

Development of a Decision Support System for

Long Sea Outfall

Designing and Operations

Final Report

Dissertation submitted in partial fulfillment of the requirements for the



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Declaration

I certify that this thesis does not incorporate any material previously submitted for any degree or diploma in any university and to the best of my knowledge and belief it does not contain any material previously published or written or orally communicated by another person except where due reference made in the text.

Date

Nalaka Lankasena

To the best of my knowledge above particulars are correct.



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Abstract

Long sea out-fall is an acceptable method of domestic wastewater disposal, provided that the design is done properly, and it is constructed robustly and according to the design. The dispersion of the sewage after discharging to the sea has come under increased scrutiny in recent years, due to the sea and seashore pollution.

In a properly designed and constructed long sea out-fall, the waste is discharged at a point in sea, away from any environmentally sensitive areas such as coral reefs, and far enough from the beach so that the quality of water reaching the beach conforms to the stipulated standards.

In this research development of SOS (Sea Outfall System) was done and a successful implication of GA (Genetic Algorithm) in sea outfall optimization and ANN (Artificial Neural Network) in concentration prediction after discharging to sea is introduced.



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The SOS is specially developed to design and identify pollutant behavior of sewage discharged using Multi-port Diffusers. The system is designed to handle several scenarios such as stratified and unstratified sea conditions and stagnant and flowing plumes. The system can predict concentrations of parameters in the far field as well as the near field, and also can be used as a decision support system for designing. It is also capable of analyzing the near field of single port sea outfalls, and can be developed for the far field analyzing and design decisions of multiport diffuser discharges.

SOS Expert (Decision-maker) provides decisions on required designing configurations, so that the user can find optimum configurations. SOS HELP provides necessary information about long sea outfalls as well as information about the SOS.

In addition to SOS, Artificial Neural Network (ANN) too is used in concentration prediction after outfall discharging. Artificial Neural Networks are capable of modeling experience based non-algorithmic knowledge. Different technologies and data gathering methodologies used in ANN training and it is possible to develop site-specific neural networks for predictions.

The system is developed according to Object Oriented Techniques. Major programming is done using Visual C++ Version 6.0 and MATLAB 5.3 was used in GA optimizations. WinNN Version 0.93 used in ANN designing, training and testing. The system provides an easy way to identify concentrations due to dispersion and decaying. With the help of SOS Expert designers can optimize outfall configurations. The cost and time needed in sea outfall designing and operations can be reduced with the SOS, SOS Expert, GA optimization technique and ANN predictions.



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Table of Contents

Declaration	II
Acknowledgement	III
Abstract	IV
Table of Contents	VI
List of Figures	X
List of Tables	XII
Notation and Sign Convention	XIII
1.0 INTRODUCTION	
1.1 Long Sea Outfall as a Method of Waste Disposal	1.1
1.2 Artificial Neural Network as a tool of Prediction	1.2
1.3 Genetic Algorithm as an Optimization tool	1.3
1.4 Computer System Development	1.4
1.5 Objective and Scope of the Project	1.5
1.5.1 Objective	1.5
1.5.2 The Scope of the Project	1.6
2.0 THEORETICAL BACKGROUNDS	
2.1 Long Sea Outfalls	2.1
2.1.1 Types of Classification Systems	2.3
2.1.2 Factors to be considered in Sea Outfall Designing and Construction	2.5
2.1.3 Near-field and Far-field Regions	2.8
2.1.4 Near-field Modeling	2.8
2.1.4.1 Initial Dilution of Vertical Single Port Discharges in Unstratified Sea	2.9

