

On-site Wastewater Management Training Course

Other On-site Primary Treatment Systems and Greywater Options

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Domestic Wastewater Systems

- Earliest known flushing toilets found in the Indus Valley, India dating from mid-3000 BC
- Modern septic tank use involving clay pipes from home to concrete tank outside traced back to 1860's in France



*The Royal Flush: 2,400-Year-Old Toilet Used by Emperors Unearthed in China (Feb 2023)



Gone in a flush: Blenheim Palace's \$9.6m 18 carat golden toilet stolen in just five minutes (Sept 2019)

*<https://www.livescience.com/2400-year-old-flush-toilet-unearthed-in-china-could-be-one-of-the-worlds-oldest>

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Other On-site Options

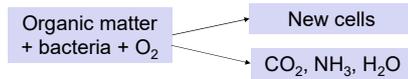
- Alternative toilets may involve:
 - Incineration – combustion of human waste
 - Chemical stabilisation - addition of odour control solution &/or maceration before removal & treatment off-site
 - Waterless composting (dry) toilet systems
 - Vermiculture (wet) biological filter systems
 - Hybrid toilet systems
- Also possible to separate urine (yellow water) and faeces (urine diverting systems) or segregate blackwater & greywater following treatment for re-use using separate pathways

An A20 – Onsite wastewater management system permit is required to construct, install or alter an OWMS (< 5,000 L/day). Councils must not approve installation of certain facilities unless they have been accredited. See EPA Victoria May 2024 Guideline for onsite wastewater management.

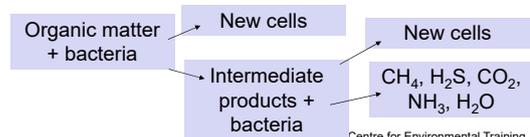
Aerobic/Anaerobic Decomposition

Organic solids are readily broken down into more stable inorganic compounds by bacteria and other micro-organisms

Aerobic oxidation



Anaerobic oxidation



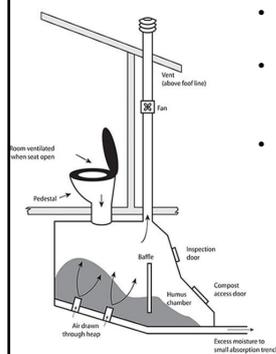
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Composting Toilets

- Rely on actions of microorganisms in an aerobic environment to decompose organic material into humus like material which requires periodic removal
- Systems usually dry (waterless), although wet system available incorporating vermiculture
- Success is dependent to a large degree upon the commitment of the homeowner
- Installation must cater for leachate generation (typically 1.3 L/p/d) either directed to greywater or small soil absorption system
- Still a requirement to consider household greywater treatment and effluent dispersal
- Refer to requirements of AS 1546.2 Part 2: Waterless Composting Toilets, also see Appendix E

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Composting Toilets



- Can take either all toilet waste or separate the solids and urine
- Typically faecal solids collected in one or several containers and replaced when full
- Types of container systems:
 - Continuous - single container where toilet waste decomposes and moves through chamber or large vault
 - Batch - two or more containers, one active and one fallow
 - Self-contained with heating element and fan

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Composting Toilets



<http://www.yourhome.gov.au/water/waterless-toilets>

- Conserve water and keep pollutants out of the environment
- Humus needs to be periodically removed and buried (300 mm)
- Liquid directed to sewer (if available) or land (urine trenches) or evaporated

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Control Variables

- Optimum composting achieved with C:N ratio approaching 30:1 - excreta requires added carbon source to balance C:N ratio; 12-month composting period before subsurface disposal
- Moisture content needs to be reduced to 12-40% - adequate ventilation required to enhance moisture:air ratio

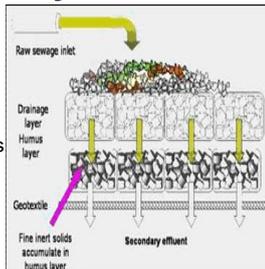
<http://www.yourhome.gov.au/water/waterless-toilets>

Odours	None, inoffensive
Consistency	Friable, humus
C:N ratio	> 14:1
Microbiological Criteria	< 200cfu/g Thermotolerant coliforms



