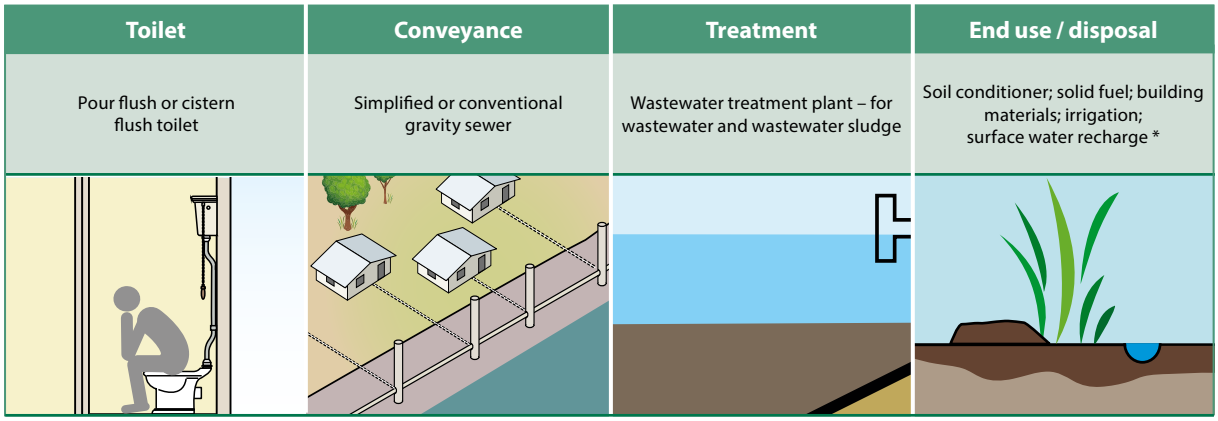
World Health Organization

Fact sheet 10

Flush toilet with sewerage and offsite wastewater treatment



* Sludge: treated and used as soil conditioner, solid fuel or building materials. Effluent: treated and used for irrigation or surface water recharge.

Summary

This is a water-based sewer system in which wastewater is transported to a treatment facility. Importantly, unlike the system described in Fact sheet 9, in this system there is no interceptor tank (i.e. a containment technology such as a septic tank).

Inputs to the system include faeces, urine, flushwater, cleansing water, dry cleansing materials, greywater and possibly stormwater.

There are two toilet technologies that can be used for this system: a pour flush toilet or a cistern flush toilet. A urinal could additionally be used. The blackwater that is generated at the toilet together with greywater is directly conveyed to a treatment facility through a conventional or a simplified gravity sewer network.

As there is no containment, all of the blackwater is transported to a treatment facility where a combination of technologies is used to produce treated effluent for end use and/or disposal, and wastewater sludge. This sludge must be further treated prior to end use and/or disposal.

Applicability

Suitability: This system is especially appropriate for dense, urban and peri-urban settlements where there is little or no space for onsite containment technologies or emptying. The system is not well-suited to rural areas with low housing densities.

Since the sewer network is (ideally) watertight, it is also applicable for areas with high groundwater tables.

The system requires a constant supply of water for flushing, to ensure that the sewers do not become blocked.

Cost: The capital investment for this system can be very high. Conventional gravity sewers require extensive excavation and installation that is expensive, whereas simplified sewers use smaller diameter pipes laid at a shallower depth and at a flatter gradient, so are generally less expensive.

Users may be required to pay a connection fee and regular user fees for system maintenance; the size of the fees will depend on the operation and maintenance arrangement and whether or not the local topography dictates that the blackwater requires pumping to reach the treatment plant.

The capital cost of the treatment plant may also be considerable, while the treatment plant maintenance costs will depend on the technology chosen and the energy required to operate it.

Overall, this system is most appropriate when there is a high willingness and ability to pay for the capital investment and maintenance costs and where there is an appropriate treatment facility.

Design considerations

Toilet: The toilet should be made from concrete, fibreglass, porcelain or stainless steel for ease of cleaning and designed to prevent stormwater from infiltrating or entering the sewer.

Conveyance: This water-based system is suitable for cleansing water inputs, and easily degradable dry cleansing materials can be used. However, rigid or non-degradable materials (e.g., leaves, rags) could block the system and should not be used. In cases when dry cleansing materials are separately collected from the flush toilets, they should be collected with solid waste and safely disposed of, for example through burial or incineration.

The inclusion of greywater in the conveyance technology helps to prevent solids from accumulating in the sewers and stormwater could also be put into the gravity sewer network. However, this would dilute the wastewater and require stormwater overflows. Local retention and infiltration of stormwater, or a separate drainage system for rain and stormwater are therefore preferred approaches.

