Pour-flush Toilets linked to Twin-pits

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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.

Contents

1. Concept

Background

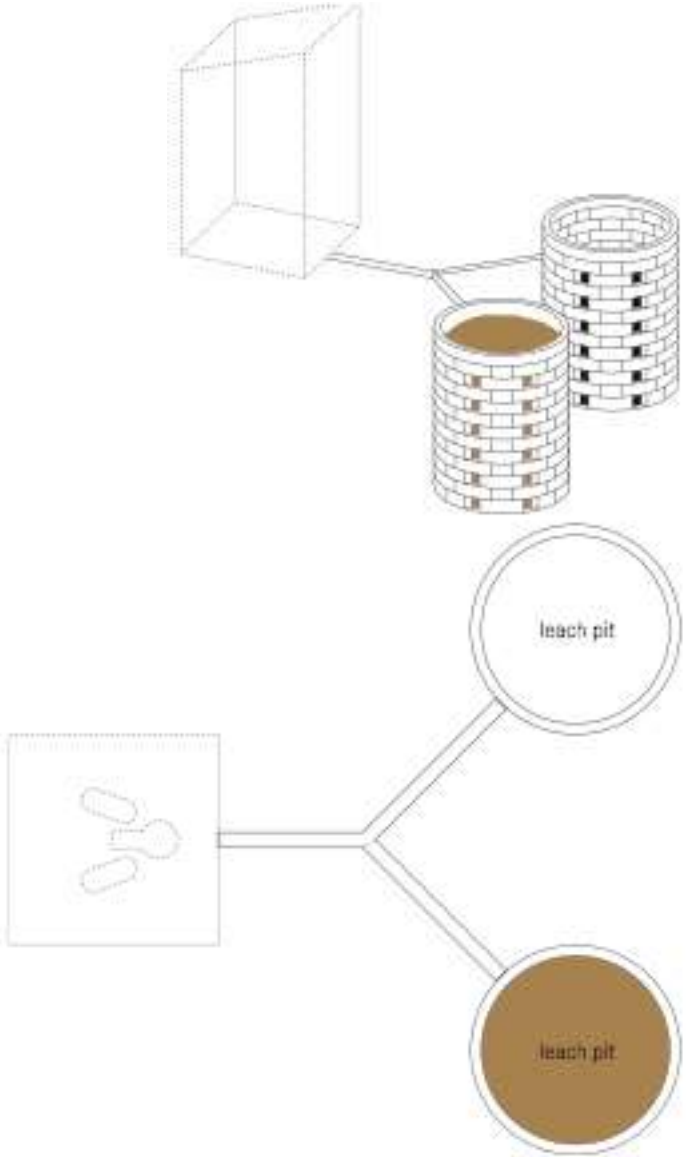
Pour-flush **toilets** linked to **twin**-pits (also called **Twin-pit Pour-flush** (TPPF)) toilets are improved pit latrines, allowing **on-site treatment** and transformation of the faecal sludge into a **hygienised soil amendment**.

They have been constructed over the past 30 years mainly in India, Bangladesh and Nepal, at **household, community or institutional** level.

They are **semi-dry** toilet systems (not linked to a piping system, but require water for flushing).

Different models of different prices exist.

They require generally **little maintenance** but due to the need of the construction of two pits, initial **investment costs** can be high.

