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To: SFPUC Commissioners

From: Tommy T. Moala, AGM Wastewater Enterprise *Moala*

Re: Composting Toilets

Date: October 19, 2011

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Please find attached an informational packet on composting toilets as requested by Commissioner Torres.

**Edwin M. Lee**  
Mayor

**Anson Moran**  
President

**Art Torres**  
Vice President

**Ann Moller Caen**  
Commissioner

**Francesca Vietor**  
Commissioner

**Vince Courtney**  
Commissioner

**Ed Harrington**  
General Manager



# Composting Toilets

## Informational Report

# Important Facts

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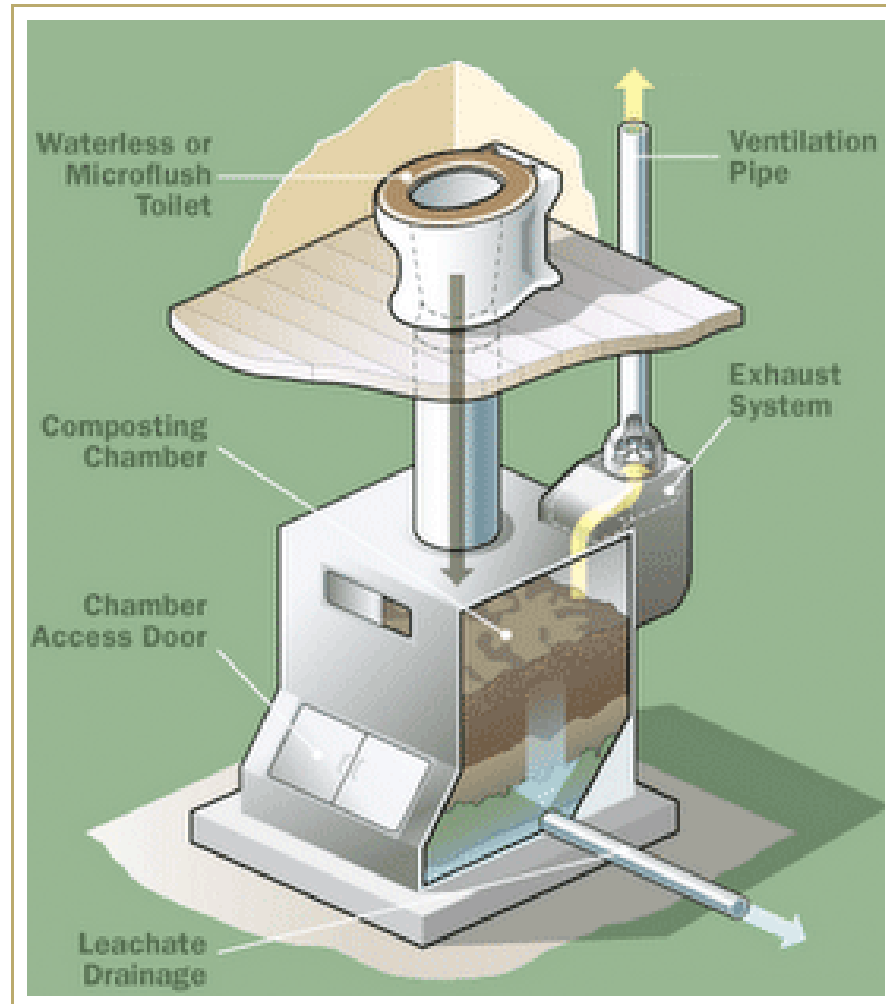
- Costs about \$1000-\$5000 per unit (toilet + compost chamber)
- Waterless
- Odorless
- Waste is transformed into a dry material that can be recycled back into the earth
- Takes from 6 months to a year to produce finished compost

# Features

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- A container where the composting process takes place
- An exhaust system (often fan-powered) that will remove water vapor, carbon dioxide, and any odors
- A manner in which oxygen is supplied to the composting container so that aerobic decomposition can take place
- A way in which excess liquid is drained
- An access door to empty the finished composting

# Example

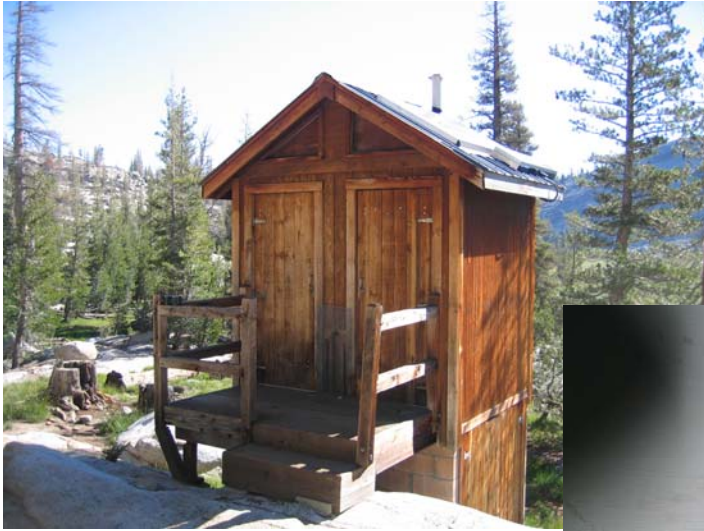


# Different Types of Uses

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- Part-time use in second homes
- Full-time use in permanent homes
- Industrial applications
- Non-electrical/solar energy units
- Outdoor use

