ecoEng
Technical Information sheet: DCT 1705

Dry composting toilet options

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Contents

1 Composting 101

This technical information sheet is about composting toilets in the context of the importance of humus. Humus is an essential part of the cycle of life that we all depend on.

Composting toilets, if designed and managed well, will produce healthy and essential humus.

Humus defined: From Wikipedia http://en.wikipedia.org/wiki/Humus (2 January 2014)

*In soil science, **humus** (coined 1790–1800; < Latin: earth, ground) refers to any organic matter that has reached a point of stability, where it will break down no further and might, if conditions do not change, remain as it is for centuries, if not millennia. Humus significantly influences the bulk density of soil and contributes to moisture and nutrient retention.*

In agriculture, humus is sometimes also used to describe mature, or natural compost extracted from a forest or other spontaneous source for use to amend soil. It is also used to describe a topsoil horizon that contains organic matter (humus type, humus form, humus profile).

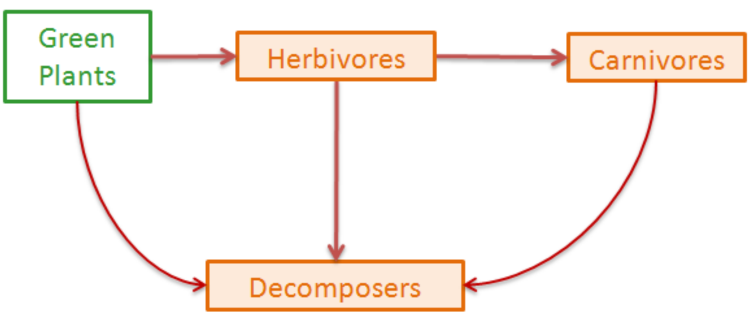
An excellent 20 min TEDx presentation on the importance of humus is given by Graeme Sait (an internationally acclaimed expert in Sustainable Agriculture). Graeme presents the essentials in 20mins far more effectively and succinctly than could be done in this document. The presentation can be found at: http://www.nutri-tech.com.au/blog/2013/09/soil-health-is-everything/#more-2071 (1 Jan 2014)

Key points:
*The cornerstones of a highly productive, disease-resistant soil are **minerals**, **microbes** and **humus**.*

Humus is the only storage medium in the soil capable of latching on to all minerals, including the highly leachable nitrate form of nitrogen. Humus holds its own weight in water and a simple increase of 1% organic matter (humus) confers 170,000 litres of extra water storage per hectare. ……Humus prevents nitrate leaching, cleanses soil contaminants and houses the predatory organisms and microbe exudates that protect plants from pests. However, the most important "understanding" in relation to humus relates to reversing climate change. When we build organic matter in our soils, we are intervening in the carbon cycle and sequestering CO_2 from the atmosphere. This CO_2 sequestration is actually the only way we can effectively address global heating within an increasingly small timeframe.

Composting is a decomposition process that occurs in the natural ecosystem and is an essential process in the nutrient cycle, refer to **Figure 1**.

Figure 1. Basic trophic levels

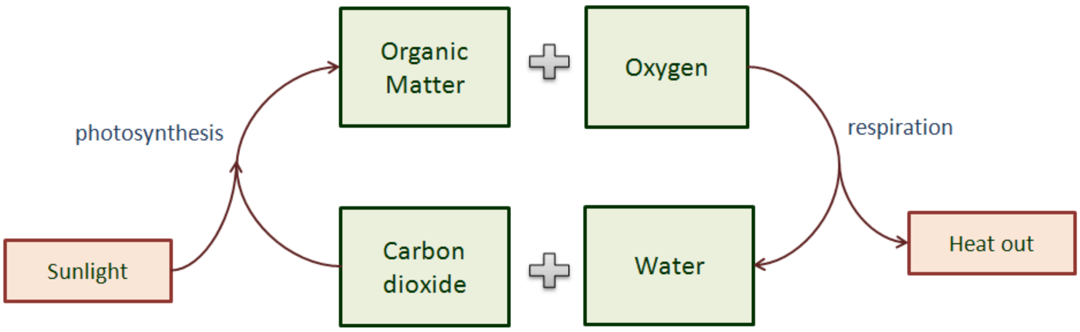


Examples of decomposer organisms include:

- Bacteria
- Fungi
- Worms

95% of living matter is made up from predominantly carbon dioxide and water plus a small but essential quantity of various minerals. Carbon dioxide plus water plus minerals, with energy input from sunlight produces the organic matter that makes the living ecology we are all part of and imbedded in. The decomposition phase releases energy and produces CO_2 + water + minerals. See **Figure 2**. Composting is a process of decomposition of organic matter. The main product of natural decomposition (composting) is humus. As noted above humus is a vital component of the biosphere, acting as a store of energy and minerals for soil organisms, resulting in the formation of soils, essential for life on earth.

Figure 2. Basic carbon/energy cycle in nature



Biodegradation in composting involves a wide range of decomposer organisms. The rate of decomposition is important when applying the process to, for example, composting toilet design and management. The following factors will influence this rate:

- Oxygen/air input and penetration
- Pile temperature
- Moisture level
- Carbon to nitrogen ratio
- Availability of nutrients and carbon.
- Special organisms
- Toxic materials

Optimising these factors will aid good compost toilet performance.

Ensuring air/oxygen penetrates as far into the pile as possible is important for aerobic composting bins. If there is insufficient air penetration the pile can go anaerobic creating offensive odours and slowing rate of biodegradtion. Toilet waste has a consistency that can easily form a dense and soggy mass, preventing air penetration. Ways to minimise these risks are:

- Add suitable bulking material
- Regular mechanical mixing of the pile
- Careful design and venting (forced venting) of the collection chamber and or pile
- Separate out urine (reduces moisture content)

- Heating the chamber

Compost toilet process

There are four basic processes by which faeces and other organics are biodegraded and stabilized in a composting toilet system. These are:

1. Aerobic decomposing where air access throughout the composting pile must be possible;
2. Vermiculture – the pile must provides a favourable worm habitat;
3. Anaerobic fermentation – such as the Bokashi process;
4. A combination of processes 1 and 2 above.