2.1.4.2 Initial Dilution of Vertical Single Port Discharges in Stratified Sea	2.10
2.1.4.3 Initial Dilution of Multi-port Diffuser Discharges in Linearly Stratified Sea	2.12
2.1.5 Far-field Modeling	2.16
2.1.5.1 Eddy Dispersion	2.17
2.1.5.2 Plume Centerline Concentration Calculation	2.17
2.1.5.3 Plume Width Calculation	2.19
2.1.5.4 Pretreatment of Sewage	2.19
2.1.6 Long Sea Outfall Designing and Decision Making	2.22
2.1.6.1 Pipe Length Estimation	2.22
2.1.6.2 Diffuser Length Calculation	2.22
2.1.6.3 Waste Velocity in the Pipe	2.23
2.1.6.4 Diameter of the Pipe and Diffuser	2.23
2.1.6.5 Diffuser Port Diameter	2.23
2.1.6.6 Port Spacing	2.24
2.1.6.7 Diffuser Discharge Depth	2.25
2.1.6.8 Diffuser Alignment	2.26
2.1.6.9 Maximum Peak Sewage Velocity	2.26
2.1.6.10 Diffuser Length and Discharge Depth Ratio	2.26
2.2 Prediction Using Artificial Neural Networks	2.26
2.2.1 Learning System	2.26
2.2.1.1 Feed-forward Back-propagation	2.27
2.2.2 WinNN Software	2.30
2.2.3 Mathematical Models for Determination of Dilution	
Dilution due to Dispersion and Decaying	2.32

2.2.3.1 Data Abstraction Theory for ANN Training due to Dispersion	2.32
2.2.3.2 Data Abstraction Theory for ANN Training due to Dispersion	2.35
2.3 Genetic Algorithm	2.37
2.3.1 The Need for GA	2.37
2.3.2 General Terminology of GA	2.38
2.3.3 Biological Phenomena Related to GA	2.38
2.3.4 Evolution process of GA for Long Sea Outfall Optimization	2.39
2.3.4.1 Individuals Representation	2.39
2.3.4.2 Initial Population Generation	2.39
2.3.4.3 Selection of Individuals	2.40
2.3.4.4 Application of GA Operators	2.40
2.3.4.5 Evaluation of Individuals	2.44
2.3.4.6 Termination of GA Operations	2.45



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3.0 METHODOLOGY

4.0 DEVELOPMENT OF THE SYSTEM

4.1 Integrated System Architecture	4.1
4.2 Flow Chart of the System	4.4
4.3 Development of Interfaces	4.6
4.4 Critical Scenario for Sea Outfall Designing and Concentration Prediction	4.23
4.5 Assumptions of the Model	4.23
4.6 General Suggestions for Design Operation	4.23

5.0 DISCUSSIONS AND TESTING

5.1 Discussion of System Interfaces	5.1
5.2 Calibration and Verification of SOS	5.2
5.2.1 SOS Verification using Field data from Wellawatte and Mutwal	5.2
5.2.2 Far-field Verification	5.5
5.2.3 SOS Prediction for Wellawatte Outfall	5.8
5.2.4 Limitation of the Model	5.10
5.3 Discussion of ANN Results and Testing	5.11
5.3.1 Discussion of ANN Results	5.11
5.3.2 ANN Testing	5.17
5.4 Discussion of GA Results	5.19
5.4.1 Summary of GA Program Outputs	5.19

6.0 CONCLUSIONS AND DISCUSSIONS	
6.1 Conclusions	6.1
6.2 Recommendations for further Work	6.1

List of References	R.1
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APPENDIX

Appendix I - Program outputs of GA	A1.1
Appendix II – Tables and Figures of DFID	A2.1
Appendix III – Codes of Interfaces (Included in the CD)	A3.1
Appendix III - Codes of GA programs (Included in the CD)	A4.1

