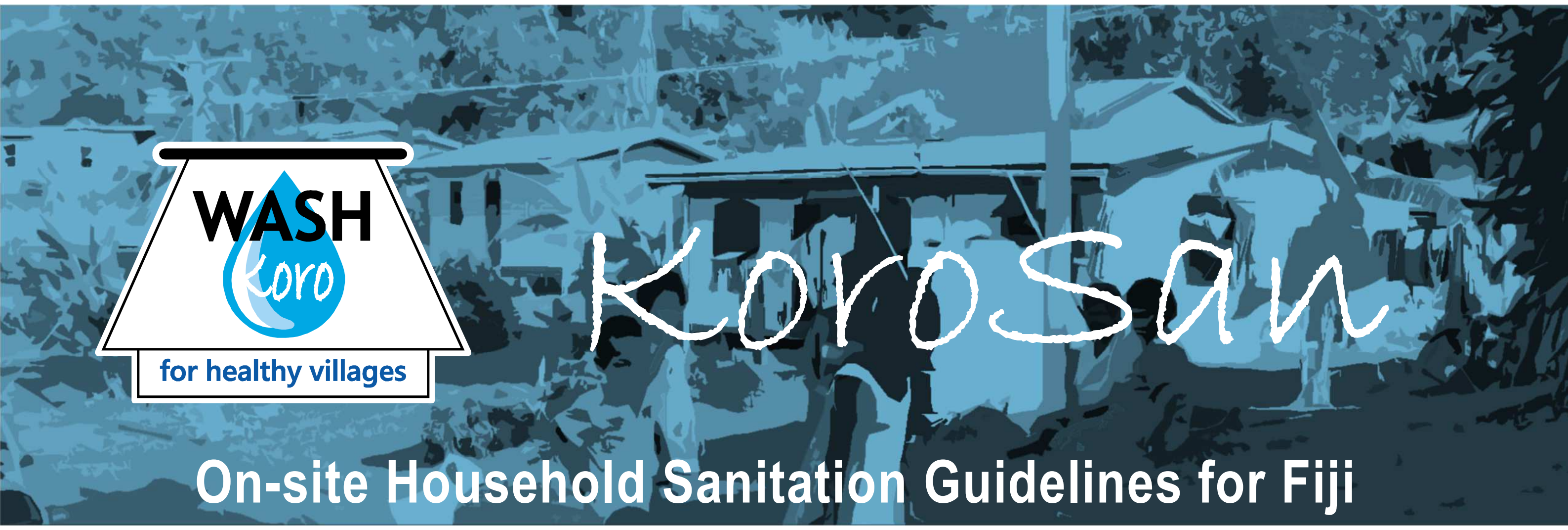


#1 CHOOSING AN APPROPRIATE ON-SITE SANITATION SERVICE

1 PURPOSE

A safe, sustainable, effective and affordable sanitation system is an essential service for the health and wellbeing of all people. The focus of this guideline is on safe management of human body waste and wastewater from individual households, clusters of houses, and schools or community buildings in rural villages and settlements that are not serviced by a reticulated sewage treatment system. It provides technical information to help identify which sanitation management options are the most appropriate to reduce health and environmental risks.

Sanitation is the provision of facilities and services for the maintenance of convenient and hygienic living conditions. For households, this involves safe management and disposal of:

- Toilet wastes, which include human urine, faeces and other bodily wastes, and any water used for flushing or anal cleansing. When water-flushed, this is collectively known as "blackwater".
- Kitchen wastewaters produced during food preparation and dishwashing.
- Bathroom wastewaters from hand, teeth, hair and body washing
- Laundry wastewaters from washing of clothes, bedding etc.
- House-cleaning wastewaters from washing of floors, walls and furnishings.
- Rubbish or garbage (solid non-faecal wastes)

This guideline covers on-site management of household wastewaters and voided human body waste, faeces and urine disposed to wet (flush and pour flush) and dry toilets (pit and composting toilets). It does not cover management of solid rubbish wastes, although this is also important for human health.

2 BENEFITS OF A SAFE AND SUSTAINABLE ON-SITE WATER MANAGEMENT SERVICE

2.1 SANITARY LIVING CONDITIONS

Anyone who has had to clean up decomposing faecal wastes or overflows of wastewater knows that this isn't a pleasant task. A well-functioning wastewater management service is an important component of pleasant and healthy living conditions. It avoids the occurrence of spillages, leaks and overflows that cause objectionable odours, dampness, pest problems, and associated health risks. Table 1 lists some of the common diseases and health hazards that can arise from poorly managed wastewaters and faecal wastes. Provision of a sustainable and reliable wastewater management service is a key requirement for avoiding contact with these pathogens to ensure the health and well-being of families and villages.

