SNV

Estimating Safely Managed Sanitation in Bhutan

June 2018

The Sustainable Development Goal (SDG) 6.2 for sanitation targets universal access to a safely managed sanitation and hygiene service. This introduction of a "safely managed" category seeks to ensure that the faecal waste from improved latrines is safely emptied, transported, treated, disposed of and/or reused.

The challenge for practitioners and decision makers alike is in establishing how much of the current sanitation and hygiene services are safely managed in their contexts.

This learning brief shares the experiences of a process facilitated by IRC and SNV in May 2018 to use available knowledge and data to estimate the levels of access to safely managed sanitation, assuming current practices in pit construction and handling of faecal waste during emptying, transport and disposal within various contexts in Bhutan. The shit flow diagram (SFD) methodology was applied, using a combination of information from:

- indicators when faecal waste is NOT safe to handle;
- data from SNV's end-line survey in 2018; and
- field experience of SNV's SSH4A team and national stakeholders.

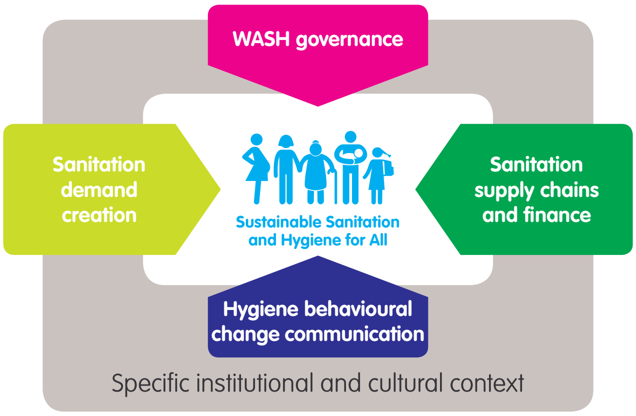
The results illustrate the likelihood of existing systems being safely managed if current practices in faecal waste management continue, and thereby enable decision-makers to identify major risk areas and develop interventions to improve the probability of safely managed sanitation systems. Safe reuse of faecal waste is not within the scope of this paper.

Background

In Bhutan, SNV works as a capacity development and knowledge-sharing organisation at national, district and sub-district levels. Since 2008, SNV has worked to support the Public Health Engineering Division (PHED) of the Ministry of Health (MoH) in the development of a national Rural Sanitation and Hygiene Programme (RSAHP) based on SNV's Sustainable Sanitation and Hygiene for All (SSH4A) approach. With support from the Australian Government's Department of Foreign Affairs and Trade, the programme technically supported PHED in scaling in six districts (Mongar, Samdrupjongkhar,

Inside Sustainable Sanitation and Hygiene for All (SSH4A)

SNV's Sustainable Sanitation and Hygiene for All Programme (SSH4A) supports local government to lead and accelerate progress towards district-wide sanitation and hygiene services with a focus on institutional sustainability and learning.
The SSH4A approach has four integrated components supported by performance monitoring and learning. Developed since 2008, SSH4A is implemented as part of government-led rural sanitation programmes across 19 countries in Africa and Asia.



Wangdue, Trongsa, Trashiyangtse and Tsirang), provided ongoing support to two districts (Lhuentse, Pemagtshel) and expanded further to the country's two largest districts (Samtse and Trashigang). As of 2018, RSAHP has been scaled-up to 10 districts, reaching half of the country.

While Bhutan has historically low levels of open defecation, access to basic toilets was often unhygienic. Much of the programme's emphasis has been on universal access to and use of improved sanitation, environmental safety of sanitation facilities in relation to groundwater contamination and improving hygiene behaviours. Since 2010, this has resulted in a rapid uptake in the use of pour flush toilets. Whilst there has been increasing focus on the safe management of faecal waste disposal, the introduction of a uniform five-year benchmark for emptying was found too frequent for most rural contexts. At the commencement of the SDGs in 2015, 63% of the population had access to improved sanitation, but like many countries in the region, there was insufficient data for the Joint Monitoring Programme (JMP) to estimate the access to safely managed sanitation services. As a result, policy makers in Bhutan have struggled to set evidence-based national targets as part of the country's upcoming Five-Year Plan and deeper understanding of pit management is needed in rural contexts.

When is faecal waste NOT safe to handle?

