AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING

FEASIBILITY STUDY OF REUSE OF TREATED EFFLUENT

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Cairo 2009

STATEMENT

This thesis is submitted to Ain Shams University, Cairo, Egypt, on April 2009 for the degree of Master of Science in Civil Engineering (Public Works Department)

The work included in this thesis was carried out by the author in Civil Engineering (Public Works Department), Ain Shams University, from October 2002 to April 2009.

No part of this thesis has been submitted for a degree or a qualification at any other University or Institute.

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(Public Works Department)

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ACKNOWLEDGEMENT

The writer wishes to express his sincere appreciation to all who have contributed to this study.

The writer is deeply indebted to **Dr. Mohammed Shabaan Negm** Professor of sanitary and environmental engineering, Faculty of Engineering, Ain Shams University for his constant supervision, planning, guidance, valuable suggestions, precise advice, and constant encouragement during all stages of this research work.

The writer wishes to express his sincere appreciation to **Dr. Mohammed Hassan Abdel Razik**, Professor of sanitary and environmental engineering, Faculty of Engineering, Ain Shams University, for his kind and constant supervision, for his sincere help, encouragement, and cooperation to the fullest degree during all phases of this work.

Finally, the writer dedicates this thesis to his family, especially to his **Parents, Wife** and **Daughter** for their continuous encouragement, support, patience and fruitful care.

AIN SHAMS UNIVERSITY
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PUBLIC WORKS DEPARTMENT

Abstract of the M.Sc. thesis submitted by:

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Title of the thesis:

FEASIBILITY STUDY OF REUSE OF TREATED EFFLUENT

Supervisors:

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ABSTRACT

This study presents the reuse of treated effluent from El-Berka WWTP in agriculture for three scenarios: the first is reuse of primary treated effluent in irrigation of a new wooden trees farm by using surface irrigation system, the second is reuse of secondary treated effluent in irrigation of a new farm consisting wooden trees, vegetables eaten after cooking, and industrial crops by using sprinkler irrigation system, and the third is reuse of tertiary treated effluent in irrigation of a new farm consisting vegetables eaten raw by using drip irrigation system.

Detailed feasibility study – environmental, technical, and economical – is presented to determine the viability of the reuse of treated effluent in agriculture. Where public health considerations are the important constraint for reuse of treated effluent in agriculture. The detailed feasibility study presents for each scenario environmental feasibility, technical feasibility, and economical feasibility. The environmental feasibility study presents the environmental impacts and the environmental evaluation by using risk assessment techniques using semi quantitative method for determination of risk values and the recommended mitigations to mitigate the environmental impacts. The optimal environmental scenario for reuse of treated effluent in irrigation is the lowest risk values. The technical feasibility study presents the

technical issues and the recommended mitigations to mitigate the technical impacts. The economical feasibility study taking into consideration the recommended mitigations from the environmental and technical feasibility. The economical feasibility using Cost-Benefit Analysis CBA presents for each scenario the basic assumptions, cost and benefit stream for each step of the scenario, and the economic measures (NPV – B/C – IRR). The optimal economical scenario for reuse of treated effluent in irrigation is determined by studying the economic measures. Where the scenario with the highest (NPV – B/C – IRR) is the optimal scenario. The optimal economical and environmental scenario is determined by using relative weights or according to the priorities of the owner. The sensitivity analysis has been applied to examine the feasibility of the optimal scenario against the future uncertainty on the variables and /or technical coefficients used in the environmental risk assessment evaluation and in the economical evaluation.

The current situation of El-Berka WWTP is discharging the treated effluent without any reuse application, which is not recommended while the treated effluent can be reused for agriculture of 15,000 feddan wooden trees, potatoes, and sugar beets according to the second scenario – The optimal environmental and economical scenario –

The highest risks in the second scenario is the pollution of air by droplets and bad smells and the use of agriculture drains in municipal uses and fishing farms. The most effective risk to reduce the risk value of the second scenario – optimal environmental and economical scenario – is the risk No. 3 (pollution of air by droplets and bad smells). The most effective variable to increase the NPV of the second scenario is the running costs where if the running costs are reduced by 20% the NPV will be increased by 23.6%.