A composting toilet system should therefore be designed and managed to facilitate one of the decomposition processes above.

Regrettably most composting theory and science excludes the science (biology) of vermiculture composting (discussed later). It should be noted that high temperature composting is not favourable for high rate vermiculture composting as the high temperatures will kill worms.

High temperature composting has the advantage of increasing pathogen die-off (necessary for mitigating health risk). However there is research that shows vermiculture is also effective in attenuating pathogens (discussed in more details later in the paper).

For **aerobic composting** the higher the pile temperature the faster the biodegration of the organic faecal material. The temperature ranges are:

- Pyschrophilic : 5 to 20 deg C
- Mesophilic : 21 to 44 deg C
- Thermophilic 45 to 70 deg C

Most composting toilets operate at lower temperatures. Very few achieve thermophilic conditions and instead operate at lower temperatures, called **mouldering.**

The breakdown rate of aerobic composting of domestic waste was studied by P Chapman. (Thesis for Degree in Masters of Applied Science, Lincoln University, 1993).

The results of Chapman's research are illustrated in **Figure 3**.

Figure 3. Time vs temperature graph (From AS/NZS1546 Pt 2. 2008 Fig E1)

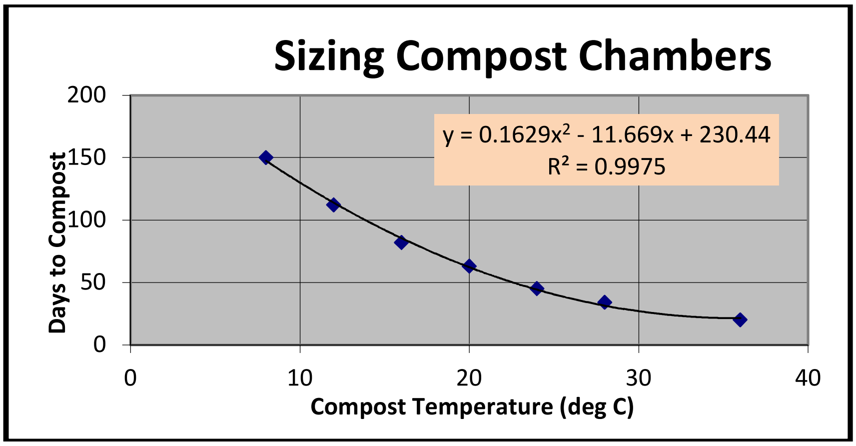


Figure 3 provides the number of days to aerobically degrade 50% of the raw organic matter. For example at 4°C about 180 days are required to aerobically degrade 50% of the organic matter. This assumes the pile is well aerated.

Other factors to consider when designing and operating aerobically composting toilets

- The most efficient composting occurs with a carbon:nitrogen mix of about 30 to 1.
- Optimum moisture content 35-65% (max 75%)

Vermiculture composting

Earthworms possess a grinding gizzard that fragments the organic matter. They ingest microorganisms and depend on them as their major source of nutrients. The earthworm gut secretes mucus and enzymes that selectively stimulates beneficial microbial species. Earthworms promote further microbial activity in the material they consume so that the casts they produce are much more fragmented and microbially active than the matter they consumed. Effectively, earthworms inoculate the soil, or organic matter, with finely ground organic residuals and beneficial micro-organisms which increase the rate of decomposition and enables further ingestion of microorganisms by earthworms.

Castings are pH neutral and well aggregated in structure. They retain moisture and enhance aerobic conditions. In effect, earthworms create their own ideal environment for enhancing earthworm and beneficial microbial activity. Castings also provide the ideal habitat for cocoon (egg capsule) survival in an otherwise toxic environment. The good structure of castings is due to the action of worms in digestion and aggregation of organic material into crumbs that maintain their integrity. Moreover the vermicaste has a better structure than other media, and contains plant growth hormones, soil enzymes, high microbial populations, and that earthworms selectively cull pathogens and harmful microorganisms.

A recent study by Hill and Baldwin (University of British Columbia)[1] reports that urine separating vermicomposting toilets out-performed the more conventional aerobic microbial composting toilets, consistently producing high quality, low pathogen, neutral, stable, vermicompost.

The worms used in vermifilters are generally of the epigeic type (e.g. tiger worms, *Eisenia fetida* or *Eisenia andrei,* or the red wriggler, *Lumbricus rubellus*), meaning that they inhabit and feed on decomposing litter on the soil surface. They usually inhabit only the top 100 - 200 mm. It has been suggested that in depths of over 450 mm of solids, compaction will result in an absence of oxygen and hence below this there will be no worm activity.

It is generally known that a worm will consume the equivalent of it's body weight in 1 day. However other research has concluded that, for estimating inputs for a given worm biomass, a maximum of 5 kg of input maintains 10 kg of worm biomass/m^2 surface of the vermiculture compost bin.

For more information on research (included scientific references) summarized above contact ecoEng Ltd.

Refer to **Appendix A** for vermin-composting trials conducted by ecoEng.

