SANITATION

FOR A HEALTHY NATION

February 2002

Sanitation Technology Options

Department: Water Affairs and Forestry

Your partner in creating a better life for all

National Sanitation Task Team

Department: Water Affairs and Forestry, Health, Education, Provincial and Local Government, Housing, Environmental Affairs and Tourism, Public Works, Treasury

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Introduction

The full range of technical options for providing adequate basic sanitation is still not widely understood. In particular, there is little appreciation of the long-term financial implications of operating the various sanitation systems. As a result, communities and local governments are currently choosing technical options that, in the long term, are unaffordable and unsustainable.

Complications arise from the wide range of options available and the differing environments in which they must be implemented. Experience shows that it is important to allow local solutions to be developed. The options include the ventilated improved pit toilet in all its variations, composting toilets and on-site wet systems such as septic tanks, and full water borne systems.

Communities often face choices ranging from single pit ventilated improved latrines to double ventilated improved pit latrines to urine diversion/composting latrines. These options promote household management of operation and maintenance. (In most cases, the cost of emptying a single pit every five years is estimated at between R35 and a still-affordable R60.) Where higher levels of service are chosen, the costs are a lot higher - as much as R500 per household per annum. The initial capital cost is also dependent on the choice of technology. One of the lessons learnt from the DWAF programme is that it is possible to provide on-site dry systems for an initial, capital outlay of less than R1000. The Archloo, which is provided to many cholera-affected areas, is an example of a facility that can be provided at a cost of R600 using local materials and local labour - and that can be put into large-scale production. However, such provision must be coupled with health and hygiene promotion if health improvements are to be ensured.

In this document you will read more about the various technical options that meet the requirements for basic sanitation. These need to be considered within all the sustainability requirements, e.g. affordability, operation and maintenance. The options are divided into two categories: Dry on-plot systems (that do not require water for operation) and wet systems (that do require water for operation).The following information is provided for each technical option described:

- A technical drawing of the recommended option
- A description of the options
- An explanation of the principles of operation
- Operational and institutional requirements
- A summary of costs
- Notes on previous user experiences and comments on these

Technical guidelines are available from the Department of Water Affairs and Forestry for on-site dry sanitation.

Please note: The capital cost of a given technology varies widely - depending on location, locally available materials, construction method, extent of existing infrastructure, etc.

Options not recommended

Unimproved pit toilet

• This system is not recommended (subject to bad smells and insect infestation)
A top-structure around and /or over a pit, generally unlined where soil conditions allow, with a pedestal or squat-plate.

Chemical toilet

• This system is not recommended (expensive and temporary)
Various modern types. These utilise a water-diluted chemical in a receptacle below the toilet seat to render excreta harmless and odourless. These are generally standalone units.

Bucket toilet

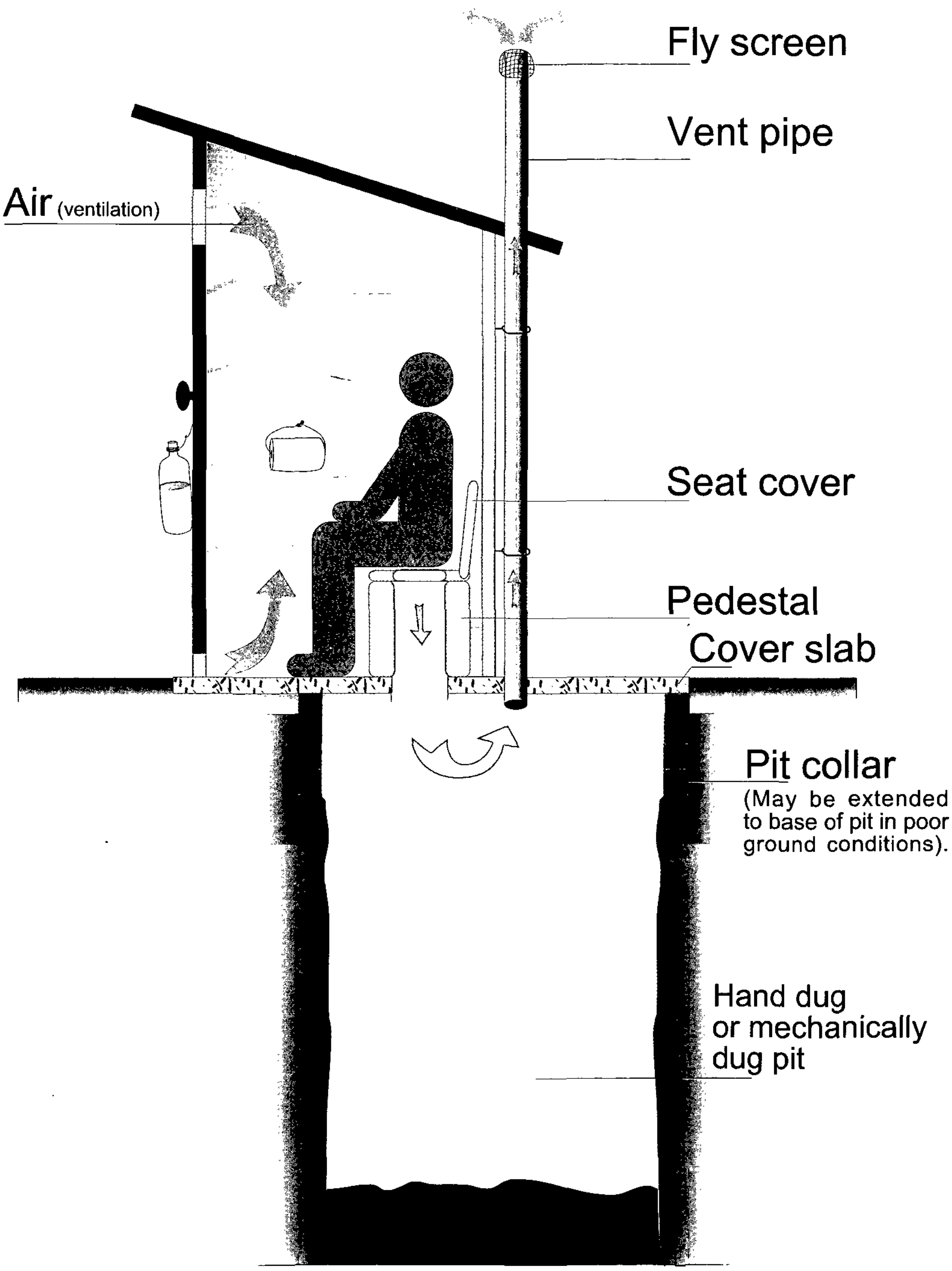
• This system is not recommended (unhygienic sanitation system, environmentally undesirable)
A top-structure with the seat positioned above a bucket or other container located in a small compartment beneath.

