

Technical Brief: Effluent Management



Contents

1	Introduction	2
2	Effluent Characteristics	3
3	Treatment Technologies	3
4	Use	5
5	Disposal	5
6	Risk Management	7
7	Definitions	8
8	Additional Resources	9
9	References	10



Technical Brief: Effluent Management

1 Introduction

Effluent, also known as leachate, is the general name for a liquid that is produced by an on-site sanitation technology, like a septic tank. Effluent can also be produced from fecal sludge treatment technologies.

Effluent needs to be safely managed to protect public health and prevent environmental contamination. Yet, it has traditionally received little attention and its importance is overlooked. As a result, effluent is often discharged to surface water without treatment. Effluent can also infiltrate into soil and potentially contaminate the groundwater. Or effluent that does not drain away can create pools of stagnant water that provide an ideal environment for mosquitos to breed, including mosquitos that transmit malaria.

This Technical Brief introduces the importance of safely managing effluent. It includes technologies to treat effluent, as well as ways to use or dispose of it. This Technical Brief does not address effluent from latrines that are designed to infiltrate directly into the surrounding soil (like a simple or ventilated improved pit latrine). However, it does address on-site sanitation technologies that produce effluent that needs to be managed (like a septic tank or composting latrine).

This document provides a technical overview and is not a design manual. An experienced professional should be consulted for the design of specific technologies.

CAWST focuses on the planning, design, and implementation of on-site sanitation projects for low-income communities not connected to a sewer. For such communities, household or decentralized sanitation offers a hygienic and affordable solution.

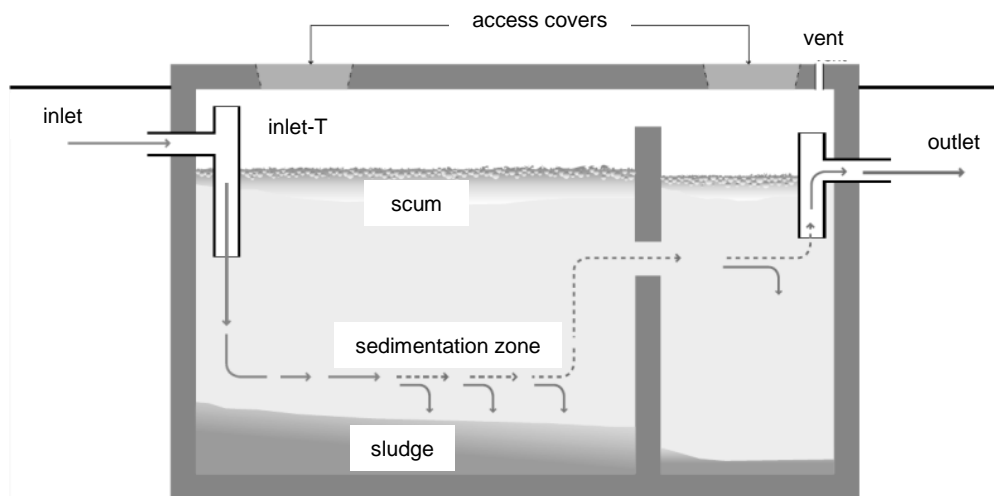
CAWST's free, open content resources and schedule of international training workshops can be found at: <https://resources.cawst.org> and www.cawst.org/training.

Technical Brief: Effluent Management

2 Effluent Characteristics

Many on-site sanitation technologies and fecal sludge treatment technologies produce a liquid effluent. Effluent is typically high in nitrogen and pathogens. It may also contain other nutrients, heavy metals, and salts (Strande, Ronteltap & Brdjanovic, 2014).

Effluent either overflows or drains through a technology. In a septic tank, for example, solids settle to the bottom while the effluent overflows out through a pipe into a leach field or infiltration trench. Effluent in a composting latrine or bin, however, drains through to the bottom of the pile. It is often called leachate because the liquid drains (or leaches) rather than overflows.