While it is difficult to determine when faecal waste is safe to be exposed, to handle or to reuse, some simple indicators can help practitioners to ascertain when faecal waste is NOT safe to handle. Faecal waste is most efficiently digested by aerobic (with air) + anaerobic (no air) processes:

- Aerobic digestion: more efficient in reducing pathogens (i.e. faecal bacteria, parasites and viruses) → **Public Health.**
- Anaerobic digestion: more efficient in reducing solids (including biological oxygen demand (BoD), nitrogen and phosphorous) → **Environmental Health.**

Faecal waste is comprised of sludge (solids) and effluent (liquids). The dangers posed by faecal waste to public health are reduced or eliminated by the effectiveness of aerobic processes in neutralising pathogens. The efficiency of aerobic processes is, however, often determined by the effectiveness of anaerobic processes in removing solids from liquids and liquids from solids. That is, the aerobic bacteria cannot neutralise the pathogens in faecal waste unless the effluent is clear and the sludge is dry.

Faecal Waste CANNOT be safe if:

- the faecal sludge is NOT dry, or
- the faecal effluent is NOT clear.

This does not imply that dry sludge and clear effluent are safe to handle.

Estimating access to safely managed sanitation

Management of faecal waste is extremely complex and often poorly understood. The SFD[1] is a tool designed to understand and communicate how safely excreta is managed from defecation through to disposal within cities and towns (https://sfd.susana.org/). These estimates were developed by applying the above indicators for when faecal waste is unsafe, projecting the data from the currently known management practices of sanitation systems from the SSH4A end-line survey and making

SDG definitions

Open defecation
Disposal of human faeces in fields, forest, bushes, open bodies of water, beaches or other open spaces or with solid waste

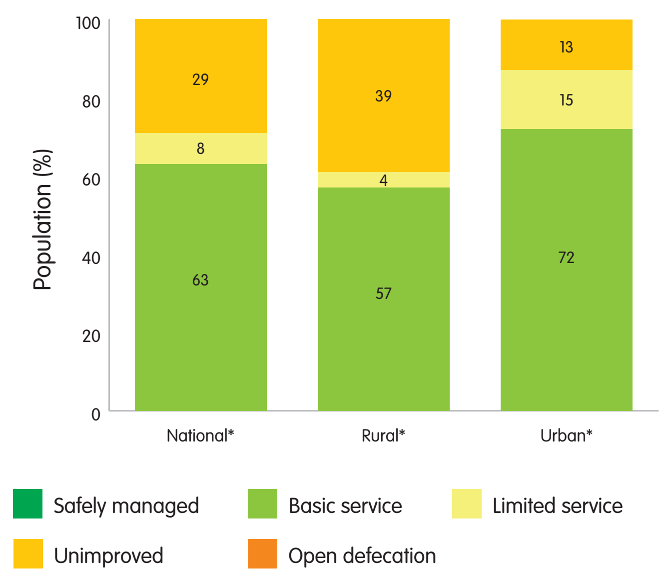
Unimproved
Use of pit latrines without a slab or platform, hanging latrines and bucket latrines

Limited
Use of improved facilities shared between two or more households

Basic
Use of improved facilities which are not shared with other households

Safely managed
Use of improved facilities which are not shared with other households and where excreta are safely disposed in situ or transported and treated off-site

Figure 1: Bhutan sanitation status



Source: WHO/UNICEF, 2017. *No safely managed estimate available assumptions based on stakeholder engagement. Given that only a small percentage of pits have filled or been emptied thus far, the SFD should be considered as a dynamic tool and the projections of safely managed sanitation systems should be regularly updated as more pits start filling up and more data on actual faecal waste management practices becomes available.

