

## HAROLD H LEICH

### APPROPRIATE SANITATION FOR HUMAN SETTLEMENTS IN AFRICA

Despite the known disadvantages of centralized sewerage systems in the industrial nations, they are still being recommended for adoption in cities of the developing world (ref. 1). And what are these disadvantages?

#### Cost

Installation of new gravity sewers through densely built-up sections of a large city would be extremely expensive.

#### Waste of water

Where houses are served by a piped-in water supply, some 40 per cent of the water used goes down the flush toilets. Many developing nations are already short of water, and the notion of supplying vast additional quantities of potable water to transport body wastes for millions of inhabitants is not realistic.

#### Depletion of ground water

Where water supplies are pumped from ground water and the resulting wastewater is released into surface waters, there is a gradual depletion of ground water because the water table is not re-charged. In some arid regions of the United States, the ground water level is dropping three metres a year and the water table is already 260 metres below the surface, because of over-pumping.

#### Incomplete sewage treatment

Even with expensive secondary and tertiary treatment, the effluent from a treatment plant contains unwanted nutrients that cause eutrophication in the receiving waters. Sewage treatment plants are subject to interruptions such as power failures, employee strikes, and by-passing during high water, any one of which can send millions of litres of raw sewage into receiving waters. For example: "In San Francisco, up to 90 per cent of the city's wastewater during storms goes untreated and fouls the bay and the ocean. A new treatment system under consideration would cost \$1.93 billion." (ref. 2)

#### Accumulation of sludge

Municipal sewage treatment plants produce large quantities of sludge, representing a serious disposal problem. Agricultural use as fertilizer may be foreclosed because industrial plants discharge toxic materials into sewers.

#### Risk of disease to downstream users

Pathogenic organisms such as viruses can survive chlorination, and the very act of chlorination may create carcinogenic compounds in the public water supply.

#### ALTERNATIVES TO CENTRAL SYSTEMS

The developing nations of Africa have an opportunity to learn from the mistakes of the industrial world by adopting waterless or water-saving sanitation methods. Fortunately ingenious people in many nations, developing and industrial, have given thought to this problem. New sanitation devices are now available that avoid all the disadvantages listed above and that would be appropriate for the prosperous sections of cities in the developing nations. Some examples follow:

#### Recycling systems

One type purifies all "black water" (wastewater from toilets and urinals) so that it can be re-used for flushing. (Wastewater from wash basins can also be accommodated, but not the "gray water" from kitchen sinks, bathtubs, or laundry.) Such a device would be suitable for a large office building, for example, providing a self-contained sanitation system needing no sewer connection and a limited supply of piped-in water.

Another type purifies all wastewater (both "black" and "gray") to the point where it can be used for all purposes, including cooking and drinking. Such a system would be appropriate for large hotels, apartment houses, and mansions in prosperous areas. Again, no sewer connection is required and only limited additional water is needed to replace water lost through evaporation, etc.

### Subsurface disposal systems

The septic or anaerobic tank with its subsurface tile drain field has been used successfully for many years in areas where the soil permits absorption of the effluent. Recent adaptations have allowed installation of septic systems even where soil conditions are unfavorable; for example, building two drain fields which are used alternately to allow each a period of recovery, use of mounds or evapotranspiration beds where bed-rock is near the surface, and use of pressure sewers to collect effluent from several tanks for transport to an area where a satisfactory drain field can be constructed.

A different approach is to convert the tank from septic to aerobic action by using an electric pump to inject air into the tank and break up solids. Makers claim the following advantages over septic systems: longer periods between pump-outs, reduction of odours, use of a smaller drain field, and reduced danger of a clogged and failing drain field.

Both systems, of course, require adequate land area near the building served.

### Waterless toilets

Several new toilet systems do not need any water. The composting toilet, originating in Sweden, has two principal forms. The large model uses no electricity and produces finished compost, formed from body wastes and kitchen garbage, in about two years. The small model uses electricity for heating body wastes and for ventilation, and finishes the compost in about six months. Compost from either model is largely free of pathogenic organisms and makes a valuable fertilizer.

Several Swedish and U. S. companies make incinerating waterless toilets, fired by oil, electricity, or piped or bottled gas. They reduce body wastes to a sterile ash but there is some release of gases and odours to the air. They completely solve the water pollution problem but consume considerable amounts of energy.

Some American companies make closed-loop toilet systems that use a low-viscosity oil as the flushing medium. Wastes are piped to a gravity separation tank where the oil floats to the top and the wastes sink to the bottom. The oil is drained off the top, filtered, and recirculated to the toilets. Wastes are stored until they can be removed for land or other disposal.