Communal toilets

• This system is not recommended for household use (unhygienic)
Toilet "blocks", which may be based on dry or wet systems as, outlined above.

References:
Franceys, Pickford & Reed (WEDC) "A guide to the development of on-site sanitation", WHO 1992. • SMLC, Johannesburg, report to Executive Committee, "Review of sanitation in informal settlements" 1999. • Guy Pegram, "A protocol to support peri-urban sanitation provision in the GJMC", final draft, 2000. • Julia du Pisani, "Providing Sanitation in South Africa", unpublished draft. • The Applicability of Shallow Sewer Systems in South Africa, Guy Pegram and Ian Palmer July 1999.

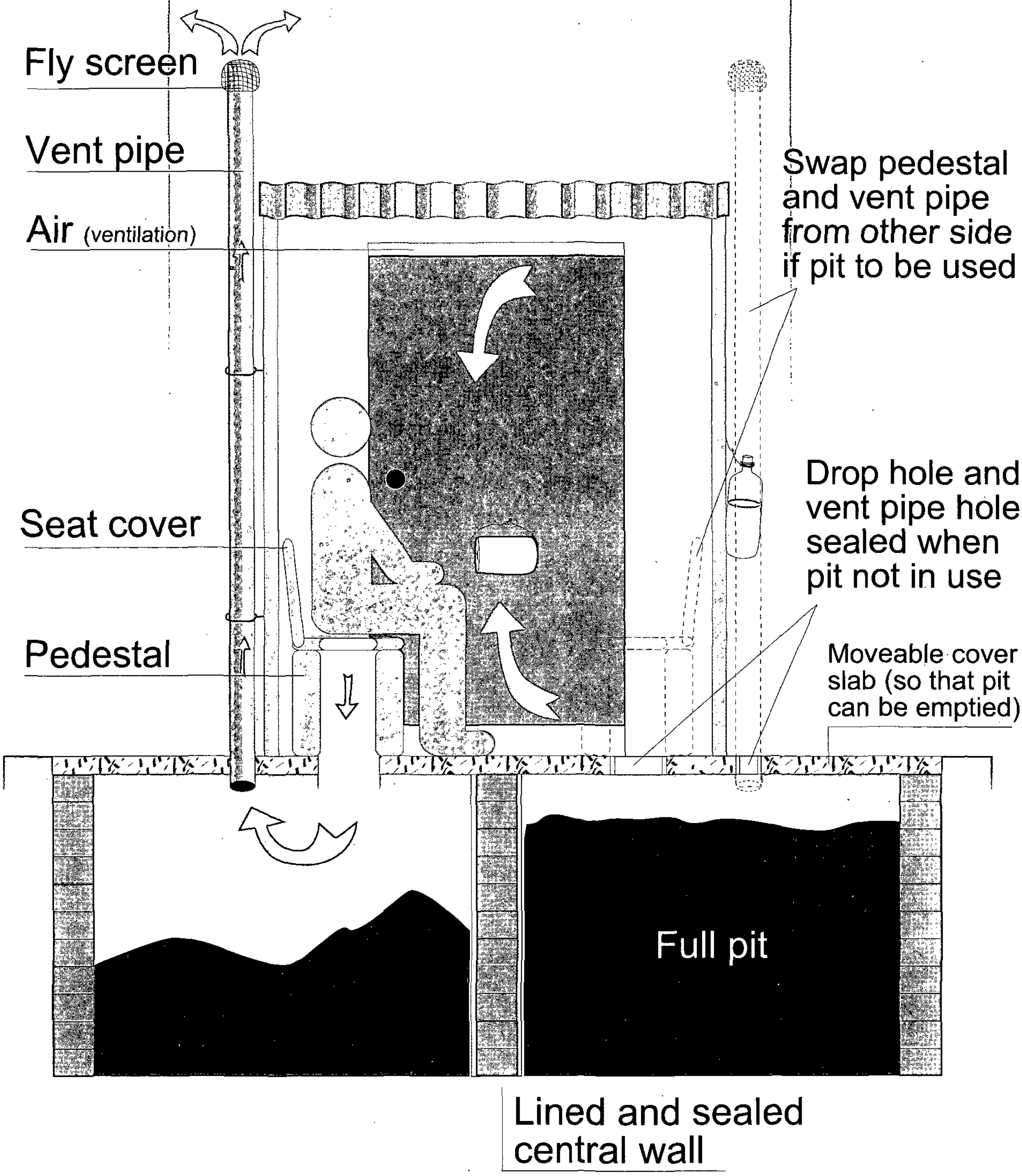
Ventilated Improved Pit (VIP) toilet



A top-structure over a pit. The pit is vented by a pipe over which a fly-screen is fixed. The pit may be lined (recommended where emptying is required), or unlined where soil conditions allow.

Principles of operation	Operational and institutional requirements	Costs	Experience and comment
Waste drops into the pit where organic material decomposes and liquids percolate into the surrounding soil. Continuous airflow through the top-structure and above the vent pipe removes smells and vents gases to the atmosphere. A darkened interior is maintained causing insects entering the pit to be attracted towards the light at the top of the vent pipe and trapped by the fly screen. A separate hand washing facility is required.	Locate to prevent ingress of storm water to pit, as well as in consideration of local groundwater use and conditions. Does not accept domestic wastewater. Cannot be placed inside house. Ensure access for mechanical pit-emptying and availability of sludge treatment and disposal where required. Ensure repair/replacement of damaged/worn materials.	Capital: may range from R600-R3000, depending on householder input and choice of materials. Operating: R60 per year if emptied once in 5 years.	Widely used internationally and in rural and peri-urban areas of South Africa. Most successful in water-scarce environments. Failures generally due to inadequate user education and/or poor design and construction. Costly adaptations can result where shallow rock or shallow water tables occur.

