Regulating Public and Private Partnerships for the Poor

Cranfield UNIVERSITY

REGULATORY TOOLS: TECHNICAL

WATER

Individual connections:

In-house

Pre-paid metered

flexible pipes to meter/ valve clusters

Daily filled overhead tank

Daily filled ground tank

Yard connections/taps

Communal or shared yard connections/ taps

Communal connections with tank

Staffed Public Standposts /with storage

Pre-paid standposts

Public Standposts

Drinking fountains

Private vendors

Tankers, carters, neighbours on-selling

Bottled water & Sachet water

SANITATION

On-plot sanitation

On-site sanitation

*San-*plats

Sealed lid

Ventilated Improved

Pour Flush

Single Pit

Twin Pit

Sealed pit

Community Toilets

Pay & Use Communal Toilets

Sewerage

Condominial

Reduced cost

Conventional

PERI-URBAN WATER SUPPLY AND SANITATION

In lower-income countries, and particularly amongst lower-income communities, the regulatory process needs to recognize alternative means of delivering clean water and sanitation in order to achieve the Universal Service Obligation. Achieving USO should not default to the level of a standpost serving a hundred families. This summary sheet illustrates some of the many variations of service and pricing differentiation to serve the poor which can be considered by economic regulators in agreeing asset management plans for peri-urban areas. Although apparently requiring a 'lowering' in technical standards all these methods have been used and have enabled the delivery of effective water and sanitation services to the poor at a level which householders report is much more satisfactory than queuing at 3.00 am for water from a standpost.

Service and pricing differentiation to serve the urban poor

DFID

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Diagrams from: "Serving All Urban Consumers: Sansom, K., Franceys R, Njiru C., Kayaga S., Coates, S., & Chary, S. WEDC & IWE , Loughborough University, 2004

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Research Summary

Incentive based, economic regulation of monopoly water and sanitation providers is a powerful tool for improving services. Regulators determine the maximum water price ('price cap') to finance a desired level of outputs. Prices in high-income countries have tended to increase faster than inflation as society demands higher standards. The total revenue requirement (from which the price cap is derived) is determined by adding anticipated operating expenditure to planned capital expenditure (for capital maintenance as well as for improvements in quality, security of supply, service standards and service extensions), plus an acceptable cost of capital. Both opex and capex plans include efficiency targets derived from comparisons between a number of providers. Water companies are allowed to retain any further efficiency savings achieved within the price cap for a period (five years for example), an incentive to achieve even higher efficiency, before the benefits are shared with customers in reduced prices for the future.

This model has been adapted around the world with varying degrees of success, usually in the context of a Public Private Partnership, but until recently it has tended to be reactive rather than proactive regarding early service to the poor. There is now a recognised need for adequate economic regulation of public providers, as well as private companies, in lower-income countries, to deliver similar mechanisms for financeability and efficiency and as a prerequisite for developing effective pro-poor urban services.

The purpose of this DFID research project is to give water regulators the necessary technical, social, financial, economic and legal tools to require the direct providers to work under a *Universal Service Obligation*, to ensure service to the poorest, even in informal, unplanned and illegal areas, acknowledging the techniques of service and pricing differentiation to meet demand.

Looking to achieve early universal service, the research also considers how the role of small scale, *alternative providers* can be recognised in the regulatory process. *Customer involvement*, at an appropriate level, is seen as the third key aspect. The research investigates mechanisms for poor customers, and most importantly potential poor customers, to achieve a valid input to regulatory decision-making to achieve better watsan services within the context of social empowerment and sustainable development.

Regulatory Tools: Technical

This summary brings together the numerous ways in which service to the poor can be differentiated to meet the various levels or segments of poverty identified earlier: the Destitute, Very Poor, Coping Poor, Developing Poor and vulnerable Lower-middle Income Households.
The premise of economic regulation is that services provided should be, to the greatest extent possible, cost reflective. The goal therefore is to match a level of service provision to the affordability of the majority of consumers. This is the demand responsive approach which has been long recommended in the water sector.

DRA effectively combines technical, social and financial goals into one tool. The reason for this pictorial approach is to provide a tool to future customers, as well as regulators, to assist in the process of choosing what is required. Matching the affordability and willingness to pay of peri-urban households to the appropriate delivery mechanisms with reduced cost tariffs for simpler, 'differentiated' technology is described in more detail in "Serving All Urban Consumers: a marketing approach to water services in low- and middle-income countries" (WEDC & IWE, 2004).

Table 3.2. Water service options for selected variables in urban areas

Location of water delivery point	Max 100m	Max 25m	Yard	House
Pressure	As in conventional network	Roof (1st storey)	Ground	Trickle feed
Hours of supply	24, 12, 9, 6, 2 hours (do those hours only apply to column 1?)			
Type of dwellings	Bungalows and maisonettes (with internal plumbing)	Flats (with internal plumbing)	1, 2 or 3-roomed (without internal plumbing)	Dwellings in informal settlements
	Commercial premises	Single or two-storey	Multiple storey	Tenement rooms/flats
Water point Delivery	Multiple taps	Single tap	Water kiosks	Valve clusters with hosepipe offtakes
	Standposts	Standpost vendors	Locked shared standposts	Machine dispensers
	Standposts or kiosks with storage tanks	Smart card or pre-payment meters	Neighbourhood on-selling	Handcart vendors
	Flow restrictors / trickle flow	Storage containers	Shared connections	Water flow regulator
	Site storage	Area storage		Tanker vendors

Figure 3.11. Public standpost

Public
Standposts: 1/475 ?
1/250 ?
How to ensure supply?
How to charge?
How to maintain?