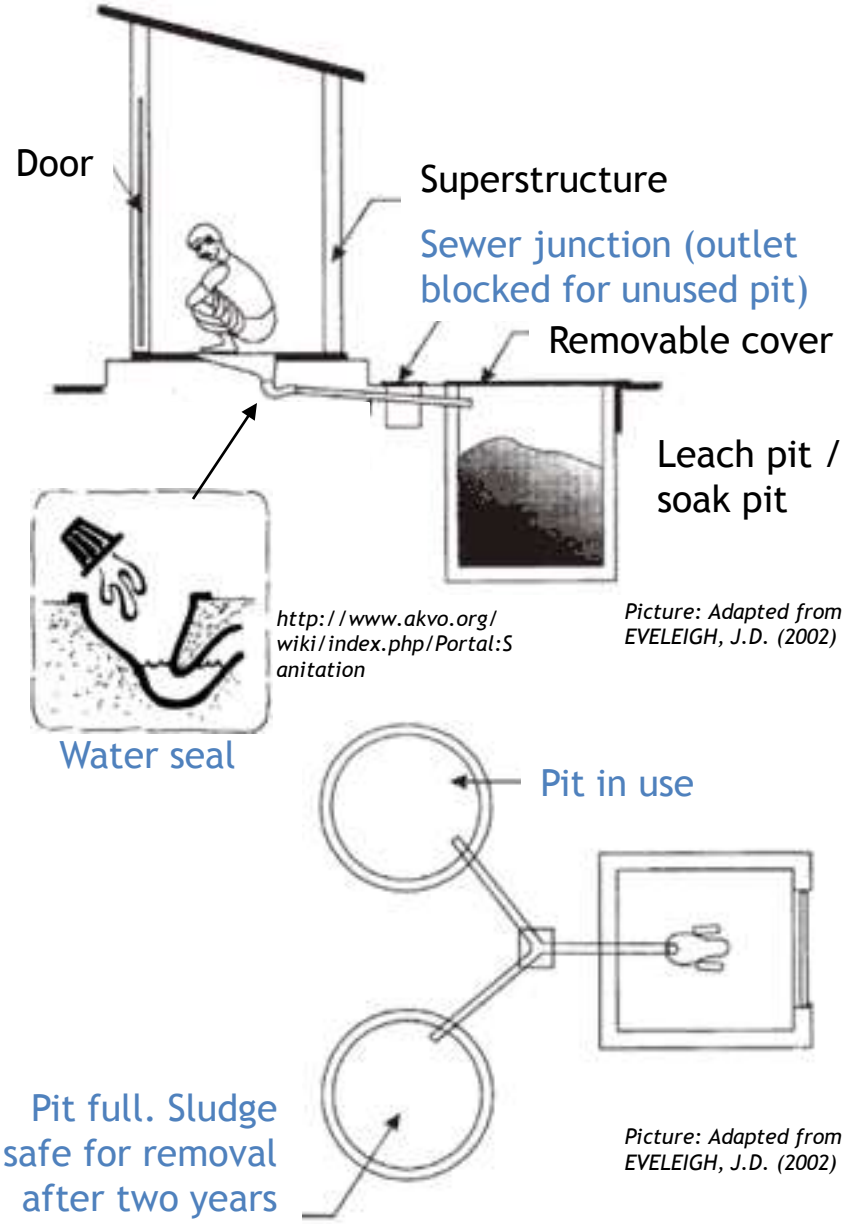


Picture: TILLEY et al. (2008)å

1. Concept

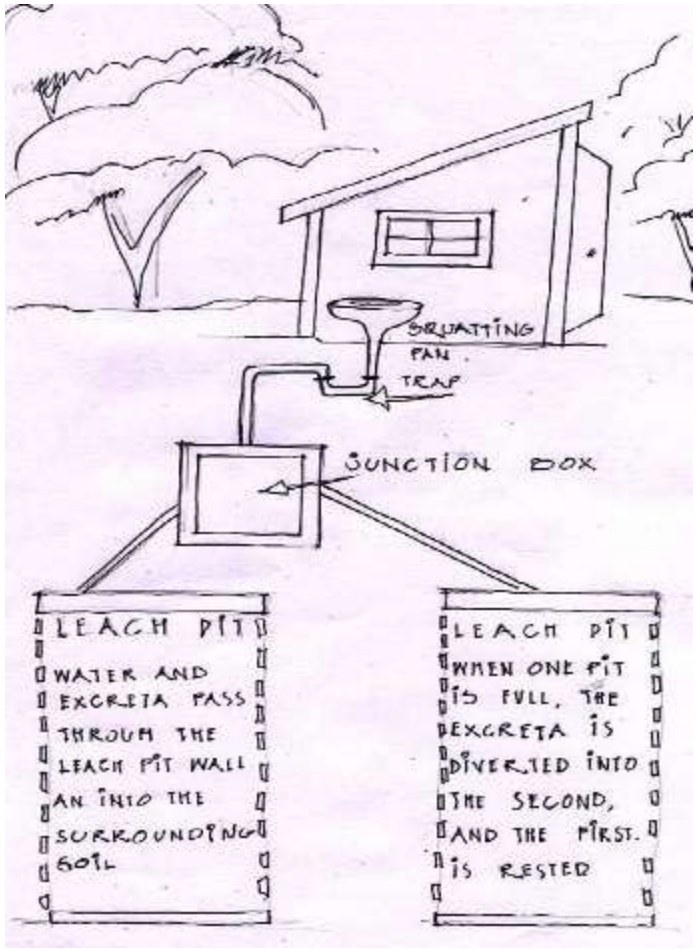
What are TPPF Toilets?

- A simple **pour-flush** squatting platform (porcelain or cement).
- A **water seal** as a barrier for odour and flies
- Set into a brick and concrete based.
- The outlet is piped to a Y junction box.
- From the box the blackwater (faeces, flush water, cleansing water) are directed to one of two shallow (leach or soak pits)
- Pits are used in alteration
- A superstructure is added for privacy and can be constructed from a wide range of locally available materials.



1. Concept

How does it work?



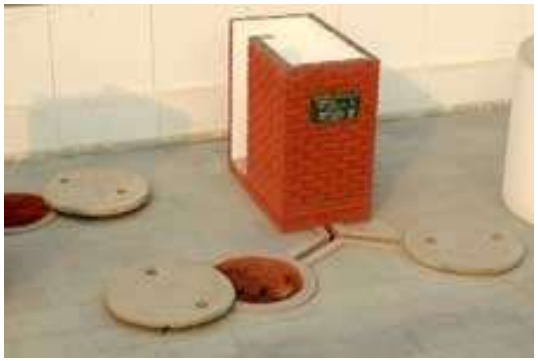
Souce: UNKNOWN (n.y.)

- Pits are lined with **porous material**: water **infiltrates locally** into the soil, solids (faeces) remain in the pits and are decomposed (by a mixed **composting/digestion process**).
- The two pits are used in **alteration**: while one pit is filling, the other pit remains out of service.
- When the first pit is full, it is covered and temporarily taken out of service.
- When the second pit is full, the first pit is re-opened and emptied.
- It should take a minimum of **two years** (WHO 1992; TILLEY et al. 2008) to fill a pit and during that time, the faeces in the pit out of service can continue to decompose.
- The treated sludge can be used as solid fertiliser (i.e. **humanure**).

