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INTERMEDIATE SANITATION: SOLIDS-FREE SEWERAGE

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The high cost of conventional sewerage renders it unaffordable to all but high-income communities in developing countries. Low-cost, on-site sanitation technology has been popularized during the past decade to bring adequate sanitation service within the means of low-income communities. Intermediate sanitation technology offers good promise for addressing the hitherto unmet sanitation service needs of middle-income communities. One example of this type of technology is solids-free sewerage.

INTRODUCTION

In many developing countries, middle-income communities find the cost of conventional sewerage to be too high, yet at the same time find the level of service afforded by on-site sanitation inadequate. It appears that the needs and preferences of this group would be best met by **sanitation technologies whose cost and level of service are intermediate between those of conventional sewerage and low-cost on-site sanitation systems.** Such technologies have been in existence for some 30 years, but they are not widely known. They afford the same degree of convenience to the user as conventional sewerage, but at a lower cost. This note is on the first of these to be developed, solids-free sewerage.

SALIENT FEATURES

The key factors that influence the cost of sewerage are the diameters, depths and total lengths of the systems as well as population density, number and depths of manholes and such other factors as set-up costs and excavation in rock. For example, in one Bank project, manholes accounted for 23.4 percent of the total cost; by reducing the average sewer depth from 2.5 meters to 1.5 meters, the cost of manholes was reduced by 73 percent; and by reducing the minimum sewer diameter from 200 millimeters to 150 millimeters, the cost of branch sewers, which constituted 12 percent of the total cost, was reduced by 43 percent.

Intermediate sanitation technologies are lower in cost than conventional sewerage because they have smaller average diameters, shallower depths, shorter lengths (particularly of laterals), and fewer or simpler manholes. The key approaches that have been used to achieve these ends are the **introduction of a physical device immediately after the house sewer, and the introduction of modifications in the sewer design standards and specifications.** Another important approach is to reduce the quantity of flow reaching the sewers. This can be achieved by using pricing and/or regulatory mechanisms to promote the use of water saving devices and practices such as low volume flush toilets and reduced flow shower heads (the U.S. Congress is currently contemplating legislation for this purpose). Another way is to reduce the quantity of ground water that infiltrates into sewerage systems; this can be achieved be using flexible joints or flexible piping.

EXAMPLES

Examples of intermediate sanitation technologies based on physical devices are solids-free sewerage, septic tank effluent pump sewerage, grinder pump sewerage, and vacuum sewerage; those based on modifications in design standards are simplified sewerage, shallow or *condominiale* sewerage, and flat grade sewerage. The solids-free sewerage system is described in this note.

SOLIDS-FREE SEWERAGE

Solids-free sewerage, SFS, (also known as small-bore sewerage), is a hybrid between a septic tank and a normal sewerage system. Its distinctive feature is a solids interceptor tank located between house sewers and the rest of the sewerage system. Typically, there is one such tank for every house sewer. This tank retains the solids in the incoming sewage and attenuates variations in the incoming flow. The cost-saving features of SFS are derived from these two effects.

<u>Impact of Solids Removal</u>: The sewage downstream of the tank is free of solids. Therefore, there is no need to adhere to conventional sewer design practices like ensuring self-cleansing velocities; sewer slopes can be flatter, leading to shallower depths and savings in excavation (a 50 percent reduction in the minimum velocity results in a 75 percent reduction in the slope); minimum diameters can also be reduced because the risk of solids deposition is negligible, and therefore there is no need to maintain a minimum diameter to facilitate the dislodgement of solids from sewers. For the same reason, manholes are not that necessary, and can be spaced at longer intervals; in many situations they can be replaced by cleanouts that are simpler, cheaper, and more effective in excluding sand.

<u>Effect of Flow Attenuation</u>: The attenuation of flow also makes possible a reduction in the peak flow factor by as much as 60 percent. This makes possible a significant further reduction in sewer diameters.