Effluent from a septic tank overflows through an outlet (Credit: Tilley et al, 2014)

Effluent from a fecal sludge treatment technology is also different than effluent from a wastewater treatment facility. A domestic wastewater treatment facility uses a sewer system to transport excreta and flush water from toilets, as well as greywater from kitchens, laundries, and bathrooms. As a result, the effluent from a wastewater treatment facility is more dilute than effluent from fecal sludge treatment technologies. Fecal sludge is not usually mixed with large quantities of flush water and greywater, so the effluent constituents are 10-100 times more concentrated than wastewater (Strande et al., 2014).



In Haiti, leachate is called Ji Kaka. This means poop juice. This is very accurate and emphasizes the fact that leachate is not a safe liquid.

3 Treatment Technologies

There are several technologies available to treat fecal sludge effluent. The level of pathogen inactivation and nutrient removal depends on the design and operation of the technology. The choice of treatment option usually depends on the quality of the effluent and its final use or disposal. For instance, effluent that is to be used for irrigation will need a higher level of treatment than effluent that is to be infiltrated into the ground. Even if effluent is not to be used,

Technical Brief: Effluent Management

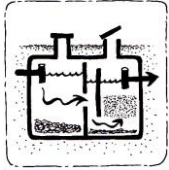
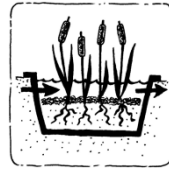

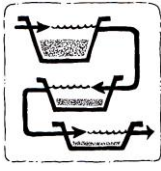
treating it before discharge into the environment can help to reduce water and soil contamination.

The level of research and knowledge on treatment technologies can also influence technology selection. Most fecal sludge effluent treatment technologies are transferred from wastewater treatment. There are various levels of experience in the design, operation, and maintenance specifically for faecal sludge effluent treatment.

The choice of treatment technology will also depend on national standards. Most countries have effluent quality standards, but they are not necessarily enforced in low- and middle-income countries (Strande et al., 2014).

The following table describes various fecal sludge effluent treatment technologies.

Table: Effluent Treatment Technologies

Treatment Technology	Description
 <p data-bbox="240 993 407 1020">Anaerobic Filter</p>	<p data-bbox="475 804 1430 993">One or more watertight tanks are filled with filter material, like gravel, crushed rocks or bricks. A biolayer forms around the filter material over time. As effluent flows through the filter, the filter traps solid particles and the biolayer degrades organic material. Anaerobic filters are not efficient at removing nutrients and pathogens. However, worm eggs may be removed depending on the filter material used (Tilley, Ulrich, Lüthi, Reymond & Zurbrügg, 2014). The filter works without oxygen, so harmful and bad smelling gases are produced which need to be managed and vented.</p>
 <p data-bbox="207 1213 448 1241">Constructed Wetlands</p>	<p data-bbox="475 1052 1430 1213">Also called planted gravel filters. A constructed wetland aims to copy the naturally occurring processes in wetlands. They are constructed of a bed that is lined with impermeable material and filled with coarse sand and gravel. A soil layer is usually placed on top to grow plants. As effluent slowly flows through the wetland, solid particles are trapped and adsorped, and pathogens, organic material, and nutrients are degraded by complex biochemical processes.</p>
 <p data-bbox="224 1444 431 1472">Planted Drying Bed</p>	<p data-bbox="475 1283 1430 1444">Also called planted dewatering beds, vertical flow constructed wetlands, and drying reed beds. A planted drying bed is filled with filter material, usually gravel at the bottom and sand on top. Specific plants (macrophytes) grow in the sand filter layer. The bottom of the bed is sloped and lined with perforated pipes to drain away the liquid. Effluent is placed on the surface of the bed and the liquid flows through the sand and gravel for a period of days. The plants need to be harvested on a regular basis.</p>
 <p data-bbox="224 1703 431 1755">Waste Stabilization Ponds</p>	<p data-bbox="475 1514 1430 1755">Waste stabilization ponds can be used to co-treat effluent with wastewater. Lined ponds are filled with effluent that is then treated by naturally occurring processes. The ponds can be used individually, or linked in a series for improved treatment. There are three types of ponds, (1) anaerobic, (2) facultative, and (3) aerobic (maturation) – all with different depths and retention times. The first pond in a series is the deepest while the last pond is the shallowest. The first pond stabilizes the effluent through anaerobic digestion. The second pond further stabilizes the sludge through both anaerobic and aerobic digestion. The shallowness of the last pond allows sunlight to penetrate through the water to inactivate pathogens.</p>

