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Recode Draft Plumbing Code for Composting and Urine Diversion Toilets

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Justification

Introduction

Water scarcity and pollution concerns are driving the adoption of composting and urine diversion toilet systems in the US and abroad. In the US, these systems have been treated unevenly by a patchwork of regulations in Health, Onsite Sanitation, and Building Code departments because they do not fit neatly into categories designed to guarantee safe sanitary drainage systems. It is the opinion of this code group that composting and urine diversion toilets are at a turning point, mature enough to build sound regulation around while also being a site of active research and development. Our intent is therefore to create code language that provides for strict protections on public health while also encouraging the growth of domestic industry and innovation in composting and urine diversion systems.

Performance Coding

As far as is possible, this code is a performance code, meaning that it does not judge systems on what they look like, but rather on the operational conditions within. For this code, that means integrating field testing into the evaluations of new systems and providing prescriptive best practice guidance in conjunction with performance requirements.

Protections for Public & Homeowner Health

This code is a combination of performance testing and prescriptive guidelines for ventilation, screening, and retention time of compost and urine to create easy-to-follow and inspect requirements that protect public health even in the event of system failure and poor owner maintenance. Our code mandates that unsaturated aerobic decomposition conditions be maintained, that temperature stay within the range of beneficial decomposing organisms, and that decomposition occur for at least one year, outside the survival time of pathogens. In the event of maintenance failure, watertightness, screening, and ventilation requirements prevent both public health threats from arising and major inconvenience in the home.

Environmental Protection:

Urine diversion can reduce nitrogen in domestic wastewater by 80%, and Composting Toilet Systems can reduce household nitrogen by close to 90%, both at installed costs of $3-6,000. This is a higher performance than Alternative Treatment Technologies (ATTs) and sand filters currently required in many jurisdictions with surface and groundwater concerns, and at a fraction of the cost. This code brings new, lower cost options for environmental protection to homeowners.

Innovation:

This code enables the installation of innovative technologies by creating a code with clear inspection points to safeguard public health even in the event of the failure of new or experimental designs. It also provides a path towards standardization of innovative designs through its Reference Design system, whereby the output of the first eight UPC installations of a composting toilet system are subjected to biological field testing and verification. Our hope is that this code will help launch a vigorous domestic industry in composting toilets and urine diversion systems.

Composting Toilet System Definitions

Bulking Material. Usually carbonaceous material added for purposes of controlling odor, creating air space, balancing nitrogenous inputs, and absorbing liquid.
Commode. The Lavatory fixture for collecting, containing, or transporting excreta to the Compost Processor.
Compost Additives. Any material added to the Commode or Compost Processor to maintain operational conditions within the Composting Toilet System, bulking material such as sawdust, woodchips, etc.
Composting Toilet System. A system designed to safely collect and process Excreta and compost additives into Humus through aerobic decomposition.
Compost Processor. The site of aerobic decomposition transforming Excreta and Compost Additives into Humus.
Desiccation. The process of dehydrating excreta or leachate for odor, volume, or pathogen control.
Diverted Urine. Urine that is collected such that it has not made contact with feces.
Divided Bowl. Toilet bowl designed to separately collect urine and feces. See examples systems for imagery.
Excreta. Includes but is not limited to urine, feces, menses, toilet paper, and other human body emissions and biodegradable cleaning products.
Humus. The biologically decomposed, soil-like output of the compost processor.
Leachate. Liquid draining from the Compost Processor.
Owners Manual. A manual provided to the owner of a Composting Toilet System containing instructions for all management aspects of that system.
Reference Design. A non-proprietary Composting Toilet System design that has been tested, documented and approved under this code standard or by authorities having jurisdiction.
Building Codes, Onsite, Health, state EPA or DEQ may all be authorities having jurisdiction.
Secondary Composting. Additional retention and continued decomposition of humus removed from compost processors in order to meet a safe retention time.
Site-Built. Constructed at the site of use.
Transfer. The controlled transfer of Excreta or partially processed Humus between Commode and Composting Processor or between multi-stage Composting Processors.
Urine Diversion. Separation of urine and other excreta that occurs at the commode. See Urine Diversion Systems.
Vectors. An organism that has the potential to transmit disease.

Composting Toilet Systems

Approved Designs. All Composting Toilet Systems tested as Reference Designs or manufactured and tested to an IGC or ANSI-approved standard such as NSF 41 are approved.

New designs not tested to an approved standard or certified as a Reference Design may be installed with an open permit if the system(s) meet the Design Requirements. Permits will be finalized upon laboratory certification of the end product. (See Reference Standard).
Composting Toilet System may be installed in conjunction with approved Urine Diversion System.

Reference Standard. Composting Toilet System designs not designated as Reference Designs are provided with an open permit finalized upon compliance with microbial and moisture testing.

