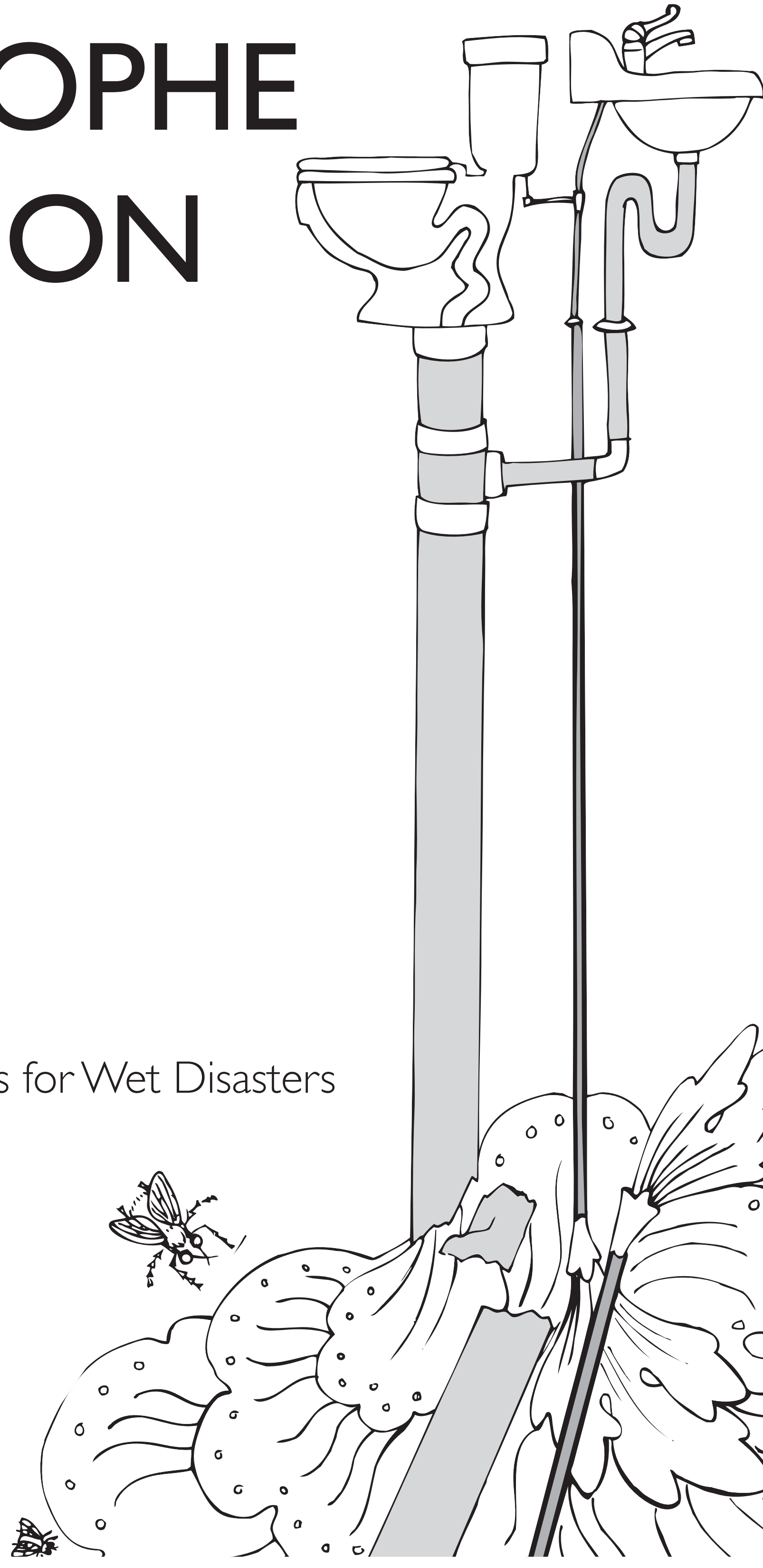
A SEWER CATASTROPHE COMPANION

Dry Toilets for Wet Disasters



EMERGENCY

The year is 20__.

The Juan de Fuca tectonic plate has shifted, causing an **earthquake** with a magnitude of 9.0, devastating the Pacific Northwest.

Underground infrastructure has shaken. **Sewers are broken** and leaking into waterways.

You have food and water, your house is still habitable, and your friends and family are all accounted for. Finally, you can slow down and take stock.

You need to poop. **Where will you go?**

RESPONSE

This guide presents a toilet system that you can do yourself without relying on a co-ordinated and timely response by someone else. This system served after earthquakes destroyed sanitation systems in Haiti and New Zealand. This guide is for planning ahead and preparing kits, whether for yourself, your household, your apartment building, or your block. This flexible system is built around ubiquitous and freely available 5-gallon buckets.

A solution for today that's not a problem for tomorrow.

1. Pee in Bucket

2. Poop in Bucket

3. Wash Hands

Urine itself is sterile, it can be applied to land, dramatically reducing the amount of material handling.

After the earthquake in New Zealand, people used separate toilets for poop and pee to reduces material handling, disease risks, and work.

Washing hands is fundamental. We designed a simple, efficient, and ergonomic portable sink using buckets.

A solution for managing excreta that's not excreting problems later.

or

1. Cap and Store

2. Load Compost Pile

3. Rinse Buckets

4. Pour Rinse Water on Pile

5. Cover with Carbon

Store materials until they can be properly processed and treated. This allows time for an official response and pickup, or to build your own compost processing area.

Cracked sewers and roads take time to repair. Composting allows hygienic human waste and food scrap handling for when trucks and pipes can't deliver service.

This bucket toilet system with hot composting served after earthquakes in Haiti through the Oxfam funded SOIL project, and in Christchurch, NZ through the New Zealand Permaculture Guild.

A Sewer Catastrophe Companion:
Dry Toilets for Wet Disasters
First Edition

Contributors

This handbook came out of a collaboration between Pacific Northwest College of Art's (PNCA) Collaborative Design's inaugural cohort and MDML.

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PHLUSH
Public Hygiene Lets Us Stay Human

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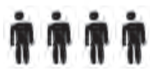
Getting enough buckets

A curbside bin can hold

for 4 adults 

If the pipes break, it can take anywhere from a month to a year to completely restore the underground piped infrastructure and treatment system. What does it look like to contain and treat your waste for a year? Each adult poop is 3-10 ounces, each pee is 4-40 ounces. Although highly variable from event to event, it averages out over the week to about 2 lbs of poop and just under 2 gallons of pee.