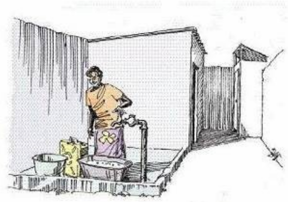
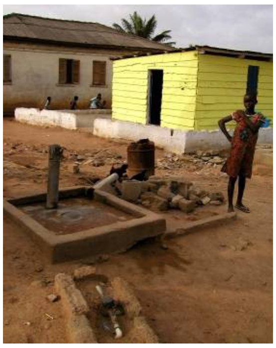


Figure 3.6. Communal or shared yard connections/taps

Left: Standpost waiting
3am supply ?

Right and far right: Public drinking water fountains to ensure water for survival—drinking water for the destitute?



Left: compound houses & landlord metered Standpost

Far right: public standpost with storage

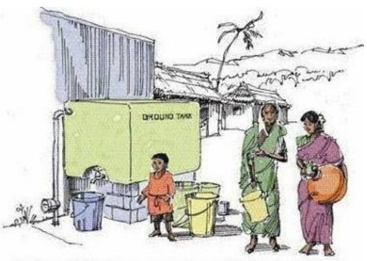


Figure 3.7. Communal yard connections with raised or ground tank .

Paid Standposts

Remote access to water

Standposts

- Water for carrying to household
- Water for bathing, laundry and sanitary services direct
- Single/dual/multi-tap standposts
- Storage standposts
- Handpump access storage standposts

Households can access water remotely from the house and either use that water where it is accessed or transport it (or arrange for it to be transported) to the house. Transportation methodologies are described below. Using the water at the point of access refers to bathing, laundry and other sanitary functions being undertaken at the standpost, formally where appropriate facilities have been made available or informally which is rarely satisfactory.

Standposts benefit from self-closing taps (though communities often find the designs too awkward and find ways to disable them) and require appropriate drainage facilities to ensure that there is no ponding of surplus/ spilled water which would become a health-hazard. Designs of standposts can include having multiple taps to facilitate access by more users at once to reduce queuing times, washing areas, 'lifting steps' to facilitate head carriage of water jars, storage tanks so as to guarantee availability even when the supply is intermittent, and in some examples access to those tanks through handpumps, thereby limiting wastage and overuse whilst capturing any

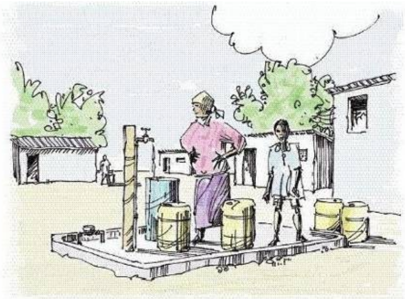


Figure 3.8. Public standpost - staffed (kiosk)

Above: Dhaka: DSK WaterAid water points - handpumps on utility pipe filled tanks—community sharing out metered

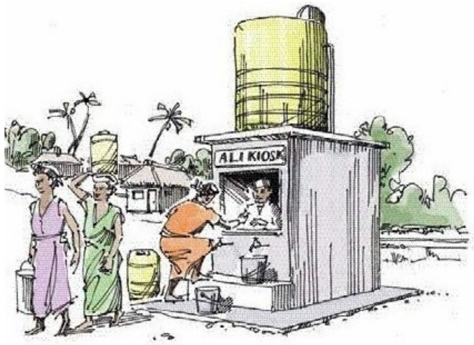


Figure 3.9.
Public standpost with water storage - staffed

Above*: **Tire Lire***
Cote d'Ivoire for daily household savings to pay for water at end of the month (Fonseca)

Left: & below: Philippines, 'Hidden Paradise' A customer is buying water tokens from local shop to access standpost water at the close-by tap - a means for the community to share out metered costs (ADB, WaterVoices)

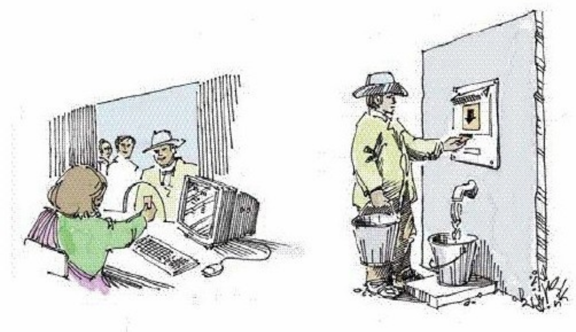


Figure 3.10. Public standpost - pre-paid with tokens

Left:
Cote d'Ivoire
Pay for Use
Tapstand (WSP, 2003)

available low-pressure piped water in the below ground tank.

There are special cases of standposts serving compound housing whereby the standpost could also be described as a communal yardtap, that is a tap within a very few meters of the house door which is accessed by perhaps upto a dozen households in the compound.