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[1] Hill, G.B., Baldwin, S.A. Vermicomposting toilets, an alternative to latrine style microbial composting toilets, prove far superior in mass reduction, pathogen destruction, compost quality, and operational cost. Waste Management (2012), http://dx.doi.org/10.1016/ j.wasman.2012.04.023

2 COMPOSTING HUMAN WASTES

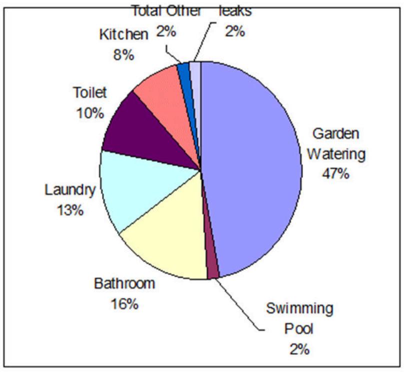
Why composting toilets?

Composting toilets are preferred for a variety of reasons. These may include:

- There is a shortage of water for flushing toilets
- Desire to recycle nutrients and create humus
- Dry toilet systems can reduce daily volume of wastewater. This can be an advantage on small sites. May also reduce environmental and public health risks.

Composting toilets enable segregated wastewater systems – blackwater/greywater; faeces/urine

- May enhance conventional disposal methods using soil absorption
- Can eliminate significant quantities of pollutants from the wastewater stream
- Conserve potable water and reduces hydraulic loadings
- Increase treatment and disposal options.



It can be argued from an ideological perspective, composting toilets are the most "ecological sustainable" option. However there are practical issues that can make the alternative sanitation systems more "sustainable". Consider the following:

- Composting toilets are not necessarily a cheap (capital and operating) option;
- For a domestic dwelling a compliant greywater (shower, bath, kitchen and laundry wastewater) system will be required;
- Excess moisture in the composting solids can result in inhibited biodegradation, odours, pest insects and very unpleasant handling issues;
- Flies and other nuisance insects can occur if the system is poorly designed and/or managed;.
- Visual "uncleanliness" can occur if the system is poorly managed;
- Regular and acceptable compost removal and disposal may be required (for the batch barrel system);
- Achieving compliance from regulatory bodies (e.g. District Councils, Regional Councils) can be difficult, time consuming and costly.

Table 1 and **Figure 4** provide details of the typical characteristics of voided human waste.

Table 1. Faeces and urine characteristics

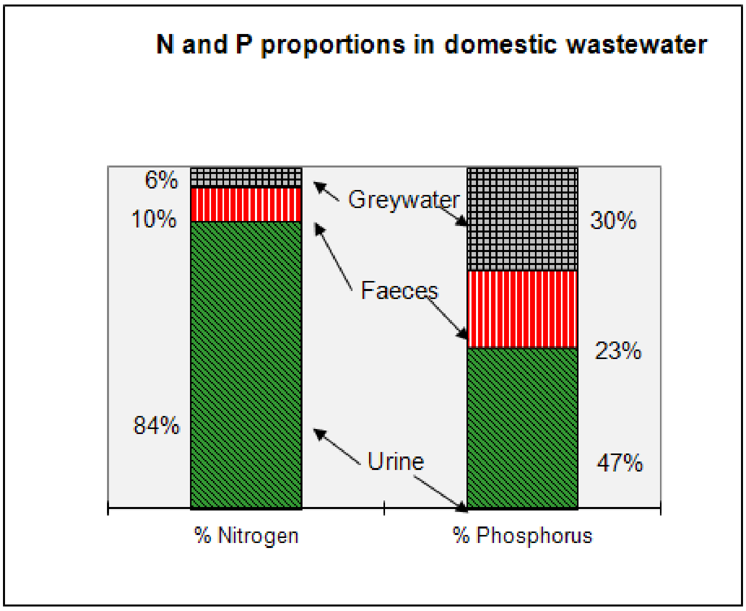
Pollutant Distribution of Household Wastes

Human Excreta –
- 135 – 270 g/d
- 66 – 80% moisture
- 5 – 7% nitrogen
- 3 – 5.4% phosphorus
- 1 – 2.5% potassium
- 40 – 55% carbon
- 4 – 5% calcium
- 5 – 10 C/N ratio

Human Urine –
- 1.2 L/d
- 95% moisture
- 15 – 19% nitrogen
- 2.5 – 5% phosphorus
- 3 – 4.5% potassium
- 11 – 17% carbon
- 4.5 – 6% calcium

Source: Gotaas, Composting (1956) p35

Figure 4. Typical proportions of N & P in the domestic wastewater stream



Essentials for good aerobic composting:
- Well designed and ventilated composting chamber;
- Regular, dry and fibrous bulking material;
- Screening for pest (insect) management;
- Regular maintenance and servicing.

Desirable for good aerobic composting:
- Locate toilet outside;
- Effective Micro-organism (EM) or equivalent for odour and pest insect management.

Essentials for good vermiculture composting:

- Separate out the urine prior to composting;
- Regular, dry and fibrous bulking material;
- Use a worm farm to convert the faecal material to vermicaste;
- Regularly add a handful of healthy topsoil to the pile;
- Dilute urine at least 5:1 before irrigating to garden/lawn.

Desirable for good vermiculture composting;

- Locate loo outside;
- EM or equivalent for odour and pest insect management.

Bulking Material

It is important to add the right kind of dry bulking material. The bulking material must be:

- Organic (no added chemicals);
- Large particle size (e.g. greater than 10mm);
- Not too moist.

Examples of **good bulking material include:**

- Dried leaves;
- Untreated wood shavings ;
- Organic straw (chopped);
- Chopped cabbage tree leaves or similar fibrous vegetation.

Addition of topsoil

ecoEng recommends the addition of a small quantity (about half a cupful) of healthy topsoil after each use. The micro (and macro)-organisms in the soil seed the process with natural decomposers.

Unsuitable bulking material:

- Lawn cuttings (green and dry);
- Sawdust (if particle size is less than 5mm);
- Treated wood shavings;
- Green vegetation.