Testing. Composting Toilet System owner or owner's agent shall submit a sample of the Humus from the first treatment period to a certified laboratory before removal of Humus from the Composting Processor. Shall not have a moisture content exceeding 75% by weight, and shall not exceed 200 fecal coliforms/gram (Per NSF 41 7.1.4, Quality Criteria For Water, EPA, 1986).

Records Retention. The owner is solely responsible for retaining test result records and making them available to authorities having jurisdiction upon request. Upon transfer of property or tenancy, all test records must be transferred, and humus must be re-tested after its first treatment period and a record retained.

Listing. After 10 system(s) of the same design have passed the test successfully, the design is considered a Reference Design. A list of designs may be maintained by an individual jurisdiction or listed by IAPMO.

Operation. Composting toilet system shall be operated in a safe and sanitary condition in accordance with the Owners Manual. Operation of composting toilet system may be suspended to alleviate a nuisance or dangerous or insanitary condition, until such time as the owner or owner's agent shall conduct sufficient repairs or alterations to composting toilet system.

Humus Removal. Humus removal shall be described in the Owner's Manual. Humus from compost processor may be used around ornamental shrubs, flowers, trees, or fruit trees and shall be buried under at least six inches of soil, mulch or cover material. Depositing humus from any composting toilet system around any edible vegetable or vegetation shall be prohibited.

Secondary Composting. Humus may be retained in a well maintained compost bin or other facility designated for the exclusive purpose of containing humus removed from the compost processor. Secondary Composting must be labeled and fenced against human contact. Contact with precipitation and surface waters is prohibited.

Inspection. In the event of a nuisance complaint or documented system failure, Composting Toilet System will be made available for inspection. At the owner's expense, the authority having jurisdiction may request results of all laboratory testing, and new tests following repairs to alleviate dangerous or unsanitary conditions. Microbial tests are limited to microbial standards defined in the Reference Standard.

Design Requirements. Design Requirements are for Reference Designs and do not effect NSF, ANSI, or IGC approved designs.

Durability. All components shall be constructed of corrosion-resistant material such as stainless steel or durable polymers (ABS, PVC Schedule 40, HDPE, FRP, or material of equivalent durability). Concrete in contact with excreta or leachate shall meet requirements of Concrete Construction.

Concrete construction. Concrete construction shall be watertight and able to withstand loading weight. Drainage not required. If the processor floor is to be drained it shall be pitched not less than ¼" per foot. The flange of each sub-drain shall be set exactly level.

Commode

Structure. Shall be designed to support users and provide a solid connection to the floor.

Odor. Commode shall prevent the infiltration of odors into the building during normal operation and in the event of temporary power failure.

Contact. Commode shall transport Excreta directly into the Compost Processor or contain Excreta for Transfer as designed and explained in the Owners Manual.

Vectors. Commode shall limit Vectors and prevent human contact except for regular maintenance as designed and explained in the Owners Manual.

Compost Processor.
Compost Processor shall be designed to maintain unsaturated aerobic conditions within the compost

mass the drainage, absorption, or desiccation of leachate, and aeration of the Processor.

Leachate. Leachate may drain to an approved plumbing drainage system, be collected for removal or recirculation within the processor, or evaporated.

Containment. Compost Processor shall prevent the infiltration of rainwater and provide containment to prevent the discharge of the contents to the native soil, except leachate, which may drain to an approved plumbing drainage system, or other approved location.

Vectors. Compost Processor shall be designed and installed to limit access by vectors through management as described in the Owners Manual and rodent proof physical barriers. No unsecured opening may exceed 1/2" in the least dimension.

Transfer. If unfinished excreta or diverted urine is Transferred between processors or from commode to processor, Transfer and cleaning of containers and provisions for limiting user exposure shall be described in the Owners Manual.

Watertightness. Processors shall be constructed of watertight material such as reinforced, lined concrete meeting standards for Concrete Construction, or polyethylene, polypropylene, PVC, Fiber-reinforced polyester, or equivalent durable polymer. Polymer containers that meet or exceed US 49 CFR Section 178 are approved. Processors shall meet 24-hour watertightness test by being filled to a minimum of one inch with water.

Active Conditions. Compost Processor or processors, if multi-stage composting is used, shall be sized to compost excreta for a minimum of one year of biologically active conditions. Biologically active conditions are at or above a daily average of 42°F (6°C).

Exception.

Systems with shorter retention may be approved where either a) humus from the compost chamber has been tested to Reference Standards and there is a Secondary Composting stage or, b) humus is removed off-site for processing or disposal at an approved facility.

Ventilation. If Compost Processor is connected directly to commode without a trap, negative ventilation between Commode and Compost Processor shall be provided. **Exception.** Commodes unconnected from the Compost Processor do not require a vent.