Bulk water points

Water point for filling vendor carts and tanks

Transporting large quantities of water to households requires special filling points with closer/larger diameter access to water mains to facilitate speed of filling. Adequate drainage of surplus/spilled water is even more critical for a bulk water filling point than for standposts.

Transported water distribution

Self-filled & carried

- Bottle (eg 0.75-1 litre)
- Pot/bucket/container (eg 8-10 litre)
- Plastic jerrycan (20 litre)

Children are often involved in water carriage and smaller children, particularly girls, may well start by learning to balance a bottle of water on their heads in order to carry it home before growth leads to the ability to carry larger amounts. Head carrying of larger amounts of water is less common in urban areas where older boys tend to use some form of mechanism to transport larger amounts in exchange for payment.

All carried water, or vended water as below, is considerably more expensive to deliver to the home than piped water, in either cash or resource (carrying time) terms. Householders who have no choice of supply mode can only cope by drastically limiting their use of water with the subsequent health and convenience disbenefits.

Vendor-filled & transported

- Hand cart (6-12 x 20 litres)
- Animal cart (10-12 x 20 litres)
- Animal cart tank (eg 1000 litres)
- Tractor-towed tanker (3,000 to 9,000 litres)
- Tanker (7,500 to 12,000 litres)

There is a wide range in capacities available of vendor -filled and transported household water, ranging from handcarts based on bicycle wheel technology carrying a number of plastic jerry-cans through to small tanks on carts pulled by animals (donkeys, camels etc) to the much larger, and therefore potentially cheaper, tankers, either integral to the vehicle or towed by tractor.

Transporting with smaller containers allows householders to use the same containers for storage until the subsequent delivery, swapping full for empty, without having to invest themselves in storage. Tankers necessarily require household storage to discharge into which can be relatively expensive and which allows vendors to require payment for full loads only, irrespective of the amount of storage available, and therefore to be able to charge more for the water delivered by selling non-delivered water again.

All carrying approaches introduce the possibility of further contamination of the water by the additional steps of handling and the likelihood that the containers/ tanks may not be clean and regularly disinfected.

Producer remote-filled

- Water Bag (0.6 litre)
- Water Bottle (eg 1 litre)
- Large Water Bottle (eg 19 litre)

Low-income consumers can chose to pay for small quantities of potable water, carried to their homes where the quality has been 'assured' by some external provider, that is a provider other than the conventional water utility. This should avoid the dangers of contaminated containers described earlier. Although very high cost in volumetric terms because of the small quantities needed these systems can be affordable, the choice between bagged water and large water bottles delivered to the door being very much one of household income. Note that not all countries have standards for bottled water and those that do may well not be able to enforce them. Customers may well be paying for the illusion of good quality water where those payments would be more useful facilitating a differentiated household supply.

Point of Use Treatment

www.astro.su.se/~magnusg/photogallery.html

Katadyn Filter

Unilever PureIt

Differentiated Household Connections

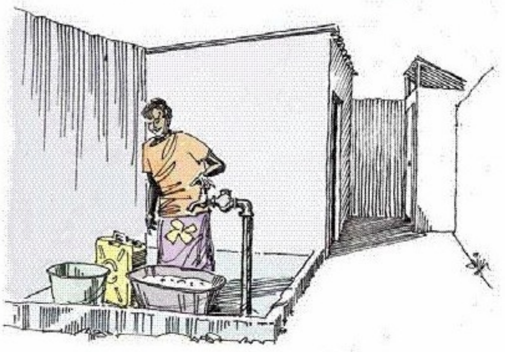


Figure 3.4. Individual yard connections/taps

Figure 3.3. Individual house connections - daily filled overhead tank

'Durban Tank': Manifold for daily household tank filling

IMO Working Group, WSSCC , Kayaga Photos ↑→

Figure 3.5. Individual yard connection with ground tank

Differentiated Pipework

PCWS/Capistrano Photos:↓↑→↗

Piped water distribution 'household supply pipe'

- Below ground pipes
- Surface pipes
- Suspended pipes
- Conventional pipes (GI, AC, MDPE, PEX etc)
- Flexible household managed 'hosepipes' (or as for conventional)
- Yard tap
- Surface yard tanks
- Mains pumps
- Below ground tanks
- Elevated tanks

Originally pipes were buried beneath the ground so as to avoid the effects of frost in those, usually northern, countries where piped systems developed (in the modern era that is, recognising Roman successes in a previous era). Burying pipes also gives protection against accidental damage and particularly nowadays against damage or loading from road vehicles. In many very low-income urban communities frost is not often a threat to the pipes and the access widths may preclude vehicles and therefore vehicular damage. Running pipes along the surface of the ground can facilitate leakage detection with leaks being immediately visible. Similarly illegal connections are also visible but in both situations this is only valuable if the community of consumers have a sense of responsibility and a mechanism to arrange for mending of leaks and restricting of illegal connections.

In an informal housing area installing water supply pipes on the surface means that existing drainage paths, whether surface water or grey water, are not disrupted which reduces costs. Burying pipes in narrow access-ways can require complete reconstruction of drains and pavement to a higher standard than was previously there – a benefit to slum dwellers but an expensive one which could restrict the installation of piped supplies.