Table 1. Common sanitation health risks

Organism	Examples	Organs infected	Disease
Virus	Rotavirus and Norovirus	Intestinal tract	Gastroenteritis
	Hepatitis A	Liver, spleen and lymph nodes.	Infectious hepatitis
	Poliovirus	Entry into body via gastrointestinal route, multiplication in the small intestine, lymph nodes and tonsils leads to CNS infection	Poliomyelitis
Bacteria	Shigella spp.	Invades the intestinal mucosa	Bacterial dysentery
	Salmonella spp.	Intestinal tract	Typhoid/Paratyphoid fever
	Escherichia coli (E. coli)	Intestinal tract	Gastroenteritis
	Campylobacter jejuni	Intestinal tract	Gastroenteritis
Protozoa	Giardia spp	Intestinal tract	Gastroenteritis (Giardiasis)
	Cryptosporidium spp	Intestinal tract	Gastroenteritis (Cryptospiridiosis)
Helminths(worms)	Ancylostoma and Necator spp	Hookworm which develops in the gut. Adults attack lungs, liver and other organs	Chronic anaemia
	Schistosoma spp	A fluke which infects the blood of the host.	Chronic anaemia
	Taenia spp	Eggs of tapeworm hatch in gut and may attack eyes, brain and heart	Gastroenteritis
	Ascaris spp	Nematode whose larvae infect the intestinal tract	Pneumonitis; gastroenteritis

3 WASTEWATERS AND TREATMENT SYSTEMS

Wastewaters can be subdivided into:

- **Blackwater**: from flush and pour toilets and urinals
- **Greywater**: wastewater from sinks, baths, tubs, showers, washing platforms and laundry.

Dry or waterless composting and pit toilets produce **waste** products that include solid faecal material, urine, and materials used for anal cleansing or added to improve decomposition. Liquid discharge from such systems is generally minimal.

An on-site wastewater management service must treat and then safely dispose of treated effluent to a specifically designed land application system (LAS), located within a defined land area. Such a service can be applied to houses individually or in clusters, or to a whole village or settlement. Operation and servicing is normally the direct responsibility of those who use it.

A water based on-site wastewater management service consists of four main components. These are:

1. Wastewater source technologies (e.g., toilet, sink or washing machine)
2. A treatment unit
3. A dosing device (recommended, but not required under some circumstances)
4. A land application system.

Treatment units process incoming wastewater **(influent)** to produce an outflow (**effluent**) that is of higher quality and easier to manage than the influent. The three common treatment levels are:

- **Primary** treatment which provides a low level of wastewater treatment, mainly removal of solids. Septic tanks are the most common on-site primary treatment system used around the world.
- **Secondary** treatment which provides an improved moderate level of treatment; including better removal of organics, suspended solids and some nutrients. Examples include a wide range of commercial package plants, engineered sand filters and subsurface-flow constructed wetlands
- **Tertiary** treatment, which provides an improved reduction in disease causing microorganisms (viruses, bacteria, protozoa and parasitic worms) and nutrients.

The more advanced the treatment the less potential there is for subsequent disease transmission and environmental effects, but the greater the costs.

Dry toilets such as pit toilets and composting toilets are managed differently to water based flush toilets and involve different technologies. They focus on keeping faecal wastes safely stored away from where humans can come into contact with them, and so are not dependent on a reliable water supply to function. However, installation of dry toilets does not eliminate grey water discharges from a dwelling, which still pose a potential human health risk.

In this guideline there is more emphasis on the management of wastewater from water-flushed toilets, although reference is made to site specific circumstances that would favour selection of dry toilet services. More detailed technical information on dry toilet options is provided in the KoroSan #6, and for composting toilet and pour flush toilet options, in the *Clean Communities, practical guide to building and* *maintaining toilets in the Pacific*, Live and Learn (2011). A wider range of toilet options are outlined in the *Compendium of Sanitation Systems and Technologies* (EAWAG/IWA/WSSCC, 2014)

As secondary and tertiary treatment systems are significantly more expensive than primary treatment systems and require a higher level of servicing by well trained technicians, these guidelines refer only to primary treatment units, i.e., septic tank systems. To address the higher risks associated with primary effluent these guidelines recommend that the land-application systems are selected and designed to avoid health and environmental risks. If more advanced treatment units are required (e.g., where soil conditions are unsuitable or suitable land areas are not available), then specialist advice should be sought.