1. Concept

Examples

TPPF with brick leach pit and either brick or concrete superstructure



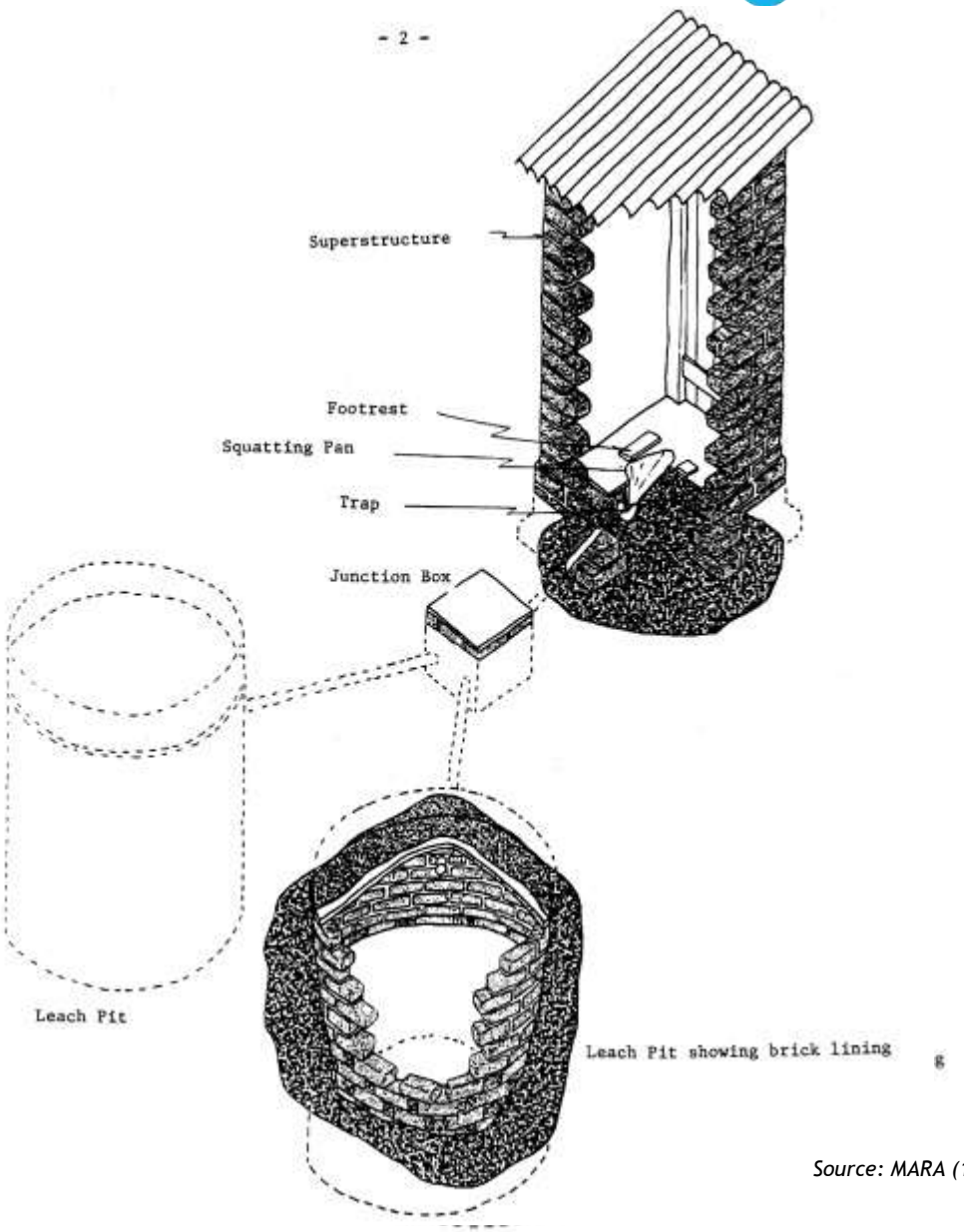
Source: http://www.sulabhenvis.in/pages/tppft.asp [Accessed: 01.06.2010]

Source: http://waterandpoop.files.wordpress.com/2009/08/1264780380_c562077436.jpg [Accessed: 01.06.2010]

1. Concept

Examples

Schematic overview of pour-flush toilet with two alternating leach pits made out of brick work



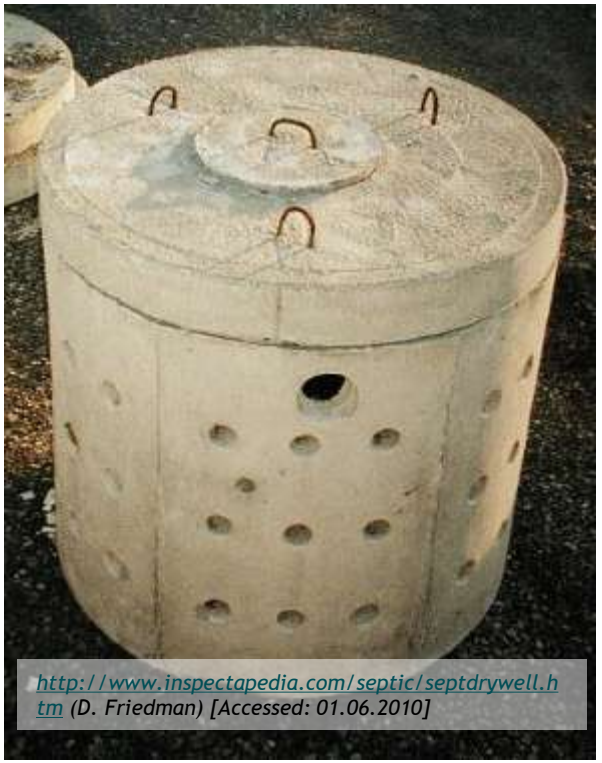
Source: MARA (1985)

