



Comments on leachpit pourflush latrines

J Shome and S Mukherjee, India

THE STRATEGY FOR leach pit pourflush latrines has been conceived to provide on-site low-cost sanitation systems for the poor to improve their quality of life and control water-borne diseases. Human excreta is a reservoir of pathogens and viruses. Indiscriminate and open defecation is a serious pollution source affecting human health and has thus become a great concern in the field of environmental sanitation and public health worldwide. With time, the gap between the growth of population and provision of sanitary latrines appears to be divergent amongst the economically weaker sections. Concerted efforts are being made to close this gap, but the peoples' response is found to be not as strong as predicted. In the absence of low cost solutions, both in construction and maintenance, the sanitation approach to the community will be ineffective. Thus the choice of leachpit latrines needs to be popularized, with remedial measures for its short-comings, as contemplated and presented in this text.

Materials and Methods

Groundwater

While dealing with groundwater pollution, the character of water bearing strata needs to be well identified. There are two relevant zones namely (a) *zone of aeration* – a layer near the surface which is unsaturated or is only occasionally saturated, and (b) the *zone of permanent saturation* – a lower layer, from which water is available for supply. The function of the leachpit to be assessed is consideration of the upper surface of the saturation zone to be considered for water table. In the non-saturation zone there may exist a belt of soil-trapped water under-laid with capillary fringes over the zone of saturation. Perched water may also be present in some pockets. Porosity of the soil is a measure of its water holding capacity, whereas the size of the effective openings between the grains is more important for water transmissibility of the medium.

Leachate travel

In densely populated urban slums, where the leach-pit can be constructed, the areas available are mostly prone to water logging. Under such conditions the selection of earth to build up the area for setting the pit and the percolation of the leachate needs to be done with care. A combination of porous as well as clayey medium should be designed to control the seepage travelling to groundwater susceptible to nitrate pollution. Mud and silt beds in anaerobic systems are a good sink of NO_3 where the action of denitrifying

bacteria may break the NO_3 and cause nitrogen to escape into the air. Use of a clay barrier may be applied in this situation. The ranges of components of the clay texture normally found are sand (0–46%), silt (0–40%) and clay (40–100%). The hydraulic conductivity in that case varies between 0.12 to 0.50m/day. With the decrease of sand and increase in silt and clay content, this hydraulic conductivity reduces to between 0.06 to 0.12m/day. Putting a clay wall called a 'barrier' across the path of travel, the movement of leachate may be controlled and disposed off in a larger area, with reduction of the magnitude of the pollution. This is shown in Figure 1. When a greater area for horizontal infiltration is required an envelope of more porous material between solid media and pit lining may be provided.

