PAPER 11

FAECAL SLUDGE MANAGEMENT – WHAT DO YOU NEED TO KNOW?

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ABSTRACT

According to DWS data, in 2021 South Africa had 2.7 million VIP toilets and 498 000 septic tanks. A further 1.7 million households were served by substandard pit toilets, which should be upgraded to an acceptable form of improved sanitation as soon as possible. South Africa has a much lower percentage of its population using on-site sanitation than most other countries in Africa, but these numbers are still large and the chances of most of these toilets being connected to a sewer network within the foreseeable future are zero. Pits and septic tanks ultimately fill up, which means that from time to time they must be emptied, or the toilets must be abandoned and replaced. When pits and tanks are emptied, the result is faecal sludge (as opposed to wastewater treatment plant sludge) which requires handling, possibly transport, possibly treatment and either disposal or conversion into a product that has a beneficial use, such as compost. Whose responsibility is this, what are the pros and cons of the various options for getting the job done, and what should Water Services Authorities do to ensure that all sanitation in their jurisdictions is, in the words of the United Nation's Sustainable Development Goal 6.2, "Safely Managed"?

The Department of Water and Sanitation is currently finalising a national Faecal Sludge Management Strategy and when this has been adopted it will be mandatory for all Water Services Authorities in South Africa to develop a detailed understanding of their FSM obligations and to adopt policies, plans and budgets to meet those obligations.

1. INTRODUCTION

In historical terms, fully sewered sanitation is still a relatively recent phenomenon. The sewer systems of London and Paris were only constructed in the second half of the 19th century, less than 160 years ago. It is estimated that 60% of the world's population today still relies on some form of on-site sanitation, and for Africa, the continent with the world's highest population growth rate, only 8% have sewer connections (Unicef and WHO, 2020). For the most part, those without the benefit of sewers use septic tanks, leach-pits and pit latrines, all of which accumulate what is known as faecal sludge. Faecal sludge is simply the accumulation in the septic tanks and pits of human waste and anything else which is discarded in the toilet. It is not the same as fresh faecal waste in that it has gone through an anaerobic digestion process which typically reduces its volume by as much as 90% (Still and Foxon, vol 2. 2012). It is also different from the sludge produced by sewage treatment plants in that it is less uniform, is more hazardous and it contains a variable amount of non-organic waste (domestic solid waste and sand).

With the exponential growth of the world's population over the last hundred years and the rapid growth of towns and cities, many of which have very low sewerage cover, the need for the safe management of faecal sludge has emerged as an international priority. For example, two faecal sludge management conferences organised by South Africa's Water Research Commission and hosted in Durban in 2011 and 2012 led to the formation of the international Faecal Sludge Management Alliance (fsm-alliance.org) and the holding of biennial "FSM" conferences which have alternated between Africa and Asia since 2012. The World Health Organisation and Unicef's Joint Monitoring Project not only tracks countries' progress towards the United Nation's Sustainable Development Goal (SDG 6.2) of achieving improved sanitation for all, but they also track progress to achieving "safely managed sanitation". *Safely managed* means not only that wastewater is properly treated but also that faecal sludge is properly managed (WHO and Unicef, 2021). Faecal Sludge Management encompasses all stages of the service chain, starting with containment, then emptying, transport, treatment and re-use/disposal (Figure 1). At present South Africa does not have data on what percentage of our sanitation is safely managed. We only have data on the breakdown of the different types of sanitation.

2. THE STATUS OF SANITATION AND FAECAL SLUDGE MANAGEMENT IN SOUTH AFRICA

Table 1 shows sanitation data for South Africa drawn from Statistics SA's 2011 Census and its 2016 Community Survey, as well as from the Department of Water Affairs and Sanitation's Water Services Knowledge System (wsks). The latter is aligned with Statistics SA data but also draws data from the Water Services Development Plans submitted by Water Services Authorities (Behrmann, 2022).

