

CHAPTER 5

WASTEWATER MODIFICATION

5.1 Introduction

The characteristics of the influent wastewater can have a major impact on most any onsite treatment and disposal/reuse system. To enhance conventional strategies, and to encourage new ones, methods can be used to modify the typical characteristics of the influent wastewater.

Methods for wastewater modification have been developed as part of three, basic interrelated strategies: water conservation and wastewater flow reduction, pollutant mass reduction, and onsite containment for offsite disposal. Each strategy attempts to reduce the flow volume or to decrease the mass of key pollutants such as oxygen-demanding substances, suspended solids, nutrients, and pathogenic organisms in the influent wastewater to the onsite disposal system.

Although the primary thrust of this chapter is directed toward residential dwellings, many of the concepts and techniques presented have equal or even greater application to nonresidential establishments. Good practice dictates that water conservation/flow reduction be employed to the maximum extent possible in a dwelling served by an onsite wastewater system.

At the onset, there are several general considerations regarding wastewater modification. First, there are a number of methods available, including a wide variety of devices, fixtures, appliances, and systems. Further, the number of methods and the diversity of their characteristics is ever growing. In many cases, the methods involve equipment manufactured by one or more companies as proprietary products. In this chapter, only generic types of these products are considered. Also, many methods and system components are presently in various stages of development and/or application; therefore, only preliminary or projected operation and performance information may be available. Finally, the characteristics of many of the methods discussed may result in their nonconformance with existing local plumbing codes.

5.2 Water Conservation and Wastewater Flow Reduction

An extensive array of techniques and devices are available to reduce the average water use and concomitant wastewater flows generated by individual water-using activities and, in turn, the total effluent from the residence or establishment. The diversity of present wastewater flow reduction methods is illustrated in Table 5-1. As shown, the methods may be divided into three major groups: (1) elimination of nonfunctional water use, (2) water-saving devices, fixtures, and appliances; and (3) wastewater recycle/reuse systems.

5.2.1 Elimination of Nonfunctional Water Use

Wasteful water use habits can occur with most water-using activities. A few illustrative examples include using a toilet flush to dispose of a cigarette butt, allowing the water to run while brushing teeth or shaving, or operating a clotheswasher or dishwasher with only a partial load. Obviously, the potential for wastewater flow reductions through elimination of these types of wasteful use vary tremendously between homes, from minor to significant reductions, depending on existing habits.

5.2.1.1 Improved Plumbing and Appliance Maintenance

Unseen or apparently insignificant leaks from household fixtures and appliances can waste large volumes of water and generate similar quantities of wastewater. Most notable in this regard are leaking toilets and dripping faucets. For example, a steadily dripping faucet can waste up to several hundred gallons per day.

5.2.1.2 Maintain Nonexcessive Water Supply Pressure

The water flow rate through sink and basin faucets, showerheads, and similar fixtures is highly dependent on the water pressure in the water supply line. For most residential uses, a pressure of 40 psi (2.8 kg/cm²) is adequate. Pressure in excess of this can result in unnecessary water use and wastewater generation. To illustrate, the flow rate through a typical faucet opened fully is about 40% higher at a supply pressure of 80 psi (5.6 kg/cm²) versus that at 40 psi (2.8 kg/cm²).

TABLE 5-1

EXAMPLE WASTEWATER FLOW REDUCTION METHODS

- I. Elimination of Nonfunctional Water Use
 - A. Improved water use habits
 - B. Improved plumbing and appliance maintenance
 - C. Nonexcessive water supply pressure