There are examples of above ground pipes where distribution pipes are hung at the level of the eaves of (single storey) houses (alongside electricity cables) so as to be above the level of doorways and to be well clear of any road damage. Although this technique is rare there is again the advantage of controlling leaks but the dwellings and fastenings have to be strong enough to take a much higher load than the more usual power cables.

Pipe material can vary according to country practice and likely loading. Asbestos cement pipes, although seen as dangerous to health when asbestos fibres are released through inappropriate cutting techniques, are cheap and very long-lasting but have to be buried for protection and require adequate cover, that is depth of ground, to protect them. Galvanised iron is also very commonly available and has the inherent strength to be laid on the ground surface in low-income slums, strong enough to withstand two or three-wheeler vehicle loading. However GI is much more liable to internal corrosion and therefore has a shorter lifespan – which may well be irrelevant if the aim is to upgrade slums step by step over time. The various types of plastic pipe, particularly the polyethylenes (HDPE, MDPE, PEX etc) are ideal for flexible, above ground connections between distribution main and homes, easily made by householders themselves, as demonstrated by the many illegal connections made from such materials. The advantage of self-connection, perhaps from a delivery point on the edge of a (smaller) slum, is that it reduces costs to the utility by transferring the responsibility for negotiating rights-of-way and easements to the householder. The reduction in bureaucracy can lead to significant savings, making such systems affordable. Similarly, where it is appropriate to bury connection pipes, householders (groups of householders) can excavate and reinstate more cheaply than utility employees.

At the extreme, the connection to the home can be a flexible 'hose-pipe', very cheap plastic pipe, but these are more suitable to be hung above ground where they cannot be stepped on, let alone ridden over, too often.

Supply pipes can terminate in a yard tap, that is a form of standpost on the housing plot or an internal tap. The idea of the yard tap is that it limits consumption, in that there is no internal plumbing and facilities where water is used, as water required still has to be carried into the house in buckets or used directly for washing pots etc by the external tap. Yard taps therefore require physical or communal security against over-use by neighbours and presume fairly regular hours of supply at acceptable pressure. Alternative systems use surface tanks connected directly to the supply pipe to store water for easy availability but these need protection against pollution.

'Developing poor' and 'vulnerable non-poor' households in middle-income countries may, like their richer neighbours, invest in underground tanks to capture as much water as possible when the mains are charged or may have small pumps to suck water out of the mains. These pumps, illegal in many countries, have the disadvantage of changing flow patterns in pipes leading to the delivery of high levels of silt and grit along with the water. They also significantly disadvantage neighbours beyond them in the distribution system, capturing too much water for some rather than allowing delivery of a little for all. A more normal use of small pumps is to lift water collected in underground delivery tanks to elevated tanks so as to ensure a conventional head of water at taps inside the dwelling.

Surface pipes with flexible household managed connecting pipes to yard taps and/or surface yard tanks are highlighted as being the cheapest means of achieving the convenience and low cost of piped water supply in low-income high-density housing areas – far better than standposts but cheaper (and therefore more affordable if the utility recognises those savings) than conventional distribution systems.

Differentiating Household Connections

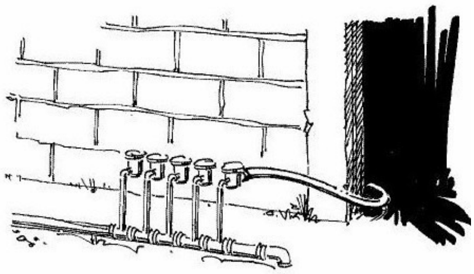


Figure 3.2. Individual house connections - flexible pipes to meter/valve clusters

Weitz Photo ↑

PCWS/ Capistrano ←Photos→→

Innocencio Photos ↑ ←

Three Cities, ADB Video

Metering options

- Unmetered
- Flow restrictors
- Volumetric controllers/allowances
- Conventional meters
- Group/Street meters
- Pre-paid meters
- Smart meters

Many pipe systems incorporate elements of the charging mechanism by which the utility direct provider ensures sufficient revenues not only to operate the system but also to ensure sufficient maintenance so that it continues to operate long-term and to extend the services as demand grows.

The most common form of charging is by volume consumed as measured by a water meter. Frustratingly the larger part of the costs of water supply is not variable according to volume consumed but is fixed, that is related to the investment in and maintenance of the fixed assets which treat and deliver the water. Water meters, of which the installation, maintenance, repairing, replacing, reading, billing and resulting complaints resolution, can add one quarter to one third to the water bill are an expensive solution. Some societies, having achieved almost universal coverage and community acceptance, have ensured reduced costs for consumers by not having meters. Instead they charge for water through a fixed payment for access, which might vary according to perceived housing value as a proxy for wealth and presumed use. This solution is definitely unfashionable but is widely practised, as an unacknowledged default, by utilities which only supply water for one or two hours per day (thereby limiting all in that area to a similar consumption) and by utilities which fail to maintain their meters (remarkably common) and then charge a fixed amount.

