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SUSTAINABILITY OF WATER AND SANITATION SYSTEMS

Sustainability of Lusaka sewage works

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LUSAKA, THE CAPITAL city of Zambia, has a central waterborne sewerage system which was first constructed in 1956 and expanded upon in 1970 and 1980. It is currently serving more than 400,000 people which represents about 36% of the city's population including trade effluents from industries. No major rehabilitation works have ever been carried out on this aging system over the past 15 years.

In recent years, the system has experienced both operational and maintenance problems, ranging from poor management, untrained plant operators, lack of motivation among the workers and scarcity of funds. The key technical problems seriously affecting the works include: inoperative equipment such as influent flow meters, mechanical bar screens and grit chambers, reduced sewer and pump capacities, sediment build-up that block sewers and interfere with sewage pumps and frequent mechanical and electrical breakdowns.

This paper highlights the main causes of these problems, the efforts that have been made to solve them and a mechanism that has been adopted in order to sustain the existing sewage works.

Background

The sewerage system is of "separate" type. Originally, it was under the management of the Lusaka City Council. However, in 1988 this was handed over to the Lusaka Water and Sewerage Company, (LWSC). LWSC now owns, operates and maintains seven sewage pumping stations; six of which are standardized with 30kW Flgyt submersible pumps allowing pumps to be interchanged. Two of the stations consist of 3 pumps arranged in parallel, with the remaining stations configured for 2 pumps in parallel.

The sewer network of LWSC comprises 90 km of trunk sewer lines and over 230 km of lateral sewers. Sewage is treated in 4 waste stabilisation (oxidation) ponds and in 2 three stage conventional treatment plants. The latter, which treats about 70% of the city's wastewater consist of screening and grit removal, primary sedimentation, filtration through percolating (trickling) filters and final sedimentation in humus tanks. The sludge which is drawn off from the primary sedimentation tanks and humus tanks is treated in anaerobic digesters followed by dewatering on drying beds. The Western plant at Chunga area receives wastewater from major industries in the city as well as domestic sewage. The other, the Manchinchi plant treats only domestic sewage including septage delivered by vacuum tankers that service septic tanks.

Oxidation ponds treat domestic sewage only and are located at Ngwerere, Kaunda Square, Chelston and Matero areas within the city boundaries. None of them incorporate anaerobic pretreatment ponds, but each have one primary facultative pond (except the Ngwerere ponds which have two parallel primary facultative ponds) followed by two maturation ponds in series. The total area for all the ponds is 30.5 hectares with the Ngwerere ponds occupying about half of the area.

Constraints on the sewer network

In 1987 German Consultants were contracted to investigate the deficiencies of the sewer network and the conditions of the sewers. The main problems that were identified were:

(i) Completely blocked gravity sewer line from the Lumumba Pumping Station to the Chunga treatment works;

(ii) Blocked main sewer to Chelston ponds.The sewage was discharged into a small river beneath the sewer line. All manholes were without covers and the sewage was used for irrigation, which is a health hazard;

(iii) Blocked main sewer line to Ngwerere ponds by stones, rags, textiles and the sewage was held back. Manholes covers were not properly fixed;

(iv) Frequent sewage overflows during the rainy seasons, particularly along the main south trunk line feeding the Manchichi plant. This was mainly due to the loose sewer network that allowed groundwater to infiltrate the sewers and the absence of manhole covers in many places of the sewer line;

(v) Insufficient pumping capacity, since each of the seven pumping stations operated with only one pump in service. This resulted also in sewage overflows at manholes upstream of the stations. The mechanical and electrical breakdown of the pumps also occured frequently.

Effeciency of the sewage treatment plants

The treatment efficiency of the 2 mechanical plants at Chunga and Manchinchi has been seriously reduced over the years due to old and inoperative equipment.

Table 1: Estimated influent BOD_5 and Bacterial Removals in Waste Stabilisation Ponds, 1989

Pond Site	BOD -Strength g / m^3	Bacterial Removal FC /100 ml
Ngwerere	350	10 000
Matero	485	2 500
Kaunda Sq.	350	81 000
Chelston	300	59 400

Both plants experience excessive hydraulic and organic overloading and require immediate expansion. At the Manchinchi plant, for example, only 2 out of 16 trickling filters have functioning distributor arms. Calculations on filter loadings earlier on showed that these were being loaded at the rate of 1400 g BOD_5 / m^3.day compared to the acceptable rate of 125 - 175 g BOD_5 / m^3.day (German Environmental Consultants,1987). Alongside with the Chunga plant, the influent flow meters, mechanical bar screens and grit chambers are not operational.

All oxidation ponds require rehabilitation and extension. They are all overloaded and not properly maintained. Flow recorders are absent, inlet structures are broken down and screenings are not properly removed, not even buried. The embankments of all the ponds are presently overgrown with tall grass and the pond sites are not fenced. According to Baird, (1993), the treatment efficiency of the oxidation ponds was very poor, except the matero ponds which showed satisfactory results (Table 1).

As seen from Table 1, both the Kaunda and Chelston ponds produce poor quality effluent in terms of bacterial removal. This is quite worrying because the final effluent from both ponds is presently being used by smallholder farmers for irrigating their crops; which is a health hazard.