- II. Water-Saving Devices, Fixtures, and Appliances
 - A. Toilet
 - 1. Water carriage toilets
 - a. Toilet tank inserts
 - b. Dual-flush toilets
 - c. Water-saving toilets
 - d. Very low-volume flush toilets
 - (1) Wash-down flush
 - (2) Mechanically assisted
 - o Pressurized tank
 - o Compressed air
 - o Vacuum
 - o Grinder
 - 2. Non-water carriage toilets
 - a. Pit privies
 - b. Composting toilets
 - c. Incinerator toilets
 - d. Oil-carriage toilets
 - B. Bathing devices, fixtures, and appliances
 - 1. Shower flow controls
 - 2. Reduced-flow showerheads
 - 3. On/Off showerhead valves
 - 4. Mixing valves
 - 5. Air-assisted low-flow shower system
 - C. Clotheswashing devices, fixtures, and appliances
 - 1. Front-loading washer
 - 2. Adjustable cycle settings
 - 3. Washwater recycle feature
 - D. Miscellaneous
 - 1. Faucet inserts
 - 2. Faucet aerators
 - 3. Reduced-flow faucet fixtures
 - 4. Mixing valves
 - 5. Hot water pipe insulation
 - 6. Pressure-reducing valves

- III. Wastewater Recycle/Reuse Systems
 - A. Bath/Laundry wastewater recycle for toilet flushing
 - B. Toilet wastewater recycle for toilet flushing
 - C. Combined wastewater recycle for toilet flushing
 - D. Combined wastewater recycle for several uses

5.2.2 Water-Saving Devices, Fixtures, and Appliances

The quantity of water traditionally used by a given water-using fixture or appliance is often considerably greater than actually needed. Certain tasks may even be accomplished without the use of water. As presented in Table 4-2, over 70% of a typical residential dwelling's wastewater flow volume is collectively generated by toilet flushing, bathing, and clotheswashing. Thus, efforts to accomplish major wastewater flow reductions should be directed toward these three activities.

5.2.2.1 Toilet Devices and Systems

Each flush of a conventional water-carriage toilet uses between 4 and 7 gal (15 and 26 l) of water depending on the model and water supply pressure. On the average, a typical flush generates approximately 4.3 gal (16 l) of wastewater. When coupled with 3.5 uses/cap/day, a daily wastewater flow of approximately 16 gpcd (61 lpcd) results (Table 4-2).

A variety of devices have been developed for use with a conventional flush toilet to reduce the volume of water used in flushing. Additionally, alternatives to the conventional water-carriage toilet are available, certain of which use little or no water to transport human wastewater products. Tables 5-2 and 5-3 present a summary of a variety of toilet devices and systems. Additional details regarding the non-water carriage toilets may be found elsewhere (1)(2)(3)(4)(5).

5.2.2.2 Bathing Devices and Systems

Although great variation exists in the quantity of wastewater generated by a bath or shower, typical values include approximately 25 gal (95 l) per occurrence coupled with a 0.4 use/capita/day frequency to yield a daily per capita flow of about 10 gal (38 l) (Table 4-2). The majority of devices available to reduce bathing wastewater flow volumes are concentrated around the activity of showering, with their objective being to reduce normal 4- to 10-gal/min (0.25 to 0.63 l/sec) showering flow rate. Several flow reduction devices and systems for showering are characterized in Table 5-4. The amount of total wastewater flow reduction accomplished with these devices is highly dependent on individual user habits. Reductions vary from a negative value to as much as 12% of the total wastewater volume.

TABLE 5-2

WASTEWATER FLOW REDUCTION - WATER CARRIAGE TOILETS AND SYSTEMS

<u>Generic Type</u>	<u>Description</u>	<u>Develop- ment Stage^a</u>	<u>Application Considerations</u>	<u>Operation and Maintenance</u>	<u>Water Use Per Event gal</u>	<u>Total Flow Reduction^b</u>	
						<u>gpcd</u>	<u>%</u>
Toilet with Tank Inserts	Displacement devices placed into storage tank of conventional toilets to reduce volume but not height of stored water. Varieties: Plastic bottles, flexible panels, drums or plastic bags.	4-5	Device must be compatible with existing toilet and not interfere with flush mechanism. Installation by owner.	Post-installation and periodic inspections to insure proper positioning.	3.3-3.8	1.8-3.5	4-8
74 Dual Flush Toilets	Devices made for use with conventional flush toilets; enable user to select from two or more flush volumes based on solid or liquid waste materials. Varieties: Many	3	Device must be compatible with existing toilet and not interfere with flush mechanism. Installation by owner.	Post-installation and periodic inspections to insure proper positioning and functioning.	2.5-4.3	3.0-7.0	6-15
Water-Saving Toilets	Variation of conventional flush toilet fixture; similar in appearance and operation. Redesigned flushing rim and priming jet to initiate siphon flush in smaller trapway with less water. Varieties: Many manufacturers but units similar.	5	Interchangeable with conventional fixture. Requires pressurized water supply.	Essentially the same as for a conventional unit.	3.0-3.5	2.8-4.6	6-10