Meter costs, particularly where installed meters cannot be used in any acceptable way for the reasons described above, can therefore be removed by design through the use of flow restrictors and volumetric controllers. Flow restrictors, sometimes know as trickle devices, allow a limited flow and therefore avoid excess use by some consumers making it possible to charge fairly a fixed tariff to all. However, flow restrictors come with the need for household storage which adds to the cost and in areas where supplies are intermittent and/or pressures are low the inability to access sufficient water usually leads to householders arranging to bypass the flow restrictor.

Alternative devices include the use of ground tanks with float valves and limited supply hours during each day so that customers receive a fixed amount for which they can pay an adequate tariff but without the expense of a meter. An intermediate approach is a volumetric controller, in effect a meter but one which does not need to be read and billed separately. Both these systems can be used where water is paid for cash in advance, very appropriate in slums where there are no addresses to send bills to and little means of enforcing payment. Which makes the point that none of these technologies works in isolation from the acceptance of the community of customers – these cannot be technical solutions to social problems, only aids to enabling fair customer involvement and responsibility.

Some low-income households actually value having their own personal water meter and even more surprisingly their own personal bill. As in richer countries, where utility bills are seen as proof of identity and/or residence, slum dwellers also value that recognition. To reduce costs of metering one technique is to install rows of household water meters at the edge of, or in a convenient location in, the low-income housing area. Householders make their own flexible pipe connections to their own distant meter (or on occasion collect water from their meter by bucket) whilst the utility reduces costs by not having to provide individual house connections in difficult areas and reduces the costs of meter reading.

A variation on remote metering is group or street metering where a group of householders share out the bill from a single meter, taking responsibility for equitable payments by whatever mechanisms they chose, thereby reducing costs. This approach depends upon the utility allowing for reduced tariffs as a result of reduced costs and not using the incremental block tariff approach which would quickly disadvantage groups of households. There is a similar challenge when standposts are metered with tariffs collected through 'kiosk vendors' or community appointed on-sellers. If no allowance is made within the incremental block system the poor end up paying commercial/industrial rates for water. As ever, the technology is only effective in conjunction with suitable approaches. One variation on this idea for standposts is for householders to agree to buy tokens from a local shop-keeper adjacent to the metered standpost, contributing a token per container filled. This ensures that cash is received in advance and removes the expensive (time-consuming) task of trying to get poor households to contribute towards a monthly group water bill long after that water has been consumed.

Utilities in higher-income countries are beginning to seek to reduce their costs through the use of various types of smart meters, most being variations on the theme of digitising the volumetric analogue information so that it can be accessed remotely (touch pad/radio to street van/mobile phone technology) but in particular measures time of day (daily peaks) and time of year (seasonal peaks) such that very focused tariffs can be applied to minimise demand and hence fixed asset costs. These technologies are unlikely to be of particular value in low-income areas in the immediate future.

The metering development which must be noted is the use of pre-paid meters. Originally using some form of coin-in-the-slot mechanical device, electronic versions are now available and have been well-received by customers (if not by NGOs) in, for example, South Africa. Householders value the opportunity to manage their spending on water, buying top-ups as they can afford it and, just as for their similar popularity in mobile phones, being able to prevent excess use (and unaffordable bills) by accident or theft.

The development of pre-paid meter and volumetric controller technology, along with adaptation of tariffs to

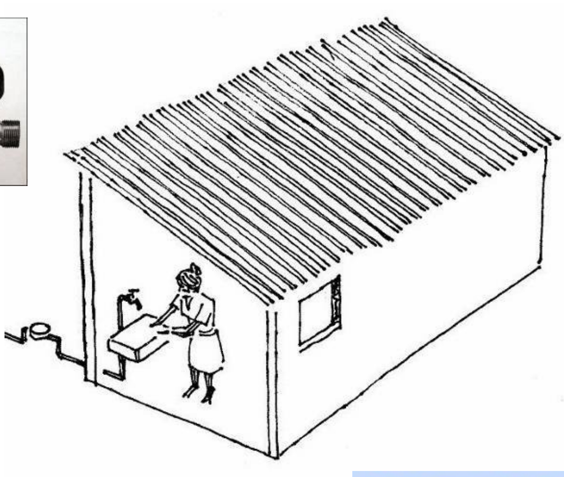


Figure 3.1. Individual, in-house co

Above: household storage & pumps—low-income housing, Jakarta

YARD METER ABOVE GROUND

PrePaid Meters
Conlog Photos :← ↖

Volumetric **Controllers**
RWE Thames Photos ← ↑

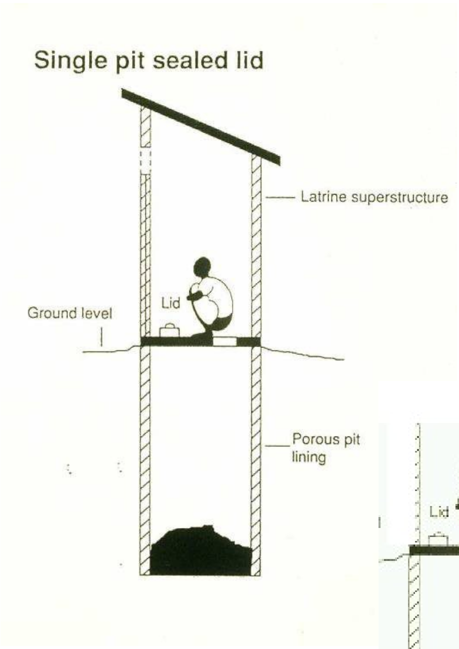
Differentiating Sanitation for USO in peri-urban areas

