



Sewer Systems

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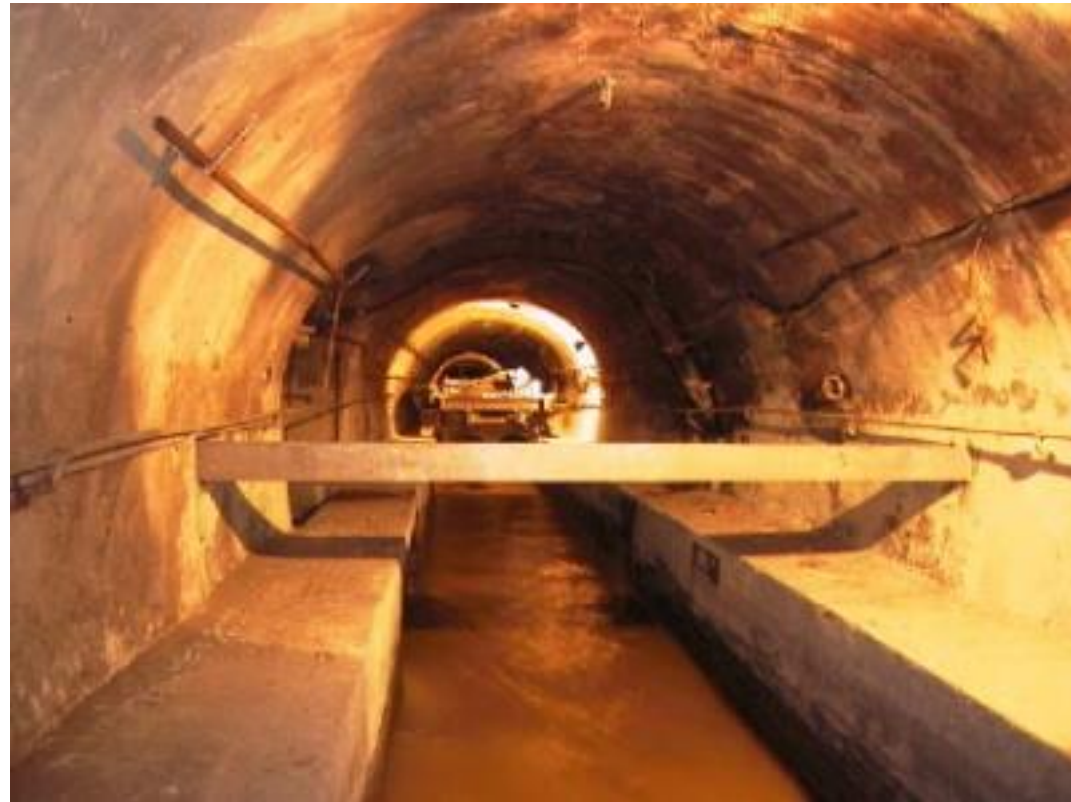
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Depending on the initial situations and respective local circumstances, there is no guarantee that single measures described in the toolbox will make the local water and sanitation system more sustainable. The main aim of the SSWM Toolbox is to be a reference tool to provide ideas for improving the local water and sanitation situation in a sustainable manner. Results depend largely on the respective situation and the implementation and combination of the measures described. An in-depth analysis of respective advantages and disadvantages and the suitability of the measure is necessary in every single case. We do not assume any responsibility for and make no warranty with respect to the results that may be obtained from the use of the information provided.



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A large sewer system. Source: RiverSides (n.y.)

1. Concept

What is a Sewer System?

- A piped system to transport wastewater (and sometimes storm water) from the source (households, industry, runoff) to a treatment facility.
- There are several designs, depending on topography, amount and kind of wastewater, size of community, etc.



“Flush and forget”: in many cases, sewers lead into surface water sources without any treatment.

Source: STAUFFER (2010)

1. Concept

What Kinds of Sewer Systems Exist?

There exist several different sewer systems:

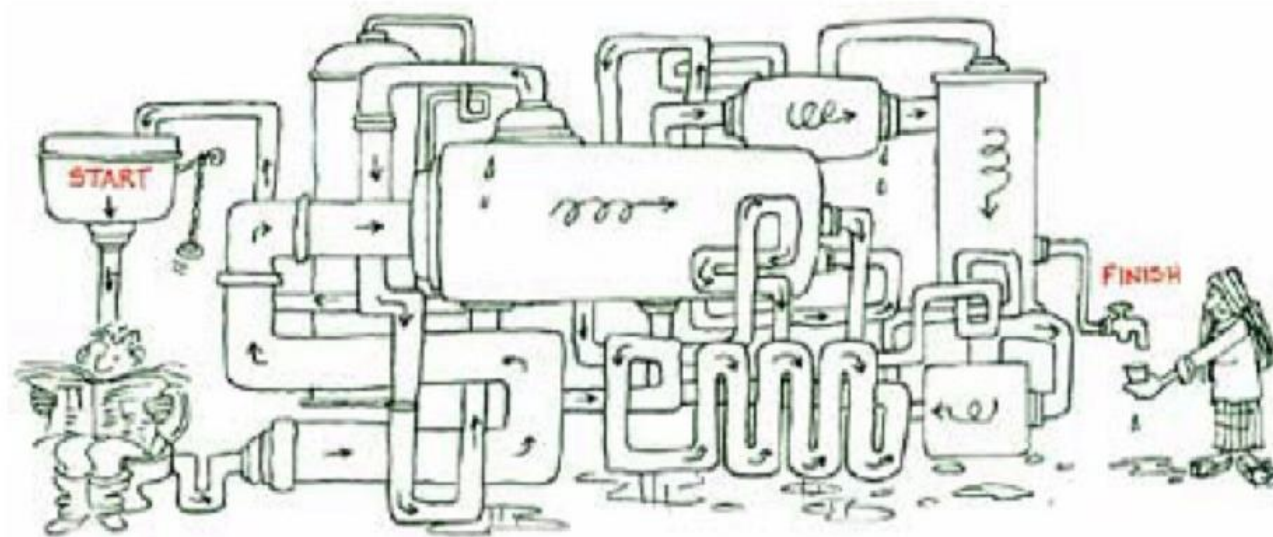
- Conventional Sewers
- Separate Sewers
- Simplified Sewers
- Solids-free Sewers
- Pressurised Sewers
- Vacuum Sewers
- Channels

Some of them require supporting elements such as:

- Sewer Pumping Stations
- Transfer Stations

2. How it can Optimise SSWM

Think Before You Flush!

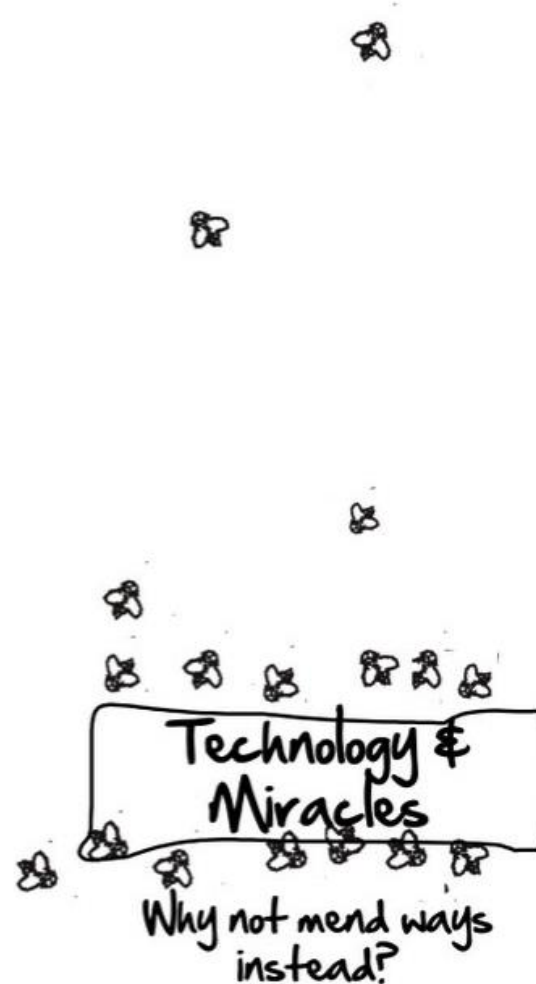


Sewers: a subsidy for the rich to excrete in convenience. Source: NARAIN (2002)

What happens with my blackwater?

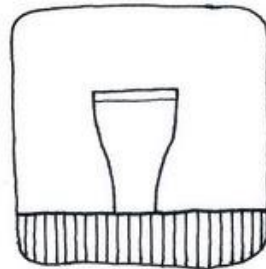
How could I optimise my behaviour?

2. How it can Optimise SSWM

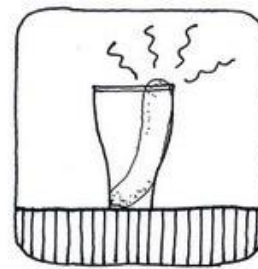


Source: PHADKE, S. (2009): Poo. Pune: Aman Setu Publication. <http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=706> [Accessed: 22.04.2012].

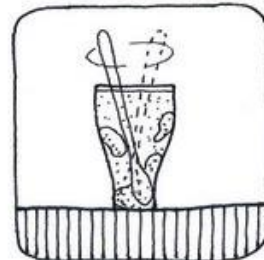
2. How it can Optimise SSWM



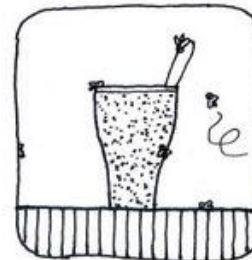
Lets fill a glass with pure,
cool water. Nice!



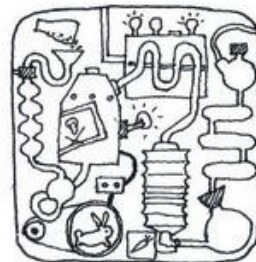
Now add a scoop of poop



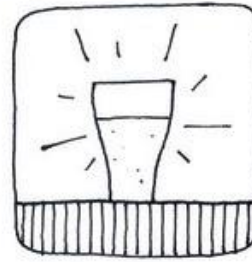
Stir gently. Do not spill!