TABLE 5-2 (continued)

<u>Generic Type</u>	<u>Description</u>	<u>Develop- ment Stage^a</u>	<u>Application Considerations</u>	<u>Operation and Maintenance</u>	<u>Total Flow Reduction^b</u>	
					<u>Water Use Per Event gal</u>	<u>gpcd</u> <u>%</u>
Washdown Flush Toilets	Flushing uses only water, but substantially less due to washdown flush. Varieties: Few.	3-4	Rough-in for unit may be nonstandard. Drain line slope and lateral run restrictions. Requires pressurized water supply.	Similar to conventional toilet, but more frequent cleaning possible.	0.8-1.6	9.4-12.2 21-27
75 Pressurized Tank	Specially designed toilet tank to pressurize air contained in toilet tank. Upon flushing, the compressed air propels water into bowl at increased velocity. Varieties: Few.	3	Compatible with most any conventional toilet unit. Increased noise level. Water supply pressure of 35 to 120 psi.	Similar to conventional toilet fixture.	2.0-2.5	6.3-8.0 14-18
Compressed Air-Assisted Flush Toilets	Similar in appearance and user operation to conventional toilet; specially designed to utilize compressed air to aid in flushing. Varieties: Few	3-4	Interchangeable with rough-in for conventional fixture. Requires source of compressed air; bottled or air compressor. If air compressor, need power source.	Periodic maintenance of compressed air source. Power use - 0.002 kWh per use.	0.5	13.3 30

TABLE 5-2 (continued)

<u>Generic Type</u>	<u>Description</u>	<u>Develop- ment Stage^a</u>	<u>Application Considerations</u>	<u>Operation and Maintenance</u>	<u>Water Use Per Event</u> gal	<u>Total Flow Reduction^b</u>	
						gpcd	%
Vacuum- Assisted Flush Toilets	Similar in appearance and user operation to conventional toilet; specially designed fixture is connected to vacuum system which assists a small volume of water in flushing. Varieties: Several.	3	Application largely for multi-unit toilet installations Above floor, rear discharge. Drain pipe may be horizontal or inclined. Requires vacuum pump. Requires power source.	Periodic maintenance of vacuum pump. Power use = 0.002 Kwh per use.	0.3	14	31

^a 1 = Prototype developed and under evaluation.

2 = Development complete, commercial production initiated, not locally available.

3 = Fully developed, limited use, not locally available, mail order purchase likely.

4 = Fully developed, limited use, locally available from plumbing supply houses or hardware stores.

5 = Fully developed, widespread use, locally available from plumbing supply houses or hardware stores.

^b Compared to conventional toilet usage (4.3 gal/flush, 3.5 uses/cap/day, and a total daily flow of 45 gpcd)