Ventilation stacks shall terminate in building exterior as described by local building codes.

Passive venting. Passive vents shall be screened against insects and rodents with non-corrosive metal screen having a mesh opening of not larger than 3/32 inch.

Active Venting. Active vents preventing Vector infiltration through air flow shall be screened with non-corrosive metal screen having a mesh opening of not larger than 1/2 inch.

Owner's Manual

Owners Manual must present clear instructions for maintenance and be transferred to new owner upon transfer of property or tenancy.

Owners Manual must include:

1. Schedule for addition of necessary Compost Additives.
2. Source or provider of necessary Compost Additives. Source may be on site.
3. Schedule of all regular maintenance tasks and instructions for performing said tasks.
4. Expected input of and capacity for excreta and compost additives to Compost Toilet System specifying loading of Commode(s) and Compost Processor(s).
5. Plan for container transfer and cleaning, if Transfer is used.
6. Expected schedule for removing humus from Compost Processor.
7. Plan for on-site disposal of Humus or professional removal.
8. Plan for managing Leachate.
9. Plan for microbial testing.

Guidance

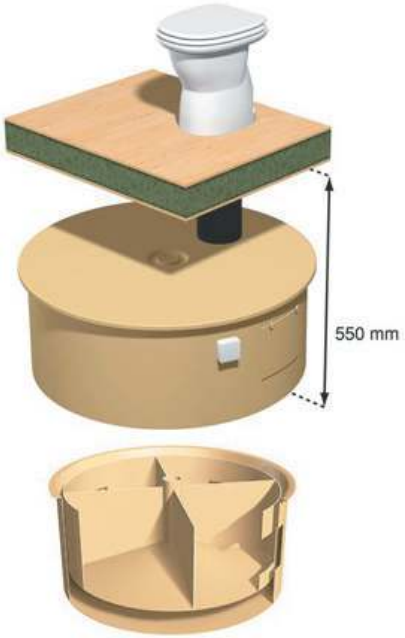
Sizing

It is recommended to size the Compost Processor to accept 0.25 gallons per full-time user per day. Use of urine diversion may reduce input to Compost processor to 0.125 gallons.

Composting Toilet Example Systems

Note: All images are conceptual and are not construction diagrams.

Manufactured Batch Composting Toilet System
Carousel System By Vera Environmental.
This batch system where a toilet pedestal with a 6-10" tube drops directly into a ventilated composting four part chamber that is rotated to the next chamber when full (approximately every 3-6 months for a family of four). Currently costs $3,000.