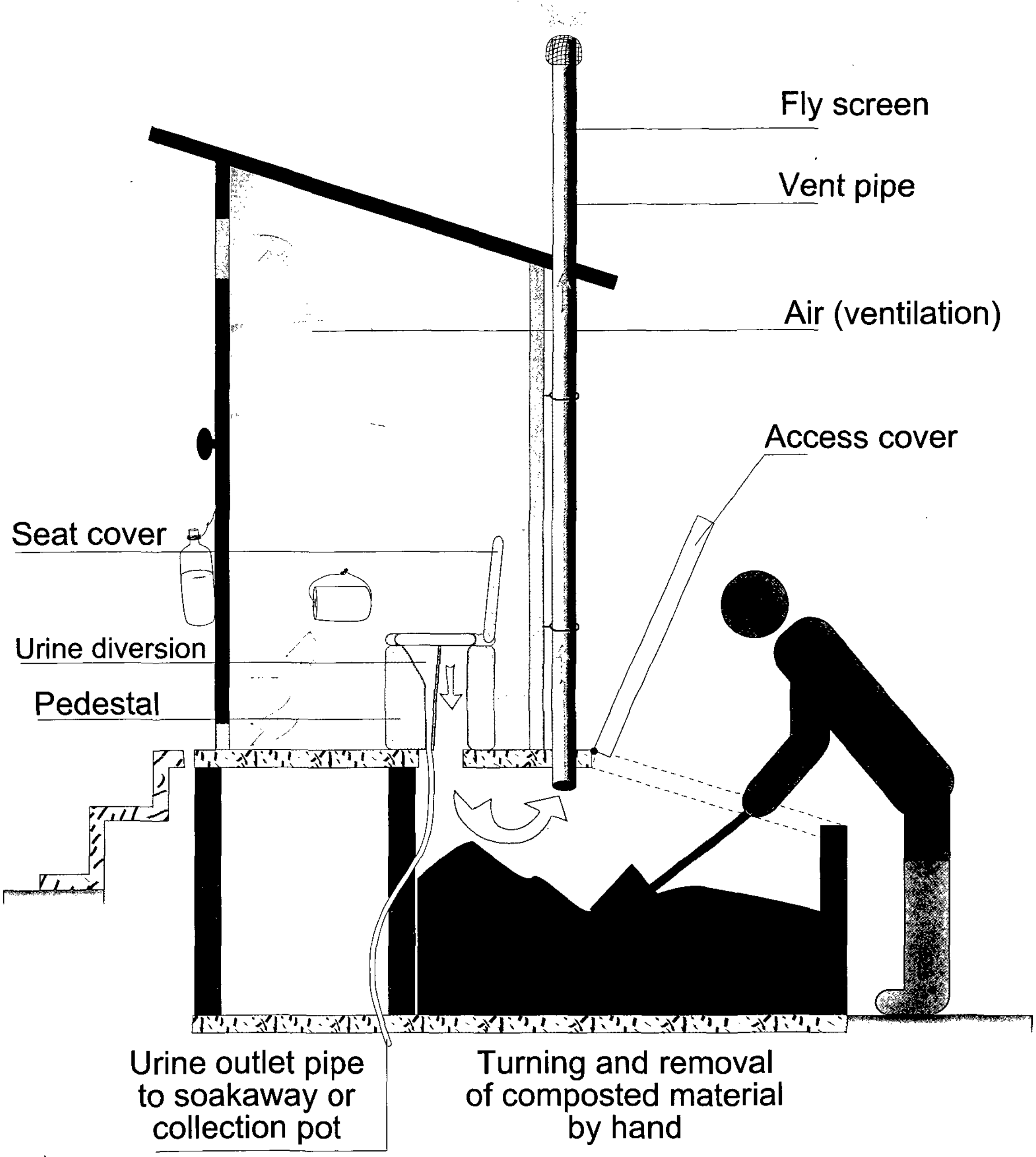
Ventilated Improved Double Pit (VIDP) toilet



A single top-structure over 2 shallow pits, side by side. Only one pit - vented by a pipe protected with a fly screen - is in use at any time. Generally lined and the central wall fully sealed to ensure isolation of one pit from the other.

Principles of operation	Operational and institutional requirements	Costs	Experience and comment
As for the VIP toilet. One pit is used until filled to within about half a metre of the top. The defecation and vent pipe holes are then completely sealed and the other pit used. The contents of the first pit are dug out after a period of ***at least*** two years, once the contents have become less harmful.	As for the VIP toilet, except that promotion of manual emptying by the householder is usual, and use of decomposed waste as a soil conditioner possible. Suitable disposal site necessary.	Capital: R2 500-R4 500 depending on householder input. Operating: R35-R135 every 2 years depending on local government involvement, householder willingness to handle waste, disposal options.	Resistance to handling of decomposed waste and timely changeover of pits by householders has often been overcome through education and over time - both internationally and in SA. This VIP alternative is often applicable where rocky or groundwater conditions prohibit deep excavation.

