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NATIONAL FAECAL SLUDGE MANAGEMENT GUIDELINES FOR RURAL HOUSEHOLDS

Ministry of Rural Development
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Preface

Faecal Sludge Management (FSM) is an emerging priority for the Royal Government of Cambodia. Great achievements have been made over the past decade to promote the use of toilets in rural parts of the country. These achievements are due to the leadership of the Ministry of Rural Development, programme implementation by sub-national authorities, strong engagement of Small-Medium Enterprises (SMEs) in revolutionising the marketplace, and the broad support of development partners and non-government organisations.

While efforts to realise full sanitation coverage will need to continue, simultaneously, attention in FSM services is increasing. Faecal sludge management is a challenge for our sector and one that we readily accept. The National FSM guidelines for rural households represents an important first step in the direction of safely managed sanitation services. It ensures that our sanitation programmes and solutions have a strong foundation to build on.

On behalf of the Ministry of Rural Development, I would like to extend my profound gratitude to SNV Netherlands Development Organisation Cambodia and the FSM Technical Team for leading the drafting and providing technical support towards the development of these guidelines.

Finally, I would also like to thank the Stone Family Foundation for their financial support in developing these guidelines.

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Acknowledgements

The National Faecal Sludge Management Guidelines for Rural Households were developed through a consultative process led by the Ministry of Rural Development (MRD). The process was guided and supported by the Faecal Sludge Management Sub-group, Chaired by MRD and Co-chaired by SNV Netherlands Development Organisation and the World Bank, comprising members of the Faecal Sludge Management Technical Team – a group of stakeholders from the Government, Non-Governmental Organisations (NGOs) and development partners. The drafting and finalisation of these guidelines was led by SNV Netherlands Development Organisation, supported by iDE, with inputs from the FSM Technical Team, and the inputs received from the Consultation Workshop on the FSM guidelines with representation from national and sub-national stakeholders from all 25 provinces in Cambodia. The contributions by the many stakeholders at all levels towards the development of these guidelines are gratefully acknowledged.

Acronyms

ADB	Asian Development Bank
ATP	Alternating Twin Pit
BCC	Behaviour Change Communication
CCWC	Commune Committee for Women and Children
CDB	Commune Database
CDP	Commune Development Plan
CIP	Commune Investment Plan
CSES	Cambodia Socio Economic Survey
DEWATS	Decentralised Wastewater Treatment Systems
DORD	District Office of Rural Development
DRHC	Department of Rural Health Care
DWG	District Working Group
EWB	Engineers Without Borders
FSM	Faecal Sludge Management
iDE	International Development Enterprises
KAP	Knowledge, Attitudes, and Practices
MAFF	Ministry of Agriculture, Forestry and Fisheries
MIS	Monitoring Information System
MoE	Ministry of Environment
MoH	Ministry of Health
MPWT	Ministry of Public Works and Transport
MRD	Ministry of Rural Development
NAP	National Action Plan
NGO	Non-Government Organisation
O&M	Operations and Maintenance
PAP	Provincial Action Plan
PDRD	Provincial Department of Rural Development
PPE	Personal Protective Equipment
PSI	Population Services International
PWG	Provincial Working Group
RGC	Royal Government of Cambodia
RWSSH	Rural Water Supply, Sanitation and Hygiene
SCE	Sanitation for Challenging Environments
SDG	Sustainable Development Goal
SNV	Netherlands Development Organisation
VIP	Ventilated Improved Pit
WASH	Water, Sanitation and Hygiene
WHO	World Health Organisation
WWTP	Wastewater Treatment Plant

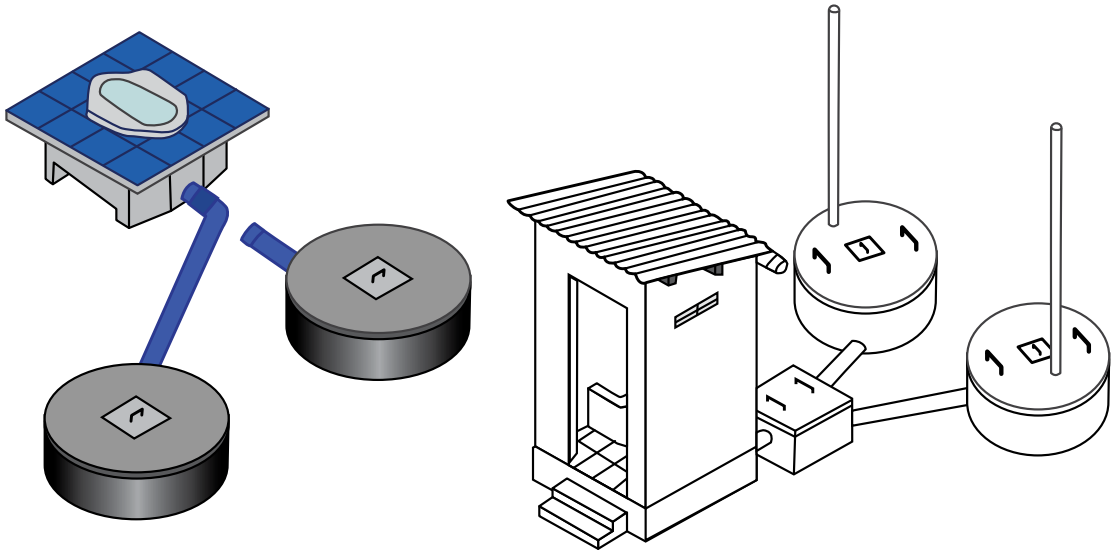
Executive Summary

Background. Cambodia has realised remarkable achievements in increasing rural sanitation coverage over the past decade. Most toilets in rural Cambodia are relatively new. Faecal sludge is typically stored in cement-lined pits connected to household toilets. With pits likely to fill up anywhere between 3-10 years of use, proper faecal sludge management (FSM) is an emerging priority. This is especially important because research has shown that many households have the tendency to practise the unsafe disposal of untreated sludge onto fields, rice paddies, or water bodies.

Scope. The National FSM guidelines for rural households describes how faecal sludge treatment, emptying and disposal can be safely practised in the rural Cambodian context and establishes the enabling environment needed to scale up solutions throughout the country. These guidelines offer solutions for rural households to carry out the safe management of their own sanitation situation, on their own property – referred to herein as ***on-site*** sanitation. Off-site solutions – when faecal sludge is collected, often by a private company or entrepreneur – are mentioned to provide context but are not the focus of these guidelines. Faecal sludge management in 'challenging environments' – such as flood-prone areas - is also discussed briefly.

Safe on-site faecal sludge management. Faecal sludge can be safely managed in rural Cambodia by containing it underground for at least two years. Adhering to this process allows faecal matter to dewater, decompose, and become safe. Lime can also be utilised to enhance the treatment process of faecal sludge. Should the household desire, organic material that remains after decomposition can be used as a fertiliser.

The burial and decomposition of faecal sludge can be performed in different ways. The safest and most practical way is to utilise an Alternating Twin Pit (ATP) design (which is also referred to as Alternating Dual Pit in Cambodia) as pictured below.



The ATP design has the following particular advantages:

a) Alternating Twin Pits consist of two pits, which allow for the toilet to remain functional, almost immediately, after it becomes full. Households must only change the direction of wastewater flow into the empty alternate pit. The way this directional change is done depends on the design of the ATP. In some cases, a pipe must be dug up and re-arranged. In other cases, the ATP has a diversion box that must be opened. Inside the diversion box the blockage for the outflow pipe to the empty pit must be removed, and the outflow pipe to the full pit must be blocked. A key advantage is that the time needed to perform this directional change is likely to be much less than the time needed to empty the pit (regardless of whether the household empties it themselves or if a service provider does so) – particularly for designs with a diversion box.

b) If correctly operated, ATPs allow for faecal sludge handling only ***after*** it has fully decomposed and is safe for re-use. When a pit is actively receiving wastewater and has become full, the faecal sludge within it remains unsafe. For a typical single pit toilet, emptying of a full pit heightens the risks for the health of the emptier, the surrounding community, and the environment. These risks are avoided with the ATP as the faecal sludge does not need to be moved while untreated.

If a household does not have an ATP and untreated faecal sludge must be handled, then precautions must be taken. The handler must ensure that they are wearing personal protective equipment (PPE) that prevents the contact and spread of faecal sludge. They must also ensure that the sludge is contained in sealed or covered containers to avoid spillage during transport. Any spills must be cleaned up, buried, and/or disinfected, as appropriate. Disinfection of spills, equipment, and/or clothing can be performed using household bleach available in the marketplace.

To summarise, on-site and in-pit treatment is the recommended and preferred faecal sludge treatment method for rural households. Therefore, faecal sludge is best treated by leaving it in the pit for at least two years before emptying. Pits should be emptied in the dry season whenever possible. The recommended option for households is to upgrade existing latrines to an Alternating Twin Pit. Pit emptying, using PPE and burial of faecal sludge in the vicinity of the household and their property is the second best option.

Roles and responsibilities. Leadership over on-site rural household FSM in Cambodia lies with the Ministry of Rural Development and its Department of Rural Health Care. Sub-national authorities need to be engaged in programme implementation and non-government organisations can provide various support. Private sector can also have a role within FSM by offering ATP-related products (including upgrades of existing toilets) or pit emptying services (despite this being an off-site solution). Priority activities for all stakeholders include integrating and executing FSM programming within sub-national

action plans, private sector strengthening for safe FSM solutions, capacity development of local authorities for behaviour change communication, and integration of FSM monitoring into existing WASH systems.

Gaps and future priorities. Various research needs remain, including: a) an assessment of ongoing rural private sector FSM services, b) the efficacy of faecal sludge treatment and correct usage practices among ATP users, and c) the development of economical off-site treatment systems scalable within rural districts. Further study and innovation are also needed to strengthen methods to communicate safe FSM to communities, and to confirm assumptions towards safe faecal sludge re-use.

Terms and Definitions

Aerobic digestion. A process which uses bacteria and oxygen to break down organic and biological waste.

Anaerobic digestion. A process which uses bacteria to break down organic and biological waste in the absence of oxygen.

Basic sanitation. Use of an improved sanitation facility that is not shared with any other household.

Decomposition. For the purposes of this document, decomposition refers to a controlled method to treat faecal sludge whereby its components are broken down by aerobic and/or anaerobic digestion processes. Decomposition in this context can be successfully practised when faecal sludge is contained (typically underground) for at least two years in an environment where liquids drain and remaining faecal sludge becomes dry. The end product after the decomposition process is called humus, which can then be used as a soil conditioner. Decomposition is an appropriate FSM solution and contributes to safely managed sanitation.

Containment/storage. Ways of collecting and storing (and in some cases treating in-situ) faecal sludge generated from a latrine.

DEWATS. Decentralised wastewater treatment systems are of a smaller scale compared to traditional urban sewerage and wastewater treatment works and are designed to address affordability and maintenance constraints while relying on local materials.

Drying beds. A method of treating faecal sludge off-site whereby sludge is spread out over a contained space to dry.

Dry pit latrine. A type of latrine that does not require water for flushing. Excreta typically falls directly into the pit.

Direct pit. A pit that is directly under a latrine pan, whereby excreta falls directly into the pit.

Excreta. Urine and faeces.

Faecal sludge. Contents of an on-site sanitation facility (such as a latrine pit) typically comprising of excreta, flush water, and anal cleansing materials.

Faecal sludge management (FSM). Methods and processes to manage faecal sludge.

Leach pit. Latrine pit that facilitates the draining of liquids into the surrounding soil.

Human health hazards. Hazards associated with faecal sludge that may be related to its microbial, chemical or physical properties. Microbial hazards refer to the health risks associated with exposure to potentially harmful microbes. Chemical hazards can include exposure to cleaning agents and physical hazards, to dangerous labour or machinery.

Humus. A dry, nutrient-rich by-product of the decomposition of faecal sludge over a long period of time (typically at least two years). Humus is generally safe to excavate and be used as a soil conditioner or fertiliser.

Improved sanitation facility. A type of latrine that is more likely to result in the separation of excreta from human contact. Improved sanitation facilities include flush/ pour-flush toilets to piped sewers, septic tanks, pit latrines, ventilated improved pit latrines, composting latrines, and pit latrines with a slab.

Microbe/Microorganism. Microscopic organisms (not visible to the human eye) such as bacteria, protozoa, virus, amoeba, etc. Some microbes can cause diseases in humans.

Off-set pit. A pit that is beside (rather than directly under) a latrine pan. Typically, an off-set pit is connected to a latrine via a plastic pipe.

Off-site safely managed sanitation. A sanitation system in which faecal sludge is collected, transported away from the plot where it was generated and treated. Following this, remaining faecal sludge products are either disposed or re-used. Currently, there are few safe treatment options for off-site faecal sludge management in Cambodia.

On-site safely managed sanitation. A sanitation system or technology in which faecal sludge is contained, collected, stored, emptied and treated on the institutional or household plot where it was generated.

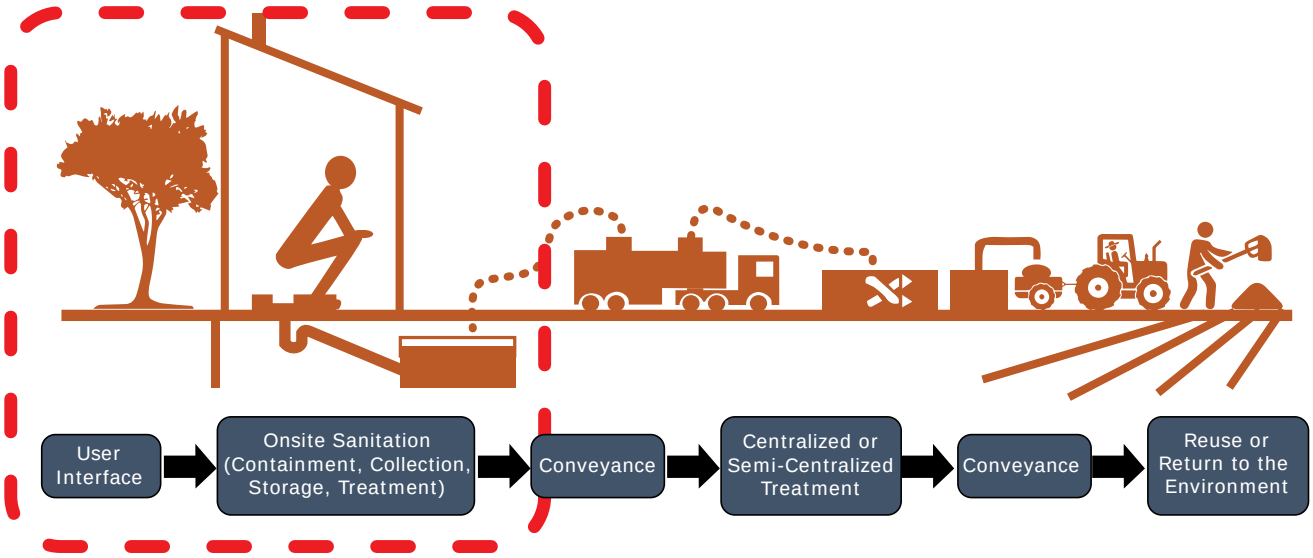
Personal Protective Equipment (PPE). Equipment used to reduce the risk of contact between a person and the faecal sludge (and spreading potentially disease-causing microbes) during handling and/or transport. PPEs can include equipment such as gloves, waterproof boots, hats, full overalls and face masks.

Pour-flush latrine. The most common type of latrine in rural Cambodia and one where the user pours water into the toilet pan to carry excreta into a pit. Pit contents are separated from the user by a water seal in the toilet pan.

Septic pit. A pit that is fully sealed (often using cement), connected to a latrine, and collects and stores faecal sludge. Given that pit is sealed, liquid cannot drain from the pit into the surrounding soil.

Safely managed sanitation. Refers to the use of an improved sanitation facility, which is not shared with any other household, and where excreta are either: (1) treated and disposed in-situ (in the place where it is kept); or (2) transported and treated off-site; or (3) transported through a sewer to a treatment facility. Safely managed sanitation aims to ensure that the potential health and environmental risks associated with faecal sludge are minimised throughout the entire sanitation service chain.

Sanitation service chain. Refers to the collection, containment, conveyance, treatment and disposal of faecal sludge. *Figure 1* depicts a typical sanitation service chain, including the delineation between ***on-site*** (processes inside the dotted line) and ***off-site*** systems.



Adapted from IRC, 2015

Figure 1. Sanitation service chain

Latrine. A sanitation system that captures faecal sludge and contains it. Through this containment, a barrier is established to prevent contact between humans and potentially disease-causing microbes in faecal sludge. Numerous types of latrine systems, technologies, and configurations exist.

Treatment. A process that changes the physical, chemical and biological characteristics of faecal sludge so that it is converted into a product that is safer for end-use or disposal.

1. Introduction

Cambodia has experienced significant economic growth in recent years, and access to sanitation amongst the rural population has increased dramatically over the past decade. Over 4.1 million people gained access to basic sanitation between 2007 and 2017, while the prevalence of open defecation has been reduced from 73% to 29% (National Insititute of Statistics, 2007; Ministry of Planning, 2017).

The Sustainable Development Goal (SDG) 6 aims to ensure the 'availability and sustainable management of water and sanitation for all.' Tied to this goal is an ambitious global target for water, sanitation and hygiene (WASH), i.e., for national governments to provide both equitable and safely managed access (United National Children's Fund (UNICEF) & World Health Organization (WHO), 2019).

Having achieved an enormous increase in sanitation coverage in the last decade, Cambodia is now focusing on the emerging challenge of safely managed sanitation, particularly as this relates to the issue of latrine pits filling up over time. Most rural residents store faecal sludge in one or more pits connected to their latrine (Ministry of Planning, 2017). This faecal sludge accumulates over time and eventually fills up the pit. Most households have not yet needed to manage their faecal sludge because most latrines have been constructed recently, and most pits have not yet become full (Harper, 2019). However, recent studies have shown that amongst those households that have already emptied their latrines, very few have done so safely. Faecal Sludge Management (FSM) has, therefore, quickly become an emerging priority for the Royal Government of Cambodia (RGC) and the WASH sector.

The Ministry of Rural Development (MRD) is mandated to improve sanitation and hygiene conditions amongst the rural population, in line with national strategies and policy (Ministry of Rural Development, 2016). The MRD is also responsible for increasing the prevalence of safely managed sanitation through on-site (household-level) FSM solutions. The MRD's National Action Plan 2 has set a target of 35% of rural households' practising safely-managed on-site sanitation by 2023 (MRD, 2019).

2. Objectives and Scope

Overall, these National FSM guidelines for rural households provide technical guidance to government, development partners, non-government organisations (NGOs) and private sector on appropriate methods that may be taken for the safe on-site management of faecal sludge in the rural Cambodian context. Specifically, the National FSM guidelines for rural households Provides a brief overview of the current context of rural FSM and safely managed sanitation in Cambodia and:

- Explains what faecal sludge is, why it needs to be safely managed and dispels some common myths;
- Ensures a consistent understanding of technical terminology and vocabulary;
- Describes the methods of achieving safe on-site FSM;
- Identifies FSM-related roles and responsibilities of different institutions and actors; and
- Outlines the remaining gaps in FSM knowledge, highlighting future priorities.

Intended audience for the Guidelines

The intended audience of these guidelines includes staff of relevant technical departments within MRD, namely the Department of Rural Health Care (DRHC), Provincial Departments of Rural Development (PDRD) and District Offices of Rural Development (DORD), NGOs and development partners. These guidelines are also intended to be used by district and commune-level WASH focal points, Commune Councils, and the Commune Committee for Women and Children (CCWC).

Focus areas of the Guidelines

These guidelines primarily focus on on-site faecal sludge collection, treatment and disposal methods. On-site solutions are the mandate of MRD and are the preferred approach to achieving safely managed sanitation in rural Cambodia. These guidelines also briefly discuss FSM solutions relating to challenging environments – referring to locations where use of conventional latrines is likely to contaminate the surrounding environment. Examples of such locations include floating communities, flood-prone areas, and areas with high groundwater tables. However, more comprehensive guidance can be found separately in the Guidelines for Sanitation in Challenging Environments (SCE).

Limitations and the future of the Guidelines

The National FSM guidelines for rural households represents a first step towards harmonising approaches that aim to achieve safely managed sanitation within the WASH sector of Cambodia. Going forward, it is envisaged that measures will be intermittently

revised and adapted as technical, institutional, economic, social and financial capacities evolve, and as new technologies, concepts, and best practices emerge.

These guidelines are not intended to be comprehensive of all FSM issues, and do not explicitly include a dissemination plan for how they will be shared and adopted; business models for FSM service providers; detailed explanations of how to execute FSM-related behaviour change communication (BCC) activities; and infant faeces management.

3. Background

This chapter highlights the current FSM context in rural Cambodia, based on the findings of various studies completed to date and as summarised in a recent comprehensive review (Harper, 2019). Due to the recent rapid expansion of sanitation coverage, most households in rural Cambodia have not yet had the experience of their latrine pit becoming full. However, this situation is expected to change rapidly over the coming years and poses a significant environmental and public health issue for households, communities, and the RGC; each of which has a responsibility for managing the problem. In addition to the health risks associated with faecal sludge itself, there is a risk that households will stop using their latrines and revert back to practising open defecation if pits become full, rendering their latrines unusable. Approximately 78% of Cambodia's population of 15.8 million live in rural areas (National Insititute of Statistics, 2007).

Faecal sludge accumulation rates in pits

Several field studies have been undertaken in rural Cambodia to estimate faecal sludge accumulation rates in pits. These studies represent diverse contexts and geographies, and are therefore not directly comparable. Two pit accumulation rates have been estimated at 58 litres/capita/year (SNV, 2018) and 85 litres/capita/year (PSI, 2018). Estimated average pit accumulation rates for a variety of common pour-flush off-set pit configurations are shown in Table 1.