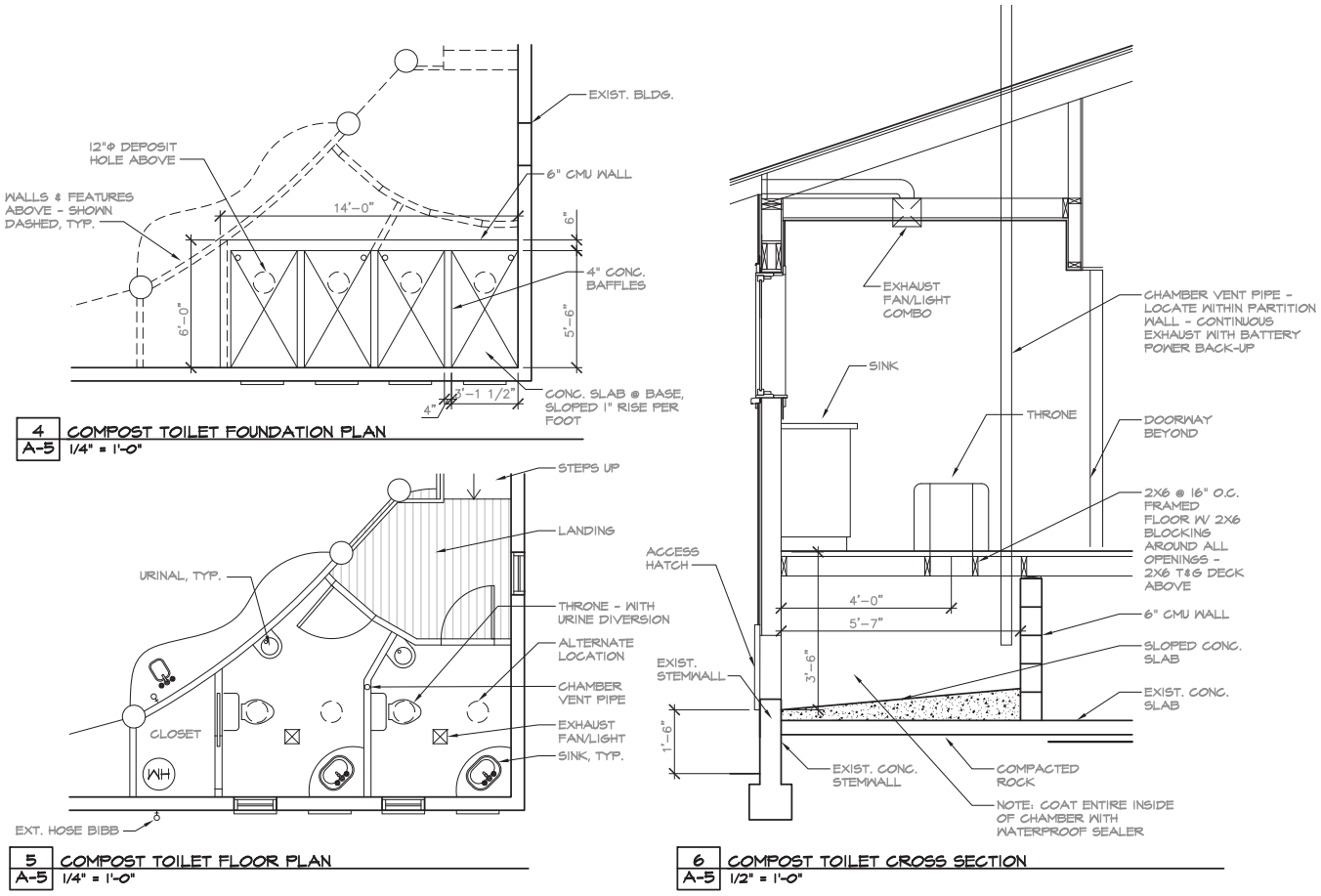


Composting Toilet with Container Transfer
Separett with Composting Bag

Manufactured Outdoor Compost Processer
Biolan Composter 550 and 220 by Biolan
Biolan's insulated compost processing container has a built in thermometer to monitor temperature. Unit is rodent proof and allows for adjustable ventilation while insulating the compost from freezing temperatures. The shape of the cover returns the condensed moisture to the compost pile.

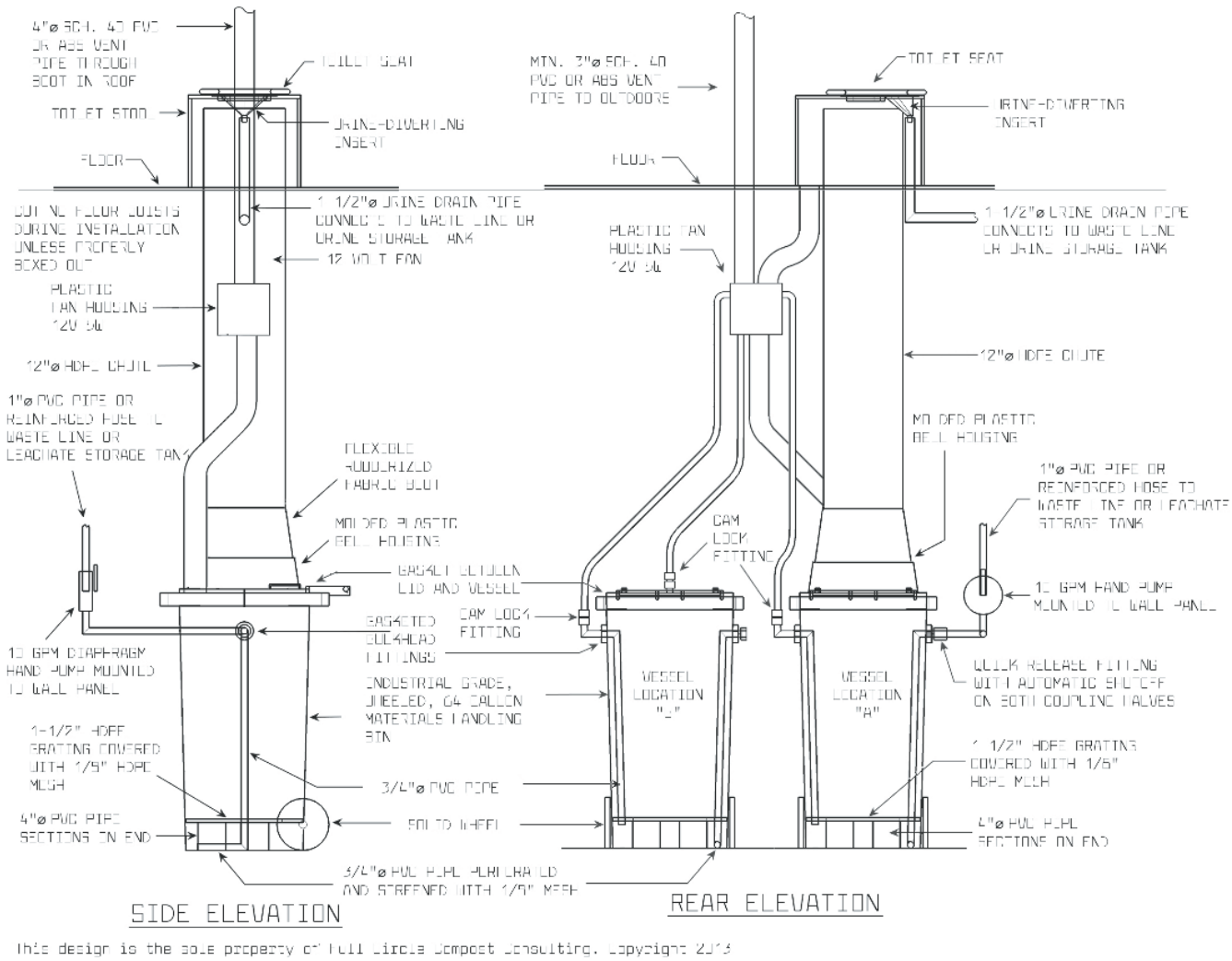
Site Built Outdoor Compost Processer
Designed by David Omick.
Bin of polycarbonate panels shown with carpet compost cover. The carpet cover serves several functions: it helps prevent compost from drying out, it provides an additional insect barrier and it helps prevent leaching of rainwater through the compost during thunderstorm downpours. Bins about 3' high and 5' in diameter are a good size for two or more people.