TABLE 5-3

WASTEWATER FLOW REDUCTION - NON-WATER CARRIAGE TOILETS

<u>Generic Type^a</u>	<u>Description</u>	<u>Develop- ment Stage^b</u>	<u>Application Considerations</u>	<u>Operation and Maintenance</u>
Pit Privy	Hand-dug hole in the ground covered with a squatting plate or stool/seat with an enclosing house. May be sealed vault rather than dug hole.	4	Requires same site conditions as for wastewater disposal (see Chapter 8), unless sealed vault. Handles only toilet wastes Outdoor installation. May be constructed by user.	When full, cover with 2 ft of soil and construct new pit.
Composting Privy	Similar to pit privy except organic matter is added after each use. When pit is full it is allowed to compost for a period of about 12 months prior to removal and use as soil amendment.	4	Can be constructed independent of site conditions if sealed vault. Handles only toilet waste and garbage. May be constructed by user. Outdoor installation. Residuals disposal.	Addition of organic matter after each use. Removal and disposal/reuse of composted material.
Composting-Small	Small self-contained units accept toilet wastes only and utilize the addition of heat in combination with aerobic biological activity to stabilize human excreta. Varieties: Several.	3-4	Installation requires 4-in. diameter roof vent. Handles only toilet waste. Set usage capacity. Power required. Residuals disposal.	Removal and disposal of composted material quarterly. Power use = 2.5 KWH/day. Heat loss through vent.
Composting-Large	Larger units with a separated decomposition chamber. Accept toilet wastes and other organic matter, and over a long time period stabilize excreta through biological activity. Varieties: Several	3-4	Installation requires 6- to 12-in. diameter roof vent and space beneath floor for decomposition chamber. Handles toilet waste and some kitchen waste. Set usage capacity. May be difficult to retrofit. Residuals disposal.	Periodic addition of organic matter. Removal of composted material at 6 to 24 month intervals. Power use = 0.3 to 1.2 KWH/day. Heat loss through vent.

TABLE 5-3 (continued)

<u>Generic Type^a</u>	<u>Description</u>	<u>Develop- ment Stage^b</u>	<u>Application Considerations</u>	<u>Operation and Maintenance</u>
Incinerator	Small self-contained units which volatilize the organic components of human waste and evaporate the liquids. Varieties: Several.	3	Installation requires 4-in. diameter roof vent. Handles only toilet waste. Power or fuel required. Increased noise level. Residuals disposal.	Weekly removal of ash. Semiannual cleaning and adjustment of burning assembly and/or heating elements. Power use = 1.2 kWh or 0.3 lb LP gas per use.
Oil Recycle	Systems use a mineral oil to transport human excreta from a fixture (similar in appearance and use to conventional) to a storage tank. Oil is purified and reused for flushing. Varieties: few.	2	Requires separate plumbing for toilet fixture. May be difficult to retrofit. Handles only toilet wastes Residuals disposal.	Yearly removal and disposal of excreta in storage tank. Yearly maintenance of oil purification system by skilled technician. Power use = 0.01 kWh/use.

^a None of these devices uses any water; therefore, the amount of flow reduction is equal to the amount of conventional toilet use: 16.2 gpcd or 36% of normal daily flow (45 gpcd). Significant quantities of pollutants (including N, BOD₅, SS, P and pathogens) are therefore removed from wastewater stream.

^b 1 = Prototype developed and under evaluation.
 2 = Development complete; commercial production initiated, but distribution may be restricted; mail order purchase.
 3 = Fully developed; limited use, not locally available; mail order purchase likely.
 4 = Fully developed; limited use, available from local plumbing supply houses or hardware stores.
 5 = Fully developed; widespread use, available from local plumbing supply houses or hardware stores.

TABLE 5-4

WASTEWATER FLOW REDUCTION - BATHING DEVICES AND SYSTEMS

<u>Generic Type^a</u>	<u>Description</u>	<u>Develop- ment Stage^b</u>	<u>Application Considerations</u>	<u>Water Use gal/min</u>
Shower Flow Control Inserts and Restrictors	Reduce flow rate by reducing the diameter of supply line ahead of shower head. Varieties: Many.	4	Compatible with most existing showerheads. Installed by user.	1.5-3.0
Reduced-Flow Showerheads	Fixtures similar to conventional, except restrict flow rate. Varieties: Many manufacturers, but units similar.	4-5	Can match to most plumbing fixture appearance schemes. Compatible with most conventional plumbing.	1.5-3.0
ON/OFF Showerhead Valve	Small valve device placed in the supply line ahead of showerhead, allows shower flow to be turned ON/OFF without readjustment of volume or temperature.	4	Compatible with most conventional plumbing and fixtures. May be installed by user.	---
Thermostatically Controlled Mixing Valve	Specifically designed valve controls temperature of total flow according to predetermined setting. Valve may be turned ON/OFF without readjustment.	3	May be difficult to retrofit.	---