4 CHOOSING AN APPROPRIATE ON-SITE WASTEWATER MANAGEMENT SERVICE

4.1 DRY OR FLUSH TOILETS

There are three categories of basic toilet types commonly used in villages:

1. Dry toilets (no flushing facilities) such as composting toilets and pit toilets, in particular Ventilated Improved Pit (VIP and ecoVIP2 toilets).
2. Pour flush toilets (requires small quantities of collected water to manually flush)
3. Flush toilets.

Waste from dry toilets and wastewater from pour flush and flush toilets require appropriate management to avoid health and environmental risks. Appropriate management of dry toilet waste products are dealt with in KoroSan #6 and the Clean Communities Manual (Live and Learn, 2011).

Flush toilet options are often initially the preferred option, however relatively expensive compared to common dry toilet options and may not be an appropriate choice under some conditions. Flush toilets require a reliable and plentiful water supply[1] and a proper treatment system, including sufficient area of land with suitable soils for the safe and hygienic disposal of the daily wastewater flow. Areas with very high water table, and/or poorly draining soils may not be suitable for disposal and treatment of wastewaters from flush toilets.

Flow charts provided later in the guideline outline a simplified approach to help determine the "best-fit" type of wastewater service for a particular site. Where appropriate, reference is made to other technical guidelines for further information on these options.

[1] A flush toilet will consume an additional daily 30 to 40L of water for each person living in the dwelling.

4.2 WASTEWATER MANAGEMENT REQUIREMENTS

Blackwaters (from flush toilets) and greywaters are typically managed separately in the Fijian communities that rely on on-site treatment. Alternatively, greywater and blackwater can be combined and managed together, but this requires significantly greater treatment capacity, land application areas and associated costs.

For a village, individual dwellings or cluster of dwellings within the village, the key site attributes and constraints (other than availability of funding) for the optimal selection of a dry toilet, flush toilet and greywater services are:

- Quantity and reliability of village water supply.
- Location and proximity of surface water supplies, drinking water bores, bathing areas, recreation and play areas that could be contaminated by wastewater discharges.
- Power supply reliability and cost (if pumps are required).
- Village soil and slope characteristics – soil infiltration rates, slope stability.
- Flood risks, drainage patterns.
- Depth to groundwater.
- Land area available and its location for receiving and safely processing treated wastewater.
- Availability of local trade and skill capability for competent installation, construction and servicing.
- Financial resources available to fund installation and ongoing operation.
- Negotiation and co-ordination with neighbours.
- Village scale and cluster on-site wastewater management will also require:
    - Sound village governance, leadership and financial management.
    - Support from key landowners and clan leaders.

The most common treatment unit for a flush toilet system is the septic tank. This is the cheapest wastewater processing technology; however, it provides minimal treatment of the wastewater, in terms of risk reduction. Careful management of the effluent discharging from the septic tank is still required to reduce health and environmental risks. Remember, what goes in to the septic tank must come out the other end, and this discharge must be managed safely. What the septic tank does achieve is significant removal of larger solids in the wastewater stream. This makes disposal of the septic tank outflow to land less likely to block and fail.