Composting Toilet Example Systems



Site Built Composting Toilet with Leachate Vault
Schematic by Erica Ann Bush. Design by Mark Lombard. Each bathroom has two composting chambers. Composting toilet empties into large vault, when vault is full it is capped and toilet throne is moved to the opening above the second vault. This system allows compost from the first vault a year to two to process and assures no human contact until compost is fully treated.

Composting Toilet Example Systems



Custom Composting Toilet System
Full Circle Composting System designed by Abraham Noe-Hays

The Full Circle batch composting system consists of a waterless, urine-diverting commode. The commode is connected with a chute to a small composting container on wheels. Includes a 4-watt fan that draws air from the bathroom, through the commode and compost, and out a roof vent. The urine is piped to a storage container for periodic removal. The collection containers are interchangeable and can be switched out when full.

Urine Diversion Systems

Purpose.
The purpose of this code is to enable the installation of urine diversion and collection systems to improve the function of composting toilet systems and prevent nutrient pollution of ground and surface waters.

Material Requirements. Material used for urine diversion shall be stainless steel or non-metallic pipe. Concrete piping is prohibited.

Pipe Requirements. All urine diversion piping shall be clearly marked "URINE DRAIN ONLY."

All urine diversion piping shall be plumbed to prevent clogging from struvite. For example, when making a 90 degree turn use a long-sweep 90 degree elbow instead of a short-sweep elbow (for vertical to horizontal, or horizontal to horizontal turns), or use two 45 degree elbows.

Sizing. Appropriate pipe sizing depends on the length of flow and expected flushing. Piping shall be sized to prevent obstruction of flow through the buildup of scaling between periodic maintenance performable by occupants or building staff at reasonable intervals. Pipe sizing may vary from ¼" to 4" depending on the length of the run, number of connections to a trunk line, and the cleaning strategy deployed (Von Münch 24, Kvarnström et al. 59). See guidance documents for more information pipe selection.

Traps. With the exception of tank overflows and vents, urine diversion piping shall not be connected to plumbing drainage system unless trapped as per 1000.1. Trapped and untrapped fixtures shall not share the same drain line.

Grade. Urine piping shall be installed at the highest practical grade and at a minimum of one half inch per foot, or 4%.

Cleanout. A Cleanout shall be provided every 100 ft and at an aggregate horizontal change of direction exceeding 135 degrees. Systems with removable and replaceable pipe, tubing, or joints excepted.
See guidance (tube in a chase or conduit)

Venting. Commode fixtures without traps that require ventilation shall be connected to either a dry toilet ventilation stack or a urine only ventilation stack as per 901.0. Commode fixtures with p-traps may be connected to plumbing drainage system ventilation per 901.0.

Pressure Relief. Stored urine shall not be vented except as required for pressure equalization. Pressure equalization vent shall be installed on urine storage tanks and shall extend from the top of the tank. The vent terminal shall be directed downward and covered with a 3/32 inch mesh screen to prevent the entry of vermin and insects. Storage tank vents shall be permitted to connect to the plumbing venting system 6 inches above the flood level rim of the highest connection to a toilet drain. Outdoor pressure equalization vents shall terminate no less than 12" above grade.

Discharge. A urine-diversion system shall be diverted to a storage tank or discharge to an approved plumbing drainage system. If the urine diversion system is installed to meet a pollution reduction requirement, overflow to a plumbing drainage system is prohibited.