# Yosemite Composting Toilets



# Brands

<b>Brand</b>	<b>Type of Toilet</b>	<b>Average Cost</b>
Sun-Mar	Both	\$1500 - \$2200
BioLet	Self-Contained	\$1300
Phoenix	Remote	\$5000
Envirolet	Remote	\$3500
Clivus Multrum	Remote	\$4000
EcoTech	Remote	\$2700



# General Advantages

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- Saves more than 6,600 gallons of water per person a year
- Useful when unable to connect to a sewer or septic system, or in areas of water shortage
- Can also accept kitchen wastes, and thus further helps with reducing household waste
- Reduces pressure on large infrastructure facilities that deal with human waste and the need for new treatment facilities to be built
- Reduces the threat of pollution of groundwater and soil

# General Disadvantages

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- Maintenance requires the learning of new practices and habits, and ultimately requires more responsibility by users and owners
- Improper maintenance can make cleaning unpleasant, may lead to odor problems, and can create health hazards
- Often considerably more expensive up front than flush toilet systems

# Classifications

## 1) Self-Contained vs. Remote



Self-Contained



Remote

## Self-Contained

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- Toilet and composting chamber form a single unit
- Sits higher than normal toilets, and requires a step stool
- Ideal for small homes and single-person use
- Easy to install and often ready to go right out of the box
- There are both electric and non-electric versions. Electric models have a fan for correct moisture density
- Costs about \$1000-\$1500, cheaper than remote systems

# Remote/Centralized

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- Toilet is connected to a composting chamber below the toilet
- Best for multiple individual use on a daily basis
- Looks very similar to a regular flush toilet
- Initially costs about \$3500 and usually requires additional installation and plumbing costs
- Appropriate space is needed to install these units

# Classifications

## 2) Batch vs. Continual Process

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- **Batch Composting Toilet Systems**

- Rely upon a single or series of composting containers
- Some use a single composting container that is replaced by hand when full, while others use a carousel system where there are 3 to 4 different containers that rotate as they are filled
- By the time the carousel system is full, the first container will have been fully composted and ready to be used as a soil amendment

- **Continual Process Composting Toilet Systems**

- Involve a large composting chamber underneath the toilet
- In 6 months to a year, the composting human waste will gradually move downwards through the system and once it reaches the bottom of the chamber it is ready to be harvested and used
- The compost process varies, but most involve aerobic decomposition and micro-organisms and sometimes macro-organisms (earthworms)

# Classifications

## 3) Manufactured vs. Owner-Built



Manufactured



Owner-Built

- One may purchase a manufactured composting toilet or build one
- Site-built toilets may be cheaper than manufactured ones, but owners may find it challenging to get them approved by local health agencies

# Classifications

## 4) Active vs. Passive Composting

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- **Active composting systems**
  - Rely on mixing, aeration, and heat
  - Feature automatic mixers, thermostat controlled heaters, tumbling drums, and fans
  
- **Passive composting systems**
  - Rely on natural rather than mechanical forces
  - Gravity, ambient temperature and the shape of the composting chamber are all optimized to promote efficient composting



# Urban Application: Challenges

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- Legislation, planning approvals, and design requirements
- Retrofitting existing buildings
- Transportation & system maintenance (incl. ventilation, composter bin rotation, liquid pipe work)
- User acceptance (including selling the apartments)
- Alteration of user habits, including toilet cleaning process
- Beneficial reuse of by-products (including design and operation of agricultural reuse)

# Urban Application: Advantages

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- 15%-28% savings in household indoor water use
- Over 65% reduction in nutrient loads, 25% in BOD, and 50% in salt load to sewer → increased longevity of sewer systems that lowers cost of maintenance/repairs
- Recovery of safe-to-handle nutrient-rich fertilizer replacement