(Strande et al., 2014; Tilley et al, 2014; Credit images: Akvo)

Technical Brief: Effluent Management

4 Use

As the world population continues to grow and water scarcity increases, there is more awareness on water conservation. Treated effluent can be used to irrigate home gardens or agricultural crops. This can help communities to grow more food, while at the same time conserve precious water. Effluent should be treated before it is used to reduce the risk of transmitting pathogens.



Watch the Salt!

Using effluent for irrigation will increase the salinity of the soil over the long-term. Salt can interfere with plant growth and have long-term impacts on the soil. It is recommended that salinity control practices are used, like making sure that there is enough drainage.

(Strande et al, 2014; WHO, 2006)

5 Disposal

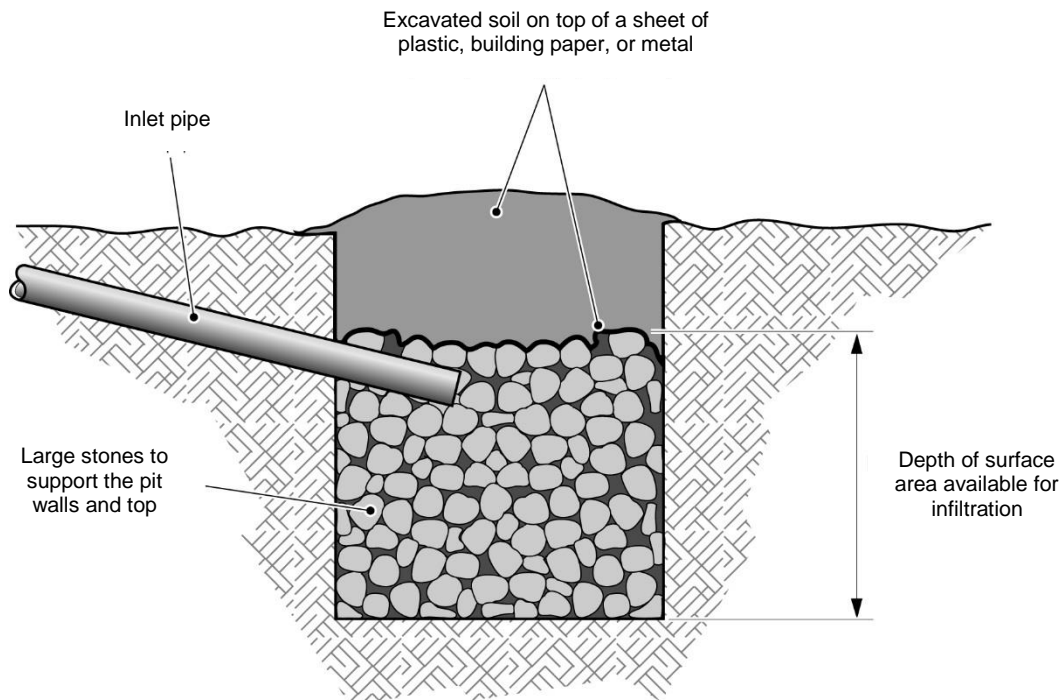
Discharging effluent into a surface water body (like a river, pond, lake or sea) is the most common method of disposal, especially in urban and peri-urban areas. Effluent should be treated before discharge to protect public health and the environment. The level of treatment will depend on national standards.