Table 1: Estimated pit accumulation rates for various configurations of pour-flush off-set pit latrines

Pit diameter	Study	Single off-set 3-ring pit (0.5m ring height)	Double off-set 3-ring pit (0.5m ring height)
1m^3	SNV, 2018	4.6 years	9.2 years
	PSI, 2018	3.2 years	6.3 years
0.8m^3	SNV, 2018	3.0 years	5.9 years
	PSI, 2018	2.0 years	4.0 years

Figures depicted in Table I are from studies conducted in Siem Ream and Kratie (n=632) by PSI in 2018; and in Kampot (n=49) by SNV in 2018. An average rural household size of 4.4 persons was used in the calculations (as per CSES, 2017).

Leach pits fill more slowly in permeable soils (sand, loam, etc.) and more quickly in less permeable soils (clay). Pour-flush latrines installed in areas with seasonal high groundwater levels or flooding fill more quickly in the wet season, coinciding with the times of highest demand for pit emptying. Some surveys have indicated that latrines connected to septic pits fill up most quickly (PSI, 2018).

Faecal sludge management is typically triggered when a pit overflows, when there is the presence of foul odour, or when the latrine can no longer be flushed. Most households cannot or do not monitor the contents of their pit regularly. Decisions to respond to a full pit are, therefore, typically reactive rather than proactive.

Pit emptying practices in rural Cambodia

Most households that have emptied their pits have done so unsafely (Harper, 2019). There appears to be little social stigma associated with households manually emptying their pits themselves (WaterSHED 2018). Untreated faecal sludge is typically disposed of in fields and waterways and is sometimes used as fertiliser before it has been safely treated.

When the pit is manually emptied, faecal sludge is usually transported in unsealed containers. Handling practices are unsafe when personnel protective equipment (PPE) – such as gloves, masks, and protective clothing – are not used by the emptier, and/or when containers or buckets are uncovered.

Mechanical emptying methods are also relatively common with households using pumps and hoses to extract liquefied faecal sludge from their pit(s). If not already owned, pumping equipment is often shared, borrowed, or rented. Agricultural pumps, such as those typically used for irrigation, are often used for pit emptying.

Households may empty their pits themselves or with support from hired local labourers. However, finding local labourers willing to do the 'dirty work' of FSM is reportedly a challenge in many areas. Faecal sludge management poses particular challenges in flood-prone areas. It is reportedly common for households to remove the lid of their pits during the wet season so that faecal sludge disperses through flood waters. Access to suitable lands for disposal is a constraint for some households as it is not acceptable to dispose of faecal sludge on other peoples' property. Surveys have shown that very few households bury or intend to bury their faecal sludge (PSI 2018, SNV, 2019). However, on-site (within a household plot/property) burying of faecal sludge is also an important part of the decomposition method that is commonly associated with safe on-site FSM.

Common faecal sludge management practices in rural Cambodia

- For households that did empty their pits, below is a listing of faecal sludge management practices that are common - and some are often unsafe.
- Self-emptying of the pit, either manually (using buckets or scoops) or mechanically (using a mechanised suction pump). Self-emptied faecal sludge is typically disposed of onto fields or into waterways or is sometimes stored around the household for future use as fertiliser;

- Hiring a vacuum truck or tanker truck/cart to empty the pit and take contents to an off-site location;
- Making pit modifications to allow faecal sludge to flow out of the pit (for example, by punching a hole in the pit or adding a drainpipe);
- Abandoning and covering the pit (leaving the contents in-situ) and building a new one;
- Installing an additional pit in series to increase storage capacity;
- Installing an additional pit in parallel to form an alternating pit configuration (where only one pit is actively receiving faecal sludge at a time while the second pit remains inactive until the first one becomes full).

Studies have shown that both household-led pit emptying practices and private FSM services are not managed safely and are not contributing to the MRD's FSM national targets. Therefore, a coordinated effort is needed to find and implement appropriate solutions to the emerging issue of rural FSM.

The growing importance of on-site faecal sludge management

There is growing consensus amongst decision-makers that on-site FSM should be prioritised over off-site methods in rural contexts. Alternating Twin Pit (ATP) latrines are, at the moment, the most suitable technology for on-site FSM. A number of NGOs have been piloting and refining ATP designs and have been supporting latrine businesses to integrate ATPs in their product line; in addition to developing and implementing demand creation strategies. While ATP designs have been included in MRD's Latrine Construction Manual (Ministry of Rural Development; Department of Rural Health Care, 2010), latrine businesses are typically unaware of them and do not know how to construct them unless they have received training.

On-site versus off-site faecal sludge management solutions

Despite the fact that decision and policy makers prefer on-site FSM solutions, most studies indicate that rural households prefer off-site solutions (Harper, 2019). Off-site solutions typically include hiring a pit emptying service to clean out the pit and to take faecal sludge away. However, the FSM services industry is not regulated, thereby making off-site FSM services environmentally unviable. Although FSM services remain very small in rural areas, demand is expected to increase.

4. Faecal Sludge Management and Safely-managed Sanitation in Rural Cambodia

Safe Faecal Sludge Management (FSM) can be achieved through both on-site or off-site approaches and processes. **On-site FSM is the preferred and recommended solution** to achieve safely managed sanitation in rural Cambodia. A brief description of safe off-site FSM solutions is provided in Annexure A with the recognition that they are also emerging and in-demand. However, off-site solutions are not within the scope of these Guidelines or MRD's mandate.

4.1 Faecal sludge management at household levels

Households should routinely monitor accumulation of faecal sludge in their pit(s), when possible and safe to do so. Once a pit(s) has become approximately two-thirds full FSM actions must be taken to prevent the pit from overflowing and/or causing the latrine to become dysfunctional.

Pit lids equipped with a 'viewing' window can facilitate the routine inspection of the height of faecal sludge in the pit. Pits with solid cement lids, however, may not allow for the pit contents to be easily monitored. Sealed lids will need to be hammered free to allow for inspection. Regardless of whether a pit lid has a viewing window or the entire pit lid is sealed by cement, the lid must be moved gently and fully sealed after inspection is completed. Alternatively, low-cost products to monitor the height of faecal sludge in a pit without opening it are becoming available in the marketplace (iDE has developed a Pit Gauge for this purpose, which is available from its suppliers).

As faecal sludge height approaches the recommended limit (two-thirds of pit capacity), households should decide on the type of safe FSM solution they wish to implement. Chosen actions and solutions will depend on the options available in the community, the type of latrine they have, and the household's budget.

4.2 On-site faecal sludge management solutions

The most practical way for a rural household to achieve safe on-site FSM is by decomposing their faecal sludge on their property. However, ease of decomposing depends on the type of latrine facility a household possesses and whether household decision-makers have been trained and sensitised to the decomposing process.

Types of latrines in rural Cambodia

The main types of latrines in Cambodia include:

- Alternating Twin Pit (ATP) latrine (i.e., pour-flush off-set double pit latrine with two or more pits in parallel);

- Pour-flush off-set single pit latrine;
- Pour-flush off-set double pit latrine (i.e., off-set pit latrine with two or more pits, typically in series); and
- Dry or pour-flush direct (or ventilated) improved pit latrine.

4.2.1 Alternating Twin Pit (ATP) latrines - The first recommended safe on-site faecal sludge management option

The ATP latrine design is the preferred and **first recommended solution** to achieve safe on-site FSM because it avoids the problems associated with abandoning a full pit and building a new one, or extracting dangerous faecal sludge and burying it somewhere else on a household's property. The ATP latrine uses water for flushing and comprises two off-set pits arranged in parallel. While one pit is filling with faecal sludge, the other pit remains out of service. When the first pit is full, it is disconnected from the latrine. The second empty pit is then connected to the latrine. During this period, the contents of the full pit, which is no longer accepting new faecal sludge, will be decomposed, dewatered and will transform into humus. This process takes no less than two years. There are currently two main designs being trialled, produced and sold by latrine businesses with support from NGOs (Figure 2, 3 & 4). Further design details of these ATP models are included in Annexure B.

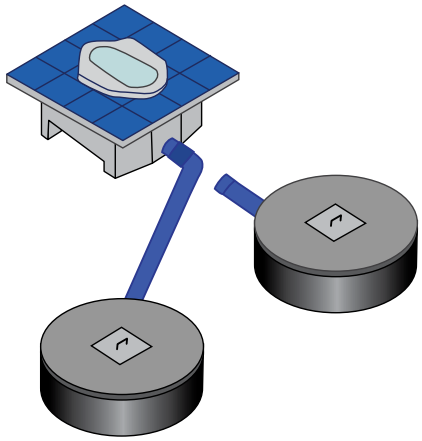


Figure 2. ATP with direct PVC pipe connections

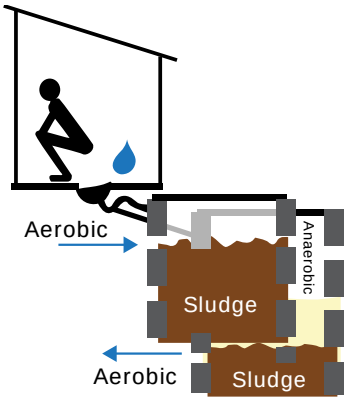


Figure 3. Digestion processes in ATPs

Most households require a minimum of two years to fill a pit. Therefore, when the second pit becomes full, the contents of the first pit will already have decomposed and is ready for emptying. The emptied pit is then reconnected to the latrine and put back into operation. This cycle can be repeated indefinitely.

The ATP latrine is designed specifically to reduce the risks and challenges associated with on-site decomposition while also allowing for the uninterrupted use of the latrine once a pit has become full. However, safe on-site FSM can also be achieved through decomposition without having an ATP latrine.

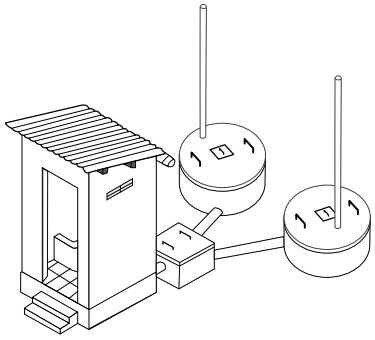


Figure 4. ATP with diversion box controlling flow to either pit

4.2.2 Achieving safe faecal sludge management with other latrine types

Pour-flush off-set single pit latrine

A pour-flush off-set single pit latrine is typical of the majority of latrines in rural Cambodia (Figure 5). These pits are usually constructed with cement rings. Water is poured into the pan to flush excreta and a water seal prevents odour and flies to come back up the pipe. A vent pipe allows release of gases. In cases where the pit is monitored by the household, action should be taken when the pit has become 2/3 full (preferred option). At this stage if the pit is left further unused (decommissioned), the digestion process that then treats (after decommissioning the pit) faecal sludge within the pit is anaerobic. Effluent is subject to anaerobic digestion when it leaches through the soil (Figure 6). In some cases, the absence of sufficient dewatering mechanisms (holes in rings, spaces between rings, unsealed base, etc.) and/or impermeable soil prevent effluent from leaching and results in the pit filling up more quickly. The pit contents are generally highly liquid and unsafe for handling.

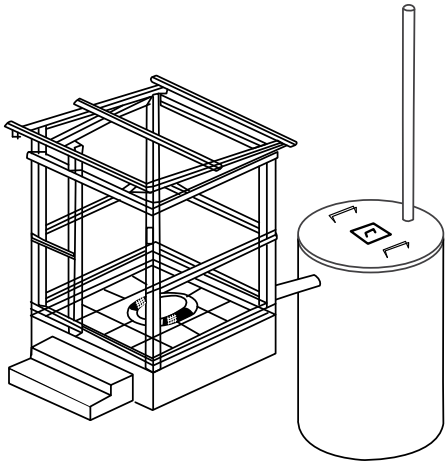


Figure 5. Design of a pour-flush off-set single latrine

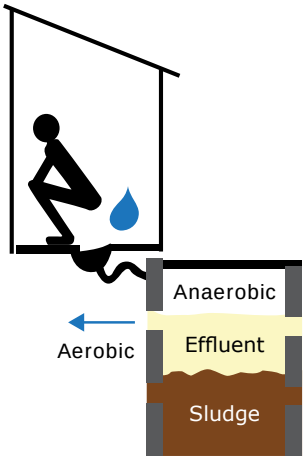


Figure 6. Digestion in an off-set pour-flush latrine

The best management option is to build an additional pit (in an alternating configuration) and to redirect waste to the second pit. Contents of the first pit is then allowed to digest for two years, after which the humus is emptied safely. Alternatively, if adding an additional new pit is not possible, the contents of the full pit may be manually or mechanically emptied and buried, following safe handling protocols (see section 4.2.3 below on emptying and burying faecal sludge).

Pour-flush off-set double pit latrine

A modification to the pour-flush off-set single pit latrine is to add one or more additional pits in a series (Figure 7). These additional pits increase the total storage volume. They could either be leach pits or septic pits (described below). In areas where effluent accumulates quickly in pit/s, or for consumers that wish to reduce the frequency of pit emptying, this modification may be more desirable. However, adding pits in series is not a recommended option, but an option for households that have land constraints.

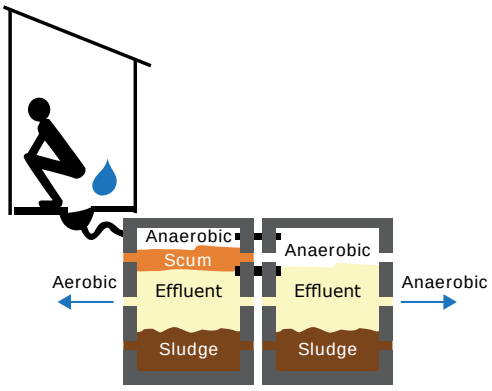


Figure 7. Pour-flush off-set double leach pit in series

Septic pits

Septic pits operate as a septic tank and contain all liquids and solids with no discharge to the surrounding environment (Figure 8). Liquids typically need to be regularly drained from septic pits. However, septic systems can also direct faecal liquids to a leach tank or trench (Figure 9). The best option to treat liquids from septic pits is by adding a leach tank or underground trench for effluent to filtrate through the soil. The efficacy of leach tanks and trenches in treating liquid waste is being tested by iDE and EWB as part of the development of safe FSM solutions that are suitable for flood-prone and high groundwater contexts.

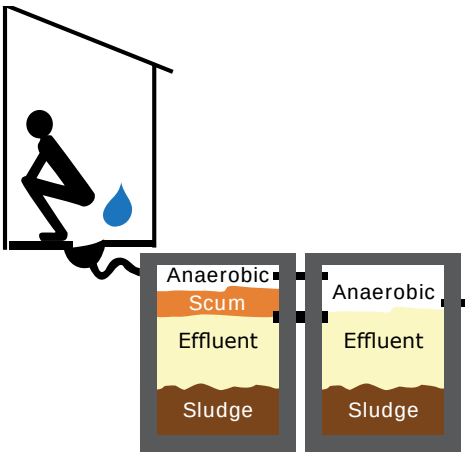


Figure 8. Pour-flush off-set double septic pit in series, known as "septic pits"

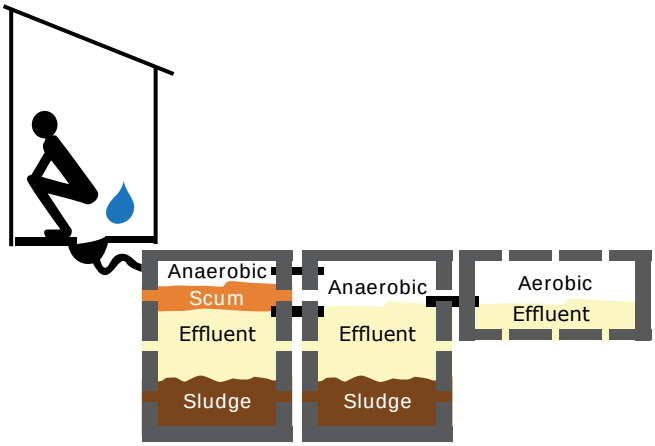


Figure 9. Septic pits including a third leaching chamber

Dry, direct or ventilated improved pit

This system is based on the use of a single pit (one that is not off-set from the toilet pan) to collect and store excreta. The system can be used with or without flush water, depending on the latrine. Inputs to the system include urine, faeces, cleansing water, flush water and dry cleansing materials. The use of flush water, cleansing water and cleaning agents will depend on water availability and local habits. The latrine for this system can either be a dry latrine or a pour-flush latrine. A urinal could additionally be used. The latrine is directly connected to a single pit or a single ventilated improved pit (VIP) for containment. As the pit fills up, leachate permeates from the pit into the surrounding soil; unless the latrine is connected to a septic tank.

Treatment and management: Once this pit is no longer in use (after it becomes nearly full), digestion in a **dry pit** is primarily aerobic but can be anaerobic at greater depths with higher moisture content (Figure 10; left). Small amounts of carbon (i.e., leaves) increase the pit temperature and ash raises the pH to assist in destroying pathogens.

When the pit is full, it can be backfilled with soil and closed. A fruit or ornamental tree can be planted in the pit (in line with Fact sheet 1 recommendation of the WHO Guidelines on

Sanitation and Health). Alternatively, contents of the pit can be left to decompose for at least two years. If the dry humus is removed, it can be used as fertiliser (Howards, 2002).

Digestion in a **wet pit** is mostly anaerobic (Figure 10; right). The effluent leaches through the walls of the pit where it is exposed to an aerobic digestion process. These pits generally fill rapidly, and contents are wet and not safe to handle.

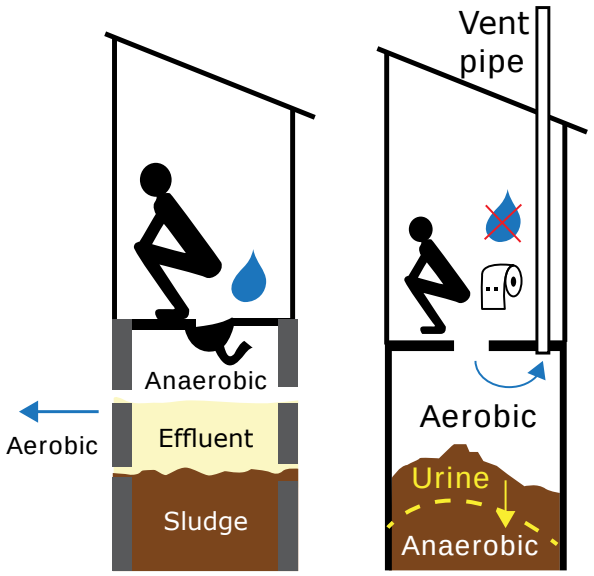


Figure 10. Direct dry and wet pit latrines

It is best to build superstructures for both dry and wet pits that can be disassembled and moved later. Such preparations allow for the relocation of the superstructure to a new pit once the original pit has become full and has been closed. Direct pits (dry or wet) should not be emptied without a resting period of two years.

Despite being practised by some households, holes should not be broken into the second pit to allow flow of untreated effluent to the surrounding surface environment.

However, the building of a new pit may not be a viable solution for some households. To date, the abandonment of full pits is not common practice. This is likely because of the practical challenges associated with constructing a new pit (typically involving the hiring of a mason) and difficulties in reconfiguring an existing latrine to a new pit.

Regardless whether a full pit is abandoned, emptied into a pit or trench (as described in Section 4.2.3), or treatment is performed using an ATP latrine, decomposition needs to be handled by individuals who have received sensitisation and training on the following:

- Safe management of faecal sludge;
- Correct steps for the decomposition of faecal sludge; and
- Safe extraction and handling of faecal sludge during transfer from a full pit to a decomposition location.

Therefore, the behaviour change and sensitisation component of achieving safe FSM needs to be fully implemented in sanitation programmes. Towards this, a package of FSM behaviour change materials is presented in Annexure C.

4.2.3 Manual pit emptying and on-site treatment of faecal sludge – The second recommended safe on-site faecal sludge management option

In cases where building and connecting a new pit is not viable or desired, faecal sludge must be extracted from the full pit and buried elsewhere **on the household's property.**

A summary of the guidance for the manual emptying of pits and on-site treatment of faecal sludge is presented in Figure 11.

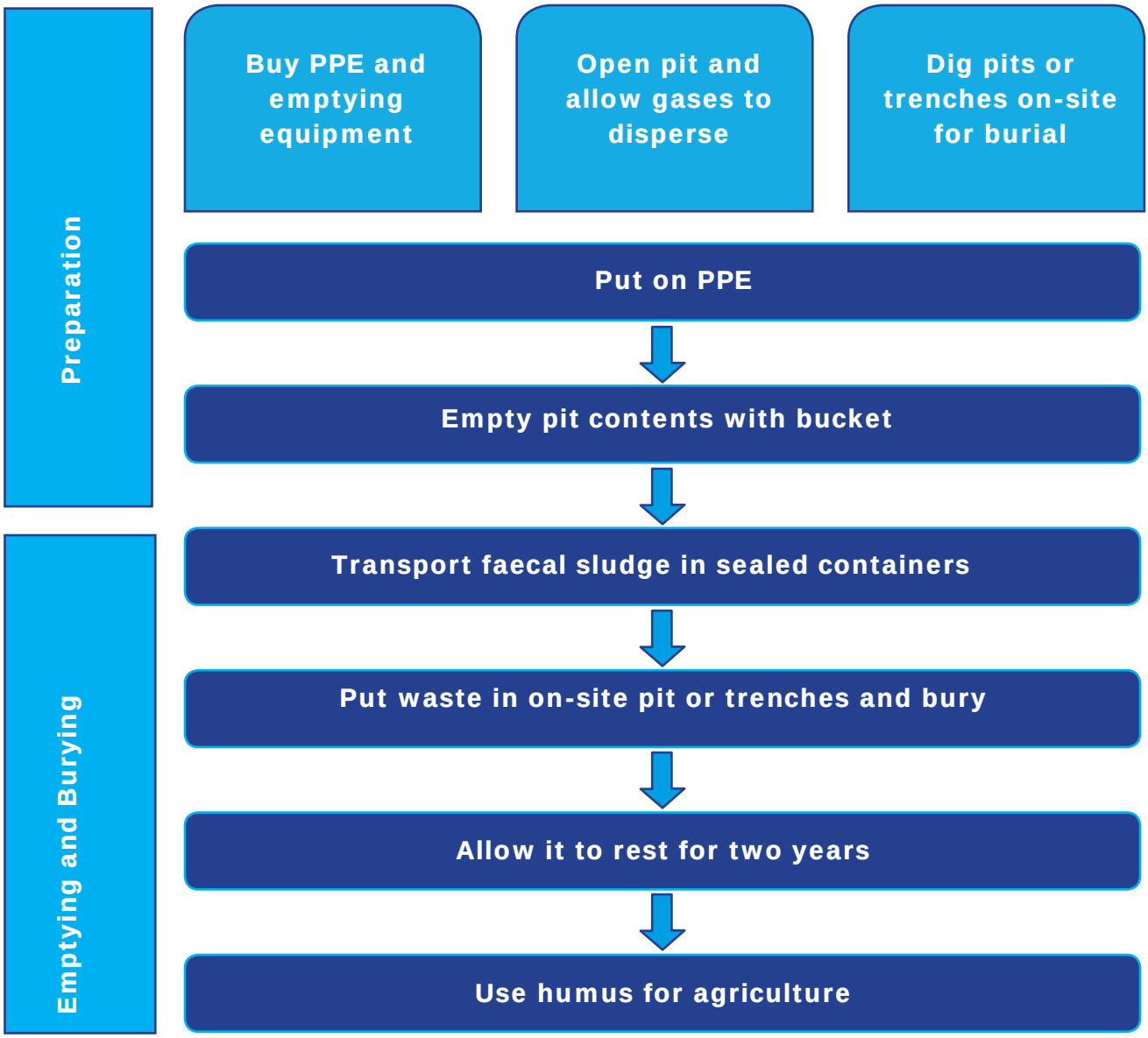


Figure 11. Guidance for manual pit emptying for on-site burial

Faecal sludge that is being extracted from a full pit represents a potential health risk to both the person emptying the pit and individuals and community in surrounding areas. Guidelines for safe handling and transport of faecal sludge are presented in Section 4.3.