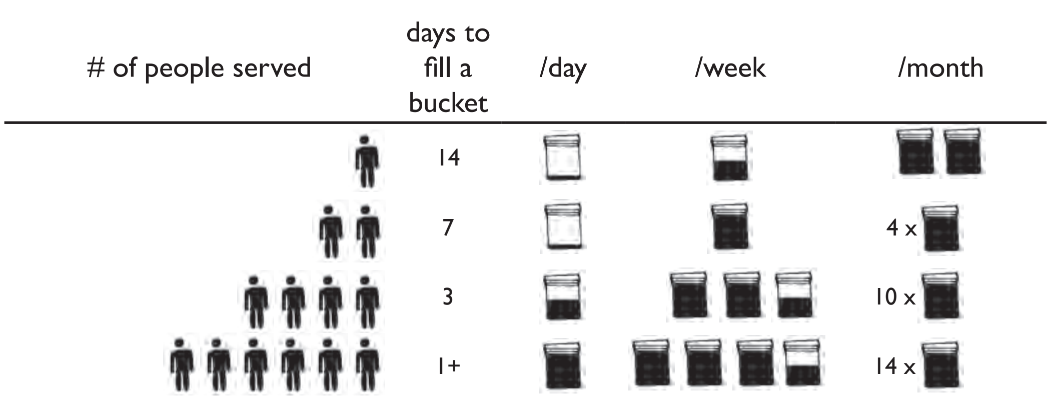
In the US, it's illegal to for food service businesses to reuse their plastic buckets for food. That means that supermarkets, food processers, bakeries and any place that handles food produces huge quantities of polyethylene buckets. Lids can be harder to find since they're not always saved or they're torn off.

 = 65 gals. They range from 55-70 gal in the US or 240 liters in the UK.

Poop by the Bucket

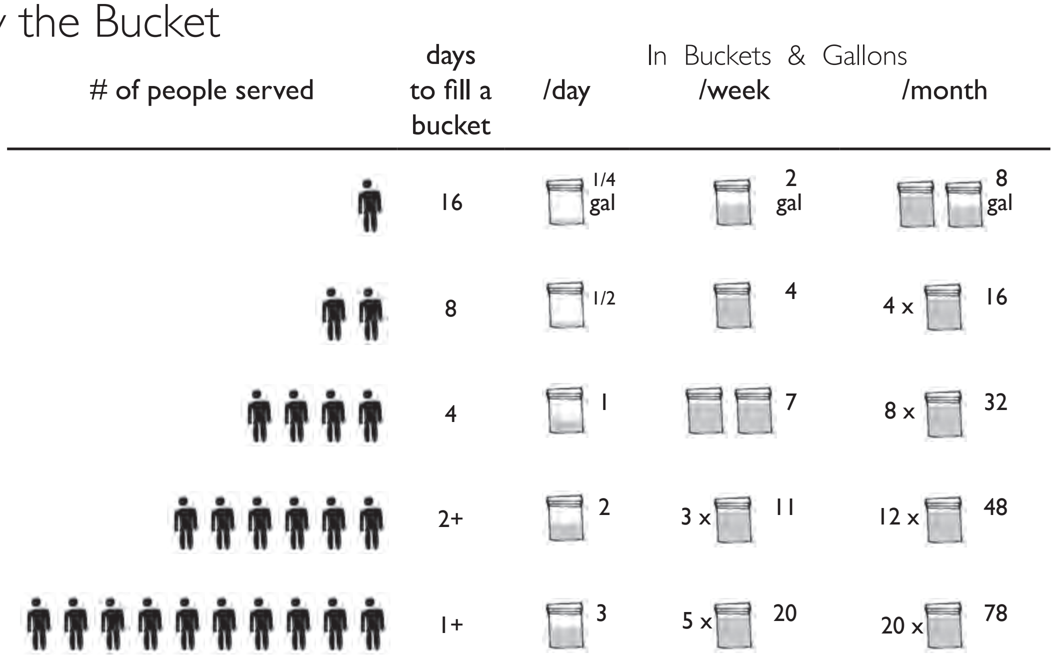
4 gallons of toilet paper, carbon, and poop in a 5 gal bucket

This chart assumes 2 large scoops of carbon cover (sawdust, wood chips, coffee hulls, etc see page 12) and lots of toilet paper are used with each addition. Buckets are filled 4/5ths full.



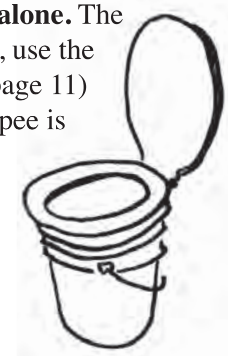
Pee by the Bucket

4 gal. of urine in a 5 gal bucket



Twin Toilets- a lesson from Christchurch, New Zealand

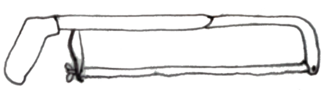
Pee and poop together require more odor control than each alone. The poop bucket takes pee and poop, but if you're only going to pee, use the pee bucket. Poop is covered with sawdust (or similar material, page 11) and then held until collected or composted (see page 10), while pee is applied directly to root zones in measured doses (see page 12). Filling the pee bucket with wood chips will keep odor down. The pee can be emptied out without disturbing the wood chips, which can be reused until they develop an odor.



Several manufacturers create snap-on bucket seats for using a 3-5 gallon bucket as a toilet, they generally cost $10-20 (see page 18).

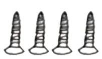
Materials

To make a toilet seat that can be fitted to buckets 3.5-7 gallons, take a 5 gallon bucket and cut the bottom off and screw the lip of the bucket into a toilet seat.



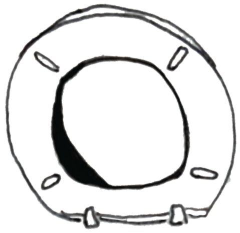
Any saw that's long enough to cut a bucket will do.

drill & screwdriver bit

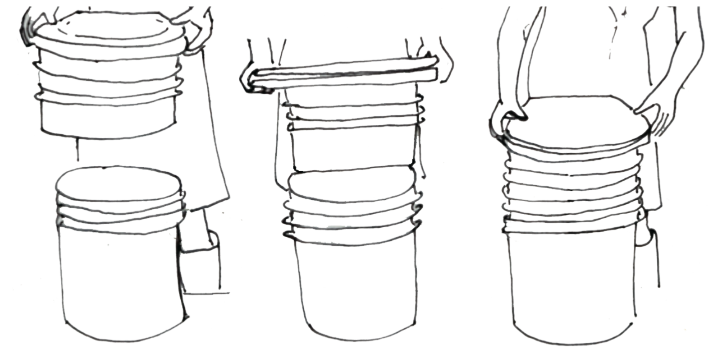


four 1/4" long screws

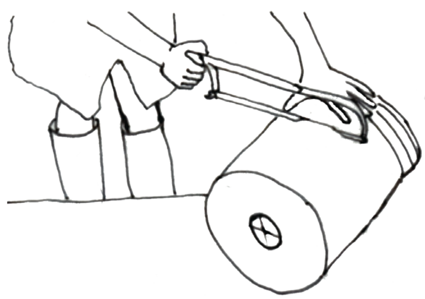
At least two buckets with handles and lids. See page 6 to calculate how many your household will need.



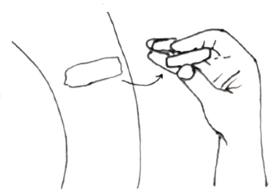
Make Your Own



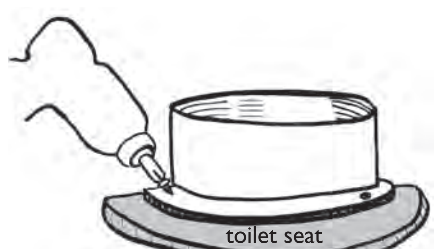
A cut off bucket becomes a flange to fit a seat tightly into a bucket.



1.Cut off a 5 gal. bucket 4" below the rim.



These risers pads on the toilet seat may not allow the bucket to fit tightly against the seat. If so, detach, pry, or cut off.



