Low-cost unconventional sewerage

by Marcus Vines and Bob Reed

Community involvement in Brazil and Pakistan with unconventional sewerage systems promises more affordable solutions.

SEWERAGE, THE COLLECTION of excreta and sullage by means of buried pipes, is generally thought of as an inappropriate sanitation option for most poor urban communities in the developing world. This is chiefly because sewerage systems in such countries have tended to be:

- very costly (not only in monetary terms but also in the amount of potable water required for toilet flushing); and
- severely under-utilized (there are many reports of extremely low rates of connection to sewerage systems in developing countries).

There are signs, however, that in one or two developing countries it has proved possible to install sewerage systems that low-income earners both want to connect to and are willing and able to pay for.

These systems can operate with low-volume pour- or cistern-flush toilets, which use as little as three to five litres per flush compared to the 15 to 20 litres often reported for conventional sewerage. What is it then that is different or unconventional about these systems? Part of the answer lies in their design.

Interceptor tanks

Some systems include an on-plot tank designed to collect solids before they enter the sewer network (Figure 1). The cost of the sewer network can be reduced because smaller pipes and flatter pipe-slopes may be used if it is assumed that the tanks prevent the majority of solids from entering the sewer network.

Treatment costs can also be reduced. Screening, grit removal and primary sedimentation will not be required at the treatment plant since they occur in the on-plot interceptor tanks. In a waste-stabilization-pond treatment system anaerobic ponds will be similarly unnecessary.

The cost of constructing tanks is, however, significant and may even outweigh the sewer network and treatment savings. If it is possible to make use of previous investments by adapting existing pit latrines and septic tanks to serve as the interceptor tanks, then this type of sewerage becomes a more attractive economic proposition. As far as is known however, this has not yet been done anywhere in the developing world.

A further drawback is the need to empty periodically the tanks and dispose of the accumulated sludge safely. In the case of systems built in Zambia and Nigeria in the 1950s and 60s it has been reported that such maintenance has tended to be either neglected or else performed inadequately.

Recent developing country experience with interceptor tank sewerage is limited, but there are positive reports from one system installed in 1987 in the Brazilian state of Ceara which serves a community of roughly one thousand people. It was constructed at a cost of US$76 per person (about one fifth of the cost of a conventional sewerage system) and its operating costs amount to US$0.25 per person a month (both figures are at 1988 values). The sewers have a minimum diameter of 40mm, compared with the 150mm or larger pipes that would be used in a conventional system.

Access points

Access points such as manholes can be an expensive cost item in a sewerage system. Common to just about all unconventional sewerage designs is the attempt to use cheaper and/or fewer access points. Figure 2 shows manhole alternatives used in 'simplified' sewerage schemes in the state of Sao Paulo in Brazil. Substantial savings can also be made by simplifying manhole designs. In Karachi for example, the manhole design used in the Orangi Pilot Project low-cost sewerage programme was 70 per cent cheaper than that adopted for municipal sewerage systems in the same city.

Efficient pipe layouts

Unconventional sewerage schemes constructed in Rio Grande do Norte and other Brazilian states during the 1980s have substantially reduced costs by making pipe layouts as efficient as possible. Depending on the site layout and the position of toilets and sinks etc., this is often done by connecting households to a sewer running through the owners' back gardens rather than to one under the street at the front of the house (Figure 3).

The drawback is that it is more difficult for the authorities to supervise and maintain a sewer on private

