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Spring 2004 Volume 5 Number 1

JURIED ARTICLE

Skaneateles Lake Watershed Composting Toilet Project

NATIONAL SMALL FLOWS CLEARINGHOUSE
1979–2004
25TH ANNIVERSARY

Wastewater Treatment in Alaska Native Villages

Small Flows Quarterly
Juried Article

Skaneateles Lake Watershed Composting Toilet Project

Rich Abbott

Abstract:

The City of Syracuse selected composting toilets for a demonstration project to phase out a century-old service of collecting pails of raw sewage from privies located at private residences in the watershed of its primary drinking water supply, Skaneateles Lake. In 1998, 100 remaining sites presented the most challenging obstacles for replacement of this service, including small, remote lakefront lots and residents reluctant to abandon a unique service that had been used for generations. Even though cottage owners using pail service were accustomed to offensive odors and unsanitary conditions, many were prejudiced against composting toilets. To offset these concerns and insure a smooth transition, the city launched a public education campaign. Cottage owners were closely involved with toilet model selections and unit placement, either in the cottages or existing privies. A total of 74 composting toilets have been installed at residences within the Skaneateles Lake Watershed. Pail service residents who did not participate in the project have chosen acceptable, alternative onsite wastewater treatment systems (OWTS).

Skaneateles Lake, located in the Finger Lakes region of New York State, serves as the primary drinking water source for the City of Syracuse. It is one of the few remaining unfiltered drinking water supplies left in the U.S. Due to the rural character of the watershed, only dwelling units within the Village of Skaneateles, located on the north-end of the lake, are connected to a municipal sewer system. This accounts for less than 8 percent of the estimated 2,577 residences located within the 59-square-mile watershed. The lakefront is densely populated, accounting for approximately 40 percent of all dwelling units on the watershed.

The City of Syracuse funds and coordinates numerous water quality protection programs including the watershed protection program, Skaneateles Lake Watershed Agricultural Program, and the Skaneateles Lake Watershed Land Protection Program. These programs utilize sophisticated data management tools, such as geographic information systems (GIS) and global positioning systems (GPS), in an effort to protect and/or enhance water quality in Skaneateles Lake.

One of the primary facets of the watershed protection program is conducting comprehensive inspections of all properties within the watershed. This entails intensive annual inspections of all residences, farms, and commercial enterprises. Watershed inspectors inspect residential sites for onsite wastewater treatment system (OWTS) failures and unpermitted construction activities. Since 1990, watershed inspectors have detected as few as four, and as many as 69, failing OWTS in a year. City personnel also review all OWTS design proposals for new construction and repairs and conduct backfill inspections of installed systems. In addition, the city has direct oversight of repairs to failing systems. With these layers of watershed protection and technology in place in Syracuse, the practice of collecting five-gallon pails of raw sewage and transporting them by pick-up truck and boat for disposal has become antiquated and inefficient.

Pail Service

Many of the watershed rules and regulations adopted by the City of Syracuse have been in effect since 1896 to assure the protection of this unique water resource. To address development pressures on the watershed and specifically, the lakefront, a city-sponsored pail service was initiated in 1908 to create an efficient alternative to traditional pit prives (City of Syracuse Department of Water, 1908). Privies were built to specifications issued by the city to facilitate pail removal and replacement. Five-gallon galvanized steel pails provided by the

Prior to the composting toilet project, many lakeside residents in Skaneateles relied on a pail pick-up service initiated in 1908 to dispose of their household sewage. Five-gallon pails of raw sewage were transported by truck and boat to Syracuse. Photos by Rich Abbott.

city were placed under a hinged box seat in the privy and collected on a weekly basis by city personnel (City of Syracuse Department of Water, 1912). Two full-time and two seasonal employees were responsible for collecting and sealing full pails and replacing them with clean, disinfected pails. The full pails were transported to a holding tank on city property and periodically pumped out by a licensed waste hauler.

With few exceptions, pail service was provided for seasonal cottages where use was only on weekends. The term *seasonal* refers to use between three and eight months per year. A survey conducted in 1998 indicated that this is still the case. However, three locations were using the service year-round, and ten were full-time summer residences.

Over the years, some residents have chosen to install holding tanks or conventional OWTS as a replacement for pail service. Thus, the number of pail service locations has dropped from approximately 250 at the height of its popularity in the 1920s to 100 in 1998.

Site conditions at remaining pail service sites have made installing and maintaining acceptable alternatives to pail service virtually impossible or, at the very least, extremely expensive. These include the following conditions:

- boat-access-only properties with no utilities;
- extremely small lots;
- entire lake-front lots consisting of rock outcroppings, steep slopes, or cliffs;
- fill material enclosed by bulkheads extending into the lake;
- cottages with no bathrooms; or
- no practical and economic bathroom expansion or plumbing hook-up options.

