

## Contents

Heading	Page
Certificate from guide	
Declaration	
Acknowledgements	
Contents	i- vi
List of tables	vii – x
List of figures	xi- xiv
List of Plates	xv
Abstract	xvi - xxii
<b>Chapter 1 Introduction</b>	
1.1 Soil: its definition	1
1.2 Soil composition	1
1.3 Soil Contamination	3
1.4 Water	4
1.5 Contaminant uptake by Plants	5
1.6 Heavy metal toxicity	8
1.7 Textile Industry and the environmental issues	8
1.8 Objectives of the present work	12
<b>Chapter 2 The study area and methodology</b>	14
2.1 Rangia town: Important features	14
2.2 The Textile Mill	18
2.3 Collection of samples	
2.3.1 Sampling frequency	19
2.3.2 Soil samples	19
2.3.3 Water samples	23
2.3.4 Rice grain samples	25
2.4 Selection of parameters for soil analysis and methodology	
2.4.1 pH	25
2.4.2 Electrical Conductance	25
2.4.3 Bulk Density	25

2.4.4	Water holding capacity	26
2.4.5	Hydraulic Conductivity	27
2.4.6	Organic Matter (OM)	28
2.4.7	Total Nitrogen	29
2.4.8	Available phosphorus	30
2.4.9	Soil Texture	31
2.4.10	Oil and grease	32
2.4.11	Exchangeable Cations	33
2.4.12	Trace Metals	35
2.4.13	Major and Minor Oxides	37
2.4.14	Identification of clay minerals with XRD analysis	37
2.5	Selection of parameters for water analysis and methodology	38
2.5.1	pH	39
2.5.2	Electrical Conductivity (EC)	39
2.5.3	Solids	40
2.5.4	Total Hardness	41
2.5.5	Total Alkalinity	42
2.5.6	Sulphate	42
2.5.7	Nitrate	43
2.5.8	Phosphate	44
2.5.9	Chloride	45
2.5.10	Fluoride	45
2.5.11	Oil and grease	46
2.5.12	Phenol	47
2.5.13	Common metals, Ca, Mg, Na, K	49
2.5.14	Trace metals, Al, As, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Zn	
	Al	50
	As	51
	Cd	51
	Cr	52
	Cu	52
	Fe	53

Hg	53
Mn	54
Ni	54
Pb	55
Zn	55
2.5.15 Extraction of the metals and Analysis	55
2.5.16 Determination of heavy metals in rice grains and husks	56
<b>Chapter 3 Results and Discussions</b>	
3.1 Soil Quality of the Study Area	57
3.1.1 pH	57
3.1.2 Soil Electrical Conductivity (EC)	58
3.1.3 Bulk density	65
3.1.4 Water Holding Capacity	70
3.1.5 Hydraulic Conductivity	76
3.1.6 Soil texture and chemical composition	80
3.1.7 Organic Matter	91
3.1.8 Oil and Grease	94
3.1.9. Total Nitrogen	96
3.1.10 Available Phosphorus	97
3.1.11 Exchangeable cations	
i) Calcium	97
ii) Magnesium	102
iii) Sodium	106
iv) Potassium	109
3.1.12 Trace Metals	117
(a) Aluminium	118
(b) Arsenic (As)	121
(c) Cadmium (Cd)	121
(d) Chromium (Cr)	122
(e) Copper (Cu)	127
(f) Iron (Fe)	127
(g) Mercury (Hg)	130

(h) Manganese (Mn)	135
(i) Nickel (Ni)	136
(j) Lead (Pb)	143
(k) Zinc (Zn)	143
3.2 Drinking water quality of the study area	161
3.2.1 pH	161
3.2.2 Electrical Conductivity (EC)	162
3.2.3 Total Alkalinity	162
3.2.4 Total Dissolved Solids (TDS)	167
3.2.5 Total Solids (TS)	167
3.2.6 Total Hardness	168
3.2.7 Phenol	168
3.2.8 Chloride (Cl)	171
3.2.9 Sulphate (SO <sub>4</sub> )	174
3.2.10 Fluoride (F)	174
3.2.11 Nitrate (NO <sub>3</sub> )- N	176
3.2.12 Phosphate (PO <sub>4</sub> )	176
3.2.13 Calcium	176
3.2.14 Magnesium	180
3.2.15 Sodium	180
3.2.16 Potassium	181
3.2.17 Trace metals	
(a) Aluminium (Al)	181
(b) Arsenic (As)	181
(c) Cadmium (Cd)	181
(d) Chromium (Cr)	185
(e) Copper (Cu)	185
(f) Iron (Fe)	185
(g) Mercury (Hg)	185
(h) Manganese (Mn)	188
(i) Nickel (Ni)	188
(j) Lead (Pb)	188

(k) Zinc (Zn)	188
3.3 Surface water quality of the study area	194
3.3.1 pH	194
3.3.2 Electrical Conductivity (EC)	195
3.3.3 Total Alkalinity	195
3.3.4 Total Hardness	198
3.3.5 Total Solids (TS)	198
3.3.6 Total Dissolved Solids (TDS)	198
3.3.7 Chloride (Cl)	202
3.3.8 Fluoride (F)	202
3.3.9 Sulphate (SO <sub>4</sub> )	204
3.3.10 Phosphate (PO <sub>4</sub> )	204
3.3.11 Nitrate (NO <sub>3</sub> )- N	204
3.3.12 Phenol	208
3.3.13 Oil and grease (O &G)	208
3.3.14 Calcium	208
3.3.15 Magnesium	210
3.3.16 Sodium	210
3.3.17 Potassium	210
3.3.18 Trace metals	
(a) Aluminium (Al)	214
(b) Arsenic (As)	214
(c) Cadmium (Cd)	214
(d) Chromium (Cr)	217
(e) Copper (Cu)	217
(f) Iron (Fe)	217
(g) Mercury (Hg)	219
(h) Manganese (Mn)	219
(i) Nickel (Ni)	219
(j) Lead (Pb)	221
(k) Zinc (Zn)	221
3.4 Rice grains and husks	

3.4.1 Rice grains	225
3.4.2 Rice husks	228
<b>Chapter 4 Conclusions and suggestions for further work</b>	231
<b>References</b>	234