Over all design capacity of both the conventional plants and oxidation ponds is 36,380 m^3 / day; but the estimated total daily flows in all cases far exceeds this by over 49,000 m^3 / day; which is more than 35% overloading of the ponds.

It can also be seen from Table 2 that both the Kaunda and Chelston ponds are overloaded by more than twice their intended design capacities.

This is because these ponds serve a potentially large catchment area of the city and at the time they were constructed were located in an undeveloped part of the city and therefore served a much smaller community.

Problems and their causes

The main causes of the problems which have persistently affected the smooth running of the sewage works over the years are:

Table 2: Design capacities and estimated daily flows of sewage treatment plants

Site	Design Capacity m^3/day	Estimated Daily flows m^3/day
Manchinchi	18 100	25 000
Western	9 050	10 000
Ngwerere	4 320	5 420
Kaunda Sq.	1 690	4 750
Chelston	820	1 700
Matero	2 400	2 300
Total	36 380	49 170

(i) Absence of preventive maintenance for grit and sand removal from blocked grit chambers.

(ii) Until recently, (December, 1994), the Sewerage department of LWSC had no drain rods and as such clearing of blocked sewers had become difficult and cumbersome.

(iii) Unskilled operators. While operators for a particular unit in the works are familiar with simple operational skills, this however is not enough to operate and maintain the mechanical structures and facilities that are present at the Manchinchi and Chunga plants. For example, there is only one engineer who was employed in November 1994, responsible for sewer maintenance for the works; but there are still three more vacancies not yet filled to take charge of each of the two mechanical plants and the oxidation ponds.

(iv) Lack of job motivation. Up until May 1994, apart from the low salaries that were paid to the workers, provision of clothing such as uniforms, overalls, gum boots etc was generally not sufficient. All these seriously affected the job motivation of the workers within the sewerage sector.

(v) Awareness of the importance of the sewerage system particularly by decision makers in the Water and Sanitation Department was very poor. Because of the budget constraints, there was usually not enough money for operation and maintenance purposes and the necessary repairs that was required for servicing technical equipment and other structures.

(v) Abuse of the system. Most manhole covers on the entire sewer network have been vandalised or stolen; and individuals throw stones, rags, plastics, garbage and other solid materials into the uncovered manholes which cause blockage of the system.

Towards sustainability

In order to attain sustainability of the works, the LWSC has already embanked on a rehabilitation project, which

it looks at as a first priority rather than construction of new works. External funding for this project was sought in 1993, mainly from the Japanese Government through JICA; but no favourable reply has yet been received. Consequently, the company is currently carrying out this project using internally generated funds. Funds are obtained through billing households and industries that use this service. Two tariffs are therefore used: a flat fee for households, whether low or high density dwellings; and the volume of wastewater generated by each industry based on the calculated water consumption and BOD-strength of the effluent.

The ongoing activities which are meant to sustain the Lusaka sewage works include the following:

(i) Rehabilitation of the 16 trickling filters at the Manchinchi plant. So far, more than 90% fabrication of the distributor arms and other dilapidated structures has been done. The cost of fabrication and installation is ZK 80,104,000 (ZK 1 is approx. US $ 0.00125).

(ii) Twelve mono pumps have already been bought at ZK 19,000,000; which are to be installed at the Manchinchi and Chunga plants for pumping humus and raw sludge from pump houses. In addition, two stand-by submersible flygt pumps hve also been bought at a cost of ZK 3,791,902.92. These are to be stationed at the Manchinchi and Chunga plants as well.

(iii) A total of 800 drain rods including their accessories were bought in December, 1994 from South Africa at cost of SAR 31,928.20. The rods are being used to clear the blocked sewers.

(iv) Desludging of the digesters and oxidation ponds is an ongoing work. The desludging of the Matero oxidation ponds was completed at the end of 1994. The contractor also completed desludging the Manchinchi maturation ponds in February , 1994; and is now working on the Kaunda waste stabilisation ponds.

(v) The entire Ngwerere sewer line was cleared by the end of October, 1994. Unfortunately, however, the sewer line was again deliberately chocked by small-holder farmers who use crude sewage for irrigating their fields.

(vi) Various other tools and safety equipment have also been bought from South Africa at a cost of SAR 78,000. These include a set of hand winches, one Flexian rodder complete with accessories, one safety harness and one Quadalarm personal gas detector.

Conclusion

The main problems of the Lusaka sewage works can be associated to a large extent with inadequate funding that is required to purchase tools, technical equipment and spare parts. Others include: insufficient trained personnel, lack of awareness of the significance of the sewerage system by decision makers which existed before May, 1994 and inadequate routine preventive maintenance.

While actual training of the required workforce has just begun, the company envisages to train more workers in the near future on a short-term basis at first, followed later by long-term training for its workers.

Since measures to sustain the sewage works are already under way using internally generated funds, the company is optimistic that external funding for the rehabilitation project through technical support from different organisations will soon be available.

The LWSC is included in the 5-year National Programme under the Water Supply and Sanitation sector. The ongoing rehabilitation of the Lusaka Sewage Works is on a priority list and cannot therefore be abandoned.

References

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