1. Concept

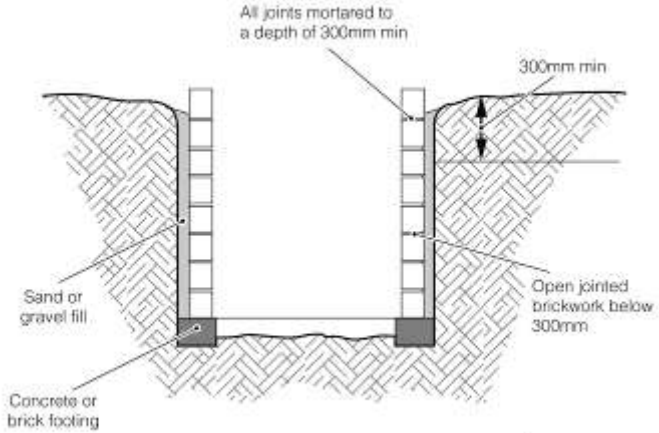
Examples

TILLEY et al. (2008)

Leach pits made out of **bricks** (much like a honeycomb) and perforated **concrete**



http://www.inspectapedia.com/septic/septdrywell.htm (D. Friedman) [Accessed: 01.06.2010]



http://wedc.lboro.ac.uk/knowledge/img-lib-lres.html?id=8-5 [Accessed: 01.06.2010]

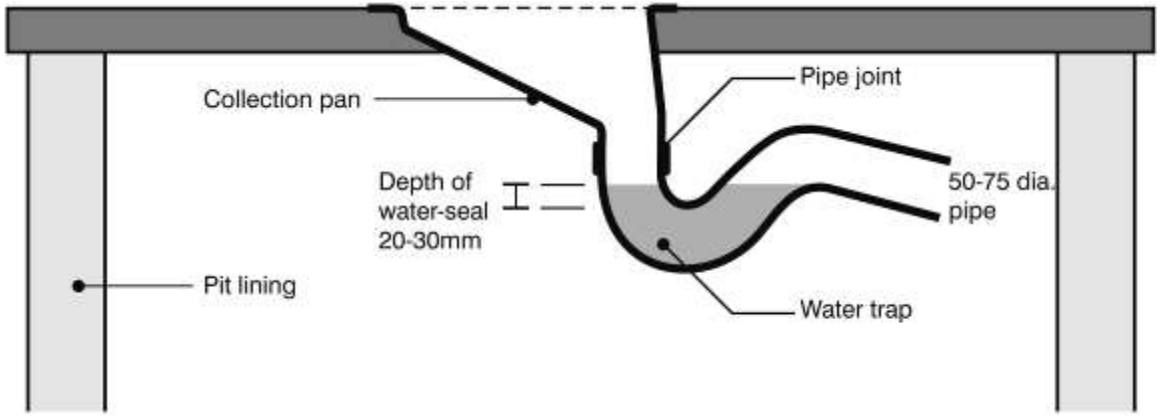
UNKNOWN (n.y.)

1. Concept

Examples

Different types of water seals

http://www.flickr.com/photos/gtzecosan/sets [Accessed: 01.06.2010]



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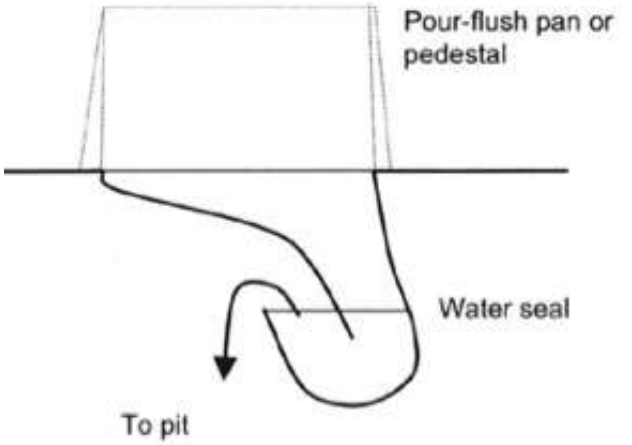

http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/lcsahgt.htm [Accessed: 01.06.2010]

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2. How it can optimize SSWM

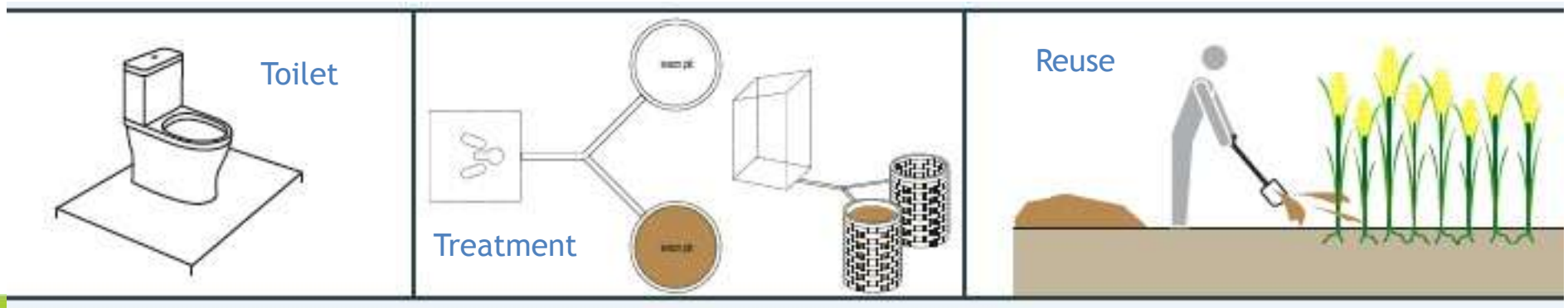
TPPF toilets provide a safe way of reducing the volume of polluted blackwater by soil infiltration.