Hmm..



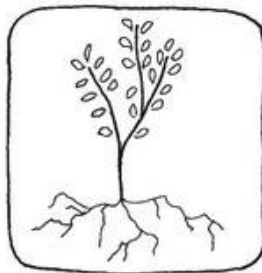
Tan taran ta raa!
Technology comes to the
rescue!!



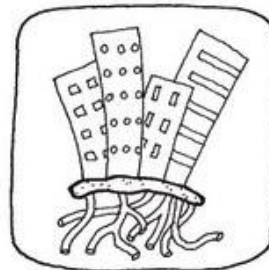
We now have a glass
nearly full of nearly pure
water! Yay..

Source: PHADKE, S. (2009): Poo. Pune: Aman Setu
Publication. <http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=706>
[Accessed: 22.04.2012].

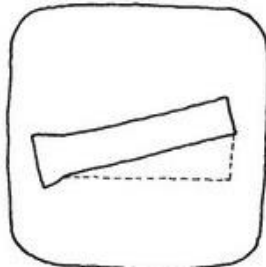
2. How it can Optimise SSWM



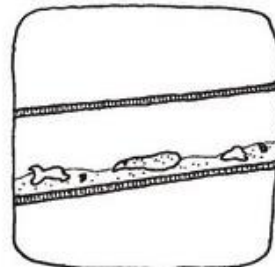
Plant-roots search for
water and nutrients



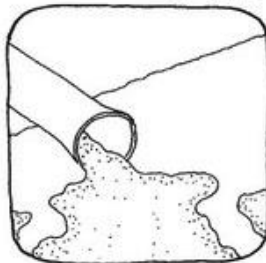
City-roots spew out the same!



A sophisticated
network of sloping pipes



So that our poo slides, and
doesn't stick



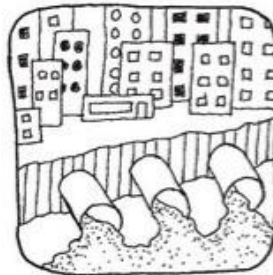
All the way down to the
river or ocean



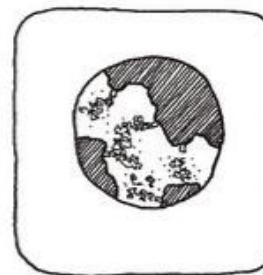
NIMBY as can be eh?

Source: PHADKE, S. (2009): Poo. Pune: Aman Setu Publication. <http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=706> [Accessed: 22.04.2012].

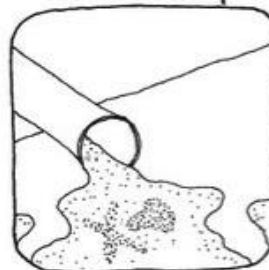
2. How it can Optimise SSWM



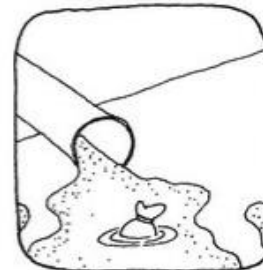
Imagine the amount of
waste we dump



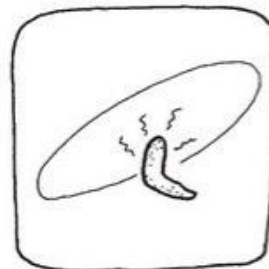
All around the world



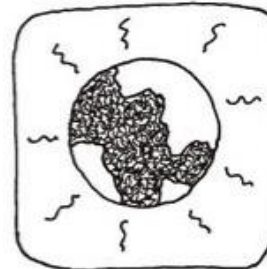
We throw out toxic
chemicals



And precious nutrients
& resources too!



But what goes around
comes around..



Need I say more..

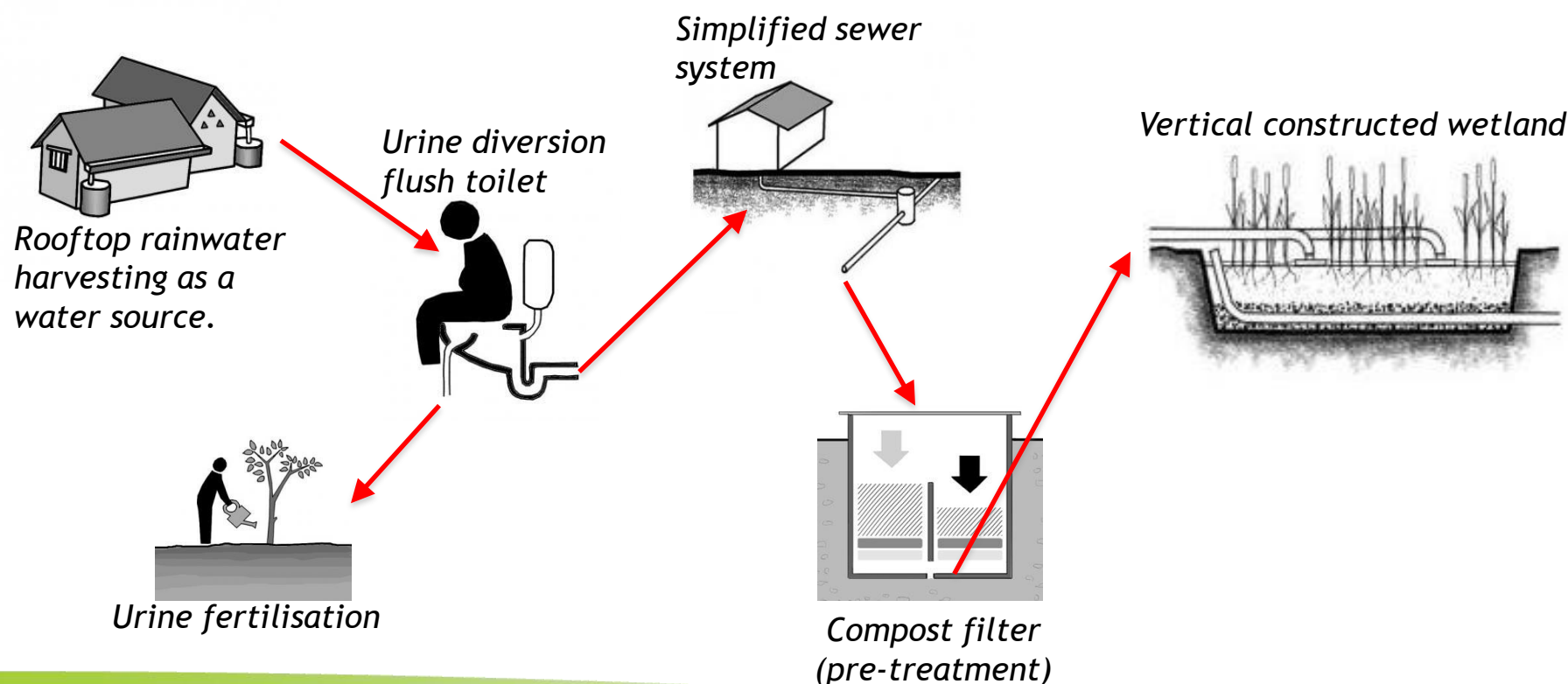
Source: PHADKE, S. (2009): Poo. Pune: Aman Setu Publication. <http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=706> [Accessed: 22.04.2012].

2. How it can Optimise SSWM

Use a Sewer System

In many countries around the world, flush toilets and sewer systems are the common sanitary systems.

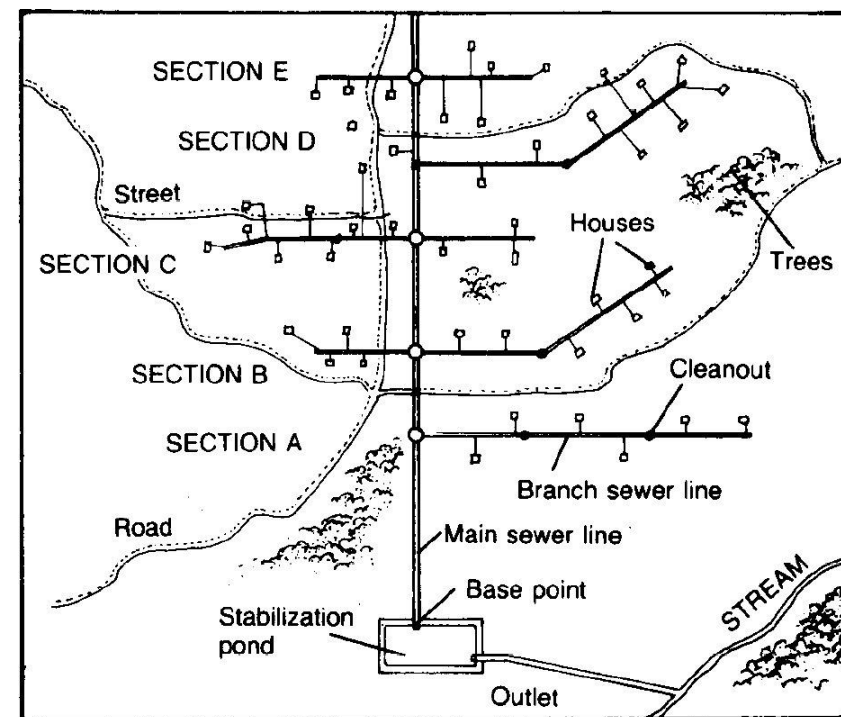
However, there are several possibilities to keep your wastewater low and provide a sustainable treatment:



3. Conventional Sewers

Design Principle

- Large networks of underground pipes, mostly in urban areas.
- Collection of blackwater, brownwater, greywater and stormwater.
- The system contains three types of sewer lines:
 - Main line (primary): the centre of the system, all other lines empty into it.
 - Branch lines (secondary): extend from the main.
 - House laterals (tertiary): bring wastewater from the houses to the branch lines.