According to the 2011 Census, 8.2 million households, 57% of the population in South Africa, were served with sewer connections at that time. A further 4.6% were served by chemical toilets or bucket toilets. The contents of chemical toilets and bucket toilets is discharged into sewage treatment plants, which means that the faecal waste of 61.6% of the

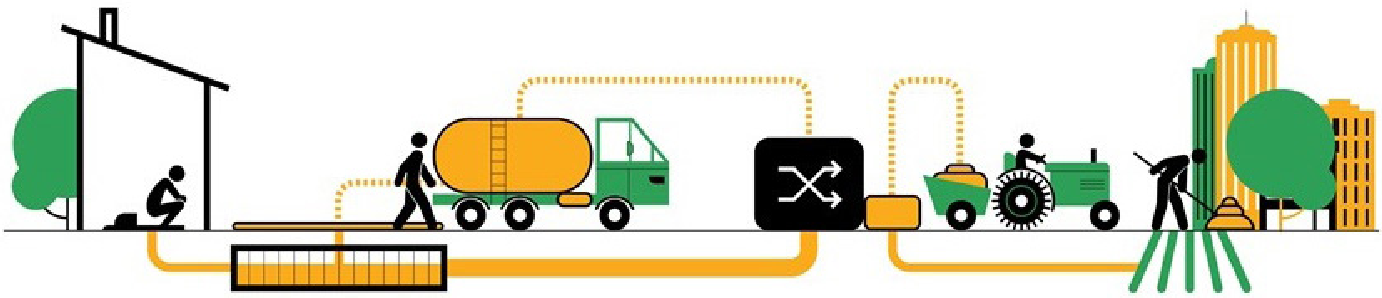

FIGURE 1: *The stages of the Faecal Sludge Service Chain (Containment, Emptying, Conveyance, Treatment and Disposal)*

TABLE 1: *Sanitation Statistics for South Africa*

	2011 Source: Census Stats SA		2016 Community Survey Stats SA		2021 Dept. Water and Sanitation wsks	
	households	%	households	%	households	%
Flush toilet connected to sewer	8 242 932	57.0%	10 236 960	60.5%	12 229 352	63.9%
Chemical toilet	360 634	2.5%	720 621	4.3%	1 246 254	6.5%
Bucket Toilet	297 791	2.1%	320 622	1.9%	207 877	1.1%
Subtotal	8 901 357	61.6%	11 278 203	66.6%	13 683 483	71.5%
Flush toilet connected to septic tank	442 454	3.1%	435 558	2.6%	498 667	2.6%
Pit Latrine, ventilated, improved	1 266 063	8.8%	2 206 500	13.0%	2 677 462	14.0%
Pit Latrine unimproved	2 786 011	19.3%	2 399 373	14.2%	1 684 353	8.8%
Subtotal	4 494 528	31.1%	5 041 431	29.8%	4 860 482	25.4%
Toilet - other	305 380	2.1%	257 624	1.5%		0.0%
No sanitation	748 556	5.2%	353 317	2.1%	600 914	3.1%
TOTAL	14 449 821	100%	16 930 575	100%	19 144 879	100%

population was at the time processed at sewage plants. The 2011 Census counted 4.5 million households using some form of on-site sanitation: 0.44 million with septic tanks; 1.3 million with ventilated, improved pit latrines; and 2.8 million with unimproved pit latrines. Thirty one percent of the population was using on-site sanitation in 2011. According to the Department of Water and Sanitation's estimates, by 2021 the number of households using some form of on-site sanitation had increased to 4.9 million, although by that time this constituted only 25.4% of the population. Between 2011 and 2021 the number of VIPs more than doubled, from 1.3 million to 2.7 million (Behrmann, 2022).

Broadly speaking, the places where on-site sanitation is used can be categorised as: unsewered urban areas, peri-urban areas and rural areas:

