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The Manipulation of Household Wastewater

by

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THE MANIPULATION OF HOUSEHOLD WASTEWATER

By

Robert Siegrist[1] and Neil Hutzler[2]

While the search for improved methods of on-site disposal of household wastewater has centered largely around improving the soil absorption system, recently more emphasis has been placed on improving the quality of the effluent discharged to the soil. Higher quality effluents may enhance soil infiltration, reduce the dependence on soils for final disposal, or even eliminate the need for soil altogether. An obvious means of improving the effluent quality is to remove waste constituents at the source. This may be accomplished through waste segregation and/or flow reduction.

WASTE SEGREGATION

Over the past few years, the concept of segregating body wastes emanating from the toilet ("Black Wastes") from the other household wastewater ("Grey Waters"), and then handling and disposing of the two separately has drawn renewed attention. Serious questions have been raised by those planning development in water short areas and/or unsewered locations regarding the use of valuable drinking water to transport body wastes and the

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practice of co-mingling the black and grey waters prior to on-site treatment and disposal. Removing the black wastes from the other household wastewaters through the use of a non-water carriage toilet would conserve water resources and result in reduced quantities of flow and pollutants reaching the on-site disposal system. Although the daily savings can vary considerably at a given home and between homes, recent studies conducted by General Dynamics (1) and the University of Wisconsin Small Scale Waste Management Project (2, 4, 5) have revealed some possible reductions as shown in Table 1.

Table 1. Effect of Toilet Waste Segregation on Household Wastewater

Parameter	% Reduction[1]
Flow l/c/day	22 - 31% of total
BOD_5 mg/c/day	22 - 49 "
SS	36 - 67 "
TN	68 - 99 "

[1] Based on studies conducted by Cohen (1), Ligman (2), Siegrist (4), and Witt (5)

Note: Although not shown, there would also be substantial reductions in the quantities of pathogenic organisms.

The reductions could result in the increased life of an existing soil absorption field, but by what factor is not known for certain. For a new home, it might be possible to reduce the size of the proposed on-site system by some factor. However,

this could be dangerous since there is always the possibility that, at a later date, the waste segregation facilities might be abandoned, increasing the actual loadings to the system, possibly beyond that of its design capability and result in early failure.

To facilitate the segregation of the black wastes, many alternatives to the conventional flush toilet have been proposed. In a study conducted at McGill University (3), various types of non-water carriage toilets were reviewed and a comprehensive catalogue was compiled, listing the manufacturers of each type along with brief equipment descriptions. The pertinent characteristics of various alternatives as well as the conventional flush toilet are shown in Table 2.

The authors of the McGill study stated in their concluding remarks on non-water carriage toilets, that there was no simple system that offered a solution in every situation and, to date, the only truly low-cost system for low density settlements was the pit latrine.

A major problem associated with many of these alternatives which was not discussed in the McGill report should be emphasized. Namely, that although the alternative systems do segregate the black wastes, many of them do not provide for its treatment and/or final disposal. The homeowner may find himself responsible for its periodic disposal and if health hazards are to be prevented, safe disposal practices must be employed. Unfortunately, suitable, reliable methods for final disposal have not always been adequately outlined.

Table 2. Alternative Toilet Systems

TYPE	INITIAL COST	POWER REQ'D	CHEMICALS REQ'D	WATER REQ'D PER USE
Conventional Flush Toilet	appr. $125	No	No	15-23 liters
Pit Latrine	0 - $25	No	No	0-1
Chemical Toilet	25 - $100	No	Yes	0
Freeze Toilet	100 - $500	Yes	No	0
Packing Toilet	500 - $1000	Yes	No	0
Recirculating Chemical Toilet	100 - $500	Yes	Yes	0-1
Recirculating Fluid Toilet	appr. $3000	Yes	No	0
Incinerating Toilet	100 - $500	Yes	No	0
Compost Privy	100 - $500	Some	No	0

Note: All of the above data was taken from the McGill University report (3) except the data for the conventional flush toilet which was obtained from a local plumber.

Assuming the toilet waste can be segregated and adequately disposed of, attention must then be directed toward the disposal of the grey water. The grey water has been thought to be fairly uncontaminated, especially when compared to the black waste, and how or where it was disposed of wasn't of much concern. Recent studies, however, have shown that household grey water can contain substantial quantities of physical and chemical pollutants as well as pathogenic indicators. Tables 3 and 4 summarize the findings of recent studies conducted at the University of Wisconsin (4).

It should be noted that the wastewater contribution from the household garbage disposal was not included in the results shown in Table 3. It is felt that the use of a garbage disposal is not justifiable for a home employing on-site sewage disposal since it can contribute substantial quantities of pollutants which could be removed more effectively as solid wastes.

