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Reduced cost sewerage - does it work?

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INTRODUCTION

Good disposal of human wastes is a necessity if the health of the community is to be protected. In urban areas conventional water-borne sanitation is often the system most desired by communities. It is 'modern', clean and hidden. Unfortunately it is also very expensive, both in terms of the communal and in-house fittings required, and has a high water demand (about 100 l/c/d) to keep it operating.

The alternative is some form of on-site sanitation system such as a pit latrine. Such systems are much cheaper than conventional water-borne sanitation, particularly if the cost of wastewater treatment is included, and still provide all the health benefits of conventional sewerage. However there is often resistance to such systems from the community, who feel they are second rate technology or have memories of badly designed similar systems that were used when they lived in the country. They are also inappropriate in very high density housing areas or where the soil has poor absorptive capacity.

Sullage disposal in urban areas is increasingly important as water supplies increase. Excess waste water can be and often is, discharged to surface drains. This is not always a satisfactory solution since sullage often contains suspended matter that blocks the drains, encourages the breeding of flies and produces offensive odours.

In such situations reduced cost sewerage schemes may be appropriate. Unfortunately details of such schemes are limited and widely spread. Recent research at WEDC (Vines et al 1989) has attempted to draw together all the available information and this paper is a summary of the findings.

REDUCED COST SEWERAGE DESIGN

How it works

Reduced cost sewerage systems are designed upon one of two different principles. The first type, often known as 'shallow sewer systems' are designed to transport faeces and liquids in the same way that conventional sewers do. Savings are made by a relaxation of technical standards, careful location of

sewers and the incorporation of recent research findings (UNCHS 1986).

The second type include some form of solids interceptor tank, usually within the property. The tank is designed to collect solid material so that the sewer need only be designed to carry liquids. Such systems are often called 'interceptor tank systems'.

The two types of system often share many of the same cost saving design modifications. This paper will therefore consider the individual components of the systems rather than try to look at the two types separately.

Solids interceptor tank.

The size of the tank varies widely as is demonstrated in Table 1. Many of the larger tanks were designed as septic tanks or aqua privies where the tank is expected to contribute to the treatment process. Such tanks are expensive and the economic viability of systems including them may well be limited to situations where a large proportion of the population already possess suitable tanks.

The smaller tanks however are intended only to collect the heaviest of solids and allow time for other solids to liquify before being washed into the sewer. Such systems require frequent emptying of the tank (which must be done hygienically to obtain the desired health benefits) to prevent blocking of the sewer (OPP 1986).

Pipe Size

Pipe sizes, particularly at the heads of systems are often fixed by regulation rather than technical design. Accurate assessment of wastewater generation patterns often leads to smaller diameter pipes at shallower gradients with more connections being possible. Pipes as small as 50mm diameter have been used successfully (Simmons et.al. 1985) however 100mm is usually considered more suitable to facilitate maintenance (Otis & Mara 1985).

There is evidence that smaller pipes may be prone to blockage than larger ones since the increased flow depth produces higher hydrostatic pressures behind blockages thus assisting with their resuspension (UNCHS 1986)

TABLE 1. SOLIDS INTERCEPTOR TANKS USED IN REDUCED COST SEWERAGE SYSTEM (Vines et al 1989)