- While most parts of South Africa's towns and cities are served with sewers, there are notable exceptions. These include affluent suburbs on what were once the fringes of the cities, such as parts of Sandton in Johannesburg and the outer western suburbs of Durban, and the many informal settlements which are scattered throughout our cities and towns. In the affluent areas sewage is piped to septic tanks and conservancy tanks. Sanitation arrangements in the informal settlements vary from city to city and encompass the full range from chemical toilets or portable toilets, to pit latrines (formal and informal, shared and private) to sewered communal ablution blocks.
- Peri-urban areas are places in transition from rural to urban. They may be served with electricity and water, but the settlements are not formally laid out, the roads are typically not surfaced and there are no sewers. Unlike informal settlements within the towns, peri-urban settlements tend to be more spread out. People use pit latrines or septic tanks according to what they can afford. In many of these areas government has provided VIP toilets to most homes, or in Durban's case, double-vault urine diversion toilets.
- South Africa's rural areas are a mix of farmland, dispersed settlements and small towns. The more affluent generally use septic tanks and the less affluent generally use pit latrines. Parts of some of the small towns are served with waterborne sanitation. Owner built pit toilets tend to be of a poor standard (unsanitary and unsafe) and are broken down and moved when they have become too full to use. Over the last 20 years approximately 3 million homes have been provided with VIP toilets, mainly in rural areas, as part of the South African government's drive to provide universal access to decent sanitation.

The current construction cost of a VIP toilet is approximately R15 000. The value of the 3 million VIP toilets that have been built in the last 20 years is therefore in the order of R45 billion. However, most pits are designed with capacity for 8 to 12 years use (Still and Foxon, Vol 2. 2012), which means many of those 3 million VIPs are now full or close to full, and once they are full they are no longer usable.

3. DEPARTMENT OF WATER AND SANITATION NATIONAL FAECAL SLUDGE MANAGEMENT STRATEGY

As far as sanitation is concerned, the focus for the last 20 years has been on the eradication of sanitation backlogs, by which is meant the number of households who do not have at least a VIP level of sanitation. Little to no attention has been given to the question: what happens when the pits are full? Ten years ago, it was hard to find a municipality which had a policy, plan or budget for FSM management (Still and Foxon, 2012, vol 1), and there are no indications that this has changed since then. However, the Bill of Rights in the South African Constitution includes the provision that "Everyone has the right … to an environment that is not harmful to their health or wellbeing" (Clause 24 (a)). Furthermore, in 2001 the South African government introduced the policy of Free Basic Services for the indigent. The implications of Free Basic Sanitation were touched on by the Department of Water Affairs and Sanitation (and its predecessors) in the *White Paper on Basic Household Sanitation* in 2001, expanded on in the *Strategic Framework for Water Services* in 2003 and developed further in the *National Sanitation Policy* in 2016. The 2016 policy states that:

- Free Basic Sanitation refers to the cost associated with the ongoing operation and maintenance of any type of sanitation system as well as the ongoing Hygiene Education. Free Basic Sanitation will be targeted to indigent households.
- Free Basic Sanitation provides support of water for flushing of waterborne systems and for ongoing operation and maintenance of on-site systems.
- Free Basic Sanitation should be provided as part of the basket of social services available to support and assist indigent households.

The implication of Clause 24 (a) in the Bill of Rights and the Free Basic Sanitation policy is that all Water Services Authorities must make provision for Faecal Sludge Management. For this reason the Department of Water and Sanitation has developed a National Faecal Sludge Management Strategy. The Strategy identifies short (1-3 year), medium (4 to 7 year) and long term (8 to 10 year) priorities for the development of functional faecal sludge management systems in South Africa.

4. WATER SERVICE AUTHORITY RESPONSIBILITIES

Among the primary stakeholders identified in the National Faecal Sludge Management Strategy are Water Services Authorities (WSAs). It is the responsibility of WSAs to know the basic details of all on-site sanitation facilities in their areas. They should know where they are located, what their operational requirements are and how those requirements are met. They should have a policy for providing services to indigent families and must budget accordingly. WSAs in South Africa, particularly those that serve our more rural areas where most of the VIPs are located, are typically very stretched financially, and may balk at this responsibility. The National Treasury will however point out that these WSAs receive grant funding every year which includes significant funding for sanitation provision to the poor.