Master sewer system map.
Source: USAID (1982)

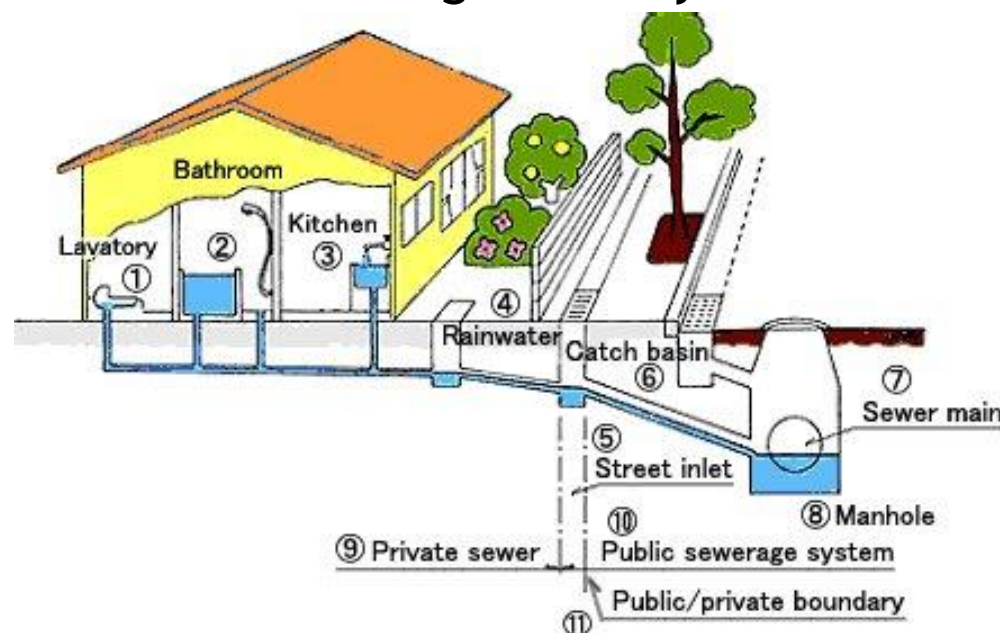
3. Conventional Sewers

Design

- Wastewater is transported to a centralised treatment facility by gravity.
- Depending on topography, sewer pumping stations are necessary.
- The lines are in a depth of 1.5 to 3 m and manholes provide access for maintenance.
- It must be designed to maintain “self-cleansing” velocity that no particles accumulate

Cross-section of a conventional sewer in a common urban set-up.

Source: EAWAG/SANDEC (2008)



3. Conventional Sewers

Costs

Initial costs are high because:

- Excavation and refilling of trenches to lay the pipes;
- Requires specialised engineers and operators;
- Maintenance costs are high compared to decentralised systems;
- Extension of the system can be difficult and costly (redesign of the whole system)

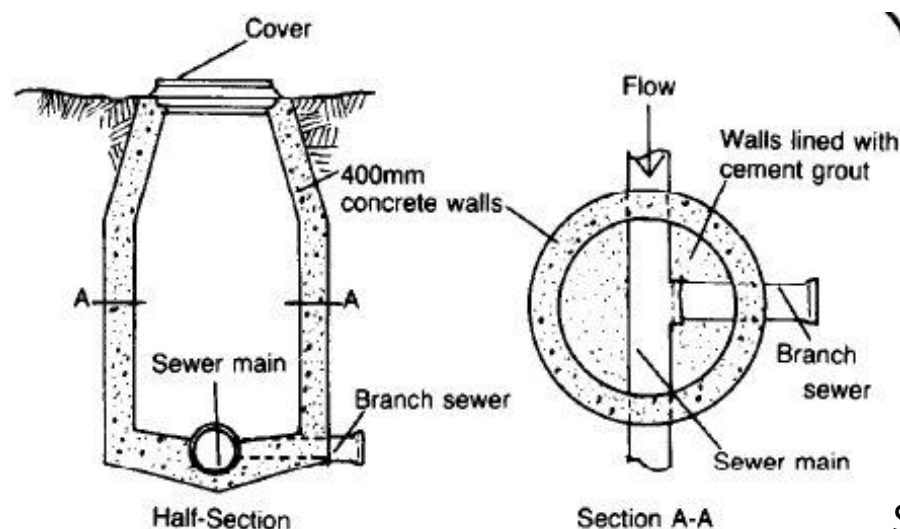
Maintenance and operation of the City's water system is quite a costly task. Source: THE CITY OF MADERA (n.y.)



3. Conventional Sewers

Operation & Maintenance

- Maintenance should be done by professionals.
- Manholes are installed wherever there is a change of gradient or alignment and are used for regular inspection and cleaning.
- It must be systematically planned and carefully implemented.
- Overflows are required to avoid hydraulic surcharge of treatment plants during heavy rain events.



Sewer access manhole. Source: USAID (1982)

3. *Conventional Sewers*

Applicability

- Suitable for urban areas that have the resources such a system.
- They only make sense if a centralised treatment system exists which is able to handle big loads of waste- and stormwater.
- Sufficient water as a transport medium needs to be available.
- A professional management system must be in place.
- They provide a high level of hygiene and comfort for the user.

3. Conventional Sewers

Pros and Cons

Advantages:

- Convenience (minimal intervention by users)
- Low health risk
- No nuisance from smells, mosquitoes or flies
- Stormwater and greywater can be managed at the same time
- No problems related to discharging industrial wastewater
- Moderate operation and maintenance costs

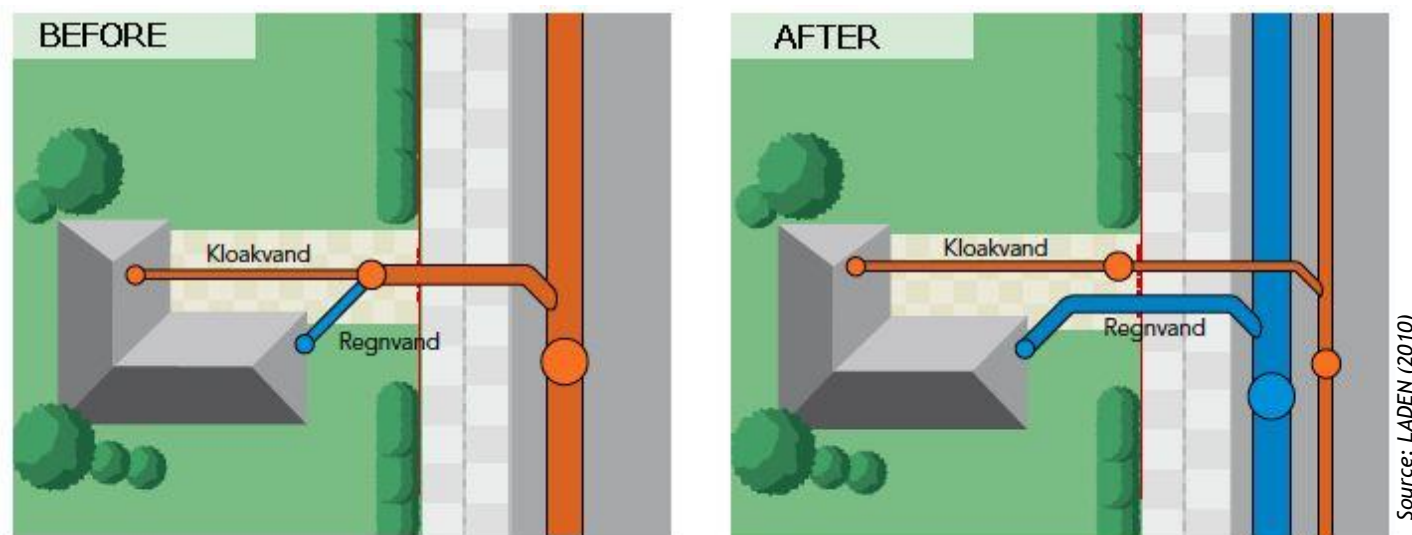
Disadvantages:

- High capital costs
- Need a reliable supply of piped water
- Difficult to construct in high-density areas, difficult and costly to maintain
- Recycling of nutrients and energy becomes difficult
- Unsuitability for self-help, requires skilled engineers and operators
- Problems associated with blockages and breakdown of pumping equipment
- Adequate treatment and/or disposal required

4. Separate Sewers

Design Principle

In contrast to conventional sewer systems, wastewater (e.g. from households or industries) and stormwater are transported separately.



- During heavy rains, overflow contains no harmful blackwater.
 - Stormwater in general is less contaminated.
- Source: UNEP and MURDOCH 2004

4. *Separate Sewers*

Costs

- Construction costs might be higher than for the combined sewer system because two separated networks are necessary.
- They must also be maintained and operated separately.
- A replacement of a combined system by a separated system is very costly.

Operation & Maintenance

- Same as conventional systems

Health Aspect

- More secure than a conventional system, because blackwater is transported in a closed network.

4. Separate Sewers

Applicability

- Suitable for urban areas that have the resources to implement, operate and maintain such systems plus provide adequate treatment to avoid pollution at the discharge end. UNEP (2002)
- Enough water for transportation must be available.
- Especially suitable during monsoon -> large amounts of stormwater can be treated separately.



