

PAPER 3

WHY FLUSH YOUR TOILET WITH 9L OF WATER WHEN YOU CAN FLUSH WITH 2L : THE NEW NORMAL

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1. ABSTRACT

When properly designed, built, and maintained, the VIP (Ventilated Improved Pit Latrine) provides a decent basic level of sanitation, however most people prefer a higher level of sanitation, with full flush toilets being the most desired and accepted. The drawback however with conventional full flush toilets is that they require a large amount of water, which is not always available (Recent local example Cape Town Day Zero). VIP toilets, whilst, not requiring water to operate, have several inherent problems as they do not have a water seal, can smell extremely bad, attract flies and are perceived by users to be undignified. In a VIP scenario the pit/chamber is directly below the top structure resulting in communities often using the pit as a solid waste disposal site and consequently the pits fill up much faster. By having the pit/chamber directly below there is also always the increased risk that children may fall in and when the pits are full, emptying is a messy, unpleasant, and expensive operation with many municipalities now reporting a “reverse backlog”.

The complex nature of sanitation in South Africa means there is no “one size fits all” solution. Each area whether an informal settlement or rural school has its own unique set of challenges, and it was essential to develop a new sanitation solution which could provide a hygienic, safe and most of all dignified solution for all users. The necessity for a suitable solution that could help address the various sanitation challenges led to the development of a Low Flush system that could flush with as little as 2L of water (Potable and Non-Potable water).

The system can bridge the gap between a VIP and full flush toilet essentially providing users with the benefits of a flush toilet in areas with limited infrastructure and water. The versatility of the system ensures that it can be adapted to different conditions and on-site requirements. The Low Flush system has been tried, tested, and approved by various government departments and independent organisations such as the Department of



FIGURE 1: Current Sanitation in South Africa

Science and Technology, and the Water Research Commission (WRC), the system is Agrément certified ensuring it complies with all regulatory requirements. It has proved to be a game changer in the sanitation space and its ability to provide a safe, sustainable, and dignified alternative solution has been seen in the 100000+ units successfully rolled out across South Africa.

2. INTRODUCTION

A new, more suitable, and cost-effective system had to be developed:

Envirosan Sanitation Solutions have designed, developed, and tested the Eaziflush™ low/pour flush sanitation solution over five years of extensive research, with both the Water Research Commission in Pretoria and Partners in Development in KZN, both of which have independently tested and rolled out the system in various projects throughout South Africa.

Every household, no matter whether in the outlying rural or peri-urban areas (where potable water is not always made available to the individual household,) still has access to enough water (either being collected from streams/ rivers, and/or rainwater harvesting and/or communal taps), which they rely on for washing, bathing, cleaning, and cooking. The Low/Pour Flush Sanitation System can be easily adapted for use in all areas, ranging from rural to urban, including areas with limited or restricted water supply.

As a pour flush option, the sanitation solution is entirely off-grid and requires no water connection from the main feed, as it flushes manually, with as little as two litres of grey water, thus placing absolutely no strain on the rural households' limited access to potable water supply, whilst simultaneously providing a safe and hygienic method for the disposal of the households' grey water.

As a low flush (i.e. conventional flush with an internal



FIGURE 2(A) AND 2(B): Typical layout designs
Free Standing and/or Schools / community blocks with either internal leak free with wash basin cistern or externally mounted demand flush system with rainwater harvesting

cistern or externally mounted flush on demand tank), the sanitation solution flushes with as little as two litres of water, as opposed to the conventional nine litres usually required, translating to a significant benefit to not only the end user, but also the municipality and water services authorities. The Low/Pour Flush has been designed to be compatible with a conventional sewer system, and places far less strain on the sewage treatment plants, because of the great reduction in the volume of water required for flushing.

The Pour / Low Flush sanitation system has been designed to be compatible with a range of rural "back end" solutions, including a leach pit, septic tank, conservancy tank, biodigester, solids-free sewer system or similar onsite/off-grid treatment facilities, without any adverse effects on the surrounding soil conditions.

3. EAZIFLUSH™ LOW/POUR FLUSH SANITATION SOLUTION

3.1. Bridging The Gap in Sanitation

The design incorporates a water seal within the outlet (P-trap) of the pedestal, which prevents any odours from the chamber entering the toilet bowl. The "P-trap" holds less than 1L of water within the water seal and only requires between one and two litres of water to flush.



FIGURE 3: Patented P-Trap water seal – designed for low water volume flushing

3.1.1. Eaziflush™ Low/Pour Flush compared to conventional full flush toilet facilities

3.1.1.1. Direct Cost saving because of less water being used:

The National Standard bases a typical household to flush 20 times per day. If we base this on a standard 9L flushing cistern, it calculates to 5474L of water per month (30.41 days per month).