A useful planning tool which the Strategy recommends is used by all WSAs is the Shit Flow Diagam (SFD). The SFD is a schematic representation of the way that all faecal waste is managed within a given jurisdiction, and combines data for all forms of sanitation, from open defecation (i.e. no sanitation) to full waterborne sanitation. The output of a SFD is the percentage of faecal waste in the area which is safely managed (green) and the percentage which is not safely managed (red). Figure 2 shows an example of an SFD for a city which combines both waterborne sanitation and on-site sanitation, where 25% of the waste is considered to be safely managed. The SFD can be carried out at different levels ranging from a high-level desk top assessment where lots of assumptions are made, all the way to a comprehensive assessment. A comprehensive assessment requires a great deal of field work and ground level verification, but is a very useful management tool once it is compiled (see https://sfd.susana.org/ and https://www.fsmtoolbox.com/ for more information).

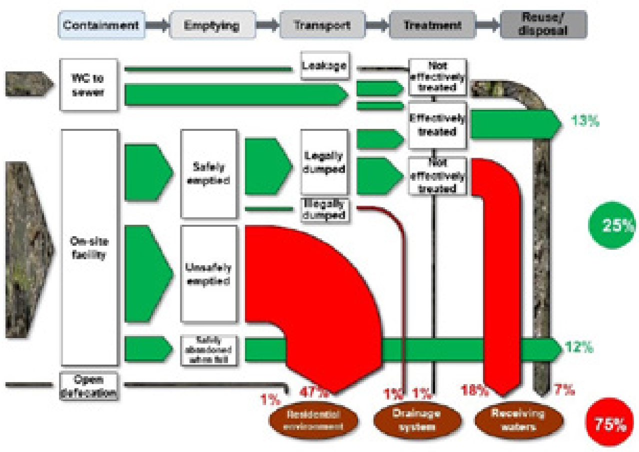

FIGURE 2: *Illustration of the Shit Flow Diagram (SFD) concept from https://health.bmz.de/stories/uncomfortable-truths-how-shit-flow-diagrams-expose-the-gaps-in-urban-sanitation-systems-and-help-to-close-them/*

Another critical task for Water Services Authorities is to plan, construct and operate Faecal Sludge Treatment Plants. South Africa has 850 publicly owned Wastewater Treatment Plants (Green Drop Report, 2022), but we have no dedicated Faecal Sludge Treatment Plants. Such facilities will be required in the future.

5. CONTAINMENT OPTIONS

As shown in Table 1, in 2021 DWS estimated that in South Africa there were 4.9 million households using on-site sanitation: 0.5 million with septic tanks; 2.7 million with ventilated, improved pit latrines; and 1.7 million with unimproved pit latrines.

On sites where there is no sewer connection and where a functional seepage bed or pit can be maintained, septic tanks are a standard sanitation solution. Most septic tanks belong to relatively affluent families who have the means to maintain them. However, septic tanks are used in some low-income housing projects in South Africa and in these cases the local authority may need to make provision for their emptying and maintenance.

The overwhelming majority of on-site sanitation in South Africa (4.4 million households) comprises some type of pit latrine. Pit latrines are classified either as unimproved or improved. Unimproved pit toilets have typically been built with cheap or freely available materials (Figure 3). They are temporary structures which are broken down and moved when the pits are too full to use. While unimproved pit toilets are often unpleasant and may even be unsafe to use, they do not pose a faecal sludge management problem. After the structure is moved the pits are covered over and the faecal sludge is left in place.

FIGURE 3: *Typical unimproved pit latrines, built from cheap or freely available materials. While these toilets are generally unpleasant and sometimes unsafe to use, they do not present a faecal sludge management challenge. When the pits are full the structures are moved and the pits are covered.*

FIGURE 4: *Ventilated Improved Pit Latrines (VIPs) in South Africa are typically of masonry or precast concrete construction. In the last 10 years the latter type has become standard, due to their speed and ease of construction. To ensure stability the underlying pits must be partially or preferably fully lined. The pits should not, however, be sealed, as that will turn the pits into conservancy tanks which require much more frequent emptying.*