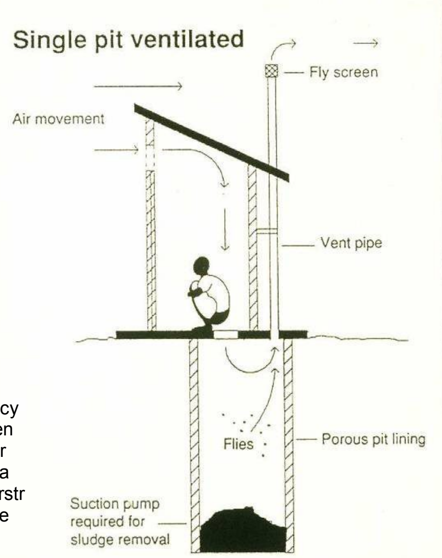
There is an overwhelming imperative to get excreta off the streets in densely populated urban areas to protect inhabitants against any resulting pathogens and disease. Defecating directly into open drains or into bags and newspaper for 'wrap and throw' may meet the first criteria of removing faeces from the street but are not an acceptable alternative. There are various forms of **'pit latrine'** which serve the purpose well, giving, where well designed and constructed, convenience and privacy which are often the drivers for households to invest in their own sanitation as well as health protection.

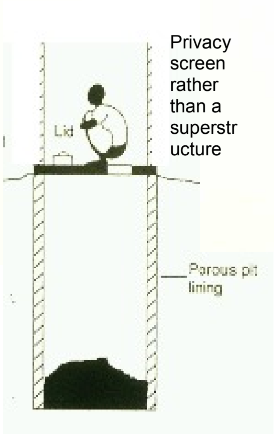
There is a key difference between types of latrines based upon the method used for anal cleansing (see A guide to the Development of On-Site Sanitation, WHO, 1992 for further information). Where paper or agricultural waste is used for anal cleansing there has to be a clear hole which will not block. However, that easy access also means that smell and flied can come back up again. There is then a need for a lid or plug to seal the hole when not in use, something often forgotten or disregarded, particularly when it becomes fouled, or an alternative approach such as the **ventilated improved pit latrine** which utilises air flow over the top of the pipe to create a suction effect, drawing gases out of the pit and up the vent pipe (rather than back into the cubicle) and where designed properly give a light source which light sensitive flies respond to (rather than the deliberately darkened (but not dark) cubicle) where they are trapped by the gentle upflow of air through the vent pipe against a non-corroding mesh or screen where they die and fall back into the pit. The bottom right picture illustrates and offset vent pipe with a small glass window at ground level to 'start the flies on their journey' whilst minimising the expense of a latrine slab strong enough to support an additional opening and the vent pipe itself.

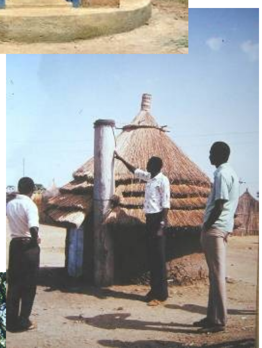
Key points for peri-urban sanitation:

- *Recognise the need for community involvement in achieving total sanitation where sanitation primarily to be undertaken by households*
- *Accept possible short-term groundwater pollution to ensure immediate sanitation for health within a phased approach (recognising that it is more economic in short term to pipe in clean water than pipe out waste water)*
- *Recommend sanitation approaches which minimise grey water; storm water and solid waste challenges in the short term*
- *Assess environmentally-sensitive means of excreta disposal (eco-sanitation, composting, reed beds)*
- *Avoid 'Rolls-Royce' sanitation solutions that demand unaffordable standards and require almost total slum and shanty upgrading*

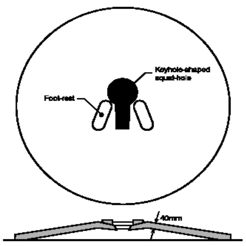








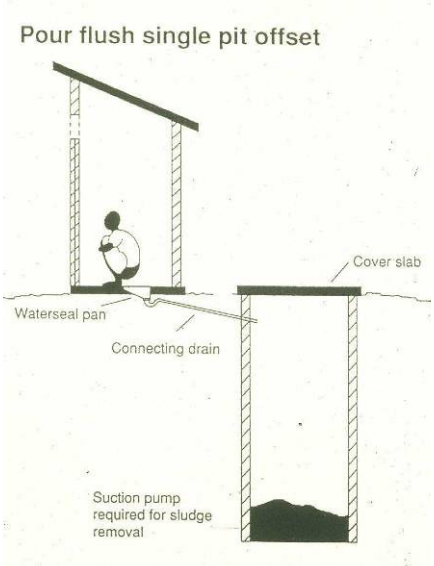
Domed, unreinforced 'Mozambique' slabs with lid

