Water Systems

There are numerous ways to conserve the amount of water consumed by a building and its surrounding grounds. This includes using low water use appliances, toilets, and faucets, recycling grey water (water produced by sinks, showers, and laundry), and eliminating irrigation.

- Recycled grey water can be used to irrigate the landscape rather than being discharged into the municipal sewer system
- Grey water is collected in an exterior subsurface holding tank
- Select microbial plant life to neutralize bacteria in grey water
- Roof rain water can also be collected in a subsurface tank and be used to ensure that the microbial plant life continually has enough water to survive and for site irrigation in the summer
- Rain water can also be stored for cold water laundry
- Grey water should pass through a filtration chamber to remove any hair, lint and food particles before being reused
- Grey water can also be cycled through the house to provide cooling
- Using water conservation fixtures reduces water consumption by approximately 60% thereby reducing the amount of wastewater produced

Flush Toilets

- Sanit™ in Sweden produces a 4/5 gallons per flush toilet
- Control Fluidics of Greenwich, Connecticut produces a 2/5 gallons per flush toilet, which is a 90% water savings compared to conventional toilets

Composting Toilets

- Composting toilets can reduce the waste volume by 90%. Although there are numerous composting toilets that are available on the market, they all work on the same general principal: when human wastes are mixed with enough plant matter (i.e. kitchen scraps, garden wastes, etc.) and when exposed to enough air, will decompose and become nutrient-rich fertilizer.

Larger Composting Toilets

- These systems are commonly referred to as passive systems, as they have few or no mechanical parts. As such, they use little or no electricity. Furthermore, there is almost nothing that can wear out.
- The composting chamber for the larger units is typically located in the basement
- Designing the tank on a slight incline can prevent liquid accumulation and compaction
- Liquid buildup can also be prevented by ensuring that the appropriate amount of bulking material is present
- The decomposition process generates heat and as long as the temperature reaches an appropriate level and remains steady, the process will continue until the decomposing bacteria have no more waste to act on
- Insulating the system (including vent stack) helps to regulate the temperature and prevent water vapor from condensing on the inside of the piping. If condensation occurs and begins to drip back into the tank, liquid buildup can begin to be a problem.
- Condensation will occur if the difference between the temperature of the pile and temperature of the vent stack is larger than 2-3°C
- Systems that contain a strong fan (or if there are high winds in the area), are much more tolerable and condensation will be less
- Before the toilets can be used, several cubic feet of an absorbent organic material (i.e. compost, garden soil, etc.) must be spread over the bottom of the tank. This will absorb liquid and introduce the natural bacteria that is necessary for decomposition
- The larger units operate almost entirely on their own. They require a stir every once and a while, but should never need watering.
- They are able to handle organic wastes from meat, dust, lint, sanitary napkins, contents of vacuum cleaner bags, kitty litter, disposable diapers, cold ashes from fire places and wood stoves, hair, twigs, leaves, grass clippings

Problems

- Before the decomposition process stabilizes, problems with liquid buildup or insects (i.e. fruit flies) may occur. If this happens, it typically occurs within the first year. Liquid

buildup can be avoided by properly insulating the system and ensuring that there is enough bulking material. Fruit flies can be eliminated if you dump your kitchen scraps immediately after they are generated.

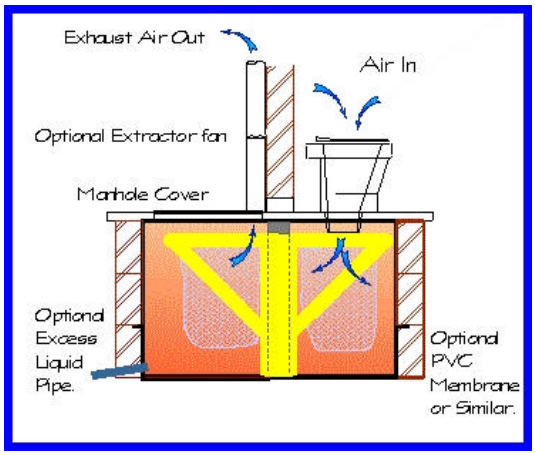


Figure 1: A schematic of a Dryloo™ Composting Toilet [1]

Smaller Composting Systems

- These systems are known as the active systems because they have more mechanical parts
- The smaller units sit entirely in the bathroom
- Before using these toilets, the bulking material should be a minimum size of 2 cubic feet
- Due to the size of these systems, they generally don't generate enough heat from the pile to keep the decomposition process moving at a steady state. Thus, most of these systems contain fans and heaters
- A good practice is to extend the vent stack above the house roof line. If the fan malfunctions, the height of the stack should create a sufficient draft
- Levers for stirring are located near the toilet seats and should be turned frequently to level the bulking material

Problems

- Maintaining proper moisture content during times of heavy use (don't want to create anaerobic conditions) can be tricky. To fix this, one can add more bulky material to absorb any excess liquid
- Dryness can occur from too much heat and ventilation. To help fix this problem, one can periodically pour water directly on the pile until an appropriate amount of moisture is reached.
- Don't overdo the kitchen or garden scraps. Small units cannot handle piles of leaves, cardboard, large stacks of newspapers, or more than a couple of cups of fruit or vegetable peelings at one time
- Unlike the larger toilets, disposable diapers, kitty litter, tampons, sanitary napkins, grease, etc., or matter that is acidic or alkaline based, should never enter the smaller units
- The finished product is only about 9% it's original volume
- If used regularly by at least 2 people, the storage area should only need to be emptied about once a year

http://www.cityfarmer.org/comptoilet64.html#toilet contains a list of composting toilet manufacturers