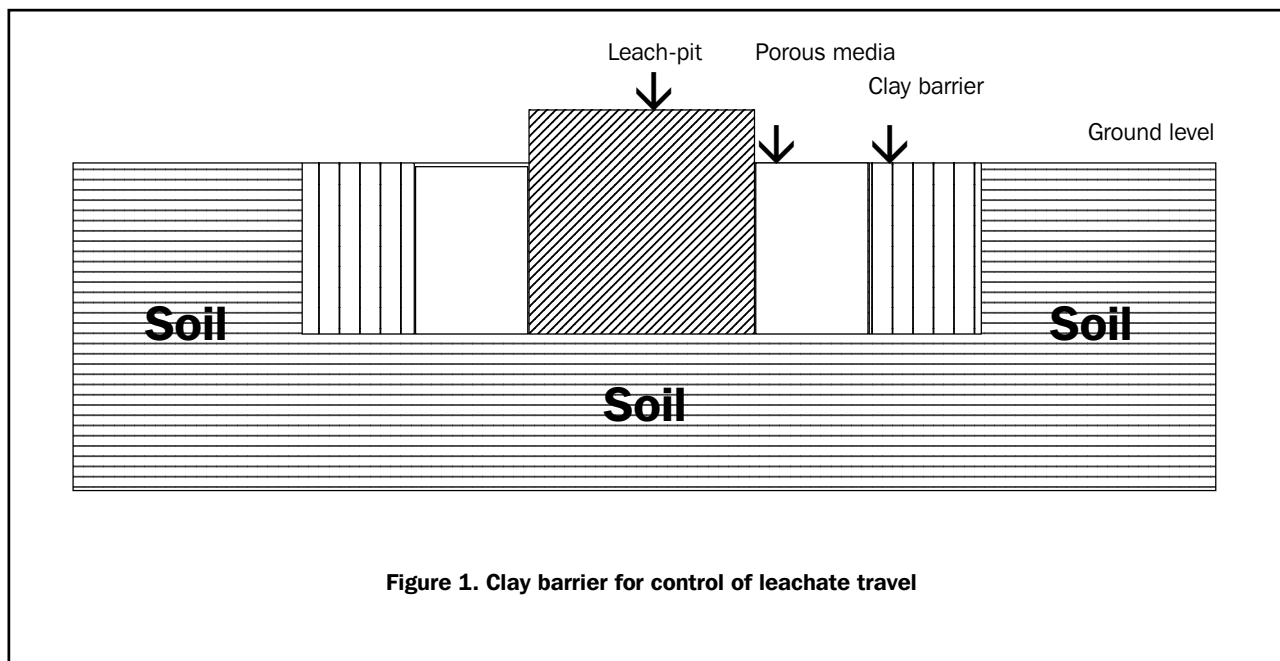
Compost moisture

To change the moisture content of the digested material within the pit in 2-3 years, the texture of the solid media around the pit should be consistent with the desired permeability requirement. In low lying areas, where the soil medium remains saturated throughout the year, mechanisms of surface evaporation and evapo-transpiration should be developed to create the driving force that may lead to the pit moisture percolating into its surroundings. Unless the moisture of the pit compost is brought down to 60% or less the fluidity will cause problems in the emptying process. Underground drainage may help to improve this situation.

Leachpit in benchings of hilly areas

This is a new area where design guidelines are required by the Community. Leachpits constructed at the benching contribute to moisture in the soil mass, resulting in a reduction of shearing strength of the soil. In a dry state, the strength is comparatively higher. On sloping land the upward increasing hydraulic conductivity plays an important role on lateral groundwater flow and migration of mobile pollutants. Depending upon the situation, the use of a cut-off barrier built with a clay matrix may be resorted to, in reducing the hydraulic conductivity of the soil media.¹

To protect landslip, a cover of dwarf tree and shrubs having long roots capable of penetrating deep into the slope and acting as reinforcement, may be provided over the influence zone active in drainage response. A plantation of *eucalyptus*, *luncaena* and *poplar* may be considered effective in the reduction of soil moisture through evapo-transpiration. In a sea beach at Puri, India, a plantation of *eucalyptus*, and *casuarina* trees has been utilized to dispose



of treated effluent from a sewage treatment plant, through absorption and evapo-transpiration to atmosphere causing zero discharge. The root growth of grass and shrubs readily takes place in the upper 0.50 metre layer, whereas the roots of the trees penetrates up to 1 metre, or even more. This may serve as root reinforcement, thereby making a positive contribution to the stability of the slopes. Resistance against slip-circle failure should also be examined and a guideline for the construction of leachpits provided to the community in such areas of habitations.

Hydraulic Loading

Water utilization per person per day

Flushing :	2.5 x 2	= 5.0 litres.
Ablusion :	1.25 x 2	= 2.5 litres.
Urine & Faeces :	1.0 x 2	= 2.0 litres
	Total	= 9.5 litres.

Organic Solid Content in Fresh Liquid

Excreta released per person per day

Faeces (gms) : 135 – 275 (205 average).
 Moisture content (%) 66 – 80 (73 average).
 Solids person⁻¹ day⁻¹ (gms) 205 x 0.27 = 55.35

Concentration of organic solid (mg^l⁻¹) :
 $55.35 \times 10^3 / 9.5 = 5826$

% of solid = $55.35 \times 10^3 \times 100 / 9.5 = 0.5826$
 % of liquid = $100 - 0.5826 = 99.4174$

Soil Moisture and Hydraulic Conductivity

Considering the saturation condition of the soil medium and 60% moisture to be retained, the soil-water drainage requirement for each person daily comes to

$$= 9.5 \times 0.40 = 3.8 \text{ litres cap}^{-1} \text{ day}^{-1}.$$

To achieve this condition, the soil medium surrounding the pit should have the property of good hydraulic conductivity and a positive energy gradient needed to maintain the driving force to migrate water from the pit at 3.8 litres cap⁻¹ day⁻¹. In case this condition cannot be met, due to adverse site conditions (i.e. soil mass surrounding the pit is small, area is water logged), the mounding in the pit will develop readily and impair use of the pit much earlier than the design period. Design of a porous envelop around the pit, linked with subsoil drainage, may help in keeping the soil mass in the influence zone active and the leaching mechanism alive. The use of a sand envelope around the pit has been tried in water logged areas in North 24-Parganas, West Bengal, and the performance has been kept under observation. No adverse effect has been found during its use of about one year.