3.1.1.2. To compare this to the Eaziflush™ model where you only use 2L per flush, 1 216L of water per month will be used to flush the toilet (an average household water saving of 4258L per month)

3.1.1.3. The saving to the Municipality on water losses is even more important: Considering a 4 258L water saving per month per household (5474L – 1216L) or 51 000L of water saved per household per annum!

3.1.1.4. The toilet facility can be flushed by pouring greywater as a flushing medium instead of using potable water – taking the system completely off grid and saving more than 30% of the total household water usage

Water saving resulting from low flush toilets are crucial, especially for a water scarce Country like South Africa, Figure 4 depicts on-going water related issues.

FIGURE 4: The Theewaterskloof Dam, a key source of water supply to Cape Town. Image, Halden Krog, AP. (courtesy: IOL, by Corrie Kruger)



Water crisis-Day Zero: First it was Cape Town, now it is Nelson Mandela Bay, which Metro is next?

3.1.2. Eaziflush™ Low/Pour Flush compared to dry sanitation (VIP/UDDT)

There is little doubt that the Low/Pour Flush Sanitation System represents a major upgrade from both the VIP and Urine-Diverting Dry Toilets (UDDT) systems, which currently are the standard for basic sanitation in South Africa. The Low/Pour Flush System can replace the VIP/UDDT system in its entirety, since the entire system costs approximately the same as said systems, with the following significant advantages:

3.1.2.1. There is absolutely no smell or access for flies! This is due to the effectiveness of the water seal within the P-trap, which holds less than 1L water, compared to the standard 2L of water contained in a conventional toilet's P-trap. In a dense urban/peri-urban/rural context, the Low Flush/Pour Flush System can either be installed closer to (or even inside) the homestead. since the water seal prevents any unpleasant odours from being released.

3.1.2.2. The Low/Pour Flush system provides a higher standard of basic sanitation, with increased dignity to the end user. Users do not see the contents of the pit due to the P-Trap and water and therefore cannot use the toilet for solid waste disposal, effectively lengthening the lifespan of the pit and minimising emptying costs.

3.1.2.3. Community members commonly refer to the system as the 'safe toilet', as there is no open pit below the toilet, thus negating the horrific incidents where children have tragically fallen into VIP pits in the past.

3.1.2.4. The system is extremely robust and easy to operate, with minimum maintenance requirements and limited risk involved.

3.1.2.5. If the initial project allows for a Pour Flush application it can be upgraded from pour flush to low flush with the addition of a cistern or external flush tank, once sewage and water connections are available, it can be connected at a minimal cost! Retrofitting is a simple process!

3.1.2.6. All Low/Pour Flush pedestals are precision injection moulded from SABS approved virgin raw material, thus resulting in an extremely high quality and hygienic finish to the products. The products used for the piloting, testing as well as project roll out carry Agreement Certification and are fully endorsed by the National Home Builders Regulation Council and Department of Human Settlements.

Ultimately, the Low/Pour Flush Sanitation System can be used to not only eliminate existing sanitation backlogs, but also eradicate reverse sanitation backlogs. They are cheaper to empty/treat due to no solid waste / trash in the leach pits and they provide users with a dignified sanitation solution which they are content to use and so rightly deserve, without placing any strain on our already scarce water supply and at no additional operational cost to municipalities!

All this whilst simultaneously establishing a new and improved benchmark of Safe, Dignified and Sustainable Sanitation throughout the Country.

3.2. Replacement For Dry and Full Flush Toilets

To understand what makes the Low/Pour Flush Sanitation System innovative, you must investigate the challenges the solution was designed to overcome. Municipal engineers and planners in South Africa are engaged in the delivery of improved sanitation to the 11% of South African households without sanitation services. An additional 26% of households have sanitation services that do not meet national standards for dignified sanitation (Report on status of sanitation services in South Africa - https://www.gov.za/sites/default/files/gcis_document/201409/sanitation-reporta.pdf)

In addressing these issues, many engineers were stuck in a binary way of thinking, which is why a paradigm shift was needed. Towns and cities were generally characterised by flush toilets and piped infrastructure, while people living in townships usually use pit toilets of one type or another.

Full flush is extremely expensive, not only in terms of actual water consumption but also in terms of infrastructure maintenance. VIP toilets are more robust and require less maintenance but have also been known to exhibit several issues when it comes to unpleasant odours and child safety. Additionally, VIPs and UDDTs tend to fill up quickly and can be difficult to clean.

The Eaziflush™ Low/Pour Flush Sanitation System combines the advantages of both dry and flushing systems without any of their disadvantages.

