Sliding Dual-Pit Latrine Design

Introduction

The sustainability of any sanitation system depends on an effective faecal sludge management (FSM) process being in place. For many rural locations, or indeed anywhere where there is no sewerage system, FSM involves periodic emptying of storage or treatment receptacles in which faecal sludge builds up over time. If mechanized de-sludging equipment or services are not available, then manual emptying of septic tanks, pits or other receptacles presents a serious health hazard to those involved. Further, disposing of raw or untreated faecal sludge presents its own health and environmental issues, particularly if there are space constraints that restrict the ability to bury it—often the case in urban or peri-urban areas.

Twin-pit latrines present one option for addressing the issue of FSM in resource-constrained rural areas. Faecal sludge, if kept aerobic, will break down and become harmless to handle after around one to one and a half years[1]. If the volume of the pits is balanced with user numbers such that pits take more time than this to fill then when one pit is full, it can be closed and left for sufficient time for the faecal sludge to break down whilst the other is used. This concept is very commonly applied for pour-flush latrines, whereby water is used to transport faecal matter from the squat plate to one of two pits adjacent to the latrine (known as the twin-offset pit latrine).

In places where access to water is constrained, the concept becomes slightly more complex. Dry pit latrines (most commonly the ventilated improved pit latrine, or VIP) are very common in many rural areas, consisting of a squat or sit-plate set over a pit. When the pit fills up, the usual solution is to close the pit and dig a new one and move the latrine superstructure, but of course this requires skills and resources that many poor, rural people do not have, leading to the abandonment of the latrine altogether. For households, whilst still a sustainability problem in the long term, generally the time for the pit to fill is long—perhaps ten years or more.

In many locations, dry pit latrines are also the most viable technology for sanitation in institutions (schools and clinics) as well. Under these circumstances, where user numbers are much higher, sustainability is a greater issue as the pits can fill much more quickly. Compounding this is the need for sanitation infrastructure in institutions to be more robust than at the household level, making the option of simply abandoning a latrine and building anew, complex and expensive.

This technical note presents a possible solution for school latrines, based on existing technology and concepts, but with some new features. The twin pit, sliding toilet is still in its development phase, having been installed in only a few sites in PNG. The purpose of this technical note is to present the concept for broader review and critique.

[1] Naughton, C., Orner, K., Stenstrom, T. and Mihelcic, J.R. 2019. Composting and Dry Desiccating Toilets (Latrines). In: J.B. Rose and B. Jiménez-Cisneros, (eds) Global Water Pathogen Project. http://www.waterpathogens.org (J.R. Mihelcic and M.E. Verbyla) (eds) Part 4 Management Of Risk from Excreta and Wastewater) http://www.waterpathogens.org/book/composting-and-dry-desiccating-toilets Michigan State University, E. Lansing, MI, UNESCO. https://doi.org/10.14321/waterpathogens.57

Twin Pit VIP Latrines

Twin pit VIP latrines are described in the literature[2] and have been used in schools. However, there is a lack of detail in the formal or grey literature about practical experience with this technology, and in particular details of designs that have been used. Whilst the concept of the twin pit dry latrine is simple, there are just two practical ways of building them described:

- Building a superstructure that extends over both pits, with the full pit able to be closed by moving the seat or squat plate to the empty pit and sealing the hole above the full pit.
- Building a superstructure that is able to be moved from one pit to the other, and a system for closing the full pit.