Backwater Valve. Urine drains subject to backflow shall be provided with a backwater valve at the point of connection to the plumbing drainage system, so located as to be accessible for inspections and maintenance. Storage is recommended if urine diversion is used to meet a nitrogen or phosphorus reduction standard.

Storage Tank Traps. Urine storage tanks shall prevent odors and nitrogen loss from the tank inlet. Methods shall include but are not limited to termination of inlet piping such that it remains submerged during use and after pumpout, or through the use of a p-trap or mechanical trap. Tanks of five gallons or less excepted. See guidance document for discussions of appropriate use of different odor control and nitrogen retention methods.

Storage Tanks. Indoor tanks and outdoor underground tanks are approved. Outdoor above ground tanks where freezing conditions are not present are approved. Polymer containers that meet or exceed US 49 CFR Section 178 are approved. The urine storage tank level shall be clearly visible or shall be provided with a high-water alarm. Alarm shall report when 80% volume is reached. If storage tank is a part of a treatment system, see Treatment.

Buried Tanks. Buried tanks shall meet AASHTO H10, H15, or H20 depending on the expected vehicular loading of surrounding soil. All openings shall covered and secured to prevent tampering. Openings shall be screened or covered to prevent rodent infiltration and be protected against unintentional

human entry. Openings that could allow human entry shall be marked "DANGER - CONFINED SPACE."

Maintenance Plan. Every urine diversion system must have a maintenance plan that includes either a pumpout schedule & contract or onsite discharge plan. Plan must also include pipe cleaning schedule.

Treatment, Reuse, & Disposal. If urine is to be reused on-site, a treatment method for sanitization must be included and described in the Owner's Manual.

Approved methods of Treatment.
1. Retention. Urine may be sanitized by being retained without addition for six months before usage (Von Münch 12, Kvarnström et al. 63). Two or more holding tanks are required for retention.
2. Application to compost processor.
3. Pasteurization to 176 degrees Fahrenheit.
4. Other methods approved by local authority having Jurisdiction.
Onsite discharge plan must take into account sanitization through storage or treatment, and the nutrient demand of flora.

Guidance
Tank Sizing:
Sizing Guidance
Tanks should be sized to 10% greater than expected loading over the given fill period, and fill period shall be described in the owner's manual. Loading can be calculated by full-time user equivalents at 1.5 L per day per user, for the fraction of full-time use expected, in addition to flush water (Von Münch 25).

Pipe Sizing:
Appropriate pipe sizing depends on the length of flow and expected flushing. Piping shall be sized to prevent obstruction of flow through the buildup of scaling between periodic maintenance performable by occupants or building staff at reasonable intervals. See guidance documents for more information pipe selection.

Pipe sizing may vary from ¼" to 4" depending on the length of the run, number of connections to a trunk line, and the cleaning strategy deployed (Kvarnström et al. 59, Von Münch 24).

Pipe Cleaning:
Cleaning is recommended to include hot water, acetic acid, citric acid, or NaOH or other cleaning products.

Appropriate installations:
Public restrooms. The urine collection portion of urine-diverting toilets installed in public restrooms should be resistant to clogging or soiling caused by misplaced waste or toilet paper. Divided bowls are not recommended. Urine diversion urinals are recommended. A child seat is recommended for in-home use of divided bowls.

Citations
Von Münch, E., Winker, M., Technology review of urine diversion components, GIZ (2010). 12, 24, 25.

Kvarnström et al., Urine Diversion: One Step Towards Sustainable Sanitation, Stockholm Environment Institute (2006). 59, 63.

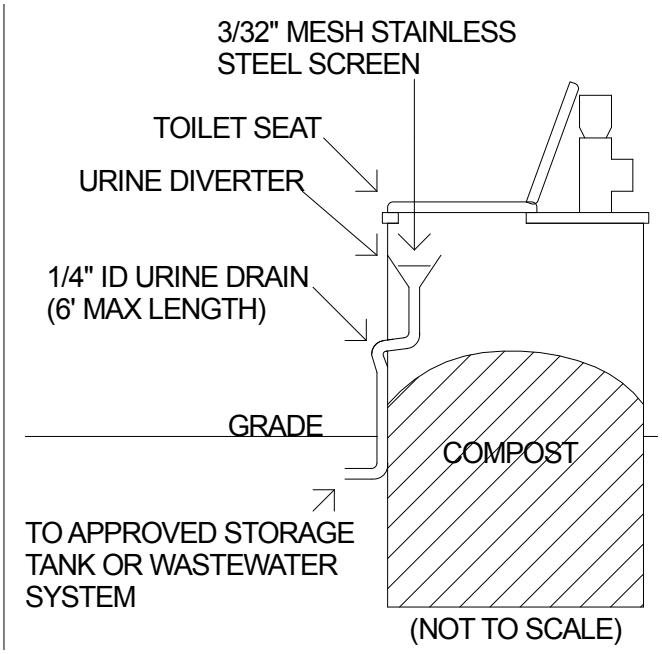
Note: All images are conceptual and are not construction diagrams.