Composting/urine diversion (UD) toilet

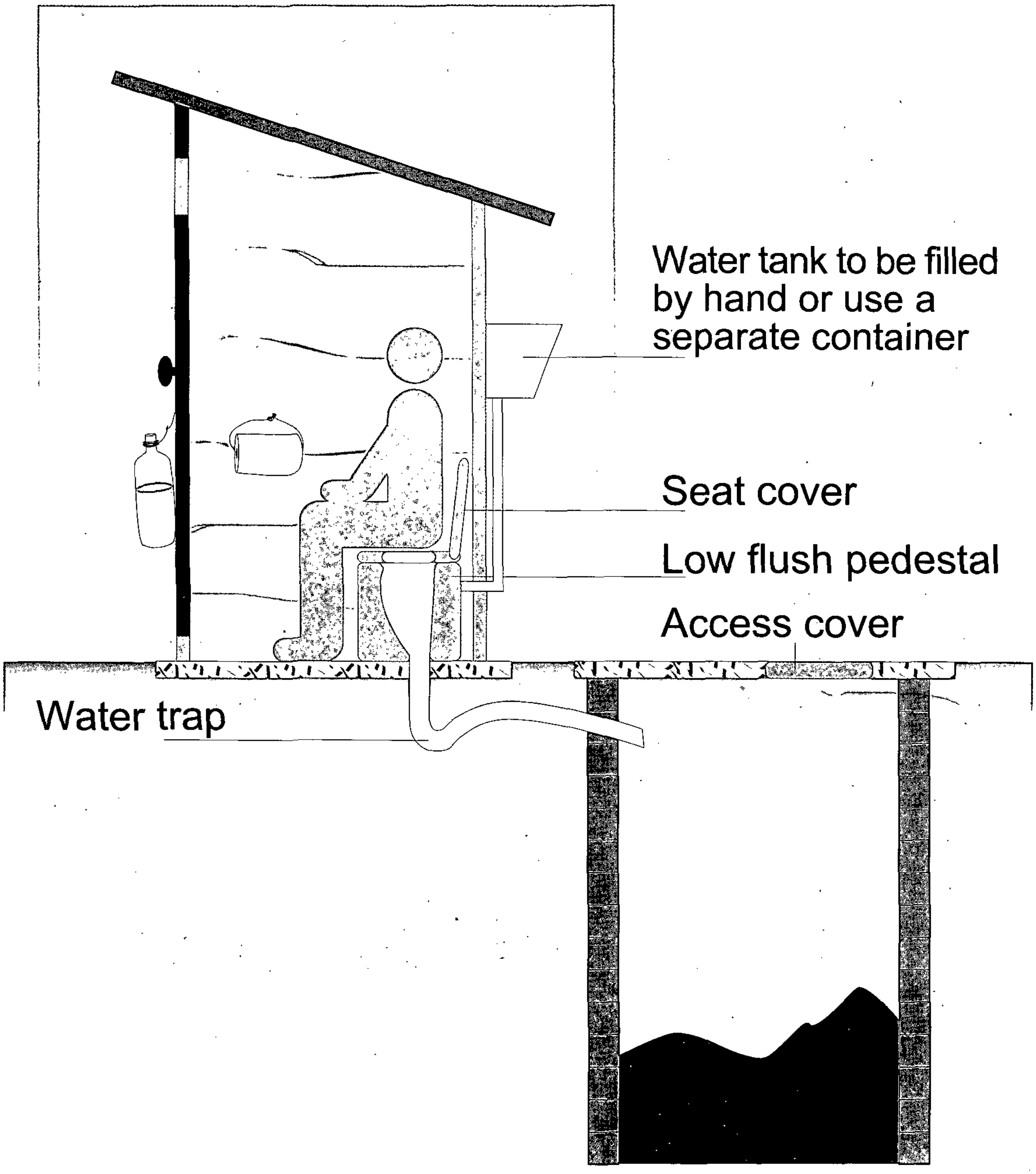


A single top-structure over a sealed container, which could be one of two chambers side by side (as for the VIDP), with access for the removal of decomposed waste. A vent pipe may be installed to encourage drying of the waste.

Principles of operation	Operational and institutional requirements	Costs	Experience and comment
Waste is deposited in the chamber and dry absorbent organic material, such as wood ash, straw or vegetable matter is added after each use to deodorise decomposing faeces and/or control moisture and facilitate biological breakdown (composting). Urine may be separated/diverted through use of specially adapted pedestals. This may be collected and used as a fertiliser. In desiccation systems, ventilation encourages the evaporation of moisture.	Does not accept domestic wastewater. Ensure ease of access by householder and promotion of manual 'turning' of compost and removal of composted/desiccated material. Suitable disposal site/area necessary.	Capital (variable depending on system and householder input): R3 000-R4 000 for commercial systems. Operating: R35-R500 per annum, depending on local government involvement and householder willingness to handle waste, and disposal options.	Control of moisture content is vital for proper operation. Contents often become too wet, making the vault difficult and unhygienic to empty, as well as malodorous. UD systems in SA still being monitored but appear to be accepted by certain communities and working without significant problems. Burning of compost prior to removal also being tested in SA. Proprietary systems have been piloted in SA, generally with inconclusive results as to their likely success on a large scale and under varying conditions. User educational requirements and continuous input significant for proper operation in terms of the composting process.