2. Place cut off bucket on top of the toilet seat so that the opening of the seat is entirely inside the bucket flange. Screw the cut off bucket into the toilet seat through the outer rim of the bucket., taking care not to screw through the wall of the bucket. Use four screws.

Cut off 5 gallon bucket as flange for toilet seat developed by Ole Errson.

What to do with Pee?

Pee can be applied directly to land because it is mostly sterile and a low diesase risk; some bacteria and viruses may be present in low concentrations. Urine is not a health risk unless it contains blood, which can happen if someone has a severe kidney infection. Pee contains a considerable amount of nitrogen, an essential plant nutrient that if over-applied to land can create smelly releases of ammonia. In large enough quantities nitrogen can poison groundwater. Urine is mostly water (ranging from 95-97%) and less than 1% nitrogen. There's about the same amount of salts in urine as nutrients (Phosphorus, Magnesium, Potassium and Calcium (Putnam 40, Olkowski 215, Hoeglund 4). Salts make nutrients unavailable to plants, urine should not be applied to heavily to the land.

Option A: **Apply Pee to Compost**

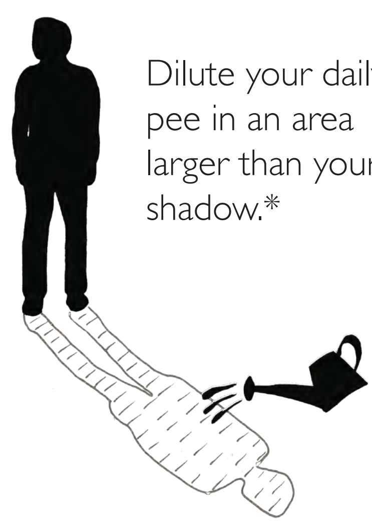
Urine can be added directly to compost to provide moisture and an easy source of nitrogen for microorganisms. If adding urine to an already moist pile, add 4 buckets of wood chips or other carbon bulking material for every bucket of urine (See page 19 for the calculation references).

Option B: **Dilute Pee & Pour on Land**

Different soils and plants can accept different quantities of pee, see *further readings* to get a handle on the complexities, or just use this simple rule:

> "A rule of thumb is to apply the urine collected from one person during one day (24 hours) to one square metre of crop . . . For most crops, the maximum application rate before risking toxic effects is at least four times this dosage."
>
> Joensson, et. al,
> Guidelines on the Use of Urine and Faeces in Crop Production

*Using this guideline urine can be reapplied every 6 months. This is based on a fertilization rate of 3.13 g of Nitrogen/year. A 120 lb person can fertilize 6.3 sq ft of garden every day (Olkowski 211).



Dilute your daily pee in an area larger than your shadow.*

Safety

"Pathogens that may be transmitted through urine are rarely sufficiently common to constitute a significant public health problem and are thus not considered to constitute a health risk related to the reuse of human urine in temperate climates." (Hoeglund 52).

Special Considerations for Gardens

Pee contains salts people eat, and potentially some viruses and bacteria. Some plants are especially sensitive to salts and especially in acidic soils. To lower disease transmission risks even further, wait at least four weeks after applying pee to pick plants (Hoeglund 49).

Quantifying Pee

Day to day your pee contains similar levels of nutrients and salts, but can vary widely in the amount of water. Safe land application is therefore more related to person-days (one person's pee for one day) than volume (Joensson 7).

For more on managing poop and pee safely see page 14.

What to do with Poop?

Poop can contain more than 120 pathogens and is a high disease risk if it touches people before it is treated (Stenstroem et al. 3). There are many ways to sterilize poop. Two of the simplest methods for home owners are to either retain it for 2 years and/or make sure the compost pile rises to 55° C (131° F) for 3 consecutive days (National Research Council 265).

In the US the major concern is spreading Hepatitis A and diarrhea through contact with untreated feces. Poop is a hazard for the same reason it makes a great fertilizer: it contains nutrients plants and animals want, like Nitrogen, Phosphorus and Potassium. If your excrement is treated to reduce the pathogens, the nutrients in it can be used to nourish crops. Currently, most wastewater treatment plants in the US treat sewage and apply it to crops as "biosolids."

Every day you excrete about 1 pint of poop.

Option A: **Store it and Wait**

If your sewer pipes aren't working, find a curbside bin or other sturdy waterproof container and fill it 1/3 full with wood chips or another carbon material. Empty the contents of your emergency toilet into the container and cover with more carbon material. Even with wood chips, poop in a closed bin will decompose wihtout oxygen. This will smell very bad. Make sure to add carbon materials and store in the shade to keep contents from heating up and smelling. Note: This is a short term solution, not a long term strategy.

Option B: **Compost it to Treat it**

Compost needs a buffer to keep it off the ground and insulated. Make sure the walls and bottom of the compost have a floor of carbon material to insulate them from extreme weather and pests. The edges and bottom of the pile need to get to temperatures hot enough to kill pathogens (131° F for 3 days). A long thermometer will be useful to track the progress of the pile. If you can't assure your pile reaches high temperatures, hold it for 2 years before applying it to food crops (National Research Council 265).

Composition of Human Urine and Feces*

	per capita wet	per capita dry	Moisture	Nitrogen	Phosphorus	Carbon	Calcium
Feces	0.3-0.6 lbs	0.08-0.16 lb	67%	5-7%	3-5.4%	40-55%	4-5%
Urine	1¾- 2¼ pints	0.12-0.16 lb	95%	15-19%	1-2.5%	11-17%	4.5-6%

*Farallones institute 118.

Redundant Design: Make the Easiest Choice the Most Hygienic Choice

Provide multiple barriers between yourself and untreated feces. Redundancy makes a system hygienic even if users make small mistakes. Make sure carbon material is within arms reach of the emergency toilet so that feces is never left exposed. Feces left uncovered is open to contact with flies that will later land on food. Design your setup so the easiest choice is also the most hygienic choice. Don't make it a hike to get a new bucket for the toilet and a lid for a full toilet. Keep supplies stocked nearby.