Site investigations and interviews with property owners conducted through the 1998 season revealed that all lakefront pail service cottages used the lake as their primary water source. Although residents had an unrestricted and free source of high-quality water, consumption is minimal for two primary reasons: use is limited to weekend and holidays, and plumbing fixtures typically consist of a kitchen sink and a shower. Seepage pits are the most common source of disposal for greywater at pail service cottages. Many of these have been constructed by hand because of the difficulty in accessing the site with motorized equipment.

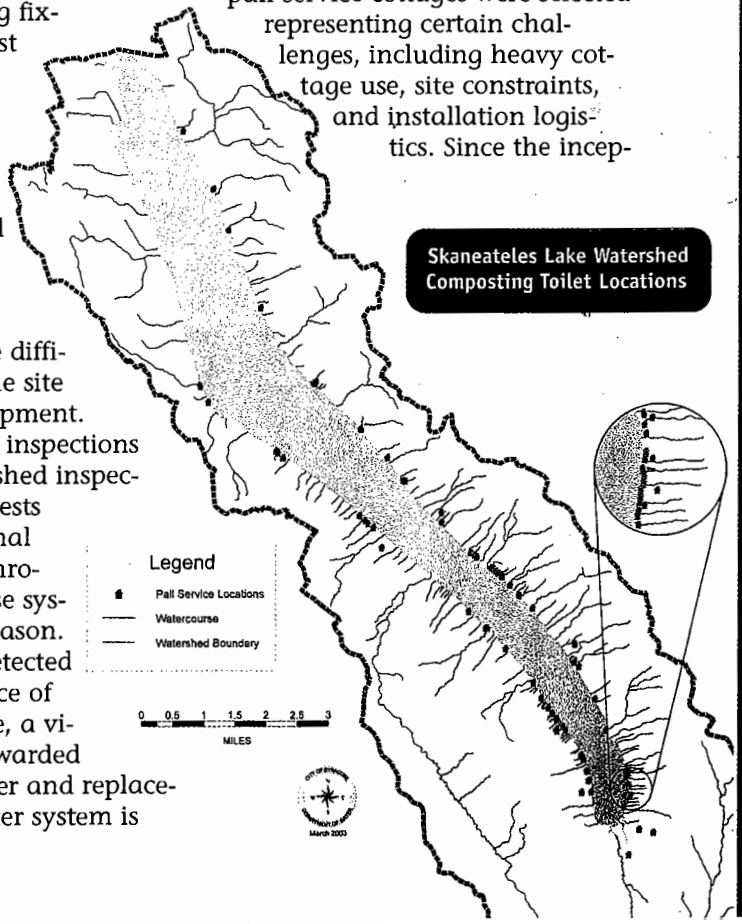
Annual property inspections conducted by watershed inspectors and septic dye tests performed by seasonal employees are synchronized to inspect these systems during peak season. When a failure is detected either by the presence of ponded water or dye, a violation notice is forwarded to the property owner and replacement of the greywater system is required. Abatement requires complying with all local sanitary codes to the extent possible.

Selection of Composting Technology

Based on the conditions described above, the city concluded that a technology that did not promote any additional water consumption at pail service sites was most desirable. A technology that does not discharge to ground or surface water could provide a cost-effective and efficient OWTS solution for replacement of pail service. Composting toilets were selected over other technologies, such as incinerating and chemical toilets, for a pilot project after researching the alternatives. Reliability, cost, and system performance were considered during the selection process.

Composting Toilet Pilot Project

A pilot project was initiated in the summer of 1998 to determine the feasibility of replacing the remaining 100 pail service locations with composting toilets. Five pail service cottages were selected representing certain challenges, including heavy cottage use, site constraints, and installation logistics. Since the incep-



Skaneateles Lake Watershed Composting Toilet Locations

tion of pail service, the City of Syracuse has documented the number of pails collected at individual cottages. Ultimately, decades of usage data provided the necessary baseline for the proper sizing of composting units for specific sites.

A database was created for the project to record information on cottage owners, including the composting toilet model selected, installation location, occupancy of residence, unit cost, and installation cost. The database also documented correspondence with cottage owners and recorded the progress of each installation. Problems encountered during installation and operation were identified on the individual cottage owner's records. This information was added to the database and was used during the official replacement program to expedite installations.

Two self-contained composting toilet models from different vendors were selected for this project. These units have a toilet and composting chamber combined in one unit. Both models were the highest capacity available through each vendor for this design. Both units were certified by NSF International, an independent testing laboratory, and are listed under NSF Standard 41 for Non-Liquid Saturated Treatment Systems.