All these dry toilets have the great advantage of solving the problem of disposing of body wastes, but leave unsolved the problem of "gray water" disposal. One solution

where land is available is a dry well or small subsurface drain field. Inventors are working to devise a simple filtration system for cleansing such wastewater so that it could safely be used for irrigating lawns and gardens, or drained into surface waters.

### Vacuum or pressure systems

Inventors have developed the use of differential air pressure to move body wastes through sewer pipes without the need for large quantities of water. Vacuum and pressure toilets need only a litre or two of water per flush. Such systems can be used for individual homes or apartment or office buildings, with the wastes directed to a holding tank for periodic removal. Or vacuum or pressure sewers can be used for an entire community in lieu of gravity sewers; in addition to water savings, such lines can move wastewater up moderate grades and thus reduce the cost of ditch-digging, as compared with gravity sewer lines.

### INSPECTION AND MAINTENANCE OF ON-SITE SYSTEMS

The on-site sanitary systems described above require systematic inspection and maintenance to insure that they are functioning properly. In the United States public sanitary districts are being organized in some areas for this purpose. An alternative approach is to require the owner of each system to have a valid service contract with the manufacturer's representative.

### NEED FOR EXPERIMENTATION

It would be helpful if some international body such as the United Nations Environment Programme, the World Health Organization, or the World Bank would test these various devices to determine whether they can be successfully used in cities of the developing nations. In the absence of such an international effort, an African nation could conduct its own experiments. It is likely that no one system would satisfy all sanitation needs; one can visualize a spectrum of solutions determined by such factors as comparative costs, density of population, soil conditions, and size of buildings to be served.

### LOW-COST SANITATION NEEDS

The cost of all the devices mentioned above, although much less than that of a central system, clearly rules them out for the great majority of inhabitants of the developing nations, both urban and rural. Simple and inexpensive toilet systems are needed for the cities, towns, villages, and rural areas of Africa, and much thought and experimentation are being given to this

subject (ref. 3). One very promising device is the double-vault privy, originating in Vietnam (ref. 4). Another system, a dry indoor method costing very little per household, might also be the subject of experimentation. An adaptation of the British "earth closet" of the nineteenth century, this toilet uses dry, pulverized soil to cover body wastes and thereby eliminate odours, unpleasant sights, and insect infestations. It could take several forms; the following is one suggestion:

-- A small enclosed space, for privacy, is set aside in the dwelling.

-- A wide-mouthed bucket or box, its bottom covered with a layer of dry soil, is provided. The sides of the container are low enough to allow the user to squat over it. Or if desired, a raised pedestal seat could be built over the container.

-- At hand is another container of dry, pulverized soil and a small trowel or paddle. Each user is trained to cover the new deposit with a layer of soil to begin the composting process. Sand, sawdust, or wood ashes could be mixed with the soil, but lime should not be used since it tends to preserve the wastes.

-- If the dwelling has land available, a member of the household buries the contents when the container is nearly full. Burial under 30 centimetres of soil should be sufficient. Garden crops can then be grown on the enriched soil but edible root crops should not be planted for a year or so.

-- Where no land is available at each dwelling, a collection system is organized. In this case the bucket or box is lined with a bag containing the layer of soil, and each bag is tied shut and collected periodically. Simple hand carts can be used to transport the bags to farmland for burial. In several years the same field can be used again.

-- In places where dwellings do not have enough space indoors to install the system, public toilets will be needed. They can operate on the same principle as the household system.

-- Costs of the system should be paid by the public sanitation agency.

The importance of experimentation as a first step should be emphasized before any such system is widely used. The public sanitation agency of a developing nation could undertake such an experimental programme, reviewing the following points:

-- What absorbent mixture of dry soil and other materials is best adapted to local conditions?

-- Is it preferable to separate the functions of urination and defecation by providing a special bucket for urination (possibly including a small quantity of water for dilution)? Such a bucket could be emptied, when nearly full, into a small dry well outside the dwelling.

-- When bags are needed for the system, what material should be used: cloth, plastic, reinforced paper?

In introducing such an indoor system, a society should conduct an intensive information programme and obtain the support of political and social leaders.

#### REFERENCES

1. MUIGA M I AND REID G W. Cost analysis of water and waste water treatment processes in developing countries. Water Resources Bulletin, 1979, June, 838-852.
2. Washington Post, 1979, December 27.
3. RYBCZYNSKI W, POLPRASERT C, AND MCGARRY M. Low-cost technology options for sanitation. International Development Research Centre, Ottawa, 1978.
4. NIMPUNO K. Private correspondence, 1979.