Treatment: Typically, the wastewater treatment technology will consist of a series of ponds or wetlands, which can produce a stabilized, pathogen-free effluent, which is suitable for use as crop irrigation water. As well as effluent, the treatment technology will produce wastewater sludge, which may require further treatment prior to end use and/or disposal. For example, dewatered and dried wastewater sludge can be used as a solid fuel or as an additive to construction materials.

End use/disposal: Options for the end use and/or disposal of the treated effluent include irrigation, fish ponds, floating plant ponds or discharge to a surface water body or to groundwater [2].

Operation and maintenance considerations

Toilet: The user is responsible for the construction, maintenance and cleaning of the toilet.

At shared toilet facilities, a person (or persons) to clean and carry out other maintenance tasks (e.g. repairs to superstructure) on behalf of all users needs to be identified as well as an emptying service provider.

Conveyance: Depending on the sewer type and management structure (simplified vs. conventional, city-managed vs. community-operated) there will be varying degrees of operation or maintenance responsibilities for the user. Where conventional, city-managed sewerage is found, users' involvement will be limited to paying user fees and reporting problems to the service provider. In contrast, if simplified, community-operated sewerage is used, users may help the community organization inspect, repair and/or unblock the sewer line [3].

Treatment: Functioning, properly maintained wastewater and sludge treatment technologies are a key requirement. In most situations these are managed at the municipal or regional level. In the case of small-scale systems, operation and maintenance of the treatment plant is managed and organized at the community level. All machinery, tools and equipment used in the treatment step will require regular maintenance by the relevant service providers.

End use/disposal: Farmers and the general public will be the main end users of the treatment products and will be responsible for maintenance of all tools and equipment they use [4].

Mechanisms for protecting public health

Toilet: The toilet separates the excreta from direct human contact, and the water seal reduces smells, nuisance and disease transmission by preventing disease carrying vectors from entering and leaving the sewer.

Conveyance: The conveyance step removes the pathogen-containing blackwater from the neighbourhood or local community to a treatment plant. The (ideally) watertight sewer network isolates the blackwater from physical human contact and ensures groundwater is not contaminated.

As the blackwater contains pathogens, when clearing blockages or repairing sewers, all workers require personal protective equipment and must follow standard operating procedures. For instance, the wearing of boots, gloves, masks and clothing that cover the whole body is essential, as well as washing facilities and good hygiene practices [4].

Treatment: In order to reduce the risk of exposure of the local community, all treatment plants must be securely fenced to prevent people entering the site, and to safeguard workers' health when operating the plant and carrying out maintenance to tools and equipment, all treatment plant workers must be trained in the correct use of all tools and equipment they operate, wear appropriate personal protective equipment and follow standard operating procedures [4].

End use/disposal: If correctly designed, constructed and operated, treatment technologies can be combined to reduce the pathogen hazard within the effluent or sludge by removal, reduction or inactivation to a level appropriate for the intended end use and/or disposal practice. For example, effluent requires stabilization and pathogen inactivation in a series of ponds or wetlands before use as crop irrigation water. While sludges require dewatering and drying followed by co-composting with organics before use as a compost-type soil conditioner, but for use as a solid fuel or building material additive, they only require dewatering and drying [2, 5, 6].

To protect the health of themselves, co-workers and the general public, end users must wear appropriate protective equipment and follow standard operating procedures in accordance with the actual level of treatment and end use [4].

References

The text for this fact sheet is based on Tilley, et al. [1] unless otherwise stated.

1. Tilley E, Ulrich L, Lüthi C, Reymond P, Schertenleib R, and Zurbrügg C (2014). *Compendium of Sanitation Systems and Technologies. 2nd Revised Edition.* Swiss Federal Institute of Aquatic Science and Technology (Eawag).

2. Strande L (2017). *Introduction to Faecal Sludge Management*. Online Course available at: www.sandec.ch/fsm_tools (accessed March 2017). Sandec: Department of Sanitation, Water and Solid Waste for Development Eawag: Swiss Federal Institute of Aquatic Science and Technology.

3. Brikké F, and Bredero M (2003). *Linking Technology Choice with Operation and Maintenance in the Context of Community Water Supply and Sanitation. A reference document for planners and project staff.* Geneva, Switzerland.

4. World Health Organization (2015). *Sanitation Safety Planning – Manual for safe use and disposal of wastewater, greywater and excreta.* Geneva, Switzerland.

5. World Health Organization (2006). *WHO Guidelines for the safe use of wastewater, excreta and greywater. Volumes I to IV.* Geneva, Switzerland. 2006.

6. Stenström T A, Seidu R, Ekane N and Zurbrügg C (2011). *Microbial exposure and health assessments in sanitation technologies and systems*. Stockholm Environment Institute (SEI).