TABLE 5-4 (continued)

<u>Generic Type^a</u>	<u>Description</u>	<u>Develop- ment Stage^b</u>	<u>Application Considerations</u>	<u>Water Use gal/min</u>
Pressure- Balanced Mixing Valve	Specifically designed valve maintains constant temperature of total flow regardless of pressure changes. Single control allows temperature to be preset.	4	Compatible with most conventional plumbing and fixtures.	---
Air-Assisted Low-Flow Shower System	Specifically designed system uses compressed air to atomize water flow and provide shower sensation.	2	May be impossible to retrofit. Shower location < 50 feet of water heater. Requires compressed air source. Power source required. Maintenance of air compressor. Power use = 0.01 Kwh/use.	0.5

^a No reduction in pollutant mass; slight increase in pollutant concentration.

- ^b 1 = Prototype developed and under evaluation.
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 4 = Fully developed; limited use, available from local plumbing supply houses or hardware stores.
 5 = Fully developed; widespread use, available from local plumbing supply houses or hardware stores.

5.2.2.3 Clotheswashing Devices and Systems

The operation of conventional clotheswashers consumes varying quantities of water depending on the manufacturer and model of the washer and the cycle selected. For most, water usage is 23 to 53 gal (87 to 201 l) per usage. Based on home water use monitoring, an average water use/wastewater flow volume of approximately 37 gal (140 l) per use has been identified, with the clotheswasher contributing about 10.0 gpcd (38 lpcd) or 22% of the total daily water use/wastewater flow (Table 4-2). Practical methods to reduce these quantities are somewhat limited. Eliminating wasteful water use habits, such as washing with only a partial load, is one method. Front-loading model automatic washers can reduce water used for a comparable load of clothes by up to 40%. In addition, wastewater flow reductions may be accomplished through use of a clotheswasher with either adjustable cycle settings for various load sizes or a wash water recycle feature.

The wash water recycle feature is included as an optional cycle setting on several commercially made washers. Selection of the recycle feature when washing provides for storage of the wash water from the wash cycle in a nearby laundry sink or a reservoir in the bottom of the machine, for subsequent use as the wash water for the next load. The rinse cycles remain unchanged. Since the wash cycle comprises about 45% of the total water use per operation, if the wash water is recycled once, about 17 gal (64 l) will be saved, if twice, 34 gal (129 l), and so forth. Actual water savings and wastewater flow reductions are highly dependent on the user's cycle selection.

5.2.2.4 Miscellaneous Devices and Systems

There are a number of additional devices, fixtures, and appliances available to help reduce wastewater flow volumes. These are directed primarily toward reducing the water flow rate through sink and basin faucets. Table 5-5 presents a summary of several of these additional flow reduction devices. Experience with these devices indicates that wastewater volume can be reduced by 1 to 2 gpcd (4 to 8 lpcd) when used for all sink and basin faucets.

5.2.3 Wastewater Recycle and Reuse Systems

Wastewater recycle and reuse systems collect and process the entire wastewater flow or the fractions produced by certain activities with storage for subsequent reuse. The performance requirements of any wastewater recycle system are established by the intended reuse activities. To simplify the performance requirements, most recycle

TABLE 5-5

WASTEWATER FLOW REDUCTION - MISCELLANEOUS DEVICES AND SYSTEMS

<u>Generic Type^a</u>	<u>Description</u>	<u>Develop- ment Stage^b</u>	<u>Application Considerations</u>
Faucet Inserts	Device which inserts into faucet valve or supply line and restricts flow rate with a fixed or pressure compensating orifice. Varieties: Many.	4	Compatible with most plumbing. Installation simple.
Faucet Aerators	Devices attached to faucet outlet which entrain air into water flow. Varieties: Many.	5	Compatible with most plumbing. Installation simple. Periodic cleaning of aerator screens.
Reduced-Flow Faucet Fixtures	Similar to conventional unit, but restrict flow rate with a fixed or pressure compensating orifice. Varieties: Many.	4	Compatible with most plumbing. Installation identical to conventional.