New construction of a separated sewer system in Germany. Source: VILLINGEN-SCHWENNINGEN (2010)

4. *Separate Sewers*

Pros and Cons

Advantages:

- Surface run-off, greywater and blackwater can be managed separately
- Limited of sewage overflow
- Low health risk
- No nuisance from smells, mosquitoes or flies
- No problems related to discharging industrial wastewater
- Moderate operation costs
- Surface run-off and rainwater can be reused

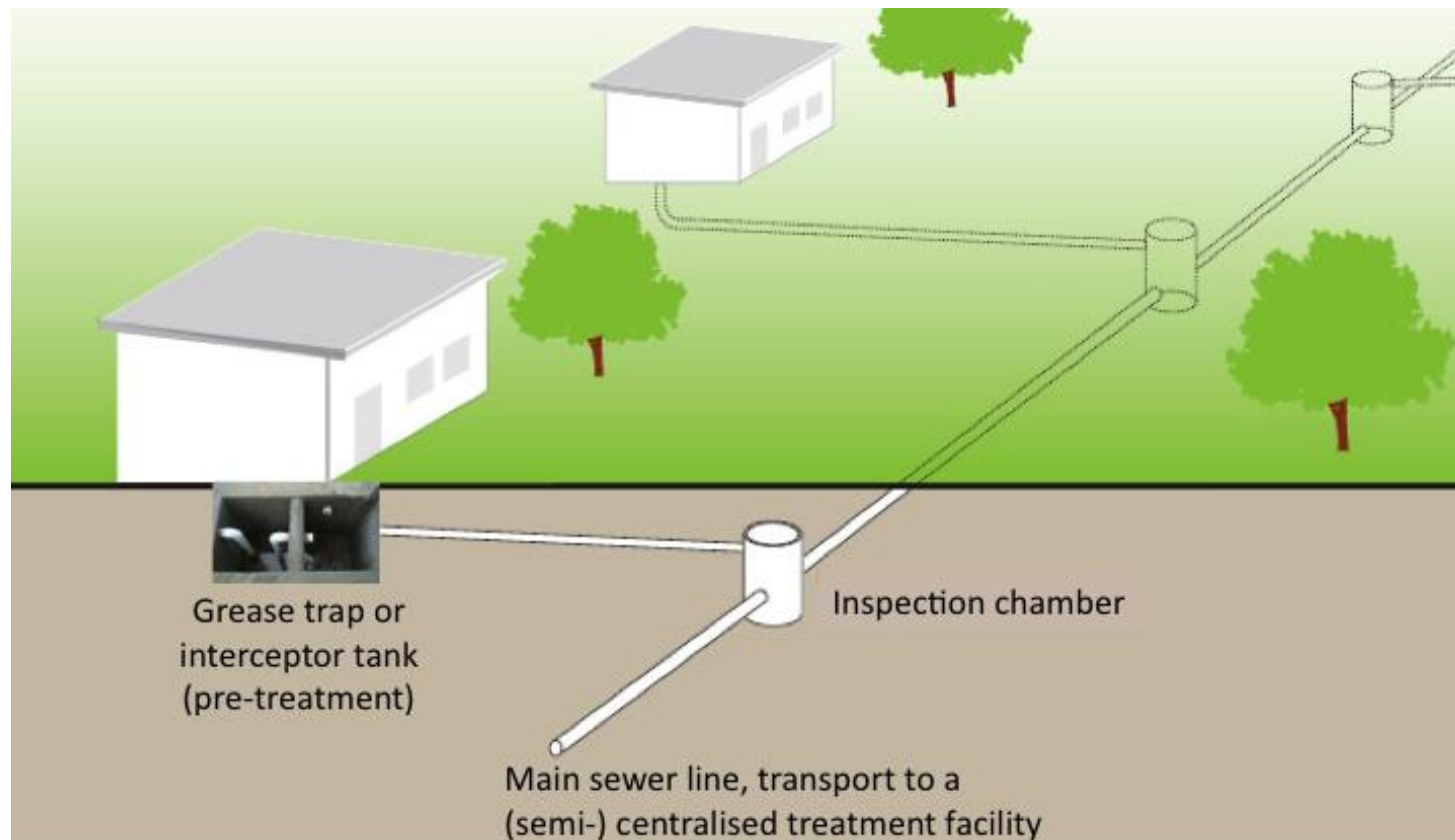
Disadvantages:

- Supply of piped water
- Difficult to construct in high-density areas, difficult and costly to maintain
- High capital costs
- Requires skilled engineers and operators
- Problems associated with blockages and breakdown of pumping equipment
- Adequate treatment and/or disposal required
- Higher risk of water pollution by accidents

5. Simplified and Condominal Sewers

Design Principle (MARA 1996)

It is a simplified sewerage, which is technically and institutionally feasible, economically appropriate and financially affordable sanitation option.



Source: STAUFFER (2012), adapted from TILLEY et al. (2008)

5. *Simplified and Condominal Sewers*

Design Principle (TILLEY et al. 2008; SANIMAS 2005)

It consists of:

- Small-diameter pipes (e.g. 100 mm).
- Inspections chambers (for maintenance).
- Every household should have a grease trap or an other appropriate pre-treatment facility.
- Semi-centralised treatment facility or transfer/ discharge station.

5. Simplified and Condominal Sewers

Design Principle (TILLEY et al. 2008; SANIMAS 2005)

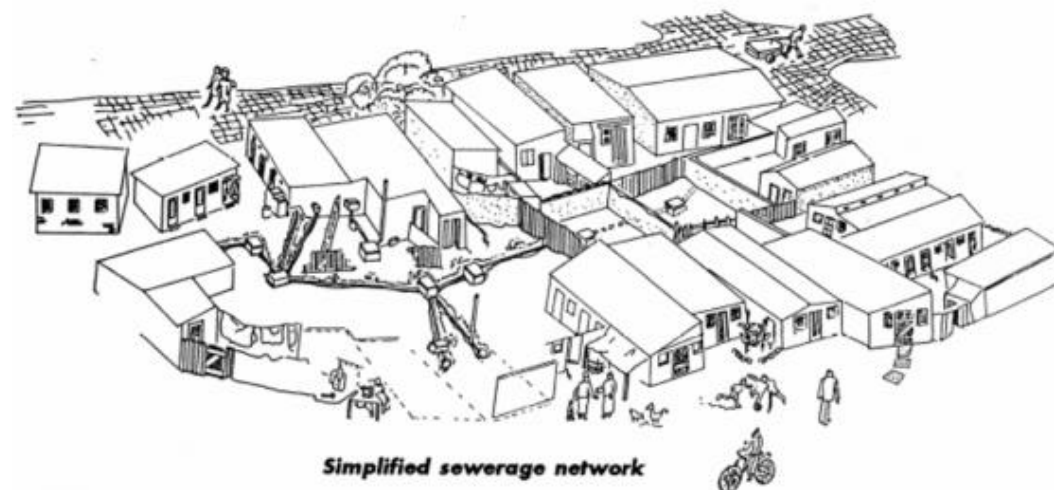
Sewers are laid on users property:

- Higher connection rates can be achieved.
- Fewer and shorter pipes can be used.
- Less excavation is required (reduced traffic load).

→ This requires careful negotiation between stakeholders (see stakeholder analysis), since design and maintenance must be jointly coordinated.

A simplified sewer (condominal sewer) network. Sewers are laid within property boundaries rather than beneath central roads.

Source: EAWAG and SANDEC (2008)



5. *Simplified and Condominal Sewers*

Costs (MARA 1996)

Costs are low (50 to 80 % less expensive than conventional sewerage) because:

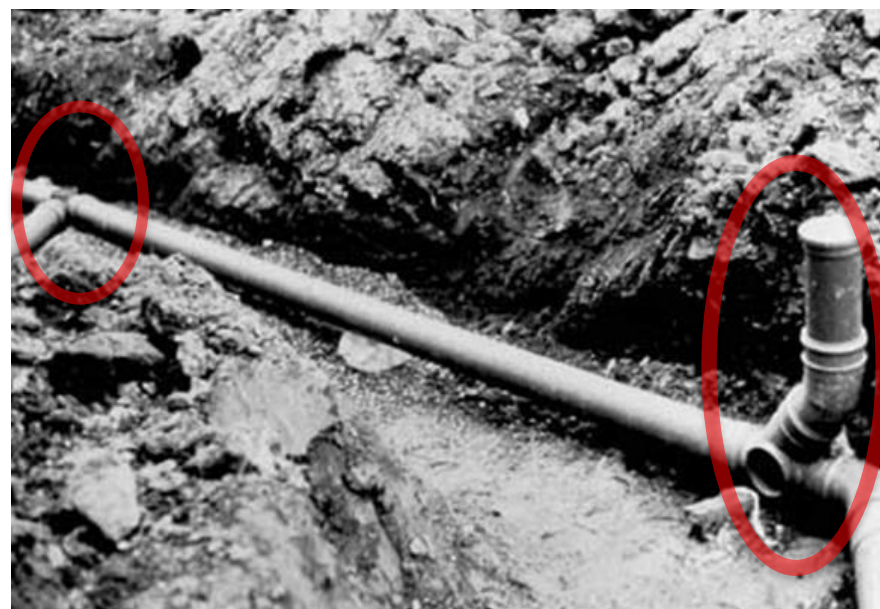
- Flatter gradients
- Shallow excavation depths
- Small diameter pipe
- Simple inspection units

→ The costs for emptying interceptors and pre-settling units must be considered!

5. Simplified and Condominal Sewers

Operation & Maintenance (BRIKKE and BREDERO 2003)

- All greywater should be connected to ensure adequate hydraulic loading.
- No solids should enter the system.
- The system needs to be flushed regularly.
- Interceptor tanks and pre-settlement units must be emptied periodically



A typical cleanout, also called flushingpoint (right) and a junction without a cleanout (left).