3.3. Flush Efficiency and Water Saving

Various flow and flush tests have been conducted, both for pour flush as well as for low flush options fitted with an internally mounted low volume cistern. The below figures indicate the volume of water used to flush away the different wiping media.

Based on the work completed for Overstrand Municipality in Hermanus and Gansbaai, the following water savings was achieved:

TABLE 1: Household water savings for Overstrand Municipality

Overstrand Municipality (Mandela Square (83), Beverly Hills (100), Transit Camp(136), Zwelihle (125) and Masakhane (387) (831 households in total)				
Toilet Facility	Number of households	Water Saving per household	Water Saving on current households per month	Water Saving on current households per year
Flush Toilet Connected to Sewerage	831	4 258 L / Month	3,538,398 L / month	42,460,776 L / year



FIGURE 6: Overstrand Reference Letter

3.4. Development Testing



FIGURE 7: Piloting and Testing by the Department of Science and Technology



FIGURES 8(A) AND 8(B): SANS, Edict of Government and typical Agrément Certification

has been rolled out to test the efficiency of the available Agrément Approved Low Flush Sanitation Systems.

3.6.1. Typical School Sanitation:

More than 200 privately and publicly funded school sanitation projects have been completed, varying from very rural schools with limited water sources to more peri-urban schools where more formal water supply was available.

The variance of School selection was to test how efficient the Low/Pour flush units will perform, even in areas where limited water sources were available including the durability and functionality testing between Junior and Senior Schools.



FIGURES 9(A) AND 9(B): Failed Structures with no Certification in Eastern Cape

Each School was individually visited with a full investigation report to ensure that the Low Flush Sanitation System to be installed and tested allowed for the minimum norms and standards as set by the Department of Education. Refer to figure 10 and 11 below.

Schools with no access to water received new boreholes which in turn filled raised water tanks installed close to the School Ablution block and allowed to feed a low-pressure cistern.

Schools with limited/interrupted water source was fitted with a raised water tank/s which was periodically filled by the existing water source. Depending on the existing water source, the water tanks was sized to suite and to allow for flushing of the toilets for 1-2 weeks before re-filling was required. This system catered for interrupted water supply allowing full time operation as would be the case with other waterborne sanitation options.

3.5. Large Scale Roll Out - Requirements

Before any large-scale roll outs can be considered, it is essential for any and all Low/Pour Flush Sanitation Systems and associated products to be tested, piloted and approved for use both structurally as well as system appropriateness. This as per the requirements of the South African National Standards which require at least Agrément South Africa Certification as a minimum requirement, and which are legally required.

Figures 8a) and 8b) stipulates the minimum certifications required as per the South African National Standards, SANS 10400-Q (2011)

Figures 9a) and b) depict potential risks by using structures that aren't certified as per the South African National Standards.

The South African National Standards make specific reference to the requirements of Agrément certifications for non-standardised systems and products such as is the case with precast concrete toilet facilities and all other related Alternative Building Technologies (ABT's)

Agrément South Africa was established to facilitate the introduction, application and utilisation of satisfactory innovation and technology development in the construction industry. This is an edict of Government and a lawful requirement as set by the Republic of South Africa. In terms of the South African National Standards (SANS) all products must have a certificate that confirms fitness-for-purpose on a non-standardised product, material or component or the acceptability of the related non-standardised design and the conditions pertaining thereto (or both) issued by the Board of Agrément South Africa.

The only way to prohibit future fatal failures of this nature is to demand a quality product that has been tested and approved for use by qualified body such as Agrément South Africa or SABS.

3.6. Low/Pour Flush Sanitation Projects

Several projects, both at School level as well as individual household level



FIGURE 10: Low Flush Toilet Facilities installed in Schools in Eastern Cape



FIGURE 11: Eastern Cape Low Flush Toilet Facilities at Schools



FIGURE 12(A) AND 12(B): Individual Household Units installed in the Eastern Cape with rear mounted Demand Flush Tank and leach pit directly below



FIGURE 13(A), 13(B), 13(C), 13(D) AND 13(E): Sanitation units with off-set dual leach pits with rain water harvesting and externally mounted demand flush tank



FIGURE 14: The EaziSwitch connection between dual leach pit applications



FIGURE 15: Communal Sanitation Facilities: Mosselbay with 5 users to 1 facility

3.6.2. Typical Household Sanitation

Different models of the Low/Pour Flush sanitation systems have been installed in provinces across South Africa. The options included Agrément Approved Precast Concrete Structures that can sit directly on top of the leach pit, single off-set leach pit or dual off-set leach pit with swivel drainpipe connection.

All these designs are compact, can be used in any area where VIP toilets are approved for use and once any of the leach pits are full, can easily be emptied by vacuum tanker.