TABLE 5-5 (continued)

<u>Generic Type^a</u>	<u>Description</u>	<u>Development Stage^b</u>	<u>Application Considerations</u>
Mixing Valves	Specifically designed valve units which allow flow and temperature to be set with a single control. Varieties: Many.	5	Compatible with most plumbing. Installation identical to conventional.
Hot Water Pipe Insulation	Hot water piping is wrapped with insulation to reduce heat loss from hot water standing in pipe between uses. Varieties: Many.	4	May be difficult to retrofit.

^a No reduction in pollutant mass; insignificant increase in pollutant concentration.

- ^b
- 1 = Prototypes developed and under evaluation.
 - 2 = Development complete; commercial production initiated, but distribution restricted.
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systems process only the wastewaters discharged from bathing, laundry, and bathroom sink usage, and restrict the use of the recycled water to flushing water-carriage toilets and possibly lawn irrigation. At the other extreme, systems are under development that process the entire wastewater flow and recycle it as a potable water source.

The flow sheets proposed for residential recycle systems are numerous and varied, and typically employ various combinations of the unit processes described in Chapter 6, complemented by specially designed control networks. In Table 5-6, several generic units are characterized according to their general recycle flow sheet.

5.3 Pollutant Mass Reduction

A second strategy for wastewater modification is directed toward decreasing the mass of potential pollutants at the source. This may involve the complete elimination of the pollutant mass contributed by a given activity or the isolation of the pollutant mass in a concentrated wastewater stream. In Table 5-7, several methods for pollutant mass reduction are outlined.

5.3.1 Improved User Habits

Unnecessary quantities of many pollutants enter the wastewater stream when materials, which could be readily disposed of in a solid waste form, are added to the wastewater stream. A few examples include flushing disposable diapers or sanitary napkins down the toilet, or using hot water and detergents to remove quantities of solidified grease and food debris from pots and pans to enable their discharge down the sink drain.

5.3.2 Cleaning Agent Selection

The use of certain cleansing agents can contribute significant quantities of pollutants. In particular, cleaning activities, such as clotheswashing and dishwashing, can account for over 70% of the phosphorus in residential wastewater (Table 4-4). Detergents are readily available that contain a low amount of phosphorus compared to other detergents.

TABLE 5-6

WASTEWATER FLOW REDUCTION - WASTEWATER RECYCLE AND REUSE SYSTEMS

<u>Flow Sheet Description</u>	<u>Develop- ment Stage^a</u>	<u>Application Considerations</u>	<u>Operation and Maintenance</u>	<u>Total Flow Reduction^b</u>		<u>Wastewater Quality Impacts</u>
				gpcd	%	
Recycle bath and laundry for toilet flushing	2	Requires separate toilet supply and drain line. May be difficult to retrofit to multi-story building. Requires wastewater disposal system for toilet and kitchen sink wastes.	Periodic replenishment of chemicals, cleaning of filters and storage tanks. Residuals disposal. Power use.	16	36	Sizeable removals of pollutants, primarily P.
Recycle portion of total wastewater stream for toilet flushing	3	Requires separate toilet supply line. May be difficult to retrofit to multi-story building. Requires disposal system for unused recycle water.	Cleaning/replacement of filters and other treatment and storage components. Residuals disposal. Periodic replenishment of chemicals.	16	36	Significant removals of pollutants.

TABLE 5-6 (continued)

Flow Sheet Description	Development Stage ^a	Application Considerations	Operation and Maintenance	Total Flow Reduction ^b		Wastewater Quality Impacts
				gpcd	%	
Recycle toilet wastewaters for flushing water carriage toilets	4	Requires separate toilet plumbing network. Utilizes low-flush toilets. Requires system for nontilet wastewaters. May be difficult to retrofit. Application restricted to high use on multi-unit installations.	Cleaning/replacement of filters and other treatment components. Residuals disposal. Power use.	16	36	Significant removals of pollutants.
Recycle total wastewater stream for all water uses	1-2	Requires major variance from State/local health codes for potable reuse. Difficult to retrofit.	All maintenance by skilled personnel. Routine service check. Periodic pump out and residuals disposal. Power use. Comprehensive monitoring program required.	45	100	No wastewater generated for onsite disposal.