Wet systems

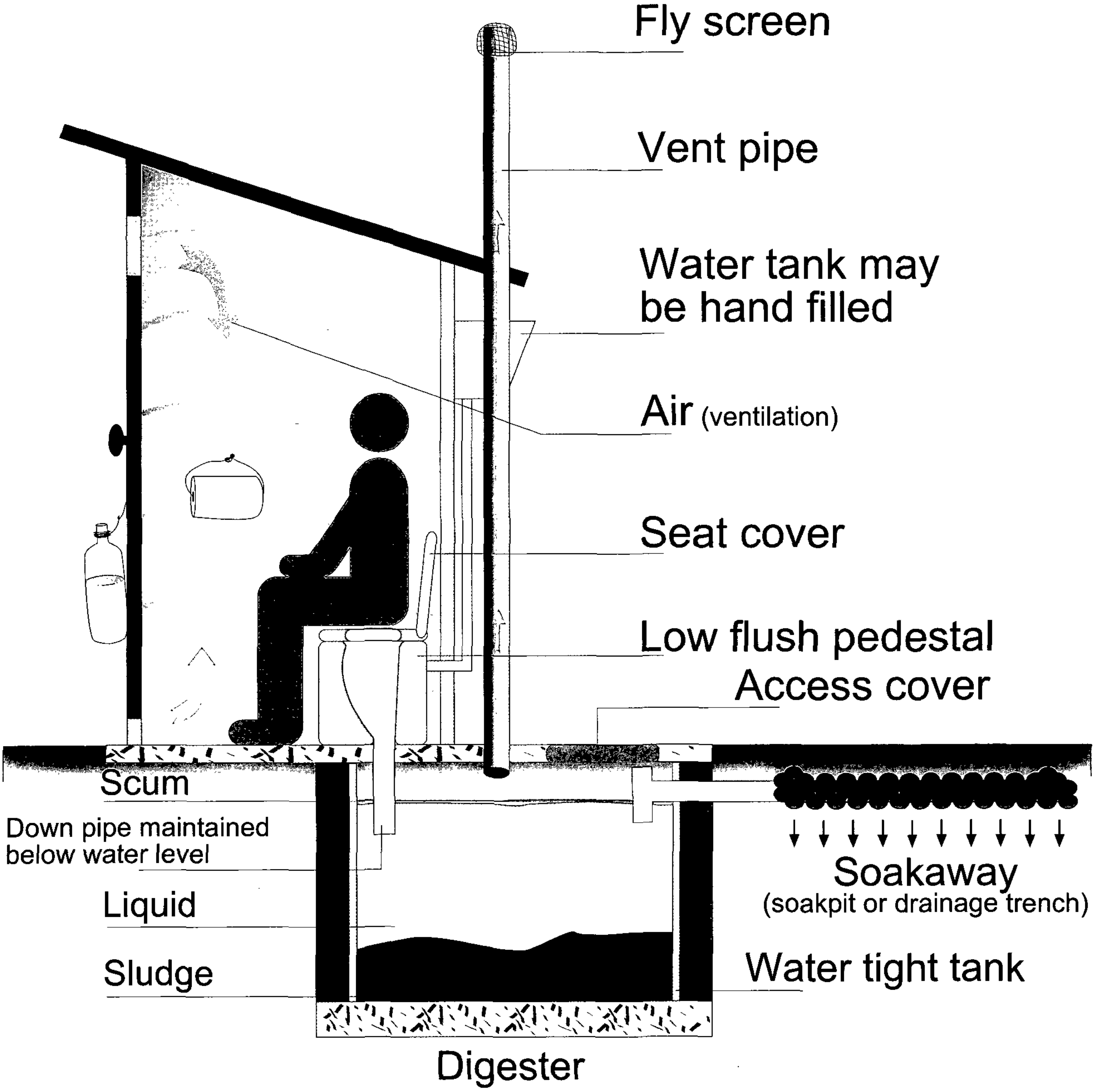
Pour-flush toilet



A toilet with a water-seal arrangement: a pan trap fitted into the floor slab, and optionally discharging through a short stretch of pipe or channel.

Principles of operation	Operational and institutional requirements	Costs	Experience and comment
After defecation, the pan requires flushing with a few litres of water. The water retained in the pan provides a seal against smell, flies and mosquitoes.	Appropriate for small volumes of water and can accept domestic wastewater - generally carried by hand to the latrine. Ensure access for mechanical emptying of contained waste, and suitable subsoil drainage (high reliance on the soil environment in rendering the effluent harmless) and/or availability of sludge treatment and disposal.	Capital: R2 000-R3 500 which can increase where soils are not well suited to drainage. Operating: R150-R300 per annum where subsoil drainage is available.	International acceptance demonstrated where water is used for anal cleansing and users squat. Blockages occur through use of inappropriate anal cleansing material. Offset pour-flush can allow location of toilet inside house, but generally larger flushing volumes are required. Experience in SA has seen failures through lack of user education and/or poor design and construction, use where inappropriate and limited provision of affordable emptying service.

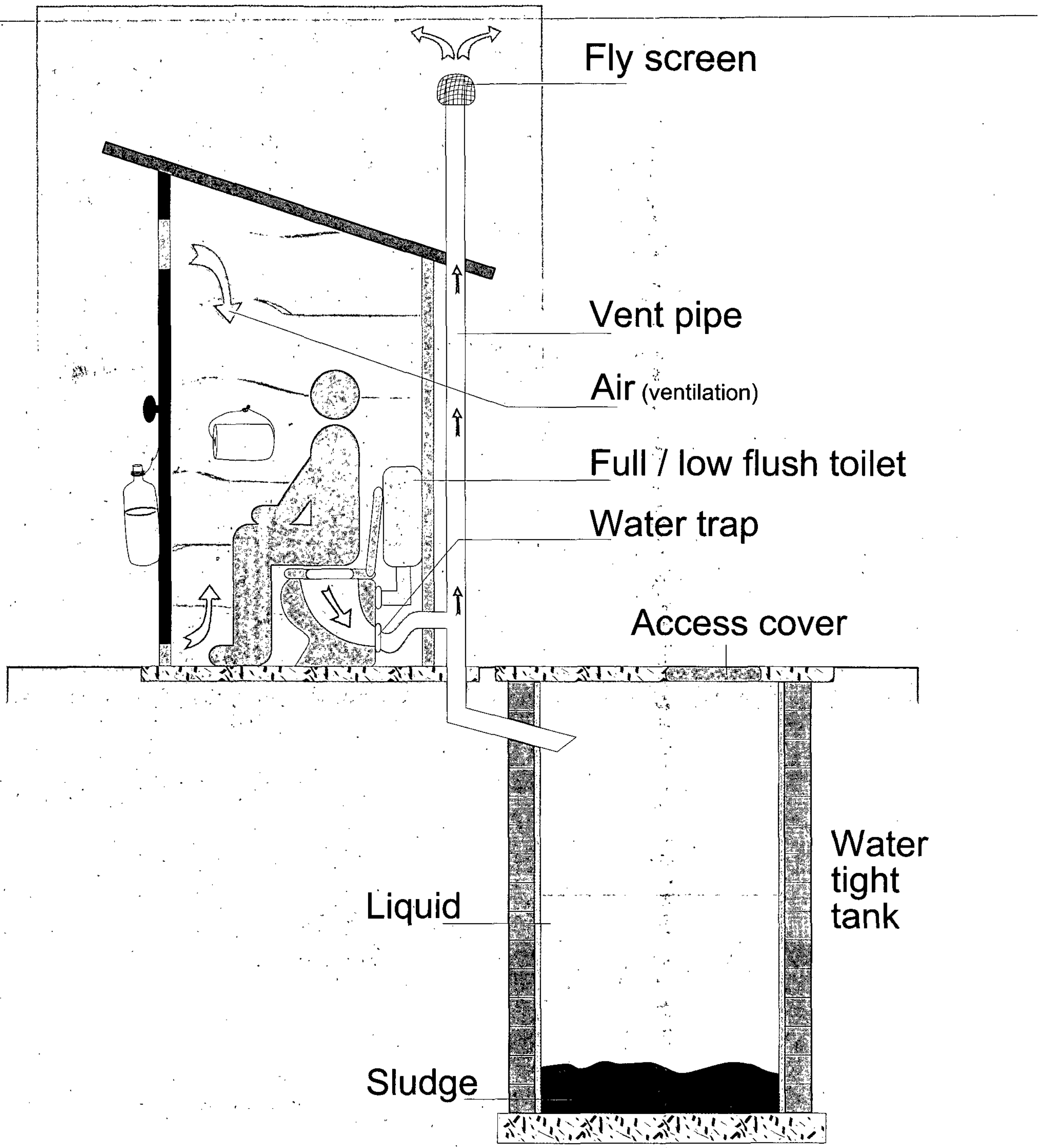
Aqua-privy and soakaway



A toilet with a water-seal arrangement: a straight or curved chute running from the seat to below the water level with some form of waste collection and disposal system.