# Urban Application: Survey Results

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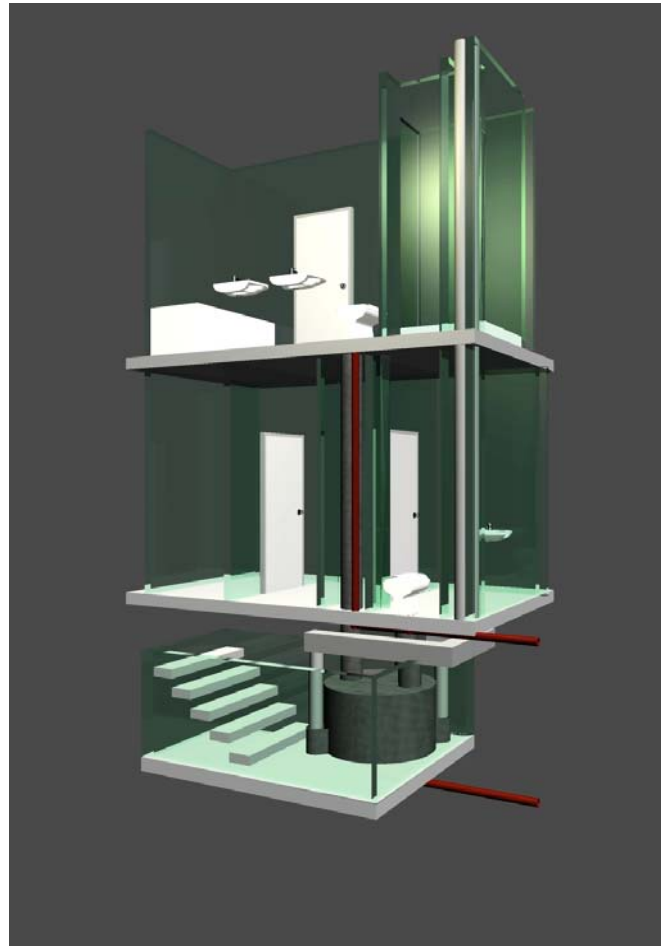
- A 2003 survey done in Victoria, Australia showed:
  - 55% would consider purchasing an apartment with a composting toilet, and 28% may consider such option, total 83%
  - 76% would consider paying \$5000 more for a water-efficient apartment, and 18% may consider such option, total 94%
  - Respondents under 40 indicated a generally higher level of interest than older respondents, yet no notable differences in interest between genders

# Urban Application: Important Facts

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- A composting toilet with a grey water sewage option is more capital intensive than conventional sewage for a dense urban development due to the additional cost of installation and the possible need to provide solar-driven ventilation
- If significant sewer upgrades were necessary, then composting toilets and a grey water sewerage system offer an attractive alternative to conventional sewage. They potentially offer a less expensive option to a dual reticulation system using recycled sewage for toilet flushing
- The cost advantage of composting toilets becomes greater if water and energy prices increase in future. If an upgrade of the sewage system is required, the water savings achieved with composting toilets are sufficient to cancel out the additional capital cost.