Source: MARA (2001)

5. Simplified and Condominal Sewers

Applicability (TILLEY et al. 2008; BRIKKE and BREDERO 2003)

- Appropriate for dense, urban settlements
- If ground is rocky or the groundwater table is high
- Can be an alternative in areas with individual soakaways

Junction chamber for simplified sewerage using larger diameter concrete pipes, used in Guatamala. Source: MARA and SLEIGH (2001)



5. Simplified and Condominal Sewers

Pros and Cons

Advantages:

- Can be built and repaired with locally available materials
- Construction can provide short-term employment to local labourers
- Capital costs are between 50 and 80 % less than conventional gravity sewers
- Operating costs are low
- Can be extended as a community changes and grows

Disadvantages:

- Requires water for flushing
- Requires expert design
- Requires repairs and removals of blockages more frequently than a conventional sewer
- Effluent and sludge requires secondary treatment
- Overflow if not maintained properly
- Blockage because of illegal connections
- Only suitable where there are interceptor tanks, septic tanks or other pre-treatment systems
- Requires the involvement of a well-organised sewerage department

6. Solids-free Sewers

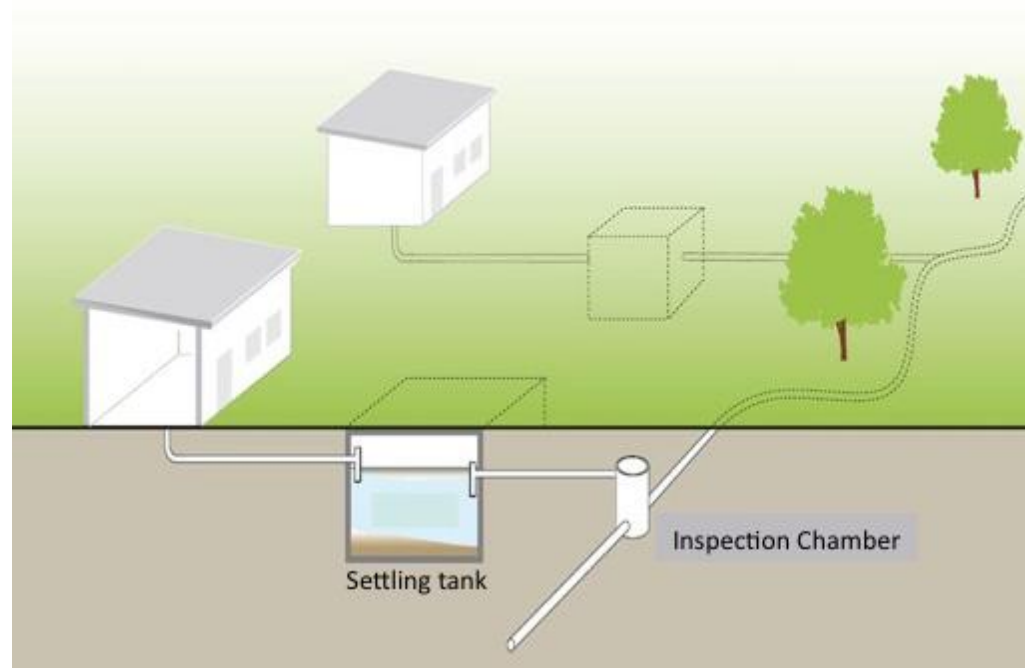
Design Principle

Solids-free sewer systems are similar to conventional systems, but the wastewater is pre-settled and solids removed before entering the system, e.g.:

- Septic tanks
- Biogas settlers
- Anaerobic baffled reactor

The recommended pipe diameter is 75 to 100 mm and an depth of at least 300 mm.

(OTIS and MARA 1985)



Source: TILLEY et al. (2008)

6. Solids-free Sewers

Design Principle

If well maintained, there is little risk of clogging, thus there is no need of self-cleansing velocity, i.e.;

- Shallow depths
- Small or even inflective gradients
- Fewer inspection points
- Can follow topography more closely

→ This results in significantly lower investment costs due to the simplified design!

6. Solids-free Sewers

Costs (TILLEY et al. 2008)

- Solids-free sewers can be built for 20% to 50% less costs than conventional sewerage.
- Repairs and removal of as well as costs for emptying the pre-settling unit must be considered.



Costs for emptying the pre-treatment unit must be considered (organisation and costs): a vacuum truck empties a pit in Bharakpur near Calcutta. Source: EAWAG/SANDEC (2008)

6. *Solids-free Sewers*

Operation & Maintenance (TILLEY et al. 2008)

- Pre-settling unit must be maintained and emptied periodically.
- Risk of pipe clogging is relatively low.
- Sewer should be flushed once a year.
- Sewers require a constant supply of water, although less water is needed compared to conventional sewers.

Applicability

- Well suited for areas where leaching fields/soak pits are inappropriate due to sensitive groundwater or lack of space for on-site infiltration in growing communities.
- In areas with a high willingness to pay (for the operation and maintenance) and with locally available expertise and resources.
- Users should receive some basic training.

6. *Solids-free Sewers*

Pros and Cons

Advantages:

- Can be built and repaired with locally available materials
- Capital costs are less than for conventional sewers
- Low operating costs if well maintained
- Can be extended as a community changes and grows
- Appropriate for densely populated areas with sensitive groundwater or no space for a soak pit or leaching field

Disadvantages:

- Requires repairs and removals of blockages more frequently than a conventional gravity sewer
- Requires expert design and construction supervision
- Requires education and acceptance to be used correctly
- Effluent and sludge (from interceptors) requires secondary treatment and/or appropriate discharge

7. Pressurised Sewers

Design Principle

- This system is not dependent on gravity to move wastewater
- Shallow trenches and relatively small pipe diameters
- Requires permanent electricity and grinder pumps



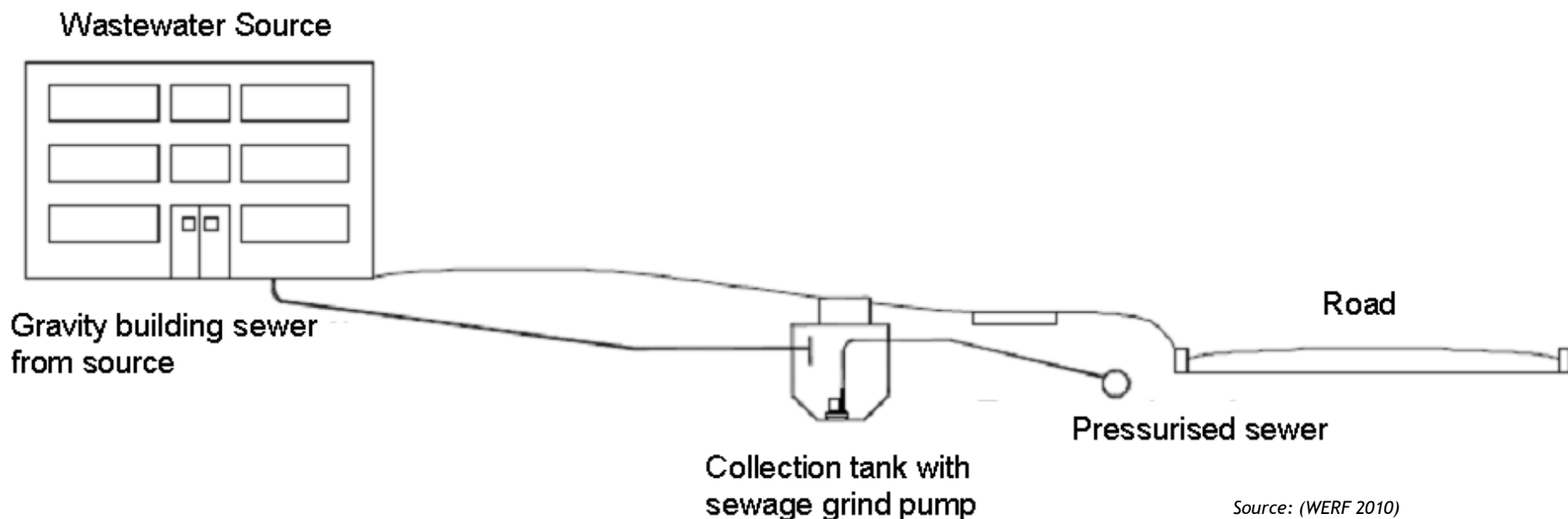
A pressurised sewer system is independent from land topography and does not need deep excavation work.

Source: ITT (n.y.)

7. Pressurised Sewers

Design Principle (WERF 2010)

- Wastewater is collected by gravity in a collection tank.
- A grinder pump moves it to the sewer → this transfer of wastewater pressurises the sewer.
- Various pumps along the sewer line move the wastewater progressively.



Source: (WERF 2010)

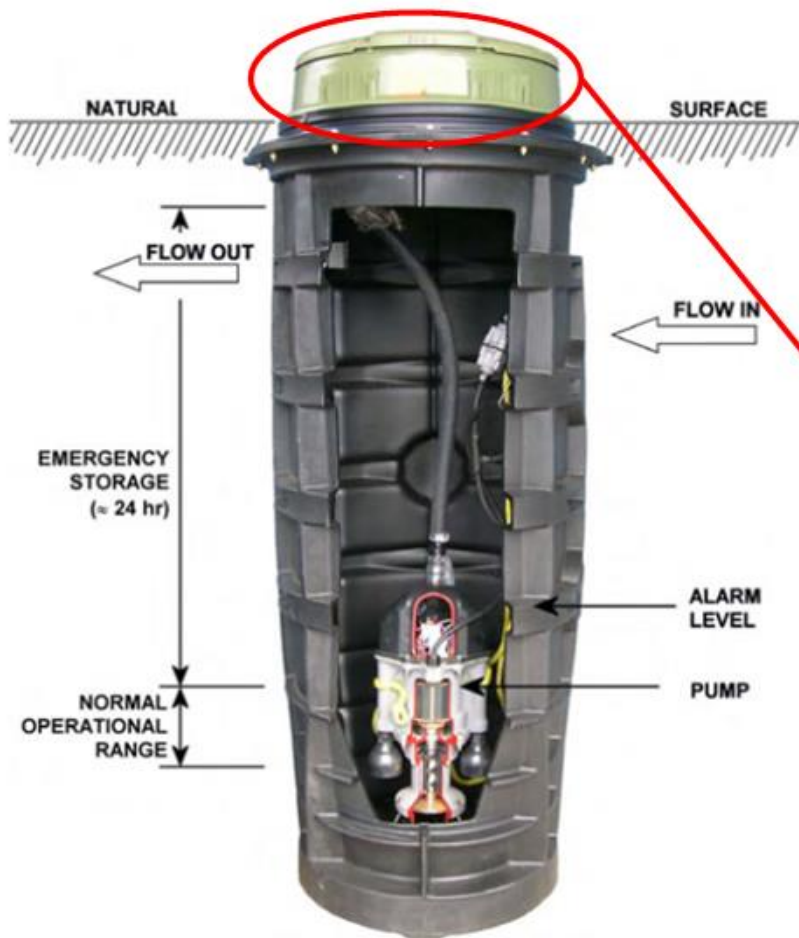
7. Pressurised Sewers

Design Principle - Pressure Sewer Unit (SHOALHAVEN n.y.)