Principles of operation	Operational and institutional requirements	Costs	Experience and comment
After defecation, the pan requires flushing with a few litres of water. An aqua-privy requires the addition of water to keep the end of the chute submerged. Containment of the waste may vary from a sealed container to a solids collection system and effluent soakaway.	Appropriate for small volumes of water and can accept domestic wastewater - generally carried by hand to the latrine. Ensure access for mechanical emptying of contained waste, and suitable subsoil drainage (high reliance on the soil environment in rendering the effluent harmless) and/or availability of sludge treatment and disposal.	Capital: R2 000-R3 500 which can increase where soils not well suited to drainage. Operating: R150-R300 per annum where subsoil drainage is available.	International acceptance demonstrated where water used for anal cleansing and users squat. Blockages occur through use of inappropriate anal cleansing material. Experience in SA has seen failures through lack of user education and/or poor design and construction, use where inappropriate and limited provision of affordable emptying service.

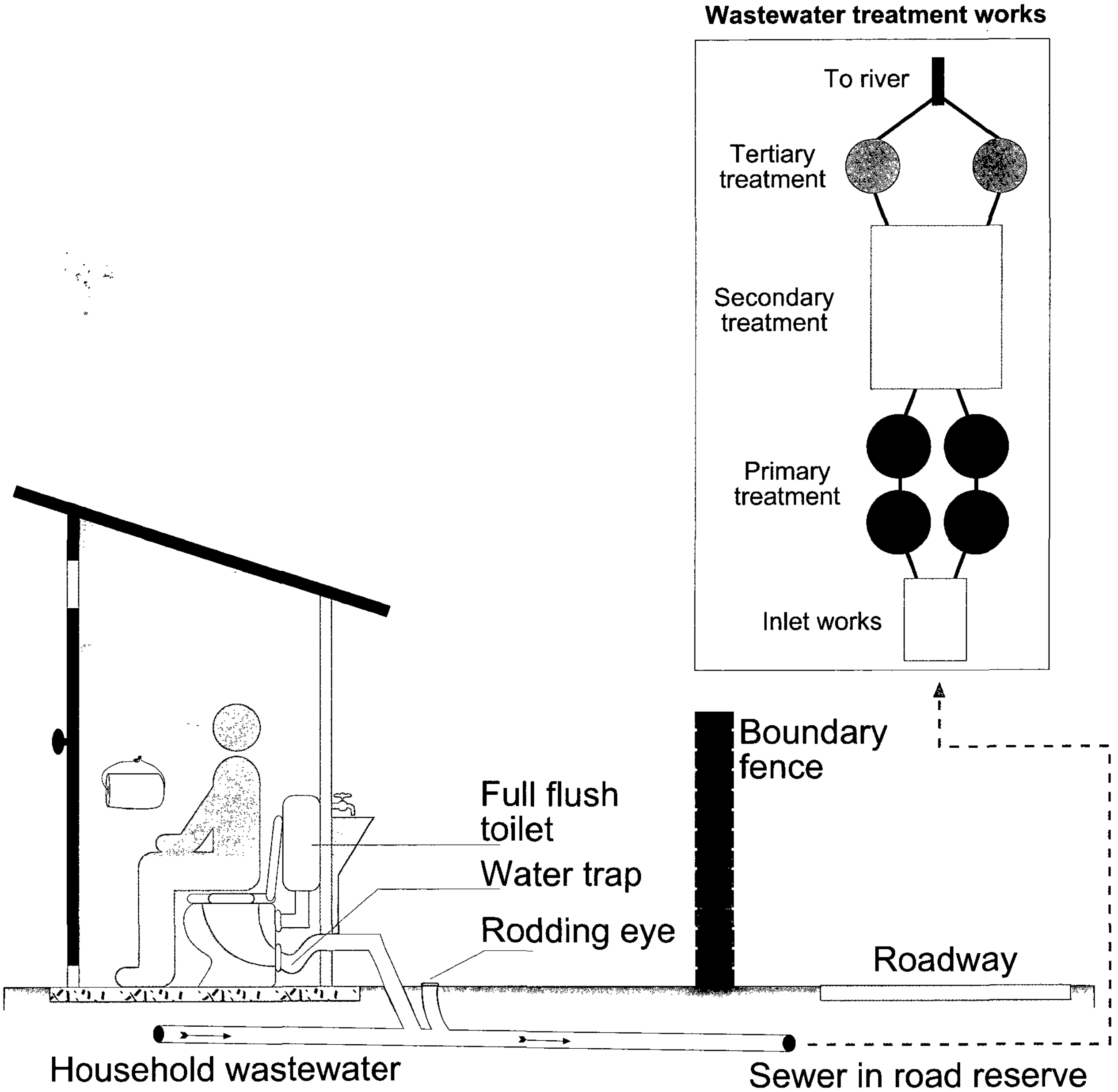
Conservancy tank



A storage system, i.e. a sealed tank, where low-flow or full-flush toilet systems are used.

Principles of operation	Operational and institutional requirements	Costs	Experience and comment
Waste is flushed into the tank where it is contained in isolation from the surrounding environment before removal by tanker for treatment.	Tank sizing dependent on flush volumes; domestic wastewater levels and frequency of emptying. Ensure access for mechanical emptying and availability of treatment and disposal facilities.	Costs depend on size and emptying frequency. Cost: At R2 000 - R5 000 depending on top structure and tank volume. Operating: R550 per household per annum (based on an estimated emptying cost of R181 per tank) assuming the tank is emptied, on average, 3 times per year.	Widely used, particularly in more sensitive soil and geo-hydrological environments.