Following installation, users of the composting units were required to record urine and fecal contributions on a daily user sheet. An optional comment section was also provided to correspond with each event. The user sheets provided valuable (and occasionally entertaining) information regarding the ability of the toilets to handle peak loading during weekends, holidays, social functions, or during extended periods of occupancy. Conversely, extended periods of inactivity could be identified, further validating the reliability of units throughout a range of conditions. For example, one of the models selected had frequent mechanical failures. Another cottage owner documented replacing a shear pin on the mixer motor assembly on six occasions. When the pin severed, two metal bars designed to automatically level, mix, and aerate the compost could not be activated. At two other locations, periods of heavy use resulted in saturated compost, requiring removal of the compost. One resident at yet another location stated that extracting compost from the finishing tray was also "difficult and messy."

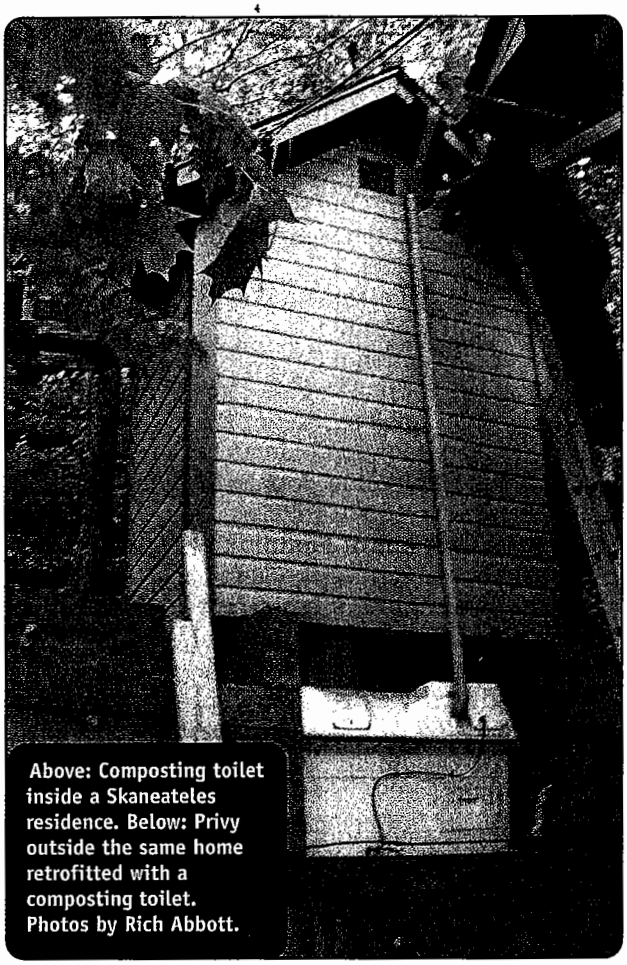
The second model selected was the Excel self-contained toilet by Sun-Mar Corporation. Participants agreed that this unit was not as aesthetically pleasing and required more involvement by the user; i.e., mixing the compost by manually rotating the compost in a steel chamber. However, when installed, operated, and maintained properly, the Excel proved to be very reliable even under heavy loading.

Over the course of the pilot program, user surveys and personal discussions with participants validated the following vendor claims about the composting toilets:

- they provide an odor-free environment,
- they are easy to operate and maintain,
- they perform efficiently under recommended capacity,
- they can handle exceptionally heavy loading when the emergency drain is connected to an evapotranspiration (ET) bed or sealed container, and
- they produce a clean, dry compost that is easy to extract.

At the conclusion of the two-year pilot project, participants who were issued the second model found their units to be an acceptable and welcome alternative to pail service. Issues related to improper installation, offensive odor, and excess leachate were all corrected with minor adjustments, such as leveling the toilet, reconfiguring or extending vent piping, and incorporating ET beds.

In regards to operation and maintenance, the city and vendor worked closely with property owners, instructing them as to the correct amount and frequency of bulking material to be added to the compost chamber, as well as to the proper blend of material if



Above: Composting toilet inside a Skaneateles residence. Below: Privy outside the same home retrofitted with a composting toilet. Photos by Rich Abbott.

TABLE 1 Common Problems Homeowners Encountered in the Skaneateles Composting Toilet Demonstration Project.

