

**A STUDY ON SEWERAGE SYSTEM WITH ON-SITE
SEGREGATION AND TREATMENT FOR WATER
SHORT HABITATIONS**

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**A Study on Sewerage System with On-site Segregation and
Treatment for Water Short Habitations**

By

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Submitted

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CERTIFICATE

This is to certify that the thesis entitled “**A Study on Sewerage System with On-Site Segregation and Treatment for Water Short Habitations**” being submitted by Mr. M. Dhinadhayan, to the Indian Institute of Technology Delhi for the award of ‘Doctor of Philosophy’ in Civil Engineering is a record of the bonafied research work carried out by him under my supervision and guidance. He has fulfilled the requirements for the submission of this thesis, which to the best of my knowledge has reached the requisite standard.

The material contained in the thesis has not been submitted in part or full to any other university or institute for the award of any degree or diploma.

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ABSTRACT

Water supply in most urban habitations in India is ranging from 70 to 100 liters per person which equates to a raw sewage BOD of 450 to 650 mg/l for which sustainable and established conventional technologies to reduce this to the permissible standards of 20 mg/l are absent. On-site disposal methods (mostly septic tanks or pit latrines) are pre-dominant in such areas. The septic tank effluent, without adequate treatment, be disposed underground through soak pits or trenches is often violated thus contaminating the ground water. The effluents are discharged into open drains and eventually form stagnant pools of water which breed malaria and filarial mosquitoes and ultimately contaminating the surface water. The guidelines laid down in Manual on Sewerage & Sewage Treatment published by the Government of India recommend a minimum per capita water supply of 125 lpcd for providing conventional sewerage system so as to ensure self cleansing velocity in the sewers.

Arising from the foregoing, the compelling need now resides in evolving an appropriate sanitation technology suitable for low per capita water supplies and consequent high raw sewage BOD concentrations at a sustainable technology of collection, treatment and off site disposal / or safe reuse. The technology conceived was (a) on-site segregation and treatment of the night soil and ablution (b) blending the effluent from the on-site treatment unit with grey water (c) alternative collection system (d) Off-site treatment facilities. Such a field model has been identified as the sewerage system put up at a Tsunami rehabilitation-housing colony at Kolachel serving about 329 families on the shores of coastal Tamilnadu.

In this context, the present study analyses the characteristics of black water and grey water to assess the per capita constituents of wastewater under Indian conditions as it varies with the socio-economic or lifestyle dissimilarities in the communities and food habits of the people etc., and validates the said sanitation system installed under such a scenario to evolve an appropriate sanitation technology suitable for low per capita water supplies and consequent high raw sewage BOD concentrations so as to address many challenges being faced by similar settings in the developing world and prevent potential waterborne epidemics.

The existing per capita water supply in the study system is about 90 lpcd. So much so, if a town with a per capita water supply at the rate of something like, say, 90 liters daily, the resulting BOD will be 510 mg/l and in such a situation, the applicability of the Government of India Manual guidelines will be non applicable prima facie. In the present study, the values of BOD and suspended solids contributed by a person is 36.78 gm per day and 86.40 gram/day respectively. The observed values of the influent and effluent BOD₅ in the study system are 510 mg/l and 22.4 ± 7.67 mg/l respectively and the suspended solids are 875 mg/l and 37.9 ± 9.71 mg/l respectively.

Gaining from the data derived from the present studies on the performance of the studied system, a mathematical design format has been developed for use in water short habitations. Using this test design format, the effluent BOD₅ values of the system have been calculated for different per capita water supplies. The design format presented the effluent BOD₅ values of 10mg/l and 18 mg/l for per capita water supplies of 125 lpcd and 70 lpcd respectively and the effluent BOD₅ values are within the permissible BOD₅ of 20 mg/l for discharge into water bodies. Thus it is

clear that the proposed technology will be able to handle a minimum rate of per capita water supply of 70 lpcd to treat the wastewater up to the permissible BOD value of 20 mg/l.

Quantitative Microbial risk assessment has been carried out for the ingestion of surface water (backwater) where the effluent from the study system is discharged as the same is used for the recreational activities. It has been observed that the public health risk associated with the present study system is 5.19×10^{-6} which is much less than the acceptable risk of 1×10^{-4} (guideline value of US EPA).

The cost aspects has been studied and it has been observed that the capital cost of the study system is less by 42% as compared to the respective cost of construction of conventional centralized sewerage system. In another way of interpretation, it can also be stated as for the same amount of money invested, the study system can give sanitation coverage for 42% more population for a comparative benefit of BOD removal.

The studies and the results obtained establish the present system as a possible unique combination of a decentralized concept of sanitation wherein the treatment part is decentralized with part of it as on-site and part of it as centralized off-site systems for water short habitations.

Keywords: black and grey water, centralized sewerage system, decentralized sewerage system, night soil and ablution water, quantitative microbial risk assessment, on-site segregation, per capita constitutes, water short habitations.

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