Building Compost

an overview

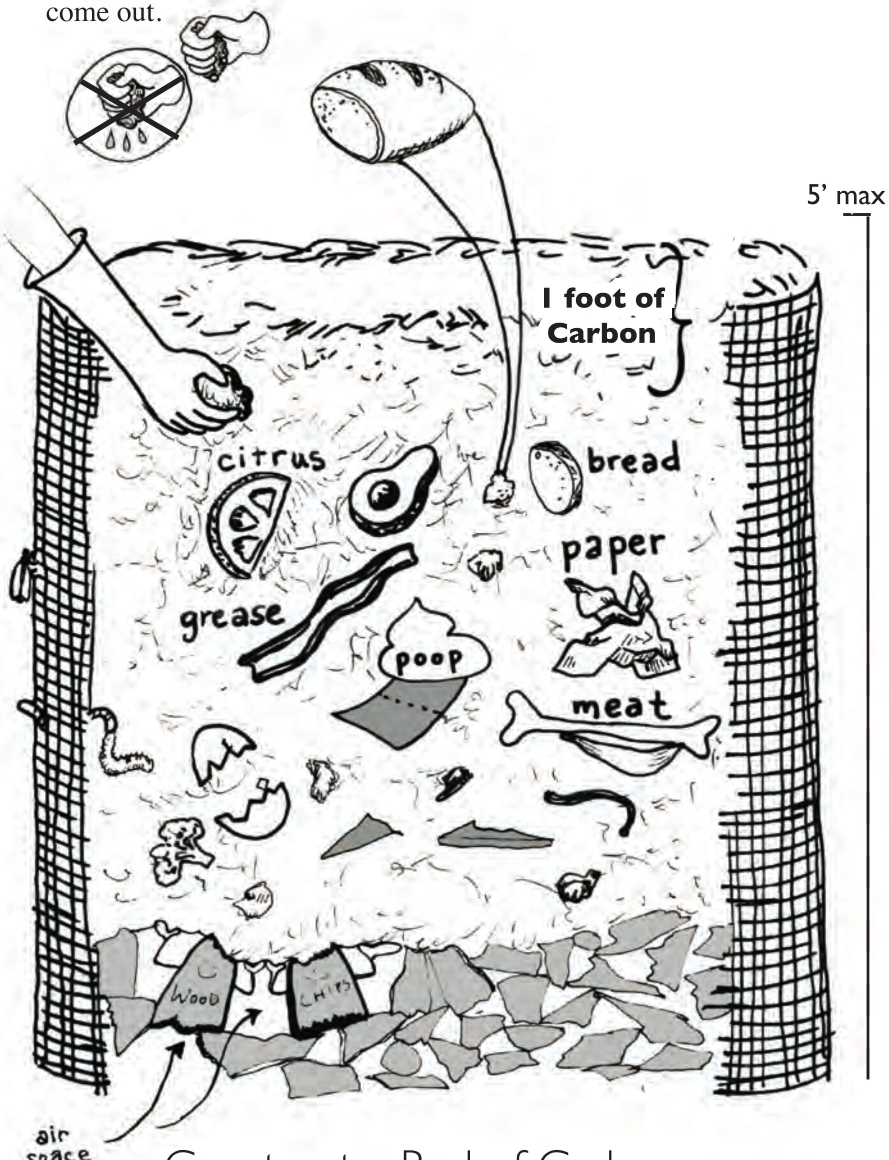
Sun helps compost piles heat up.

Moist but not Wet

Compost likes to be 45-70% saturated with water (Dickson 8). This is the same as a moist sponge. A good test is to put on a glove and squeeze a bit of compost. Liquid should bead up, but not more than a drop or two will come out.

Covered Compost Piles Don't Smell

All odors should be absorbed by **a foot of carbon on the sides and top.** Always cover up after all additions or disturbances.



Not Too Tall or It Compacts

Compost begins compacting and losing air when it is built more than two feet high. Wood chips' bulk holds air spaces that can extend the height up to 4 or 5 feet, but at that height the bottom of the compost must be turned up frequently (Yamada 49).

Bugs Volunteer for Vital Jobs

Bugs will join your compost and help out**.** Their small mouths break apart compost, making nutrients available to bacteria, and their tunnels provide aeration. Their digestive tracts also chemically transform the contents of the pile.

Construct a Bed of Carbon

Carbon materials absorb odors, create air spaces, and provide food for microbes. Sawdust, leaves, wood chips, paper, cardboard, and other materials are all sources of carbon, and make up more than half the pile by volume, and about half by weight (see page 12 for more info).

Add Paper in Shreds

Cardboard, and paper can form mats that stop air flow when concentrated in one area. Cardboard and paper cannot be the sole source of carbon material. They must be mixed with bulkier materials like wood chips and straw.

Building Dumps

how not to compost

Wet piles cool down and smell of methane.

Proteins and Fats Require Hot Piles

Fats and proteins only break down aerobically above 110° F. At low temperatures they go rancid and attract rats and other pests.

Dumps are Dumps

Compost is the deliberate compounding of organic materials to encourage decomposition and make new soil. A pile of rotting food and paper waste in the back yard is not "bad compost," It's not compost. It's a dump in the making, and a hazard.

Don't Invite Flies and Pests

High temperatures, plenty of air, and carbon cover will deter pests such as flies, birds, and rats. Animals are clever and have teeth. Focus less on fencing them out and more on not attracting them. Active fungi and bacteria make everything less delicious and attractive to pests.

Large Things Block Air

Smaller pieces break down faster. Even the largest worms have small mouths.

Pressure Treated Wood Contains Heavy Metals.

Don't use it in gardens or around compost. Beware of painted and stained wood as well. Steel mesh and unfinished wood are safe.

Don't Allow Leaching

Even with a cover over it to keep rain out, compost will leach water. Water is created during the respiration of decomposers and is called leachate. Its nutrients can poison groundwater if they escape, but a layer of carbon can absorb them and protect groundwater. A layer of coarse carbon such as wood chips will also provide air flow to help the bottom of the pile decompose.

For further readings on the safety of composting feces see page 14.

Compost Materials and Processes

Carbon Sources for Compost*

	Advantages	Disadvantages
sawdust 	• can be the only carbon material you use • available from woodworkers and small scale sawmills • available as animal bedding at pet stores • small enough to evenly mix with compost	• the high lignin content will take years for these complex polymers to completely break down (1-2 years)
woodchips 	• readily available from tree trimmers and city parks & recreation departments • can be the only carbon material you use	• large size means it takes even longer than sawdust to decompose (2 years+)
coffee hulls 	• contains less lignin than wood so decomposes very quickly • small, dry particles provide a lot of digestible carbon for biological activity	• must acquire from coffee roasters • does not hold air spaces in the compost, tends to flatten in the rain • best if used with woodchips or sawdust to hold air space
oat straw 	• quickly decomposes • easy to acquire from farms	• tends to start decomposing during storage (before it hits the pile) • does not provide a barrier to pests and vectors unless using more than 16” over a hot pile.
dry leaves 	• easy to acquire	• tend to mat down and not hold air space • need to be blended with other carbon sources
paper, cardboard 	• readily available in most homes • breaks down quickly if ripped up	• needs to be ripped up: large packs of paper create wet, airless pockets in the pile • tends to mat down and not hold air space • needs to be blended with other carbon sources

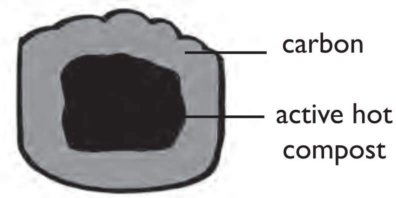
*Cornell Waste Management Institute.

Commonly Mistaken as Carbon Sources

	Advantages	Disadvantages
ash 	• covers odors effectively • contains potash, phosphate and other trace minerals • up to 20 lbs of it can be added to a 100 square foot garden a year (Lerner 1)	• not a source of carbon • 25 - 60% calcium carbonate which raises the soil pH, making it caustic
fresh leaves, fresh or dried grass clippings	• good source of nitrogen • decompose quickly	• not a source of carbon • compacts easily, smothering air spaces • does not effectively cover odors

Loading a Compost Pile

1. Put on gloves and open the compost pile to uncover the active hot center zone. Pile the compost cover you removed on the side of the pile.