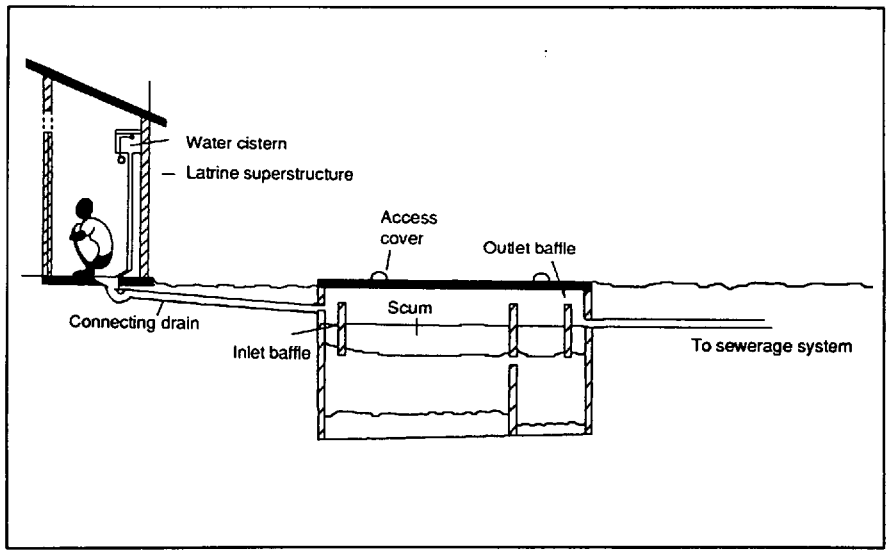

Figure 1. A sewered interceptor tank.

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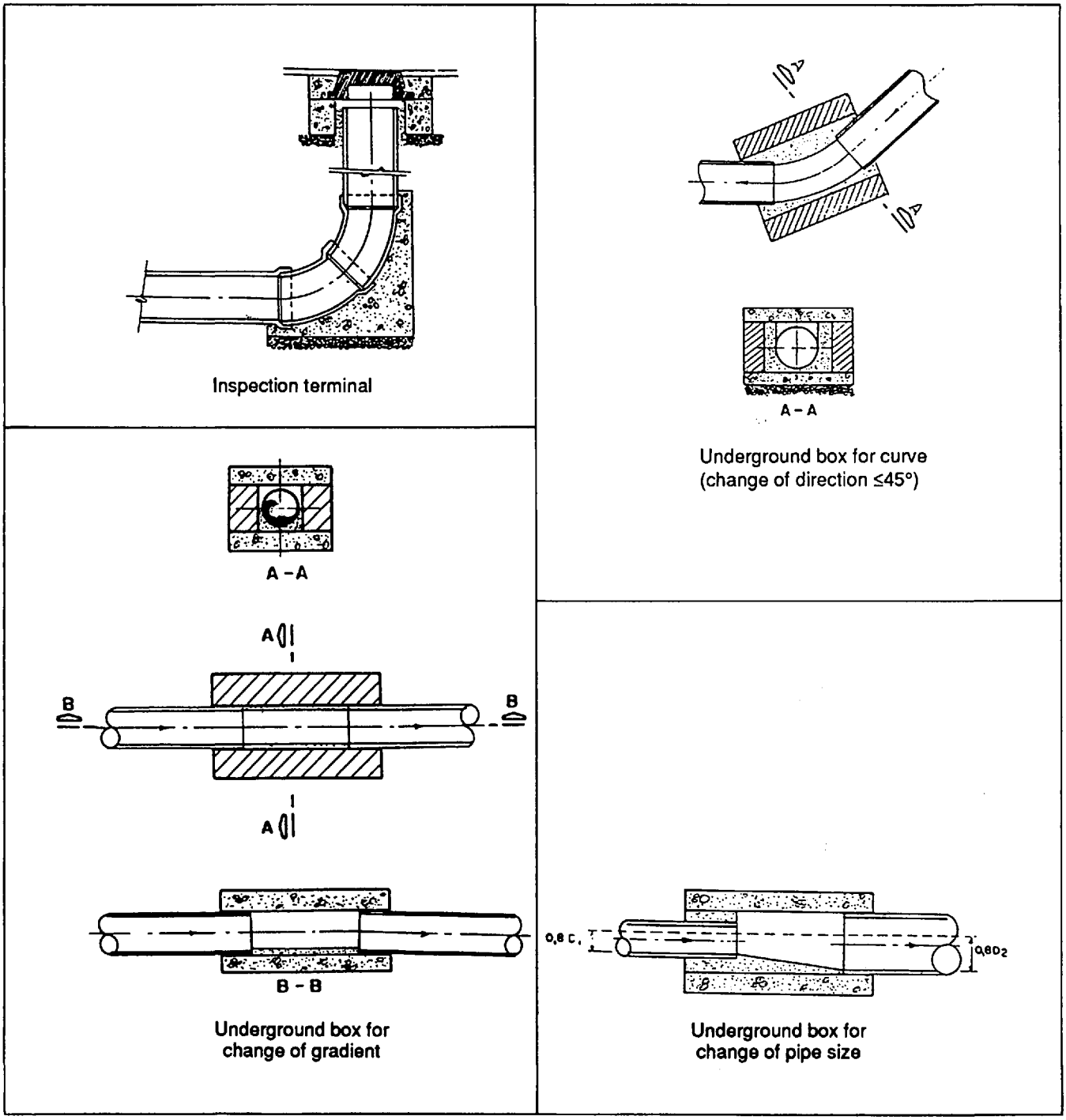