<u>Operation and Maintenance</u>: Operation and maintenance requirements consist mainly of answering service calls, and making new connections; they also involve inspection and pumping out solids interceptor tanks. Periodic inspection and cleaning by hydraulic flushing is often recommended for the collector mains; but in the United States this has not been deemed necessary by most utilities. In Australia, many large systems have been in operation for over 30 years without any flushing of the collector mains. Nevertheless, for long flat sewer sections where the daily peak flow velocities are less than 0.15 meters per second (0.5 feet per second), regular flushing is still recommended. Where there are pumping stations, they must be inspected on a daily or weekly basis. A truck mounted centrifugal suction pump is the main piece of equipment normally kept by utilities for maintaining solids-free sewerage systems.

The commonest operating problems are odors and blockages within building sewers upstream of the interceptor tanks. The odors commonly occur at pumping stations where they have been successfully eliminated by installing drop inlets that extend below the pump shut off level. The blockage problems are the same as they are in conventional sewerage and are therefore the responsibility of homeowners; however, many utilities assist in clearing them.

<u>Origin and Applications</u>: Solids-free sewerage systems were first used in Australia and the Zambia in the 1960s. In the United States, where they were introduced in the mid-1970s, there are over 160 systems installed in 34 states. They are being used in a number of Latin American countries including Brazil, Colombia, and Argentina. They have also been included in Bank-supported urban development projects in Cartagena in Colombia, the Tamil Nadu urban development project in India, and in a number of pilot projects being planned in Bangladesh, the Philippines and Indonesia.

Minimum diameters of 100 millimeters (4 inches) are commonly used downstream of the interceptor tanks; and in some places, pipes with diameters of 50 millimeters (2 inches) have been used. Cost savings of up to 30 percent have been reported from the use of conservative design criteria. Further cost savings are realized at the treatment plant end where the absence of solids in the sewage renders the use of primary treatment facilities unnecessary.

In Australia and in the United States, solids-free sewerage systems have been used mainly in low-density housing areas where the cost per house for conventional sewerage is deemed to be too high. The key question is whether it would be applicable also in high-density residential housing areas in developing countries. There is little doubt that in both low- and high-density residential areas in developing countries, the capital costs would be lower relative to conventional sewerage. The question is whether the lower capital costs would be offset by higher costs from the operation and maintenance of the interceptor tanks. But experience indicates that these tanks can be pumped out at intervals as long as 10 years. Hence, the system should work satisfactorily also in the developing countries if it is properly designed and installed. Moreover, it is conceivable that in high-density residential areas, communal interceptor tanks may be used in place of domestic tanks.

ONGOING WORK IN INUWS

INUWS is conducting field studies on the cost of operation and maintenance of intermediate sanitation technologies, especially of those that are based on modifications in design standards, such as simplified sewerage and the *condominiale* system. Complementary studies are under way on historical design costs and also on the development of cost functions that can be used to estimate the costs of the various categories of sanitation technologies at the prefeasibility stage in project preparation. There are also ongoing studies aimed at developing routine methodologies for the estimation of willingness of consumers to pay for one or another of the different types of sanitation technologies. All these are to serve as inputs into the process of strategic planning of sanitation services for urban communities.

TO LEARN MORE

Otis, R. J., "Small Diameter Gravity Sewers: An Alternative Wastewater Collection Method for Unsewered Communities". USEPA, 1983.

Otis, R. J. and D. Duncan Mara, "The Design of Small-Bore Sewer Systems", TAG Technical Note No. 14, World Bank, 1985.

Kreissl, James J., "Alternative Sewers in the United States", International Proceedings on Urban Hydrology, Hydraulic Infrastructures and Water Quality Control, University of Kentucky, Lexington, Kentucky, 1985.

Australian Water Resources Council, "Low Cost Sewerage Options Study", Water Management Series, No. 14, Canberra, 1988.

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