- Generally pre-fabricated products.
- A collection tank including grinder and pump, non-return valve (prevents backflow from the pressure sewer).
- The grinding allows small pipe diameters.
- Wired to the household power supply and regulated by a control panel.
- Alternative to this unit: a septic tank situated outside in the ground or in the basement. Effluent flows into an underground holding tank containing a pump and control devices from where it is then pumped into the pressurised sewer. (U.S. EPA 2002)

7. Pressurised Sewers

Design Principle - Pressure Sewer Unit



A prefabricated pressure sewer unit made out of plastic for outside placement. Source: SHOALHAVEN WATER (n.y.)

7. Pressurised Sewers

Costs (WERF 2010)

Costs can be divided in two major components:

- **On-lot costs:** pump, basin, controls, building sewer, lateral piping, electrical service, installation
- **Collection network:** includes all the piping in the utility easements that directs the sewage to the treatment facility.

7. Pressurised Sewers

Operation & Maintenance

- Regular service is important for all system components.
- Electricity needs to be available all the time.
- Pumps should be checked regularly.
- Pipe connections should be controlled for leakages.



Three examples of damages on pressurised piping system. Therefore it is very important to inspect and maintain the sewer system. This avoids high repair cost, environmental damages and public health hazard. Source: WSAA (2003)

7. Pressurised Sewers

Applicability

- Basically, pressurised sewer systems have the same advantages as vacuum sewers. Therefore they are used in similar surroundings;
- Flat or hilly topography: gravity systems demand installation at great depths to maintain adequate flow or requires pumping and lift stations.
- Rock layers, running sand or a high groundwater table make deep excavation difficult.
- High groundwater table.
- Densely populated areas.

7. Pressurised Sewers

Pros and Cons

Advantages:

- Effective wastewater transportation at minimum depth, minimising the excavation for the piping system
- Gravity free; independent from land topography
- Lower costs compared to a conventional gravity sewer (pipe size and depth requirements are reduced and many small pumps are cheaper than some large-capacity lift stations)
- Requires little water only for transporting the excreta

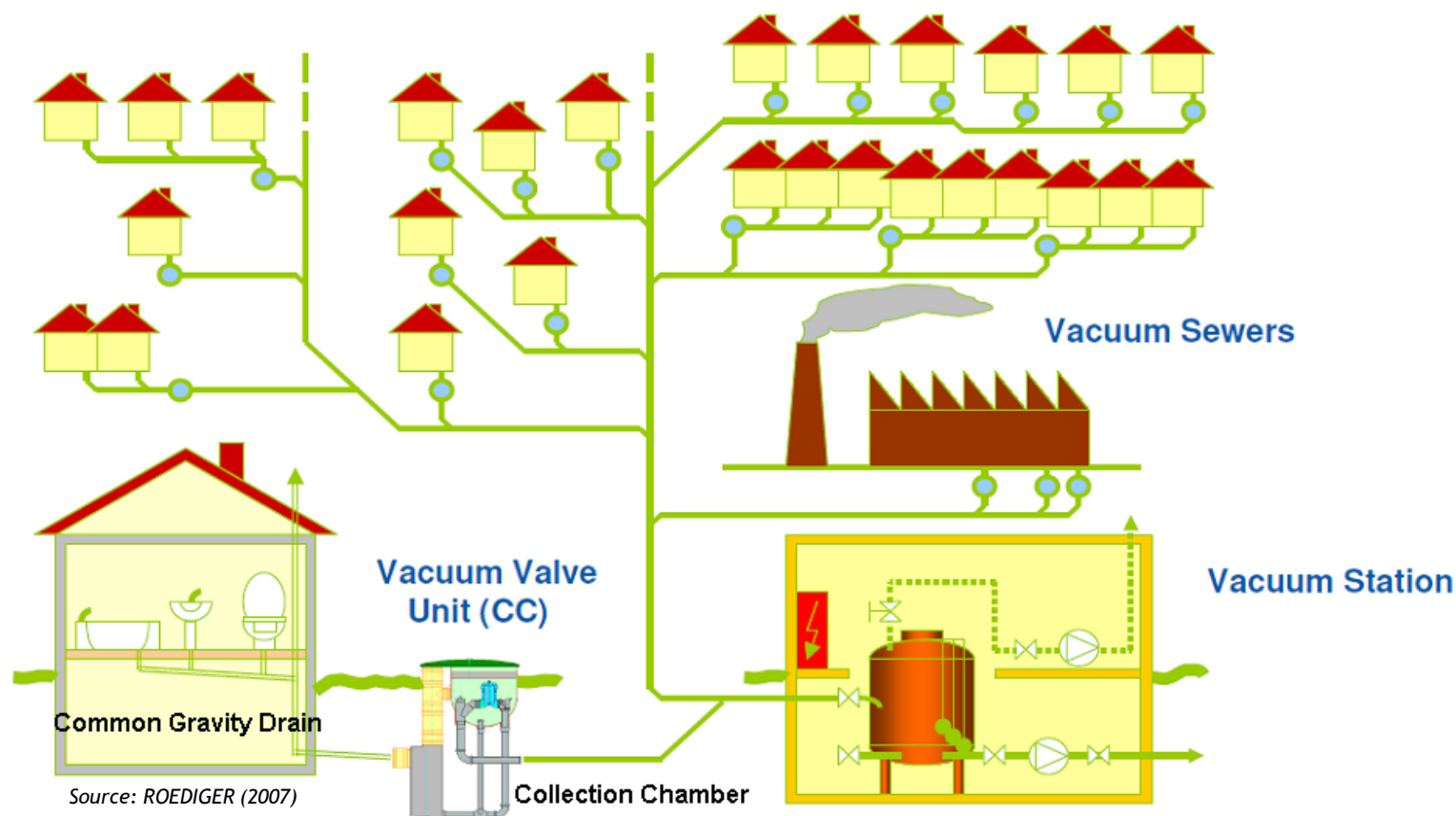
Disadvantages:

- Needs expert design, high capital costs
- Needs a permanent energy source
- A proper recycling of nutrients and energy becomes difficult, because all kinds of wastes are mixed
- Unsuitability for self-help, requires skilled engineers & operators
- It is still a flushing system which transports wastewater away. If there is no treatment plant and an unprofessional discharge it can contaminate the environment
- Leakages may lead to contaminations

8. Vacuum Sewers

Design Principle

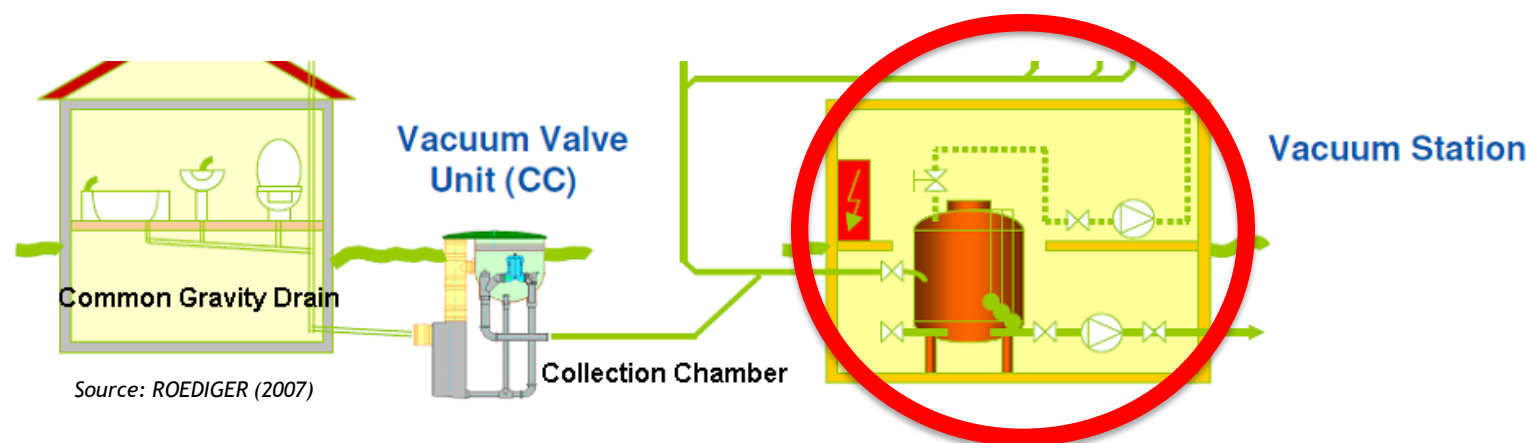
A central vacuum source conveys sewage from individual households to a central collection station. (UNEP 2002)



8. Vacuum Sewers

Design Principle

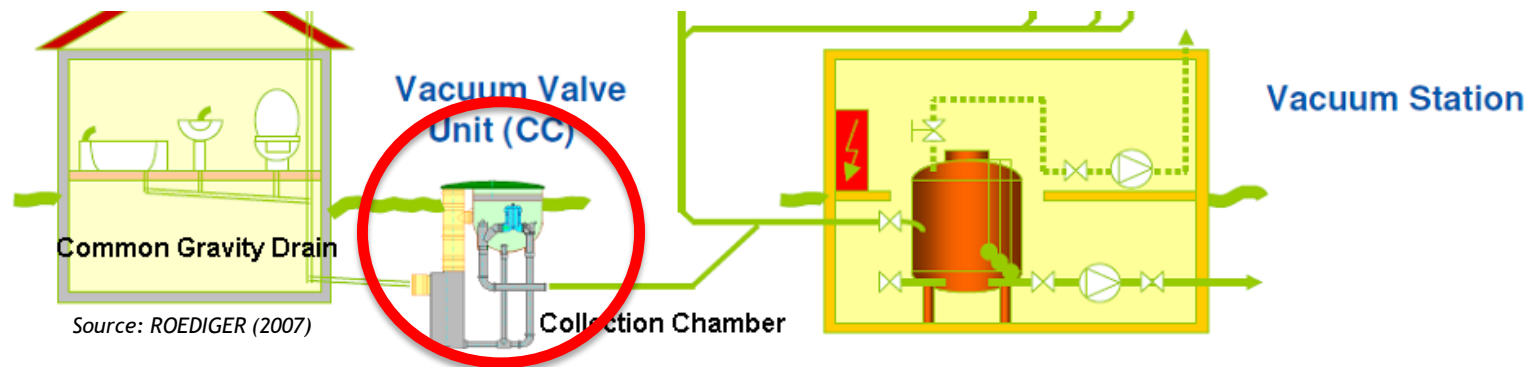
- Use of differential air pressure (“negative pressure” or “vacuum”) to move the sewage.
- A central source of power to operate vacuum pumps is required to maintain vacuum.