There are other options to dispose effluent at the household level that are simple, low cost, and effective. Infiltrating effluent into the ground using a soak pit or infiltration trench is a simple and suitable method. This is a common disposal option for effluent produced by septic tanks.

A soak pit is a dug pit that allows used water to safely infiltrate effluent into the ground. Soak pits must be lined or filled with rocks to prevent erosion and to prevent the walls from collapsing. The size of the soak pit is based on the amount and quality of effluent entering the pit. Infiltration only happens through the side walls of the soak pit. Almost no infiltration occurs through the base of the pit because it quickly clogs with solids. It is important to design the size of the soak pit to handle peak flows of effluent, especially if the infiltration capacity of the surrounding soil is low.

Technical Brief: Effluent Management

Figure: Soak Pit Filled with Rocks



Soak pit filled with rocks and covered sheet and soil (Credit: Chatterton)

The simplest and quickest way to build a soak pit is to dig a pit and fill it with rocks. However, the rocks reduce the volume of water that the pit can hold and finding enough rock may be difficult in some places. Lining the soak pit walls with bricks or blocks overcomes both of these issues, but it increases the construction time, cost and difficulty.

Trenches can be used in situations where a soak pit is unable to infiltrate the total amount of effluent. This can be either because of low soil infiltration capacity, large amounts of effluent, or a combination of the two. Infiltration trenches are long shallow pits. They require more planning, space and materials than a soak pit, but create a much greater surface area for infiltration into the soil. Infiltration trenches are often used in conjunction with septic tanks.

The WHO (2006) recommends locating soak pits and infiltration trenches so that they do not contaminate groundwater. See CAWST's Technical Brief: Siting Latrines for recommendations that can also be used to site soak pits and infiltration trenches.






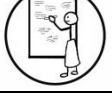
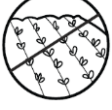



For more information about soak pits and infiltration trenches, see CAWST's Technical Brief: Design Calculations for Soak Pits and Infiltration Trenches.

Technical Brief: Effluent Management

6 Risk Management

There are many protective measures that should be put in place when managing effluent. These protective measures avoid the spread of pathogens and protect human health. These barriers focus on protecting the people handling the effluent and the local community. This is often known as a multi-barrier approach. There are particular barriers depending on if the effluent is used or disposed of. The WHO guidelines for wastewater use in agriculture (2006) gives specific recommendations to minimize the health risks if the effluent is used.

Table: Barriers to Protect Health

Barriers to Protect Health		Actions	
General		Treatment	Treat effluent before use and disposal.
		Restrict access	Construct a fence to keep animals and children out of the effluent treatment, disposal, and irrigation site. Display warning messages.
		Wash hands	Wash hands with soap after managing effluent.
		Clean tools	Disinfect the tools used or only use them for one activity. Safely store the tools so people do not touch them or use them for another purpose.
		Use protective equipment	Wear protective equipment, such as clothing, gloves, shoes, and mask.
		Train	Train workers, families, and the community on the importance of effluent management and hygiene practices.
Use		Restrict crops	Only use effluent for crops that: <ul style="list-style-type: none"> • Are not eaten (like cotton) • Are processed (like wheat) • Are cooked (like potatoes) • Do not directly touch the ground (like bananas)
		Application techniques	Apply effluent on the soil and not on the plant. Avoid spraying and sprinkling irrigation.
		Waiting period	Wait one month after applying the effluent before harvesting crops. Pathogens continue to be inactivated once they are in the soil. Inactivation is much faster in hot and sunny climates than cold and rainy climates.
		Prepare food properly	Wash fruits and vegetables with safe water before eating. Wash hands with soap before cleaning and preparing food. Thoroughly cook all food and do not eat raw food.

Technical Brief: Effluent Management

7 Definitions

Aerobic: Biological processes that occur in the presence of oxygen.