Faecal sludge burial in trenches within the household's property

After extraction, faecal sludge is then moved and placed into a confined space for long-term (at least two years) storage and decomposition. Typically, storage place takes the form of a hole or trench in the ground that allows the extracted faecal sludge to be easily covered and buried (Figure 12). A study on the burial of faecal sludge in trenches was found to demonstrate significant pathogen inactivation during the dry season within less than 1.5 months. However, dry conditions can rarely be ensured. Hence, faecal sludge should be buried in trenches for at least two years. Burial of faecal sludge should only be undertaken in the dry season. Recommendations for on-site burial in trenches are as follows (Wetlands Work!, 2019):

Figure 12. Trenches dug for burial of faecal sludge. (Photo: Wetlands Work)

- Bury faecal sludge in an out-of-the-way place within the household's property (but at least 15 metres away from a water body or water supply, and away from the home, as per WHO recommendation);
- Dig ditches ~40cm wide, 3m long and 20cm deep;
- Pour sludge into ditch (via bucket or pump hose) and replace the soil on top;
- Do not disturb the area for at least two years to allow treatment of pathogens in the soil; and
- After two years, the area may be planted with crops.

Faecal sludge burial in pits within the household's property

Faecal sludge can also be buried in pits (Figure 13). Pits are good options for households that do not have enough land for trenches. The recommendations for pit burial are as follows:

- Bury faecal sludge in the dry season;
- Bury faecal sludge in an out-of-the-way place within the household's property (but at least 15 metres away from a water body or water supply, away from the home, and 1.5 metres above the groundwater table);
- Pour sludge into pit (via bucket or pump hose) and replace the soil on top;
- Do not disturb the area for at least two years to allow treatment of pathogens in the soil; and
- After two years, the area may be planted with crops.

Figure 13. Safe manual burial of faecal sludge in a pit (photos: SNV/Martin Jacquemin)

Treatment of faecal sludge can be enhanced by adding and thoroughly mixing hydrated lime during burial. The full details on hydrated lime and its application to faecal sludge can be found in the Technical Guidelines on Alternating Dual Pits by iDE in Annexure B.

4.2.4 Decision-making for safe on-site faecal sludge management

To review and summarise the various safe on-site FSM options, Figure 14 presents a decision-tree depicting the corresponding best management practices for each latrine type.

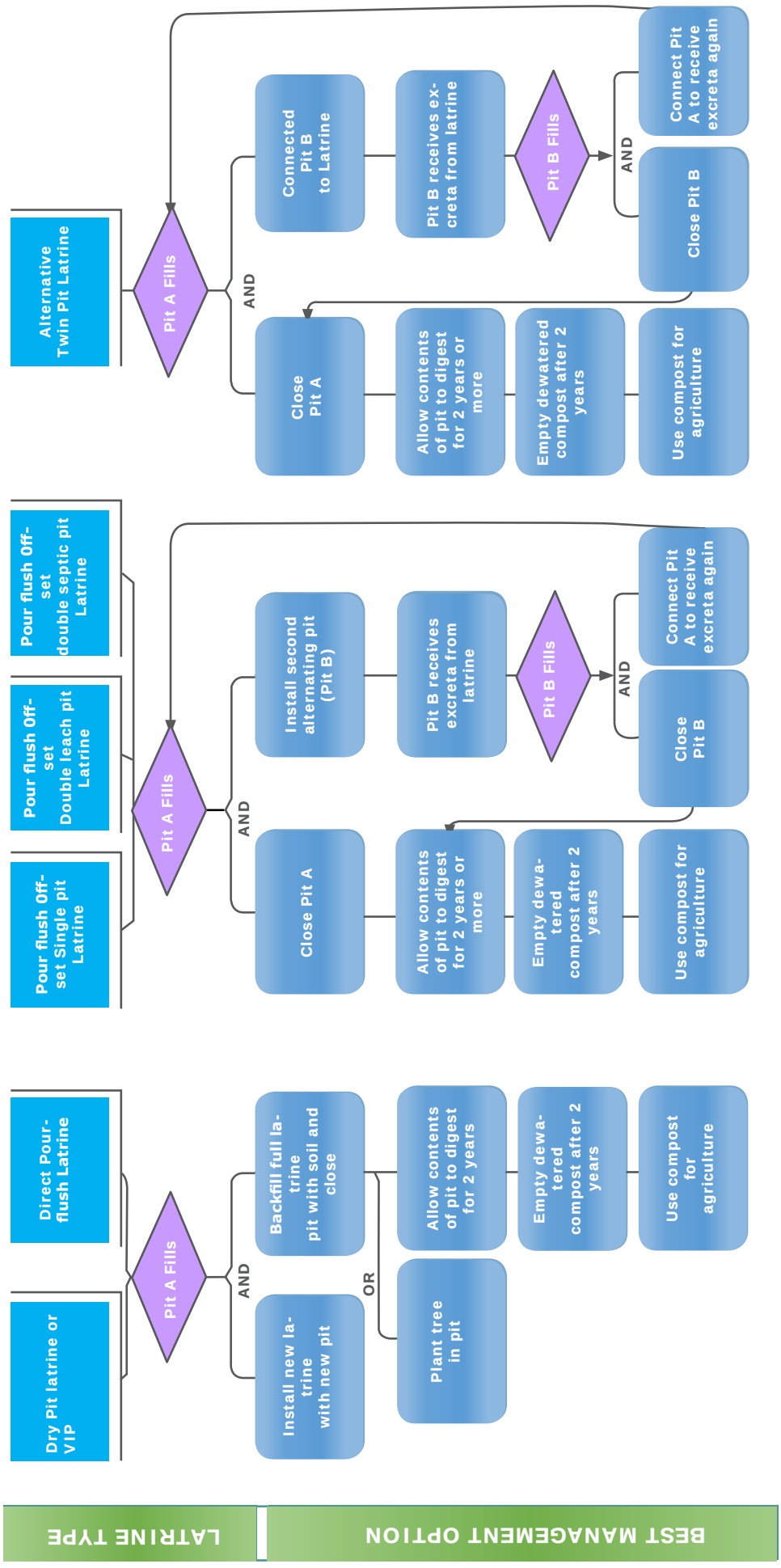


Figure 14. Safe on-site faecal sludge management decision-tree

Box I: On-site faecal sludge management in challenging environments

Safe FSM in challenging environments heightens the level of difficulty. Challenging environments are defined as communities in floating, flood-affected (moderately and severely), high groundwater, hard ground or water scarce areas (Ministry of Rural Development, 2019).

The same FSM principles apply for latrines in non-challenging contexts as they do for those in challenging environments. However, technologies and solutions may be different in many cases.

Latrine types that rely on leaching (e.g., pour-flush off-set single or double pit latrine and ATP) are not suitable in high ground water areas. In such settings, latrines need to be designed in a way that there is separation of at least two-vertical metres between the bottom of the latrine pit and the maximum annual groundwater level. Pits built in flood-prone or floating areas must be well-sealed to prevent faecal contamination of floodwater. Designs should ensure year-round functionality. Households should NOT take advantage of flood waters to empty faecal sludge from their pits.

Innovative latrine designs for floating and flood-prone communities including wetlands treatment (e.g., the Handypod) and biogas production (e.g., ATEC Bio-Digester). Further details on these designs may be obtained in the National Guidelines Principles on Sanitation in Challenging Environments for Rural Households (Ministry of Rural Development, 2019).

4.3 Guidelines for safe emptying, handling and transportation of faecal sludge

In some circumstances, faecal sludge must be extracted from a pit and moved to another on-site location (within the household's property). As all other FSM options, care should be taken to protect the individuals that are emptying the pits, as well as the surrounding community. Guidelines for the safe handling of faecal sludge under these circumstances include:

- Allowing time for gases to disperse after the pit lid has been opened;
- Wearing personal protective equipment (PPE), including gloves, waterproof boots, hats, full overalls (or clothing that covers all exposed skin) and a face mask;
- Transporting faecal sludge in covered buckets or containers to avoid spillage;
- Cleaning up and burying any spills that occur;

Furthermore, there is a need to ensure that workers follow good personal hygiene during and after faecal sludge handling, including: washing any exposed parts of the body with soap; washing contaminated clothes and garments; washing and sterilising any

equipment that was used to empty the pit (i.e., buckets, poles, pumps, hoses) or store and convey faecal sludge (i.e., buckets, jugs, tanks, containers). Rather than using water alone, household bleach can be used to sterilise such items. Bleach is available for purchase in most local markets. Product health, safety, and operation instructions should be followed accordingly.

Buckets, ropes, and various farm tools can be used for manual emptying. Buckets, pumps and hoses can be used for mechanical emptying. Regardless of the approach taken, all equipment is thoroughly washed, and contaminated soils and wash-water is buried to separate them from human contact.

Safe and unsafe faecal sludge handling and transport practices are presented and compared in Annexure D.

4.4 Summary of key recommended options and do's and do not's of faecal sludge management

On-site and in-pit treatment is the recommended and preferred faecal sludge treatment method for rural households. Therefore, faecal sludge is best treated by leaving it in-pit for at least two years before emptying. Pits should be emptied as far as possible in the dry seasons.

The recommended option for households is to upgrade existing latrines to an Alternating Twin Pit. Pit emptying and on-site burial is second best recommended option. Personal Protective Equipment (PPE) should always be worn, FS should be transported in covered containers and buried. Faecal sludge should not be dug up for at least two years and pit emptying should be undertaken as far as possible in the dry season. The do's and do not's of FSM are presented in the table below.

Do's and do not's of faecal sludge management

Do's	Do Not's
Managing the toilet and latrine pit	
• DO invest in an alternating twin pit toilet configuration because it is the best way to manage faecal sludge.	• Do NOT ignore decisions on how to best manage faecal sludge in a safe way.
• DO consult with village leaders if you have any questions about how to manage your faecal sludge safely.	
• DO periodically monitor the contents of faecal sludge in your latrine pit(s).	• Do NOT allow latrine pits to overflow or leak.
• DO use a neighbour's toilet if your latrine is full and your toilet can no longer be used.	• Do NOT start defecating in the open if the latrine pit becomes full.
• DO build a latrine pit that is offset (set a distance away from, rather than directly underneath) from the toilet pan.	• Do NOT build pour-flush latrines with the pit directly below the pan, as this makes it difficult to monitor and access.
• DO keep the latrine pit covered at all times, unless it needs to be opened for inspection or emptying. Pit opening at all times must be supervised.	• Do NOT leave latrine pits uncovered and unattended at any time to prevent accidents (e.g., children falling into pits) and health risks associated to faecal sludge (and flies) exposure.
Latrine pit emptying and handling	
• DO wear appropriate personal protective equipment – including clothing to cover your body, gloves, mask, and goggles, if possible – to avoid exposure to faecal sludge and pathogens.	• Do NOT allow faecal sludge to contact your body and skin, due to potential health risks.
• DO use motorised pumps or buckets to remove faecal sludge from pit.	• Do NOT enter a latrine pit under any circumstances.
• DO make sure that only healthy, strong, and able-bodied individuals undertake pit emptying.	• Do NOT allow the elderly, sick, or people with disabilities to empty a pit, due to the difficulty and dangers involved.
Faecal sludge transport	

• DO use containers for faecal sludge conveyance that prevent leaking or spillage.	• Do NOT use containers for faecal sludge conveyance that are uncovered, unsealed, or susceptible to leakage.
• DO clean up leaks and spills by burying.	• Do NOT leave leaks and spills without cleaning them up.
• DO clean and disinfect contaminated clothing and items that have been in contact with faecal sludge using household bleach or an equivalent disinfectant.	• Do NOT leave contaminated clothing and materials unwashed and properly disinfected.
Faecal sludge treatment and disposal	
• DO dispose of faecal sludge under the ground according to burial guidelines.	• Do NOT dispose of faecal sludge on the open ground or in a water body, because pathogens can easily enter the environment and eventually be transferred to humans.
• DO ensure that nearby water supplies are protected from the buried faecal sludge. This can be done by ensuring an adequate distance from the source of potential contamination (at least 15 metres) and ensuring that nearby water supplies are protected (such as lining and sealing dug wells, tube wells, and boreholes).	• Do NOT assume that faecal sludge will not contaminate the environment after burial.
Faecal sludge reuse	
• DO wait for faecal sludge to decompose and dewater – either underground after burial OR in a closed ATP – for at least two years prior to removal.	• Do NOT remove faecal sludge that has been buried or stored in a closed ATP until it has dried up and rested for at least two years.
• DO safely handle and dispose of liquid faecal sludge as per the recommendations in these guidelines.	• Do NOT use liquid faecal sludge as a fertiliser because it is unsafe.

5. Enabling Environment for Rural Faecal Sludge Management

Faecal sludge management-related behaviours and practices, which have been predominantly unsafe to date, are unlikely to change without some form of external support. External support and the actors responsible for them help create the enabling environment needed for safe FSM practice to thrive.

Private sector solutions

The majority of latrine producers servicing rural Cambodia are unfamiliar with the ATP latrine design. In areas where ATP latrines are intended to be promoted, producers need to be trained on the designs, construction methods and ATP functionality. Upgrades of traditional latrines to ATP latrines may also require additional training. ATP training materials for latrine producers have already been produced (Annexure B), along with informational and marketing materials for users and potential customers. Experiences to date (including SNV's ATP pilot demonstration and demand creation activities in Kampot and Kampong Speu provinces) have shown that construction quality needs to be monitored after training is completed. Latrine producers and masons need to take responsibility for educating ATP users on the correct functionality of their latrines.

With the use of latrines across rural Cambodia now commonplace, emerging sanitation solutions such as the ATP offer latrine producers a new product to meet a wider-range of customer demands. Enhancement of product offerings may help latrine producers to diversify their income streams and support profitability.

Capacity building of local authorities

Local authorities and decision-makers across rural Cambodia are unlikely to have already responded or taken FSM actions. Although an emerging issue, need and demand are still low in many areas. To prepare for the inevitable, local authorities require capacity building and sensitisation on FSM issues as well as the range of solutions available to them, in accordance with these guidelines. Local authorities and local leaders have a significant role to play in accelerating community behaviour change. Therefore, local authorities must be empowered to take ownership of the FSM issue and motivate their communities to consider FSM seriously and direct them towards practical on-site solutions. Behavioural change communication tools for safe FSM practices have already been produced and are presented in Annexure C. Local authorities who have been assigned sanitation functions through decentralisation also have a mandate for FSM-related planning, budgeting and implementation of activities. These functions are likely to require specialised capacity development.

Monitoring systems

The MRD intends to monitor progress in safe FSM against targets set in the National Action Plan (NAP) II. As a result, MRD will require monitoring tools and approaches to routinely keep track of the proportion of the rural population practising safe FSM. The national WASH Knowledge, Attitudes, and Practices (KAP) survey may be the most suitable tool to monitor safe FSM practice. However, questionnaires used in the past will have to be adapted accordingly. The national Commune Database (CDB) could also be revised to include FSM indicators. Monitoring systems serve as an accountability tool and to aid authorities in adapting programmes and approaches when they do not achieve their intended results and outcomes.

Legal instruments and incentives

Legal tools, such as district regulations, can be used to increase understanding of the importance of FSM issues and to motivate actions taken by local authorities. The MRD and sub-national governments can also consider integrating penalties and/or incentives in FSM programmes to encourage safe FSM uptake by households and communities.

Advocacy for FSM

Advocacy and awareness raising of FSM can be integrated in local and national WASH activities and events. Advocacy is important for engaging communities in FSM issues and to mobilise support in implementing safe and shared solutions.

6. Roles and Responsibilities for Rural Faecal Sludge Management

Faecal sludge management in rural areas is the responsibility of multiple levels of government, various agencies and stakeholders, each with their particular roles to fulfil. A comprehensive overview of institutional roles and responsibilities for rural water supply and sanitation is available in the ADB Water Supply and Sanitation Sector Assessment, Strategy, and Road Map. (Asian Development Bank, 2012).

Ministry of Rural Development

The MRD is responsible for ensuring that FSM is addressed in rural WASH sector strategies and policies. It is also responsible for the coordination of stakeholders and of forums for knowledge sharing, such as the FSM Technical Team (chaired by MRD). The ministry is also charged with the development and dissemination of FSM guidance (such as this document) and relevant standards. The Department of Rural Health Care (DRHC) within the MRD is responsible for rural sanitation and hygiene, including FSM.

Provincial level

Provincial Action Plans (PAPs II) have been prepared for each of Cambodia's 25 provinces, by the Provincial Working Groups (PWGs), which are led by each province's respective PDRD. The PWGs are responsible for rural WASH planning and implementation, and progress monitoring based on FSM indicators in the PAPs and NAP II. The NAP II recognises that institutional capacities of PDRDs, PWGs and local authorities will need to be progressively strengthened, including greater sensitisation to the concepts of safely managed sanitation and FSM. The MRD and PDRD are, therefore, responsible for transferring knowledge and understanding of these guidelines, and the FSM solutions herein.

District level

The DoRDs support District Administrations and commune councils with monitoring and provide technical support in investment planning. A growing number of District Administrations have also established RWSSH District Working Groups (DWGs) and appointed RWSSH focal points. Fifteen districts have accepted the transfer of functions associated with rural water supply, sanitation, and hygiene (RWSSH) under MRD's decentralisation initiative. The DWGs, DoRD and RWSSH focal points are responsible for coordinating FSM initiatives and for liaising with development partners, NGOs and the private sector, as relevant.

Commune and village level

The commune council is part of the local government and works closely with village chiefs and communities. The commune council is responsible for community-level guideline implementation within their jurisdiction – including the deployment of communication strategies and promotion of good practices. Various activities and processes have been deployed across Cambodia for local actors to engage in sanitation promotion. Many of these activities and processes can be utilised and adapted to promote FSM. Specifically, the role of commune councils in FSM includes:

- Planning FSM activities through district or commune level sanitation committees;
- Incorporating FSM activities (in accordance with these guidelines) into Commune Investment Plans (CIPs)/Commune Development Plans (CDPs);
- Conducting awareness campaigns to increase understanding of FSM concepts and solutions amongst commune residents, utilising the tools included in these guidelines;
- Mobilising private sector participation to provide appropriate FSM solutions, and to support demand creation for these services;
- Participating in and supporting FSM training of local stakeholders; and
- Requesting technical support and FSM training from PDRD and DoRD, as needed.

Households and managers of public institutions (schools, pagodas, health care facilities, etc.)

Households and managers of public institutions and facilities are responsible for operating, maintaining and managing their latrines and the faecal sludge that is produced and accumulated. They should make sure that faecal sludge is safely contained, treated, collected, transported and disposed according to these guidelines. They are also responsible in ensuring that safety procedures are followed during pit emptying.

Latrine businesses and masons

Latrine producers influence consumers' decision-making about latrine designs, through the types of products they offer. Design-specific decisions are made on, for example, the type of latrine, number and configuration of pits, proximity to the home, number of cement rings included in each pit, materials at the bottom of the pit, decision to seal the base of the pit or not, whether cement rings have leach holes, and design and installation of pit covers. These design factors influence the functioning of the latrine, fill rates and ease of emptying faecal sludge from the pit.

Capacities of latrine producers and local masons should be improved so that they are able to install or upgrade existing latrines to ATPs or add leach pits or trenches to septic pits. Businesses and masons should be educated on safe and unsafe FSM practices, and in turn be able to advise households. Latrine producers should also stock equipment and materials that rural households need for moving or upgrading their latrine, or emptying, namely: protective gloves, mask and shoes; buckets with lids; mechanical agricultural pump and hose; trowels and digging tools, and lime.

Development partners and NGOs

Development partners should support the MRD with the integration of effective FSM solutions into existing policy and strategy tools, and contribute to FSM research, innovation, and evaluation. NGOs that are implementing sanitation projects should integrate and promote FSM solutions according to this guideline.

Other national agencies

Faecal sludge management in rural Cambodia remains unregulated. The Ministry of Public Works and Transport (MPWT) is responsible for urban wastewater collection and management and has a wastewater sub-decree addressing sewerage systems. There is no specific mention of FSM in the sub-decree. It states that if households are near a sewer network then they must connect, otherwise they must install an on-site septic tank. While MPWT has developed a Wastewater System Operation and Maintenance (O&M) Guideline it does not address on-site sanitation systems and FSM (Ministry of Public Works and Transport, 2018).