Dry compost toilet configurations

There are three basic composting toilet configurations. These are:

1. **Batch systems** – the human waste collects in a container under the toilet and the contents of this container are regularly transferred (manually) to a dedicated composter:
2. **Chamber or vault system** – this is primarily a passive system with a large subfloor vented chamber that collects and composts the human waste e.g. the Clivus Multrum systems:
3. **Active mixing** – a mechanical system that includes a mixing system to aerate the pile (e.g. Sunmar).

Variations:

- Urine separating at source;
- Heat assisted and evaporative systems;
- Rotating chambers (e.g. Rotaloo);
- Alternating chambers (Faralone);

Pros and cons of urine separation:

- Urine is sterile;
- Reduces moisture content of pile;
- Provides better pile habitat for vermiculture (prevents) ammonia toxicity;
- Enables nutrient recovery opportunities;
- Requires additional management (of urine);
- Stored urine may create “unpleasant” odour;
- Cultural resistance to using urine separating toilet bowl.

Figure 5. Composition of urine

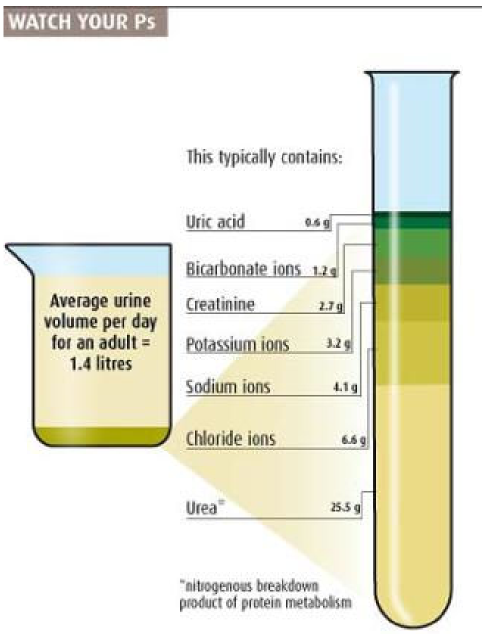


Figure 6. Examples of composting toilet systems

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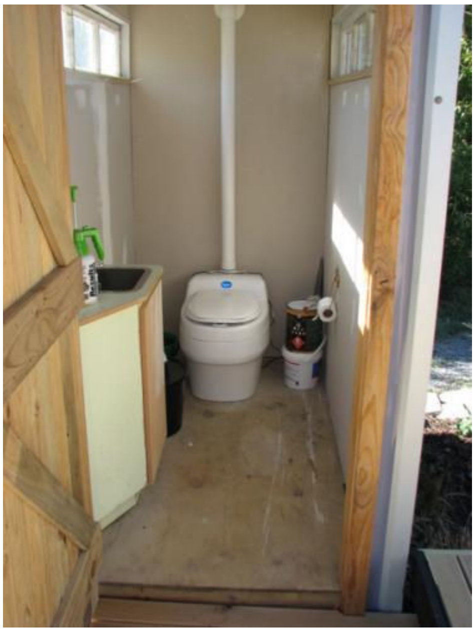
<td>
Separett, Villa 9000.</td>
<td>Separett:
The Lewis Gray urine separating toilet.: Separett Villa 9000.

Type: Batch system

This urine separating, vented toilet uses a 23 L collection chamber that requires emptying when full. The contents are to be transferred to composter. The urine can be drained to the greywater system, or diluted (by at least 5:1) and subsurface irrigated to land.

Specification:

Material: Impact-resistant high-gloss polystyrene, recyclable
Inner Container: 23 litres, Recyclable polypropylene
Fan voltage/wattage: 230V/16.5/11.5W
Power consumption: 0.396/0.276 kWh/24 hrs
Connection: Cable with earthed plug

Lewis Gray, Albany, NZ:
(http://www.lewisgray.com/contact_us.htm).
Authorised distributors for Australasia and the South Pacific of Eco & Waterless Toilets from Sweden.</td>
</tr>
<tr>
<td colspan="2">The Separett separates faeces and urine. The faeces collect in a lined composting drawer (about 23 litres) within the pedestal. Three composting bucket are supplied with the unit. When full the bucket is removed and replaced with a clean empty one. This is likely to be a weekly task. After two weeks of standing, the partially composted contents of the bucket are transferred to a suitable composter or compost bin. Following composting, the compost is to be stored for a minimum of 12 months in dedicated composting bins before being buried in the ground within the boundaries of the property. The composting bins are to be located at least 10 m from the house and on easily accessible well drained site. The bins are to be covered (for example with a simple corrugated iron roof structure) to prevent rainfall entering the compost pile. It is recommended that the bin compartment be lined with, say, a layer of corrugated cardboard on the walls and the pile be covered with say a carpet square. These measures will offer some insulation to the compost pile increasing and retaining pile temperature. This also enhances additional biological decomposition and die-off of pathogens.</td>
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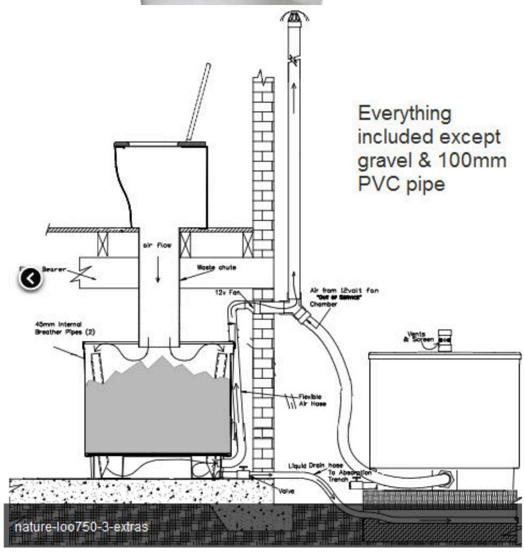
e.g. Nature Loo Classic 750-3



The Ecoflo offer a range of composting toilets. See http://www.zingbokashi.co.nz/product-category/ecoflo-composting-toilets/

The composting process for Ecoflow toilets are batch systems based on the anaerobic/aerobic fermentation – such as the Bokashi process.