The standard term for an improved pit latrine is a VIP, which stands for Ventilated Improved Pit latrine. The term originated from work done at the Blair Research Institute in Zimbabwe in the early 1980s and was adopted worldwide (Unicef, 1983). There are many variations in VIPs and one can argue the pros and cons of different aspects of design, but the essential characteristics of a VIP is that it is well-designed, well-built and well-maintained, resulting in a structure that is safe to use, easy to keep clean and relatively fly and odour free. It is a simple, robust form of sanitation which has no moving parts and requires no water to operate. Figure 4 shows two types of VIP: a concrete block structure over a concrete block lined pit; and a precast concrete structure over a concrete block lined pit. Over the last 20 years most local authorities in South Africa have adopted some form of precast structure for their VIP building programmes. The factors that have influenced that decision are threefold. Firstly precast structures are cheaper than masonry structures; secondly they are quicker to build; and thirdly they can, in theory, be dismantled, moved and re-erected when the toilet pits are full. No municipalities have to date engaged in large scale pit relocation programmes, as the cost of relocating a precast toilet is likely to be significant, particularly when one remembers that it requires a new pit of exactly the right dimensions to be dug and lined before the structure can be re-erected.

Pit latrines have become controversial in South Africa in recent years, most notably due to a number of well publicised tragic incidents where small children have drowned in pit latrines at schools. These incidents have resulted in political pledges to "eradicate pit latrines" at schools, and possibly everywhere else, and there is widespread interest in alternate forms of sanitation which offer a higher level of service. It should be noted, however, that most of the pit latrines which have been "eradicated" from schools have been replaced with blocks of VIP toilets, admittedly designed and built to a high standard, but pit latrines all the same (National Education Infrastructure Management System, 2021). A key design consideration is the choice of pedestal. It must be easy to clean and it must be designed in such a way that it is impossible for a small child to fall through the pedestal. Pedestals that meet those requirements have been available on the market for more than 20 years and they simply need to be specified. The reason that VIP toilets are still being built at schools is the poor reliability of water supplies in many rural areas. A flush toilet with no water, particularly in a public toilet setting, quickly becomes completely unusable and a serious health hazard. However, with improvements in water supply reliability, the provision of sufficient back-up water storage, improvements in the maintenance of school toilets and the use of low-flush toilets, it is possible to upgrade to flush toilets without condemning children to dysfunctional sanitation.

Worldwide there has been much interest in developing alternate forms of sanitation which do not involve either pits or sewers. Perhaps the best known of these is the Bill and Melinda Gates Foundation's *Reinvent the Toilet Challenge*, which commenced in 2011. In South Africa research, testing and development of "next-generation" sanitation technologies is championed and supported by the Water Research Commission's South African Sanitation Technology Enterprise Progamme (SASTEP). More information on those technologies can be found on the SASTEP and Gates Foundation websites. The main obstacles to the adoption of innovative sanitation technologies is cost and complexity, and these must be overcome in any large scale programmes where the ultimate responsibility for maintenance lies with municipalities which are stretched both financially and in terms of human resources.

The simplest form of upgrade to the VIP is a low-flush toilet with an offset leach pit, or a set of two leach pits which can be alternated. With offset pits the waste is much easier to access for emptying. With a water seal the toilet is more pleasant to use and it can be installed in the house if so desired. Another advantage of the water seal is that, unlike the case with pit latrines, users limit the amount of solid waste which they dispose of in the toilet. If alternating pits are used then the waste can be allowed to dry and decompose into an inoffensive compost like material before emptying is needed. In the last ten years a large number of these low-flush toilets have been built in South Africa and the acceptance of this technology is good in areas where people are accustomed to using pit latrines or VIPs and have no expectations of being served with full waterborne sanitation (Neethling & Still, 2018). The Ethekwini Metropolitan Municipality is currently considering switching to this type of toilet as their basic level of sanitation (Neethling et al, 2023).