Figure 2. Manhole alternatives used in simplified sewerage systems in Brazil (adapted from Azevedo Netto, 1989).

property. The authorities may decide to obtain legal documents (known as easements) giving them the right to inspect and maintain sewers on private land, but this will add to costs. In Brazilian unconventional sewerage schemes, easements are not usually obtained, because the maintenance of all sewers on private land is supposed to be fully the responsibility of the users. In the state of Rio Grande do Norte this arrangement is reported to work satisfactorily. The construction cost of such systems is reported to vary between US$65 and $105 per person, while operating costs are in the range US$0.30 to $0.50 per person a month (all figures are at 1988 values).

The form of sewer layout shown in Figure 3(b) has the additional advantage of reducing the amount of soil cover required by the sewer (because the pipe will be subject to smaller loads than if it were beneath a road), thus cutting the cost of excavation. This type of design is also referred to as 'shallow' sewerage.

'Partial' sewerage

Between 1981 and 1988 the low-cost sewerage programme of the Orangi Pilot Project (OPP) enabled 35,000 households in the Karachi squatter settlement of Orangi to obtain sewerage. The householders themselves met all the construction costs. In 1985 the total amount of money needed from each household to build the system was equivalent to only 85 per cent of one month's income for a median household in the area.

The OPP sewerage system however does not include any main sewers or treatment plants. Sewers carrying waste water from one or more streets discharge to open drains (Figure 4). Economic comparisons with sanitation systems that do provide full collection and treatment are therefore not strictly valid, because equal benefits are not provided.

A 1985 evaluation reported that streets with OPP sewerage definitely benefited environmentally (because of the absence of visible waste water), and that the majority of users believed that the building of OPP sewerage had improved relations between street residents.

The OPP itself admits that its sewerage programme is only part of the answer, and that the provision of main sewerage and treatment remains the responsibility of the Karachi municipal authorities.

Decentralized sewerage systems

The cost of transporting waste water from several different drainage basins to a single treatment plant can be substantial, especially if the plant is situated some distance away from population centres. It may necessitate the building of pumping stations and rising mains, as well as considerable lengths of interceptor sewers.

Figure 5 illustrates an alternative approach adopted in the state of Rio Grande do Norte in Brazil. Each drainage basin or small population centre has its own treatment plant. Pumping is eliminated and sewer lengths per household served are reduced. One drawback of such an arrangement is that it requires the operation and maintenance of a larger number of treatment plants than a more centralized system would.