The Conventional Design Guidelines for Leachpits in Wet Conditions

Desludging cycle – 3 years

The long-term infiltration rates (litres m⁻² d⁻¹) for different types of soils - namely sand, sandy loam/loam, porous silty loams/silty clay loams, compact silty clay loams/clay are 50, 30, 20 and 10 respectively. Hydraulic loading is considered as 9.5 litres cap⁻¹ d⁻¹. . For low cost on-site

Table 1. Conventional design guidelines for leachpits in wet conditions

Users No.	Hydraulic loading @ 9.5 l/c/d	Pit diameter (mm)	Liquid depth (mm)	Area required (m ²)	Areaprovided (m ²)
5	47.5	1000	1300	2.37	4.08*
10	95	1200	1400	4.75	5.27
15	142.5	1600	1500	7.13	7.54

* In a poor community, 5 persons is the size of the smallest family unit, which increases rapidly. To cater for the needs of a population beyond 5, the construction of additional latrines is hardly ever done by the community. The existing latrine continues to be used and is over-loaded, with disastrous results. Thus this unit needs to be oversized in design, to take shock loads. For the simplicity of dimensions the units of 10 and 15 users are slightly oversized and will take care of shock loads.

sanitation units for 5, 10 and 15 users are mostly required by the poor community. Depending upon the pit wall materials used for the concrete/brick wall, the cost of the 10 user's-latrines made with pukka superstructure, wooden door, porcelain basin, RC roof, all well finished is US\$220 – US\$270. The size of each type in porous silty loams, with a long term infiltration rate of 20 l/m²/d has been suggested below. For ideal maintenance and digestion, the minimum diameter and depth has been considered as one metre. For stability of the porous pit structure, a maximum diameter of 1.6 metres has been taken into account.

In water-logged areas the pit top should be 300mm above the highest water level at the time of water logging. A 1 metre, well compacted, wide earthen island around the pit should be built up to its top level. In the case of "black cotton" soil, an infiltration rate of 10 litres m⁻² d⁻¹, with provision of a 300mm thick fill of sand/gravel/ballast of small sizes around the pit, has been suggested. In rocky strata, the infiltration rate of 20 litres m⁻² d⁻¹ may be considered, except in fissured rock / chalk formation / old root channels, where safeguards of pollution are to be provided. Space constraints may be adjusted by choosing a small diameter (not less than 750 mm) but deeper pit, or combined pits each of equal size with an impervious partition wall, or different geometrical shapes such as combined oval, square or rectangular pits. The lining materials may be of brick, stones or concrete, depending upon availability and cost.

Safe distance

In soil with an effective size (ES) \leq 0.2mm, the distance of the pit from the tube well / dug well should be a minimum of 10 m. For an effective size $>$ 0.2mm, the pit must be sealed with puddle clay / plastic and a 500mm thick sand (ES 0.2mm) envelope. In sewerred cities, the reports of water