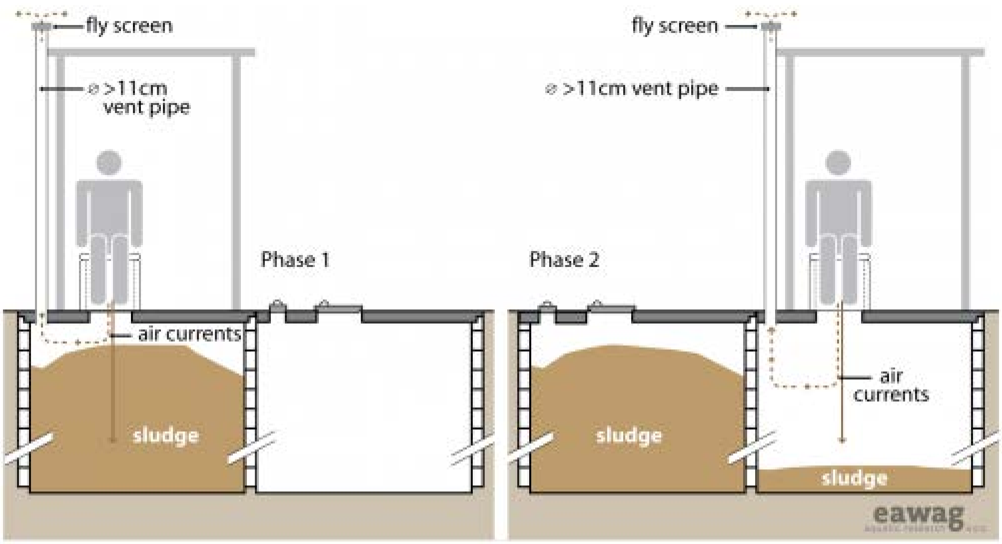

Figure 1 - Illustration of a twin pit latrine with a movable superstructure (from Tilley, et al)

Each of these has design and use considerations that need to be addressed for the system to function. A larger superstructure covering both pits means it can be much more substantial which is an advantage in an institution, but is more expensive and means that the process of emptying the pits must be done inside the toilet. Further, in general the hole in the slab created by the squat plate or seat is small, making manual removal of sludge difficult if mechanical de-sludging equipment is not available. It is possible to design this system such that the superstructure only covers a portion of the pit, with an access hole in the uncovered portion, but this requires a much larger pit to be constructed than is often feasible.

A movable superstructure means that the full pit is more accessible for manual emptying once the faecal sludge has broken down, and will generally be lighter and less permanent, and so cheaper. However, moving the superstructure generally involves either assembling enough strong bodies to physically lift it and move it, or dismantling it and re-building it over the second pit. Both of these

[2] http://www.akvopedia.org/wiki/Double_Ventilated_Improved_Pit

present challenges in an institutional setting where the skills required to re-position the superstructure may not be available, or afforded.

Case Study: Sliding Toilet Pilot, Central Province, PNG

In many parts of rural PNG, access to water is limited. In Central Province around the national capital Port Moresby, rainfall is very seasonal with a long, hot dry season, making rainfall harvesting impractical except as a back-up solution. Along the coast, where the terrain is often flat, gravity fed piped water supplies are not feasible due to the distance to suitable spring sources, and so groundwater is the only reliable fresh water option. Pumping water from wells or boreholes to a reticulated systems (eg an elevated tank) requires expensive equipment and an energy source (electricity, solar, fuel or human-power) which is often beyond the capability of a school or community to manage or maintain (let alone purchase). Water-flush toilets in these locations are simply not viable, leaving dry pit toilets as the best solution[3].

Under the Australian Government's Civil Society WASH Fund (2013-2017), WaterAid PNG sought to address the issue of poor sanitation in primary schools in Central Province. In many of these schools the sanitation facilities were in very poor condition, either unusable or very unsanitary, or did not exist at all. WaterAid funded the construction of new facilities that aimed to provide girls and boys with separate facilities at student to toilet ratios that aligned more or less with international standards[4]. The toilet design chosen met the criteria for improved sanitation, consisting of VIP latrines with concrete, washable, slabs, vent pipes and timber/corrugated iron superstructures—a design commonly used in PNG, and subsequently included in the PNG WASH in Schools Policy (Figure 2).