List of Figures

Figure 2.1: A definition sketch of a coastal area	2.1
Figure 2.2: Schematic view of a plume formation after discharge through a long sea outfall	2.2
Figure 2.3: Classification of sea according to density	2.3
Figure 2.4: Classification of outfalls	2.4
Figure 2.5: Classification of plumes	2.4
Figure 2.6: Schematic of an outfall discharge into a uniform (unstratified) environment	2.6
Figure 2.7: Schematic of an outfall discharge into a linearly stratified sea	2.7
Figure 2.8: Minimum initial dilution variation with the Froude number	2.14
Figure 2.9: Equilibrium plume height variation with the Froude number	2.14
Figure 2.10: Layout of ports in a diffuser	2.23
Figure 2.11: Basic neural network architecture	2.28
Figure 2.12: Nomograph for dilution factor due to dispersion	2.34
Figure 2.12: Nomograph for training of neural network due to decaying	2.36
Figure 4.1: Integrated system Architecture	4.2
Figure 4.2: Integrated System Architecture of ANN with GA Optimization	4.3
Figure 4.3: Flow chart of SOS with GA	4.5
Figure 4.4: About sea outfall system interface	4.7
Figure 4.5: Initial mixing data input interface	4.8
Figure 4.6: Initial mixing data analysis of single port discharges	4.11
Figure 4.7: Initial mixing data analysis of multi-port discharges	4.12
Figure 4.8: Final concentration information menu	4.14
Figure 4.9: Graphical representation menu	4.17

Figure 4.10: Outfall designing configurations interface	4.18
Figure 4.11: Decision supporting information menu	4.21
Figure 4.12: SOS Help interface	4.22
Figure 5.1: Concentration variation of SOS prediction vs. Dye tracked estimation	5.7
Figure 5.2: Outputs of trained data with expected values	5.16
Figure 5.3: Variation of Test Data with Expected Output	5.18
Figure 5.4: Variation of total cost with the diffuser length (Initial dilution, dispersion and decaying were considered)	5.21
Figure 5.5: Variation of total cost with the pipe length (Initial dilution, dispersion and decaying were considered)	5.21
Figure 5.6: Variation of total cost with the diffuser length (Initial dilution, dispersion and decaying were considered)	5.23
Figure 5.7: Variation of total cost with the diffuser length (Only initial dilution and dispersion were considered)	5.25
Figure 5.8: Variation of total cost with the pipe length (Only initial dilution and dispersion were considered)	5.25

List of Tables

Table 5.1: Comparison of SOS predicted Far-Field concentrations	5.6
Table 5.2: Predicted Coliform concentration for different current velocities and discharge concentrations	5.9
Table 5.3: Expected and trained dispersion factor with ANN trained values	5.11
Table 5.4: Expected and predicted output of the ANN (Test Data)	5.17
Table 5.5: Total cost generation according to diffuser and pipe length cost (Initial dilution, dispersion and decaying were considered)	5.20
Table 5.6: Total cost generation according to diffuser length cost (Only initial dilution is considered)	5.22
Table 5.7: Total cost generation according to diffuser and pipe length cost (Only nitial dilution and dispersion were considered)	5.24



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Notation and Sign Convention

SOS	Sea Outfall System	dz	Vertical Density Gradient
ρ	Ambient Water Density	g	Gravitational Force
$\Delta\rho_D$	Discharge Density Difference	GA	Genetic Algorithm
b_1	Plume Width	h_1	Thickness of the Plume
k	Decay Constant	L	Diffuser Length
C_D	Discharge Concentration	Q_D	Discharge Flow-rate
DNA	Deoxyribo Nucleic Acid	U	Ambient Current Velocity
q	Probability of selecting the best individual	r	Rank of the individual, where 1 is the best.
P	Population size	C_{dt}	Unit diffuser cost
C_{pt}	Unit pretreatment cost	T_l	Required pretreatment level
a_i	Lower bound of GA variable i	b_i	Upper bound of GA variable i
D_2	Dispersion factor	Q_{min}	Minimum flow rate
V_{min}	Minimum sewage velocity in the pipe	L	Diffuser length
D_p	Distance between ports	N_p	Number of Ports
P_a	Pipe area	PT_a	Port area
PE	Processing element	H	Discharge depth
H_{eqm}	Equilibrium plume height	N	Buoyancy frequency
g'_D	Discharge buoyancy	I_{avg}	Average initial dilution
F	Froude number		