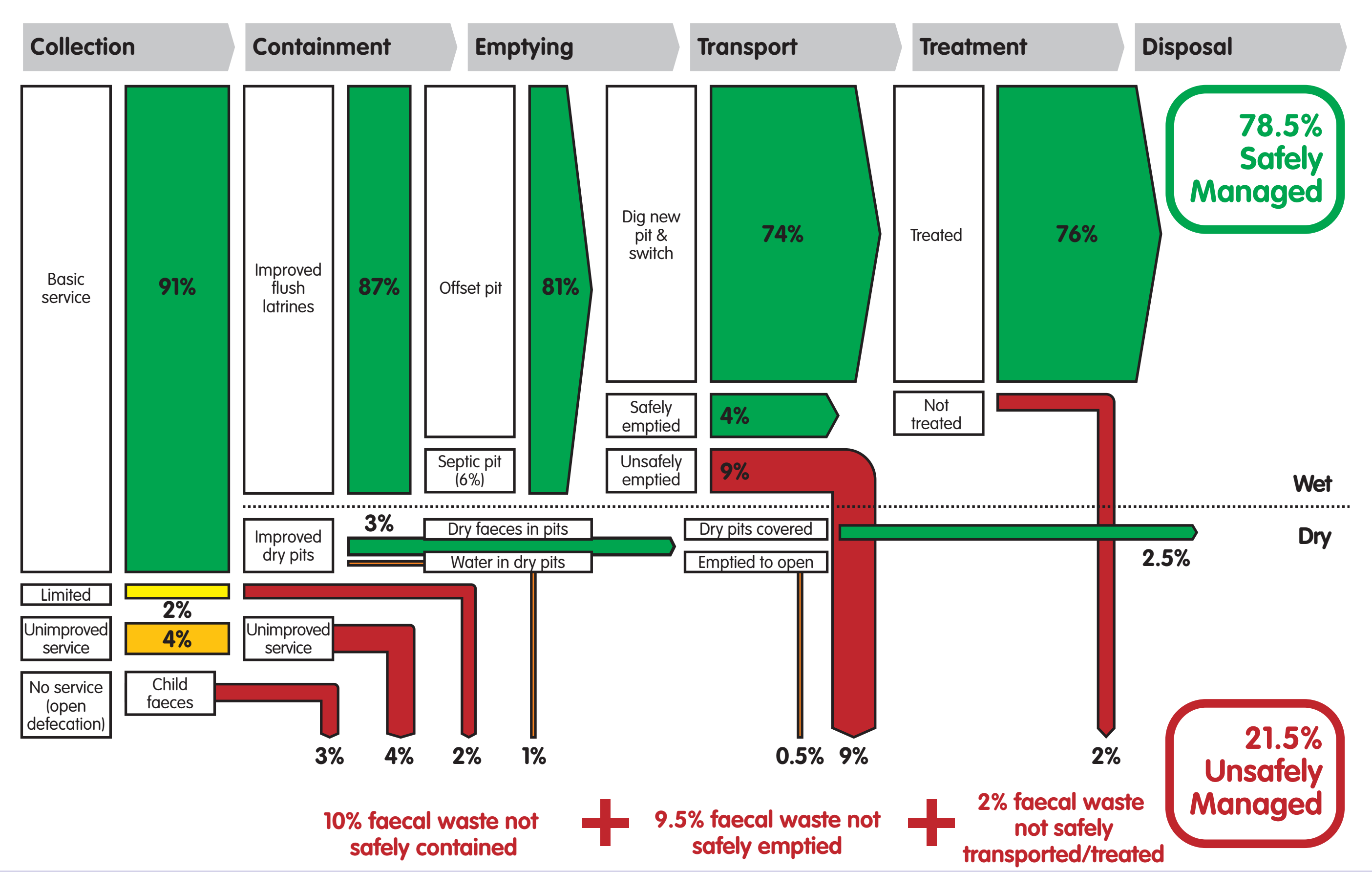
SSH4A programme districts (2018)

Results of the SSH4A endline household survey conducted in 2018[2] in four districts found that the percentage of households (3.9 persons) with no service was 3%, with an unimproved service was 4% and with a limited service was 2%. Access to a basic service increased to 91% (of which 4% were using dry pits and 87% were using pour-flush latrines) from a baseline of 53% *(figure 2)*.

- Of the households with dry pit toilets, a quarter pour water into the pit or use water for anal cleansing. When pits fill up, 85% of these households cover their pits and dig new ones.
- Of the households with pour flush latrines, almost all reported that they were connected to septic tanks, but these were in fact single offset pits.
- Although 40% of latrines were more than five years old, only 1.6% of pits had filled. Of the pits that had filled, 82% of these households had dug a second pit and switched, with only 18% having been emptied. Of the 0.3% of pits emptied, 75% were emptied safely by service providers, of which 50% were safely treated (i.e. buried and covered).
- Four percent of households reported a family member that could not use their toilet, with young children and the elderly accounting for 75%. In general, while children under three years of age are unable to use a toilet, only 13% of all households safely disposed of their children's faeces in the toilet.

Through a workshop process, practitioners and government agencies applied the SSH4A endline survey data to create a SFD for the SSH4A programme districts. The outcome of this learning process found that 78.5% of faecal waste in the programme districts was being safely managed. Major faecal exposure risks identified occurred due to unsafe emptying or disposal of wet sludge from septic tanks and soak pits and the use of unimproved sanitation services (primarily dry pit latrines). The failure to safely contain children's faeces is a major public health risk due to the high pathogen levels contained in faeces, and children's proximate exposure to these risks.

Figure 2: Safely managed sanitation estimates - SSH4A programme districts



Rural Bhutan (2015)

According to the JMP 2017, the percentage of households in 2015 with no service was 0%, with an unimproved service was 39%, with a limited service was 4% and with a basic service was 57% (of which 1% were connected to sewers, 33% to septic tanks and 23% to other alternatives). In the absence of nationally-representative data on safe emptying, transport and treatment of faecal waste and given the uniform approach of the RSAHP, data from SSH4A programme areas were used to estimate the percentage of safely managed sanitation.