Keywords: Treated Effluent, Feasibility Study, Risk Assessment, Cost Benefit Analysis, Optimal Scenario.

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LIST OF ABBREVIATIONS AND SYMBOLS

(A) .....Surface area
(B) .....Benefits
(B/C).....Benefit – Cost ratio
(BOD_5) .....Biological Oxygen Demand after 5 days in 20^o C
(CBA).....Cost – Benefit Analysis
(CC).....Capital Cost
(D) .....Diameter
(ECP).....Egyptian Code of Practice
(EPA).....Environmental Protection Agency USA
(EPD).....Georgia Environmental Protection Division
(FAO) .....Food and Agriculture Organization of United Nation
(i).....Discount rate
(IRR).....Internal Rate of Return
(L.E) .....Egyptian Pound
(N) .....Nitrogen
(NPV) .....Net Present Value
(n) .....Lifetime of the Scenario
(OMC) .....Operation and Maintenance Cost
(P).....Phosphorus
(PH).....Acidity / Alkalinity Scale
(Q) .....Discharge
(SAR) .....Sodium Adsorption Ratio
(SS).....Suspended Solids
(TDS).....Total Dissolved Solids
(TSS) .....Total Suspended Solids
(t).....Year
(UPVC).....Unplastiside Poly Vinyl Chloride
(V) .....Velocity
(WHO).....World Health Organization
(WWTP).....Wastewater Treatment Plant

CHAPTER ONE
INTRODUCTION

1.1 Background

Water used to be one of the cheapest natural resources. In recent years, it is discovered that water is no longer an abundant commodity in our country and other countries. Reasons for this include population growth, increase of the average water consumption for domestic and industrial purposes, pollution and climate changes. Treated effluent of wastewater treatment plants is one of the water resources, which can be used in agriculture.

1.2 Problem Definition

In Egypt, there is a big need for food and water due to the population growth and increase in the average water consumption for domestic and industrial purpose. The next figure presents the water share per capita and the population increase. Therefore, there is a need for land reclamation and new resources of water.

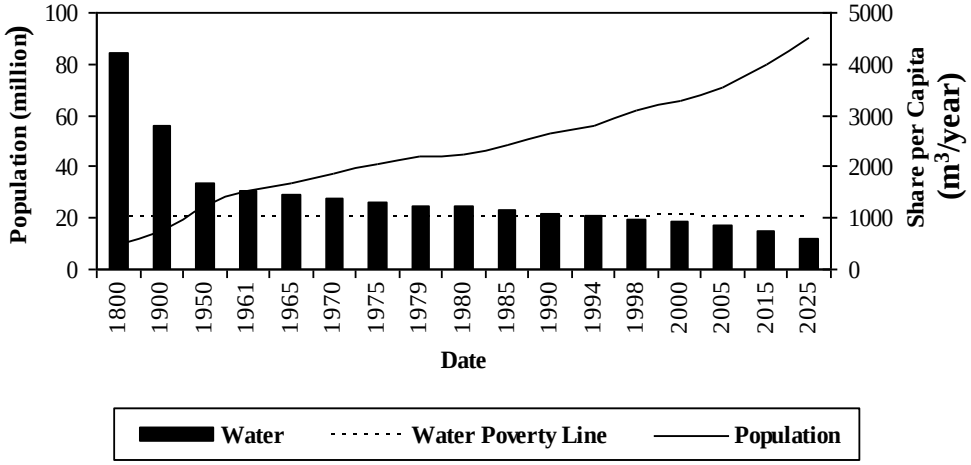

Figure (1-1) Water Share per Capita and Population Increase