# Urban Application: Layout Example

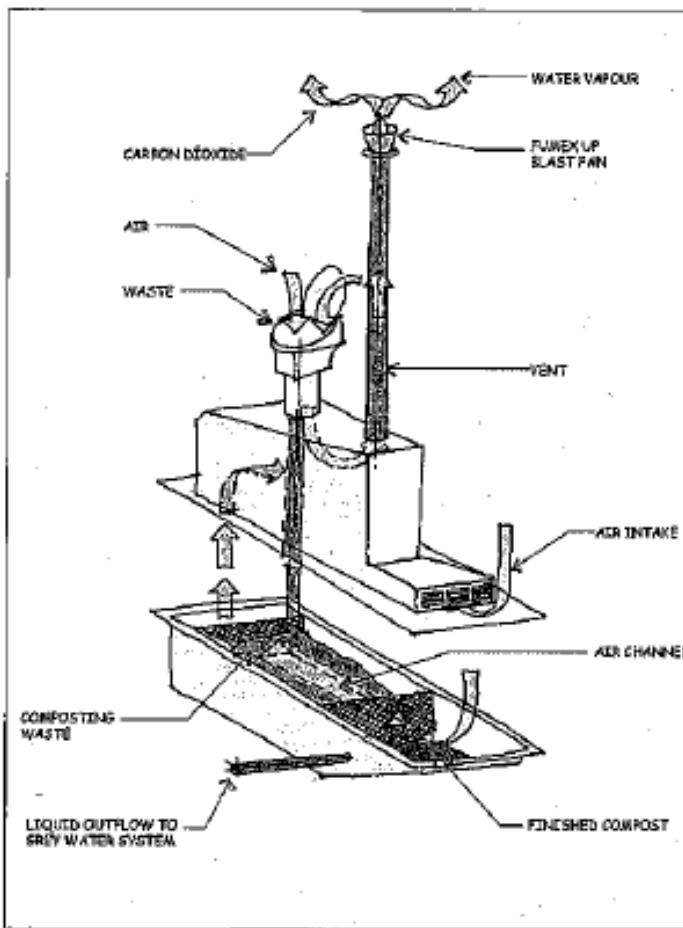


# Urban Application: Maintenance Results

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- In Canada, composting toilets were installed in a multi-level office building at the University of British Columbia – the C.K. Choi Building. Several toilet pedestals feed into each composting unit, and a building maintenance officer operates and maintains the system. A post-occupancy survey was conducted, with the conclusions that:
- Users were generally satisfied with the toilets, although regular users were more accustomed to them
- The maintenance officer found it necessary to clean the toilet bowls reasonably often (especially during a conference or similar event) to remove visible fecal matter
- Maintenance of the compost bins was aided by addition of woodchips and sawdust, as well as regular watering (1 minute per day) to keep the pile moist. (Note that watering of compost is a somewhat unusual requirement, particularly since these toilets were not urine separating, but may be related to the addition of organic matter in this case.)

# C.K. Choi's Composting Toilet



**HOW DOES IT WORK?**  
ORGANIC CARBON FOUND IN THE WASTE AND BULKING AGENT ALONG WITH THE NITROGEN FROM UREA PROMOTE THE GROWTH OF AEROBIC BACTERIA. THIS BACTERIA BREAKS DOWN THE WASTE INTO WATER VAPOR, CO<sub>2</sub>, SAFE COMPOST, AND A LIQUID END PRODUCT. RED WIGGLER WORMS ASSIST IN THE BREAKDOWN OF WASTE.

**CHARACTERISTICS OF COMPOST**  
AT THE END OF A YEAR'S USE OF DRY PRODUCT IS PRODUCED WHICH CAN BE USED AS NUTRIENT RICH POTTING SOIL. 30,000 USES PER YEAR WILL PRODUCE APPROXIMATELY 4 CUBIC FEET OF USABLE COMPOST.

**CHARACTERISTICS OF LIQUID END PRODUCT**  
A NITROGEN RICH LIQUID END PRODUCT IS PRODUCED. THIS CAN BE DILUTED 1:10 WITH WATER FOR USE AS FERTILIZER.

300 USES PER DAY PRODUCES 3-5 GALLONS OF LIQUID.

**ARE THE BY PRODUCTS SAFE?**  
YES-THE VANCOUVER DEPARTMENT OF HEALTH HAS REVIEWED THE TEST DATA FOR BOTH END PRODUCTS AND HAS AGREED TO THE USE OF THE SYSTEM. THEY HAVE REQUESTED THAT A CONNECTION FROM THE CAMPUS SANITARY LINE BE BROUGHT TO THE SITE AS AN EMERGENCY BACK UP.

**WHAT IS THE FAN FUNCTION?**  
TO AID IN THE REMOVAL OF ODORS, CO<sub>2</sub>, WATER VAPOR, AND ALLOWS FOR THE INTRODUCTION OF O<sub>2</sub> TO HELP BREAKDOWN WASTE.

**WHAT IF THE FAN FAILS?**  
THE EXHAUST SYSTEM CONSISTS OF DUTY AND STANDBY FANS. AN ALARM MESSAGE ON THE DDC WILL BE ISSUED AND THE STANDBY FAN WILL START.

**WHAT HAPPENS DURING LONG PERIODS WHEN THE TOILETS ARE NOT USED?**  
THE COMPOSTING PROCESS CONTINUES. THE FAN CONTINUES TO RUN. A MISTING SYSTEM WILL BE PROVIDED TO ENSURE THAT BACTERIAL ACTIVITY CONTINUES.

# Urban Application: Transportation of Compost

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- Maintenance of the systems in an apartment setting is best addressed as a contracted service
- Transportation of wastes from the apartment site can be managed, provided adequate provision is made for truck access and removal of compost bins
- To achieve a fully sustainable solution the compost and liquid residues need to be beneficially reused and application as fertilizer to crops is considered the most practical solution
- An agricultural trial is necessary to investigate the potential for compost and liquid residues as fertilizer and provide useful data on health risks, agricultural benefits and potential savings in chemical fertilizer



# Pathogen Removal

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- Pathogens are destroyed in the following ways:
  - **Antibiosis and pH**

Microbial and other aerobic organisms develop in the compost pile during decomposition, creating antibiotics that kill pathogens. The alkalinity of compost is not suited to some pathogens.
  - **Time**

Out of their hosts and favored environments, pathogenic microorganisms often die
  - **Predation**

Bacteria and fungi prey on some organisms and viruses

# Urban Application: Odor Issues

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- A correctly installed and operating composting toilet will not smell at all because there is a positive suction of air through the toilet at all times. In fact, there should be less odor than a conventional toilet.
- Units can produce smells if they are overloaded or not installed or operated correctly. Simple changes to the systems operation and usage should remedy the odor problems.