Biological Filter Systems

- "Wet" composting systems that are comprised of different filtering mediums
- Earthworms and bacteria breakdown and consume the solid residuals and liquid organics
- Consist of several layers - worms and finely structured humus and coco-peat layer and geofabric layer
- Worms aerate the entire system, which allows the aerobic bacteria to survive and convert waste into humus and maintain drainage and air porosity



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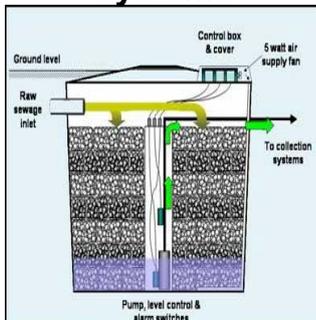
Vermiculture (worm-based)



- Aerobic process, low or no odour
- Mechanical components - single-phase industrial strength pump + small air pump
- Secondary effluent land applied
- Requires some maintenance

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Biological Filter Systems



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...as a Secondary Treatment System

- Two-tank (6000 L) system 10 EP
- Primary followed by lifting to raised sludge & sediment filter
- Passive filtration leading to second tank
- Compulsory disinfection unit prior to land application
- Achieves secondary standard plus some nutrient reduction



WormSmart Plus
Vermiculture Composting STS
<https://www.wormsmart.com.au/>

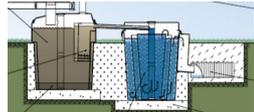
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Hybrid Toilet System

- Two-tank system involving primary and secondary tanks - aeration provided by standard rotary ventilation
- Second tank contains maze of plastic pipe media which allows biofilm to develop and results in long retention time before discharge
- Treated effluent of higher quality discharged to ground in land application area or to holding tank



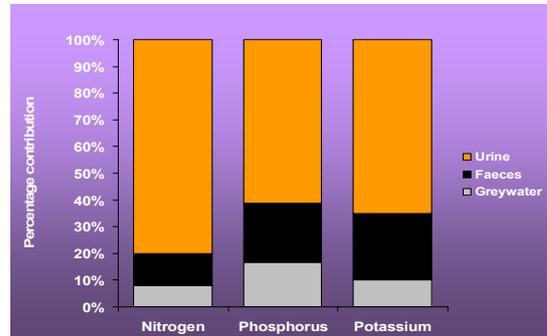
Used successfully in remote and low use areas



Source: <https://www.gough.com.au/hts/commercial/photo.php#>

Percent Nutrients in Wastewater

80% N, 60% P, 70% K of all nutrients in domestic wastewater are in urine



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Yellow is the New "Grey"

- UST used in Europe for many years to separate urine from faeces and N, P, K at source to avoid mixing with faecal matter
- Reduces water use and nutrient discharge
- Stored dehydrated urine can be used as alternative fertiliser in agriculture
- Closes the "nutrient loop"
- Global P scarcity!



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Urine Diversion Systems

- Urine separating or diverting toilets - liquid fraction separated by manual use or centrifugal force and gravity
- Urine pipe diverts liquid to collection vessel e.g. bladder



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Urine Collection Storage and Reuse



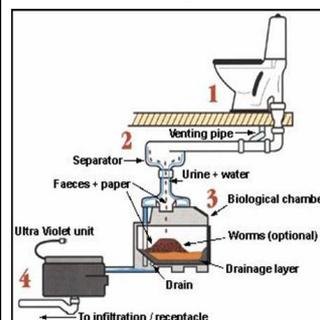
300L Storage Bladder



Nutrients in urine: pollute waterways but useful fertilisers for crop growth



Aquatron Separator



Uses centrifugal force and gravity to separate liquids and solids – schematic shows Collecting Chamber and Ultraviolet Unit (Source: www.aquatron.se)

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Research Trials

- Ongoing trials in Brisbane and Sydney - UTS & Griffith Univ.
- Currumbin Ecovillage, QLD - 20 households used Gustavsberg toilets over 2 years – sustainable living philosophy to maximise conservation and/or recycling of resources
- Kinglake West, VIC – Yarra Valley Water project to examine sustainable sewerage solutions; 23 households participated to investigate yellow water harvesting, greywater systems and STEP tanks; Results:
 - no significant reduction in nutrient load going to STP
 - harvested nutrients delivered agronomic benefits
 - significantly more expensive than commercially available fertilisers
 - high costs due to dilution of urine with toilet flush water and management of increased volumes