Table 3. Selected Chemical/Physical Characteristics of Household Grey and Black Water (Siegrist et al.)

Parameter	Grey Water	Black Water	Combined
Flow, L/Cap/D	116.6	34.8	151.4
BOD_5, mg/l	330	310	325
SS, mg/l	190	360	230
Nitrogen, mg/l	17	119	40
Phosphorus, mg/l	16	16	16

Note: The above are mean values and there is considerable variation about these means for a given home and between homes. The results shown do not include garbage disposal wastewater contributions.

For the homes studied, the grey water pollutant concentrations were in fact, similar to those of the black waste and the combined grey and black wastes. The black waste did contain higher concentrations of suspended solids, total nitrogen and bacteriological contamination. However, it is important to note that the grey water itself did contain sufficient quantities of pollutants and pathogenic indicators to cause concern for its adequate treatment and disposal.

Table 4. Bacteriological Characteristics of Laundry and Bath/Shower Wastewaters (Siegrist et al.)

Event	Organism	Data Pts.	Geometric Mean #/100 mls	Range #/100 mls
Bath/ Shower	Fecal Streptococci	13	44	1 - 70,000
	Fecal Coliforms	11	220	1 - 2,500
	Total Coliforms	10	1,100	70 - 8,200
Clothes Wash	Fecal Streptococci	15	210	1 - 1,300,000
	Fecal Coliforms	13	1,400	9 - 16,000
	Total Coliforms	12	18,000	85 - 890,000
Clothes Rinse	Fecal Streptococci	16	75	1 - 230,000
	Fecal Coliforms	14	320	35 - 7,100
	Total Coliforms	12	5,300	190 - 150,000

To date, there has been limited experience and research regarding the on-site treatment and disposal of household grey water. One obvious method of grey water treatment and disposal, and one which is most likely adequate, is the septic tank soil absorption system. However, simple alternative methods might exist which could be more desirable in certain applications. Some treatment methods might even allow surface discharge of the effluent. To enhance the sparse existing data base, the Small Scale Waste Management Project at the University of Wisconsin has recently undertaken an investigation which should provide valuable information on the treatment and disposal of household grey water as well as the general practice of waste segregation.

FLOW REDUCTION

Flow reduction is inherently a part of waste segregation since the water used for conventional toilet flushing is removed from the wastewater stream. However, flow reduction may also be accomplished without the use of waste segregation by reducing the amount of water used in various household events and/or recycling a portion of the wastewater produced. One of the most comprehensive studies performed to date was done by General Dynamics (1). They determined the flow reductions possible using several commercially available flow reducing devices by installing these devices at several homes and monitoring the water use before and after installation. Some of the results of their research may be found in Table 5.

Table 5. Water Savings Possible Through Flow Reduction (1)

DEVICE	AVERAGE WATER SAVING	
Wash water recycle for toilet flushing	44.0 LPCD	26% of total
Shallow trap toilet	14.8	6.9%
Dual flush toilet	12. - 20.	3.3 - 8.6%
Flow limiting shower head	2.7	1.0%

On the basis of this research, the maximum reasonable reduction of household wastewater flow using presently available devices would be approximately 25 - 30% with much of this savings

accomplished through the reduction of the toilet wastes. A reduction in flow could mean a dollar savings based on water use, and as discussed earlier, the extension of an old soil absorption field's life or the reduction in size of a new field. However, it should be noted that even with flow reducing devices installed, there is no guarantee that there will be any reduction in flow, much less the 25 - 30% maximum predicted. The residents of a household may take longer showers with a flow limiting shower head, flush the toilet twice instead of once with the low flush toilets, disconnect the wash-water recycle system and so on.

CONCLUSIONS

1. Segregating the black waste from the household wastewater can result in a substantial reduction in the flow and quantities of pollutants reaching the on-site disposal system and thereby benefit the system, possibly increasing its life or improving its efficiency.

2. The final disposal of the segregated toilet waste is cause for concern and suitable, reliable methods need to be outlined for each alternative toilet system and the home in question.

3. There is sufficient evidence to indicate that household grey water does contain substantial quantities of chemical and physical pollutants and also pathogenic indicators, and that if waste segregation is proposed, there must be provision for the adequate treatment and disposal of the grey waters as well as the toilet waste.

4. At the present time there is very little information available concerning on-site treatment and disposal methods for household grey water.

5. The maximum reasonable reduction in wastewater flow possible using currently available water saving devices is approximately 25 - 30% and any flow reduction is difficult to guarantee due to the uncontrollable human element.

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