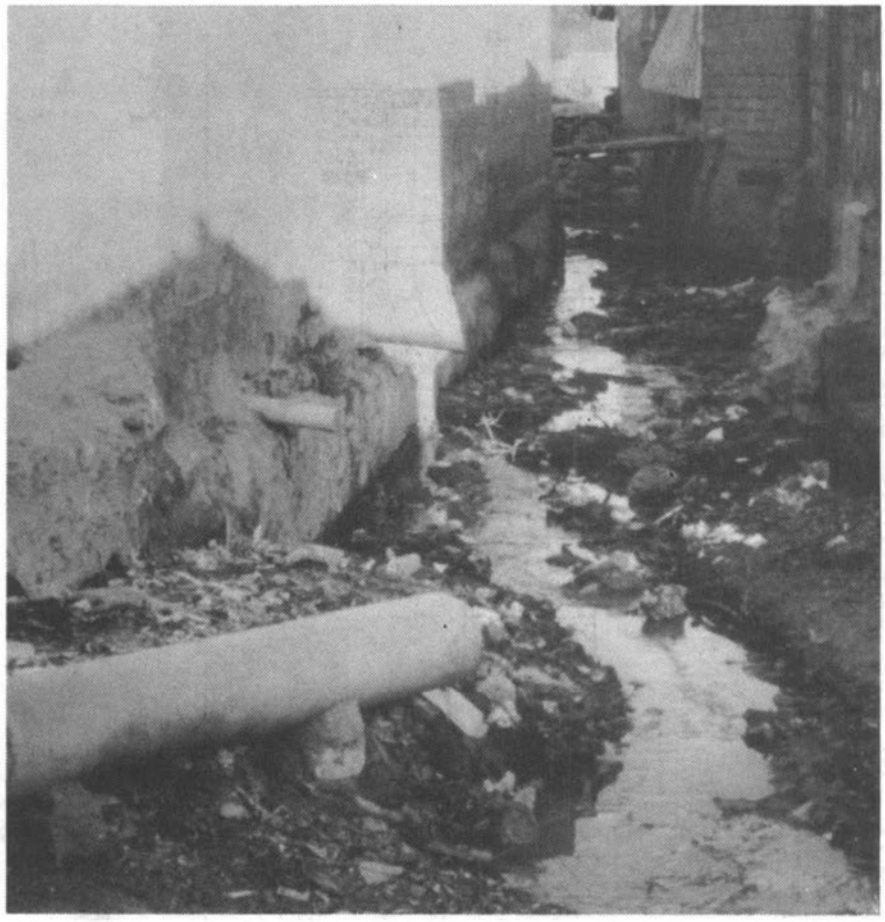

Figure 4. Sewers in the OPP system in Karachi carry waste water from one or more streets and discharge to open drains.

Implementation strategies

It would be wrong however to concentrate solely on the technical aspects of unconventional sewerage. There is strong evidence that the way in which a sewerage system is introduced is just as crucial to its chances of success. The most successful examples of unconventional sewerage are those in which implementing institutions have convinced the community that sewerage is both within their means as well as worthwhile. Technical design changes can reduce costs, but they cannot motivate people to participate in construction and operation.