The Ministry of Health (MoH) is responsible for setting wastewater quality standards. The MoH is also responsible for sanitation and FSM services within healthcare facilities. The Ministry of Environment (MoE) Department of Pollution Control (including provincial departments), is responsible for water pollution control and monitoring the quality of effluent passing into natural waterways or storm water drains. While the licensing of FSM operators is MoE's responsibility (Asian Development Bank, 2012), an active licensing system does not exist (WaterAid - Cambodia, 2018). As part of its responsibilities for waste management, MoE has set technical standards for the safe decomposition of human waste (Ministry of Environment, 2006), which align with the WHO Guidelines (World Health Organisation, 2006).

7. Knowledge Gaps and Future Priorities for Household-level Faecal Sludge Management in Cambodia

Research gaps

In Cambodia, safely managed sanitation is an emerging concept and FSM an emerging issue. Therefore, there are many gaps in the current knowledge and understanding. Research is needed in some areas, for example, household knowledge, practices and perceptions about FSM (to ensure that FSM solutions in the rural Cambodian context are inclusive). To date, studies and surveys have been limited to specific geographical areas and contexts. More data is needed to determine the efficacy and viability of faecal sludge treatment methodologies and processes for the Cambodian context. While ATPs are currently being promoted, the efficacy of the treatment of faecal sludge by burial requires further study.

Additionally, while research conducted in Cambodia shows that sludge treatment effectiveness can be enhanced with hydrated lime, there are still gaps in the understanding of how lime additives can be practically applied (Chakraborty, 2014). The WHO guidelines indicate that there should be ≤1 egg per gram of total solids before decomposed humus can be reused (World Health Organisation, 2006). Further studies are required to test practical approaches to faecal sludge treatment that claim to reduce pathogens, including helminth eggs, to safe levels. Additionally, for off-site FSM services, there is minimal information available on the scale and scope of existing operators, the pit emptying and disposal methods they deploy and the locations that they service. More consideration is needed towards service provider licensing and enforcing this. And finally, little is known so far about equity issues associated with safe on-site FSM and how contextual, cultural and poverty factors may affect a household's ability to practise safe FSM.

Need for innovation

Further innovation relating to FSM is also required in some areas. Testing and refinement of safe FSM marketing and BCC approaches are needed to determine whether they are effective. Methods for motivating households to proactively monitor the height of faecal sludge in their pits remain underdeveloped.

Although most rural households already use a single or double pit pour-flush latrine, innovative solutions are needed to adapt such configurations so that the extraction of faecal sludge can be avoided. Further research, innovation, and pilot trials are also needed to explore viable commercial possibilities for faecal sludge reuse, as fertiliser or for biogas production, including the business models that would be needed to sustain them.

Policy and regulatory gaps

Lastly, policy and regulatory gaps remain, particularly relating to sector monitoring of FSM, enacting guidelines through capacity development, and establishing environmental controls. A newly established Monitoring Information System (MIS) is the primary platform for monitoring progress in the WASH sector. However, FSM-related indicators still have to be developed and integrated.

Additionally, detailed plans are needed to enable the future dissemination of the National FSM guidelines for rural households, and the subsequent capacity building of stakeholders. In its role of protecting the quality of water resources, there is also a need for the MoE to establish effluent standards for different receiving waters and fields. Similarly, it would be useful for Ministry of Agriculture, Forestry, and Fisheries (MAFF) to establish standards for the reuse of faecal sludge for agricultural purposes or fertiliser production. Occupational health and safety guidelines for on-site service providers (i.e., latrine businesses) and pit emptying services should also be developed.

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Annexure A: Off-site Faecal Sludge Management

Off-site faecal sludge management (FSM) is not the mandate of MRD and, therefore, these guidelines do not aim to provide comprehensive guidance on the subject. However, as there is demand for off-site FSM, and as there are private service providers already satisfying this demand, off-site FSM recommendations are briefly outlined in this annexure.

Businesses that provide off-site FSM services typically operate in Cambodian cities and towns. However, some service providers have been found to be serving parts of rural Cambodia. Recent studies suggest that the majority of these off-site pit emptying service providers are disposing faecal sludge above ground, in water bodies, or onto rice paddies – without any treatment. Such practices can lead to health and environmental risks, particularly because service providers may be dumping large volumes of faecal sludge at a single location.

Going forward, the professionalisation of off-site FSM services may become a priority so as to ensure that faecal sludge is safely treated, disposed and/or reused. A range of treatment approaches have been trialled or are in use in certain locations in Cambodia include: Decentralised Wastewater Treatment Systems, Wastewater Treatment Plants (WWTP), bio-digestors, burial and sludge drying beds. In the meantime, faecal sludge collectors should dig holes and bury faecal sludge. If this is not possible, faecal sludge should be spread and ploughed into agricultural soil as far away as possible from communities. Local authorities may take actions to control or monitor the dumping of faecal sludge by FSM service providers.

Decentralised Wastewater Treatment Systems (DEWATS)

Decentralised Wastewater Treatment Systems (DEWATS) systems are engineered self-contained collection and treatment systems usually considered for medium-density populated areas such as small towns, peri-urban areas and medium sized villages. DEWATS can be suitable for treating human waste in community-level contexts or in public institutions such as schools, hospitals, communal facilities, informal settlements, temples, orphanages, etc. They can also be used to treat organic industrial wastewater arising from food factories, abattoirs, animal farms, tofu producers or markets. DEWATS have the potential for resource capture and reuse, for example for fertiliser or biogas. (ESC-BORDA, 2013).

Wastewater treatment plants

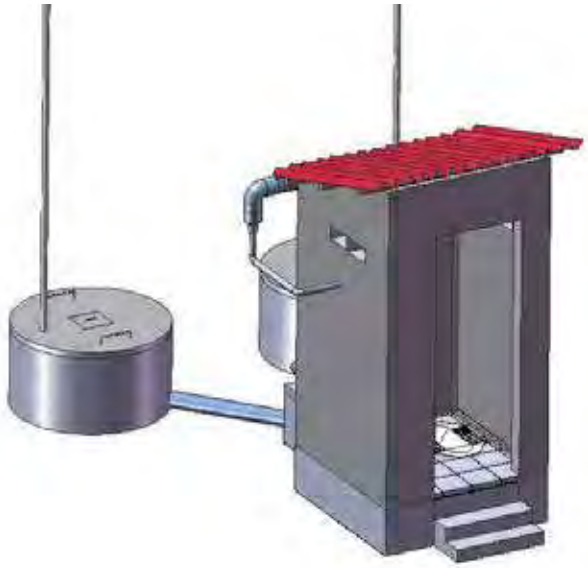
In centralised wastewater treatment systems in cities and urban areas, wastewater treatment plants (WWTPs) are usually connected to main sewers for the treatment of urban sewage collected through a piped network. In some countries FSM tankers and

vacuum trucks discharge collected waste into WWTPs for co-treatment with sewage. In Cambodia, however, there is only one functioning WWTP in Siem Reap with more to come in Battambang, Kampong Cham and Sihanoukville. Thus, there are very few options for proper disposal and treatment of faecal sludge at WWTPs. Studies (by PSI, SNV and WaterSHED) show that most tankers dispose faecal sludge directly into water bodies, rice paddies or open land posing a public health and environmental risk.

Sludge drying beds

Sludge drying beds separate the solid and liquid components of faecal sludge through evaporation, settling and filtration. Drying beds are large shallow open areas with low walls usually lined with sand and gravel and an underground drainage system to collect liquid. Faecal sludge with high solid content (>5 per cent) is discharged into these shallow beds/ponds and the drainage system allows liquid to drain away, and for solids to dry out by sun exposure. Drying beds also require large areas of land and should be located far from inhabited areas. Sludge drying beds are often a key treatment process in a WWTP but can also been built separately where loads are small (<20m3/day) (Tyler, 2018). After two years of treatment (with no new faecal sludge added to the drying bed), if humus is dry, it can be collected and used for agriculture.

Annexure B: Alternating Twin Pit Latrine Design Guidelines and Training Materials



Alternating Twin Offset Pits (ATOPs)

បង្គន់លូស្នុកឆ្ពោះឆ្លាស់គ្នា

Construction Manual *for Latrine Producers*

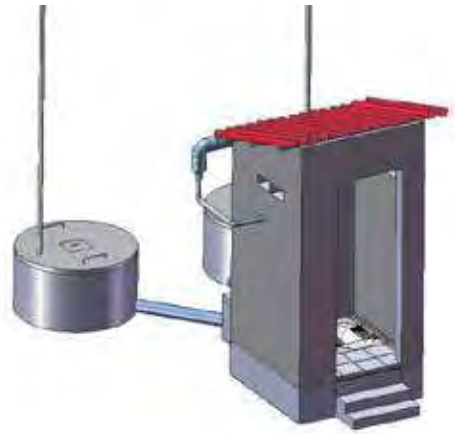
@2019

SNV

Content:

1. What are Alternating Twin Offset Pits (ATOPs)

A pour flush toilet with ATOP system has only one pit used at a time until it is full. When one pit is full, it is left untouched for at least two years to allow the waste liquid to infiltrate into the soil and fecal sludge to dewater so that it can be removed manually with a shovel and reused on-site as compost to improve soil fertility. Flow from the toilet is manually redirected to the 2nd pit during this 2-year waiting time. Like with the majority of pit latrines, most pathogens are filtered during soil infiltration or die-off with time and distance, however, there remains a risk of groundwater pollution, particularly in densely populated areas or in areas with a high groundwater table. Protective gear must be used during the manual fecal sludge emptying. Advantages and disadvantages of the ATOP design are presented below.



Advantages

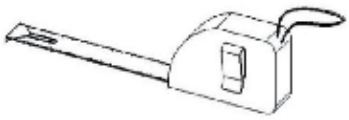
- Because double pits are used alternately, their life is virtually unlimited
- Excavation of dry fecal sludge from the pit is easier than wet fecal sludge
- Potential for re-use of fecal material as soil conditioner
- Flies and odours are significantly reduced
- Can be built and repaired with locally available materials
- Low (but variable) capital costs depending on materials; no or low operating costs if self-emptied
- Small land area required for a 2nd pit
- Moderate reduction in pathogens

Disadvantages

- Not an appropriate option in areas with high water tables (dewatering of fecal sludge would not occur)
- Manual removal of dewatered fecal sludge is required
- Moderate investment costs if upgrading an existing latrine
- Requires available land for construction of 2nd pit and/or control box to direct fecal sludge flow
- Fecal waste levels in the pit must be monitored periodically to know when to alternate flow into the 2nd pit

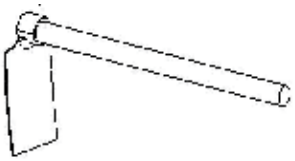
2. Tools and materials

Tools for on-site construction



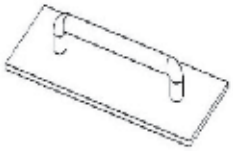
Measuring tape

Plumb rule level



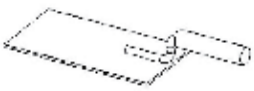
Spade

Shovel

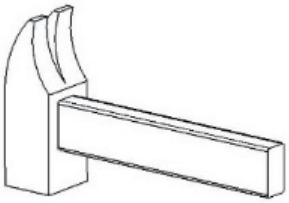


Hand float

Cement bucket



Bucket trowel



Hammer

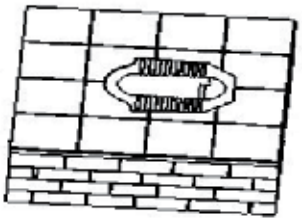
Materials

Sand
(2 cement bags)

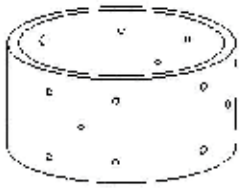
Gravel
(1 cement bag)

Cement (1 bag)

Bricks (100 pieces)

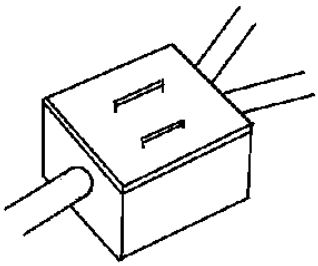


Squatting pan set



Ring
(6 cement rings)

Ring cover
(2 cement covers)



Control box
(L.40cm x W.40cm x H.40cm)

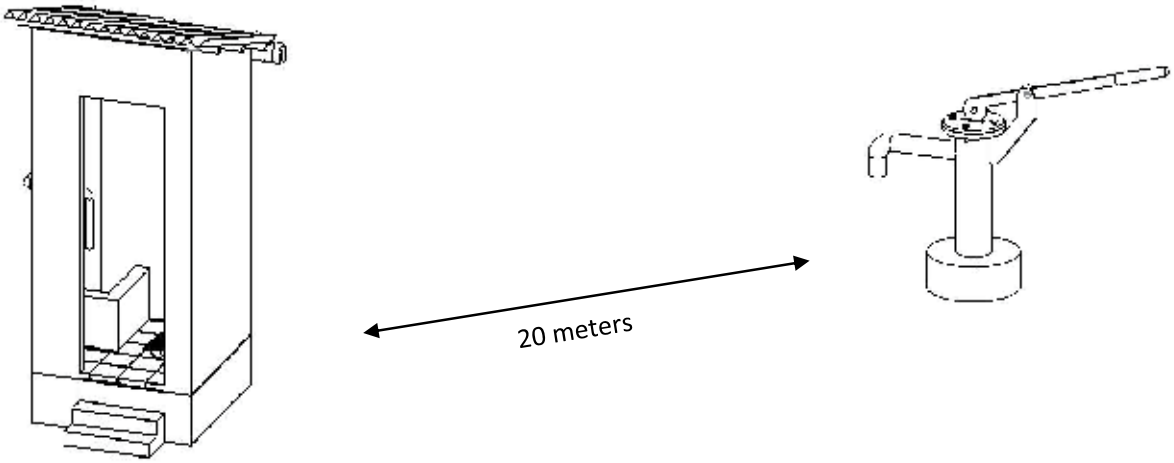
PVC pipe (4m)

3

3. Site selection for construction

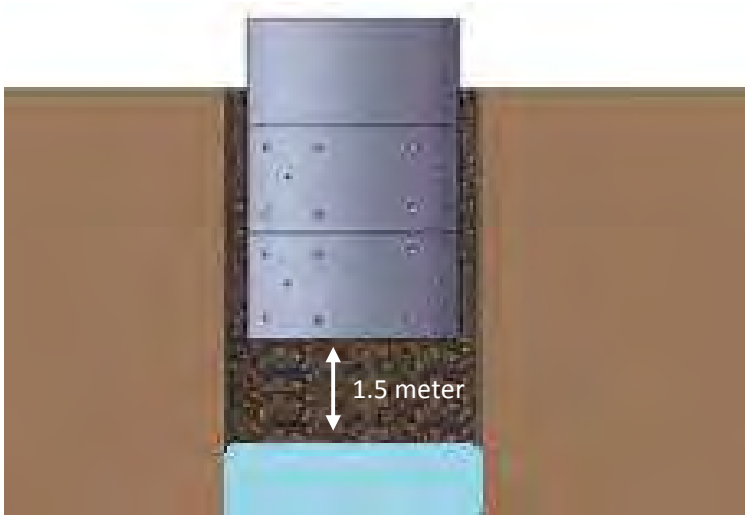
3.1 Location

It is suggested that toilets of all types should be built near the home (for convenience) but at least 20 meters away from drinking water sources such as wells, rivers, and ponds.



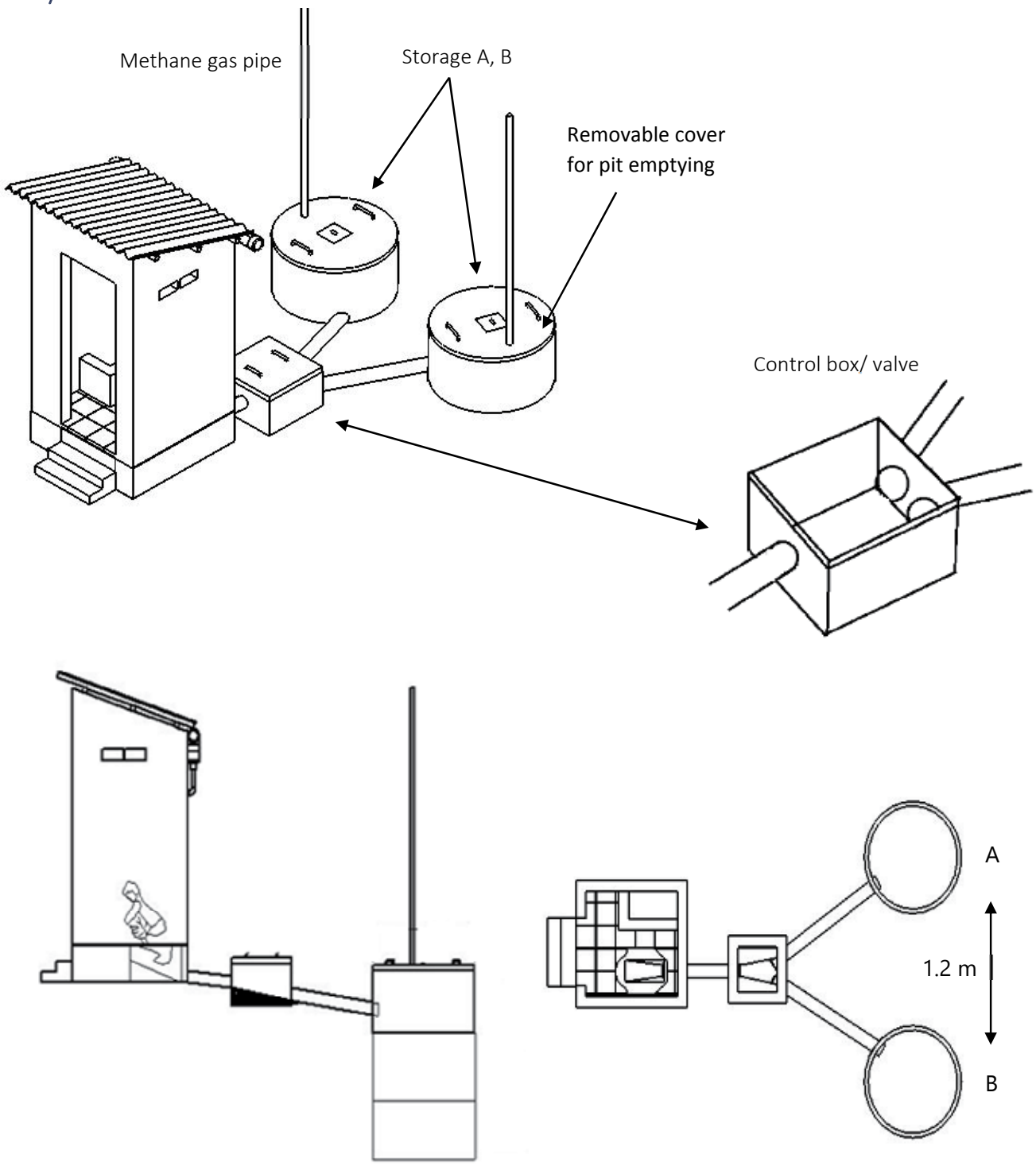
3.2 Distance to groundwater

It is suggested that the distance between the bottom of the pit and groundwater should be at least 1.5 meter. ATOPs are not suitable in areas where the groundwater level will make contact with the pit (even during the flooding season) – as this will not allow the fecal sludge to dewater over the 2-year resting period.



4. Construction

4.1 Layout



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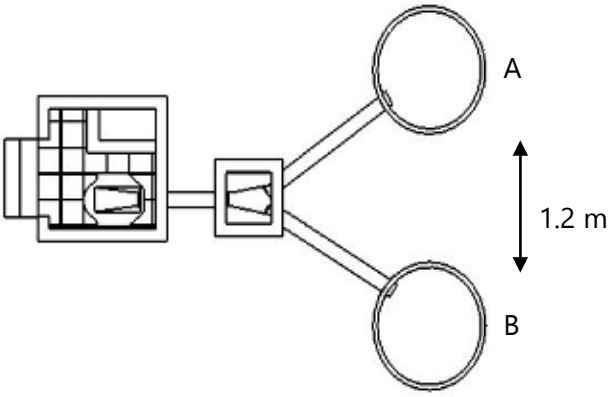
4.2 Double pit offset construction

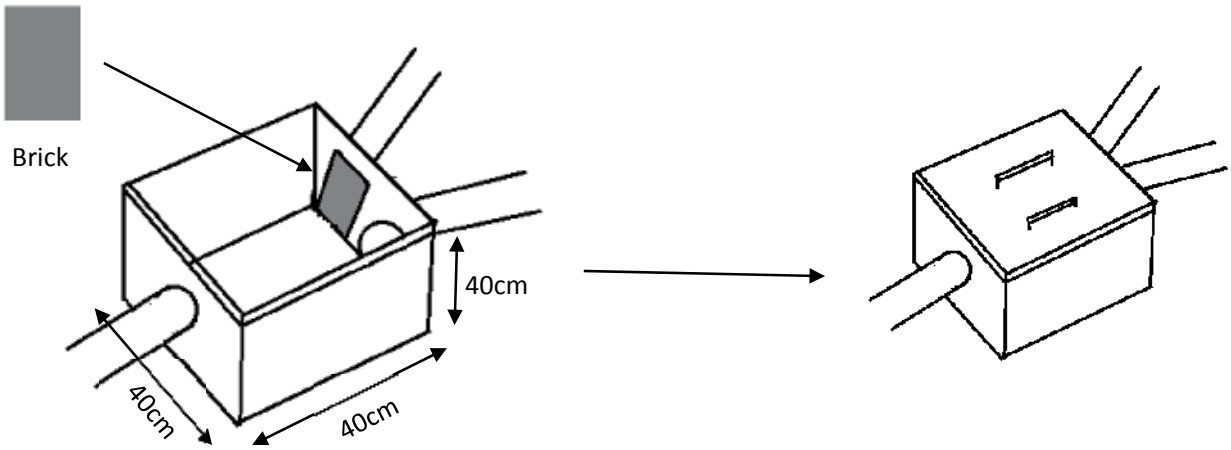
4.2a Distance between the two pits

The distance between the two pits should be at least 1.2m.