SITE/COUNTRY	SIZE (LITRES)	DESIGN NUMBER OF USERS	WATERWASTE FLOW (L.P.D.)	TYPE OF WATERWASTE	ANAL CLEANSING PRACTICE	REFERENCES
NDOLA, ZAMBIA	250	6	210	W.C. & SULLAGE	BULKY SOLIDS AND PAPER NOT ALWAYS PUT IN TANKS	IWUGO ET AL. 1978 (b)
MATERO ZAMBIA	5850	24	WATER SHORTAGES OCCUR	W.C. & SULLAGE	BULKY SOLIDS AND PAPER	IWUGO ET AL. 1978 (b)
CHILENJE, ZAMBIA	1600	6	"VERY LIBERAL"	W.C. & SULLAGE	BULKY SOLIDS AND PAPER NOT ALWAYS PUT IN TANKS	IWUGO ET AL. 1978 (b)
NEW BUSSA NIGERIA	2500	20	WATER SHORTAGES OCCUR	W.C. & SULLAGE	WATER OR HARD PAPER	IWUGO ET AL. 1978 (a)
VARIOUS SITES STATE OF SOUTH AUSTRALIA,	a) 1635 b) 545	3.5	a) 200 b) 60	a) W.C. & SULLAGE b) W.C. ONLY	PAPER	E.P.A. 1979 S.A.H.C 1986 A.W.R.C. 1988
VARIOUS SITES, STATE OF VICTORIA, AUSTRALIA,	a) 3182 b) 1818	3.5	a) 200 b) 60	a) W.C. & SULLAGE b) W.C. ONLY	PAPER	E.P.A. 1979 A.W.R.C. 1986
MOUNT ANDREW, ALABAMA, U.S.A.	2640	ONE HOUSEHOLD	570 LITRES PER HOUSEHOLD	W.C. & SULLAGE	PAPER	SIMMONS AND NEWMAN 1984
WESTBORO, WISCONSIN, U.S.A.	3785	5	190	W.C. & SULLAGE	PAPER	OTIS 1978
IBURA, BRAZIL	a) 1320	ONE HOUSEHOLD	NOT KNOWN	W.C. & SULLAGE	PAPER	GREENHALGH 1984
CARTAGENA COLUMBIA	940	6.8	135	W.C. & SULLAGE	PAPER	RIZO POMBO (undated)
ORANGI, KARACHI, PAKISTAN	265	9	29-37 (WATER CONSUMPTION)	W.C. & SULLAGE	WATER	BALFOURS 1987 KHAN 1983 (a)
LOW INCOME AREAS, KARACHI, PAKISTAN	120	9	28-40 (WATER CONSUMPTION)	W.C. ONLY	WATER	BALFOURS 1987

Layout

It has been claimed that the total length of a sewer network can be reduced by 50% by changing the layout pattern (UNHCS 1986). Instead of making separate connections from each house to a sewer in the main street, all households within a block are connected to a single sewer that is contoured to reduce the length of individual connections to a minimum. (Figure 1.) Such a layout can reduce the average length of sewer from more than 4.0 metres per plot (Bradley 1983) to just over 2.0 metres per plot (Sinnatamby 1983).

Manholes

It has been estimated that between 15% (AWRC 1988) and 45% (de Kruijff 1981) of the cost of a sewerage system is for the manholes. Suggestions for reducing this cost have been numerous. Replacing the manholes by rodding eyes and increasing their spacing (up to 200 metres) has been tried by a number of groups and an experimental interceptor tank scheme

in the U.S.A. is operating successfully without any manholes or rodding eyes (Simmons et al 1985).

Construction Methods

An evaluation of conventional sewerage costs in Brazil revealed that 80% of the cost of laying pipes was attributable to excavation and backfilling. (Greenhalgh 1984) Laying sewers at a shallow depth therefore offers considerable savings.

Interceptor tank systems do not carry solids and therefore they can be laid with a variable gradient. This means that they can follow the ground slope at a constant depth.

Even shallow sewer systems can be laid at flatter gradients than conventionally specified. 100mm pipes have been laid at 1 in 167 in Pakistan and perform satisfactorily (UNHCS 1986). Sewers laid at the rear of houses away from vehicular traffic or other heavy loads can be laid at depths as shallow as 300mm (UNHCS 1986).