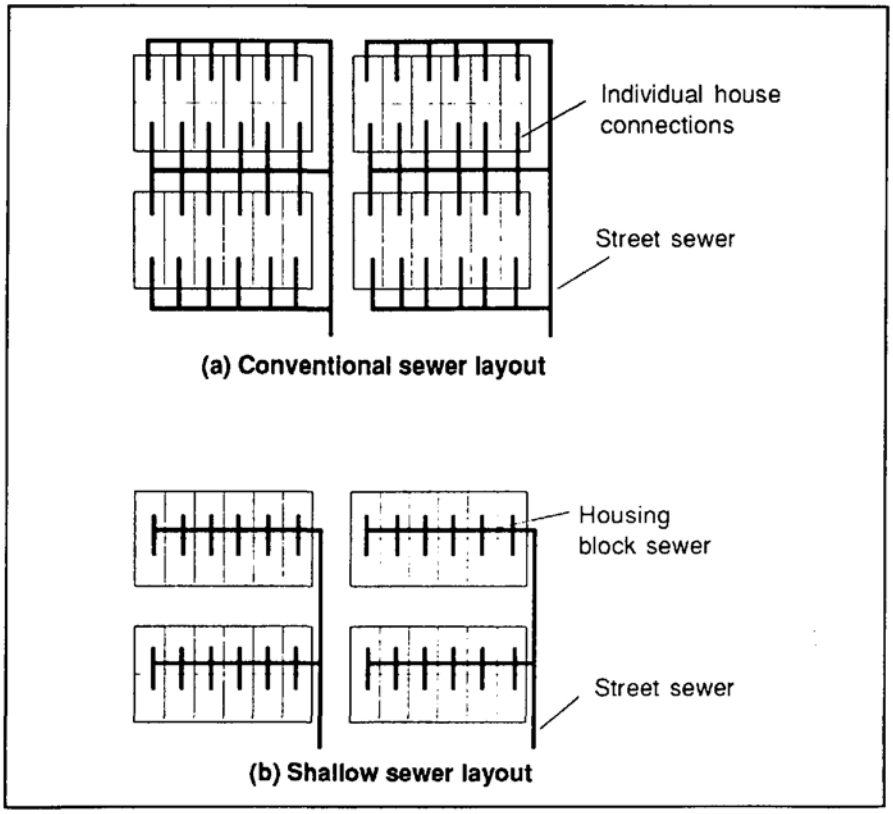

Figure 3. Schematic layout of conventional and shallow sewer-systems (adapted from UNCHS, 1986).

The means used to achieve community participation obviously vary from place to place. Two approaches which have worked well in their respective environments will be chosen for illustration.

In Karachi, the OPP, a non-governmental organization, has employed 'social organizers' from within the project area, the squatter settlement of Orangi. The focus is on individual lanes, where the social organizers arrange meetings to explain the need for sanitation, and introduce the idea of OPP sewerage as an affordable solution to the problem.

The community then has to decide whether it is sufficiently interested to select two of its number to act as lane sanitation managers. The lane managers approach OPP formally and request the organization's help, which may extend to:

- providing plans and other design documents;
- training the community's representatives in fundraising and construction management;
- recommending reliable craftsmen;

- loaning tools, shuttering and other equipment; or supervising construction.

The community is free to reject the OPP'S help and advice at any time. The community is responsible for raising and spending all the money needed for construction. The maintenance of the sewer they build is also their responsibility.

In Brazil, unconventional sewerage has mainly been implemented by the state water companies. The following information relates to the state of Rio Grande do Norte and its water company, the Companhia Estadual de Aguas e Esgotos do Rio Grande do Norte (CAERN).

CAERN's implementation policy is based upon meetings with the community organized at housing block level, significantly a scale similar to that favoured by the OPP in Karachi. The company prefers to work through the relevant locally elected municipal authorities, which it considers to be the most appropriate body for the conduct of community mobilization. Construction priorities are set according to the degree of enthusiasm which is shown by residents and municipalities in various districts.

The residents, assisted with materials by the municipality, are responsible for constructing and maintaining all sewers on private property. As Figures 3 and 5 indicate, this is usually a large part of the sewer network.

CAERN designs and supervises the building of these sewers, and has produced leaflets showing how to connect plumbing appliances to the sewer as well as how to clear blockages and carry out simple pipe repairs. CAERN is responsible for designing, constructing and operating all other parts of the sewer network plus the treatment facilities.

Further investigation

Unconventional forms of sewerage have been tried out on a significant scale in parts of Brazil, and in Karachi. They appear promising but require further investigation, particularly in relation to how well the users of such systems are coping with the maintenance tasks that they have to perform.

The Water Engineering and Development Centre (WEDC) of Loughborough University is currently carrying out field study evaluations of the most widely implemented designs, and the authors would welcome information from other countries concerning the central problem of how to make sewerage affordable to all those who need it.