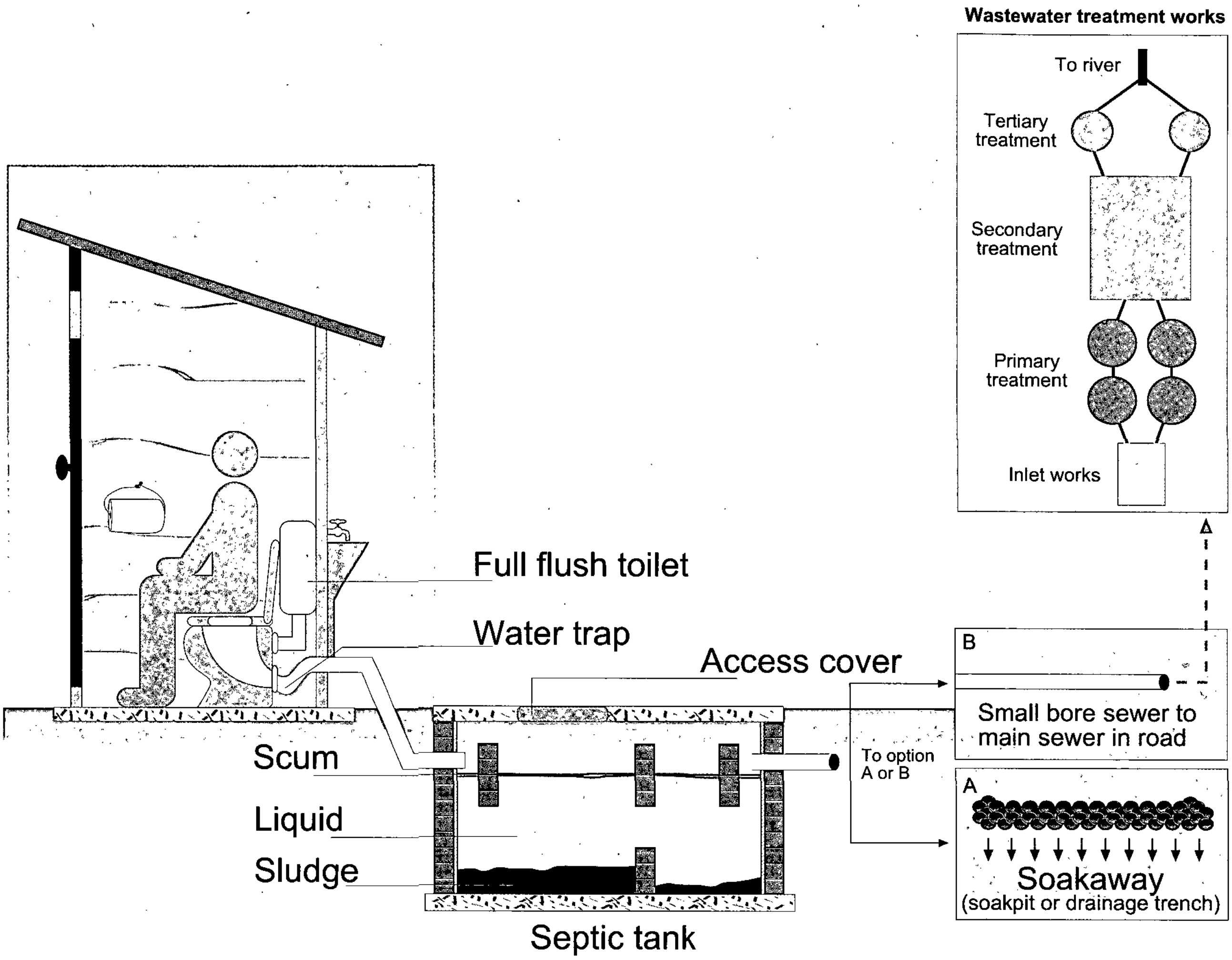
Full bore waterborne sewerage



An in-house full-flush toilet connected to a sewer (pipe) network which drains to a wastewater treatment facility.

Principles of operation	Operational and institutional requirements	Costs	Experience and comment
Waste from the toilet, and possibly domestic wastewater, is flushed using significant volumes of water into the sewer system for removal to a treatment facility. There are several types of such facilities and these treat effluent to high standards prior to discharge into the aquatic environment.	Requires a reliable and uninterrupted household water connection and spatially regular permanent settlements. Specific design criteria must be applied throughout the sewerage network. Skilled, organised and effective operation and maintenance capability is required for sewers and the full functioning of wastewater treatment facilities.	Capital: R6 000-R7 000 taking bulk and sewerage costs into account. Operating: R400-R800 per annum.	Widely used and generally the aspiration of all South Africans although unaffordable to many, particularly in terms of access to sufficient volumes of household water. Appropriate anal cleansing material is required. The health consequences of failure are devastating in comparison to on-site, dry sanitation.