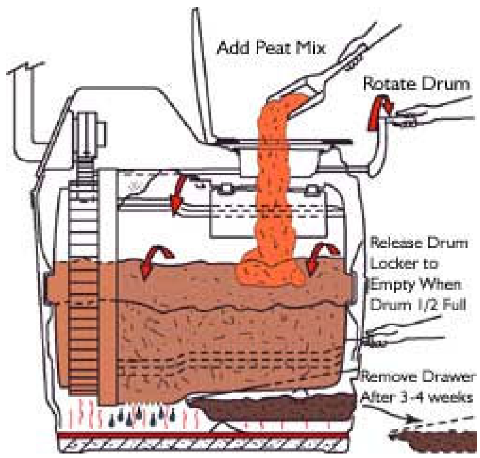
Type: Batch system

Several options are available. For example the Nature Loo Classic 750-3 comes with 3 chambers, each about 180L.

Both this and the Humus Loo are batch systems. The chambers are not emptied but moved to a storage site where fermentation continues and is replaced by an empty chamber.

The Nature Loo requires the addition Bokashi (beneficial enzymes and microbes) and to seed the fermentation process.

More sophisticated system e.g.Sun-Mar Excel: mixing system: available from Bioloo, http://www.bioloo.co.nz/index.php/products/sun-mar/

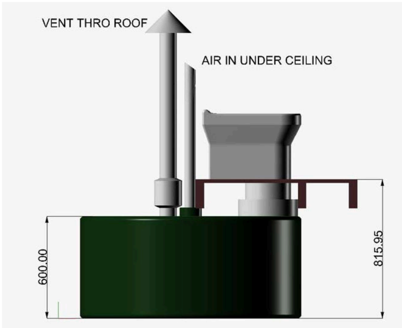


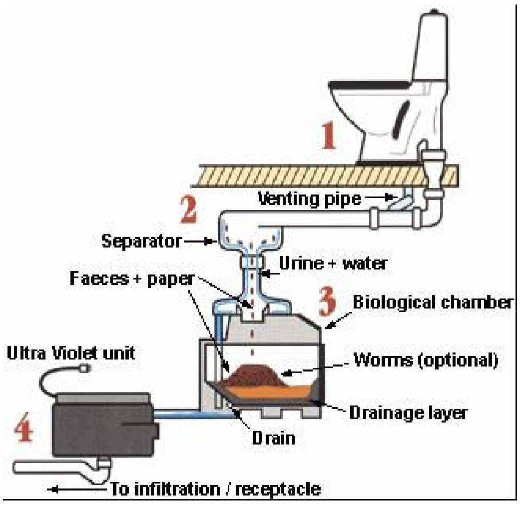
Ecomagic Ltd offer a range of composting toilet system. Their contact details are

57 - 77 Wahanga-a-Rangi Cres
Eastgate Industrial Park
PO Box 7257 Te Ngae
Rotorua 3042

Website: http://www.ecotoilets.co.nz/

One of their products is the Aquatron Separator with Collecting Chamber and Ultraviolet Unit – this is not a dry composting toilet – it is a flush toilet followed by liquid/solid separation using a hydo-cylone separator.





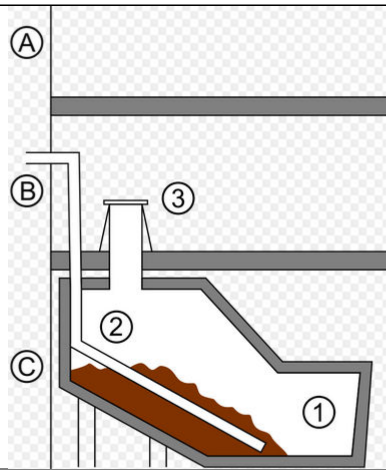
They also have the Taotrone

The Clivus Multrum is one of the original composting chamber, which seems to have withstood the test of time. It was developed by the Swedish artist, Rikard Lindström. The first prototype was built in 1939 in Tyresö.

Sawdust or suitable bulking material is regularly added, usually via the water closet. Refer diagram to the right. **A**. Second floor **B**. First floor **C**. Ground floor **1**. Humus compartment **2**. Ventilation pipe **3**. Water closet

(Ref: Wikipedia)

The A range of Waterless Composting Toilets (WCT) New Zealand is the agent for Clivus Multrum composting toilet, imported from Australia. Some of the details can be found at: https://wctnz.co.nz/producttag/29/clivus-multrum-toilet-systems



Bioloo

Website: Website: http://www.bioloo.co.nz/index.php/composting/

This unit claims to be the same as the Clivus Multrum

Process: Chamber/vault system with aerobic composting

Kiwi Bog

Contact details: Kiwi Bog Company Limited
63 Robinson Road, The Brook
Nelson 7010
Aotearoa (NZ)
email to: info@kiwibog.com
Phone (+64) 03 5469 769
Don (+64) 027 449 1699
Judith (+64) 027 204 2733

The Kiwi Bog unit is a more basic simpler (and lower cost) urine separating batch composting toilet than the Separett.