Anaerobic digestion: The decomposition and stabilization of organic material by microorganisms without oxygen. This process produces biogas.

Degradable: Also called decomposable. A material that can be slowly broken down into simple parts.

Degradation: Also called decomposition. The transformation of dead organic material into more basic compounds and elements by biological and biochemical reactions.

Disposal: The return of waste to the environment, ideally in a way that is least harmful to public health and the environment.

Effluent: Also called leachate. Liquid that is produced from an on-site sanitation technology (like a septic tank) or fecal sludge treatment technology.

Fecal sludge: Also called sludge. Excreta from an on-site sanitation technology (like a pit latrine or septic tank) that may also contain used water, anal cleansing materials, and solid waste.

Impermeable: Also called watertight. Liquids cannot pass through.

Infiltrate: To pass into or through something. Infiltration is the process by which liquid enters the surrounding soil.

Leachate: Also called effluent. Liquid that separates from solids by gravity filtration through media (like liquid that drains from co-composting or drying beds).

Organic material: Also called organic matter. Comes from the remains of living things, such as plants and animals.

Pathogen: An organism that causes disease.

Permeable: Not watertight. Liquids can pass through.

Risk: The likelihood of a hazard causing harm to exposed populations in a specific time frame and the consequences of that harm.

Treatment: Any process to inactivate pathogens, stabilize, dewater, or manage nutrients in fecal sludge.

Wastewater: Used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff (stormwater), and any sewer inflow (infiltration). Wastewater can be managed on-site or off-site. Wastewater managed off-site is often called sewage.

Technical Brief: Effluent Management

8 Additional Resources

CAWST Sanitation Resources. Available at: <https://resources.cawst.org>

- CAWST's education and training resources are available on a variety of sanitation topics including environmental sanitation; latrine design and construction; fecal sludge management; and sanitation implementation.

Compendium of Sanitation Systems and Technologies. Tilley, E., Ulrich, L., Lüthi, C., Reymond, P. and Zurbrügg, C. (2014). 2nd Revised Edition. Eawag: Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland. Available at: www.eawag.ch/forschung/sandec/publikationen/compendium_e

- The Compendium presents the concept of sanitation systems together with detailed information about sanitation technologies for each component of sanitation systems. The document targets engineers, planners and other professionals who are familiar with sanitation technologies and processes. However, it is also a useful document for non-experts to learn about the main advantages and limitations of different technologies and the appropriateness of different systems.
- The e-Compendium, is an online, interactive version of the Compendium, complete with a tool for combining technologies into a complete sanitation system. Available at: <http://ecompendium.sswm.info>

Technical Brief: Effluent Management

9 References

Chatterton, K. (nd). *Soak pit*. WEDC Image Library. Loughborough, UK: WEDC. Retrieved from <http://wedc.lboro.ac.uk/knowledge/img-lib-lres.html?id=10-0>

Strande, L., Ronteltap, M. & Brdjanovic, D. (Eds.) (2014). *Faecal sludge management: Systems approach for implementation and operation*. London, UK: IWA Publishing. Retrieved from www.sandec.ch/fsm_book

Tilley, E., Ulrich, L., Lüthi, C., Reymond, P. & Christian Zurbrügg. (2014). *Compendium of sanitation systems and technologies* (2nd Revised Edition). Dübendorf, Switzerland: Swiss Federal Institute of Aquatic Science and Technology (EAWAG). Retrieved from www.eawag.ch/en/department/sandec/publications/compendium/

WHO. (2006). *Guidelines for the safe use of wastewater, excreta and greywater* (Vol. 4). Geneva, Switzerland: WHO. Retrieved from www.who.int/water_sanitation_health/wastewater/gsuww/en/

Akvo images can be retrieved at: http://akvopedia.org/wiki/Main_Page

CAWST (Centre for Affordable Water and Sanitation Technology)
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