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Cincinnati OH 45268

Research and Development

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# Project Summary

# Liquid Waste Composting

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**This research project was conducted at the Chesapeake and Ohio Canal National Historical Park to examine the feasibility of adapting and using the sludge composting technique to compost liquid waste collected in National Parks. This study evaluated the composting of two problematic liquid raw wastes—sanitary toilet pumpings and septic tank pumpings (septage). Effectiveness of the process was characterized by measuring indicator organisms destruction, nutrient transformations, heavy metal content, and temperature and oxygen variation. Effective destruction of pathogenic microorganisms was achieved by temperatures in excess of 55° obtained within the composting pile.**

**The system was costly on a unit volume basis, but costs were reasonable when the value of the compost was considered. The process provided thorough waste treatment without costly equipment and specialized construction.**

***This Project Summary was developed by EPA's Water Engineering Research Laboratory, Cincinnati, OH, in cooperation with the U.S. Department of Interior's National Park Service, to present key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).***

## Introduction

The National Park Service Chesapeake and Ohio Canal National Historical Park (C&O Canal) was faced with a serious waste disposal problem in 1975. Several years prior to 1975, pit toilets were replaced with sanitary tank-type or portable toilets from which raw wastes had to be pumped and disposed of to municipal treatment facilities. For a period of time, waste disposal at local municipal plants was permitted; however, without warning, the C&O Canal was refused further disposal privileges. A thorough investigation of alternatives led to the selection of the aerated static pile composting system. A major question to be addressed was whether a liquid waste material, at that time estimated to be greater than 95% liquid, could be successfully composted. It was decided in 1976 to initiate a pilot project and evaluate the feasibility of composting sanitary toilet waste. As composting efficiency was obtained, the C&O Canal decided to investigate composting of a blend of septic tank waste (septage) and sanitary toilet waste. This also proved successful.

## Materials and Methods

Pile construction began with a mixture of wood chips, sawdust, and previously composted material. This mixture was used as a bulking agent to absorb the large percentage of liquid in the waste prior to composting. About 18 cu m (24 cu yd) of bulking agent were required per 3780 L (1000 gal) of liquid waste. After soaking, the bulking material was incorporated into a cone shaped compost pile 4.6 m (15 ft) in diameter and 2.7 m (9 ft) high. Each pile consisted of a bottom mattress of previously composted material, a core of the waste-soaked bulking material, and an insulating blanket of compost material. An oval of perforated pipe protected by wood chips was laid between the mattress and the bulking material during construction and was connected to the intake manifold of a blower. A damper between the pile and the blower provided draft control.

Monitoring and quality control at the site were critical to accomplishing proper composting. During the composting cycle temperature and oxygen readings were taken daily at 48 locations within each compost pile. The temperature was monitored to ensure adequate pathogen destruction, and oxygen analyses were made to ensure adequate aeration.

Weekly compost samples were taken from internal pile locations. To obtain representative samples without major disturbance of the composting mixture, four access pipes were installed during pile construction. These access pipes were capped and covered by blanketing materials to reduce heat loss during the sampling procedure.

Compost piles were usually maintained at a minimum of 55°C for 4 weeks to ensure good breakdown of organic materials and adequate destruction of pathogens. Longer periods could be maintained if desired, and some remained for up to 7 weeks. Generally, active compost piles were maintained for a standing period of 4 weeks to ensure a pathogenically safe end product. Active composting was followed by a 3- to 6-month storage (curing) phase before using the product.

*Table 1. Raw Waste Characteristics*

| Parameter | Sanitary Toilet Waste | Septage Waste |
|---|---|---|
| BOD | 9,700* | 2,900 |
| COD | 33,000 | 15,000 |
| Total Coliforms (MPN/g) | 830 | 3,700 |
| Fecal Coliforms (MPN/g) | 810 | 1,600 |
| Salmonella, sp (neg. or pos.) | neg. | neg. |
| Total Solids (%) | 2.5 | 1 7 |
| Total Volatile Solids (% of Total Solids) | 53 | 59 |
| pH | 7.7-8.2 | 5.9-6 5 |
| Soluble Salts | 3,300 | 280 |
| Total Kjeldahl Nitrogen | 160,000 | 13,000 |
| Total Phosphorus | 4,500 | 3,000 |
| Total Potassium | 3,300 | 160 |
| Cadmium | 1 5 | 1.8 |
| Copper | 230 | 520 |
| Lead | 31 | 63 |
| Nickel | 7.3 | 12 |
| Zinc | 410† | 420 |

*All units are mg/l unless otherwise noted. All values are means from three compost piles.
†A zinc-based disinfectant was used in these toilets