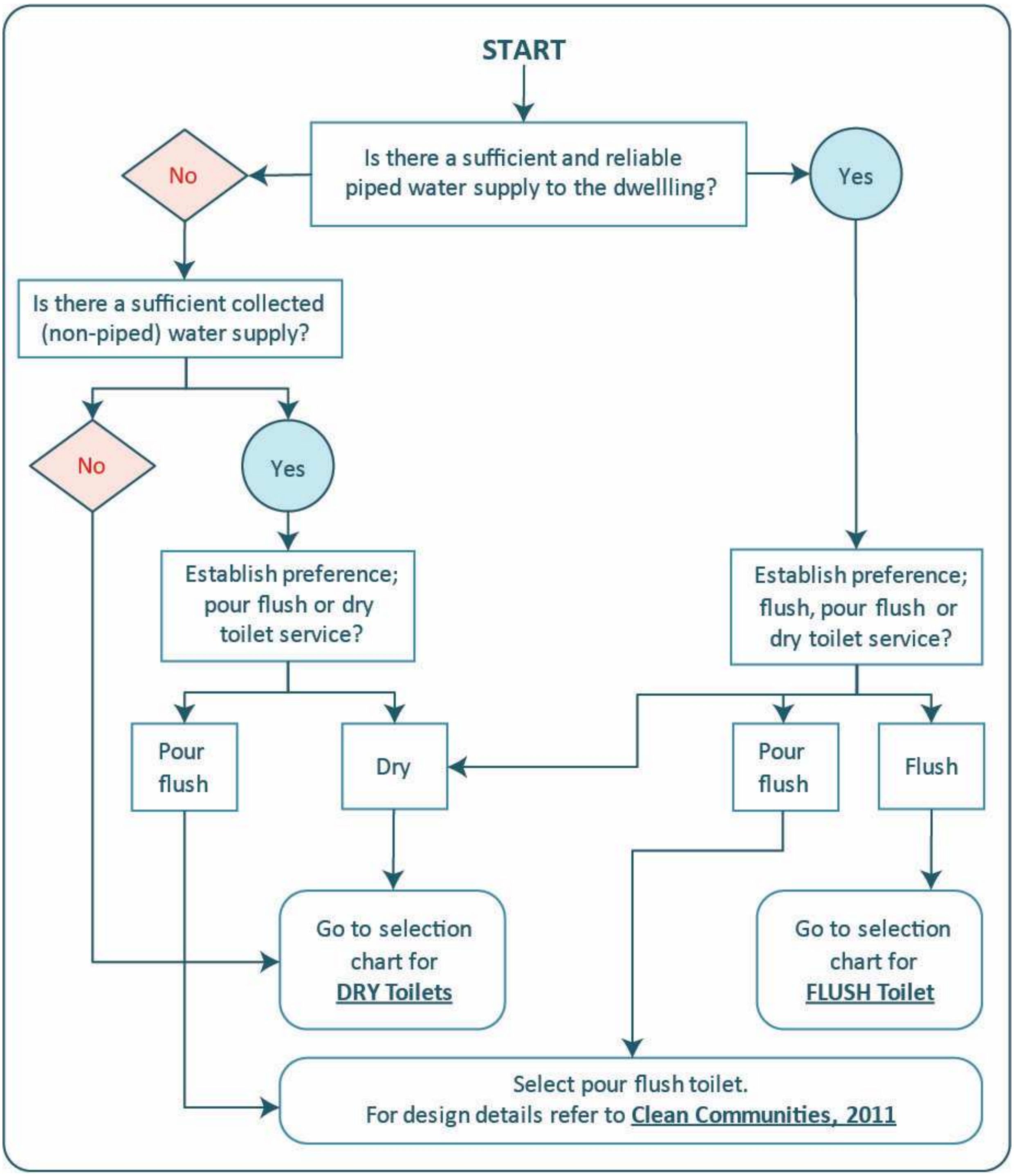
In choosing the most appropriate system, considerations should be given to the level of service required by the users, the specific site conditions, the performance requirements and the capital and running costs. The following (Table 2) compares the benefits and disadvantages for dry and wet (flush and pour flush) toilet systems.

Table 2. Comparison of dry and wet toilet systems.

	Dry toilet systems	Pour flush toilet systems	Flush toilet systems
Capital and operating costs	Generally low.	Low to intermediate.	High.
Water supply	Not required.	Limited water supply required.	Reliable and sufficient water supply required[1].
Operation and management	Require regular and careful management (addition of organic mulch, wood chips or soil) and eventual removal of the old sludge, which can be an unpleasant task. Provision of 2 pits, allows one to breakdown and stabilise while the other is filled.	Require minimal management.	Require irregular but specialist (and therefore costly) management and servicing, including periodic removal of accumulated sludge from the septic tank (e.g., by a suction tanker), and its transport to a safe disposal site.
Treatment unit	Not required.	Not required.	Water tight septic tank required.
Land application system	Composting toilets require small area of secure land designated for burial of composted solids.	Small but suitable soakage area of land required.	Larger area of suitable land required for safe disposal and soakage of septic tank effluent.
Soils	Local soil conditions not important.	Suitable soils required for soakage.	Suitable soils required for soakage.
Ground water	Pit toilets are not suitable in areas of high ground water. Composting toilets will need to be raised in areas of high ground water.	Soakage areas will not function in areas of very high ground water.	Soakage areas will not function in areas of very high ground water unless raised or mounded.
Public health risks	Health risks can be high if the toilet is not carefully designed and located, and if poorly managed, and neglected.		Health risks can be high if any of the following components are poorly designed, sized, located, installed or serviced: septic tank, dosing system, drains and land application system.
Other risks	Risk of flood and storm water damage if poorly designed or located. Risks of nuisance odours, flies, insects, rodents when poorly designed and/or managed.		Risk of flood and storm water damage if poorly designed or located. Risks of nuisance odours, when poorly designed and/or managed.