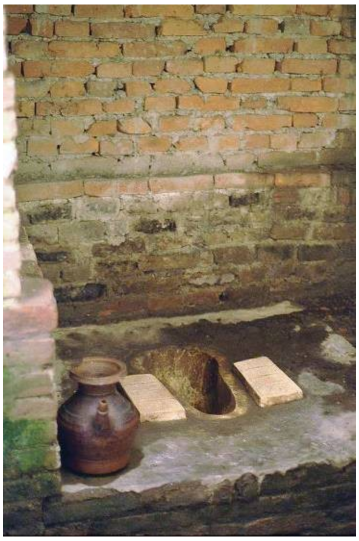


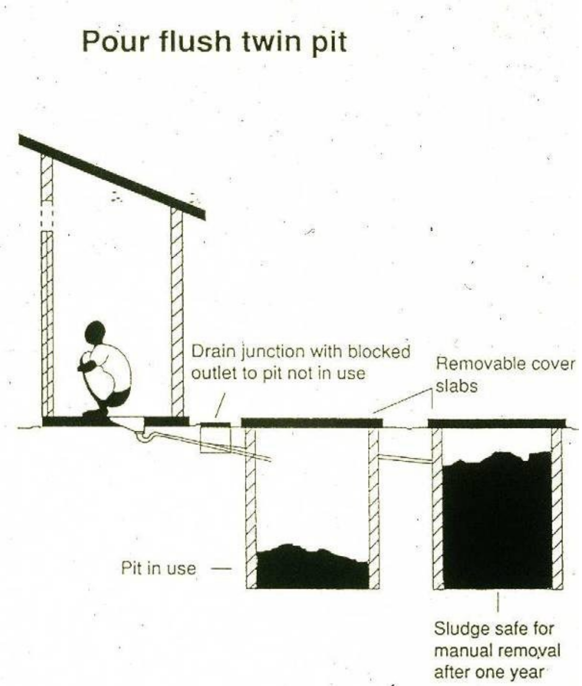
San Plats: - *'Why should a latrine look like a house?'*
Brandberg

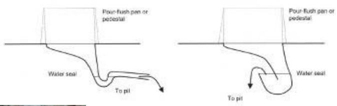
Drawings source: 'A Guide to Sanitation Selection', Technical Brief 23, Franceys & Shaw, Waterlines,

Regulatory Tools: Technical

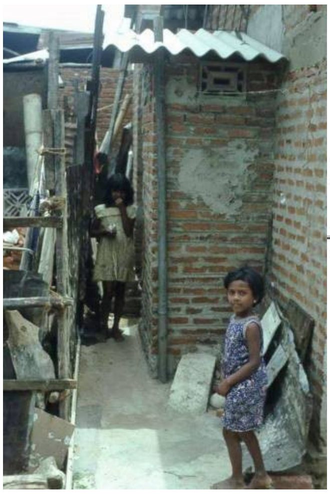


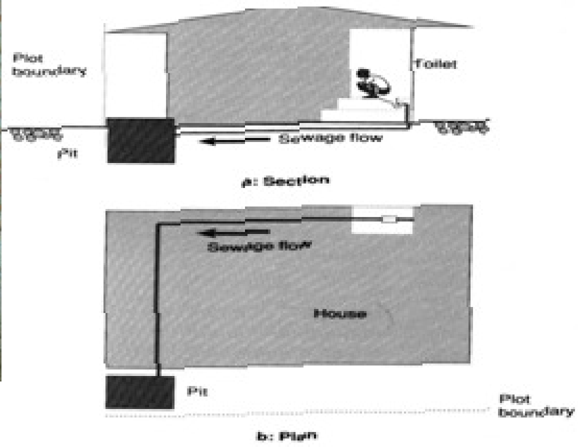


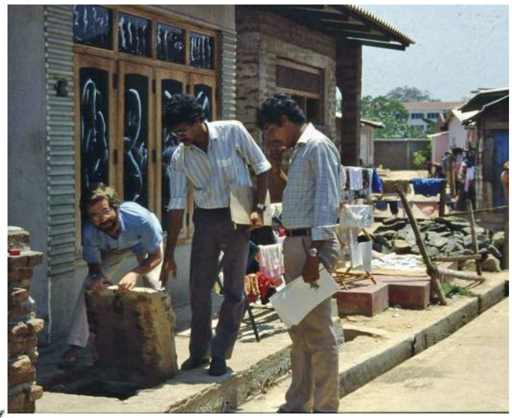




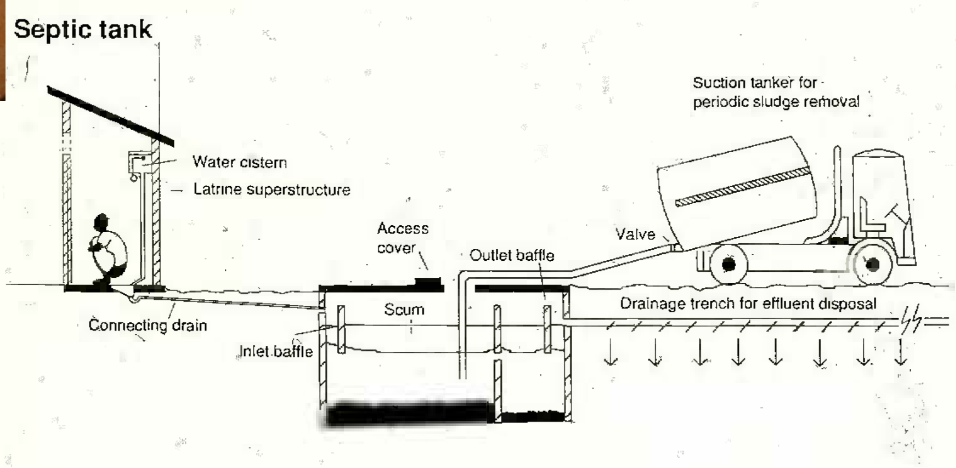
Pour flush latrines for those using water for anal cleansing provide a water seal to limit odour, taking away any need for a lid. Small amounts of water are then used for flushing the waste into either a single-pit or a twin pit which allows for safe sludge removal after approximately one year. The diagrams and pictures below illustrate an offset pour flush latrine in a very confined area, a system very similar to a septic tank.