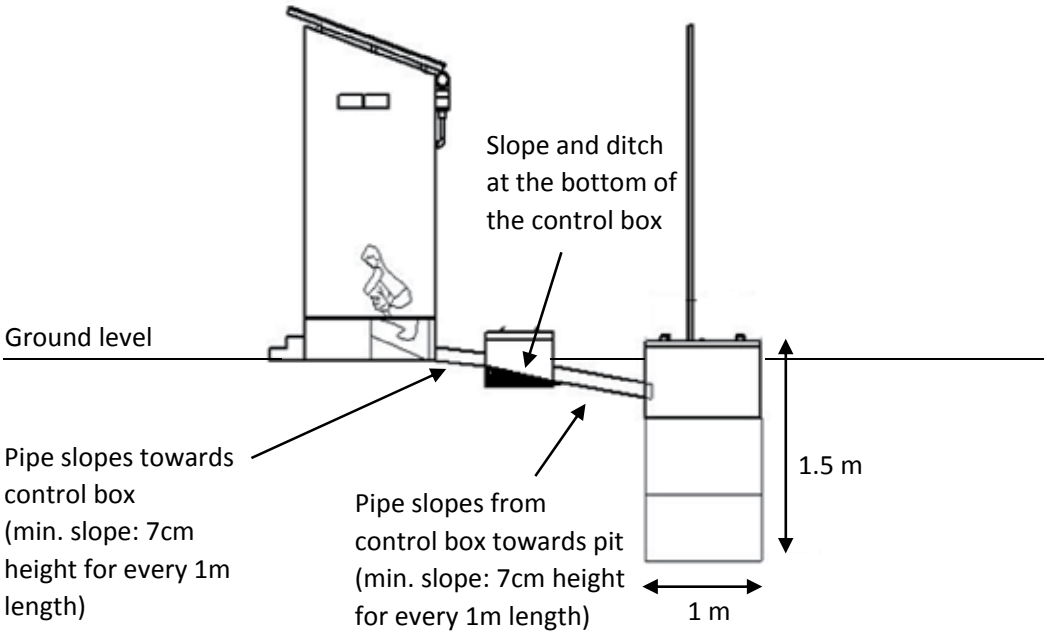


4.2b Control box

- The purpose of the control box is to direct waste water and fecal sludge to the selected pit, and to be able to manually change the direction once a pit becomes full.
- For a better flow of the faecal sludge into the pit, there should be a slope and ditch to each pit at the bottom of the control box.
- A brick and mortar should be used to seal the opening of the pipe that leads to the unused pit. When the user desires to begin using the 2nd pit, they can use a hammer to break the brick seal, and then re-seal the opening of the pipe that leads to the full pit.



4.2c Pipe slope



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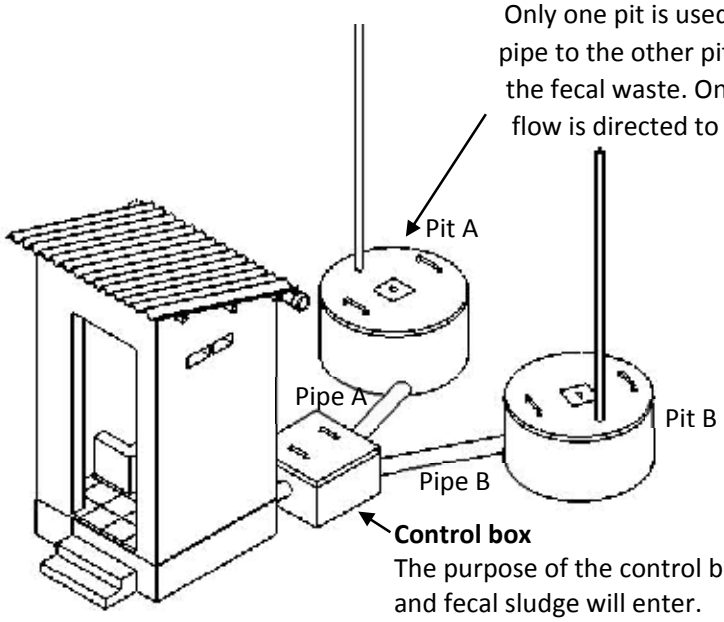
5. Functionality of the ATOP

The functionality of the ATOP is described below.

Only one pit is used at a time until it becomes full. The pipe to the other pit remains blocked to prevent flow of the fecal waste. Once one pit has become full then the flow is directed to the other pit using the control box.



Control box

The purpose of the control box is to control which pit the waste water and fecal sludge will enter.

Once the first pit (Pit A) has become full, the following steps can be followed to correctly operate the ATOP:

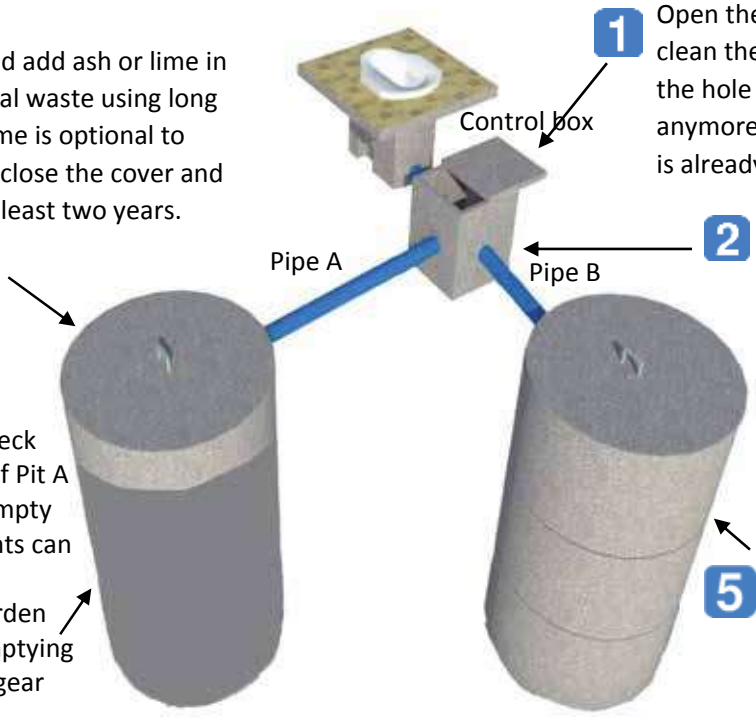
1 Open the control box. Flush water to clean the box and use a brick to cover the hole of Pipe A in order not to let anymore fecal waste enter the pit that is already full (Pit A).

2 Break open the blockage for the pipe hole to Pit B. Flush some water through it to make sure Pipe B is not clogged.

3 Open Pit A's cover and add ash or lime in and mix well with fecal waste using long wood stick (adding lime is optional to reduce smells). Then close the cover and keep it unused for at least two years.

4 After two years, check that the contents of Pit A are dry and if so, empty the pit. The contents can be used as a soil conditioner in a garden for field. When emptying the pit, protective gear should be worn, including:

- Protective dress
- Gloves
- Boots
- Face mask
- Shovel and bucket

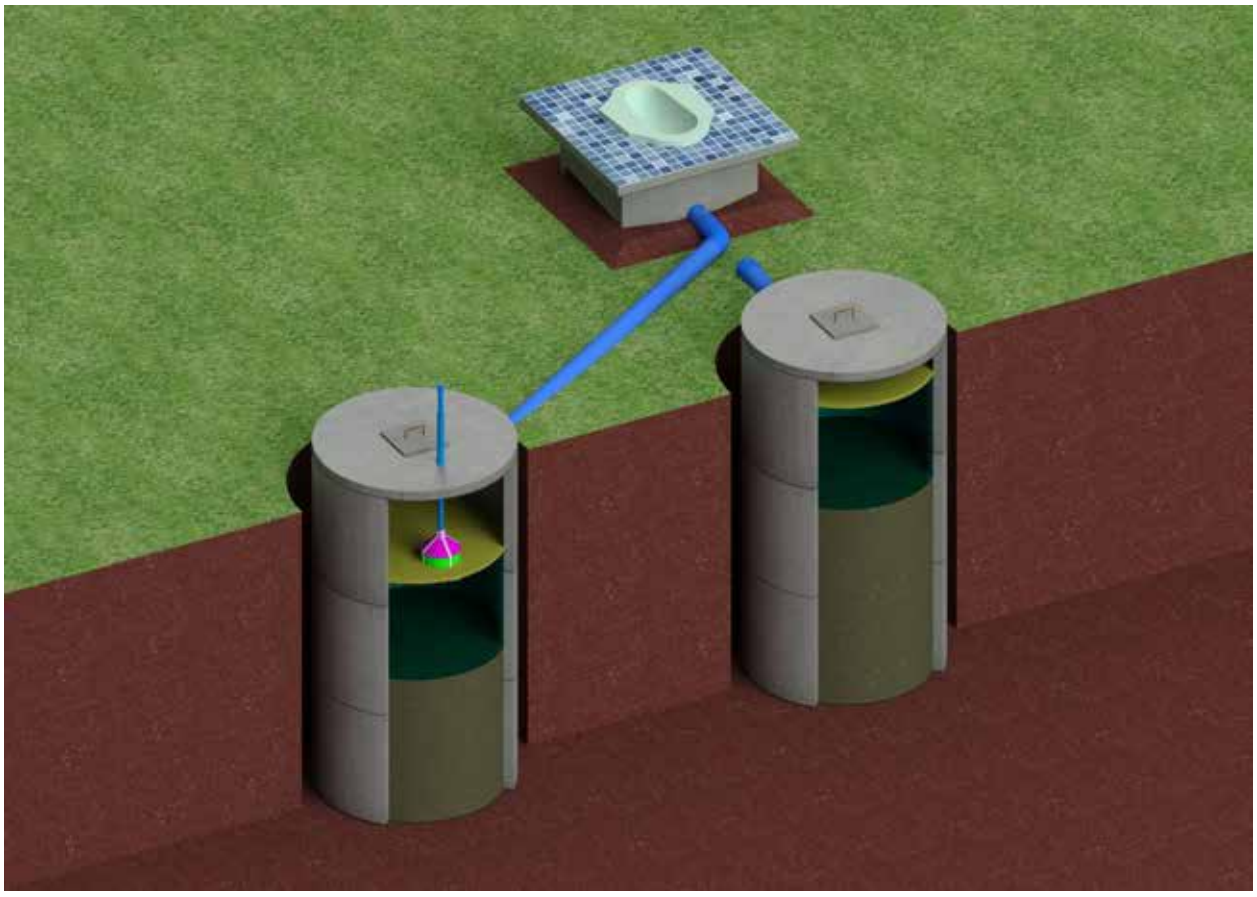


5 When pit B is full, then move to use pit A through same process.

Faecal waste cannot be safe

If empty the faecal sludge, the sludge is not dry	If empty the faecal liquid, the liquid is not clear

TECHNICAL GUIDELINES ON ALTERNATING DUAL PIT



DEVELOPED BY: iDE CAMBODIA

UPDATED: OCTOBER 2019

Technical Guidelines
on
Design, Construction and Maintenance
of
Alternating Dual Pit Upgrade Product

ACRONYMS AND DEFINITIONS

ADP- Alternating Dual Pit

FSM- Fecal Sludge Management

PG- Pit Gauge

ACKNOWLEDGEMENTS

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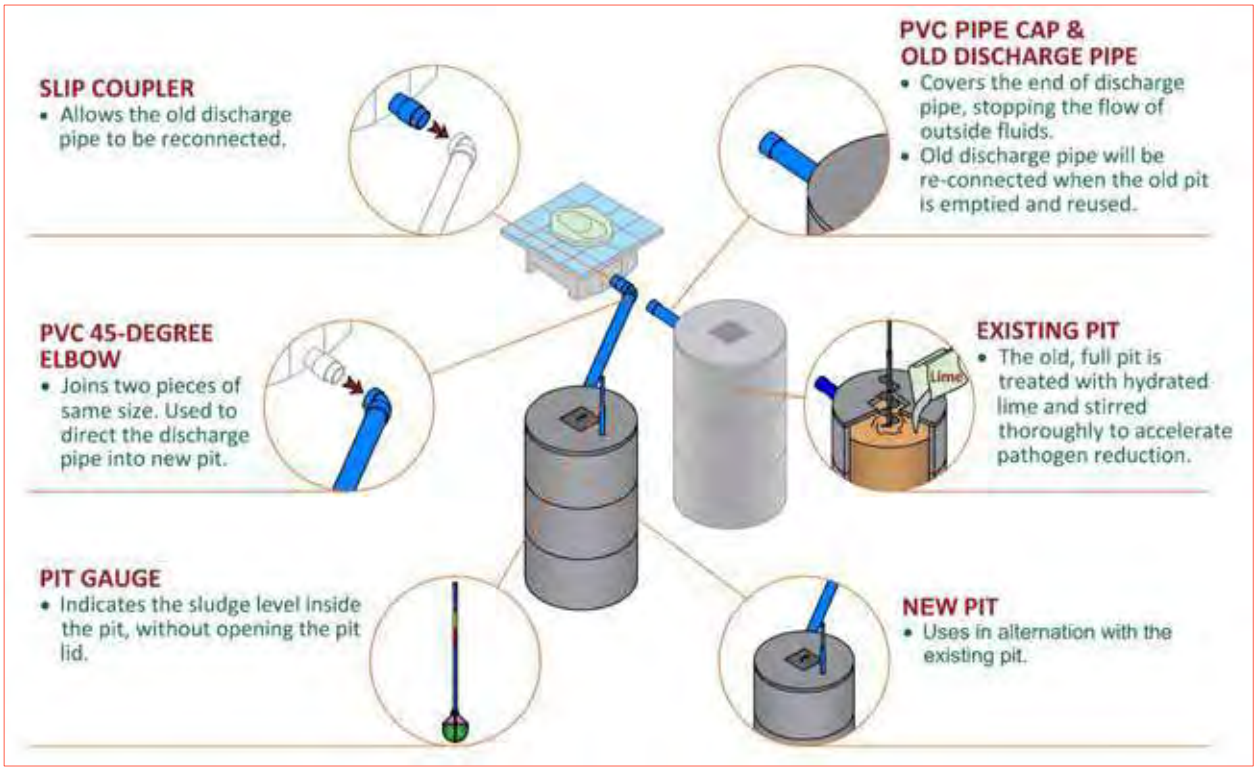
EXECUTIVE SUMMARY

iDE continues to play a role in Cambodia's increasing latrine coverage and supports the Royal Government of Cambodia's initiative to reach 35% safely managed sanitation coverage by 2023. Fecal sludge management (FSM) is a key component of safely managed sanitation. The Alternating Dual Pit (ADP) is a FSM product - service combination that iDE is currently supporting businesses to produce. The product consists of an upgrade to an offset, pour flush latrine through connection of an additional pit designed to alternate when one pit fills. This enables households to let their full pit dry and stabilize, then safely empty waste and alternate back when the other pit fills. The ADP has been designed to be installed in various orientations depending on household geographical and space constraints. Each installation also includes a Pit Gauge product that enables households to see when their latrine pit is nearly full. The service component of the ADP is the treatment of the old, full pit with hydrated lime. Hydrated lime is added and mixed into the pit before the old pit is sealed and disconnected.

1. ADP PRODUCT DETAILS

ALTERNATING DUAL PIT (ADP), also known as an alternating twin-pit offset latrine, is linked to a pour-flush latrine with PVC pipe fittings. The ADP is sold as an upgrade fecal sludge management product and service to households experiencing a full latrine pit. Only one pit is connected to the latrine pan at a time. When a pit is full, it is treated with hydrated lime (see below), separated from the latrine system, sealed, and capped. The latrine is then connected to the other latrine pit. The pathogens in the sealed pit will deteriorate over time as the waste dries and stabilizes. After approximately two years, sludge is expected to be safe to empty, as well as rich in nutrients that can be used for agriculture. [1] The owner is expected to continue to alternate the



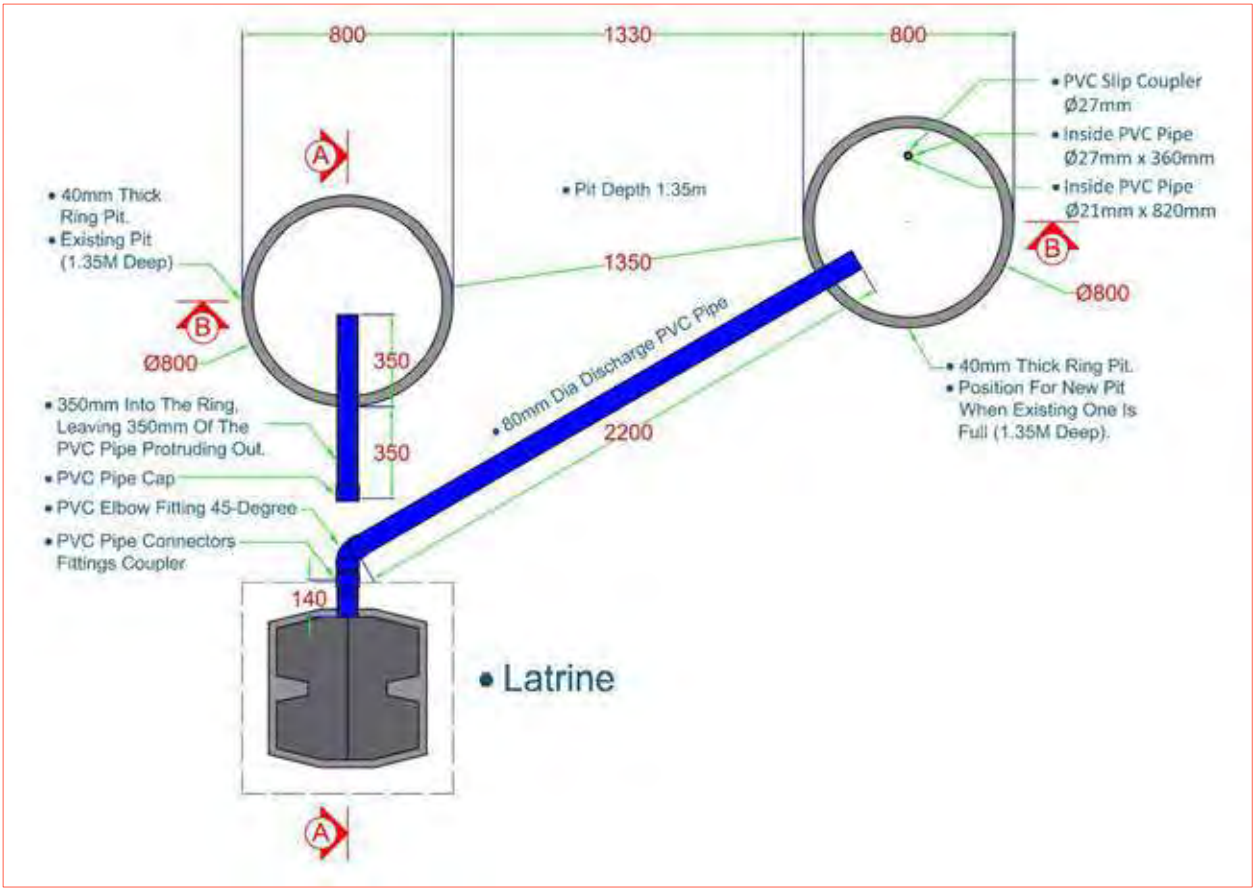
[1] Guidelines on sanitation and health. Geneva: World Health Organization; 2018. License: CC BY-NC-SA 3.0 IGO.

system's connection to the other pit as one fills, ideally by contracting the services of the local business provider who initially installed the product.

2. SITE SELECTION

The positioning of the pits is determined to a large extent by the space available.

If possible, the distance between the pits should be not less than the depth of a pit. This is to reduce the possibility of liquid from the pit in use entering the pit which not in use.



If the pits have to be built adjacent to each other, an impervious barrier should be provided between them.

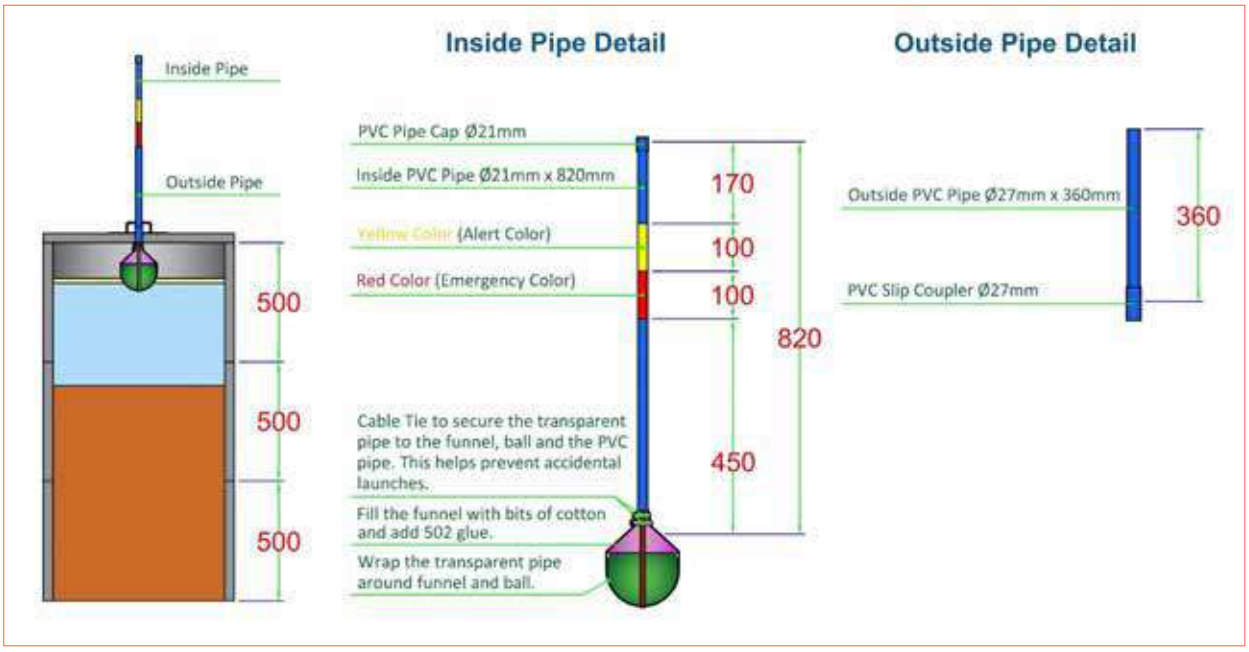
The ADP should **not** be constructed in areas with high ground water or any locations expected to experience flooding. The ADP should be installed at least 15 meters away from any open water or drinking water source.