A very common concern with pit latrines and the soakpits which serve septic tanks is that they contaminate the groundwater. A review of research into this topic, however, shows that such concerns are, in general, based on misperceptions. While pathogens and contaminants such as nitrates do move limited distances through soil and can move larger distances under specific conditions such as gravelly soil, fractured rock fissures and shallow soil on sloping rock, these conditions are more the exception than the rule. For example, van Ryneveld et al in a study of the movement of contaminants in the unsaturated zone of the subsurface from a low flush on-site sanitation system in Ivory Park, Johannesburg observed that within 3m, levels of contaminants (chemical and bacterial) were the same as background levels (van Ryneveld et al, 2016). Graham and Polizzotto reviewed 11 studies of migration of pathogens and nitrates from pit latrines and found that in most cases the impact was not observed further than 15m (Graham and Polizzotto, 2013). One case included in their review concluded that there was evidence of viruses travelling 50m from pit latrines, but a review of that paper shows that the conclusion was based on the testing of unprotected community wells, so the researchers were actually not testing the groundwater but rather water which had been exposed to the buckets used by villagers collecting water (Verheyen et al 2009). Flawed logic like this sustains a level of concern regarding the contamination of groundwater by on-site sanitation which is not sustained by the facts.

The possibility of groundwater contamination from pit latrines and septic tanks should not be ignored, but neither should it be overstated. Sensible precautions should be taken, such as siting boreholes and wells used for potable water supply upslope, preferably at least 30m from pits and testing and disinfecting water used for potable supplies.

6. EMPTYING OPTIONS

A septic tank has three distinct layers: sludge which settles at the bottom of the tank, a liquid layer above the sludge and a floating layer of scum above the liquid. Ideally the tank should be emptied when the sludge occupies more than a third of the tank. If the tank is allowed to fill up completely with sludge it will malfunction and moreover the sludge may ultimately become too dense to be emptied using a vacuum tanker. Most septic tank owners do not check the depth of sludge in their tanks, and therefore it is good practice to empty the tank every three to four years as part of routine maintenance. It is becoming increasingly common for cities elsewhere in the world to mandate scheduled emptying of septic tanks (Blackett and Hawkins, 2017) and the DWS Faecal Sludge Management Strategy recommends that Water Services Authorities in South Africa follow that example.

The contents of pit latrines differs from the contents of septic tanks in that it is denser, has a lower moisture content and a higher solid waste content. It can be emptied by a vacuum tanker, but generally not before most of the larger trash items have been removed and before the sludge has been mixed, usually with some water added, to allow the sludge to flow. Suction pumping is not possible if the sludge cannot flow. Depending on the sludge characteristics it is often more practical to empty the pit manually using long handled tools (Figure 5). A common problem is access to the pit. If the pit design does not include a removable slab, then the only access may be through the pedestal opening, which limits the emptying options to suction pumping unless a hole is broken into the side of the pit lining to give the emptiers access.

FIGURE 5: *Often the only practical way to empty pit latrines is manually. The use of suitable personal protective equipment and long handled tools makes the job less unpleasant and less hazardous.*

FIGURE 6: *A portable vacuum pumping machine such as the Pitvaq is useful for suction pumping in places where vacuum tankers are either not available, or unable to access the site.*

Emptying pit toilets is an unpleasant and hazardous occupation. However, with the right tools, training and the right personal protective equipment the risk is significantly reduced (Louton et al 2018). In some cities, such as Kigali in Rwanda, a large number of pit latrines are unreachable by vacuum tankers (Rutayisire, 2022) and portable vacuum pumping machines such as the Pitvaq have proved useful for pit emptying (Figure 6).

7. TRANSPORT OPTIONS

Faecal sludge contains pathogens and therefore falls under the classification of hazardous waste. The sludge must therefore be transported either in a vacuum tanker, or it must be transported in closed drums (Figure 7). Vacuum tanker hoses must be wiped clean and capped before they are transported otherwise they may spill sludge. Where drums are used for the transporting of sludge they should be supplied with covers that screw or clamp in place, to prevent the spillage of sludge while in transit. In the event that sludge is spilled on the outside of the drum it should be wiped clean with a disinfectant soaked rag before being loaded onto the truck.

A major consideration with transport is obviously distance. Ideally vehicles should not have to make round trips of more than 50km to and from sludge treatment sites, otherwise the costs of Faecal Sludge Management become exorbitant. For this reason, simple technologies for faecal sludge treatment and disposal such as Deep Row Entrenchment should be considered where there are no other convenient options (see Section 9).