Refer to their website for details. http://www.kiwibog.com/

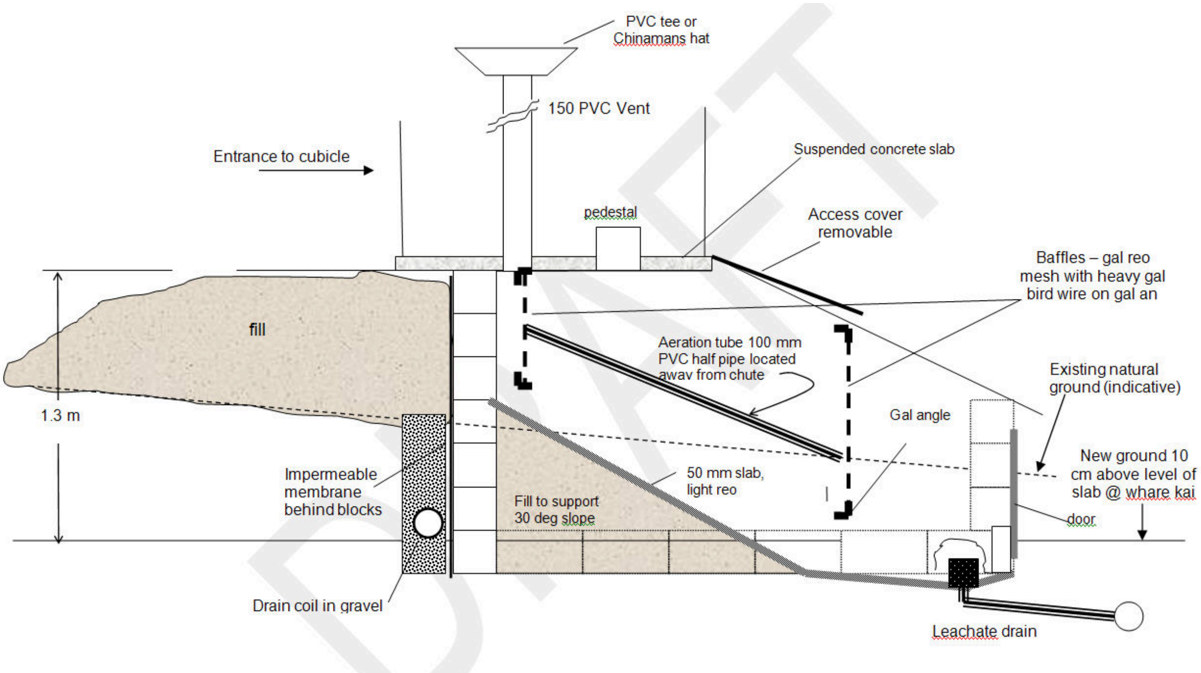
Kakapo

Distributer: Advanced Epoxy Flooring
124A Bedford St
St Clair
Dunedin 9012
ph. 03 455 7192
E-mail: advfibre@ihug.co.nz

A Kakapo composting toilet consists of a rotating drum inside a semi sealed chamber designed to separate the liquid from the solids and reduce the contents to a more "user friendly" state. It is not intended that full composting will necessarily occur within the toilet itself as this is more efficiently achieved in a separate compost bin where full thermophilic action will ensure a pathogen free, high nutrient end product.

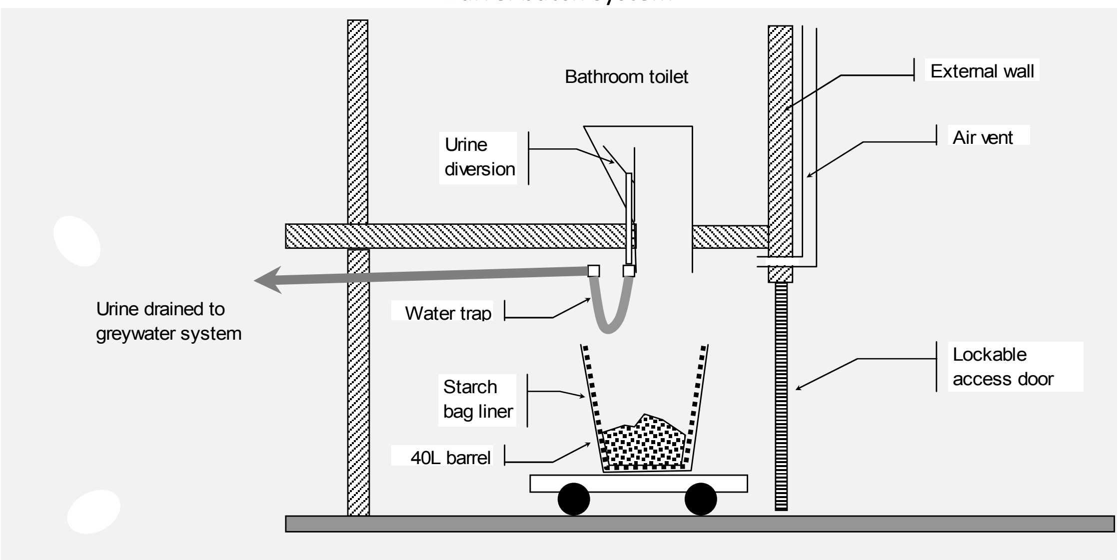
For further details refer to the website: http://kakapos.net/kakapo.htm

DIY composting toilets
The Minimus composting toilet: a chamber system An example of a cross section



The "Minimus" is a custom built continuous flow design that has been popular in northern New South Wales. It was designed by Leigh Davison, Lismore, NSW. These units are normally constructed with concrete blocks and have a height of up to 2 metres above ground level. For more details contact ecoEng Ltd.

Barrel batch system

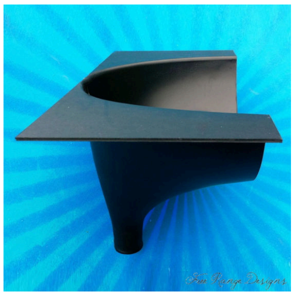


	
The above photos are of a DIY barrel batch composting toilet with urine separation (EcoLodge, Little River, Banks Peninsula).	