3. PIT GAUGE INTEGRATION

Through insights gained from sector research, operational experience, and engagement with households to better understand their needs, iDE has learned that in the Cambodian context, FSM is usually dealt with only when it becomes an emergency. Households are often surprised by their pit filling and therefore being unable to use it. This can result in haphazard practices to be able to use the pit again, like manual emptying or

puncturing the side of the ring to allow excess water to exit. While more research is needed to better understand household level FSM behaviors and motivations, one reason for this reactive, rather than proactive behavior, is likely due to the fact that the issue is not clearly visible; the fill level of pits is hard to know without opening the pit.

In order to make the status of a pit's capacity visible, iDE Cambodia has invented a simple, low-cost device called the Pit Gauge (PG). The PG is installed in a household's new latrine pit. The purpose of the PG is to serve as a type of "alarm clock" that signals when a pit is nearly full and approaching the need for maintenance. As the pit's water and sludge levels increase beyond the last 1/3 of the pit's capacity, the PG indicator rises, exposing color bands that graduate from blue, to yellow, and eventually red, signaling increasing urgency to address the issue.



This product is designed as a low-cost, durable, behavior change nudge to support households to address FSM proactively, before the toilet stops functioning and it becomes an emergency. This product can also serve as an indicator for FSM service providers and sales agents to identify households with latrine pits in need of maintenance.

The Pit Gauge is made of a plastic floater that pushes a color-coded indicator upwards, signaling that the pit is nearing its maximum capacity. The device is created with local materials, and the construction materials cost approximately 3 USD.

4. HYDRATED LIME TREATMENT

Hydrated lime (also known as calcium hydroxide) is a chemical powder derived from limestone which eliminates pathogens from human waste. In Cambodia, hydrated lime is accessible and used mostly by the construction industry to make cement. Hydrated lime can have both a sanitation and agricultural role. Generally, iDE has found that typical households are not aware of its possible use for sanitation.

Hydrated Lime Powder

HYDRATED LIME treatment of full pits is included with each ADP purchase with the aim of reducing risk and harm associated with latrine pit emptying. Recent research has indicated that pit emptying in rural Cambodia is done unsafely in nearly all instances.[2] In addition, in rural Cambodia, there is currently no commercially and environmentally sustainable solution for offsite treatment of human waste from full latrine pits. iDE Cambodia has conducted research that indicates that hydrated lime, when thoroughly mixed into full latrine pits, can effectively reduce pathogens and odors, in addition to improving the agricultural benefits of human waste.[3] Therefore, before a full latrine pit is sealed, hydrated lime is added and mixed into the sludge by the installation team. To further mitigate risk of exposure to pathogens in human sludge, households are advised to not empty this full, treated pit until the new pit is full.

TECHNICAL CONSTRAINTS OF HYDRATED LIME

- Hydrated lime powder can be touched, yet it is preferable that users wear gloves and avoid inhaling the lime dust.
- If there are powder manipulation people should wear a suitable mask and goggles.
- Hydrated lime must be distributed (mixed) well in order to react with the sludge.
- To ensure pathogen reduction in human waste, it must maintain a consistent PH of 12 for 25 days.
- Hydrated lime must be stored in a closed container to last long.
- Hydrated lime requires a lime to water mixture ratio of 1:3 for the disinfection reaction to take place.

[2] Household Pit Emptying and Sludge Reuse Practices in Rural Cambodia. Phnom Penh: Long D.; 2018
[3] Household-level application of hydrated lime for on-site treatment and agricultural use of latrine sludge. Hanoi: Chakraborty I., Capito M., Jacks C., Pringle R.; 2014

5. PRODUCT AND MATERIAL SPECIFICATIONS

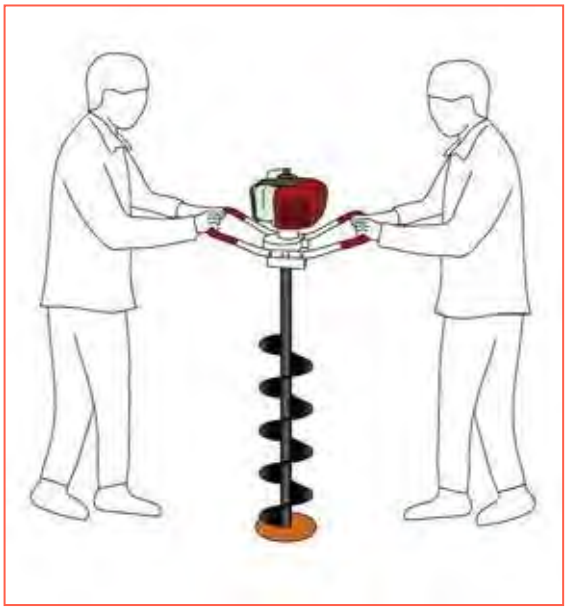
Item	PVC Pipe Fittings	Details	SIZE and Length
PVC Pipe Coupler		Very short length of pipe, with a socket at one or both ends that allows two pipes to be joined together.	Dia. 8cm
PVC 45-Degree Elbow		Joins two pieces of the same size pressure pipe at an angle of 45-degree. Use to re-direct the pipeline and to assist in turning corners.	Dia. 8cm
PVC Pipe Cap		Cover the end of the pipes, stopping the flow of fluids and protecting pipe threads.	Dia. 8cm
PVC Pipe		Standard PVC pipe	• Dia. 8cm and 14cm length • Dia. 8cm and 6cm length • Dia. 8cm and 70cm length • Dia. 8cm and 2200cm length

Dry Rings			Dia. 80cm, 4cm thickness and 50cm height.
Pit Lid			Dia. 80cm and 4cm thickness.
Pit Gauge			•
Lime Powder			At least 6kg for a standard .8-1m dia. pit latrine

6. ADP INSTALLATION INSTRUCTIONS

This guide is designed to support the appropriate installation and connection of the ADP product, including through the use push-fit fittings and pipe. During the piping process, a number of pipe fittings will need to be installed. You will need to ensure you have all of the above listed materials before beginning construction.

6.1. NEW PIT INSTALLATION



A key challenge of ADP installation is high groundwater, so before installing the ADP, the site must be checked first. In order for the pit to function safely, **ensure that the new pit is dug at least 15m from any drinking water source.**

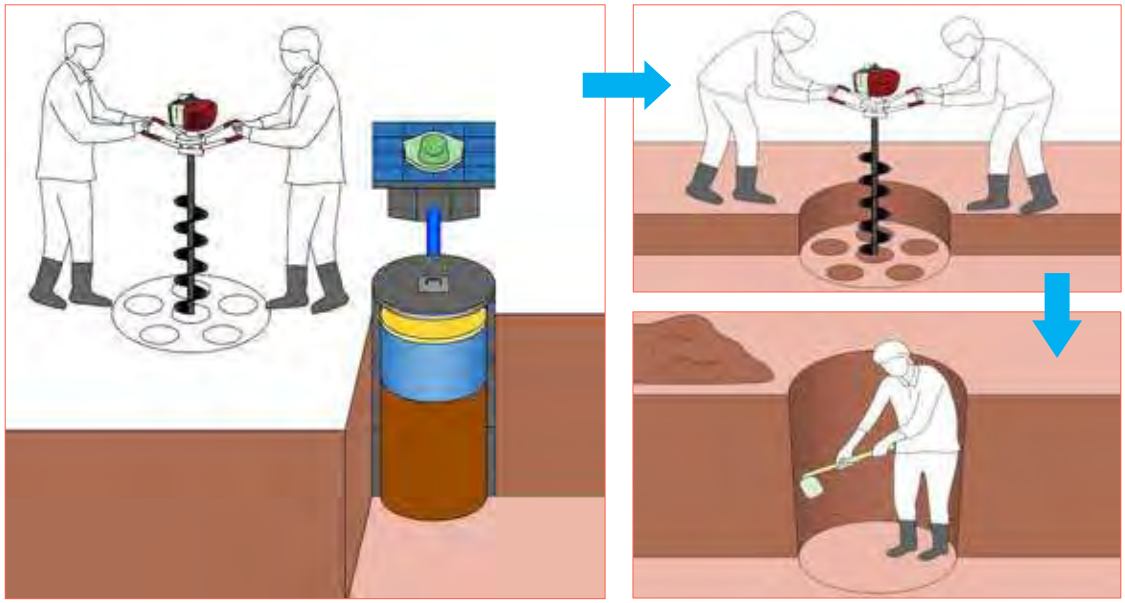
Next, check the groundwater level. In the center of where you intend to install the pit, dig a small hole, the depth of the pit (1.35m) by using a drilling machine. Use a stick or other implement to insert into the hole and check stick for wetness.

If groundwater is apparent within the hole, the installation should be postponed, moved to another area without apparent groundwater, or cancelled.

If no water is detected in the hole, start the installation process.

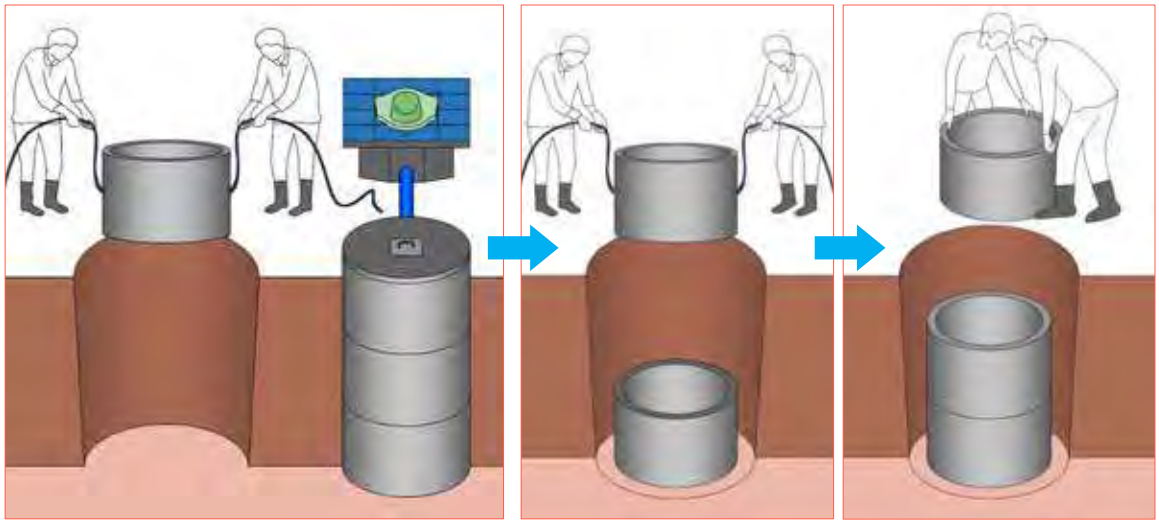
6.1.1. Using Earth Drilling Machine

a. Draw a ring-sized circle on the ground where the pit will be placed.
b. Using the machine, drill a series of small holes (approximately 13 or until the full surface area of the circle has been drilled).
c. Use a hoe to shovel out loose dirt and other debris from those 13 small holes, thereby digging a .8m diameter hole about .5m deep.
d. Repeat this process twice or until the .8m diameter hole is 1.35m deep.



6.1.2. Assembling Rings of Latrine Pit

- In order to avoid undue difficulty in the installation, it is recommended to level the surface of the ground at the bottom of the pit.
- Lift rings with care to avoid injury or damage to the products. Ensure ring is placed evenly and at a level orientation.
- Continue installing the middle and the top ring directly on top of one another.

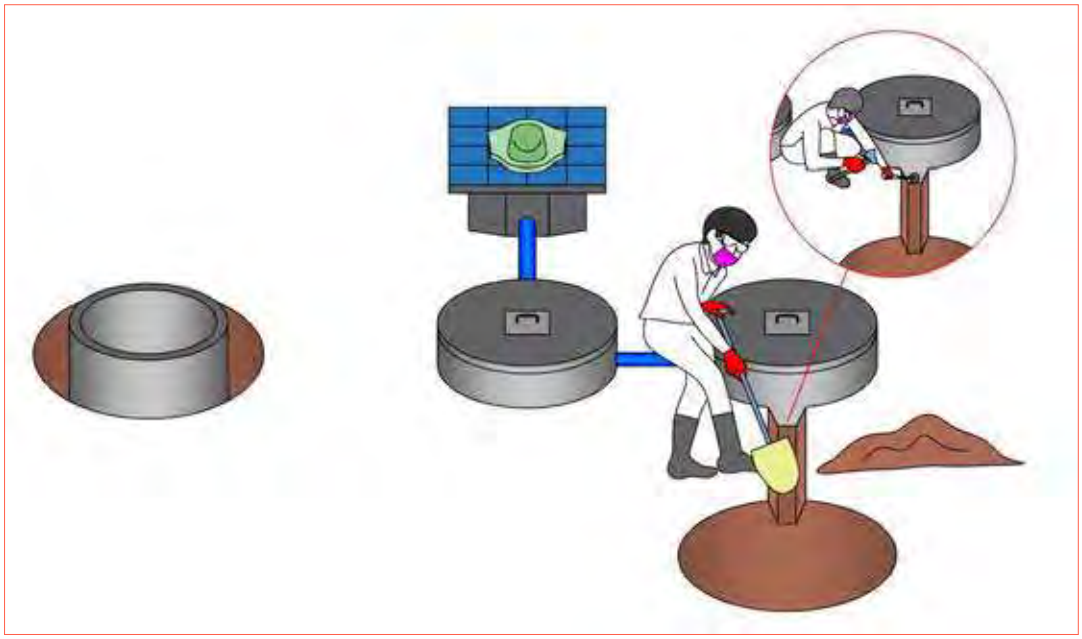


6.2. PREPARING, CUTTING, AND CAPPING EXISTING DISCHARGE PIPE

6.2.1. Remove excess waste from the latrine pit

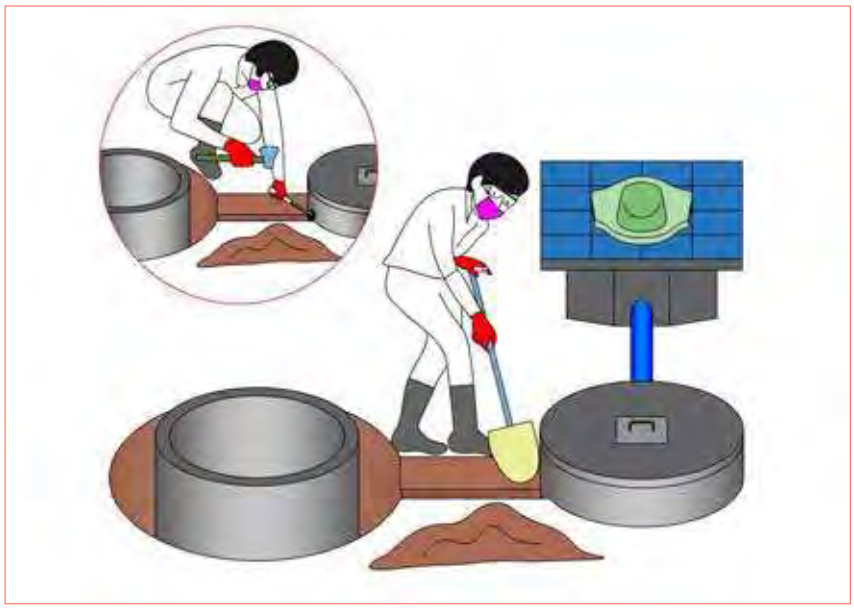
IMPORTANT: *Ensure that personal protective equipment including gloves, mask, boots, and eyewear are being worn at this point and throughout the duration of the process.*

- If original pit is 1m diameter AND/OR if there are already two existing pits connected in series, dig a new, shallow pit (1m dia. and 1m deep) 1m away from last existing pit, or a trench at least .5m deep, .5m wide, and 3m long. Pour 1kg of lime into the pit or trench, then cover with soil.



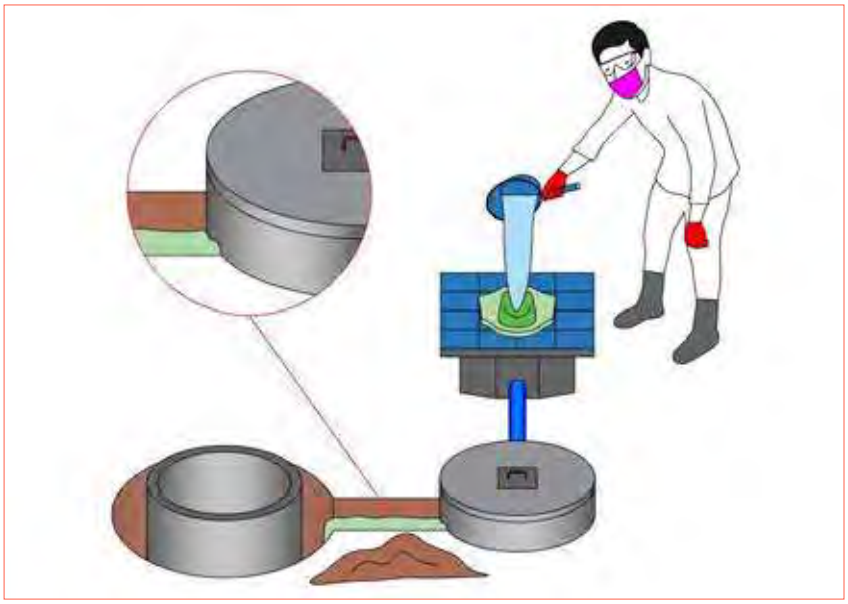
- Dig a trench in the soil from the site of the existing latrine pit to the new pit (or the new shallow hole if pit is at maximum capacity).

- Carefully make a small hole on the side of the latrine pit to drain out the excess waste through the trench into the new pit hole.



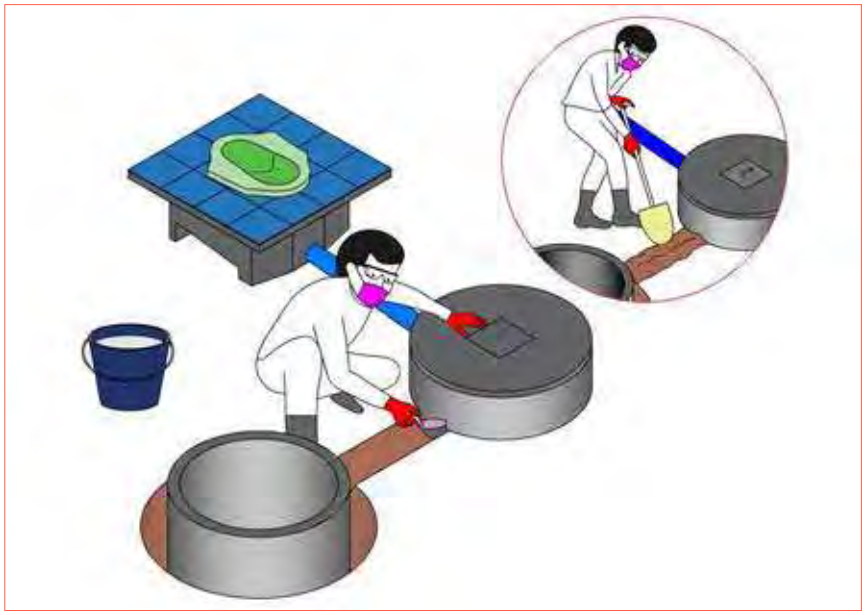
6.2.2. Clean out existing discharge pipe

- Pour several scoops of water directly down the toilet pan to flush away the scum that is sticking the existing discharge pipe.
- *Optional:* Pour a mix of hydrated lime-water solution down the toilet pan to reduce some smell that may occur during this process.



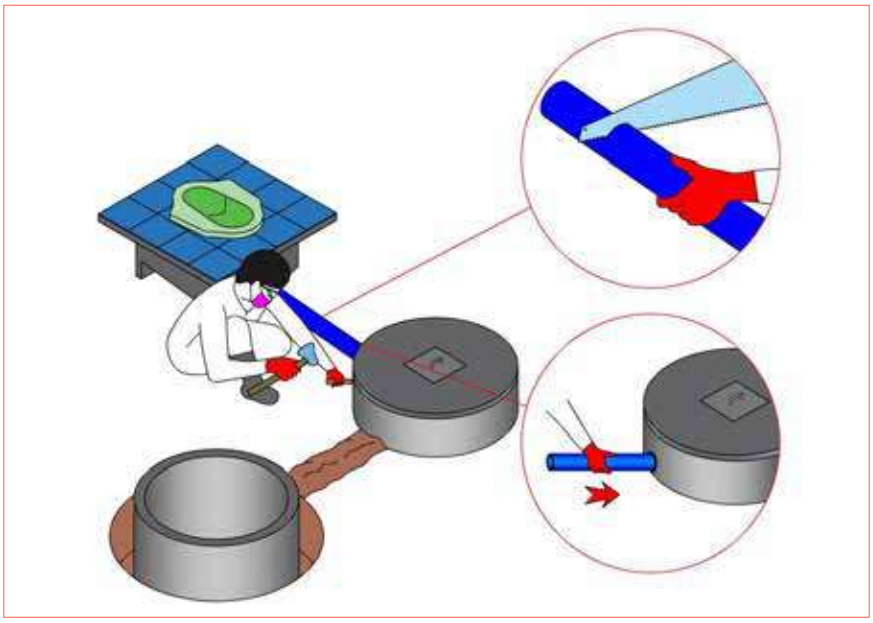
6.2.3. Seal the hole and refill the trench

- Use cement mortar to seal the hole and prevent the waste from leaking.
- Use a shovel to refill the trench with soil and spread it until the trench is completely filled to the ground level.