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Domestic Greywater

- Greywater contains some pathogenic micro-organisms
- Kitchen greywater typically not reused (due to quality) while bathroom and laundry may be
- Typically contains particles of dirt, food, lint, sand, some of which can be removed by basic filtering
- Also contains inorganic salts (Na) and organics such as oils, fats, milk, soap and detergents (plus N, P and K)
- Has potential to cause unpleasant odours and contribute to environmental problems off-site

Source	Rose <i>et al.</i> (1991) FC-cfu/100mL
Bathing/ Shower water	6 x 10 ³
Laundry wash water	126
Laundry rinse water	25
Combined wastewater	6 to 80 1.5 x 10 ³

See Table 4.6 EPA Guideline, Level 1,2,3 for Greywater treatment standards & uses

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Reuse Options – Manual Bucketing

- Considered low risk given few interested but contaminants still present as no treatment
- Reuse of relatively small volumes
- Bath, shower or laundry water collected manually
- Can also bucket water for direct toilet flushing but not to be added to cistern
- More commonly used with water shortages but overall use is unregulated



Diversion Using Gravity or Pumping

- Untreated greywater must be used when generated
- Diversion using gravity requires slope away from house
- Pump diversion requires surge tank and backflow protection; electrically operated pump
- Devices should have tap, valve or switch to provide for diversion to garden or to sewer (but some do not)
- Distributed through subsurface irrigation (min. 10 cm) and requires careful management
- Considered low to medium risk activity with reduced risk of pathogen exposure
- May/may not require approval



Greywater Treatment Systems

- Collects, stores, treats using mechanical and biological processes and may disinfect greywater
- Appropriately treated greywater can be reused for subsurface and surface irrigation and for in-house use such as toilet flushing and laundry
- Need current certificate of conformity against Standard to be installed; installation must be Council approved; installed by a licensed plumber and maintained
- Refer also to AS 1546.4 2016 Part 4: Domestic Greywater Treatment Systems



Greywater Processing Devices

- Device has capability to only treat wastewater from shower & bath & optional washing machine rinse water (claims reuse of up to 45% of daily hydraulic load); plumbing is atypical
- Uses physical separation & biological treatment to process & disinfect greywater using UV light but does not produce, store & treat biosolids*
- Is considered a SMF by NSW Health but accreditation does not apply*
- Currently being trialled by Sydney Water in NSW with further trials to commence in Vic and SA
- <https://www.awa.asn.au/resources/latest-news/hydraloop-trial-to-reduce-sydney-water-use>



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Effluent Dispersal & Recycling

- See Table 4.7 EPA Onsite Guideline (2024) & EPA Onsite Wastewater Effluent Dispersal & Recycling Systems document for options



Further Reading

- AS/NZS 1546 On-site Domestic Wastewater Treatment Units: Part 2: Waterless Composting Toilets (2008) & Part 4: Domestic Greywater Treatment Systems (2016)
- Beal, C. *et al* (2008) Urine-Separation and Reuse Trial, Water, 35(1), February, 66-69
- EPA Victoria Guideline for onsite wastewater management (2024) & Guideline for onsite wastewater effluent dispersal & recycling systems (2024) <https://www.epa.vic.gov.au/about-epa/publications/onsite-wastewater-management-guidance>
- Fernando, R. *et al* (2014) Decentralised Sewerage Servicing – Evaluation of a Yellow Water, Greywater and Blackwater Trial, Water, 41(7), November, 41-53
- Hydraloop Presentation to Hydraulic Consultants Assoc. 16 March 2023 <https://www.hcaa.org.au/resources/sydney-water-hydraloop-presentation>
- Rose, J.B. *et al*. (1991) Microbial Quality & Persistence of Enteric Pathogens in Graywater from Various Household Sources, Water Res., 25(1):37-42
- Wald, C. (2022) How Recycling Urine Could Help Save The World, Nature, 602, 10 February, 202-206

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