

## TABLE OF CONTENTS

<b>Executive Summary .....</b>	<b>x</b>
<b>Table of Contents .....</b>	<b>ix</b>
<b>List of Appendices .....</b>	<b>xi</b>
<b>List of Figures .....</b>	<b>xii</b>
<b>Terminology .....</b>	<b>xiv</b>
<b>1. INTRODUCTION .....</b>	<b>1</b>
1.1 Background .....	
1.2 Research Objectives .....	
<b>2. SETTLING AND SEDIMENTATION TANKS .....</b>	<b>6</b>
2.1 Sedimentation tanks in water treatment .....	6
2.1.1 Substances removed by sedimentation process .....	6
2.1.2 Functions of sedimentation tanks in water treatment .....	6
2.1.3 Consequences of poor sedimentation tank performance .....	7
2.1.4 Rectangular sedimentation tanks .....	8
2.2 Characterization of floc particles .....	9
2.2.1 Characterization of floccules in settling tanks .....	9
2.2.2 Mathematical description of particle settling .....	11
2.2.3 Numerical description of particles .....	17
2.3 Design of rectangular settling tanks .....	18
2.3.1 Conventional approach and guidelines for design .....	18
2.3.2 Limitations of the conventional design approach .....	21
<b>3. COMPUTATIONAL FLUID DYNAMICS (CFD) .....</b>	<b>23</b>
3.1 CFD Modelling .....	23
3.1.1 Basic methodology of CFD .....	23
3.1.2 Modelling of two-phase systems .....	29
3.1.3 The densimetric froude number .....	32
3.1.4 Aspects affecting accuracy of CFD models .....	33
3.2 History of application of CFD models to sedimentation tanks .....	34
3.2.1 Examples from literature .....	34
3.2.2 The Jönköping tank .....	36
3.3 CFD Packages available and used .....	37
<b>4. VALIDATION OF CFD MODELS OF RECTANGULAR SEDIMENTATION TANKS .....</b>	<b>40</b>
4.1 Benchmarks and validation criteria .....	40
4.2 Variables investigated .....	42
4.3 The laboratory model tank (Labtank) .....	43
4.4 Simulation of floc particles in the Labtank .....	44
4.4.1 Requirements .....	44
4.4.2 Materials tried as floc simulants .....	44

<b>5. TYPICAL RESULTS AND PRESENTATION OF CFD SIMULATIONS.....</b>	<b>47</b>
5.1 The standard case of the tanks.....	47
5.2 Comparison of simulation of 2-phase flow using scalar and discrete algorithms .....	51
<b>6. CFD SIMULATIONS OF LABTANK.....</b>	<b>53</b>
6.1 Development of the numerical model .....	53
6.1.1 Computational mesh development.....	53
6.1.2 Relaxation parameters.....	55
6.1.3 Simulation of floc behaviour .....	55
6.2 The standard case simulation of the Labtank .....	58
6.2.1 Parameters for standard case.....	58
6.2.2 List of figures with parameters changed during the respective simulations .....	59
6.3 The effect of changes in the operational parameters .....	60
6.4 The effect of changes in the tank configuration .....	61
<b>7. CFD SIMULATIONS OF MIDVAAL TANKS.....</b>	<b>63</b>
7.1 Development of the computational mesh.....	63
7.2 The standard case of the Midvaal tanks .....	65
7.3 Effect of changes in operational conditions .....	67
7.4 Effect of changes in tank configuration.....	70
<b>8. DISCUSSION AND CONCLUSIONS.....</b>	<b>74</b>
<b>BIBLIOGRAPHY .....</b>	<b>83</b>
<b>APPENDICES .....</b>	<b>87</b>

## LIST OF APPENDICES

Appendix A	Geometry of the laboratory settling tank model (Labtank).	84
Appendix B	Labtank inlet configurations.	85
Appendix C	Temperature dependence of density and viscosity of water.	89
Appendix D	Determination of floc particle simulant density.	91
Appendix E	Derivations & calculations for particle mass injection rate & spherical particle settling velocity.	92