The decomposed faeces (after two years of storage) is rich in nutrients and organic matter and can therefore be used to improve the fertility of the soils.

As a fertiliser, the treated sludge has the potential to increase food and crop production.

As a semi-dry on-site sanitation system, they do need less water for flushing (1.5 to 2 L) (ROY et al. 1984) than networked solutions.

Adapted from TILLEY et al. (2008)



3. Design Principals

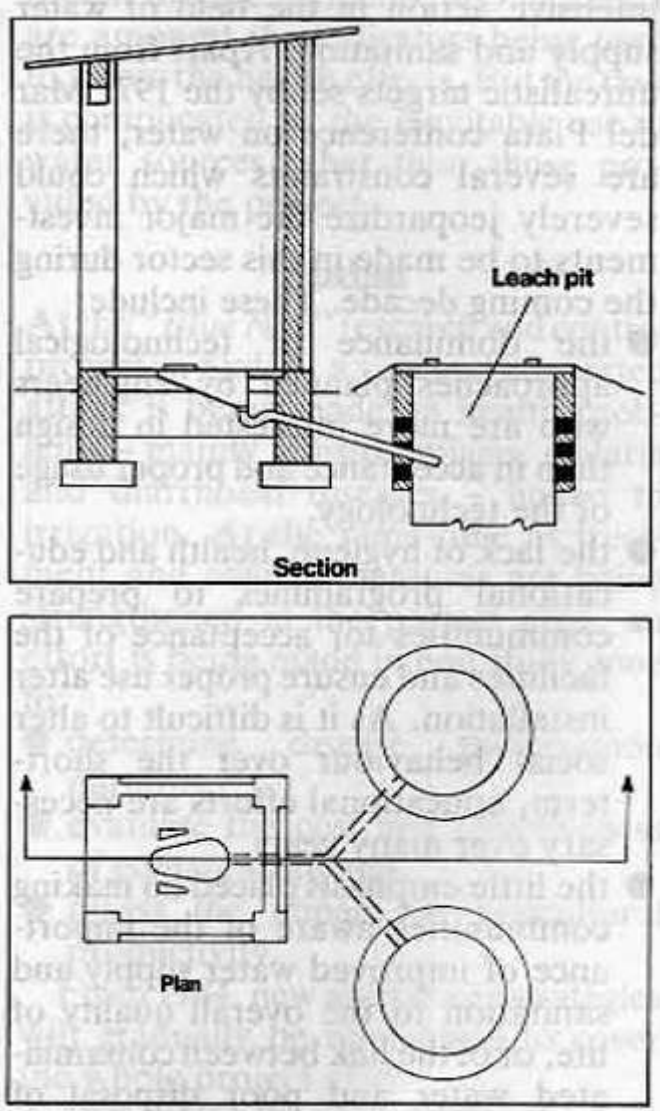
Twin-Pit Pour-Flush Toilest (1/3)

The pour-flush squatting pan consist of a steep bottom slope and a water seal trap.

From there, faeces and flushing water is directed to one of two leach pits.

An inspection chamber containing a Y junction is normally built between the pits and the pan so that the excrete can be channeled into either pit. (WHO 1982)

Each pit is designed to last for about three years before it gets filled; filling time is should be 2 years for all pathogens to die off. (ROY et al.198; TILLEY et al. 2008)