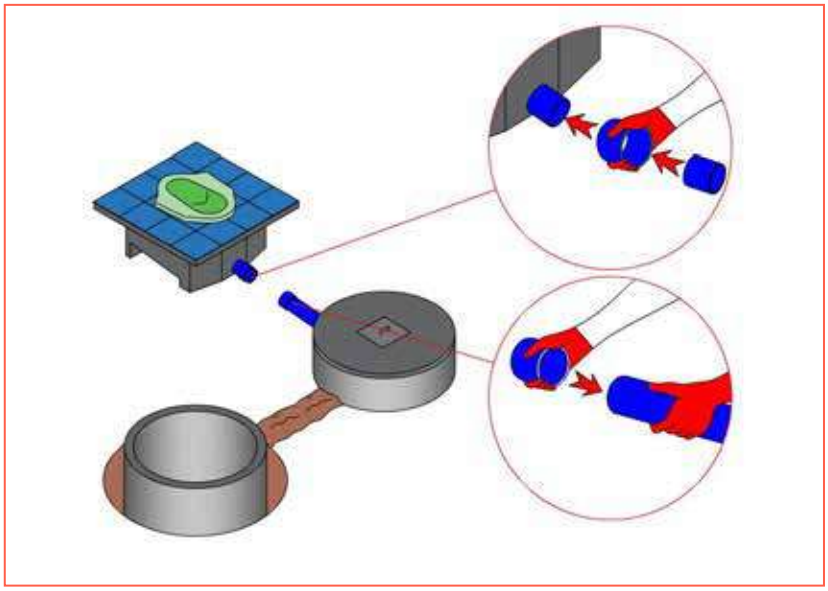
6.2.4. Cut the existing discharge pipe

- Slowly cut the existing discharge pipe with a hacksaw by leaving 350mm protruding out from the existing pit, so it will help you when reconnects next time.



6.2.5. Cap off existing discharge pipe

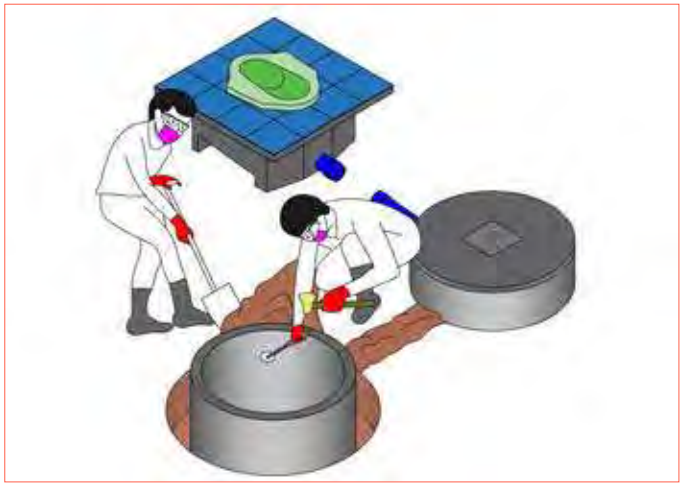
- Clean the end of the cut pipe before installing the PVC pipe cap to ensure that the pipe cap fits easily.
- Connect discharge pipe with a slip coupler, with the end of it protruding 140mm out from chamber box or toilet wall.
- Use the push-on cap to cover end of discharge pipe.



6.3. NEW DISCHARGE PIPE

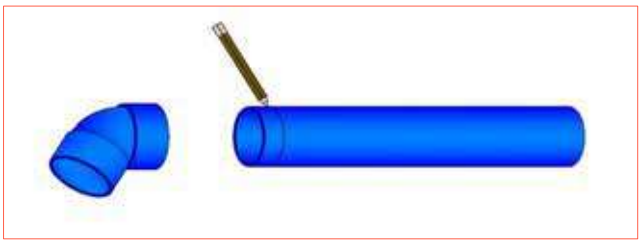
6.3.1. Make a hole inside of the new pit

- Dig out the soil from the side of the new pit to make enough slope for the new discharge pipe.
- Check the slope with the spirit level in order for the discharge pipe to work and water to flow properly, a slope of 3% (3cm of depth for every 1m of length) is necessary.
- Make a hole in the side of the new pit to insert the new discharge pipe.

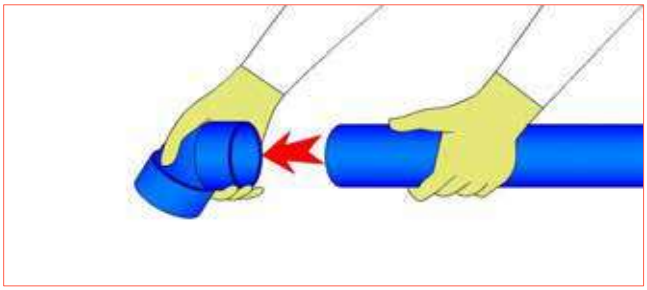


6.3.2. New discharge pipe

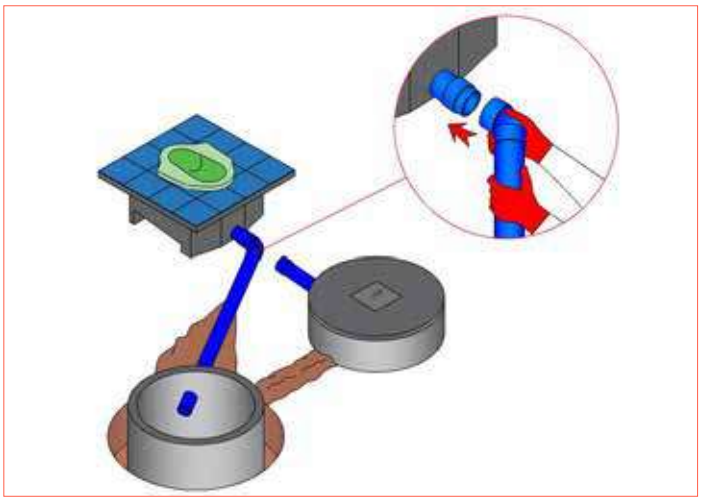
- Witness Mark the pipe: It is essential to be able to determine when the pipe end is fully secured in the elbow socket. Mark the pipe with the pencil line (witness mark) at a distance equal to the internal depth of the elbow socket.

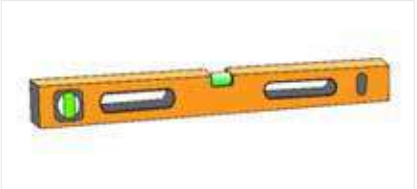


- Use the push-fit joint to join the PVC elbow with the new discharge pipe. Check the pipe for proper alignment and make sure the elbow is seated properly.



- Use PVC 45-degree elbow to connect to the new discharge pipe.
- Double check the new discharge pipe slope with the spirit level.

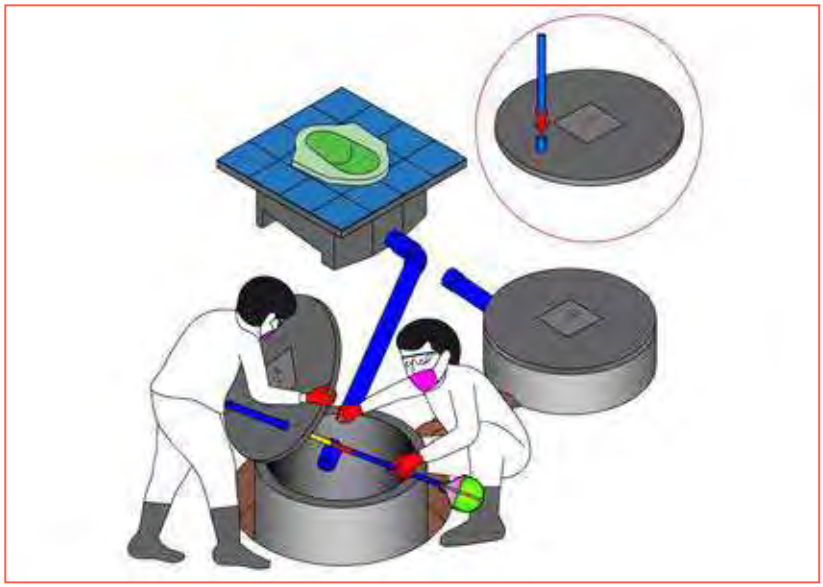




6.4. PIT GAUGE

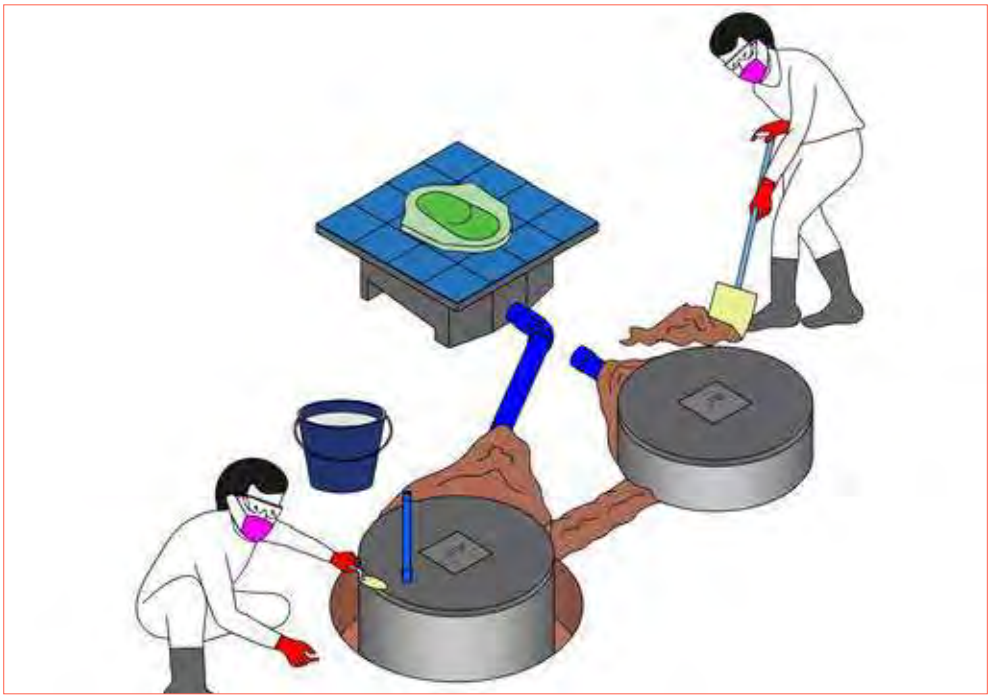
6.4.1 Pit Gauge Installation

- Insert the 27mm diameter PVC pipe into the slip coupler mounted within the latrine pit cover.
- Insert the 21mm diameter PVC Pipe into the 27mm PVC pipe through the pit cover.
- Glue the 21mm PVC pipe and the PVC cap together.



6.4.2. New Pit Installation

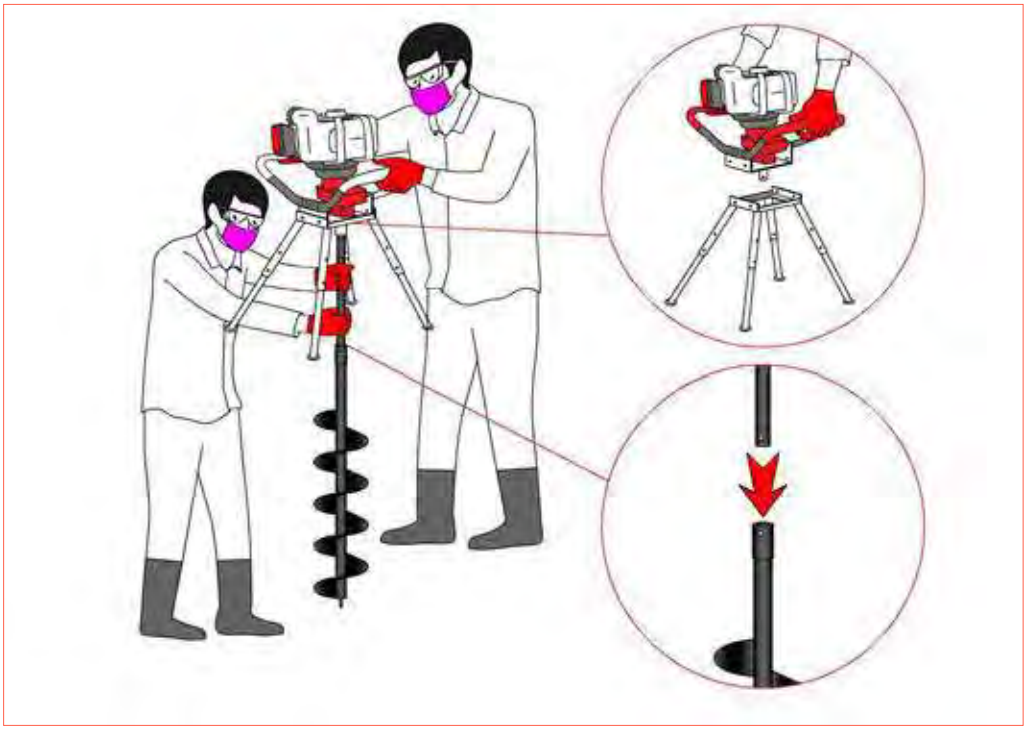
- Use cement mortar to seal the PVC pipe to the rings so waste does not leak out and the pipe does not become loose.
- The top of the ring should be 15cm above ground level and must be well sealed. This will help prevent pits from overflowing when there is heavy rainfall and/or flooding.
- Backfill the soil around the new pit, up to 20cm below ground level.



6.5. LIME TREATMENT

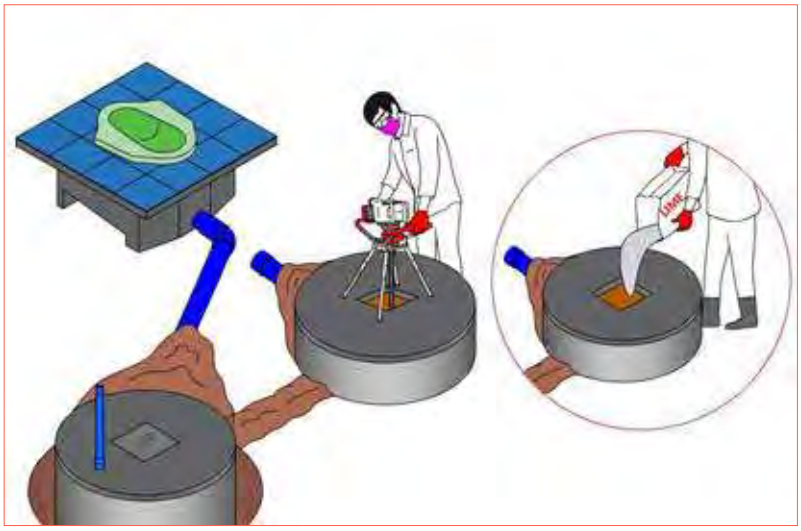
6.5.1 Preparing earth auger blade drilling machine

- Secure bolts in the drilled holes to attach the machine and stand. Fasten them together with the nuts and make sure they are tight.
- Attach blade extension to auger blade.



6.5.2 Lime Mixing

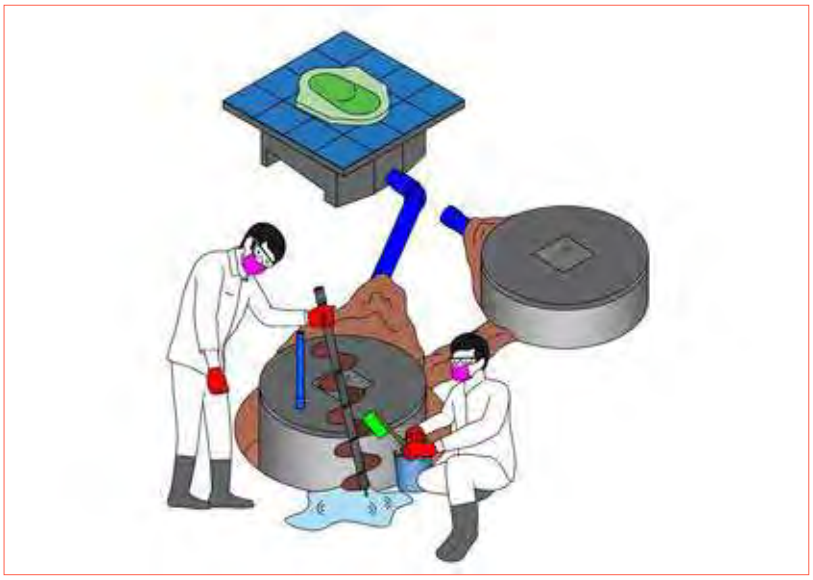
- Open pit cover(s) and add at least 6kg of hydrated lime into each full latrine pit.
- Lower the auger blade into the sludge to the bottom of the pit and start the drill. As you mix, raise and lower the Auger Blade and stir the sludge for about five minutes.
- Try to ensure that the blade hits the sludge from as many different angles as possible. Make sure you do this thoroughly and reach the parts that are left lumpy or dry. Thorough mixing is key to ensuring that the hydrated lime effectively treats the waste.

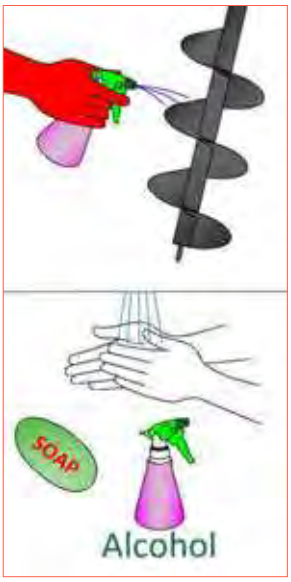


6.5.3 Sterilization of Equipment

Note: Clean all equipment directly next to the new pit and drain the waste water into the remaining backfill space next to the pit in order to prevent exposing the environment and household to pathogens.

- Above the remaining backfill area, rinse auger blade with water.
- Disconnect blade extension and auger blade from machine.
- Clean the auger blade with soapy water and long handled brush. Use the long-handled brush to gently remove sludge from the auger blade.
- Check to make sure there is no sludge remaining on the auger blade.
- Spray a mist of isopropyl alcohol over the auger blade. Let the blade air dry before storing.
- Fill soil into remaining backfill space to ensure that waste water/material is buried.
- All individuals who have come into contact with the auger blade, machine, or human waste must ensure that hands, arms, and other exposed body parts are effectively washed with soap, water, and/or isopropyl alcohol.





Key Safety Information:

1. In all steps, especially when cutting the discharge pipe and when manipulating hydrated lime powder, you must wear personal protective equipment, including, mask, eyewear, and gloves to protect yourself and those around you.

2. Use soap and water to wash any part of your body (especially hands, arms and feet) that may have come into direct or indirect contact with waste during the installation.

3. Ensure that all tools, devices, and equipment that come into contact with the waste, pipes, or pit are appropriately cleaned and stored after installation.

4. Ensure that during and after cleaning, waste water is disposed of safely, out of contact with the environment and the household.

7. MATERIALS COST AND PRICING

Item #	Description	Units Req.	Unit Measure	Total Unit Req.	Unit Cost	Total Cost
TP.1	8cm Dia PVC Pipe Fittings					**$5.50**
TP.1.1	8cm Dia PVC Pipe	1	m	2.2	$1.25	$2.75
TP.1.2	8cm Dia PVC Elbow Fitting 45-Degree	1	Pcs	1	$1.00	$1.00
TP.1.3	8cm Dia PVC Pipe Cap	1	Pcs	1	$1.00	$1.00
TP.1.4	8cm PVC Pipe Coupler	1	Pcs	1	$0.75	$0.75
TP.2	Additional					**$12.25**
TP.2.1	80cm Dia Dry Cement Ring	1	ring	3	$3.29	$9.87
TP.2.2	80cm Dia Ring Cover	1	cover	1	$2.38	$2.38
TP.3	Pit Gauge					**$3.00**
TP.3.1	Pit Gauge	1	PG	1	$2.00	$3.00
TP.4	Lime Powder					**$1.50**
TP.4.1	Lime aim to address the imminent problem of latrine pits filling up.	1	Kg	6	$0.25	$1.50
TP.5	Labor Costs					**$10.00**
TP.5.1	PVC Pipe Work	1	Set	1	$1.00	$1.00
TP.5.2	New Pit Digging and Installation	1	Set	1	$9.00	$9.00
TP.6	Transportation Costs					**$3.25**
TP.6.1	Delivery	1	Set	1	$1.25	$1.25
TP.6.2	Up and Down loading	1	Set	1	$2.00	$2.00
TP.7	Commission					**$4.00**
TP.7.1	Sanitation Teacher	1	Set	1	$3.00	$3.00
TP.7.2	Village Chief	1	Set	1	$1.00	$1.00
TOTAL COST OF LATRINE PIT UPGRADE						**$39.50**

Note: All materials are based on 2019 Cambodia market prices.

The ADP typically sells for a retail price of $49 USD. This enables for roughly a USD $9.50 profit margin for the business owner.

8. OPERATION AND MAINTENANCE

The pit is not to be emptied until the new pit is full (on average three to five years). When emptying pit contents, household or servicers should ensure that, despite the minimized risk of exposure to harmful pathogens, personal protective equipment like gloves and masks are worn. Pit contents should be disposed of as far away from the household as possible.