FIGURE 7: *Pit emptying contractors in Lusaka, Zambia, use a combination of manual/mechanically assisted emptying and vacuum tankers. When they empty pits manually they use drums which are sealed and transported by truck.*

8. TREATMENT OPTIONS

Compared with other developing countries a relatively high percentage of South Africa's population (71%) is served by a sewer network, directly or indirectly (see Table 1). This means there is a significant existing capacity for wastewater treatment in South Africa, probably in the order of 7 000ML/d. Only 3% of South Africa's population use septic tanks, and whereas an average household will produce 700ℓ of wastewater per day, the same household using a septic tank will produce only 2 000ℓ of septage every 4 years. One would therefore expect that there is plenty of capacity within the country's wastewater treatment plants to treat the septage produced by those with septic tanks, and in very general terms, that is true. However, the concentrations of nutrients (nitrogen and phosphorus) and solids in septage is typically anywhere from 10 to 100 times higher than it is in sewage, and most of the COD in septage cannot be reduced in a wastewater treatment plant, which means that in reality the mixing of septage and sewage needs to be done with some understanding (US EPA, 1984). A small wastewater treatment plant in a rural town which receives a significant amount of septage (say 1% or 2% of the plant's hydraulic capacity) may find that it is overloaded and unable to meet the DWS effluent standards.

There are a few basic measures that reduce the impact of septage on treatment plants. The most essential measure is that the septage should be discharged not directly into the head of works, but into a septage holding or equalisation tank. The outflow from the holding tank can be set to a more or less steady rate so that the works is not impacted by large nutrient load spikes when septage is discharged from tankers. Apart from the use of a septage equalisation tank, treatment plants which are equipped with primary clarifiers, or which use pond systems, are much more able to process septage than facilities that do not incorporate these features.

What of the sludge accumulating in VIPs which serve 14% of the population? The least cost, most sensible thing to do with pit sludge is to bury it on site, if there is enough space. From an environmental impact perspective burial of the sludge on site does not change the status quo, as the sludge was already in a pit on the site before the emptying. Once buried the sludge dries out and decomposes into soil like material within a few years (Neethling and Still, 2022). However, on-site burial is not always possible or acceptable, in which case the sludge must be taken off site and treated. While septage is typically 10 to 100 times more concentrated than sewage, pit sludge is typically 10 times more concentrated than septage. The implication is that the contents of a single pit toilet can be the equivalent of more than 500kL of regular sewage in terms of nutrient and solids load, and yet much of the COD in the sludge is not biologically degradable so an activated sludge treatment plant will not be of much use in treating it. It therefore does not make sense to discharge such concentrated waste into the headworks of a standard wastewater treatment plant, even though that might be the most convenient thing to do.

Dedicated faecal sludge treatment plants (FSTPs) are being built in increasing numbers in other parts of the world, especially South Asia, where a high percentage of the population uses on-site sanitation. On a per capita served basis, they are much less expensive to build and operate than sewage treatment plants. Standard features at most FSTPs are:

- An intake screen where solid waste (trash) is screened out as faecal sludge, particularly that derived from pit latrines, tends to have a high trash content. The trash has to be disposed of at a landfill site.
- A balancing and settling tank.
- Sludge drying beds, which may or may not be planted with vegetation. Plants absorb some of the nutrients in the sludge and help with the process of converting it to a compost like material.

Some FSTPs use ponds, which are simple and robust treatment systems, but require enough space and cannot be too close to residential areas. Constructed wetlands are also used for improving the quality of the effluent.

FIGURE 8: *Faecal sludge drying beds at a Faecal Sludge Treatment Plant in Shinyanga, Tanzania*

There are a number of innovative ideas for faecal sludge treatment. Some of these have been shown to be technically feasible, but the business case is somewhere between unproven and definitely non-feasible. If any innovative sludge processing technology is to be adopted, then the benefit/cost ratio must be greater than the benefit/cost ratio for the established options described above, and it must also not be too technically complex. Ethekwini has experimented with Black Soldier Fly treatment as well as the Latrine Dehydration and Pasteurization (LaDePa) system. In East London a test facility for conversion of sludge to biochar has also been tested. None of these systems have gone past the pilot testing phase. Sanergy, however, has constructed a Black Soldier Fly plant in Kenya which is designed to process 200 tons of sludge per day.