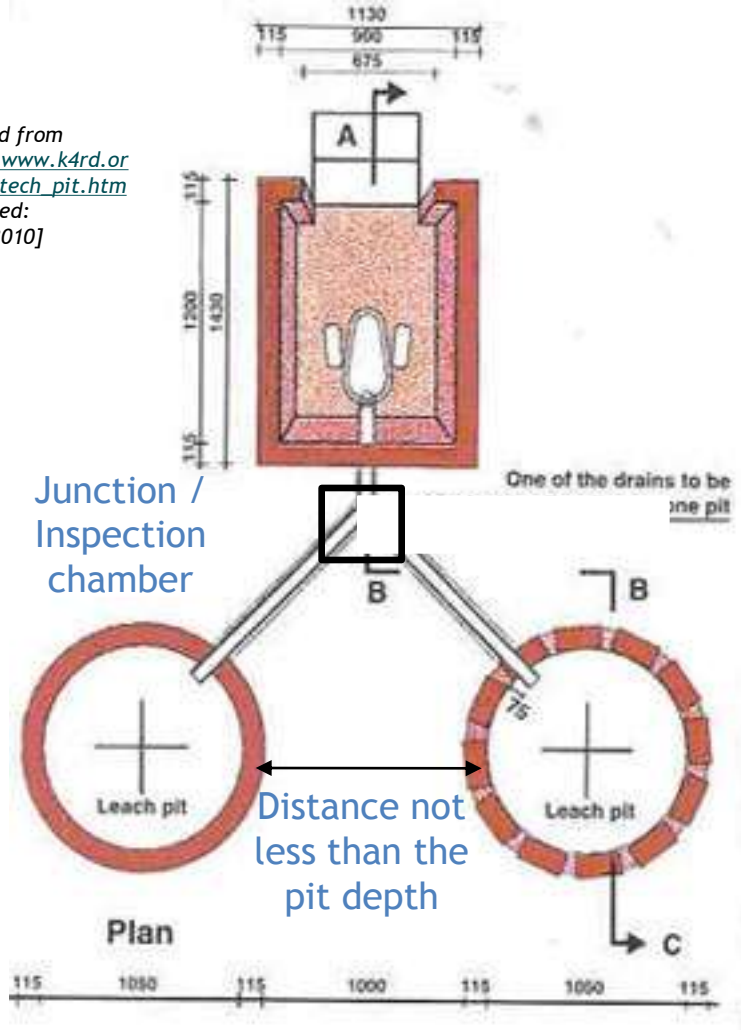


Pour-flush Toilet (Twin-pit Model)
http://rehydrate.org/dd/dd05.htm *[Accessed: 01.06.2010]*

3. Design Principals

Twin-Pit Pour-Flush Toilet (2/3)

Adapted from http://www.k4rd.org/ruraltech_pit.htm [Accessed: 01.06.2010]



The pits are constructed in brick line (much like a **honeycomb** to facilitate the liquid to flow out) or with perforated concrete tubes (e.g. pre-fabricated).

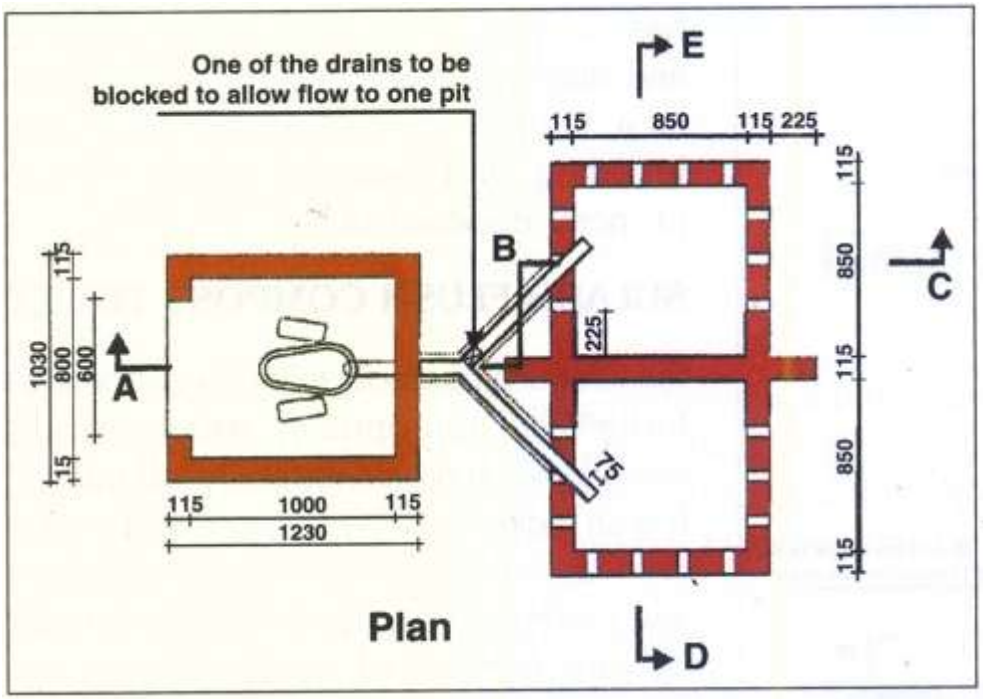
A wooden or concrete slab to prevent people falling into them

The pit shape can be circular or rectangular, but circular pits are more stable and cost less. (ROY et al. 1984)

Pits should be placed symmetrically at the back of the latrine pan (but other dispositions are possible) and have a minimal distance of the pit depth to prevent cross-contamination. (ROY et al. 1984)
If the spacing between the two pits has to be reduced, an impervious barrier should be provided between them.