1. A flush toilet will consume and additional daily 30 to 40L of water for each person living in the dwelling

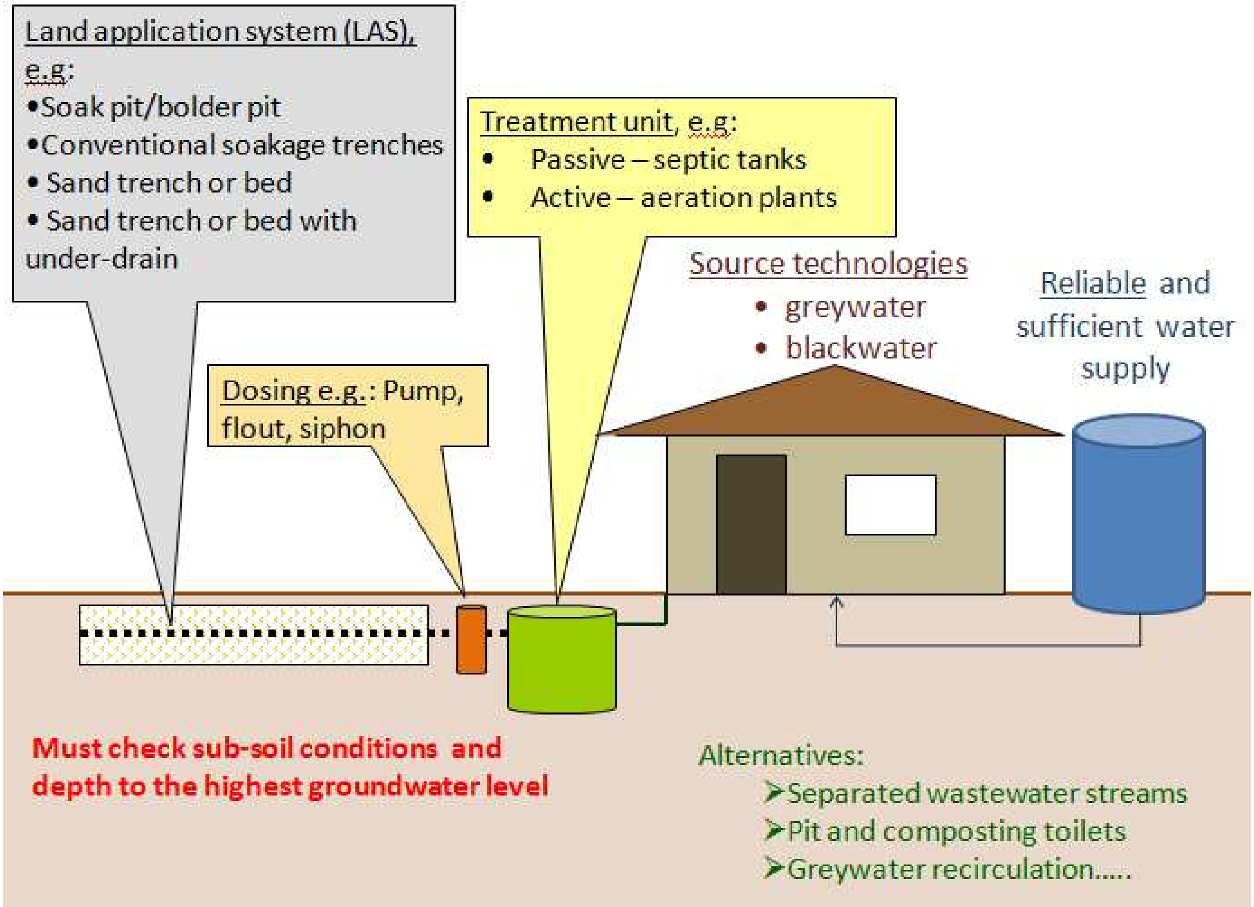
What sort of toilet system is appropriate for your situation?