8. Vacuum Sewers

Design Principle (PDH ENGINEER 2007)

- Use of differential air pressure (“negative pressure” or “vacuum”) to move the sewage.
- A central source of power to operate vacuum pumps is required to maintain vacuum.
- At each entry point (collection chamber), an interface valve is required to seal the lines so that vacuum can be maintained.



8. Vacuum Sewers

Design Principle - Transport of Wastewater (PDH ENGINEER 2007)

1. Gravity line carries wastewater from the source to the collection chamber.
2. When a defined height is reached, the vacuum interface valves opens and sucks the wastewater into the vacuum sewer main.
3. At the end of this main it is collected in a big tank.
4. After this tank is filled to a predetermined level, the wastewater is transferred to a treatment plant via a conventional/separate sewer system.

8. Vacuum Sewers

Design Principle - Piping

- Narrow and shallow trenches (1.0 to 1.2 m)
- Inspection points for pressure testing
- Small pipe diameter (80 to 250 mm)
- If a pipe is damaged, risk of leaking is low because of the negative pressure.



Local workers at construction of a shallow vacuum sewer system.

Source: ROEDIGER (2007)

8. Vacuum Sewers

Costs

It is a high-tech system, thus it is costly. But in comparison with a conventional sewer system, it is cheaper:

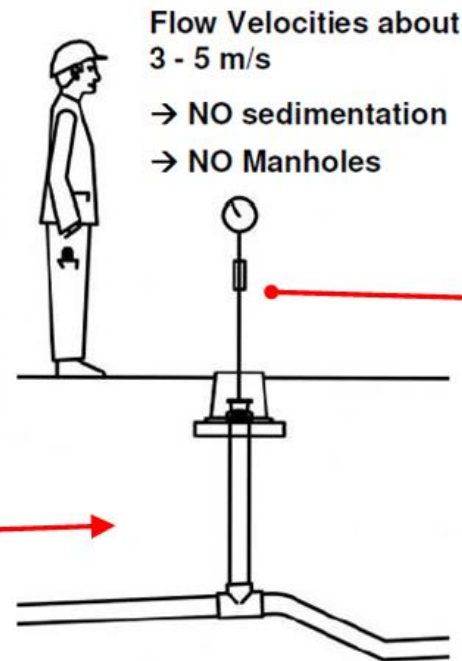
- Small Pipes (less material)
- Shallow trenches (no heavy machinery)
- Independent from topography
- Large amounts of flushing water can be saved (economical and ecological reasonable)

→ Permanent source of electrical power can increase the costs!

8. Vacuum Sewers

Operation & Maintenance

- Risk of clogging is low; almost no cleaning/emptying
- Periodically pressure testing
- Complex and/or technical problems are in the responsibility of the manufacturer.



*Construction of
a sewer at the
left side and
pressure testing
et the right
side. Source: ROEDIGER
(2007)*

8. Vacuum Sewers

Applicability

- Flat topography: gravity systems demand installation at great depths to maintain adequate flow (pump stations, lift stations).
- Rock layers, running sand or a high groundwater table make deep excavation difficult.
- Areas short of water supply or poor communities that must pay for water, but cannot afford great amounts of water necessary for operation of gravity systems.
- Areas that are ecologically sensitive.
- Areas where flooding can occur.
- Areas with obstacles to a gravity sewer route.
- Installation of a new fresh water network, allowing sewerage pipe installation in the same trench.

8. Vacuum Sewers

Pros and Cons

Advantages:

- Requires less flushing water
- Considerable savings in construction costs
- Shallow and narrow trenches, small diameter pipelines, flexible pipeline construction
- Sewers and water mains can be laid in a common trench
- Closed systems with no leakage or smell
- No manholes along the vacuum sewers
- One central vacuum station can replace several pumping stations

Disadvantages:

- Needs expert design
- Needs energy to create the permanent vacuum
- Relatively high capital costs
- Recycling of nutrients and energy becomes difficult
- Unsuitability for self-help, requires skilled engineers operators
- It is still a flushing system. If there is no treatment plant and an unprofessional discharge it can contaminate the environment

9. Open Channels and Drains

Design Principle (WHO 1991)

Separately collected stormwater has high potential for increasing agricultural production in rural areas. → The most basic way to drain off rain and stormwater is via open channels.

- It consists of a secondary drainage system, with a network of small drains attached (micro-drainage).
- Each serves a small catchment area that ranges from a single property to several blocks of houses.
- The small drains bring the water to a primary drainage system, composed of main drains (also called interceptor drains), which serve large areas of the city.
- The main drains are generally connected with natural drainage channels such as rivers or streams.

9. Open Channels and Drains

Design Principle Case

‘El Gran Canal’ in Mexico City used as primary drainage system. The water in this canal, which also transports rain and stormwater, is heavily polluted with litter and untreated wastewater.



Source: WALDWIND (n.y.)

9. Open Channels and Drains

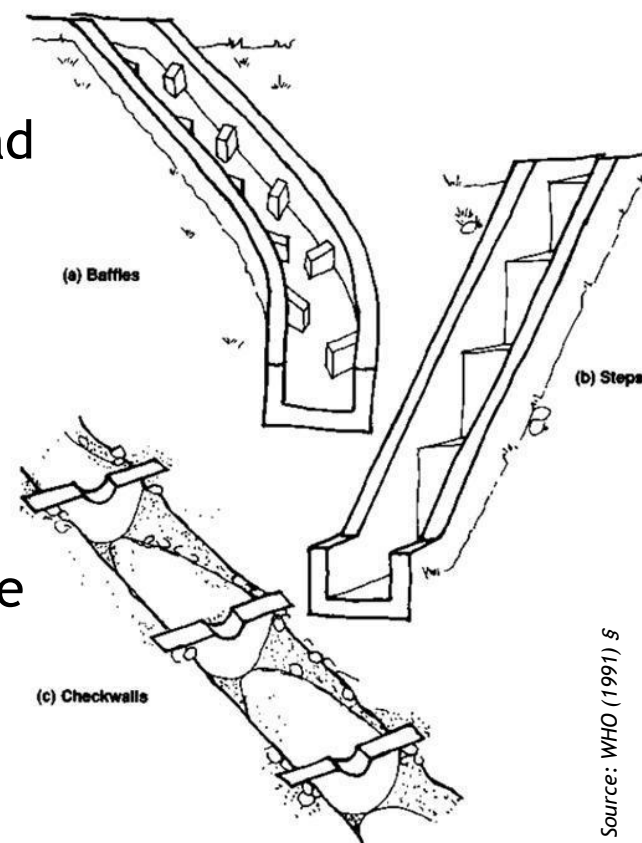
Design Principle - Steep Terrain

A return period of 5-years is widely used to design primary drainage systems in tropical cities, for micro-drainage 3-year or less.

On steep terrain, uncontrolled velocities can lead to erosion, therefore several designs exist:

- a. Baffles
- b. Steps
- c. Checkwalls

They are all built into the drain to slow down the water flow for unlined drains. The water deposits silt behind each checkwall, gradually building up a stepped drain. The checkwalls should be buried well into the ground.



Source: WHO (1991)

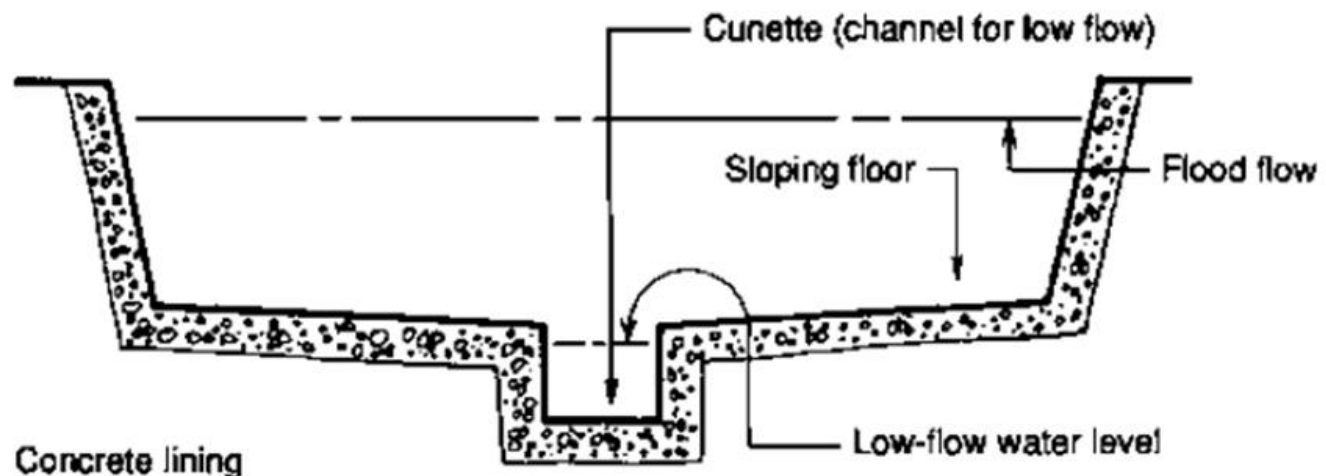
9. Open Channels and Drains

Design Principle - Flat Terrain

The central channel or “cunette” with a narrow bottom carries the flow in dry weather and moderate rain.

The outer channel facilitates for the occasional heavy flood flow. The outer channel floor should preferably slope gently down to the central channel.

If not properly design or clogged → risk of puddling and mosquito breeding



Source: WHO (1991)

9. Open Channels and Drains

Design Principle - Transport of Wastewater

Could be a temporary solution - but is NOT a satisfactory technology:

People can easily come into contact with the wastewater, with its potentially high pathogen content.