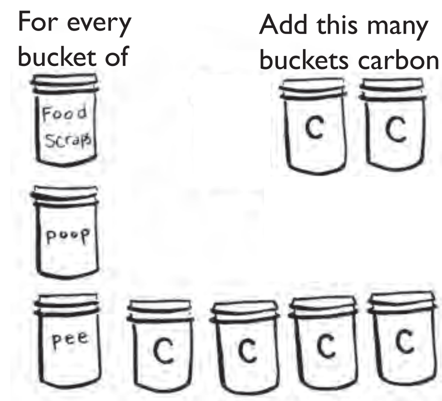


When opened up, compost should smell like a mixture of the sharp, sour odor of moldy bread and the deep earthy smell of fresh rain (geosmin). A distinct rotten egg odor indicates that there is no air inside. Add carbon and mix. A "poop" smell indicates there is not enough carbon inside. Add Carbon and mix.

2. Add 2 buckets of carbon material to the hot active zone.

Add one bucket of poop, pee or food scraps at a time. After emptying each bucket add the amount of carbon it needs.

The goal is to have the carbon dispersed through out the pile to maintain air spaces.



See bibliography for calculation.

3. Use captured rain water and toilet brush to rinse out buckets.

A little water goes a long way- clean multiple buckets with the same water.

4. Pour rinse water slowly over compost, slowly, spreading out over the whole pile.

Optional- rinse a second time.

5. Cover with at least a foot of carbon material to make sure any smells are absorbed by the carbon and not by noses of nearby animals looking for food.

Managing Poop and Pee Safely

When is the compost containing poop safe to use on an annual garden?

Option 1: Retention
Retaining compost can kill many pathogens by keeping pathogens away from their host (our gut), however, *Ascaris* eggs (roundworm) can last up to 130 days and still be viable. Retaining compost for two years (730 days) is considered extremely safe (National Research Council 265).

Option 2: High Temps
Most pathogens are adapted for a narrow temperature range around their host's body temperature, and very few survive outside of that range (Gotaas 81). Two consecutive days at 57°C (135°F) kills roundworm eggs. Federal guidelines for sewage sludge treatment require three days at 55°C (131°F) for pathogen reduction (National Research Council 265).

The Tomato Test
If you want to use the compost on the soil before two years add a few tomato seeds to the compost pile when you start the pile. Hardy tomato seeds can survive as well as *Ascaris*, and many municipal co-composting systems now throw them in as an indicator (Germer). If tomatoes spontaneously sprout up, then pathogens may have survived too.

What are the Risks of Composting Here in the US?
Depends on what crops you're using it on. If you're just burying it in the soil near trees and bushes the risks are negligible. If you're using it on annuals you should make sure you can guarantee pathogen destruction before use. In the US parasites are not as common as in other places in the world. On average a typical North American's feces will contain: *Salmonella*, fecal coliform, *Clostridium and L. montocytogenes*. Children and pets are most likely to have parasites like pinworms.

No treatment is guaranteed safe, but the most complete decomposition happens when the widest variety of decomposing organisms expose the material to the greatest number of extreme environments. **Diversity is the key to the safety** and broad effectiveness of composting against pathogens and organic pollutants. Anaerobic and saturated anaerobic (in liquid) processes are not as diverse.

Urine Disease Risks
In healthy people urine is sterile, although it may pick up bacteria or feces while leaving the urethra. Those with severe kidney and bladder problems may transmit infections through blood contaminated urine (Schoenning 3).Urine from a person with kidney problems could contain blood which might contain hepatitis A & B, CMV, JCV and BKV (flu-like viruses), albeit at low levels with a low risk of infection (Schoenning 13).

Addressing Urine Disease Risks
When retained outside the body, the urea and water in urine quickly change to ammonia and then ammonium during retention, raising the pH from around 7 to around 9 (Schoenning 8). The pH change and presence of ammonia (which is toxic to all living cells at high concentrations) is enough to inactivate most bacteria within 2 hours (National Research Council 57). Retention of urine at 20° C (68°F) for 6 months reduces the risk of pathogen exposure to negligible (10 to 15 logarithmic reduction) for bacteria (*C. jejuni*), protozoa (*C. parvum*) and viruses (*Rotavirus*) found in feces that may be present in collected urine (Schoenning 9). After urine is applied as a fertilizer to fields, pathogen inactivation continues from UV-radiation and exposure to soil biota (Schoenning 23). Simple UV sterilization or aerobic co-composting of urine is an additional treatment option. In Sweden, urine is used as a fertilizer for any crop after a one month retention at 20° C (must be applied one month before planting for crops that are to be eaten raw) (Winblad 10).

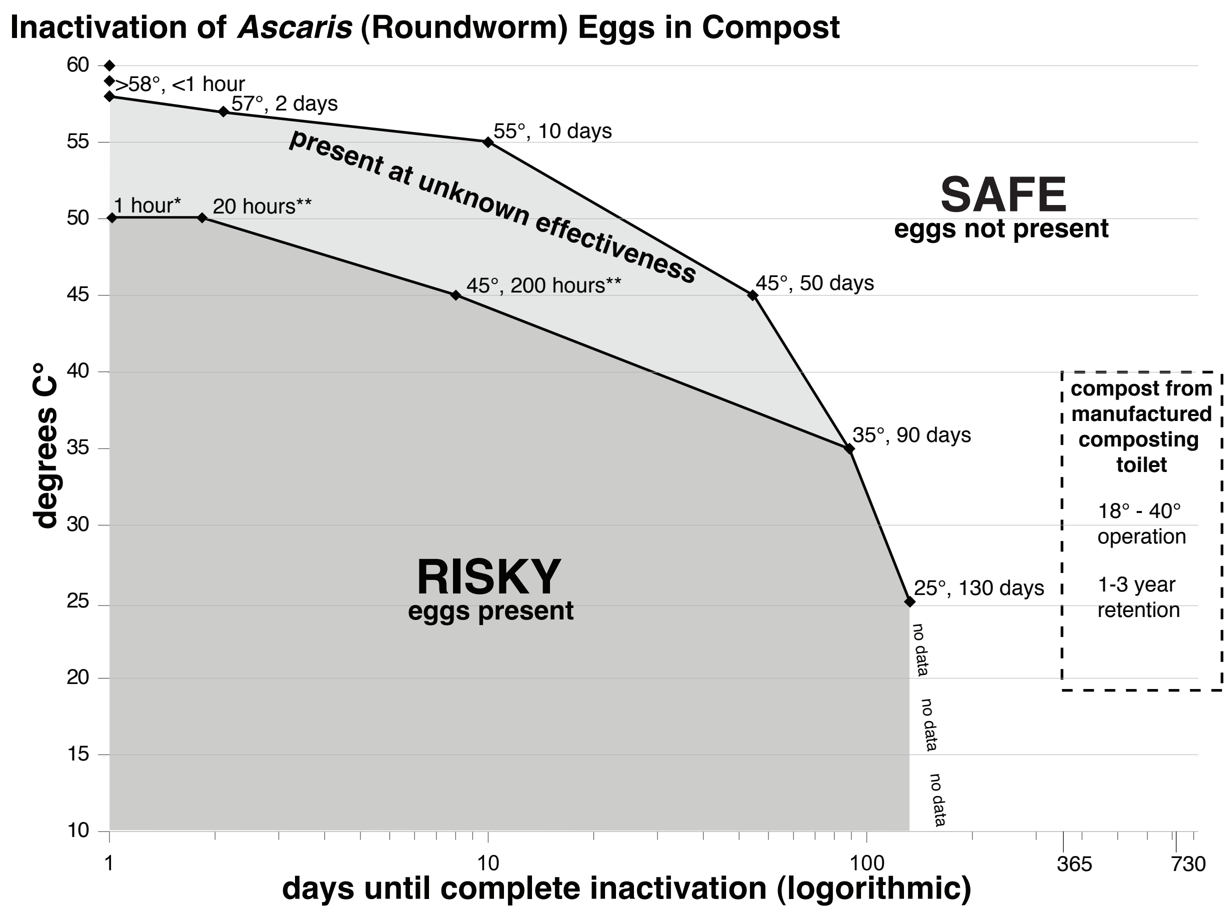
Pharmaceuticals
Pharmaceuticals are excreted primarily through urine and secondarily through feces (Daughton 1). Pharmaceuticals end up in our waterways from both treated and raw sewage. The health effects of our pharmaceuticals on other animals range from sex changes to kidney failure to disturbing the symbiotic relationships between bacteria and plants, though research has only begun in the past 10 years (Sumpter 11, Xia 93).