9. DISPOSAL/REUSE OPTIONS

The outputs from wastewater treatment works as well as FSTPs are effluent (water) and dried sludge. In the case of sewage works which are working well the effluent can be discharged into the nearest watercourse. In the case of FSTPs, while the effluent may be free of pathogens it will usually have a nutrient content higher than that which can be legally discharged into a watercourse. The volume of effluent is however typically orders of magnitude less than the effluent for a sewage plant serving a similar number of people. This effluent can be used for irrigation of non-food crops, or subjected to further treatment, or simply discharged into a soakpit or seepage bed.

Sludge derived from an FSTP contains small but still useful amounts of nutrients such as nitrogen, phosphorus and potassium, as well as a certain amount of carbon. There are various options for deriving benefit from the resource value contained in the sludge:

- Co-composting with supplementary organic waste. The most straightforward method for producing compost is windrowing (turning). Windrowing requires either machinery or a large amount of labour. Unless the heaps are properly turned the compost will not be pathogen free. Also unless other organic waste such as garden waste, animal manure or wood chips is added to the sludge the compost produced will be of a low quality.
- Deep-row entrenchment. Sludge which still contains pathogens can be safely disposed of by burying it beneath the soil surface. Evidence indicates that this practice makes a long-term improvement to soil fertility, and sludge disposal does not have to be limited to the agronomic rate. (Neethling and Still, 2022)
- Use of dried sludge for fuel. Dried sludge, ground into a powder and mixed with sawdust or charcoal dust, can be made into fuel briquettes of quality comparable to or better than briquettes made from charcoal only. The process is fairly labour and capital intensive but can be financially feasible if it is done at scale.

10. CONCLUSION

According to Department of Water and Sanitation estimates, approximately 4.9 million families in South Africa are served by some form of on-site sanitation. Of particular concern are the 3 million families with Ventilated Improved Pit Toilets (VIPs), most of which have been constructed over the last 15 years and many of which are full or nearly full. When a pit is full it must be emptied, otherwise it becomes unusable. Municipalities have been focused on sanitation backlog eradication and have not given priority to the ongoing management of sanitation. The Free Basic Sanitation Policy, which was adopted in 2001 and has been further developed since, requires all Water Services Authorities to provide for the ongoing operation of sanitation facilities for the indigent, and part of the funds disbursed to Water Services Authorities as part of the Equitable Share is intended to provide for the cost of that work.

While there is interest in alternate forms of sanitation, it is likely that pit latrines, or at least Ventilated Improved Pit Latrines, will be around for some time to come. If they are well-designed, well-built and well-maintained they do provide decent basic sanitation, and unlike most other forms of sanitation they are robust and inexpensive to build and maintain. There is a widespread belief that septic tanks and pit latrines contaminate the groundwater, but research that has been done into the effect of pit latrines and septic tanks on groundwater shows that the impact is much more limited than is generally thought. This does not mean, however, that sensible precautions should not be taken, such as not siting wells less than 30m from pits and testing and disinfecting any groundwater which is used for a potable water supply.

Emptying of pits can be made less unpleasant and less hazardous if pit emptiers are properly equipped and trained. Where space permits on-site burial of pit contents is the least cost, most sensible disposal option, and it has no greater environmental impact than the status quo (i.e. on-site sanitation). Where on site disposal is not possible or not acceptable, the sludge must be transported off site to a treatment plant. While sewage treatment plants can take small amounts of septage, it is counter-productive to discharge the contents of pit latrines into sewage plants. Dedicated Faecal Sludge Treatment Plants (FSTPs) are needed. Fortunately the technology for treating faecal sludge is very simple, comprising mainly screens, settling tanks, drying beds and wetlands or ponds, and is much less expensive than sewage treatment. The end-products of faecal sludge treatment, apart from a relatively small volume of water, is dried sludge which is suitable for making compost or fuel briquettes. Other types of faecal sludge treatment have been tested, but none have yet been found to be economically viable.

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