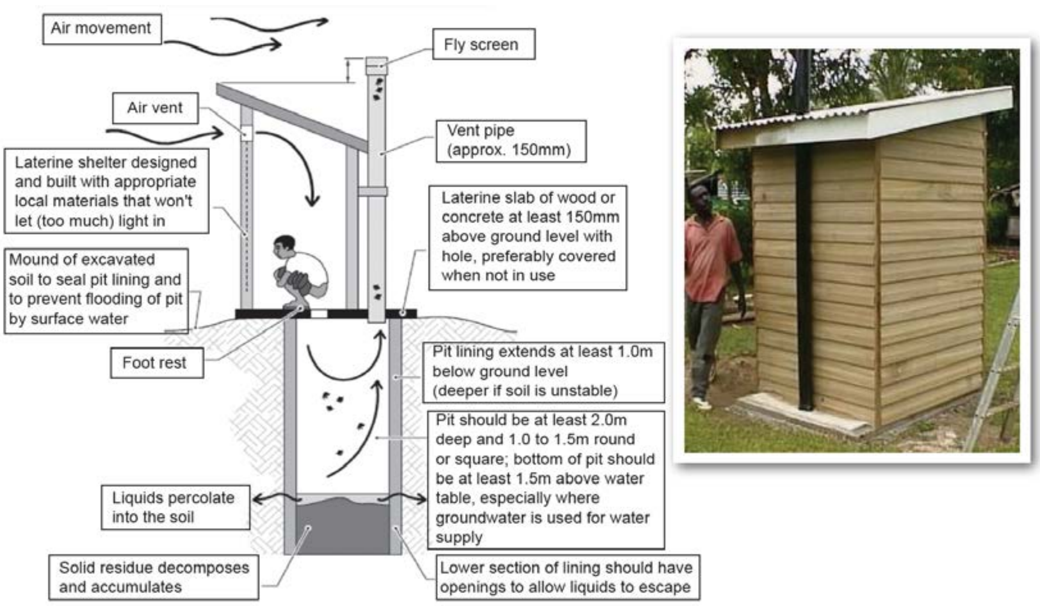

Figure 2 - Illustration of Typical VIP Latrine Design (Annex 9: PNG WinS Policy, 2018)

[3] Composting toilets are also technically feasible as a school sanitation option, but present a range of other obstacles to sustainability, not least being the capital cost. These are discussed elsewhere.
[4] The PNG WASH in Schools Policy, ratified in 2018, was not yet in place and so in the absence of national student to toilet ratios, the project drew on internationally accepted standards.

Some two years later, in 2017, a monitoring visit found that most of these toilets were full or nearly full, and students were either reluctant to use them or had abandoned them altogether and had reverted to OD or went home to defecate. The school managements were at a loss as to how to manage this situation and were waiting for the next round of external support to build new toilets. When pressed they said they had neither the skills nor resources to close the pits, dig new ones and relocate/rebuild the superstructures.

WaterAid secured additional funding to address this problem, but faced a dilemma: should they simply close and rebuild/relocate the existing toilets, or seek an alternative, more sustainable, solution? The former would just 'kick the can down the road', with the schools facing the same issue two to three years later, whilst an assessment of alternative technical options available in the local market proved the latter would be well beyond the available budget, and brought a host of other sustainability issues as well.

The solution was to modify the existing common VIP latrine design to incorporate a second pit, but address the complexity of having to dismantle and re-assemble the superstructure by designing it in such a way that it can slide backwards and forwards over the two pits (see **Figure 3**).