Applying pit emptying, transport and treatment data from SSH4A programme areas suggests that an estimated 39% of faecal waste in rural Bhutan was safely managed in 2015 *(figure 3)*. This was significantly higher than earlier safely managed estimates calculated with the JMP data, without the benefits of local knowledge and the SSH4A data. The major faecal exposure risk was due to the use of unimproved toilets, while the use of water in dry pit toilets and unsafe emptying or disposal of wet faecal sludge from septic tanks and soak pits constituted a minor faecal exposure risk.

How often do pits need to be emptied?

The time for pits to fill *(figure 4)* depends on the following:

1. Number of toilet users and their diet.
2. Size of the pit.
3. Accumulated content in the pit:
   - Dry faecal sludge and urine (including the moisture evaporation rate).
   - Wet faecal sludge and effluent (including the moisture absorption rate).
   - Other (i.e. anal cleansing materials, fats and detergents, compost).
4. Digestion efficiency (i.e. aerobic or anaerobic processes at temperature and humidity).

In dry pit latrines, the dry sludge accumulation rates conservatively range from 25-40 litres per capita (lpc) per year depending on the addition of compost or anal cleansing materials. In pour flush latrines, the wet sludge accumulation rates range from 25-40 lpc/year depending on the addition of grey water. Though faecal sludge loading rates appear to be similar at 25-40 lpc/year, the efficiency of anaerobic processes in reducing solids is superior to that of aerobic processes as the wet faecal sludge generated in anaerobic pits will further reduce in volume when dry.