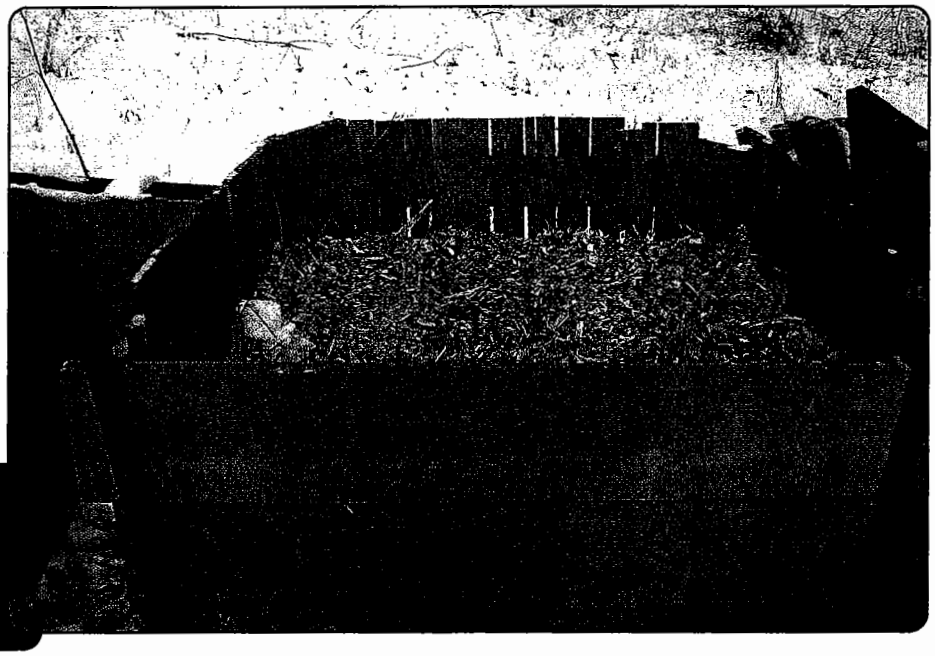
PROBLEM	CAUSE	SOLUTION
Offensive odor indoors	Loose or disconnected vent pipe adjacent to toilet	Reconnect pipes
	Fan not capable of forcing air through vent	Alter air flow in unit, forcing more air up vent, or install high speed fan
Offensive odor outside	Fan not capable of forcing air through vent	Alter air flow in unit, forcing more air up vent, or install high speed fan
	Vent pipe not sufficient height	Raise vent pipe
Excessive liquid accumulation in evaporation tray	Unit not installed level	Level unit
	Overflow drain inlet obstructed	Remove any solids which have accumulated in the evaporation tray ensuring liquid can pass through overflow drain
Anaerobic conditions observed in composting drum	Bulking material in composting drum is either compacted or too fine not allowing for proper drainage of liquid through the drum screen	Extract material and clean drum screen. Do not allow composting drum to become over 2/3's full. Ensure correct ratio of peat moss and wood shavings
Flies in compost	Compost too dry	Add warm water

they chose not to purchase products from the vendor.

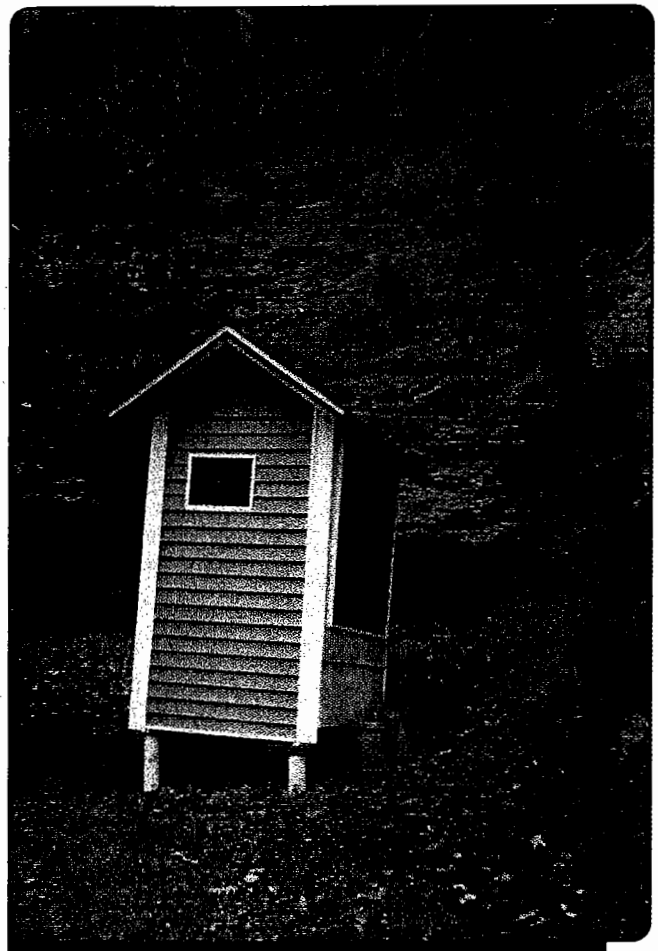
Pilot project volunteers who were issued the first model described above, were allowed to replace their units with the Excel model and are currently utilizing this toilet.

Transition From Pail Service To Composting Toilets

In the summer of 2000, Syracuse's common council appropriated the funding to provide Sun-Mar composting toilets as a replacement to pail service. Shortly thereafter, a notice was sent to the remaining pail service residents signifying the phasing out of the service. Though the letter did not specify a termination date, owners were encouraged to start making arrangements for a composting toilet installation or pursue approval of an OWTS (the latter would not be subsidized by the city). The city drafted an agreement outlining their responsibilities and those of the cottage owners. Essentially, the city would purchase the waterless self-contained or central composting toilet system and provide a contractor to install the unit. The property owner would be responsible for preparing the area for installation and for the future operation and maintenance of the unit. Another stipulation required that the cottage owner place finished compost material in a five-gallon pail, which would be provided and collected by city personnel.