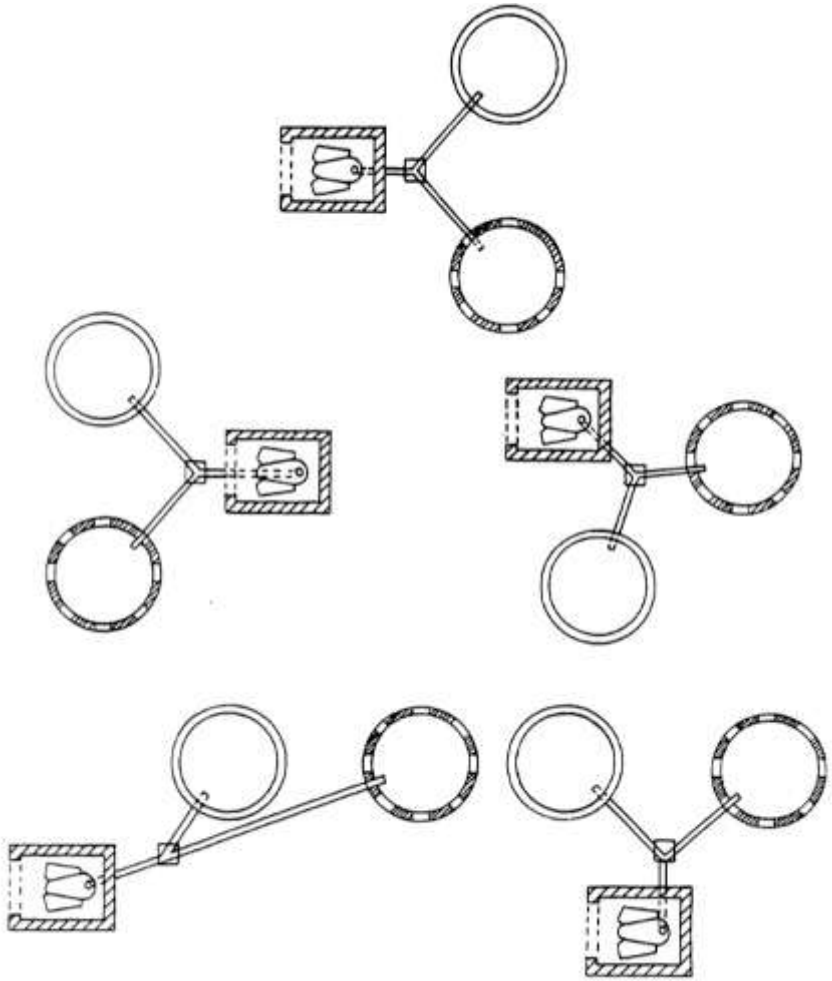
3. Design Principals

Twin-Pit Pour-Flush Toilet (3/3)



The pit shape can be circular or rectangular, but circular pits are more stable and cost less. (ROY et al. 1984)

Picture:
http://www.goodnewsindia.com/index.php/Magazine/story/sulabh/P3/
[Accessed: 01.06.2010]



Possible geometric configuration of latrine unit and leach pits.

http://www.goodnewsindia.com/index.php/Magazine/story/sulabh/P3/
[Accessed: 01.06.2010]

3. Design Principals

Pits location

If site conditions do not permit this layout, the pits can be placed on the side or even in front of the pan as shown, but this results in more water needed for flushing. (ROY et al. 1984)

Toilets can be constructed inside the house, while the pits can be situated outside the house.

To remain accessible, pits should be constructed in open ground. But if no space is available, they can also be constructed below the toilet.

In cases where there is no space close to the toilet leach pits could be located even 15 metres away from the latrine cubicle provided the connecting pipe is laid at a slope of 1:5:1 to 15. (ROY et al. 1984)

Pits should not be situated in drainage lines or the paths of stormwater drains to prvent cross-contamination. (ROY et al. 1984)

The pits should not be located in depressions where water is likely to collect. (ROY et al. 1984)

The pits be constructed over 1 m from any structural foundation as leachate can negatively impact structural supports. (ROY et al. 1984)

3. Design Principals

Urine Diversion TPPFs


Source: M. WAFLER


Source: DWSS, Nepal)

- Twin-pit Pour-flush toilets can be addapted for Urine diversion.
- The collected urine can be easely used as **nitrogen-rich fertiliser**.
- The toilets are desgiend the same way as TPPFs, but with a **urine diversion** slabs or pedestrals and **urine collection chamber** is needed.
- The faeces are flushed with water and are collected along with water used for cleansing in the twin pits.

Social acceptance high, due to usage of water for flushing.

About 190 such units have beeninstalled in Nepal by ENPHO.

3. Design Principals

Urine Diversion TPPF

Source: DWSS, Nepal

4. Treatment Efficiency

Health aspects

As pathogens move through unsaturated soil, they die off. The degree of faecal organism removal varies with (TILLEY et al. 2008)

- Soil type; Distance travelled; Moisture

Hydro-geological conditions of sites where leach pits are to be located are prerequisites. (ROY et al. 1984)

No risk in alluvial soils (silt mixed with fine sand) exists and where the pit bottom is at least 2 m above the maximum ground-water level. (ROY et al. 1984)

Virus and bacteria can travel hundreds of meters in saturated conditions. There is a risk for groundwater pollution where (TILLEY et al. 2008)

- Water table is high
- Crack and fissures in bedrock allow short-cutted flow

4. Treatment Efficiency

Health aspects

Case	Distance between the bottom of the pit and the maximum ground water level	Effective Size of the formation soil	Minimum horizontal distance of separation	Modifiction needed
1.	≥2 m	<0.2 mm (fine sand, clay and silt)	3 m	None
2.	≥2 m	>0.2 mm (coarse sand)	3 m	Provide envelope of sand and impermeable pit bottom
3.	≤2 m	>0.2 mm (coarse sand)	10 m	Provide envelope of sand and impermeable pit bottom
4.	≤2 m	<0.2 mm (fine sand, clay and silt)	10 m	None

ROY et al. 1984

If hydro-geological conditions are not known, **minimal distance of 30 m** from water sources should always be maintained! (TILLEY et al. 2008)

5. Operation and Maintenance (O&M)

Use

- Maintain correct squatting position so as excreta fall in the center of the trap opening
- Flushing and anal cleansing with 1.5 to 2 L, so that the excreta slide smoothly without sticking to the surface. (ROY et al. 1984)

Day-to-day maintenance

- Washing the latrine floor.
- Cleaning the squatting pan (brush with a long handle).