Figure 3: Safely managed sanitation estimates - Rural Bhutan

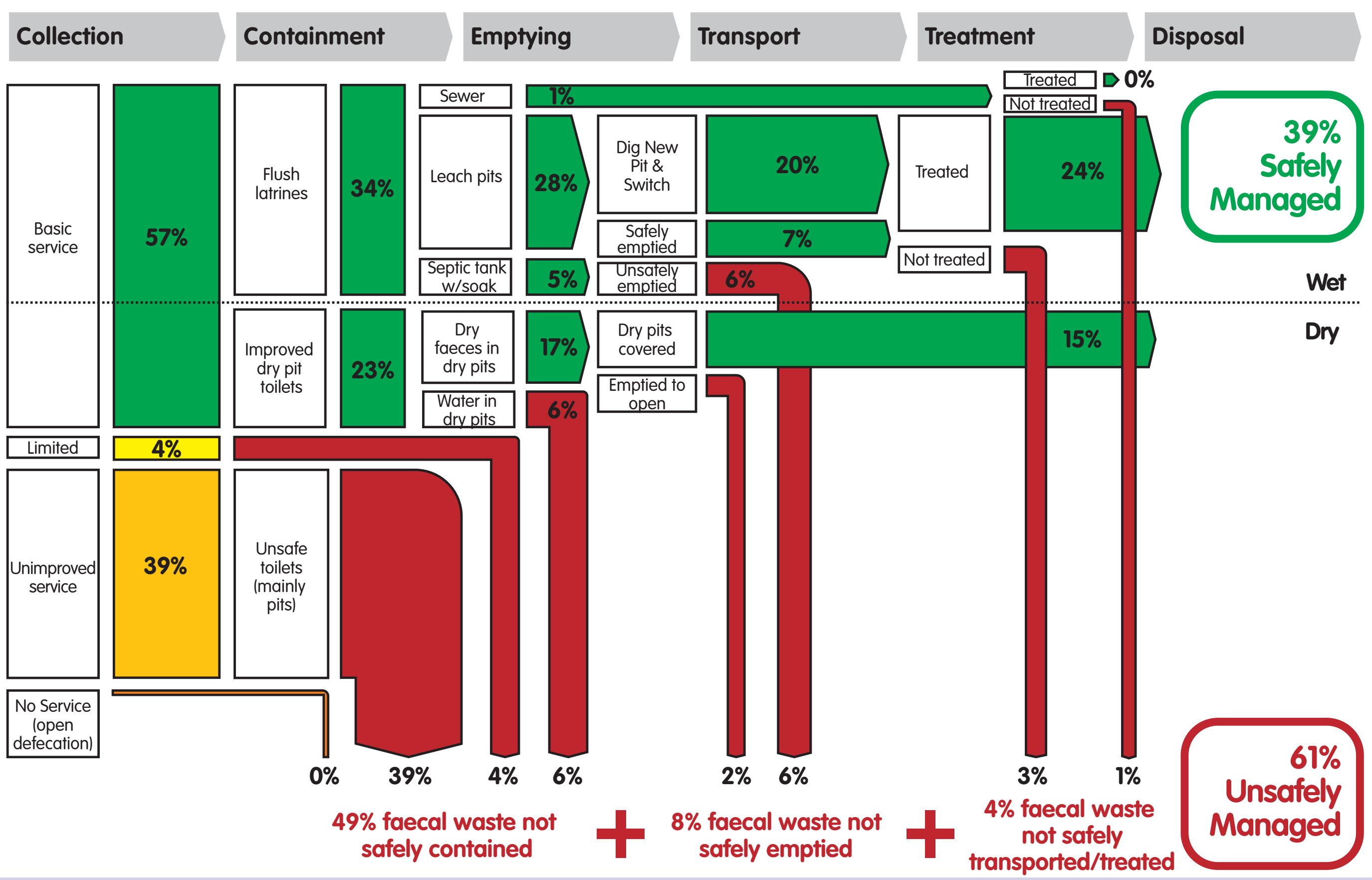
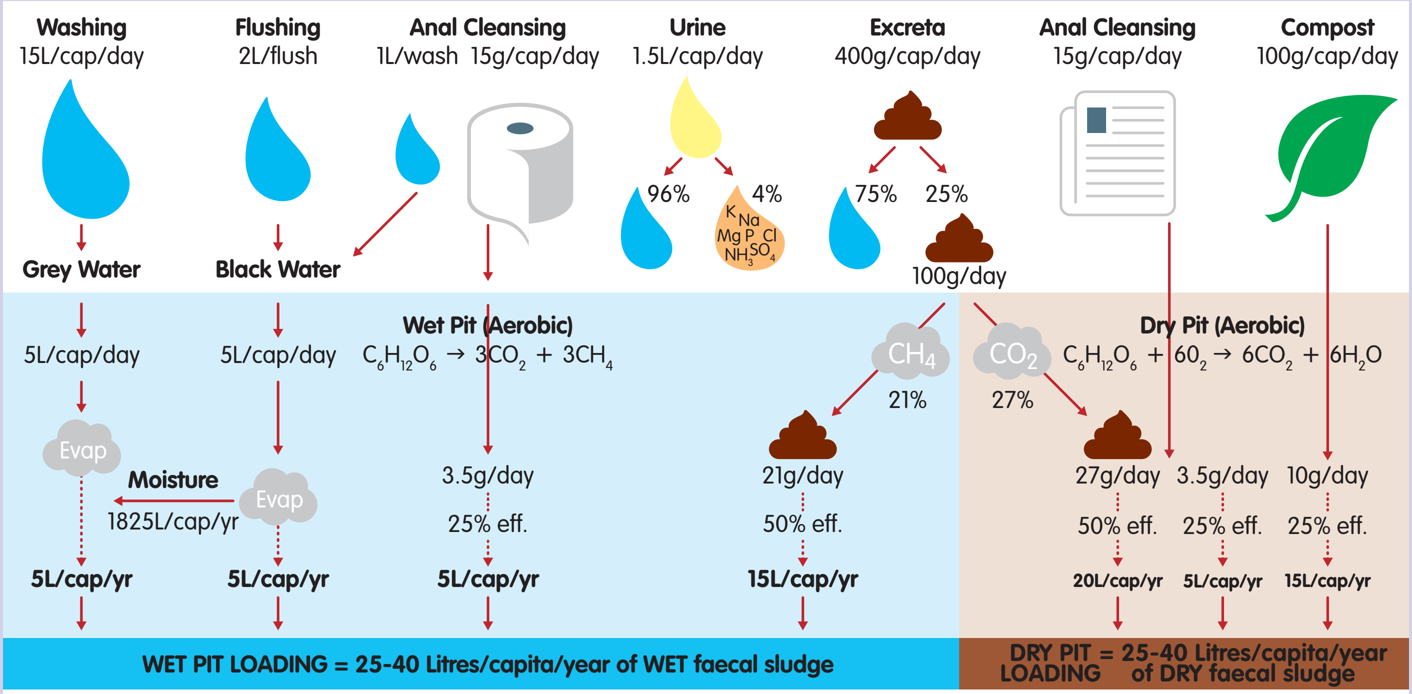


Figure 4: Faecal sludge loading



Sources: Still, D., Foxon, K., and O'Riordan, M., 2012. Reed, B., 2004.

Sludge accumulation rates

Tabulating the fill times *(table 1)* for different sized aerobic (dry pits) and anaerobic (wet) pits and tanks are subject to different inputs (i.e. compost or no compost, black or grey water) from a varying number of users under different effluent dispersion conditions (i.e. leaching or no leaching) enables the operational boundary conditions to be established and compared against actual fill times. In establishing the boundary conditions, a safety factor of 150% has been applied to give a design sludge accumulation rate of 40-60 lpc/year.

