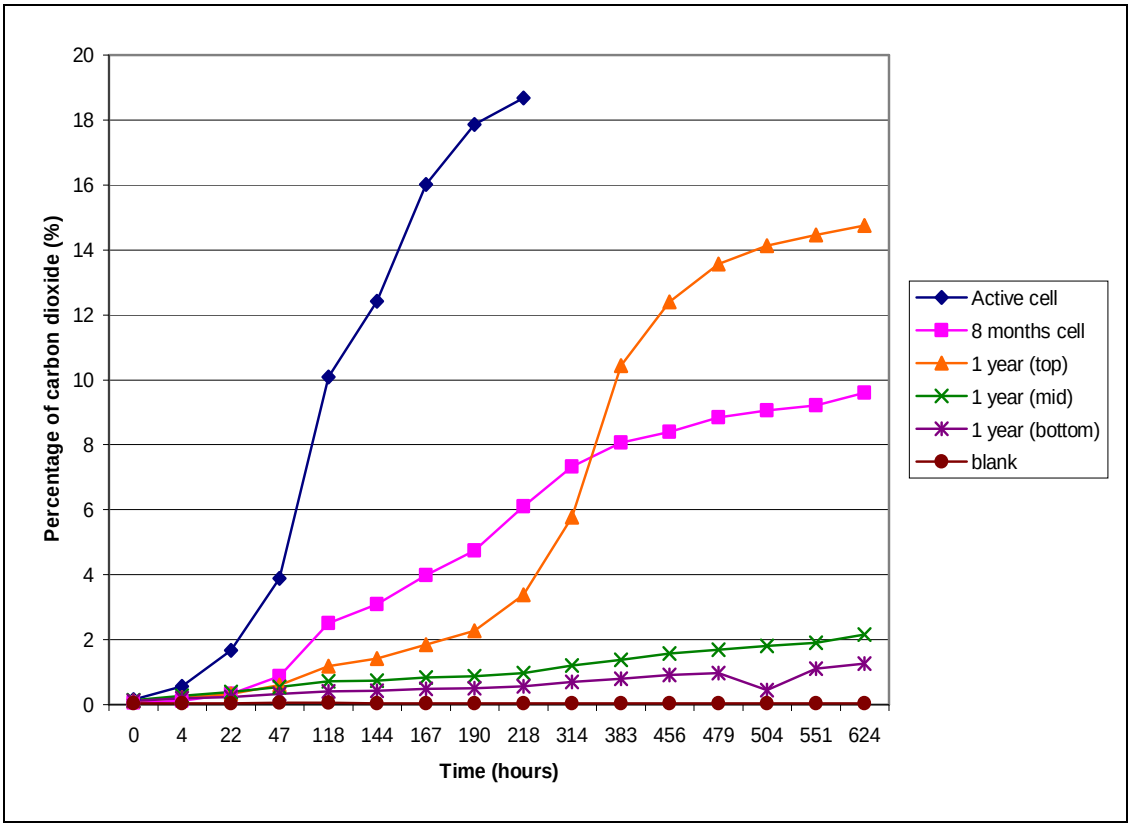
Appendix 3.42: Linear correlation between turbidity and TSS



Appendix 3.43: Linear correlation between initial pH and final pH.



Appendix 3.44: Utilization of oxygen (in percentage) over time by different soil materials.



Appendix 3.45: The generation of CO_2 by different soil types over time.