Difference in design of leach pits depends on the frequency of emptying, municipal preference, and type of soil conditions.

“The VIP and pour-flush sludge have similar chemical characteristics; however, the pour-flush sludge has a **slower filling rate** as a result of less non-faecal material present in the leach pit and the ability of the liquid component to seep into the surrounding soil, taking with it soluble material, reducing the mass of solids in the pit” (WRC Project 2137: Deliverable 10)

3.7. Eye On The Future

Overview: Eazisplit
The EnviroSan Eazisplit is a hybrid low flush urine diversion sanitation technology based upon the E005 design and the Bill & Melinda Gates Foundation (BMGF) “Reinvent the Toilet” initiative.

As a pour flush, the Eazisplit solution is entirely off-grid and requires no mains water connection, as it flushes manually, with as little as 2L of grey or potable water, whilst maintaining a 70-80% urine split.

The Eazisplit system can be upgraded to work with an internal or external cistern (still flushing with as little as 2L of water) and can be connected to a formal water supply / sewerage system if such ever becomes available. The urine can be separately collected and treated for further use as a fertilizer.

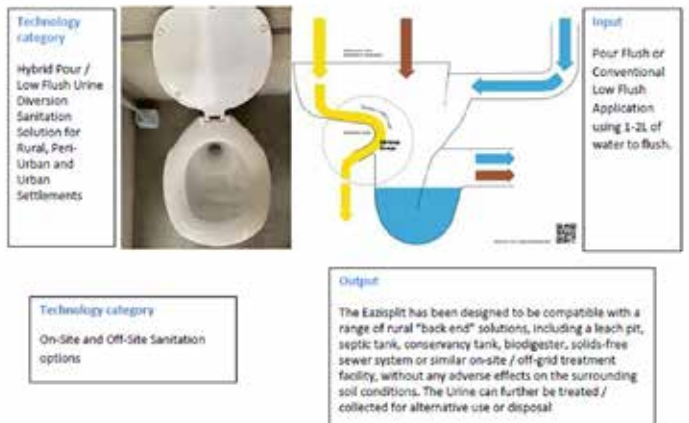


FIGURE 16: EaziSplit upgrade to close the sanitation loop

4. CONCLUSION

The Low and Pour Flush Sanitation Solutions have clearly demonstrated that a low flush system can perform well where either toilet paper or newspaper is used for anal cleansing,

Low flush technology has proven successful to provide significant savings of water over standard toilets which typically require 6 to 9L to flush. It provides a sanitation model in which scarce water resources are used responsibly and sustainably, pointing a way forward not only for those who find dry sanitation unacceptable but also for standard sanitation design which in its current form is unsustainable as it relies on freely available water.

This technology provides a viable option to municipalities under pressure to provide waterborne sanitation where laying sewers is not feasible or affordable. In addition, it could provide an option for householders desiring a flush toilet to upgrade their VIP systems to a low flush toilet.

The low flush system can be installed indoors or outdoors using the same VIP structures with the addition of a lech pit. As many households in South Africa are unable to afford toilet paper, the ability of the low flush system to accommodate newspaper makes this a technology which municipalities could specify even for poor communities.

Low flush technology shows the potential for overcoming one of the thorniest problems facing municipalities: the difficulty of removing sludge from pits. While VIP sludge is often too dry and contains too much rubbish to be removed with a vacuum tanker, the low flush system is far more conducive to vacuum removal because sludge contains less rubbish and has a higher moisture content.

5. RECOMMENDATION

With diarrhoeal diseases still a leading cause of death among young children and vulnerable people (WHO, 2013), and helminthic infections affecting as many as 80-90% of children in some South African studies (Appleton, Maurihungirire and Gouws, 1999; Appleton et al., 2008), it is imperative that an aggressive health and hygiene education programme be included in any sanitation intervention aimed at changing high risk behaviour.

This is much easier achievable with a supporting sanitation system. The Low/Pour Flush Sanitation systems provide a much safer, more dignified, and healthier system compared to the dry sanitation options. Dry sanitation options in general have direct access to the pit content, which in turn attracts flies, generate odour and in turn these aspects have a direct effect on the health and hygiene of the users.

As most South African people aspire to have flushing toilet facilities and previously could not be afforded such due to un-availability of water and the lack of sewer networks, it is now more than ever possible to supply these Low and/or Pour Flush Sanitation Systems as a replacement system to the currently implemented "dry" sanitation options.

We recommend the Low/Pour flush sanitation options over any dry sanitation system. The Low/Pour Flush systems have been tested over most parts of the Country and with different structures, back-end solutions, and design options, proofing a higher level of acceptability and more successful compared to the dry sanitation alternatives.

6. REFERENCES

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