Bin holding finished toilet compost. The compost is combined with fresh grass clippings, hay, and mulch and is allowed to secondary compost. Alternate bins allow compost to age for a minimum of two years. Photos by Rich Abbott.



Privy behind a Skaneateles home shows the steep rocky terrain and limited land available for conventional onsite wastewater treatment systems. Photo by Patricia Miller.

Education and Training

Prior to each composting toilet installation, city workers visited each site to determine the present and possible future occupancy of the cottage, assist property owners in selecting the appropriate unit, and determine the placement of the unit. Because many cottage owners were unfamiliar with composting toilets, the site visits provided an excellent opportunity to address residents' concerns and provide them with information regarding the operation and maintenance of the units.

Continuous interaction with cottage owners has been essential to the success of this project. Many cottage owners were apprehensive about abandoning a unique and functional waste disposal method that they had used since childhood. Others voiced concerns about potential odors, mechanical failures, and operation and maintenance responsibilities. Generally, the younger generation cottage owners and owners of recently purchased pail service properties were more accepting and, in many cases, excited about the project. Second and third generation cottage owners focused more on the maintenance and operation details. To address residents' concerns, workshops were offered featuring representatives from Sun-Mar, the City of Syracuse, and installation contractors. E-mails and mailings continue to be circulated frequently providing information on composting toilet operation and maintenance. An informational sheet and list of collection dates for finished compost titled *Spring Start-Up and Fall Shut-Down Procedures* is mailed annually.

A poster titled *Ongoing Toilet Maintenance* was also distributed to compost toilet owners in the fall of 2003. The poster is to be placed above the composting toilet and highlights all the critical actions that must be taken by the user to allow for trouble-free composting. To ensure that cottage owners have immediate and convenient access to bulking material, along with optional products distributed by the vendor, local hardware and home and garden stores were set up as dealers to carry the products.

Installations

It was evident from the inception of this project that improper installation or initial start-up of composting units could easily compromise its success. Since the majority of cottages using pail service were clustered on fire lanes or secondary roads located on the south end of the lake, any negative experiences would quickly be broadcast throughout the pail service community. Cottage owners apprehensive about abandoning pail service would routinely request the names and locations of individuals who already had toilets installed so they could carefully monitor the project. Those residents who already had compost toilets installed were very receptive to granting interviews and site visits for the remaining pail service residents, as well as for the local media, local regulators, and other interested parties.

Cottage owners had a choice between two Sun-Mar waterless composting toilets. Most cottage owners selected the self-contained Excel model since it can be installed directly in outhouses or existing cottages with little or no alteration to the structure. Because there is no separate toilet, installation time is typically less than four hours.

The second model was the Centrex 2000 Air Flow (AF) central composting toilet system. This two-piece system consists of a dry toilet in the bathroom, connected to a composting unit immediately below the toilet by a ten-inch diameter pipe. The composting chamber for this model is usually installed in a basement or crawl space. This model requires approximately four feet of space directly underneath the toilet stool, limiting toilet locations. Cottage owners determined to utilize the larger capacity central unit, or who preferred this unit's more traditional style toilet, worked diligently with contractors and the city to find creative solutions. Although a few of Centrex 2000 AF's have been incorporated in existing cottages, most of the units have required construction of a small addition to the cottage or an existing accessory structure.

After several composting toilets were installed, an installation checklist was created to address problems encountered by the contractors. The checklist, which was required to be submitted to the city immediately following installation, greatly streamlined subsequent installations and also ensured consistent procedures.

Composting Toilet Description

The selected models utilize a three-chamber system inside a fiberglass shell.