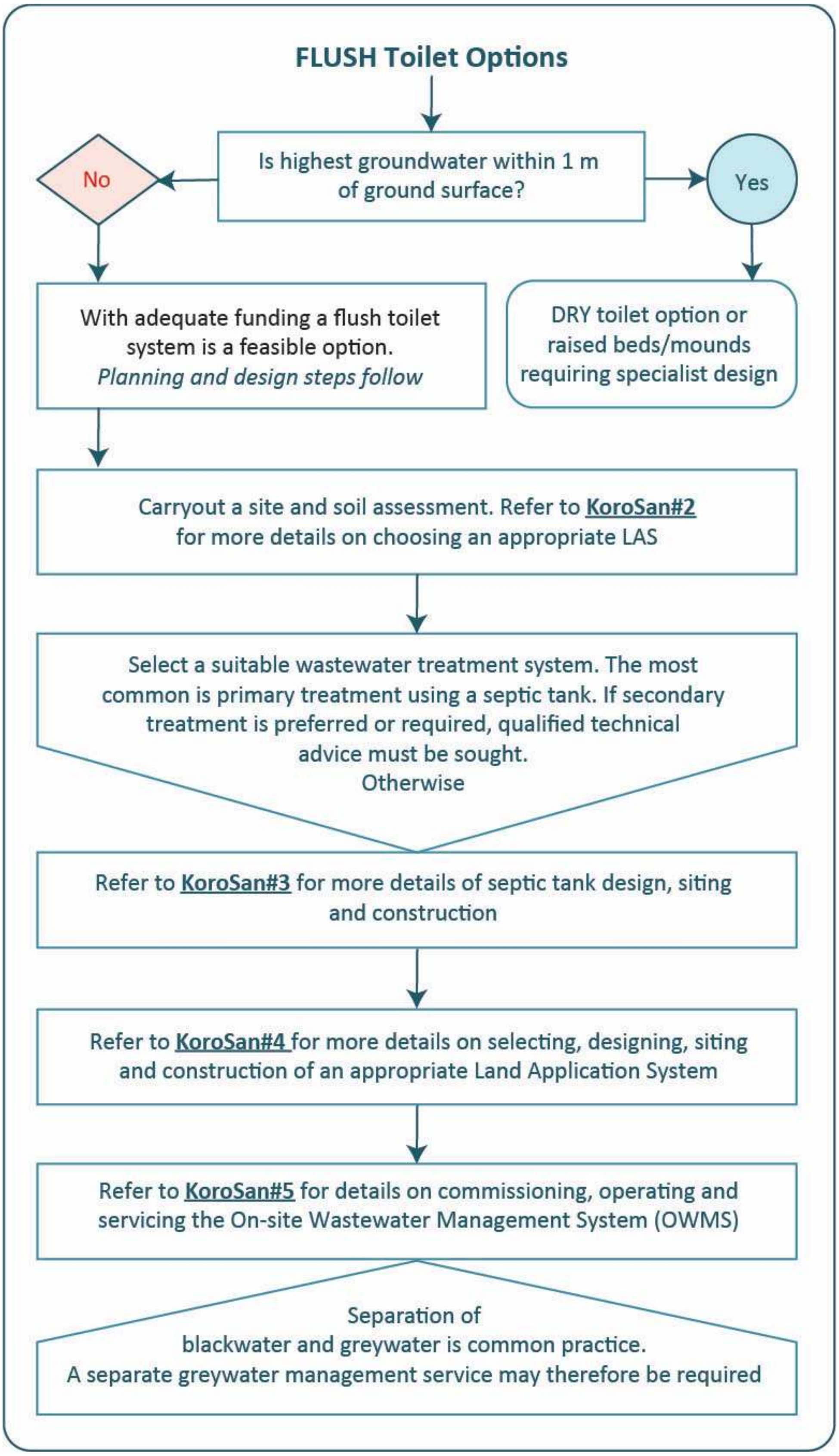
5 FLUSH TOILET OPTIONS

This section provides an outline of the types of on-site wastewater management service options that are likely to be suitable for villages requiring flush toilet systems. The key components of an on-site wastewater management service are shown in Figure 1. Each of these needs to be designed, constructed and functioning properly to provide a safe and sustainable service.

Figure 1. Basic components of an on-site wastewater management service



Flush toilet flow chart



5.1 WASTEWATER SOURCE

The volume of wastewater to be managed will depend not only on the number of people living in the dwelling or dwellings, and their habits, but also on the capacity of the water supply, types of household facilities; whether or not there are flushing toilets and the type of flushing toilet (pour flush, single flush or dual flush), if there are shower units, laundry facilities (washing machine), sinks and wash pads.

For more details on wastewater volumes, refer to KoroSan #2.

5.2 TREATMENT UNITS

For black water, the most common treatment unit that will be used in the Fijian village will be the septic tank. For an explanation of septic tanks, their design and construction, refer to KoroSan #3.

For recommendations on the treatment and management of grey water refer to KoroSan #8.

As noted in Section 2 there are a number of other technologies available for the treatment of domestic wastewater. There are high technology package plants available that treat the wastewater to a much higher standard than the septic tank. These are more expensive and are beyond the scope of this guideline. There is also the option of an add-on treatment to septic tank, should additional treatment be required before discharge to the land application system. Two examples are:

- sand filter
- constructed wetland

For these options specialist advice should be sought from a wastewater engineering specialist.

5.3 LAND APPLICATION SYSTEMS (LAS)

The best LAS for a particular site will depend on:

- Funding available
- Wastewater load and type of treatment
- Groundwater height and soil conditions
- Availability of suitable land area
- Drainage patterns and flood risk

LAS options and preferred site conditions are summarised in Table 3. More technical details on LAS can be found in KoroSan #4.