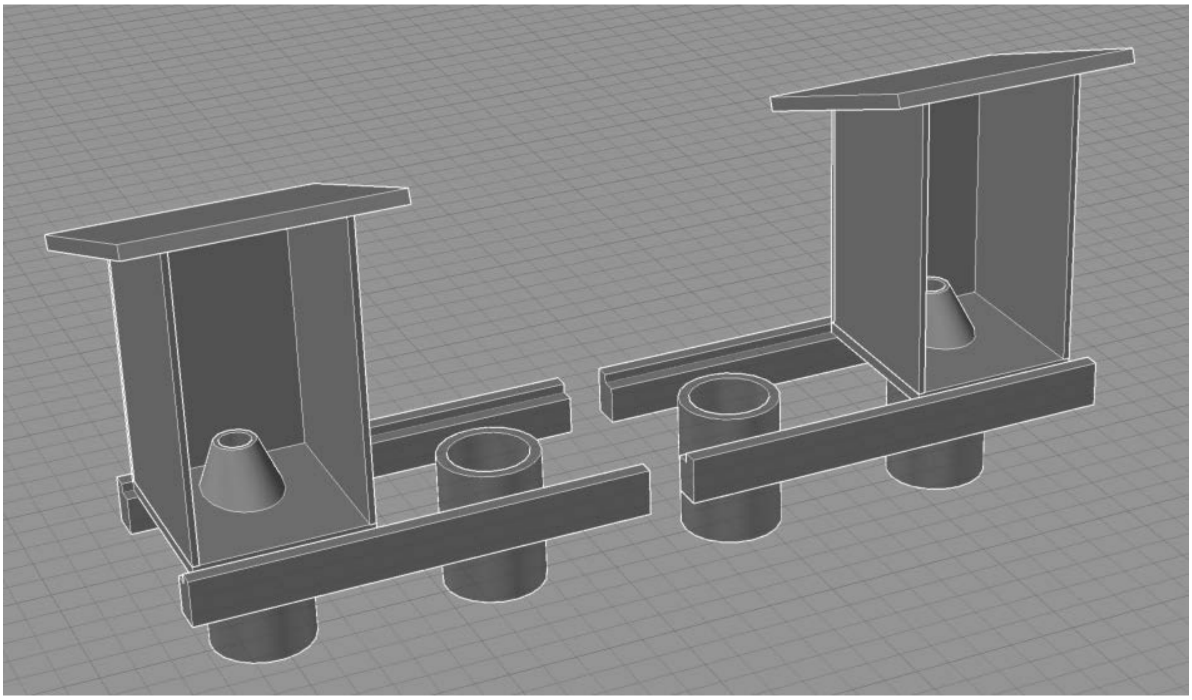

Figure 3 - Sliding, Dual-Pit Latrine, illustrating the two positions of the latrine slab and superstructure.

The unused pit is closed with a concrete cover until the used pit is full. At this point the concrete cover is removed and the superstructure slid over the empty pit. The full pit is then covered with a concrete lid after ash has been added, and left to compost whilst the second pit is used. The literature suggests that 1 – 1.5 years is needed for this material to break down to a state where it is safe to handle, and experience from the CSW latrines suggests that pits approximately 2m deep take 3 years to fill. On this basis by the time the second pit is full, the first pit will be safe to empty (and use/bury elsewhere), the latrine slid back over it and the cycle begins again.


Figure 4 - Sliding Latrine slab being cast

The suggested design utilised many of the same features as the ATLoo toilet, so is not a radical shift from existing VIP toilet designs. The slab is modified to incorporate a steel frame (see Figure 1) which forms the base that slides on a steel track embedded in two concrete beams cast in the ground. Hooks and chains attached to the slab allow the latrine to be moved using a crowbar/hook tool that does not require any skills to use. In this way schools themselves are able to easily manage the process without needing to hire any skilled labour.

Drawings have been produced for the key components of the sliding toilet, including the slab and sliding rails (attached). The design incorporates all the correct features of the VIP, including a straight vent pipe, and correct openings in the superstructure to encourage airflow. In October 2019, one sliding toilet was built and installed at Tubuserea Upper Primary School (a video of the installation is available here), and an initial assessment made several recommendations for slight modifications for subsequent planned installations at other sites. However, progress ceased in early 2020 due to the COVID-19 pandemic and no further monitoring has been possible. The staff working on this project have all left and so the current status of this initiative is not known.

It is recommended that an evaluation of the installation at Tubuserea is done to assess its status; the level of use, and whether it has gone through a cycle yet. Given the disruption to this pilot, it is recommended that it be re-started to allow the concept to be fully tested.

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