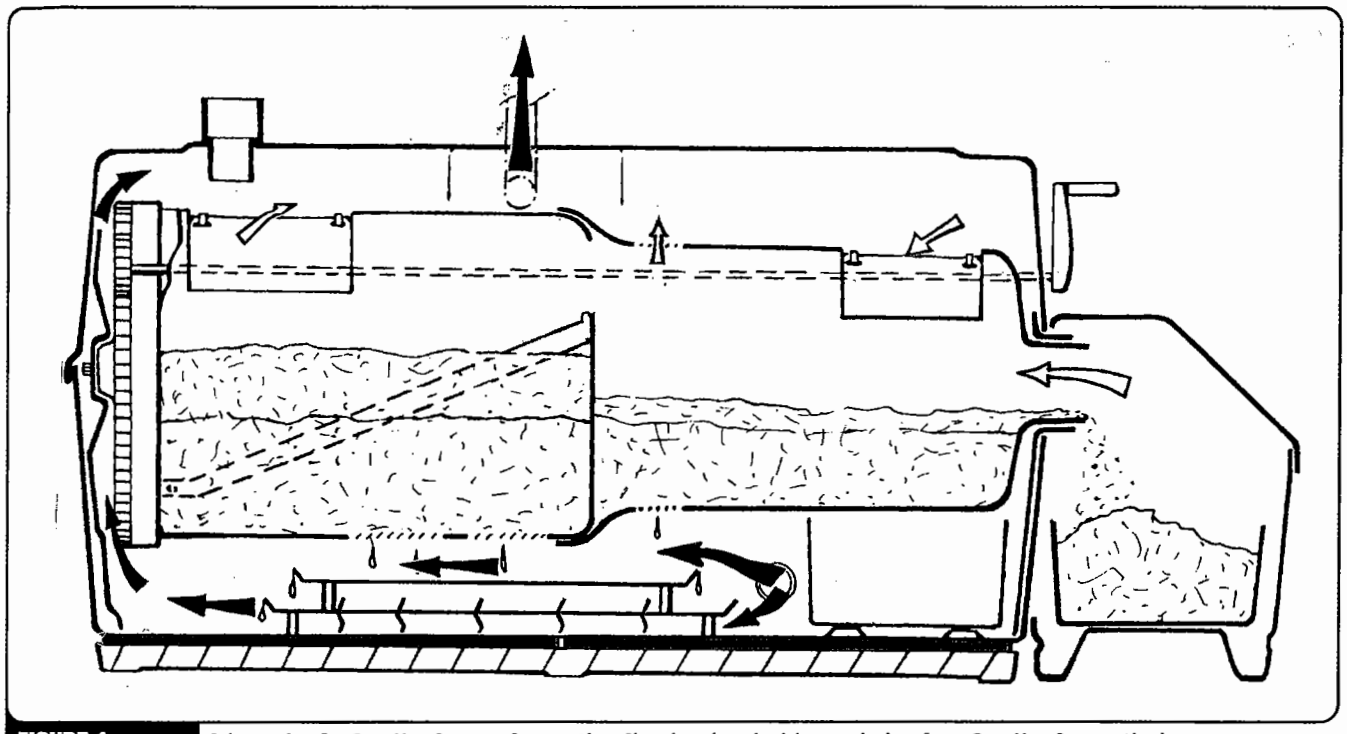


FIGURE 1 Schematic of a Sun-Mar Centrex Composting Chamber (used with permission from Sun-Mar Corporation)

The first chamber referred to as the Bio-drum is where human waste and toilet paper is broken down. Rotating this drum mixes and aerates the compost, removes excess liquid to the evaporation chamber, and keeps the compost moist by avoiding direct heat and drying air.

The second chamber is the finishing drawer. By rotating the drum backwards, material from the Bio-drum is dropped into this compartment where composting continues, isolated from fresh material.

The third chamber is the floor of the toilet where excess liquid not absorbed by the compost is evaporated. To provide air movement and heat to the compost and evaporating tray, electric units contain a 370-watt, 120-volt thermostatically controlled heating element and a 35-watt turbo fan.

In order to consistently produce a quality end product, these units must perform the following tasks:

- compost waste and toilet paper quickly and odorlessly,
- evaporate liquid, and
- ensure finished compost is safe and easy to handle.

Evapostraspiration Beds

Vendor brochures state that the models the city selected can normally evaporate all liquids. To evaluate this claim, overflow drains were connected to five-gallon containers to determine the volume of leachate, if any, that could be expected during peak use. After monitoring 42 installations, overflow leachate was observed in six containers. Based on this outcome, the city installed ET beds replacing the containers to reduce the cottage owners' maintenance and monitoring responsibilities and, more importantly, provide added insurance in the event of a prolonged power outage or unusually heavy cottage use.