The research indicates that aerobic composting can significantly reduce (84-90%) pharmaceuticals within five months and that mesophilic temperatures are more effective than thermophilic* (Hakk 949). The most diverse group of decomposers lives in the mesophilic range. In-vessel, unmanaged open piles, or managed open piles are all effective at degrading veterinary antibiotics (Dolliver 1).

***Temperature Ranges of Compost**
Mesophilic (intermediate loving):
20- 45° C (68-113° F)

Thermophilic (heat loving):
46-71° C (114-160° F)

The exact ranges are debated between academia, industry and gardeners.



Data Points:
*Gotaas, Harold B. (1956). "Composting - Sanitary Disposal and Reclamation of Organic Wastes" p.81. World Health Organization, Monograph Series Number 31. Geneva.
**Feachem, et al. (1980). "Appropriate Technology for Water Supply and Sanitation." The World Bank, Director of Information and Public Affairs, Washington D.C. 20433.
All other data points: "Biosolids Applied to Land," Table 6-2, pg 265, National Research Council of the National Academies, Washington DC, 2002.

original citation: Mbela, K.K. 1988 MS Thesis. Dept. of Environmental Health Sciences, School of Public Health and Tropical Medicine, Tulane University, New Orleans, LA.
Compost from manufactured composting toilet based on operational instructions: ClivusMultrum.com

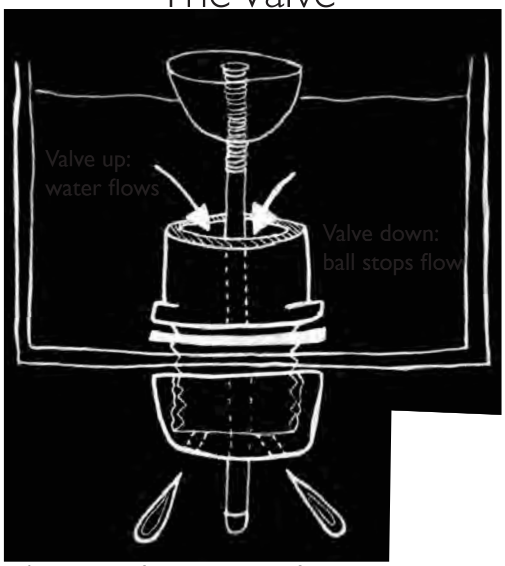
This chart presents the upper and lower limits of time and temperature necessary to kill roundworm eggs.

Roundworm eggs are one of the most difficult pathogens to eliminate. Roundworm eggs are larger and have classically been easier to detect than other hard-shelled pathogens, such as spore-forming bacteria. Human and pig *Ascaris* are used as "indicator" organisms, introduced to evaluate a processing technique alongside common indicators fecal coliform and *Salmonella*. Low levels of indicator pathogens denotes effective treatment of a range of pathogens.

The Tap Up- a two bucket hand sink

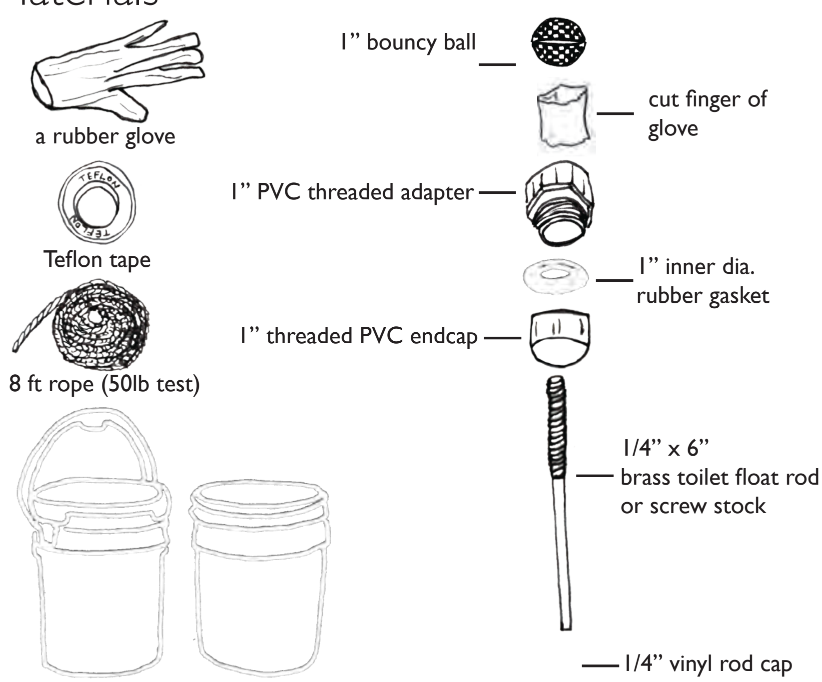
This hand sink is a simple option for food prep, eating, and first aid areas, as well as around restrooms. This bucket system is easy to fill and empty, and can be made with any two similarly sized buckets. We reccommend coupling this sink with a foaming soap dispenser. Foam does not require water to lather up, generating significant water savings.

The Valve



A quick tap from the back of the hand pushes the rod up, opening the valve.

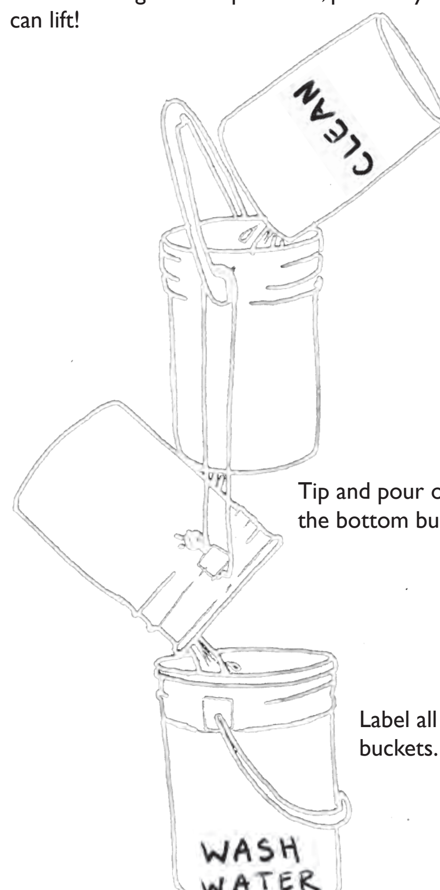
Materials



Full buckets can be heavy. **A 5 gallon bucket of water weighs 45 lbs when full.** Choose buckets that you can handle, and don't fill buckets beyond the strength of their attachment point.