Septic tank and soakaway or small bore solid-free sewer

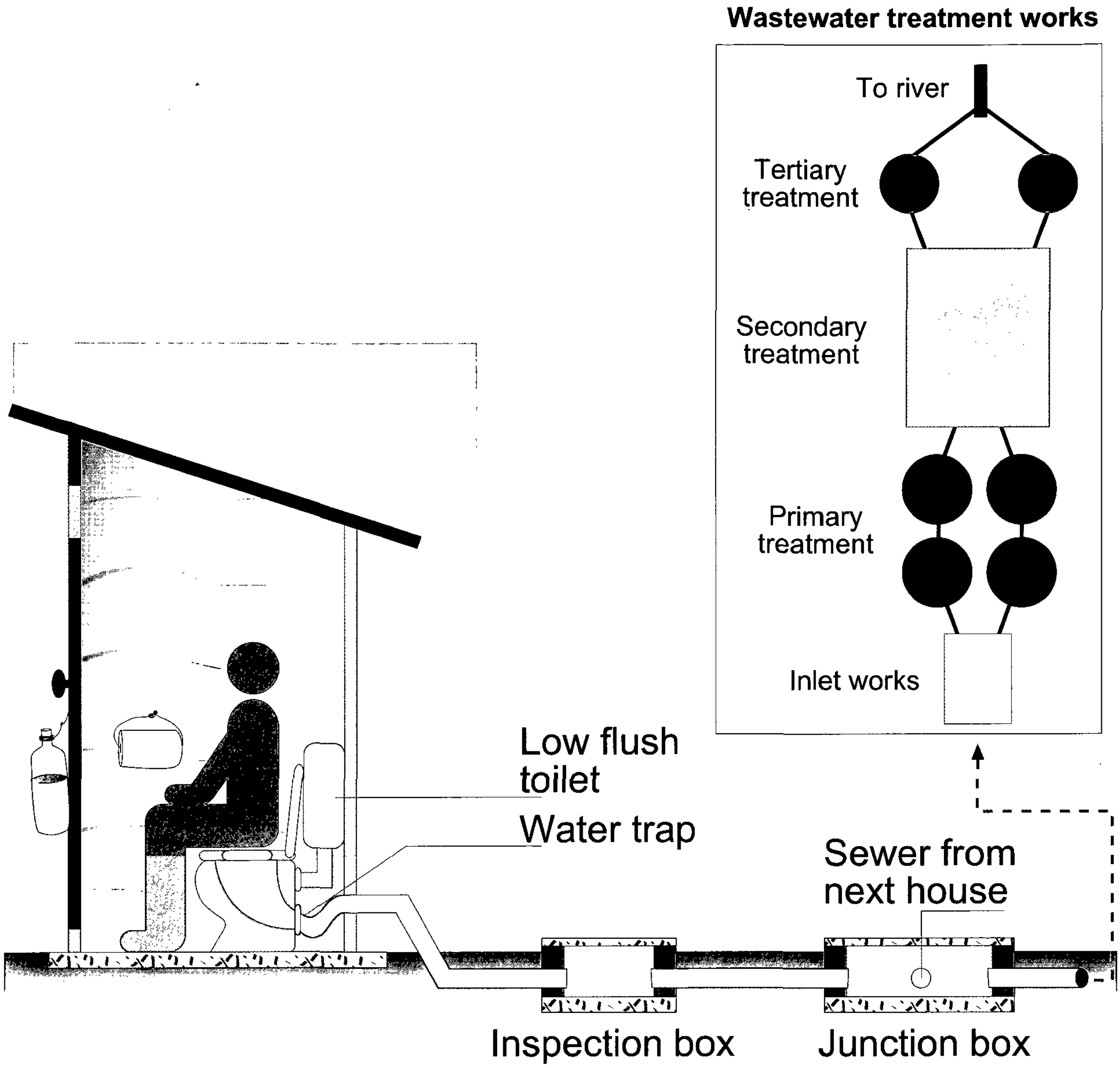


Septic tank and soakaway: *An in-house full flush-toilet connected via pipe and plumbing fixtures to an underground watertight settling chamber (the 'digester') with a liquids outlet to a subsoil drainage/soakaway system.*

Small bore solid-free sewer: *An in-house toilet discharging to a septic tank (or on-site digester) with liquids disposal via a small diameter sewer to a central collection sump or existing sewer system.*

Principles of operation	Operational and institutional requirements	Costs	Experience and comment
Septic tank and soakaway Waste from the toilet, and generally domestic wastewater, is flushed into the settling chamber where it is retained for at least 24hrs to allow settlement and biological digestion. Partially treated liquids then pass out of the tank and into the subsoil drainage/soakaway system. Digested sludge gradually builds up in the tank and requires eventual removal by tanker.	Requires a reliable household water connection. Specific design criteria must be applied to the settlement tank and soakaway system. This option is applicable only in areas of low settlement density and where soils have a high ability to drain effluent away. Ensure access for emptying of tanks by vacuum tanker, as well as availability of sludge treatment and disposal.	Capital: R7 000-R8 500. Operating: R200-R450 per emptying, depending on emptying frequency.	Widely used by formal rural households and farming areas, where reliable water supply is available. Provides a high level of service and user convenience. Failures due to poor design and construction, and use of inappropriate anal cleansing material. Soakaway system is particularly prone to failure in the long-term if detailed soil testing is not carried out.
Small bore solid-free sewer As for the septic tank and soakaway except that the liquid effluent is conveyed by a system of small-diameter pipes to a communal treatment point (which may be off-site treatment works reached either via existing sewerage or by tanker).	Although its water requirements may be less than those of a septic tank and soakaway, a household connection is needed. Ensure access for emptying of septic tank, as well as availability of sludge treatment and disposal. Routine maintenance of pipe network essential.	Within the septic tank and soakaway range detailed above if septic tank systems already in place, otherwise capital cost much higher.	Not widely used in South Africa, except where existing septic tank and soakaway systems have been converted for convenience and/or environmental reasons. Failures as for septic tanks above, and due to lack of maintenance of the pipe network.

Shallow sewerage



A toilet, usually in-house, flushed using lower volumes of water than either conventional sewerage or septic tanks, to smaller diameter sewers laid at flatter gradients and shallower depths between dwellings on a block. On-site shallow inspection chambers are provided.

Principles of operation	Operational and institutional requirements	Costs	Experience and comment
Waste from the toilet and possibly domestic wastewater, but at much lower volumes than for conventional sewerage, is flushed into the on-site sewerage system and progressively washed down to either a dedicated treatment facility or into street sewers and then on to a major treatment works.	Requires reliable household availability of water and high levels of connection into the sewerage system are necessary. Can, however, be laid out in less formal and spatially irregular settlements. Less stringent design criteria - but organised and effective operation and maintenance capability is required. This can be delegated to residents for on-site sewers. Significant user education and acceptance of shared management of the system is critical.	Capital: R 2500 to R 3000 - savings of up to 50% over conventional sewerage capital costs. Operational: R300 - R450 assuming that all maintenance is provided by the service provider. Drops to R312 where residents are responsible for operation and maintenance of block (not bulk) sewers.	Have not been used widely in South Africa although used, with reported success, under a wide range of conditions in a number of South American countries, Ghana, Pakistan and Greece. Pilot projects have been completed in Durban and Free State, with ongoing monitoring to determine overall success and sustanability. These indicate savings of up to 50% over conventional sewerage capital costs.

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