Three of the more common LAS used for the management of primary (septic tanks) effluent are:

1. The soak pit.
2. The standard soakage trench.
3. Sand trench or bed – sometimes referred to as a discharge control trench or bed.

Table 3. LAS options for Fijian villages. Refer to KoroSan #2, for advice on how to determine soil drainage capacity.

Option	Description	Attributes and limitations
Soak pit (or bolder pit)	This is a pit dug into the ground, normally back filled with large stones, and into which the effluent from the septic tank trickle loads and soaks into the base and side walls of the soak pit.	• Cheapest LAS. • No dose loading required. • Requires free draining soils for soakage[1]. • High chance of failure in poorly draining soils. • Not advised for sites with high groundwater (less than 1.5 m below ground level). • Must have an adequate setback from wells (50m) and surface waters (20m) such as streams and lagoons.
Conventional soakage trench	The conventional trench design provides an extended soakage surface area when compared to a soak pit. The length of this trench will depend on the daily volume of septic tank effluent to be disposed of and the soakage capability of the in-situ soils.	• Suitable for moderately draining and well-drained soils[1]. • While dose loading is not necessary, it will significantly reduce chances of failure and environmental impacts. • Highest groundwater needs to be at least 1.5 m below ground level. • Trenches must be located on the contour. • Must have an adequate setback from wells (50m) and public surface water bodies (20m).
Sand trench or bed	The sand trench or bed requires a suitable filter grade sand. The sand trench is used to improve the quality of the effluent being discharged to soakage. If sited over high groundwater, then it may be necessary to raise the sand bed or trench.	• Suitable for moderately draining and well-drained soils[1]. • Smaller land area required than for option 2. • More expensive due to the cost of filter grade sand. • Low chance of failure if properly constructed and maintained. • Dose loading is required. • Highest groundwater needs to be at least 600 mm below ground level, otherwise the sand bed or trench may need to be raised. • Trenches must be located on the contour. • Must have an adequate setback from well (30m) and surface water bodies (15m).
Raised sand trench or bed with under-drainage	For sites with very poorly draining clay sub-soils. The under drainage will need to be discharged safely, to a drain, wetland or stream. Therefore, it is important that this under-drainage is not a health or environmental risk. Filter grade sand is necessary to achieve this higher quality.	• Applicable to poorly draining clay soils[1]. • Smaller land area required than for option 2. • More expensive due to the cost of filter grade sand. • Dose loading is required. • Highest groundwater needs to be at least 0.6 m below ground level, otherwise the sand bed or trench may need to be raised. • Trenches must be located on the contour. • Must have an adequate setback from well (50m) and surface water bodies (20m).

LAND AREA REQUIREMENTS

The area of suitable land available for the LAS is a critical consideration. If the available land area is limiting, this can create significant constraints on wastewater management options.

The area required will depend on:

- Volume of treated wastewater to be applied to the land.
- Soil types.

More details on LAS area requirements can be found in KoroSan #4

6 DRY TOILET OPTIONS

There are two basic categories of commonly recommended dry toilets:

- Improved pit toilets such as the ventilated improved pit toilet and the ecoVIP2 toilet.
- Composting toilets.

The selection flow chart above (Section 4) provides a process for choosing between the different on-site wastewater services.

Dry toilet options are more likely to be favoured under one or more of the following site circumstances:

- Insufficient funds for flush toilets and associated treatment systems.
- Unreliable and/or insufficient water supply.
- Very high water table preventing safe disposal of flush toilet effluent.
- Villager level of service preferences.

The successful ongoing operation of dry toilet systems is contingent on the users understanding the need for, and then implementing, competent operation and management measures, particularly for composting toilet systems but also for the ecoVIP2 toilet. <u>If this high required level of management for dry toilets is not delivered by the users there is a high chance the toilets will fail.</u>

The solid waste from dry toilet system pose a serious health risk to those who have to handle it or come into contact with it. Particular care must be taken when handling and disposing of this solid waste.

More detailed technical information on dry toilet options is provided in to the KoroSan #6, and for composting toilet and pour flush toilet options, in the *Clean Communities, practical guide to building and maintaining toilets in the Pacific*, Live and Learn (2011). Refer to other relevant guidelines and back to AS/NZS standards where beyond scope of these.

