

## On-site Wastewater Management Training Course

### Other On-site Primary Treatment Systems and Greywater Options

Honorary Associate Professor Phillip Geary  
School of Environmental & Life Sciences  
The University of Newcastle NSW

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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

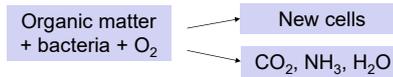
- Alternative toilets may involve incineration of human waste or chemical stabilisation (addition of solution for odours and/or maceration before removal and treatment)
- Waterless composting (dry) toilet systems
- Vermiculture (wet) biological filter systems
- Hybrid toilet systems
- Separation of urine (yellow water) and faeces (urine diverting systems)
- Segregation of blackwater and greywater for re-use

Local Councils must not approve installation of certain facilities unless they have been accredited by NSW Health:  
<https://www.health.nsw.gov.au/environment/domesticwastewater/Pages/default.aspx>

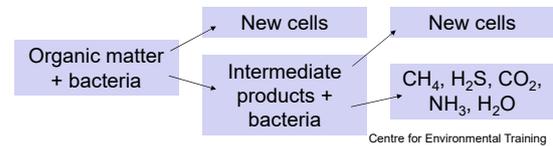
## Aerobic/Anaerobic Decomposition

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

### Aerobic oxidation



### Anaerobic oxidation



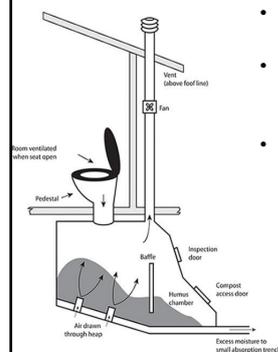
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## Composting Toilets

- Rely on actions of microorganisms in an aerobic environment to decompose organic material into humus like material which must be periodically removed
- 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 (1.3 L/p/d Appendix E AS/NZS 1546 2:2008) either directed to greywater or small soil absorption system
- Still a requirement to consider household greywater treatment and land application system
- Refer to requirements of AS 1546.2 Part 2: Waterless Composting Toilets

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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
- Liquid directed to 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

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

Source:

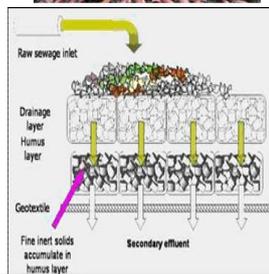
<http://www.yourhome.gov.au/water/waterless-toilets>



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## Biological Filter Systems

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

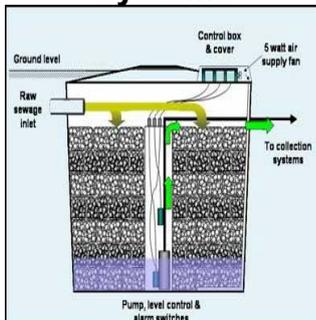


## Vermiculture Composting

- Aerobic process, low or no odour
- Mechanical components - single-phase industrial strength pump + small air pump
- In some cases, can produce secondary effluent which is land applied
- Requires some maintenance



## Biological Filter Systems



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## ...as a Secondary Treatment System

- 2-tank (6000 L) system 10 EP
- Primary followed by lifting to raised sludge and 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

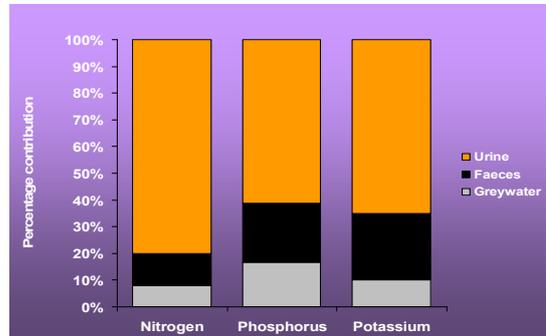
- 2-tank system involving primary and secondary tanks - aeration provided by standard rotary ventilation
- Second tank contains maze of plastic pipe media which allows biofilm to develop and results in long retention time before discharge
- Treated effluent of higher quality discharged to ground in land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



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



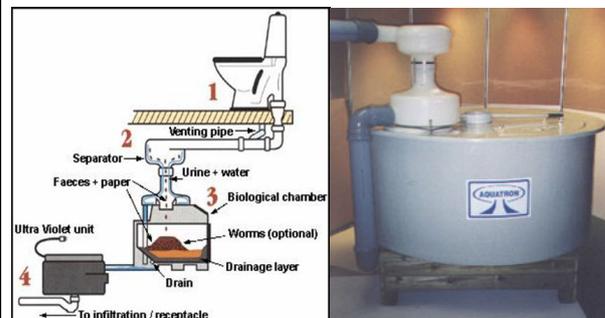
300L Storage Bladder



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](http://www.aquatron.se))

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## Research Trials

- Ongoing trials in Brisbane and Sydney through UTS & Griffith
- 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 may contain 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 (sodium) 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	Sourced from Rose <i>et al.</i> (1991)
Bathing/ Shower water	6 x 10 <sup>3</sup> cfu
Laundry wash water	126 cfu
Laundry rinse water	25 cfu
Combined wastewater	6 to 80 cfu 1.5 x 10 <sup>3</sup> cfu

FCs – cfu/100mL

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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
- 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 and requires careful management
- Considered low to medium risk activity with reduced risk of pathogen exposure
- Not a SMF and does not require NSW Health accreditation



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## 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
- Is a SMF and requires NSW Health accreditation
- 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



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## Greywater Processing Devices

- Device only has capability to only treat wastewater from shower and bath and optional washing machine rinse water (claims reuse of up to 45% of daily hydraulic load); plumbing is atypical
- Uses physical separation and biological treatment to process and 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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## Subsurface Irrigation

- Leaky pipe, soaker hoses, ag pipe, sillage drain, poly drain etc



## Further Reading

- AS/NZS 1546 (2016) On-site Domestic Wastewater Treatment Units: Part 2: Waterless Composting Toilets (2008); Part 4: Domestic Greywater Treatment Systems
- Beal, C. *et al* (2008) Urine-Separation and Reuse Trial, *Water*, 35(1), February, 66-69
- Fernando, R. *et al* (2014) Decentralised Sewerage Servicing – Evaluation of a Yellow Water, Greywater and Blackwater Trial, *Water*, 41(7), November, 41-53
- Hydralooop Presentation to Hydraulic Consultants Assoc. 16 March 2023 <https://www.hcaa.org.au/resources/sydney-water-hydralooop-presentation>
- NSW Onsite Wastewater Management Guidelines (2025) <https://www.olg.nsw.gov.au/wp-content/uploads/2025/04/Onsite-Wastewater-Management-Guidelines.pdf>
- 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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