- If there is a storm event, flooding and spreading of pathogens and other pollutants can occur. (WORLDBANK 2011)
- Very often open drains/channels are misused for depositing litter and excrete. (CORCORAN et al. 2010)
- Household sewer lines are sometimes illegally connected to open drainage systems. (CORCORAN et al. 2010)

9. Open Channels and Drains

Costs (WHO 1991)

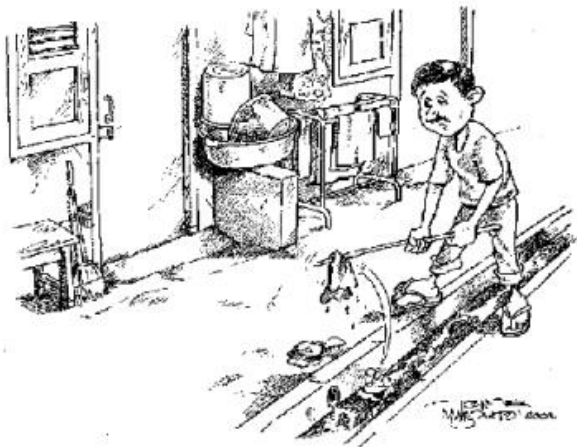
- Compared to underground sewer systems.
- Price depends on:
 - Steep terrain (extra construction to slow down velocity)
 - Flat terrain (deep or wide excavation)
 - Costs for material
- Consideration of community participation could have a positive offset on the overall costs (O&M).
- A typical value for the annual cost of maintenance would be about 8% of the construction cost of the system.

9. Open Channels and Drains

Operation & Maintenance (WHO 1991)

The main duties and responsibilities for O&M are:

- Routine drain cleaning and repairs
- Semiannual inspection, reporting of defects and blockages
- Payment for maintenance
- Passing of by-laws regarding the use of drains
- Enforcement of by-laws.



Cleaning out open drains is difficult to organise but utterly necessary. Blockages can cause spill-over and cause flooding. A solution could be to cover it with concrete slabs. Source: SANIMAS (2005)

9. Open Channels and Drains

Health Aspect (WHO 1992)

Open drains bear a high health risk, because water in open channels can contain all sorts of contaminants and pathogens

- Ponding enforces mosquito breeding
- Illegal disposal of solid waste leads to clogging
- Defecation into these channels is not an unusual habit



Greywater from laundry (left) and solid garbage which is disposed in open drains (right) pollute water and cause health hazards. Bangalore, Nepal. Source: BARRETO (2009)

9. Open Channels and Drains

Applicability

- It can be constructed in almost all types of settlements (urban or rural), but enough land area is required to build a reasonable construction.
- Scheduled maintenance is necessary to prevent clogging
- In general, they bear many risk for public health

If possible, they should be applied only where an adequate wastewater treatment and collection systems for sewage sludge as well as a solid waste management are provided.

9. Open Channels and Drains

Pros and Cons

Advantages:

- Low-cost drain-off solution if drains already exist
- Simple to construct
- Construction materials are often locally available
- Creates employment (construction and maintenance)

Disadvantages:

- High health risk due to risk illegal discharge of wastewaters and solid waste
- Blockages can cause spill-over and flooding
- Foul odour source establishment
- Breeding ground for insects and pests
- Regular cleaning service required to remove solids

10. Sewer Pumping Stations

Design Principle (EESD 2003)

They are used to move wastewater to higher elevations. In general, the need for sewer pumping stations arises when:

- The existing topography and required minimum sewer grades create deep sewers that have high construction costs. The sewage is raised and then conveyed by gravity.
- Basements are too low to discharge sewage to the main sewer.
- Sewage must be conveyed over a ridge.
- The sewage must be raised to get head for gravity flow through a treatment plant.
- Discharge outlets are below the level of the receiving body of water.
- An existing gravity system is not yet available. A pumping station will enable development and growth in accordance with the applicable community plan.

10. Sewer Pumping Stations

Design Principle

1. Sewage is fed into and stored in an underground pit (wet well).
2. When the level rises to a predetermined point, a pump will be started to lift the sewage upward through a pressurised pipe system (sewer force main or rising main).
3. From there it is discharged into a gravity manhole again.



A sewer pumping station in Germany with the pump shaft and the electricity/control unit.

Source: MAW (2010)

10. Sewer Pumping Stations

Costs

A pumping station is always in combination with a (on-site or semi-centralised) treatment plant and/or a sewer system.

- High costs for construction material, electricity, maintenance and of course expert design.
- Construction and installation costs are high.



A fibreglass tank for single households with an integrated sewage pump. The sewage is pumped up to council sewer or on site treatment plant. Source: FTM (2010)

10. Sewer Pumping Stations

Operation & Maintenance

- The system is mostly computer- or electronically monitored.
- Sensors check the sewage level of the wet wells and start/stop the pumps.
- The pumps and its monitoring unit should be maintained periodically by the supplier.
- Overflows of wet wells should be avoided and it is important that there is a treatment plant at the end of every sewer system.

10. Sewer Pumping Stations

Applicability

Pumping stations become necessary as soon as sewage has to be lifted from a lower part to a higher part.

- A well constructed piping system (e.g. conventional sewer system) and a treatment plant is necessary.
- Construction material and spare parts is expensive and might be difficult to acquire locally.

10. Sewer Pumping Stations

Pros and Cons

Advantages:

- Sewage can be pumped automatically to higher elevations
- No contact with wastewater is necessary

Disadvantages:

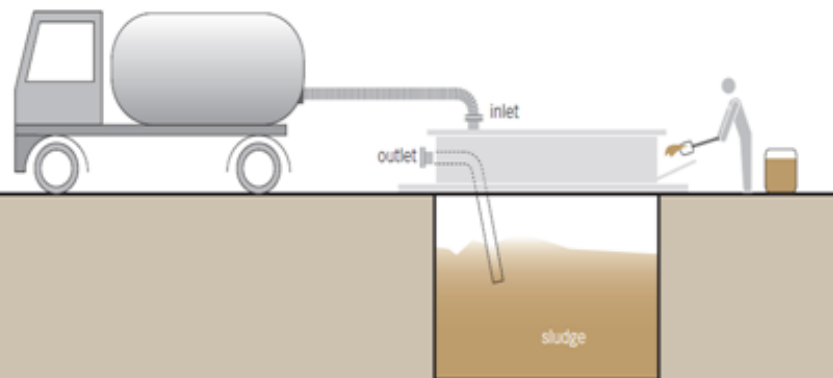
- Very costly
- Local availability of construction material and spare parts
- Needs expert design

11. Transfer and Sewer Discharge Stations

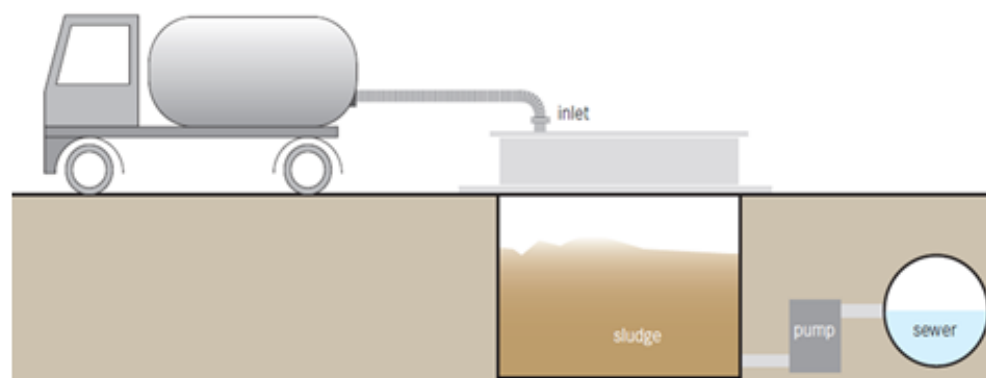
Design Principle (TILLEY et al. 2008)

- Transfer stations act as intermediate dumping points for faecal sludge/blackwater when it cannot be easily transported to a treatment facility. It is emptied by a vacuum truck.
- A sewer discharge station is directly connected to the sewer system.

Transfer Station



Sewer Discharge Station



Source: TILLEY et al. (2008)

11. Transfer and Sewer Discharge Stations

Design Principle (TILLEY et al. 2008)

- The dumping point at the transfer station should be built low enough to minimise spills when labourers are manually emptying their sludge carts.
- It should include a vent, a trash screen to remove large debris (garbage) and a washing facility for vehicles.
- It should be well protected and maintained to prevent random dumping into the sewer and to ensure the safety of the users.

11. Transfer and Sewer Discharge Stations

Costs (TILLEY et al. 2008)

The moderate capital costs may be offset with access permits and the construction and maintenance can create local income.

The system for issuing permits or charging access fees must be carefully designed so that those who most need the service are not excluded because of high costs.

Costs for maintenance, observation and operation of the facility must be considered.

11. Transfer and Sewer Discharge Stations

Operation & Maintenance (TILLEY et al. 2008)

- Racks (screens) must be cleaned frequently.
- Sand and grit must be periodically removed.
- The pad and loading area should be cleaned regularly to minimise odours.
- Sludge from transfer or sewer discharge stations is treated in an appropriate secondary treatment facility and not be illegally dumped.

If there is no opportunity to dispose sludge, disposal sites which are unhygienic and hazardous for local residents are often the only solution. Source: SuSanA on Flickr (2011)



11. Transfer and Sewer Discharge Stations

Applicability (TILLEY et al. 2008)

- Especially appropriate for dense, urban areas where there is no alternative discharge point.
- For a sewer discharge station, a connection to a sewer main must be possible.
- The site for the transfer station should be easily accessible, conveniently located, and easy to use.
- A proper legal and institutional framework is required as well.

11. Transfer and Sewer Discharge Stations

Pros and Cons (TILLEY et al. 2008)

Advantages:

- May reduce illegal dumping of faecal sludge
- Moderate capital and operation costs
- Potential for local job creation and income generation
- Reduces transport distance and may encourage more community-level emptying solutions

Disadvantages:

- Requires expert design and construction supervision
- May cause blockages and disrupt sewer flow (sewer discharge station)
- Sludge requires secondary treatment and/or appropriate discharge
- Requires an institutional framework taking care of access fees, connection to sewers or regular emptying and maintenance
- Requires expert design and construction supervision

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