→ *Only little water should used for cleaning and washing to reduce pit filling.*

→ *Bath, kitchen or rain water should not be added in large volumes because this would cause overflow of the pit*

→ *Solid waste (kitchen waste, sweepings etc.) should not be added as this would cause clogging*

5. Operation and Maintenance (O&M)

Pit alternation

- Every two years (ROY et al. 1984, WHO 1992; TILLEY et al. 2008)
- The inspection chamber is opened and one of the pipes in the Y junction is stopped off ,while the other one is opened. A brick, stone, mound of clay or block of wood cam be used as stopper .
- The pit is re-sealed to prevent gases escaping to the atmosphere.
- About 15 cm of soil should be filled in the bottom of the first pit when before use. (ROY et al. 1984)
- After two years of rest, soil will be safe for handling, dry and without any foul smell. It can be dug out manually and used as soil amendment in kitchen gardens or field.
- In case of humid sludge, it can be spread out and dried under the sun
- The twin pits can be used indefinitely. (WHO 1992)

→ *Long-term support facilities to remind and assist the user in changing and emptying pits will greatly improve operational success*

6. Applicability

Where water for flushing and anal cleansing is available

In areas with soils of soil good absorptive capacity (alleviates, silt); Tightly packed or rocky soils (clay) are not appropriate. (ROY et al. 1984; TILLEY et al. 2008)

Low groundwater tables, low risk of flooding.

Depending on soil conditions, a certain minimum vertical distance from the bottom of the pit to the groundwater is required to prevent its pollution. (ROY et al. 1984; TILLEY et al. 2008)

If soil conditions are full-filled and water for flushing available, TPPFs can be constructed in both, rural and urban housings, but to many pits in dense housing areas will cause groundwater pollution and overflow as soil matrix may not can absorb all the water. (TILLEY et al. 2008)

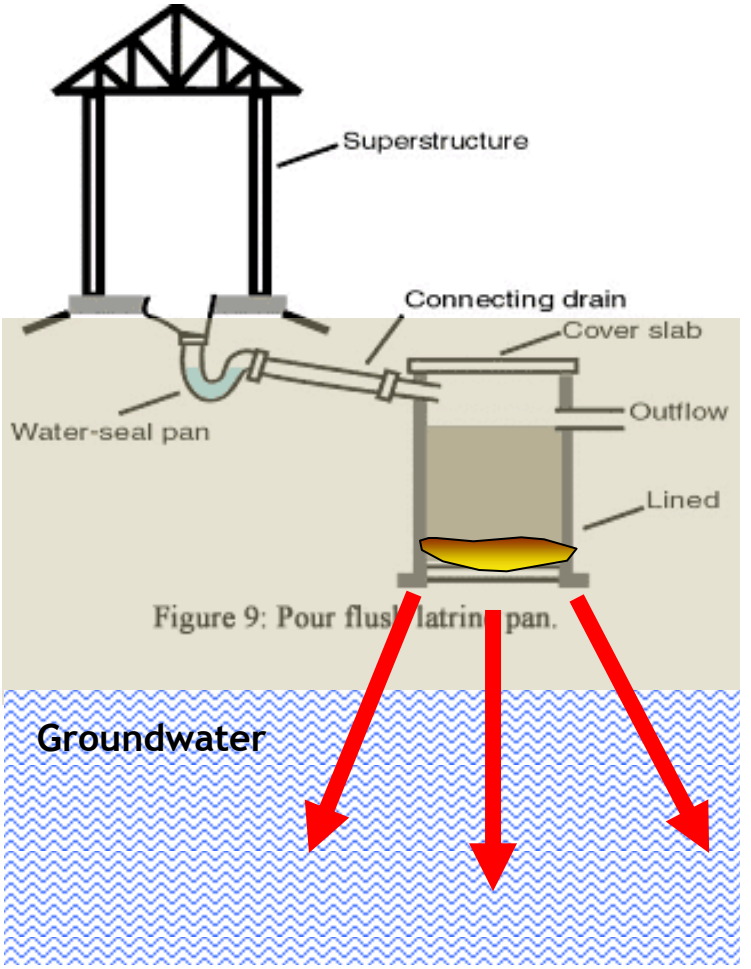


Figure 9: Pour flush latrine pan.

Adapted from L. DAGERSKOG, CREPA (2006) and http://www.unep.or.jp/letc/Publications/Freshwater/SB_summary/img/fig9 [Accessed: 01.06.2010]

7. Pros' and Cons'

Advantages:

- Improvement of simple pit latrines.
- Urine can be collected separately and reused as nitrogen-rich fertiliser.
- Maturated faeces can be used as soil amendment.
- High level of convenience (anal cleansing water can be poured into the toilet and odour and flies are prevented due to water seal).
- Can be built and repaired with locally available materials. (TILLEY et al. 2008)
- Excavation of maturated sludge (humus) is easier than faecal sludge. (TILLEY et al. 2008)
- No or low operating costs if self-emptied

Disadvantages:

- Relatively high investment costs (about 1.5 of a conventional pit latrine). (WSP 2004)
- Requires space and water for flushing.
- Not applicable in hard rock soil, high ground water levels or areas that are prone to flooding (groundwater pollution).
- Clogging of water seal happens often.
- Water-based technology, thus long retention times. (TILLEY et al. 2008)
- The degraded material is too solid to be removed with a vacuum truck. (TILLEY et al. 2008)
- Maturated sludge may need secondary treatment.

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