At time of the sale of ADP, information should be given to the customer to explain key maintenance points. In the informational sheet below, it details several critical points for the household to know:

1) Do not pay the business owner unless you see them treating your latrine pit with lime (pictured in upper right)
2) Do not empty your latrine pit until your new latrine pit is full.
3) If the pit gauge shows a red color, your pit is nearly full and needs maintenance.
4) Do not ever put a hole in the side of your pit to enable it to drain excess water. If your pit doesn't work, call the local business owner who delivered the product.
   ** Note that price is subject to change if the configuration differs from standard pit configuration*

9. ALTERNATING BACK AFTER ADP FILLS

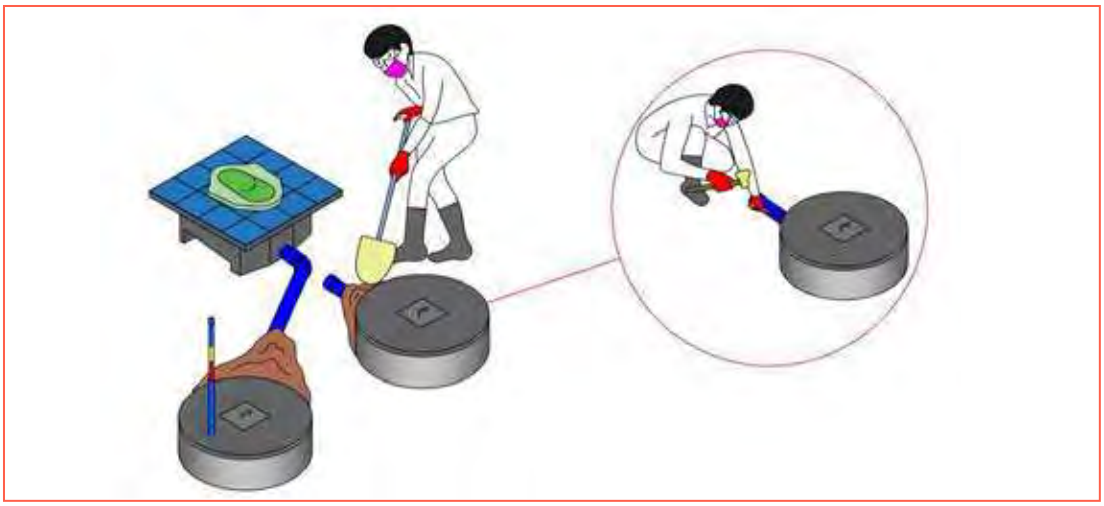
After the ADP has filled, which is estimated to take between three and five years depending on household use and geographical context, the household will need to alternate the pit connection back to the original pit. The household is informed at the time of sale to contact the business owner to alternate latrine pits back and forth.

9.1. ALTERNATING BACK INSTRUCTIONS

In order to do this, the cover of the first pit is taken off and the contents of the pit removed. Pit contents should be safe to be disposed of nearby or used for agricultural purposes. However, caution should still be taken to ensure that the household or pit emptier are doing so in a way to minimize exposure to the stabilized waste. After replacing and sealing the pit cover, the first pit can be used.

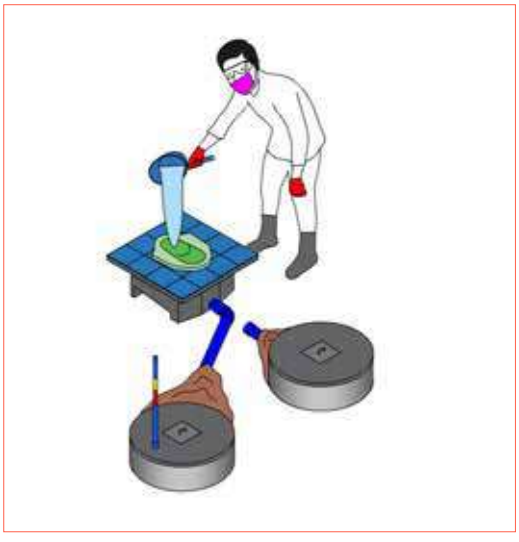
9.1.1. Remove the discharge pipe from the original pit

- Dig the soil above the PVC discharge pipe of the original pit.
- Remove the sealed mortar of PVC pipe from the ring.



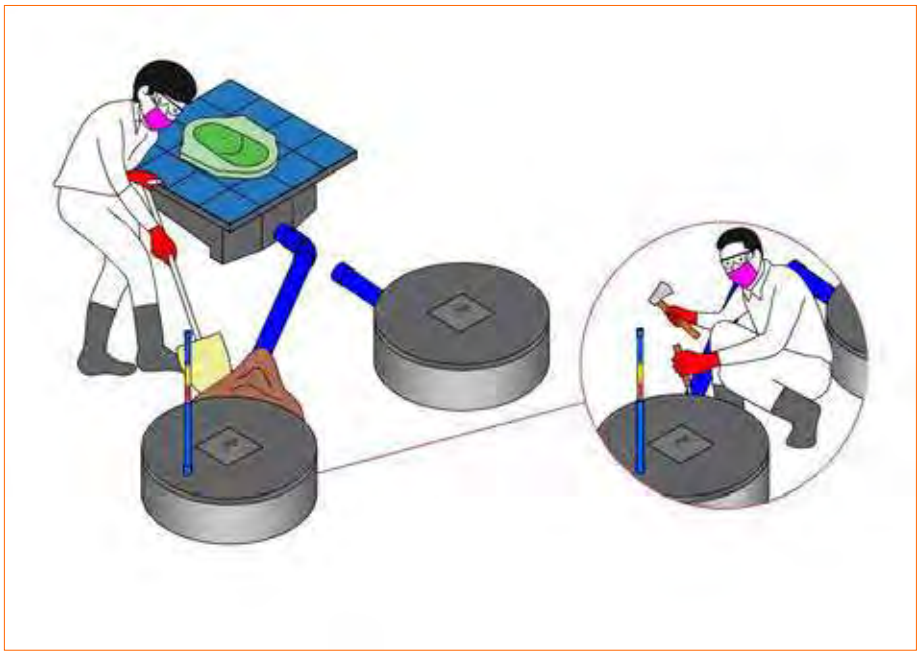
9.1.2. Clean the ADP discharge pipe

- Pour several scoops of water directly down the toilet pan to flush away the scum that is sticking the existing discharge pipe.
- *Optional:* Pour a mix of hydrated lime-water solution down the toilet pan to reduce some smell that may occur during this process.



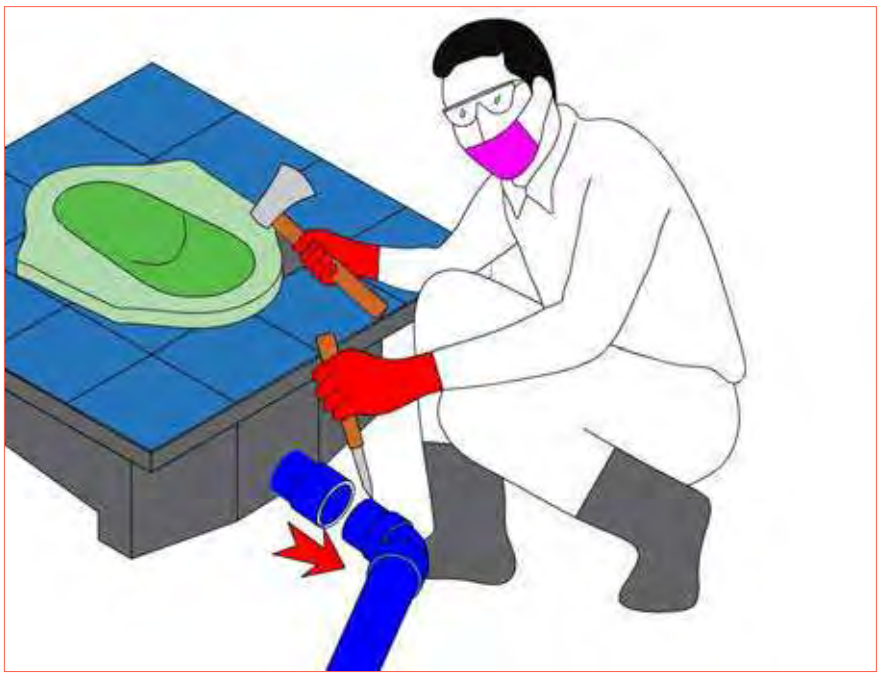
9.1.3. Remove the ADP discharge pipe

- Remove soil from PVC discharge pipe connected to the ADP.
- Remove the sealed mortar of PVC pipe from the ring.



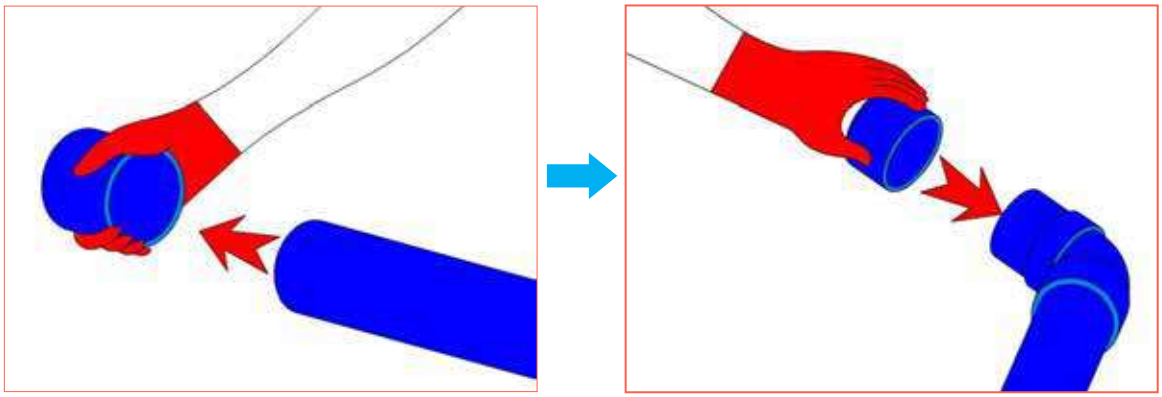
9.1.4. Remove ADP discharge pipe from the COUPLER

- Remove the 80mm diameter PVC 45-degree elbow fitting from the coupler.
- Then move the discharge pipe 20cm away from the coupler to make enough space for reconnecting the old discharge pipe connection.



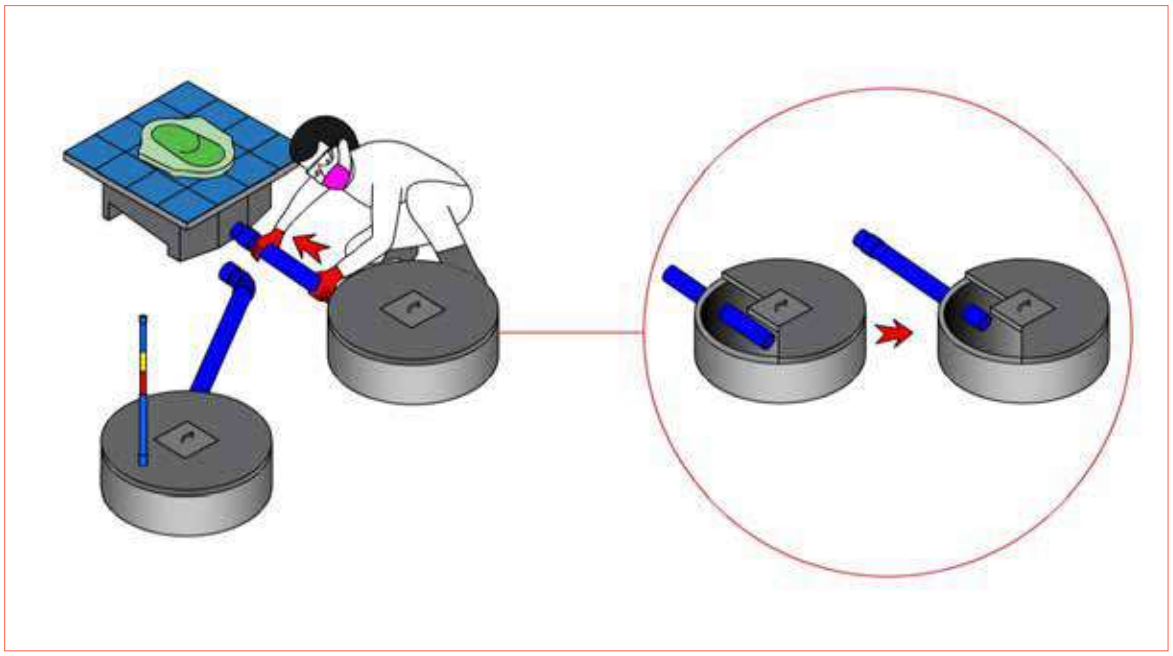
9.1.5. Cap off ADP discharge pipe

- Remove the PVC cap from the discharge pipe.
- Use the PVC cap to cap off the 80mm diameter PVC 45-degree elbow fitting.



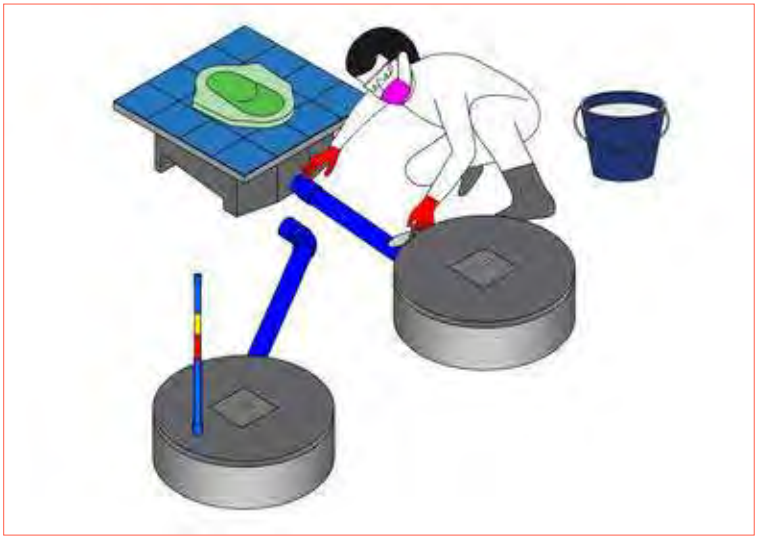
9.1.6. Connect old discharge pipe to the coupler

- Clean the end of the old discharge pipe before moving to insert in the coupler.
- Place the discharge pipe and connected with the coupler.



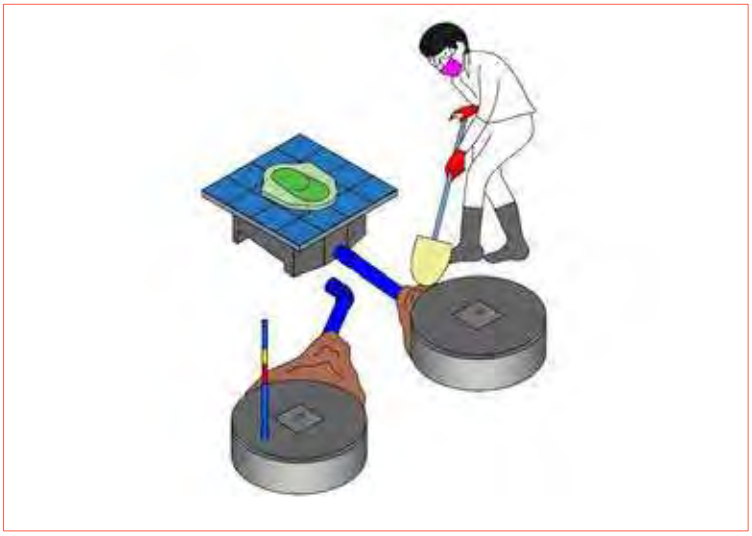
9.1.7. Seal the PVC Pipe

- Use cement mortar to seal the PVC pipes to the rings both ADP and original pit, so waste does not leak out and the pipe does not become loose.



9.1.8. Seal the PVC Pipe

- Backfill the soil after pipe and connections are in place and have been secured.



Annexure C: Faecal Sludge Management Behavioural Change Communication Materials

1

I wear a face mask, gloves and boots for protection from pathogens

2

I cover the containers when transporting the faecal sludge for disposal on my property

3

I dispose faecal sludge into a safe place on my property

4

I bury the faecal sludge underground on my property

SNV

Sustainable Sanitation and Hygiene for All

When you empty your pit unsafely by…

…NOT wearing a face mask, gloves and boots for protection

…NOT covering containers when transporting the faecal sludge for disposal

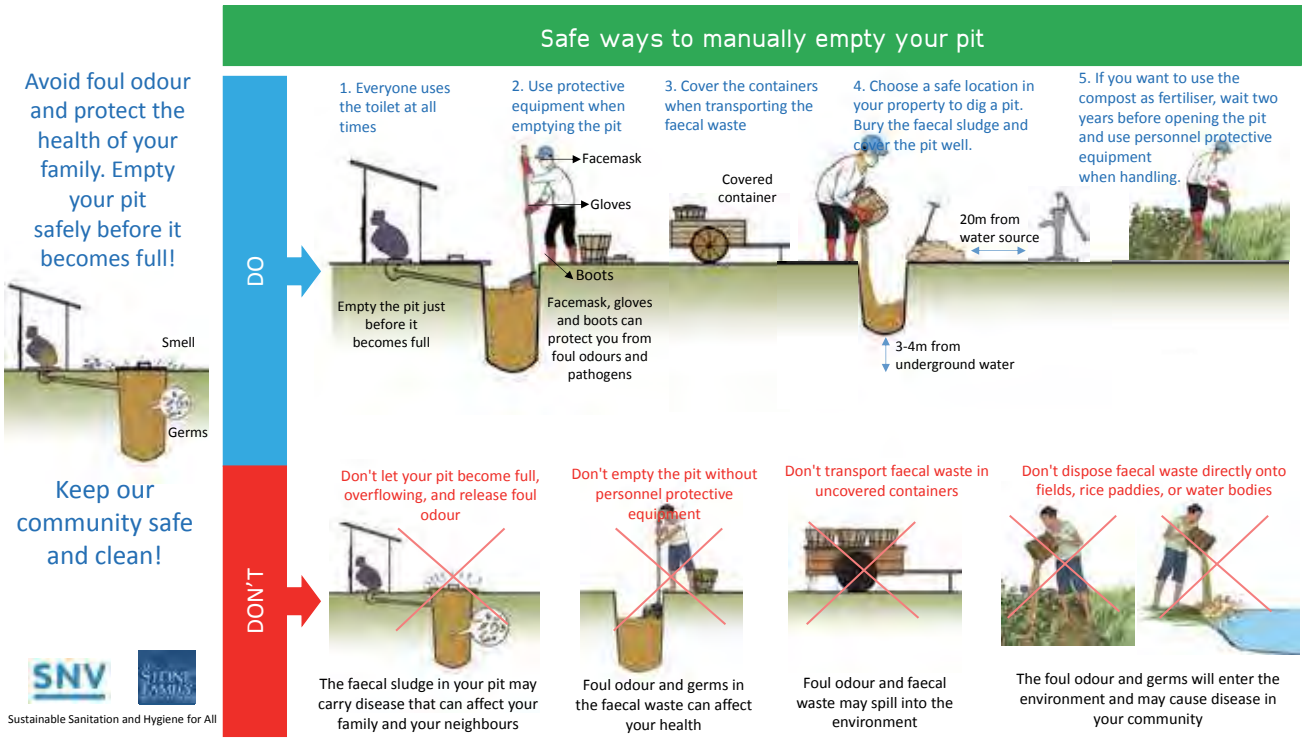
…disposing faecal sludge directly onto the land

…disposing faecal sludge directly into a water source

…and this is the result…


I dispose faecal sludge from the pit directly onto the land…
No!
You must not do that! Faecal sludge from your pit can affect the health of your family and my family!
SNV
Photo by Martin Jacquemin

Annexure D: Guidance for Safe On-site Manual Pit Emptying in the Household's Property



Annexure E: Additional Resources

EAWAG Compendium of Sanitation Systems and Technologies

This compendium presents a range of information on sanitation systems and technologies in one volume. It is structured to provide readers with a useful planning tool for arriving at informed decisions about sanitation systems and technologies. Available at: https://www.eawag.ch/en/department/sandec/publications/compendium/ (Accessed on 9 March 2020) (Free to download)

ISO standards

ISO is an independent, non-government international organisation with a membership of 164 national standards bodies. ISO sets standards for non-sewered sanitation. Relevant standards include: 30500, 24521, 24520 and 24511. Available at: http://www.iso.org (Accessed on 9 March 2020) (Charges apply to download each standard)

IWA 28

IWA 28:2018 specifies requirements and test methods to ensure safety, performance and sustainability of community-scale resource-oriented faecal sludge treatment units that serve approximately 1,000 to 100,000 people. IWA 28:2018 applies to treatment units that primarily treat faecal sludge, are able to operate in non-sewered and off-grid environments, and are prefabricated. Available at:

https://www.iso.org/standard/73400.html (Accessed on 9 March 2020) (Cost to download: US$ 180)

SANDEC Training Tool 1.0, Module 5, FSM

Produced by EAWAG, a research institute at ETC Zurich, this training module describes FSM, paying special attention to haulage, treatment and reuse or disposal of faecal sludge. It covers both technical and non-technical (socio-cultural, economic, political etc.) aspects and provides practical information on design, financing and planning of faecal sludge treatment plants. Available at:

https://sswm.info/sites/default/files/reference_attachments/EAWAG%20and%20SANDEC%202008%20Faecal%20Sludge%20Management.pdf (Accessed on 9 March 2020) (Free to download)

WHO, 2018, Guidelines on Sanitation and Health, World Health Organisation, Geneva

The new WHO Guidelines on Sanitation and Health summarises the evidence on the effectiveness of a range of sanitation interventions and provides a comprehensive framework for health-protecting sanitation, covering policy and governance measures,

implementation of sanitation technologies, systems and behavioural interventions, risk-based management, and monitoring approaches. Available at: https://www.who.int/water_sanitation_health/publications/guidelines-on-sanitation-and-health/en/ (Accessed on 9 March 2020) (Free to download)

Select Royal Government of Cambodia References

MPWT, (2018), Wastewater System Operation and Maintenance Guideline. Ministry of Public Works and Transport, General Directorate of Public Works, Sewerage Management and Construction Department, GIZ, GGGI. Available at:

https://gggi.org/site/assets/uploads/2019/01/Wastewater-System-Operation-and-Maintenance-Guideline-1.pdf (Accessed on 9 March 2020)

MRD, (2019), National Guidelines Principles on Sanitation in Challenging Environment for Rural Households, Ministry of Rural Development. Available at:

https://drive.google.com/drive/folders/112WgpbRESonrHO3b1eje3E9v90Nzmc34 (Accessed on 9 March 2020)