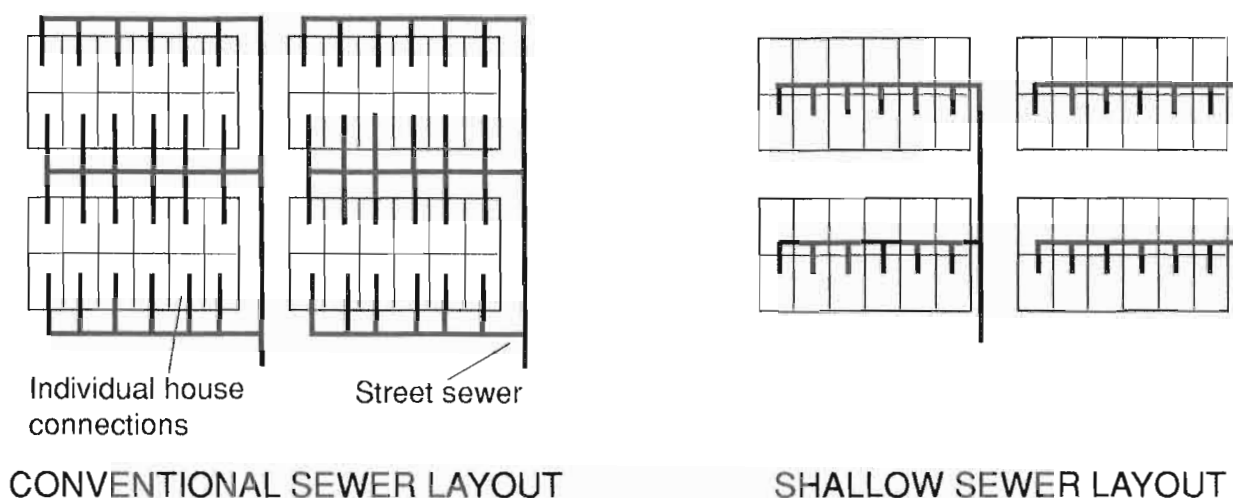


Figure 1. Schematic layout of conventional and shallow sewer systems

Shallow sewers have the additional advantages of being easier to maintain and are more suitable for areas with poor ground conditions or precariously built housing that characterizes low income settlements.

INSTITUTIONAL FACTORS

Legislation

One of the major obstacles to the implementation of unconventional sanitation systems is the constraints imposed by local rules, regulations and specifications.

Numerous examples exist of reduced cost sewerage schemes that have only been possible due to a relaxation of local building codes. Relaxations are only possible however if there is the political will for such changes to occur and political will can only be mobilized if the community is committed to the proposed system.

Controlling Institutions

The quality and commitment of the implementing organization is crucial to the success of the scheme. The implementing staff are often in the best position to suggest cost reducing design modifications such as simplified interceptor tanks or manholes.

Alternative contract management methods can be tried to keep contractors profits to a minimum. The cost of a sewerage interceptor system in Ohio for 770 people dropped by about \$1 million after the job was divided into smaller contracts rather than let as a single contract (Otis et. al 1987).

Appropriate financing arrangements are also important. Most reduced cost schemes constructed so far in developed countries seem to carry some form of subsidy to make

them affordable. This usually takes the form of a grant plus a loan at lower than the normal interest rate. Such subsidies may be as high as 85% (Otis et.al. 1987). Such subsidies are out of the question in many developing countries; indeed in Karachi the community raised the full capital cost of the scheme before work commenced. (UNHCS 1986)

COMMUNITY INVOLVEMENT

In developing countries the involvement of the community is crucial to successful implementation. Their involvement can reduce construction costs, improve maintenance and optimize the health benefits. It was calculated that community participation in Brazil reduced the cost by 10 - 15% (Sinnatamby 1983). However in Karachi it led to the use of sub standard materials and poor workmanship (Khan 1984).

The size of community selected however must be considered. Projects based at lane level seem to be more successful than those based on a larger group. This is probably due to the level of trust and cooperation reducing

COST

Data relating to cost, particularly relative cost and affordability is scant.

A sewerage interceptor tank scheme was reported to be 25-35% cheaper than conventional sewerage in Australia (Otis et.al 1985) but this excluded the cost of the interceptor tank or the house connection. A similar scheme in Karachi was estimated to be 75% cheaper than the cost of conventional sewerage (OPP 1988). However the cost of treatment and trunk sewers was excluded.

Estimates for shallow sewer schemes suggest that their investment cost can be 85-90%

cheaper than conventional sewerage (UNCHS 1986).

DOES IT WORK ?

Sewered interceptor systems have been accepted as reliable technology in Australia, the U.S.A. and Pakistan where their use seems likely to spread. In Pakistan however no treatment is provided and the wastewater discharges into nearby open drains. Also the institutional problems relating to long term maintenance have not yet been addressed .

Similar systems installed some years ago in Zambia and Nigeria have not found favour, possibly because they are prone to institutional neglect.

Shallow sewer systems are reported to have attained the status of proven technology in NE Brazil (Mara 1988) but elsewhere insufficient evidence is available to draw conclusions.

CONCLUSIONS

Reduced cost sewerage has the potential to bridge the gap between conventional sewerage and on-site sanitation. However there is insufficient evidence, particularly relating to affordability and operation and maintenance to be conclusive. There is also no information on how they perform where hard materials such as paper or leaves are put into the system.

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