Barrel Composting Toilet & Urine Diverter with 1/4" hose

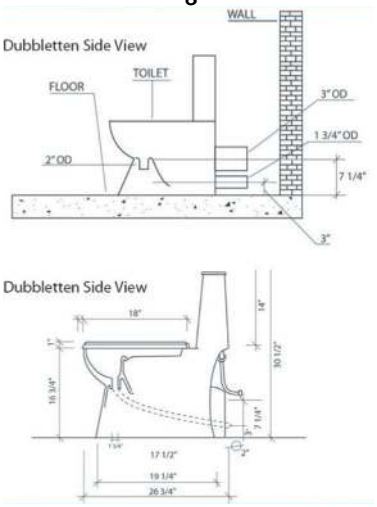
Design by David Omick.

Urine also contains high concentrations of dissolved minerals that form deposits on the inside of ordinary drain pipes, eventually clogging them. The small diameter pipe requires only a 1/2 cup of water following each use to thoroughly rinse the entire inside surface of the pipe thus preventing mineral buildup. Complete rinsing reduces the chance of struvite forming.

A small diameter drain also helps to prevent cockroaches and other disease vectors from entering or leaving the toilet through the drain.

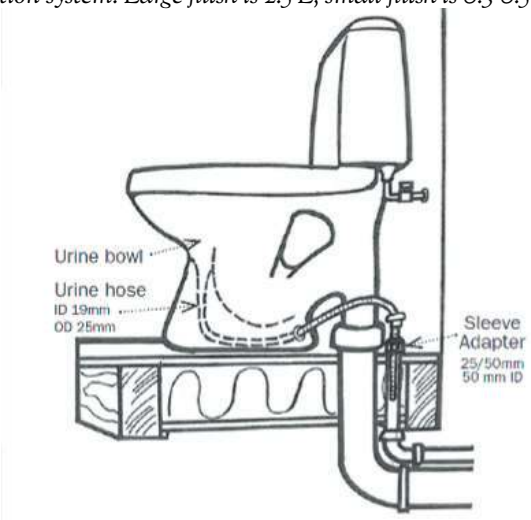


Dubbletten Urine Diverting Toilet with 2" hose



EcoFlush Urine Diverting Flush Toilet with 1" hose

Advantages: lowers water consumption by approximately 70-90% of a conventional flush toilet which lowers volume for collection system. Large flush is 2.5 L, small flush is 0.3-0.5 L.



Code Conflicts

From the 2012 UPC
California Exceptions, blue italics
Recommendations in red

Alternative Materials, Design, and Construction Methods:
"Nothing in this code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this code."
– 1.2.2, 1.8.7, 102.1, 301.2, 301.4

Disposal of Sewage
"It shall be unlawful for a person to... disposal of sewage in a place or manner, except through... an approved drainage system...
Exception: A water closet shall not be required when an alternate system is provided and has been approved by the local health official . . . The design, use and maintenance standards of such systems shall be the prerogative of the local health official." – 303.1

Required Connection
"Plumbing fixtures, drains, appurtenances, and appliances, used to receive or discharge liquid wastes or sewage, shall be connected properly to the drainage system of the building or premises, in accordance with the requirements of this code. *Exception: Alternative materials and methods shall be permitted provided that the design complies with the intent of the code, and that such alternatives shall perform to protect health and safety for the intended purpose."* - 304.1

Connections to the Sewer
713.1 Where Required. A building in which plumbing fixtures are installed and premises having drainage piping thereon shall have a connection to a public or private sewer, except as provided in Section 101.8, Section 71 3.2, and Section 713.4.
Composting Toilets designed and installed in accordance with (insert our code name or chapter) do not need to be connected to a public or private sewer.

713.2 Private Sewage Disposal System. Where no public sewer intended to serve a lot or premises is available in a thoroughfare or right of way abutting such lot or premises, drainage piping from a building or works shall be connected to an approved private sewage disposal system. *Composting Toilets designed and installed in accordance with (insert our code name or chapter) are considered approved private sewage disposal systems.*

Waterless Urinals
"Nonwater urinals shall be listed and comply with the applicable standards referenced in Table 1401.1. Nonwater urinals shall have a barrier liquid sealant to maintain a trap seal. Nonwater urinals shall permit the uninhibited flow of waste through the urinal to the sanitary drainage system. Nonwater urinals shall be cleaned and maintained in accordance with the manufacturer's instructions after installation. Where nonwater urinals are installed they shall have a water distribution line to the urinal location to allow for the installation of an approved backflow prevention device in the event of a retrofit."
- 403.3.1
Does this need revising?