For a household of four users:

- pits of 1.2 m internal diameter and 1.5 m deep, have a fill time that will range from 7 years for dry pits to 10.5 years for wet pits. This means that designing a second offset pit for pour-flush latrines to fill after 2 years could significantly reduce the size (and cost).
- urban septic tanks only receive black water with a sludge accumulation rate of 40 lpc giving these a fill time of 9 years for faecal sludge but only 2.5 months, if it is operated as a holding tank.

Table 1: Pit fill time with different faecal waste digestion options

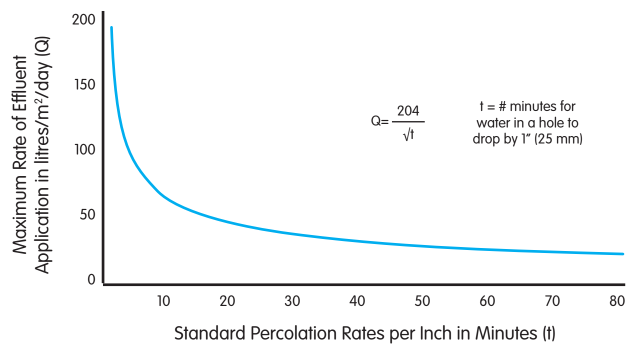
Faecal waste digestion options		Loading (lpc/yr)	Users (#)	Depth (m)	Width/Dia (m)	Length (m)	Volume (m³)	Fill time (yrs)
Dry pit	With compost	60	4	1.5	1.2		1.7	7.1
	No compost	40	4	1.5	1.2		1.7	10.6
Wet pit	Holding pit (black water)	1865	4	1.5	1.2		1.7	0.2
	1st leach pit (black water)	40	4	1.5	1.2		1.7	10.6
	2nd leach pit (black water)	40	4	0.4	1		0.3	2
Septic tank	Holding tank (black water)	1865	4	0.7	1	2	1.4	0.2
	w/leach pit (black+grey water)	60	4	0.7	1	2	1.4	5.8
	w/leach pit (black water)	40	4	0.7	1	2	1.4	8.8

Effluent absorption rates

The effluent absorption capacity *(figure 5)* for different size pits in different grades of soil suggests that:

- pits of 1.2 m diameter and 1.5 m depth should be capable of absorbing up to 30 litres/day (or 7 lpcd for a family of four) in any soil.
- the rock lattice structure lining the pits presents minimal obstruction to the leaching of the pits.

Figure 5: Effluent absorption for standard percolation rates



Source: BIS, 1985.

Why do pits fill prematurely?

Sludge accumulation and effluent absorption rates suggest that premature fill times are most likely associated with the absence of appropriate provisions for the leaching of effluent *(table 2)*. For the septic tanks, this is likely due to the absence of leach pits and the use of the septic tanks as a holding tank. The existing 6-12 month emptying cycle for septic tanks suggests that households use much less water than the predicted 5 lpc/day.

Options to improve rural faecal waste management

Safe pit management options *(figure 6)* in rural Bhutan gravitate around burying the sludge. Covering the old pit and digging a new pit enables treatment to precede emptying or transportation.

If contents of the pit are dry, then the sludge cannot be pumped out but may be 'dug out' if turned into the soil.

If contents of the pit are wet, then the sludge must be handled with caution.

- This is best pumped out and contained till dry.
- If it cannot be pumped out, then it may be bucketed out.
- Personnel should avoid direct contact with the faecal waste and should NOT ever enter the pit.
- Personal protective equipment should be worn when handling dry or wet sludge.

Dry pit toilets

In rural Bhutan, 75% of the population that use dry pit latrines continue to use biodegradable materials (predominantly tissue paper). Depending on the materials used for anal cleansing, a family of four using a dry pit toilet of 1.2 m diameter by 1.5 m deep will take between 7 and 10.5 years to fill.