Kiwi Pioneer/ecoEng (Westport/Christchurch) Humus Loo – vermicompost (Refer to **Appendix A** for trial results.) Website: http://www.ecobob.co.nz/EcoBusiness/2142/Kiwi-Pioneer-Co-Ltd.aspx		
Humus Loo 	Humus Loo showing urine separation and collection bucket 	Worm bed, using a stack of car tyres, to which faecal solids and bulking is added. 

Figure 7. Urine separating bowls

Separett bowl	Plastic bowl – available from Kiwi Bog http://www.kiwibog.com/
	

Privy 501 from Lewis Gray: http://www.lewisgray.com/product/privy-501-2/	Refer to: http://www.freerangedesigns.co.uk/index.php/urine-separator-for-compost-toilet.html
	

3 Greywater Management

Composting toilets do not provide for the management of greywater; wastewater from showers, baths, laundry, kitchen and household sinks. It is likely that if you do install a composting toilet the regulatory authorities will require you to install a compliant greywater management service. ecoEng recommends you consider installing a humus trench. For details contact ecoEng Ltd.

Greywater humus trench at the Rod Donald Trust hut, Banks Peninsula. Dual VIP toilet in the back ground	Greywater humus trench installed by Kiwi Pioneer, Westport.
	

4 Suppliers of composting toilets

Recommended

Lewis Gray, Albany, NZ: (http://www.lewisgray.com/product-category/waterless-toilets/). Authorized distributors for Australasia and the South Pacific of Eco & Waterless Toilets from Sweden.

Humus Loo. Kiwi Pioneer Co. Ltd. . Motueka. mike@kiwipioneer.co.nz . http://www.kiwipioneer.co.nz/

WCT - https://wctnz.co.nz

ZingBokashi NZ who **are agents for the** Ecoflo. See http://www.zingbokashi.co.nz/product-category/ecoflo-composting-toilets/

Others

Ecotoilets, Rotorua, NZ: (http://www.ecotoilets.co.nz/).

South Pacific Waterless Systems, Auckland, NZ – waterless urinals (but not composting) (http://www.waterless.co.nz/).

Bioloo composting toilets, Rotorua, NZ: website includes estimate of costs (http://www.bioloo.co.nz/). Makers of single-dwelling and commercial size (50-80 people per day) composting toilets based on the continuous process Clivus design. Also makers of greywater systems, low-end and high-end options. Continuous research and development. Have been in operation 8 years.

Kiwibog: Nelson company, http://www.kiwibog.com/.

Kakapo composting toilet: http://kakapos.net/, (Dunedin supplier).

The above is not a complete list of composting toilets available in NZ. For a more complete list refer to: "**Compost Toilet Guidelines**" available from: http://onsitenewz.wordpress.com/tag/compost-toilet-guidelines/

5 Composting Bins/Trenches

For the batch composting toilet dedicated and secured composting bins are required. The faeces and bulking material, are transferred to a bin and covered with a small amount of topsoil. The bins should be covered with carpet or cardboard to retain heat and polyethylene sheet to shed rainfall. Every 2 weeks the top 200 to 300 mm of the bin should be forked over to aerate. When full, a new bin is to be started and the full bin is left for 1 year before burying at a suitable and safe site.

Volumes

Urine - 1.2 to 1.5L/p.e.day

Raw faeces+bulking – 0.9L/p.e.day

For aerated (non vermiculture) composting, composted solids accumulate at the following rates:

Quantities from 3 adults (2.7 L fresh volume) using aerobic composting.

After 1 mth reduces to 2.1 L/day (0.7L/p.e.day)

After 6 mths reduces 1.5 L/day (0.5 L/p.e.day)

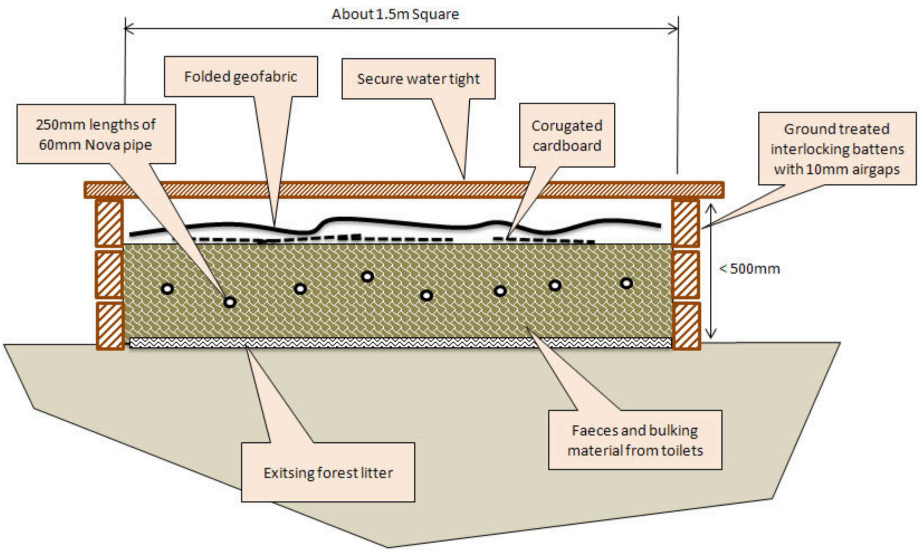
After 12 mths reduces to 0.6L/day (0.2L/p.e.day).

After 12 month families of 3 and 5 will produce about 220L and 370L of decomposed compost respectively.

For an active vermi-composting bed these volumes would be achieved after about 2 months. (Refer to **Appendix A** for ecoEng trial results).

These quantities assume the system is well designed and managed.

Figure 8. Examples of a compost bin/worm bed.