*Table 2. Final Compost Characteristics*

| Parameter | Sanitary Toilet Compost | Septage Compost |
|---|---|---|
| Total Coliforms (MPN/g) | <3* | <3 |
| Fecal Colilforms (MPN/g) | <3 | <3 |
| Total Solids (%) | 54 | 51 |
| Total Volatile Solids (% of Total Solids) | 42 | 49 |
| pH | 5 8-7 4 | 6 3-7 4 |
| Soluble Salts | 1,600 | 880 |
| Total Kjeldahl Nitrogen | 11,000 | 6,900 |
| Ammonium | 880 | 120 |
| Total Phosphorus | 2,900 | 2,500 |
| Total Potassium | 2,700 | 2,100 |
| Cadmium | 3.0 | 2.5 |
| Copper | 50 | 91 |
| Lead | 73 | 59 |
| Nickel | 28 | 26 |
| Zinc | 220 | 190 |

*All units are μg/l unless otherwise noted. All values are means from three compost piles

## Results

The raw waste and final compost characteristics are presented in Tables 1 and 2, respectively. These data are means of measurements from three compost piles for each type of waste. The raw waste values are for the liquid waste as applied to the bulking material, and the final compost values are for the product of 8 weeks of composting.

Both wastes showed a wide range in the level of measured parameters' variability of the wastes as generated. The septage had generally lower levels for most of the measured parameters. However, the heavy metal content of the septage was higher, probably due to the use of household products containing heavy metals.

Samples taken from the sanitary toilet waste composting piles indicated that total coliform and fecal coliform levels dropped to less than 3/gram between the second and third week of composting for all pile locations. By the third sampling cycle, and throughout the additional samplings, organism counts remained at these low levels.

The first compost pile constructed (using only septage) did not perform as anticipated. Temperatures were generally lower and the oxygen percentages variable. The second and third piles functioned well with thicker insulation and longer aeration time.

Analyses of indicator organisms during septage composting indicated that when proper compost temperatures were achieved, the maximum level of total coliforms dropped to less than 3/gram between the second and third week of composting for all sample locations. Fecal coliform concentrations achieved desired levels by the second week. As was the case with sanitary toilet waste composting, counts for both total coliforms and fecal coliforms did not increase when the septage compost piles were taken down and moved to the storage pit.

Temperature monitoring showed the lowest temperature readings occurred within the blanket rather than within the active composting medium. Low temperatures were expected around the lower sections of the pile because of sloughing of the blanket materials and concentrated air movement around the pipe. The highest temperatures occurred at the top of the pile and in the central core. The compost temperature rose above 55°C within the first 5 days. When compost activity proceeded normally, temperatures ranged between 64° and 75°C for a lengthy period, ensuring a high degree of pathogen destruction. Temperatures in excess of 55°C have been maintained at the C&O Canal for 6 to 7 weeks.

Oxygen data showed composting proceeded well when the oxygen range was 5% to 15%; however, the preferred range was 8% to 10%.

## Costs

The cost of treating the waste material generated during the 1978 project period was about $0.60/gallon. This figure does not include land acquisition costs or the local retail value of the final compost product. When the value of the compost material was subtracted from the total cost, the net cost of treating the wastes was $0.20/gallon. Labor and equipment rental made up about two-thirds of the total costs.

## Conclusions

The aerated static pile composting system provided adequate treatment for septage and sanitary toilet pumpings. Within a 3-week period, the waste-organic mixture became compost, and after a short storage (curing) period, the compost became a valued organic soil amendment. The system had the following features: (1) little capital expenditure was required when compared with traditional mechanical systems; (2) no full-time onsite personnel were required; (3) a minimum of equipment was needed; (4) a high degree of waste stabilization was achieved with little or no release of any effluent; (5) the user was provided with a highly flexible and efficient waste recycling alternative that was easily adapted to remote sites, differing waste loading needs, and different organic wastes; (6) wastes could be treated as they accumulated or stored until treatment was needed; (7) the product contained low levels of coliform organisms; and (8) the compost contained low levels of many micro-nutrients and was an excellent organic soil amendment, which was used on disturbed soil areas.

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***Robert P. G. Bowker** was the EPA Project Officer (see below for present contact).*
*The complete report, entitled "Liquid Waste Composting," (Order No. PB 85-160 406/AS; Cost: $11.50, subject to change) will be available only from:*
*National Technical Information Service*
*5285 Port Royal Road*
*Springfield, VA 22161*
*Telephone: 703-487-4650*
*For further information **Donald S. Brown** can be contacted at:*
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