Filling & Emptying

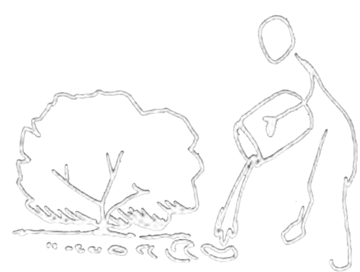
Clean water goes in top. Be safe, pour only what you can lift!



Tip and pour out the bottom bucket.

Label all wash water buckets.

Designate an area to empty your wash water and label it. Choose somewhere near the root zone of a tree or bushes. Avoid waterways, including drains. Seek a place unlikely to be exposed to yourself, the public, pets, and kids. **Label your wash water bucket so it is not confused with a potable water container.**



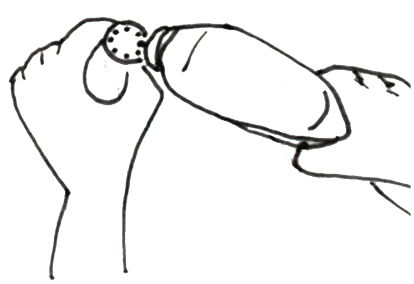
Walk and pour. Water splashed on leaves can hurt plants.

Assembling the Tap Up

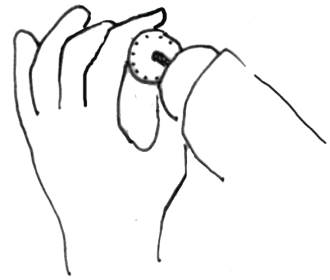
Tools needed:

1/16" bit is for the water holes, 1/4" is to allow the tap rod through, and 1" cuts into the bucket.

Drill a 1" hole in the bottom center of the bucket. Go slow and keep the drill level.

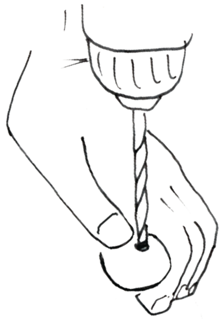


Hold PVC end cap in a clamp or wear gloves to protect your hands. Drill eight 1/16" holes for the water. Angle the drill out away from the middle of the cap.



Drill a 1/4" hole in the middle, straight down.

OPTIONAL: cut bouncy ball in half with a knife to make it easier to drill. Cut along the ball's seam.

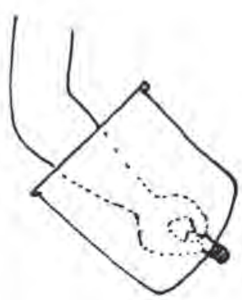


Drill a 1/4" hole in center of the bouncy ball.

Screw the 6" long 1/4" toilet float rod or 1/4" screw stock into the bouncy ball.

Wrap Teflon tape around the 1" PVC threaded adapter.

Stick 1" inner dia. rubber gasket around 1" PVC threaded adapter.



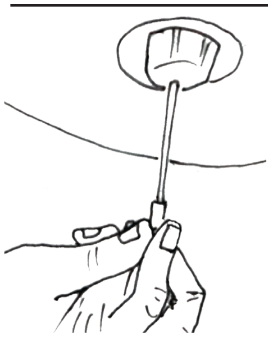
Screw 1" PVC threaded adapter through and out the bottom of the bucket.

Screw 1" PVC end cap onto threaded adaptor,. Tighten against the bottom of the bucket.

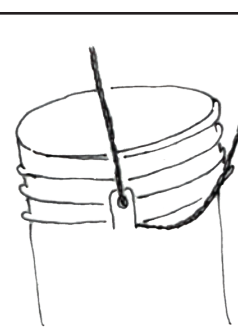
Cut the finger off of a disposable glove to make the top gasket.

Pull cut glove over the top of the 1" PVC threaded adaptor so that it leaves an opening around the rod.

Put bouncy ball with toilet float valve screwed into it through the 1" PVC threaded adaptor.



attach 1/4" vinyl rod cap onto the end of toilet float rod.



Run rope through the handle attachment hole on the lower bucket without the valve

Run rope through the handle of the upper bucket (with valve) and tie off. Repeat on other side.

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Getting Enough Buckets

Feces: based on 843g/week, Digestive Diseases and Sciences, Vol. 43, No. 11: 1998, 2358. and Gotaas 0.3-0.6 lbs/day.

Urine: based on 2 pints/day. Gotaas, Composting-Sanitary Reclamation of Organic Wastes. World Health Organization, Monograph No. 31. Geneva: 1953.

Water: based on .9 gal/flush 5 flush/day Caroma dual-flush toilet, Caromausa.com: 2010

Provisioning of Buckets
Based on our experience in our household of 4 adults and above citations.

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Public Hygiene Let’s Us Stay Human. “Emergency Toilets.” PHLUSH. October 11, 2011. <http://www.phlush.org/emergencysan/intro-to-emergency-toilets/>

Snap on Toilet Seats for Buckets
Reliance- produces the Luggable Loo seat
Emergency Essentials produces Tote-able Toilet
Custom Leathercraft, produces 1140 EasySeat
Travel John, Quake Kare also produce lids

Suggested Readings

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The first edition of this book was published in 1995. Joe Jenkins is an incredible resource for composters.

Olkowski, Helga, William Olkowski, and Tom Javits. The Integral Urban House: Self-reliant Living in the City. San Francisco: Sierra Club, 1979. 110-40.
This two inch thick book is old, but it’s still the most thorough reference on self reliant living for city dwellers. It has primary sources and great illustrations. The newer edition decided to use an unattractive an meaningless stock image for the cover instead of Diane McIntosh’s iconic cover design.

Loading a Compost Pile

See Building Compost readings for more specifics on compost dynamics and balancing inputs. At a small scale, managing moisture content and smells, as covered in this guide, will achieve better results than looking at carbon to nitrogen ratios and other calculations. We use a free compost calculator from Green Mountain Technologies. Add a two new feedstocks with this data:

Material	%N (dry weight)	%C (dry weight)	C:N	%Moisture	Bulk Density
urine	15-18	11-17	.8	97	1000
feces	5.5-6.5	40-55	6-10	66-80	1000

Compost Calculators:
Compost Calc, Green Mountain Technologies. http://www.compostingtechnology.com/probesandsoftware/compostcalc/downloads/
Washington State Compost Calculator Spreadsheet: http://www.puyallup.wsu.edu/soilmgmt/CompostMixCalc.htm

Suggested Readings

Del, Porto David., and Carol Steinfeld. The Composting Toilet System Book: A Practical Guide to Choosing, Planning and Maintaining Composting Toilet Systems, a Water-saving, Pollution-preventing Alternative. Concord, MA: Center for Ecological Pollution Prevention, 2000.
This book is a thorough reference on composting toilet systems including installation and operation. It gives case studies for each type of composting toilet and includes a section on graywater.