Septic tanks are widely used where there are no sewers but where households want the convenience of 'flush and forget'. However, septic tanks can't quite be forgotten as, depending upon household size, the accumulated sludge will need to be removed regularly (annually?) and disposed of safely (to an approved sewer disposal point of waste water treatment works) and the drainage field cared for such that the effluent can safely drain into the ground. Alternating drainage fields are ideal but unlikely to be possible in low-income settings.



Eco sanitation generally describes toilets where the urine and faeces are captured separately so that the faeces can begin to decompose and dry safely to be used as a soil conditioner and the urine, after one month's storage, as a fertiliser. In the toilet pictured men have to urinate sitting down. Where water is used for anal cleansing it must be collected and

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Pay for use Communal toilets

Experience of communal toilets is that they are extremely difficult to manage communally with no one wanting to take responsibility for cleaning and users gradually fouling the toilet area and approach areas until it becomes unusable.

The approach which has worked most effectively is through 'Pay and Use' whereby an NGO or community group obtain funds (sometimes from local government) to construct a facility and then employ a full-time caretaker to ensure it remains clean and in good condition—the caretaker's salary being paid through small amounts given by users, either monthly as a household or daily as it is used.

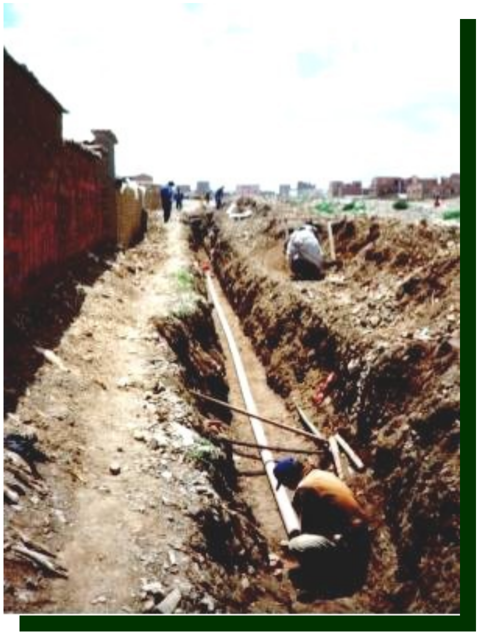
Soap is provided as part of the service and some of the Sulabh toilets in India also provide bathing and locker facilities.

A Sulabh complex in Jaipur, India

Left: communal toilets Ghana—pay for use or abuse?

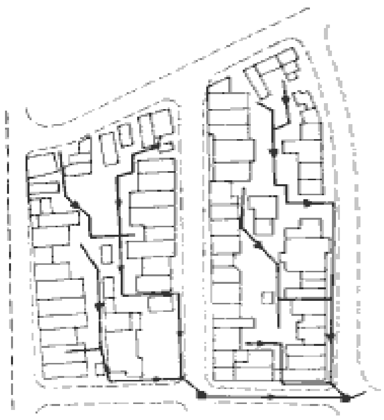
Condominial sewerage—Reduced cost sewerage

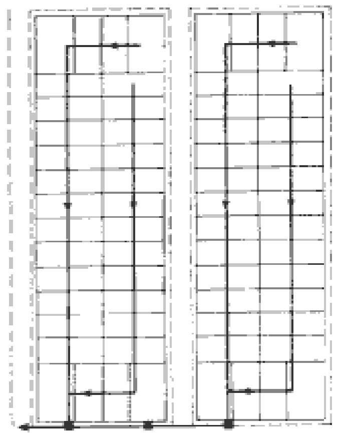
Conventional sewerage is very often too expensive in low income communities. An intermediate level (though now also being used in some high-income areas) is to design the pipe network more carefully to minimise the pipe lengths and by often running the pipes through the backs of properties to minimise the depths of sewer pipe where no cover under roads is required for protection and to use shallower gradients, particularly where small interceptor tanks are used for settling out solids outside each house. Minimising pipe lengths. Additional approaches use 'rodding eyes' rather than more expensive 'manholes' to provide access for when the sewer becomes blocked. It is necessary to ensure the involvement of the community in deciding pipe routes, perhaps in trench-digging to reduce costs but also to agree or rather accept a temporary discharge



Above: condominial sewerage, El Alto, Ondeo

A typical cleanout (right) and simple junction without a cleanout (below)





Diagrams & photo from
Sanitation Connection (sanicom.net) and Mara, D

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