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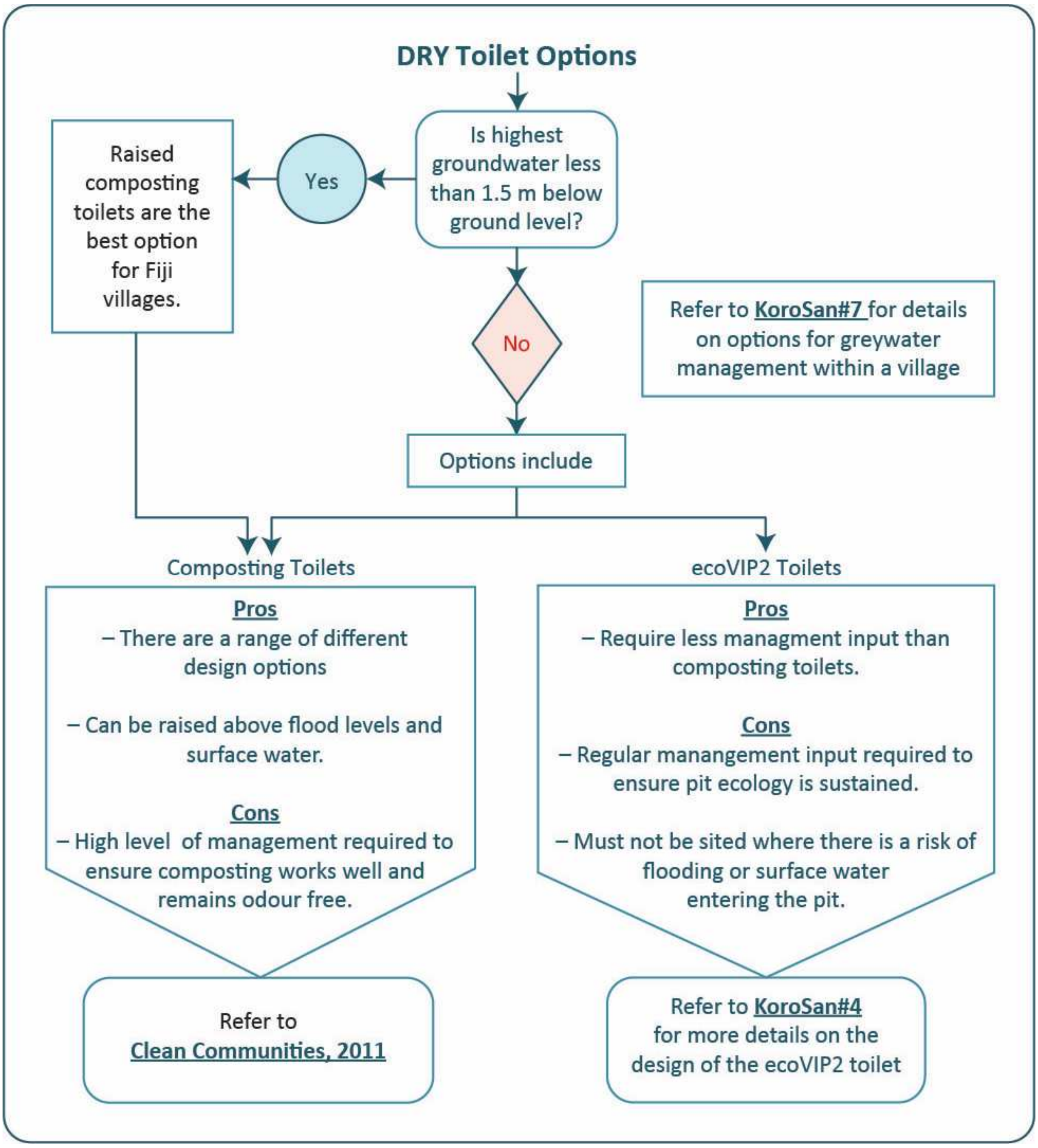
Dry toilet Flowchart



This guideline was produced in consultation with the Fiji Department of Water and Sewage and the Ministry of Health as part of the WASH Koro Project led by the National Institute of Water and Atmospheric Research (NIWA). The project was supported by the New Zealand Aid Programme through the Partnerships for International Development Fund of the Ministry of Foreign Affairs and Trade. Care has been taken to make sure the information provided is correct and fit-for-purpose, but we accept no liability for any errors or omissions, or the consequences of their use or misuse. The views expressed in these guidelines do not necessarily reflect those of the New Zealand or Fiji Governments.

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Version 1.1; July 2017

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Provincial Council

KoroSan Guidelines

The WASH w project has produced the following series of technical and participatory guidelines to help mobilise villages and settlements to improve their water supply, sanitation and hygiene. These guidelines may be freely disseminated provided the source is acknowledged.

KoroSan #	Title
1	Choosing a village wastewater management service
2	Site, soil and wastewater flow assessment
3	Septic tank construction using concrete blocks.
4	Land application systems
5	Maintaining your septic tank and land application system
6	Water-less ecoVIP2 toilet
7	Greywater management
8	Village participation in water and sanitation actions

KoroSan – for healthy villages