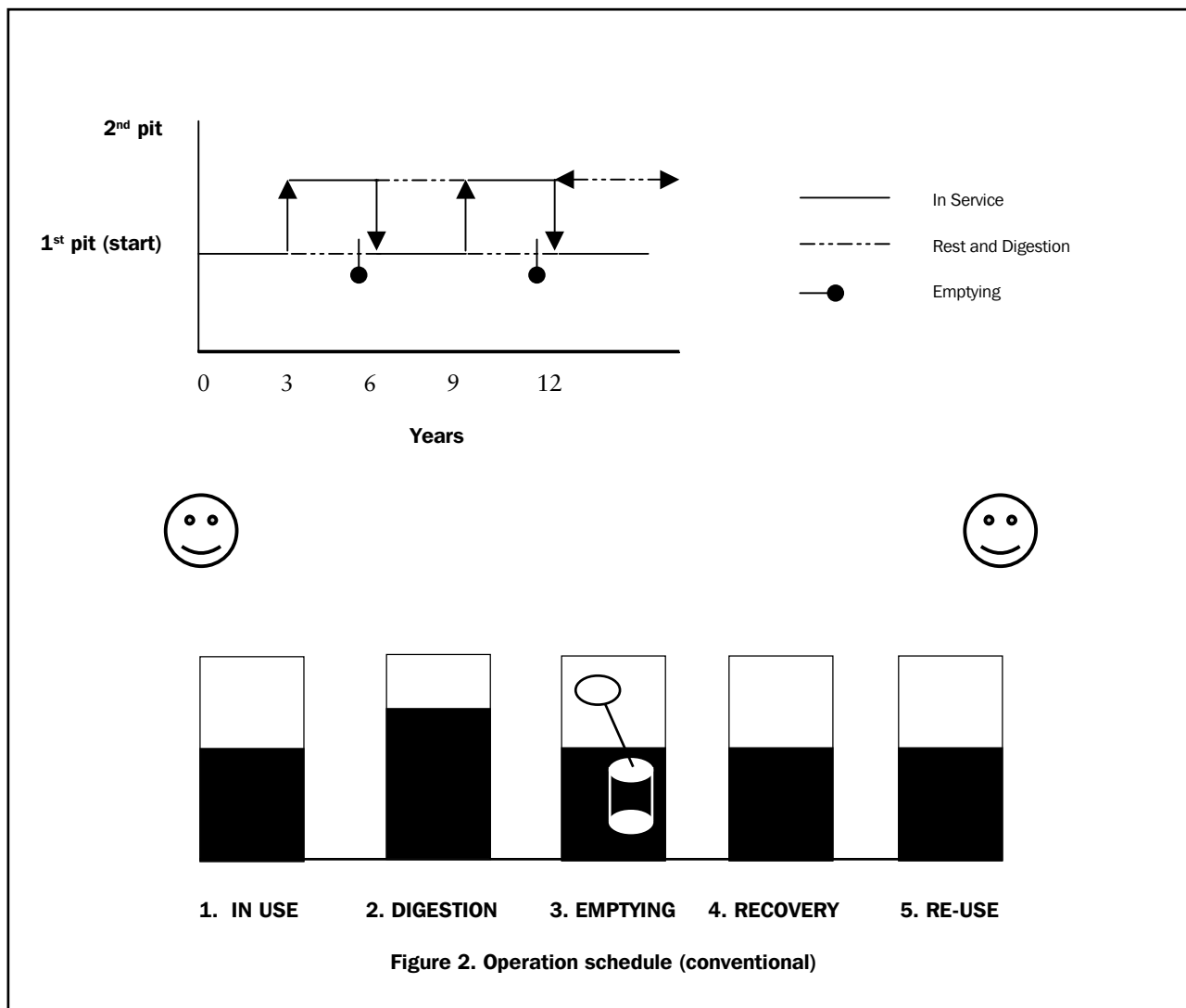
supplies contamination from sewage are received from time to time. The protection of water supplies from the ingress of contaminant is necessary. The normal survival time of pathogenic bacteria in soil medium has been reported as 10 days and the distance traveled by water carrying bacteria during this period is considered a risk from a bacteriological point of view. Under average conditions of soil permeability, this distance is 0.8 metres per day. The lateral distance between the pit and the water pipe should be \geq 8 m. When this is not possible, the pipe should be completely encased to a length of at least 3 m on either side of the pit. Building foundations should be 0.2 – 1.3 m away from the pit.

Operation Schedule (conventional)

See figure 2. overleaf.

Results and Discussion

With the rapid population growth, the ideal conditions of land for leachpit latrines in the urban situation, or in densely populated towns, is often not available. The pollution safeguard measures suggested cannot in many cases be implemented, due to unavoidable constraints. The need for condition-specific technical options cannot be overlooked, to popularize leachpit latrine sanitation as a cheaper option to the poor community. In hilly areas, the concept of modified designs of the leachpit, tailored with slope protection by root reinforcement and vegetation, has been suggested. A standard design for water-logged areas is to be evolved, with all possible devices for drainage of pit moisture. The use of a clay barrier, casing and envelope should only be considered in exceptional circumstances in the design of pollution safeguard measures, to suit the site conditions.



Conclusions

Although leachpit latrines have gained popularity in rural areas, concerted efforts are to be made to provide this low-cost sanitation service more widely and faster in densely populated areas, in urban and municipal towns, with appropriate modifications in design and construction procedures.

Without the involvement of NGOs in the massive task of educating the poor community in hygiene behaviour, acceptance by the people of this low-cost onsite sanitation programme will not gain momentum. Wide campaigns along with action programmes, involving community participation, will be of great help in accelerating onsite sanitation in developing countries.

¹ A water tight or very low permeable barrier wall laid below ground level is called a “cut-off” barrier. It is made with a mix of 0.50-1 parts sand and 2 parts clay termed the ‘clay matrix’. If laid properly, it will deflect the leachate to a wider field of dispersion, where soil absorption, uptake by terrestrial plants, evapotranspiration will dispose off most of the liquid. The chance of slope failure due to seepage from the leachpit will be minimum.

J. N. SHOME, Institution of Public Health Engineers, India

S. S. K. MUKHERJEE, Chief Engineer, Municipal Engineering Directorate, West Bengal