



CONTENTS



CONTENTS

Title	Page No.
1) Declaration by student.....	i
2) Certificate by supervisor.....	ii
3) Certificate by co-supervisor.....	iii
4) Certificate for plagiarism.....	iv
5) Turnitin anti-plagiarism report.....	v-viii
6) Certificate of viva-voice.....	ix
7) Undertaking for submission of Ph.D. thesis.....	x
8) Acknowledgement.....	xi-xii
9) Table of contents.....	xiii-xvii
10) List of figures.....	xviii
11) List of tables.....	xix
12) List of abbreviations.....	xx-xxii
13) Abstract.....	xxiii-xxv
14) CHAPTER 1: INTRODUCTION.....	1-12
1.1) Iron in water bodies.....	1
1.2) Iron presence standards and issues related to high iron concentration.....	4
1.3) Iron oxidation technique.....	5
1.4) Iron extraction techniques.....	6
1.5) Diverse techniques for iron extraction.....	6
1.6) Hypothesis.....	10

1.7) Key questions.....	11
1.8) Objectives.....	11-12
15) CHAPTER 2: REVIEW OF LITERATURE.....	13-31
2.1) Iron and manganese sources.....	13
2.2) Origins of iron and manganese in groundwater.....	14
2.2.1 Groundwater iron sources.....	14
2.2.2 The production of manganese.....	14
2.3) The chemical association between manganese and iron.....	15
2.3.1 Iron's chemistry.....	15
2.3.2 The chemical processes involving manganese in water.....	16
2.4) Iron and manganese's effects on drinking water.....	16
2.5) Elements that regulate the elimination of iron and manganese.....	18
2.6) Iron and manganese removal.....	18
2.6.1 Iron and manganese removal from ex-situ.....	18
2.6.1.1 Filtration followed by oxidation.....	19
2.6.1.2 Removal of iron and manganese by ion exchange.....	22
2.6.1.3 Removal of iron and manganese.....	22
by chemical oxidation	
2.6.1.4 Removal by membrane filtration.....	23
2.6.2 In-situ iron and manganese removal.....	23
2.6.2.1 Ferrous and manganous oxidation.....	24
2.6.2.2 NITREDOX method.....	25

2.7) Content of iron and manganese in the aquifer.....	25
2.8) Sorption.....	26
2.9) Background theory of adsorption.....	27
2.10) Filtration for iron and manganese removal.....	28-31
16) CHAPTER 3: MATERIALS AND METHOD.....	32-58
3.1) Location of the study area.....	32
3.2) Socio-economy and major drinking water practices.....	32
3.3) Isolation of iron oxidizing bacteria (IOB).....	39
3.3.1 Starter media.....	39
3.4) Gradient isolation and enrichment technique.....	39
3.5) Preparation of stock solutions.....	42
3.5.1 Preparation of ferric ammonium sulfate solution.....	42
3.5.2 Preparation of 8-hydroxyquinoline solution.....	42
3.5.3 Preparation of other reagents.....	43
3.5.4 Preparation of calibration curve.....	43
3.5.5 Determination of iron (III) in water samples.....	44
3.5.6 Recovery and stability studies of the proposed method.....	44
3.6) Identification and characterization of iron oxidizing bacterial isolates.....	45
3.6.1. Isolation of iron oxidizing bacteria.....	45
1. Sample collection.....	45
2. Culturing.....	45
3. Morphological characterization.....	45

3.6.2. Biochemical characterization.....	46
1. Biochemical tests.....	46
2. Iron oxidation activity.....	46
3.7) Characterization and formulation of soil media/carriers	
for the treatment of raw water.....	46
3.7.1 Gravel.....	46
3.7.2 Sand.....	47
3.7.3 Coarse sand.....	48
3.7.4 Bentonite.....	48
3.7.5 Lignite.....	49
3.7.6 Characterization techniques.....	49
1. X-ray Fluorescence (XRF).....	49
2. Scanning Electron Microscopy (SEM).....	49
3. Brunauer-Emmett-Teller (BET) Method.....	50
4. Mercury Intrusion Porosimetry.....	50
5. X-ray Diffraction (XRD).....	50
6. Thermogravimetric Analysis (TGA).....	50
3.8) Utilization of carrier for absorption	
of Iron in water samples.....	50
3.9) Utilization of carrier along with	
microbes for absorption of iron in water samples.....	51
3.10) Compatibility screening of iron oxidizing bacteria.....	51
1. Preparation of bacterial broth cultures.....	52
2. Centrifugation and collection of supernatants.....	52

3. Well diffusion technique for compatibility testing.....	52
4. Application of supernatants.....	53
5. Observation and interpretation of results.....	53
6. Criteria for compatibility.....	53
3.11) Preparation of consortia.....	54
3.12) Preparation of formulation using the suitable carrier.....	54
3.13) Preparation of pilot scale reactor with biological filtration.....	54
3.14) Removal of iron via filtration.....	57
3.15). Statistical analysis.....	57-58
17) CHAPTER 4: RESULTS.....	59-92
18) CHAPTER 5: DISCUSSION.....	93-101
19) CHAPTER 6: CONCLUSION.....	102-103
20) CHAPTER 7: SUMMARY.....	104-107
21) REFERENCES.....	108-128
22) LIST OF PUBLICATIONS & CERTIFICATES.....	129-142