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Further reading

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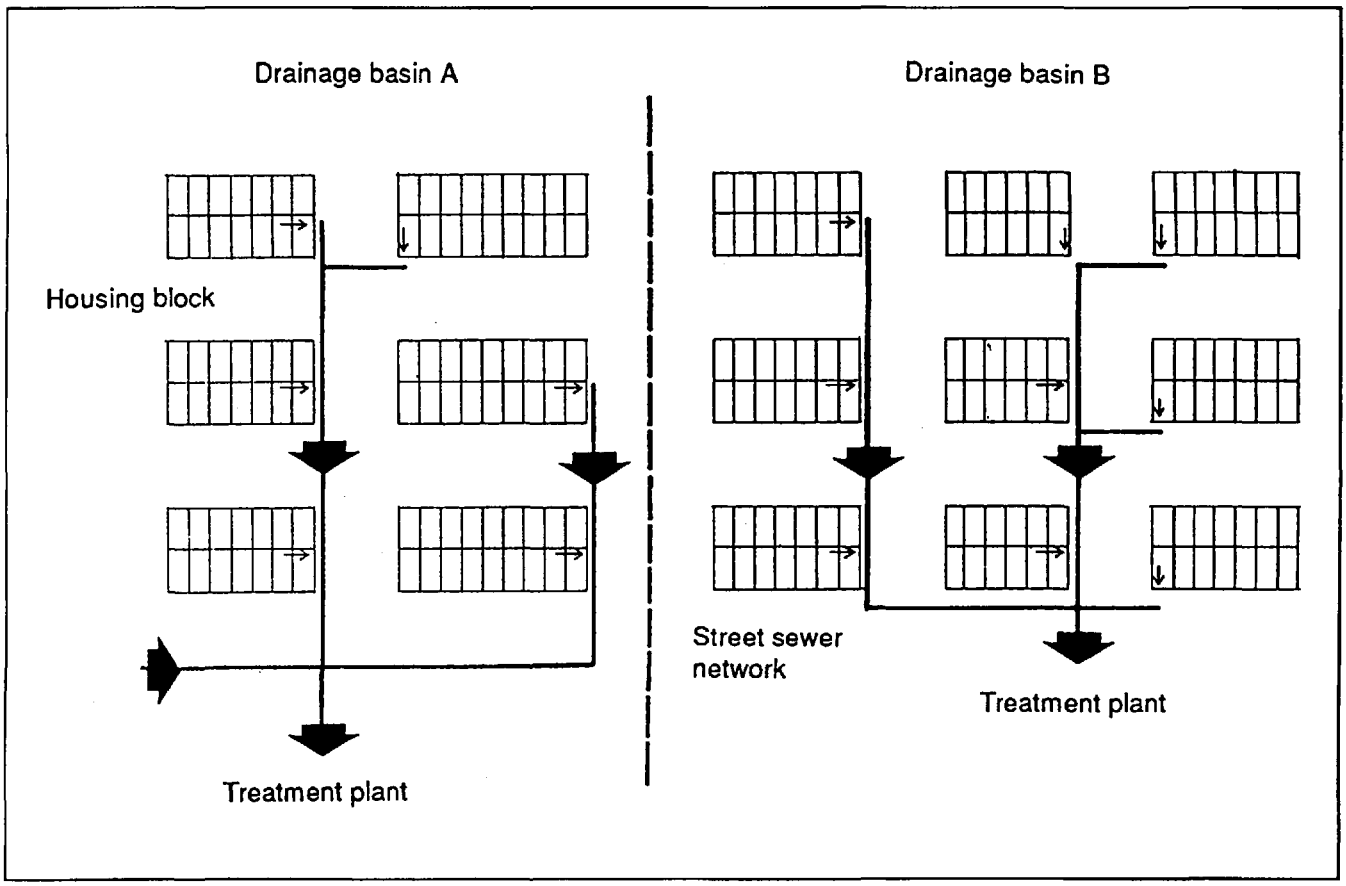

Figure 5. A decentralized sewerage system where each drainage basin has its own treatment plant, as adopted in Rio Grande do Norte in Brazil.