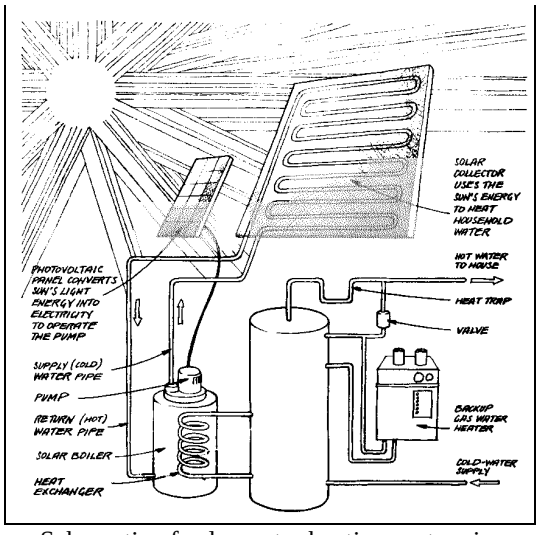
Showerheads and Faucets

- Moen manufacturers 1.8 gpm (gallons per minute) showerheads as compared to 5 gpm for conventional showerheads. The reduction in water flow is accomplished by introducing air into the flow
- High efficiency faucets can achieve 0.5 gpm, but that might be too slow when trying to fill up a kettle
- Conventional faucets use 3.5 gpm
- Look for faucets with flows in the range of 0.5-1.0 gpm in washrooms and 1.5-2.0 gpm in kitchens
- Sensors can be installed on taps that only turn the water on when an object is beneath the tap

Water Heating

- Most water heaters are set at a higher temperature than necessary, around 140 °F. Water heaters can be set at 115-120 °F
- All water heaters should be insulated using a jacket of at least R7 to R11. These can be purchased at a hardware store.
- All water pipes, cold and hot, should also be insulated
- A bottom board can also be installed beneath the heater to prevent the loss of heat into the floor
- A timer can be installed on the tank to automatically turn it off at night when the hot water is not needed

- A tankless heater or "demand" heater can be used when the simultaneous demand for water does not exceed 2-3 gpm
- According to Ontario Hydro, about 1/4 of an annual residential electric bill is for hot water heating
- The amount of energy lost from a poorly insulated tank is about 900 kWh/a
- Solar energy can be used to help supplement the energy input required
- The Waterloo Region Green Home uses hot-water panels (made by Thermo Dynamics of Nova Scotia) on the south roof. The panels collect heat from the sun and transfer it to a glycol solution in copper coils. The coils travel to a heat exchanger to deliver heat to the water tank.



Schematic of solar water heating system in Waterloo Region Green Home [2]

- The system in the Waterloo Region Green Home saves about 3500 kWh/a over conventional water heaters, based on a 80 gallon tank operated at 130 °F
- Simple steps can be taken to reduce energy consumption:
  - insulate the water tank
  - insulate the interior/exterior piping
  - install water-saving fixtures
  - lower the thermostat setting

Solar Water Heating

- Most systems use flat plate collectors that are mounted to face the sun

Closed Loop Systems

- This systems functions by circulating a pressurized heat transfer fluid through the system. This fluid is changed as part of periodic maintenance.
- The fluid absorbs solar heat and carries it to a heat exchanger where it releases heat for domestic water
- There are various heat transfer fluids that can be used in these systems such as water, propylene, glycol, glycerin, freon, and silicone oil

Thermosiphoning

- Solar heat is absorbed by the collectors, causing the fluid in the absorbers to rise
- The rising fluid is replaced by a heavier, cooler fluid at the bottom of the sloped collector
- Thermosiphoning collectors must be oriented so that there is at least a 2ft difference between the top of the collector and bottom of the tank. This is done so that reverse cycling does not occur (i.e. on cloudy days or at night)
- The rising fluid moves into the heat exchanger where it is used to heat water for domestic use. The head difference that exists between the warmer fluid and the cooler fluid creates a head pressure, which helps the natural circulation of the system.
- This system uses water, freon, or antifreeze as fluids

Open Loop Systems

- Water has more capacity to pick up and store heat than all other heat transfer fluids
- There are two types of open loop systems: recirculating and drain back

  Recirculating Systems
  - In this system, the actual domestic water is pumped through the collector
  - If the water begins to freeze in the collectors and piping, an ambient sensor is activated. Then, warm water is circulated from a water tank, through the cold collectors and piping to prevent the system from freezing

  Drain Back Systems
  - This system prevents water from freezing - by automatically draining it whenever the pump stops
  - When the collectors are sufficiently warmed, a controller (that contains a thermostat) turns the pump on to begin collecting and transferring heat
  - When the collectors cool (i.e. sun sets), power is cut to the pump and the water drains back into a holding tank

Batch Heater Systems

- These systems contain large volume collectors that heat several batches of water in a day
- Water flows on demand into the collector, where it is preheated before flowing into the water heater
- When there is not a demand for water, the water remains in the collectors, absorbing and storing solar heat until required

References:

1. Bio-Logic Dryloo™ Waterless Toilet System http://home.pix.za/sd/sd33/public_html/drlhiw.htm

2. Grady, Wayne. Green Home: Planning and Building the Environmentally Advanced House. Camden House, Camden East, ON, 1993. pg. 149