Prohibited Fixtures
406.1 Prohibited Water Closets. Water closets having an invisible seal or an unventilated space or having walls which are not thoroughly washed at each discharge shall be prohibited. A water closet that might permit siphonage of the contents of the bowl back into the tank shall be prohibited.
Exception: Composting toilet systems designed and installed in accordance with the requirements of (insert our code name or chapter).

406.3 Miscellaneous Fixtures. No dry or chemical closet (toilet) shall be installed in a building used for human habitation, unless first approved by the Health Officer.
Remove or Amend?

Water Supply Required
413.2 Flushing Devices Required. Each water closet that depends on trap siphonage to discharge its waste contents shall be designed and installed so as to supply water in sufficient quantity and rate of flow to flush the contents of the fixture to which it is connected, to cleanse the fixture, and to refill the fixture trap, without excessive water use.

601.1 General. Except where not deemed necessary for safety or sanitation by the Authority Having Jurisdiction, each plumbing fixture shall be provided with an adequate supply of potable running water piped thereto in an approved manner, so arranged as to flush and keep it in a clean and sanitary condition without danger of backflow or cross-connection.
Exceptions:
Listed fixtures that do not require water for their operation and are not connected to the water supply.
Where deemed not necessary for safety or sanitation by the Enforcing agency
Composting toilet systems installed and designed in

accordance with the requirements of (insert our code name or chapter).

Sump Codes

710.2 Sewage Discharge. Drainage piping serving fixtures that are located below the crown level of the main sewer shall discharge into an approved watertight sump or receiving tank, so located as to receive the sewage or wastes by gravity. From such sump or receiving tank, the sewage or other liquid wastes shall be lifted and discharged into the building drain or building sewer by approved ejectors, pumps, or other efficient approved mechanical devices.

710.8 Sump and Receiving Tank Construction. Sumps and receiving tanks shall be watertight and shall be constructed of concrete, metal, or other approved materials. Where constructed of poured concrete, the walls and bottom shall be adequately reinforced and designed to recognized acceptable standards. Metal sumps or tanks shall be of such thickness as to serve their intended purpose and shall be treated internally and externally to resist corrosion.

710.9 Alarm. Such sumps and receiving tanks shall be automatically discharged and, where in a "public use" occupancy, shall be provided with dual pumps or ejectors arranged to function alternately in normal use and independently in case of overload or mechanical failure. The pumps shall have an audio and visual alarm, readily accessible, that signals pump failure or an overload condition. The lowest inlet shall have a clearance of not less than 2 inches from the high-water or "starting" level of the sump.

Do these need revising?

Tanks

714.5 Tanks. An approved-type, watertight sewage or wastewater holding tank, the contents of which, due to their character, shall be periodically removed and disposed of at some approved off-site location, shall be installed where required by the Authority Having Jurisdiction or the Health Officer to prevent anticipated surface or subsurface contamination or pollution, damage to the public sewer, or other hazardous or nuisance conditions.

Traps

1001.1 Where Required. Each plumbing fixture, shall be separately trapped by an approved type of liquid seal trap. This section shall not apply to fixtures with integral traps or *composting toilet systems installed and designed in accordance with the requirements of (insert our code name or chapter).*

TABLE 1 TYPICAL PATHOGEN SURVIVAL TIMES AT 20 TO 30°C IN VARIOUS ENVIRONMENTS

	Survival Time, Days		
Pathogen	**Fresh Water and Wastewater**	**Crops**	**Soil**
Bacteria			
Fecal coliforms[a]	< 60 but usually < 30	< 30 but usually < 15	< 120 but usually < 50
Salmonella (spp.)[a]	< 60 but usually < 30	< 30 but usually < 15	< 120 but usually < 50
Shigella[a]	< 30 but usually < 10	< 10 but usually < 5	< 120 but usually < 50
Vibrio cholerae[b]	< 30 but usually < 10	< 5 but usually < 2	< 120 but usually < 50
Protozoa			
E. histolytica cysts	< 30 but usually < 15	< 10 but usually < 2	< 20 but usually < 10
Helminths			
A. lumbricoides eggs	Many months	< 60 but usually < 30	< Many months
Viruses[a]			
Enteroviruses[c]	< 120 but usually < 50	< 60 but usually < 15	< 100 but usually < 20

a In seawater, viral survival is less and bacterial survival is very much less than in fresh water.
b *V. cholerae* survival in aqueous environments is a subject of current uncertainty.
c Includes polio, echo, and coxsackie viruses.

Source: Adapted from: Crites and Tchobanoglous, 1998.