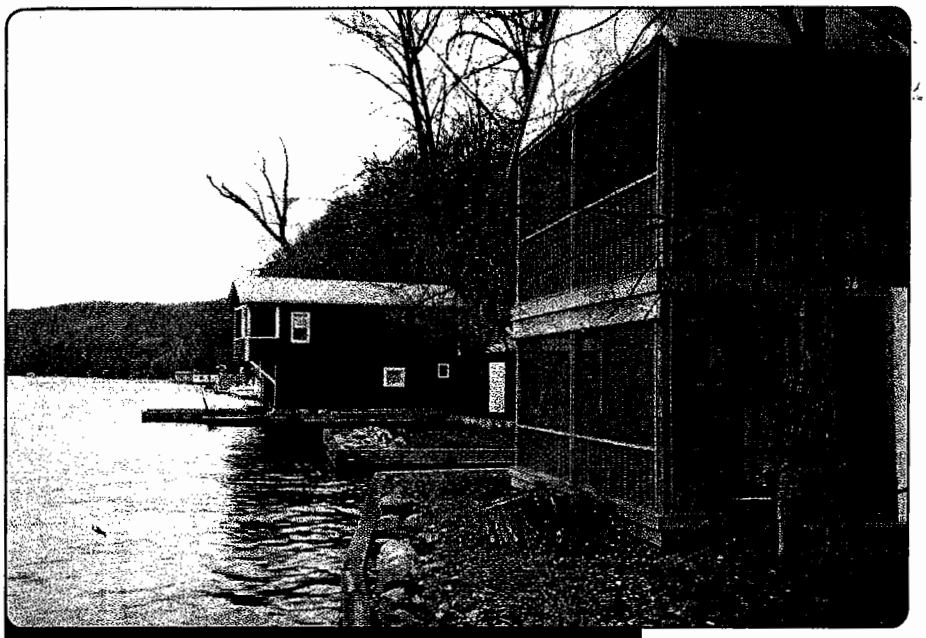
ET bed design and dimensions were based on research conducted by Dr. Alfred Bernhart as outlined in the publication *Evapotranspiration, Nutrient Uptake and Soil Infiltration* (Bernhart, 1985). Because leachate overflow loading rates ranged from zero to five gallons per week, typical bed sizes were dramatically reduced in comparison to beds incorporating standard household greywater and blackwater design flows. The required bed surface area was calculated using total input per season (total people-days per season multiplied by total waste input per person per season) and divided by the net total ET obtained from a bed over the course of a whole season. A cottage estimated to have total person days per season of 400 would require a 5.5 ft^2 ET bed.

Beds were excavated to 18 inches and lined with 20-milliliter (mL) plastic. A 6-in. base of gravel was placed above a thin layer of sand. A 4-in. perforated PVC drainpipe was placed on the stone and backfilled. Ninety-degree elbows were connected to the perforated pipe and extended to the bed surface, thus, stimulating air movement through the bed and also allowing for dilution of leachate during precipitation. Next, the beds were filled with 12 in. of 1-mm sharp sand with a center crown approximately 6 in. above the sidewalls.

The majority of ET beds were located in partial to full shade, limiting plant selection. *Hosta fortunei* (plantain lily) was routinely planted at these sites. *Hemerocallis* (day lily), *Colocasi* (elephant's ear) and *Spartina alternaflora* (saltwater cordgrass) were also planted at several sites.

COMPOST INSPECTION, HANDLING AND SAMPLING

The New York State Department of Health (NYSDOH), and all local health department's having jurisdiction in the watershed, determined that the City of Syracuse's proposal to replace pail



Some Skaneateles homes have been built partially extending out on the lake because of the limited land on the lakefront. Photo by Patricia Miller.

service with composting toilets was acceptable with the following conditions:

- annual inspections of the installations are performed by city personnel and a summary of the inspections are included in the city's annual report of watershed activities,
- compost disposal is in accordance with NYSDOH regulations, and
- the city must be prepared to facilitate proper compost disposal by providing a designated disposal site for use by residents or by collecting the compost in those cases where necessary to ensure proper disposal.

The New York State Individual Residential Wastewater Treatment Systems Handbook states that "if a homeowner chooses to personally remove the composted humus, it should be disposed of at a sanitary landfill or buried or well mixed into soil distant from food crops, water supply sources, and watercourses." The *Handbook* also states that "humus disposal sites shall meet separation distances for sanitary privy pits."

In the spring of 2002 and 2003, finished compost was sampled from 10 residences for fecal coliform. Results indicated the compost contained fecal concentrations ranging from <2 to several thousand coliform forming units per gram (cfu/gm).

In an effort to further reduce or eliminated pathogens and satisfy NYSDOH conditions regarding collection and disposal of finished compost, the city has elected to collect this material from compost sites on a designated date each spring. City personnel transfer five-gallon pails of finished compost to 4-ft square composting bins on city property within the watershed. The finished compost is combined with fresh grass clippings, hay and mulch and allowed to secondary compost. The City is experimenting with establishing optimal carbon:nitrogen (C:N) ratios, moisture, and aerobic conditions within the piles in an effort to achieve thermophilic conditions (over 105°F). Alternate bins have been constructed allowing the compost to age for a minimum of two years after the pile has been built. Prior to disposing of finished compost per NYSDOH regulations, fecal coliform counts of ≤200 MPN/gm, (NSF Standard 41 Non-Liquid Saturated Treatment Systems, Performance Criteria, 14.3) shall be met. Beginning in the spring of 2004, sampling of secondary compost and finished compost will be conducted in accordance with Environmental Protection Agency (EPA)/625/R-92/013, Appendix F, Section 1.2 and EPA/625/R-92/013, Appendix F, Section 1.2 and the modifications described in NSF Standard 41, 12.2 and 12.3, respectively.

