FLUSH SANITATION

eawag aquatic research

STRATEGY

Flush sanitation refers to the standard practice of using flush toilets to handle human excreta. A separately-piped flush stream is called blackwater, which contains urine, feces and flush water. When mixed and piped together with greywater it is referred to as mixed wastewater. Like water reuse from greywater, blackwater or mixed wastewater can also be treated for fit-for-purpose water reuse to save water. Recovery of nutrients and organics from these streams remains a challenge due to their strong dilution and the lack of simple and efficient solid-liquid separation technologies that enable recovery from the solid fraction. Flush sanitation can be combined with urine diversion, via urine diverting flush toilets, to enable nutrient recovery from urine. This strategy allows for resource recovery where a flush toilet already exists or is desired.

INPUT STREAMS

- Blackwater
- Mixed wastewater

TARGET OUTPUTS

- Treated water for non-potable water reuse (see)
- Soil amendments & fertilizers

FLUSH TOILETS

Flush toilets are the standard fixture in contexts with centralized, water-based sanitation, though they can also be installed in decentralized systems. Flush toilets often use 3 -13 L/flush depending on the toilet type. Variations include: dual flush, low flush, pour flush, and pressure flush. Commercially available urine diversion flush toilets further separate urine from the blackwater stream (see).

PIPING

Flush water can be piped separately (blackwater with or without urine diversion), which requires designated piping, or together with other streams (mixed wastewater). The latter requires only one pipe, as is conventionally installed for sewered systems.

MECHANICAL ROOM

Treatment of the collected stream(s) typically takes place in a mechanical room, integrated within a building, in underground tanks, or in a neighboring building for a semi-centralized treatment solution. Proper ventilation of mechanical rooms is crucial.

NEIGHBORHOOD SCALE
LA BISTOQUETTE
Geneva, Switzerland | 2025

BUILDING SCALE
ALPINE HUT
Rossinière, Switzerland | 2022

TO CONSIDER

COLLECTED STREAM

Flush water often contributes 20 - 40% of total domestic water use. Flush toilets mix urine and feces, and toilet paper, with large volumes of water resulting in a diluted stream. The flush stream can be collected separately, or together with greywater. The addition of greywater further dilutes the stream.

SPACE & PLACEMENT

No additional space is required for piping when flush water is mixed with other wastewaters; for blackwater collection designated piping is needed in parallel to greywater, and/or urine piping. Space requirements for a mechanical room for treatment depend on volumes collected and treatment technologies selected. While technologies can be quite compact (e.g., MBR), the series of technologies together do require space.

RESOURCE INTENSITY

Operational costs for treatment of streams containing flushwater are generally higher than for cleaner streams, such as greywater. When considering treatment options, the costs of advanced systems (e.g., membrane bioreactors) should be compared to real estate costs of space-intensive systems (e.g., nature-based solutions). Energy use varies by technology. Separate blackwater piping adds capital costs.

NEW BUILD VS. RETROFIT

Flush sanitation lends itself to building retrofits, where flush toilets are already installed in existing buildings, as well as to new build where flush toilets are preferred. Mixed wastewater requires single piping (e.g., existing piping). Blackwater, collection requires separate designated piping, next to other collected streams, and is therefore easiest in new build planning and construction.

HYBRID VS. DECENTRALIZED

Treatment of and recovery from collected blackwater or mixed wastewater can be implemented in hybrid or decentralized scenarios. Where a connection to the sewer is available, remaining streams or byproducts (e.g., from a liquid-solid separation step) can be discharged to sewer for a hybrid configuration.

USER EXPERIENCE

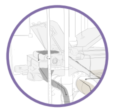
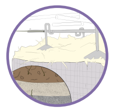
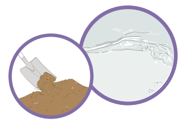
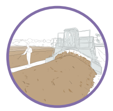
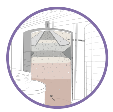
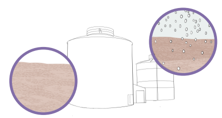
In many contexts, flush toilets are already installed, or are preferred. Implementing flush sanitation does not change the user experience at the user interface. Awareness among users about appropriate cleaning products is critical for biological treatment processes and fertilizer use of recovered products.

TREATMENT OPTIONS

A typical treatment train for blackwater or mixed wastewater begins with a solid-liquid separation step, followed by technologies that valorize the organics and nutrients from the solids fraction or treat the liquid fraction for water reuse. In remote areas, where treatment is needed independent of the grid, infiltration or discharge are also possible solutions.

WATER REUSE	Treatment of the liquid fraction for fit-for-purpose reuse via biological treatment, filtration and disinfection technologies (see for water reuse treatment options).
WATER INFILTRATION & DISCHARGE	Treatment (e.g., septic tanks or aerobic treatment of mixed wastewater, or after a solid-liquid separation step) that produces an effluent that can be discharged to the environment or infiltrated on site.
VALORIZATION OF ORGANICS & NUTRIENTS	Biological anaerobic or aerobic treatment of the solid fraction after solid-liquid separation that yields a soil amendment (e.g., compost, anaerobic sludge) or biogas.

BELOW: Treatment options for valorization of nutrients and organics from the solids fraction. For water reuse treatment options see .

PROCESS OBJECTIVE		TECHNOLOGY	PRODUCT(S)
Solid-liquid separation removes grit, debris, and grease, and/or separates suspended solids (toilet paper, feces) from the liquid fraction.	S-L SEPARATION	 T.42 SETTLING TANKS | SCREENS	 LIQUID FRACTION
	S-L SEPARATION / BIOLOGICAL TREATMENT	 T.43 VERMIFILTERS	 COMPOST, LIQUID FRACTION
Anaerobic or aerobic biological processes, driven by microorganisms, convert organics into biogas or compost. Limited pathogen and micropollutant removal is achieved.	BIOLOGICAL TREATMENT	 T.22 OFF-SITE COMPOSTING	 COMPOST
	BIOLOGICAL TREATMENT	 T.23 ANAEROBIC DIGESTION	 SLUDGE, BIOGAS

SAFE REUSE

SAFE WATER REUSE

See for details on pathogen removal and inactivation, preventing microbial regrowth, and dealing with micropollutants for safe water reuse.

PATHOGENS & PHARMACEUTICALS

Pathogen risks in fecal-derived soil amendments can be reduced by combining treatment steps (e.g., compost maturation following vermifiltration or digestion) or by application measures (e.g., lag time between last application and harvest). Pharmaceutical and micropollutant removal varies per treatment. Their environmental risks in soil remain unclear, though are likely lower than those from applying animal manure or municipal sewage sludge (which also includes industrial wastewater and stromwater).