

Higher Technical Institute
CIVIL ENGINEERING DEPARTMENT

DIPLOMA PROJECT

DESIGN OF A WATER TREATMENT
PLANT

BY
NIKI C. MITA

C/887

JUNE-1999

HIGHER TECHNICAL INSTITUTE

CIVIL ENGINEERING COURSE

DIPLOMA PROJECT

DESIGN OF A WATER TREATMENT
PLANT

C/887

NIKI C. MITA

JUNE 1999

HIGHER TECHNICAL INSTITUTE	PROJECT NO. 2952
----------------------------------	---------------------

CONTENTS

ACKNOWLEDGEMENTS	4
SUMMARY	6
1. INTRODUCTION	6
1.1. WATER QUALITY STANDARDS	6
1.2. WATER TREATMENT WORKS OBJECTIVES.....	8
1.3. SIZING	9
1.4. PROCESS SELECTION.....	9
1.5. RAW WATER RECEPTION AND COAGULATION	12
1. Raw Water Inlet.....	12
2. Coagulation.....	13
3. Flocculation.....	14
1.6. PRIMARY CLARIFICATION.....	15
1. Upward Flow Sedimentation	15
2. Dissolved Air Flotation.....	15
1.7. SLUDGE DISPOSAL.....	16
1. Sludge Production.....	16
2. Sludge Withdrawal.....	17
3. Sludge Concentrations.....	17
4. Final Disposal.....	17
5. Waste Water Recovery.....	18
1.8. RAPID GRAVITY FILTRATION.....	18
1. Filtration Rates	18
2. Filter Beds	18
3. Filter Operation.....	19
4. Cleaning	20
5. Washwater.....	21

1.9. pH ADJUSTMENT	21
1. General	21
2. Lime	21
3. Caustic Soda	22
4. Sulphuric Acid	22
1.10. DISINFECTION	23
1. General	23
2. Chlorine Gas	23
3. Sodium Hypochlorite	24
4. Chlorine Dioxide	28
5. Chlorination	29
6. Chlorine Contact Provision	30
7. De-chlorination	30
8. Housing of Chlorination Equipment	31
9. Handling and Storage of Chlorine	31
10. Ozonation	31
11. Ultraviolet Radiation	32
1.11. TASTE REMOVAL	34
1.12. FLUORIDATION	34
1.13. TREATED WATER STORAGE	34
1.14. PROCESS CONTROL AND INSTRUMENTATION	35
1.15. GENERAL DESIGN CONSIDERATION	36
1.16. STORAGE AND HANDLING CHEMICALS	38
1.17. PLANT	39
2. LIMASSOL WATER TREATMENT WORKS- DESIGN CRITERIA	
1. INTRODUCTION	41
2. NAME OF WORKS	42
3. MAXIMUM WATER INPUT	42

4. WATER SOURCE	42
5. PROCESS SUMMARY	42
6. TREATED WATER QUALITY	43
7. HYDRAULIC PROFILE.....	43
8. THE PROCESS FLOWSHEET.....	43
9. MAIN FLOW – FLOW RATE.....	46
10. COMPONENT WORKS – PRECHLORINATION AND AERATION.....	46
11. COMPONENT WORKS – INLET WORKS/FLASH MIXER.....	47
12. COMPONENT WORKS – FLOCCULATORS.....	47
13. COMPONENT WORKS – CLARIFIERS	48
14. COMPONENT WORKS – FILTERS	49
1. Existing Plant	49
2. Proposed Plant.....	50
15. COMPONENT WORKS – TREATED WATER RESERVOIR.....	50
16. COMPONENT WORKS – CHEMICAL STORAGE/HANDLING.....	51
1. Existing Plant	51
2. Proposed Plant.....	52
17. COMPONENT WORKS – SLUDGE TREATMENT	54
1. Existing Plant	54
2. Sludge Drying Beds – Specifications	54
3. Proposed Plant.....	54
3. INTRODUCTION	56
3.1. RECOMMENDATIONS.....	56
3.2. OSEC PLANT RATING.....	56
3.3. FAS STORAGE TANK – SIZING.....	58
3.4. PLANT LAYOUT.....	58
3.5. COST ESTIMATE.....	58
REFERENCES	63

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my colleagues in Design Group One, in the Department of Environment of Northern Ireland, giving special thanks to Stephanie Begley and Paul Steward for giving me useful information and IAESTE (International Association for the Exchange of Students for Technical Experience United Kingdom), for giving me the privilege to participate in such a department.

I would like to thank Mr Y. Papazoglou for showing me around the Limassol W.T.P. and providing me with useful information, as well as all the technical support staff of the plant for being very helpful.

I would also like to thank Dr Sotiris Georgiou, my brother for his help with computers and for his advice.

Last, but not least, I would like to thank Mr. N. Kathiotis for taking on the supervision of my project.

SUMMARY

The Water Development Department is committed to continuously improving standards in terms of both the quality and reliability of our water supply, while providing protection to the environment.

It is with this objective that existing Water Treatment Plants need to be refurbished and upgraded to further improve compliance with the EC Drinking Water Directive and the level of service.

The Limassol Water Treatment Plant project is one of three water treatment works that is commissioned in the present program within Southern Division illustrating the extent of the Water Development Department investment.

The following report has been prepared to define design suggestions for

- (i) upgrading existing Limassol treatment Works to ensure a better drinking water quality;
- (ii) increasing safety.

The introduction of an ozonation stage will satisfy (i) above. An on-site electrolytic chlorination (O.S.E.C.) plant will satisfy (ii) above.

The report as well as making design suggestions for the improvement of a specific Water Treatment Plant, outlines the design considerations objectives and criteria that need to be taken into account for a proper Water Treatment Plant design.

INTRODUCTION

1.1. WATER QUALITY STANDARDS

When considering any series of treatment processes it is often convenient to define the desired quality of the end product and to decide how much has to be done to the raw water in order to achieve the necessary step-by-step degree of purification.

The ultimate Objectives, Aims and Standards of Service must be set out having in mind the requirement that: 'Distribution system samples are to comply with the chemical and physical requirements of the WHO [1] standards and the EC Drinking Water Directive. The water supplied should not give rise to complaints of color, suspended matter, taste, smell or the presence of visible aquatic animals'.

To ensure that this level of service is achieved the design performance parameters of any new treatment plant should be set to allow for deterioration of quality within the distribution system.

The performance standards to be achieved, on a percentage compliance basis, for those parameters affected by treatment are recommended therefore as indicated on the Table 1. It may be helpful to specify additionally for each of the parameters affected by treatment, a target mean value which should not be exceeded. Suggested levels for use in association with the design performance standards are also given. For comparison purposes the Table also sets out the corresponding EC Directive – Minimum Admissible Concentration (MAC) values relating to the quality of the water for human consumption, as monitored at the point where it is made available to the user. [2]

Compliance with the design performance standards should be assessed over a 12 month period, for key parameters on at least 250 discrete samples taken on an approximately daily basis, at various times of the day, and for non key parameters, on at least 10 samples at a rate of one per month. (Key parameters being those which the treatment process is designed to affect; non key parameters being all other water quality