Tuladhar, Bhushan and Dorothee Sphuler. “Co-composting (Small-scale).” SSWM Fact sheet.
http://www.sswm.info/category/implementation-tools/wastewater-treatment/hardware/site-storage-and-treatments/co-composting
The Sustainable Sanitation and Water Management Toolbox is an extensive reference on the hardware and software necessary to create sustainable water and sanitation systems. This fact sheet points to the advantages, disadvantages, case studies, further readings and corresponding educational materials for household scale composting with human excreta. It is updated regularly by Seecon Intl.

Van der Ryn, Sim. The Toilet Papers. Santa Barbara, Calif: Capra Press, 1978.

Carbon Materials and Processes

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Cornell’s extension service provides a thorough description of carbon sources and ideas for where to find them.

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What to do with Urine & Feces

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Joensson, Stintzing, Vinnerås, Salomon, “Guidelines on the Use of Urine and Faeces in Crop Production.” Stockholm Environment Institute, EcoSanRes Project, 2004 <http://www.ecosanres.org/pdf_files/ESR_Publications_2004/ESR2web.pdf>

National Research Council. Biosolids Applied to Land: Advancing Standards and Practices. Washington, D.C.: National Academies, 2002.. p 57.

Olkowski, H. See Twin Toilets Suggested Readings.

Putnam, David F. Composition and Concentrative Properties of Human Urine. NASA Contractor Report. July 1971. p 40

Stenstroem, Thor Axel, Razak Seidu, Nelson Ekane, and Christian Zurbruegg. Microbial Exposure and Health Assessments in Sanitation Technologies and Systems. Stockholm Environment Institute, Stockholm ,2011. <http://www.ecosanres.org/pdf_files/Microbial_Exposure_&_Health_Assessments_in_Sanitation_Technologies_&_Systems.pdf>

Building Compost

Dickson, N., R. Thomas and R. Kozlowski. “Composting to Reduce the Waste Stream. A guide to Small Scale Food and Yard Waste Composting.” Ithaca, NY: Northeast Regional Agricultural Engineering Service Cooperative Extension, 1991. <http://cwmi.css.cornell.edu/compostingtoreduce.pdf>
Written by researchers from Tellus Institute and Cornell University. A thorough 45 page document on household scale composting. Table 6 Composting Trouble Shooting Guide is very useful.

Yamada, Y., and Y. Kawase. “Aerobic Composting of Waste Activated Sludge: Kinetic Analysis for microbiological Reaction and Oxygen Consumption.” Waste Management 26.1. 2006: 49-61.

“a compost pile should not smell”
Aerobic decomposition $CH_2O + O_2$ ---> $CO_2 + H_2O$ + 6722 kcal/mole
organic material + oxygen produces carbon dioxide and water and heat

Anaerobic decomposition $(CH_2O)_x + H_2O$ ---> $CH_4 + CO_2$
organic material- + water produces methane and carbon dioxide

Cornell Waste Management Institute. “Compost Fact Sheet #5 Compost Bulking Materials.” Ithaca, NY: Cornell, 2005. <http://cwmi.css.cornell.edu/compostfs5.pdf>
Cornell’s extension service provides a thorough description of carbon sources and ideas for where to find them.

Other Simple Handwashing Sinks

Tippy Tap <http://www.akvo.org/wiki/index.php/Tippy_Tap>
The Tippy Tap is a simple hand washing device that can be made from readily available household containers.

Andy Handy <http://www.andyhandy.com/>
The Andy Handy is a simple hand washing valve made and sold in Finland. The 'tap up' sink is similar, but lacks the delay of the Andy Handy. Recommended for permanent unplumbed restrooms.

Suggested Readings
Oasis Designs <www.oasisdesign.net/greywater>
Art Ludwig maintains an excellent resource site with case studies, instruction and FAQs on greywater. Look past the web design to the high quality content.

Managing Poo & Pee Safely

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Earthquakes in Contemporary Cities- getting perspective

by Morgan O'Hara

The Pacific Northwest rests on the Cascadia Subduction Zone, where the Juan de Fuca and North American plates meet. The last earthquake here was in the year 1700, sending a tsunami to Japan. The geologic record says the average time between magnitude 8 and larger earthquakes in our region is about 240 years (Revkin). Practically speaking, "Cascadia is '9 months pregnant' and overdue" (Revkin).

The devastating 1906 San Andreas earthquake caused pipelines and structures to move 6 feet laterally, and as a result there was no water when the city burst into flames (Richie). At that time, San Francisco's plumping systems were no more than 20 years old and mostly carried water. Many of America's pipes today are over 100 years old, and according to the Natural Resources Defense Council, the amount of sewage they carry to wastewater treatment facilities would be enough to fill all of the Great Lakes every four months (NRDC). The earthquake that is expected to occur in the Cascadia region is predicted to be of greater magnitude than the San Francisco earthquake of 1906.

The dangers associated with fecal contamination are demonstrated dramatically in the outbreak of cholera in the aftermath of Haiti's 2010 earthquake, a plague unseen in Haiti since the 1800s. Left untreated, the disease has a fatality rate that can reach fifty percent (Shapin). In Haiti, the World Health Organization has stepped in to provide re-hydration treatment units.

Our experience with the next earthquake in the Northwest may be similar to the 6.3 magnitude quake in Christchurch, New Zealand in February 2011. Most people were "able to flush" their toilets by August, but the contents were directed to the river without treatment. This led to confusion about when and if people could use their household toilets again. Portable and chemical toilets were brought in from various outside aid organizations, but many people found them difficult or unpleasant to use, preferring instead to dig "long-drop" toilets in their back yard (Show Us Your Long Drop.co.nz). Unlike Christchurch however, most urban areas in Oregon have high water tables and impermeable clay soils that make digging pit latrines a health hazard.

Amidst the confusion in New Zealand, a local community of permaculturists stepped forward to teach people about composting toilets (Compost Toilets.co.nz). The workshops focused on emergency use, but the discussions extended to the wider issues of environmental impacts on the city (Williams 2011). Once people became aware of this more user and environmentally friendly solution to their sanitation crisis, the workshops spread by request and volunteer instruction. The widespread success of the composting toilet solution in Christchurch is a beautiful model for how communities can take charge of their own sanitation design to build resilience and protect health.

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When the pipes break . . . What's your plan?

I'm going to safely store our excreta . . .

My family has _____(#) curbside bins.
It will take us _____(#) weeks to fill one bin (See page 6).
It will take us _____(#) weeks to fill all our bins.
We have _________(amount) of carbon materials stored at __________(location near our dwelling) to add to our curbside bin after we empty the toilets.

I'm going to safely compost our excreta . . .

We have _______(quantity) of carbon materials on hand.
We have enough carbon cover materials for ___(#) weeks (See page 6).

We can get carbon materials at__________________. (*nearby pet stores hay from farms, wood chips from Parks Department, arborist, sawdust from local mills, coffee hulls from local roasters*). Their phone # is __________________.They're =located at ______________.
We have ______(type of container) to store urine. Each can hold _____ (# of gallons/liters). We can store up to ______(#s of days) or urine from ______ (# of people).

I'm going to excrete in water and create a public health disaster . . .

Supplies for Composting at Home

An Emergency Sanitation Kit for 2 people for a week

add a curb-side bin full of wood chips and this will take care of 2 people for a month!

- ☐ Toilet Paper (store in water proof container)
- ☐ Twin Toilets
- ☐ Tap Up Hand Sink
- ☐ Soap towels and wipes.
- ☐ Extra bucket and lid