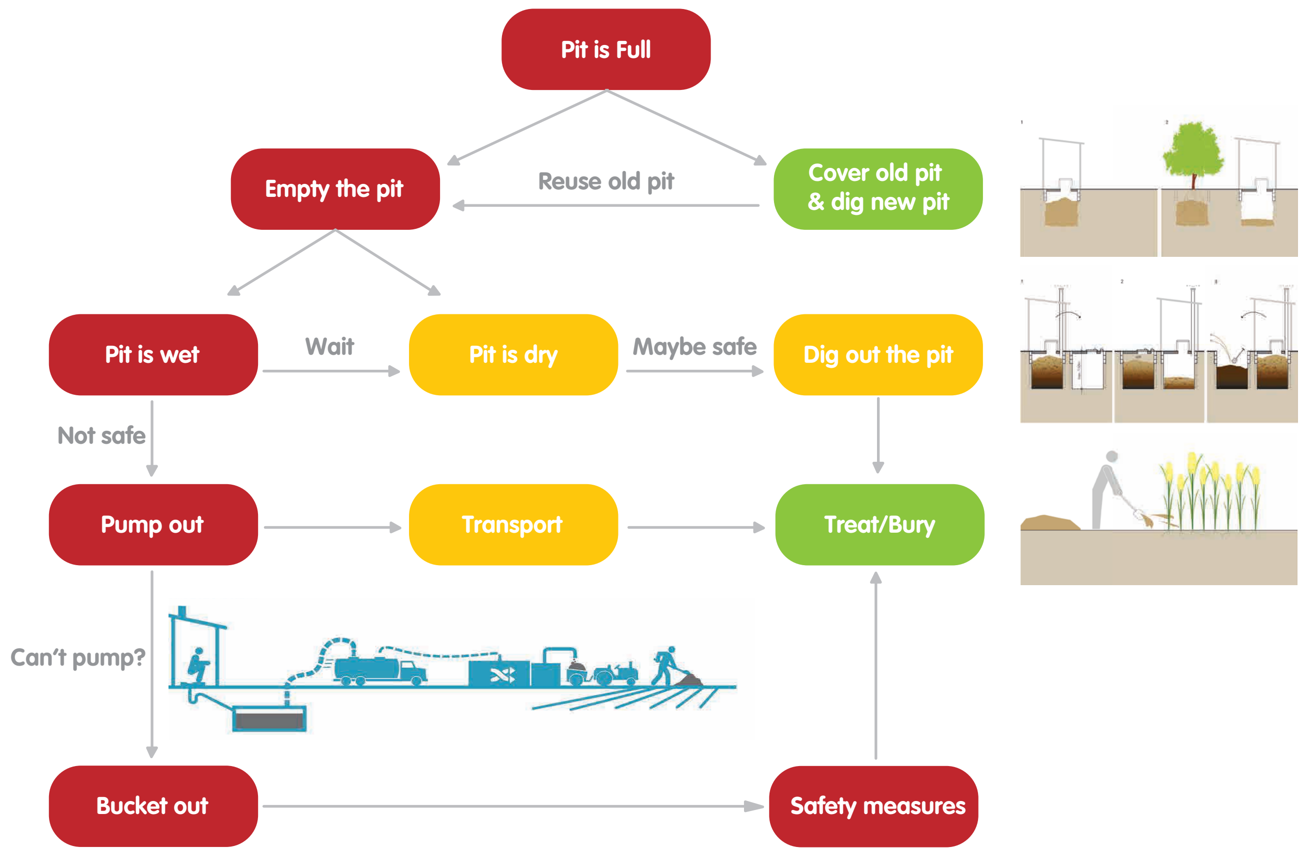
Along with the rapidly increasing levels of access to piped water, Bhutan has witnessed a massive shift toward the use of pour-flush toilets and water for anal cleansing. While dry pit toilets will remain an important technology option, minimising moisture introduced into dry pits is crucial to the effectiveness of aerobic processes. For dry pit toilets, this potentially requires:

- prioritising dry biodegradable materials for anal cleansing rather than water.

Table 2: Absorptive capacity of different size pits in different soils

Soil type	Soil percolation (min/inch)	Absorptive capacity (l/m²/day)	Maximum soil absorption (litres/day)			
			Soak pit 1.2Ø*1.5 m	Soak pit 1.0Ø*0.4 m	Soak drain 0.5*0.5*1 m	Soak drain 0.2*0.4*2 m
Gravel	1.5	167	942	209	167	160
Fine gravel	5	91	516	115	91	88
Coarse sand	15	53	298	66	53	1
Sand	30	37	211	47	37	36
Fine sand	60	26	149	33	26	25
Very fine sand	150	17	94	21	17	16
Silt	300	12	67	15	12	11
Clay	1500	5	30	7	5	5

Figure 6: Safe faecal waste management



Diagrams from: Tilley, et. al., 2014.