RESULTS

Seventy-four composting toilets have been installed at residences on the Skaneateles Lake Watershed. Thirty-nine units have been installed in cottages and 35 units in outhouses. Eighty-seven percent of the installations have been self-contained units. Pail service residents who did not participate in the project have chosen acceptable, alternative OWTSs. For the most active pail service cottages (annual use of more than 100, five-gallon pails of raw sewage), the transition to composting toilets has resulted in less than four buckets of finished compost per year. In the majority of cottages, compost can accumulate for an entire season in the composting chamber. Upon returning the next season the cottage owner is expected to extract material from the chamber into the finishing drawer and deposit the compost into City of Syracuse supplied five-gallon buckets. Compost can also be extracted into the finishing tray during the cottage season if the chamber becomes one-half to two-thirds full. This isolates the material from fresh waste entering the chamber, and it can remain in the tray until additional material needs to be removed from the chamber. In 1998, 3,402 pails (or approximately 11,226 gallons of raw sewage) were collected on the Skaneateles Lake Watershed. This required over 2,400 person-hours for collection, cleaning, and disposal. By comparison, 54 pails of finished compost were collected in 2003.

The operating budget for pail service is approximately $70,000 annually. Funding the replacement of pail service at 74 cottages with composting toilets has cost the City of Syracuse less than $ 95,000. This represents a return on investment of 1.4 years.

Most problems encountered during this project were due to errors in installation or poor operation and

maintenance of the unit. The most commonly occurring problems and the resultant actions taken are listed in Table 1.

CONCLUSIONS

The Skaneateles Lake Watershed has proven to be a significant challenge for installing composting toilets on a large scale. Challenges have included the following:

- overcoming extreme venting conditions, such as cottages positioned immediately below steep slopes and cliffs and dense shoreline development;
- satisfying the demands of cottages with multiple owners/families, including coordinating operation and maintenance responsibilities and managing consistently heavy seasonal use;
- convincing cottage owners to abandoned a free sewage collection system that placed virtually no responsibility on the owner; and
- educating cottage owners that composting toilets are an efficient and environmentally sound alternative to pail service.

Despite these challenges, it is evident that the cottage owners and the City are benefiting. Cottage owners who have elected to abandon their privy now have the luxury of an indoor facility. The offensive odor and unsanitary conditions related to accumulation of raw sewage has been eliminated. The City of Syracuse's is rewarded for its investment with the elimination of a costly and antiquated service. The city's remaining pail service employee has been incorporated into the watershed inspection team, allowing for a more productive use of staff-hours.

From the perspective of watershed management and protection, the potential for spillage of accumulated raw sewage during transportation by boat or pickup truck, or contamination of groundwater through a failure at the holding tank has been removed. The project also benefits the environment, because the amount of waste generated now is a fraction of what it used to be when the pail service was in effect.

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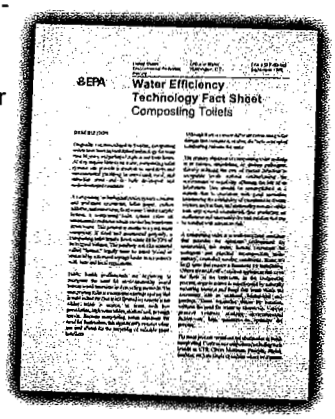
Rich Abbott is a Public Health Sanitarian for the City of Syracuse Department of Water. He is a member of the steering and technical committees for the Skaneateles Lake Watershed Onsite Demonstration Project.

Related Products

For ordering information, see page 47.

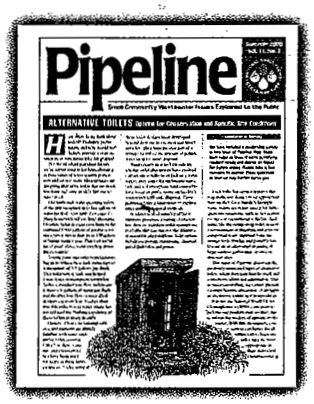
Environmental Technology Initiative Fact Sheet: Composting Toilet Systems

Developed by the NSFC, this 4-page fact sheet discusses how composting toilets work, system components, siting considerations, performance characteristics, advantages and disadvantages, operation and maintenance requirements, and cost. Detailed design information, case studies, system illustrations, and data tables are included. The cost for this fact sheet is 40 cents. Ask for item #WWFSOM20.



Water Efficiency Technology Fact Sheet: Composting Toilets

Produced by the EPA, this 7-page fact sheet discusses the composting toilet system and its applicability, including replacement, rejuvenation, and remodeling of existing disposal systems. The fact sheet details advantages and disadvantages, performance, operation and maintenance, cost, design criteria, and additional sources of information. The cost for this fact sheet is $1.40. Ask for item #WWFSGN196.



Alternative Toilets: Options for Conservation and Specific Site Conditions

The Summer 2000 issue of the NSFC newsletter *Pipeline* describes many types of alternative toilets that can be used in homes and public restroom facilities. The newsletter summarizes the operation, maintenance, advantages, and disadvantages of each type, including composting toilets. Two case studies show how alternative toilet systems helped to resolve wastewater disposal problems. The cost for this newsletter is 40 cents. Ask for item #SFPLNL22.