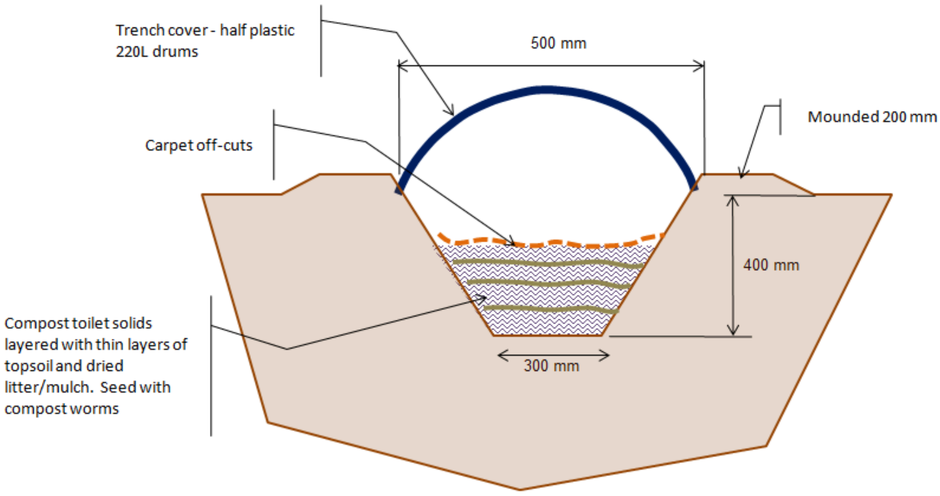


Stacked car tyres make excellent worm beds

Trenches as and Alternative to bins

Figure 9. Example of vermicultre trenches

Trench length		Volume
3 p.e.	2 m	384 L
5 p.e.	4 m	640 L



6 DISPOSAL OF COMPOSTED SOLIDS

The following recommendations are from AS/NZS1547 Pt 2 2008, Appendix K

APPENDIX K SAFE HANDLING OF SOLID AND LIQUID END PRODUCTS

K 1 General

Risks from domestic composting systems are linked to exposure to pathogens from the use and/or maintenance of the compost systems and from exposure to the system end product. If compost is not properly composted, a person may come into contact with pathogens directly by ingestion of compost particles, by inhalation of dust/aerosols or by absorption into a lesion/abrasion. A person may also come into contact with pathogens indirectly by contact with soils, vegetation or food crops contaminated by improperly composted material.

Measures are necessary in the operation and maintenance of composting systems and in the disposal of compost end products to minimize the risks of exposure to improperly composted material.

K 2 Principle

Assume all waste is hazardous and is treated with caution accordingly.

If proper composting has taken place, the compost at end products should be inoffensive and relatively "safe" to handle. Precautions, however, are always necessary as there is uncertainty about the potential for poorly compost pockets to be present within the humus material and because some organisms are able to survive and remain dormant for an extended period following the compost process.

<u>K2.1. Reduce Risk of Inhalation</u>

Wear protective clothing whenever handling the compost unit or its materials. A face mask and ideally goggles should also be worn during all maintenance actions.

The burial of compost end products to land should be undertaken in areas where direct access is restricted in accordance with the local regulations. Where on-site disposal is not authorized, the compost end product should be collected from the compost system and either removed from the site by an authorized waste removal operator, or as otherwise specified by the relevant regulatory authority.

K2.2. Reduce Risk of Ingestion

Bury composted end product for 6 to 12 months to a minimum depth of 100mm and in an area where it will not be in contact with any consumable plants for surface waters, prior to its application to land.

Restrict access by children to any areas containing compost.

K2.3 Reduce Risk of Abrasion

Wear protective clothing, including thick gloves and appropriate footwear at all times during maintenance and disposal.

Use and wash handling equipment and all protective clothing cautiously, and disinfect gloves after use.

WARNING: Human body waste can present a very real and serious health risk and must be handled with considerable care. Always wash hands thoroughly with soap or sanitizer when managing these wastes.

7 SOME REFERENCES

Recommended

During 2010 On-Site NewZ was involved in a project to produce a set of compost toilet and greywater management guidelines for Gisborne District Council. These guidelines "**Compost Toilet Guidelines**" are now available from: http://onsitenewz.wordpress.com/2012/07/11/compost-toilet-guidelines/

Also

AS/NZS1546 Pt2 2008
Lifting the lid, by P Harper and L Halestrap. CAT Publications 1999
The Composting Toilet System Book, D del Porto and C Steinfeld, CEPP, 1998.

Websites
http://en.wikipedia.org/wiki/Composting_toilet check links.
http://toilet-guru.com/
http://www.ecowaters.org/products.html#CTSBook
http://humanurehandbook.com/store/LOVEABLE-LOO-Eco-Toilet.html

8 APPENDIX A. ECOENG VERMIN-COMPOSTING TRIAL

ecoEng recently ran a trial to assess the rate of conversion to vermicaste of one 10L bucket of faecal solids with bulking material (topsoil and dry leaves) and with urine separated at the source. The following photos illustrate the results of this trial.

Photo 1. One full 10L bucket of faecal material (no urine) with bulking material (topsoil (TS) and dry leaves).

Photo 2. The 10L bucket in Photo 1 was positioned in the active worm bed made from car tyres as shown below.

Photo 3. Start of trial. 7 May 2013

Weight and volume of bucket 5kg/7.5L

Photo 4. Covered worm bed.

Photo 5. Day 18. 5.5kg/5.3L

The increase in weight is due to worm population

Photo 6. Day 49. 2.3kg/2.3L

Photo 7. Day 60. 2.3kg/2.3L

Comment.
The trial showed rapid volume and weight reduction of the original bulked faecal solids. A significant quantity of the original material was transferred outside of the bucket and surrounding worm bed. It can be concluded that the worms processed over 90% of the faecal material within 60 days.

Figure A1 summarizes the results of this trial.

Figure A1. Rate of vermi-processing of faecal solids.