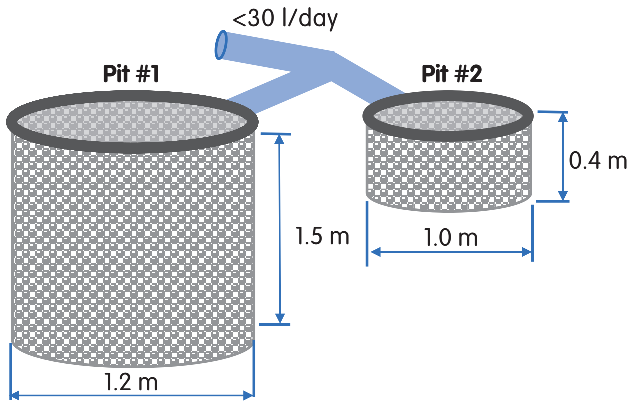
- providing a separate space in toilets and soak pits for those using water for anal cleansing.
- promoting separate urinals with soak pits to complement the use of dry pit latrines.
- establishing handwashing facilities outside of dry pit latrines.
- integrating this need in informed choice materials and behaviour change communications .

Pour-flush toilets

In rural areas, septic tanks and leach pits do not present a superior technology option particularly in remote areas where emptying wet faecal sludge from septic tanks will always be challenging. On the contrary, twin alternating pits enable households to avoid the handling of wet faecal sludge. Dry faecal sludge is removed only after treatment within the pits.

In rural Bhutan, the large single offset pits that are lined with rocks in well-draining soil take a long time to fill. It is anticipated that the pits of 1.2 m diameter and a working depth of 1.5 m used by a family of four will take more than 10.5 years to fill *(figure 6)*. In such cases, the second offset pit only needs to accommodate a maximum of two years of faecal sludge accumulation before the first pit can be emptied and the flow diverted back to the first pit. A second pit of 1.0 m diameter by 0.4 m depth installed in fine sandy soil should have the capacity to absorb 33 litres/day of effluent and two years of faecal sludge generated by a family of four.[3,4]

Figure 7: Installation of a second small offset pit in fine sandy soil where pits are filling after 10.5 years



Source: Illustrated by Mark Ellery, unpublished, 2018.

Programme implications

Understanding the specifics of sludge accumulation and pit management for wet and dry pits is essential to define pathways towards safely managed sanitation. While the SFD tool had previously only been applied to an urban city or town, the methodology proved to be helpful in interrogating and communicating the status of safely managed sanitation in rural settings. The process adopted in estimating the percentage of the population with access to safely managed sanitation highlighted the importance of combining technical design criteria, with appropriate survey data, grounded with a knowledge of common practice.

Based on the process of analysis of the SFDs, it was proposed for future programmes to prioritise:

- the risks associated with the unsafe disposal of child faeces.
- behaviour change communication messages to reduce the introduction of moisture in dry pit toilets.
- the safe closure (i.e. covering) of the old decommissioned pit toilets
- advocacy for single pit (upgradable to alternating twin pits) as a lower risk option in most rural settings as compared to the use of septic tanks with soak pits.
- promotion of a small second offset pit as a low-cost twin alternating pit option in rural areas.
- the retro-fitting of soak pits on the back or side of septic tanks (used as holding tanks) in urban areas.
- increasing awareness and the implementation of safety protocols during handling of faecal waste.

It was proposed that the learning from this process be included in the upcoming faecal sludge management (FSM) guidelines. Regular analysis based on updated data and knowledge of actual faecal waste management practices is recommended to monitor improvements and changes in the likelihood of sanitation systems being safely managed.

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Endnotes

1. Shit Flow Diagrams were constructed, and assumptions tested, with representatives of PHED (Ministry of Health), Water and Sanitation Division (Ministry of Works and Human Settlements) and the Religion and Health Project (Council for Monastic Affairs) during a workshop on the 30/05/2018 and further refined through discussions with SNV's SSH4A programme team.
2. Interviews of 1,627 households representing 100% of the households within sample clusters in the districts of Trashigang, Samtse, Lhuntse and Pemagatshel conducted from Feb-March, 2018.
3. Flow to the off-line pit must be completely blocked to enable the pit to become aerobic.
4. The contents of the off-line pit should only be emptied once dry (and ideally covered with soil).

SUSTAINABLE SANITATION AND HYGIENE FOR ALL (SSH4A)
In Bhutan, SSH4A is supported by the Australian Government in partnership with the Royal Government of Bhutan. IRC International Water and Sanitation Centre supports the programme as a knowledge partner.

SNV
SNV is a not-for-profit international development organisation. Founded in the Netherlands over 50 years ago, SNV has built a long-term, local presence in 38 of the poorest countries in Asia, Africa and Latin America. SNV's global team of local and international advisors work with local partners to equip communities, businesses and organisations with the tools, knowledge and connections they need to increase their incomes and gain access to basic services – empowering them to break the cycle of poverty and guide their own development.

ACKNOWLEDGEMENTS
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More information on SSH4A in Bhutan is available at http://www.snv.org/project/ssh4a-bhutan

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