86

^a 1 = Prototype developed and under evaluation.
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^b Based on the normal waste flow information presented in Table 4-2.

TABLE 5-7
EXAMPLE POLLUTANT MASS REDUCTION METHODS

- I. Improved User Habits
- II. Cleaning Agent Selection
- III. Elimination of Garbage Disposal Appliance
- IV. Segregated Toilet Systems
 - A. Non-Water Carriage Toilets
 - B. Very Low-Volume Flush Toilets/Holding Tank
 - C. Closed Loop Wastewater Recycle Systems

5.3.3 Elimination of the Garbage Disposal Appliance

The use of a garbage disposal contributes substantial quantities of BOD₅ and suspended solids to the wastewater load (Table 4-4). As a result, it has been shown that the use of a garbage disposal may increase the rate of sludge and scum accumulation and produce a higher failure rate for conventional disposal systems under otherwise comparable conditions (6). For these reasons, as well as the fact that most waste handled by a garbage disposal could be handled as solid wastes, the elimination of this appliance is advisable.

5.3.4 Segregated Toilet Systems

Several toilet systems can be used to provide for segregation and separate handling of human excreta (often referred to as blackwater) and, in some cases, garbage wastes. Removal of human excreta from the wastewater stream serves to eliminate significant quantities of pollutants, particularly suspended solids, nitrogen, and pathogenic organisms (Table 4-4).

A number of potential strategies for management of segregated human excreta are presented in Figure 5-1. A discussion of the toilet systems themselves is presented in the wastewater flow reduction section of this chapter, while details regarding the other unit processes in the flow sheet may be found in Chapter 6.

Wastewaters generated by fixtures other than toilets are often referred to collectively as "graywater." Characterization studies have demonstrated that typical graywater contains appreciable quantities of organic matter, suspended solids, phosphorus and grease in a daily flow volume of 29 gpcd (110 lpcd) (7)(8)(9)(10)(11)(12)(13)(14)(15) (see Table 4-4). Its temperature as it leaves the residence is in the range of 31° C, with a pH slightly on the alkaline side. The organic materials in graywater appear to degrade at a rate not significantly different from those in combined residential wastewater (15). Microbiological studies have demonstrated that significant concentrations of indicator organisms as total and fecal coliforms are typically found in graywater (7)(11)(12)(13)(14)(15). One should assume, therefore, that graywater harbors pathogens.

Although residential graywater does contain pollutants and must be properly managed, graywater may be simpler to manage than total residential wastewater due to a reduced flow volume. While diverse strategies have been proposed for graywater management (Figure 5-2), rigorous field evaluations have not been conducted in most cases. Until further field data become available, it is recommended that graywater treatment and disposal/reuse systems be designed as for typical residential wastewater (as described in Chapter 6). Design allowances should be made only for the reductions in flow volume, as compared to typical residential wastewater.

5.4 Onsite Containment - Holding Tanks

Wastewaters may be contained on site using holding tanks, and then transported off site for subsequent treatment and disposal. In many respects, the design, installation, and operation of a holding tank is similar to that for a septic tank (as described in Chapter 6). Several additional considerations do exist, as indicated in Table 5-8. A discussion regarding the disposal of the pumpage from holding tanks is presented in Chapter 9 of this manual.

5.5 Reliability

An important aspect of wastewater modification concerns the reliability of a given method to yield a projected modification at a specific dwelling or establishment over the long term. This is of particular importance when designing an onsite wastewater disposal system based on modified wastewater characteristics.

FIGURE 5-1

EXAMPLE STRATEGIES FOR MANAGEMENT OF SEGREGATED HUMAN WASTES

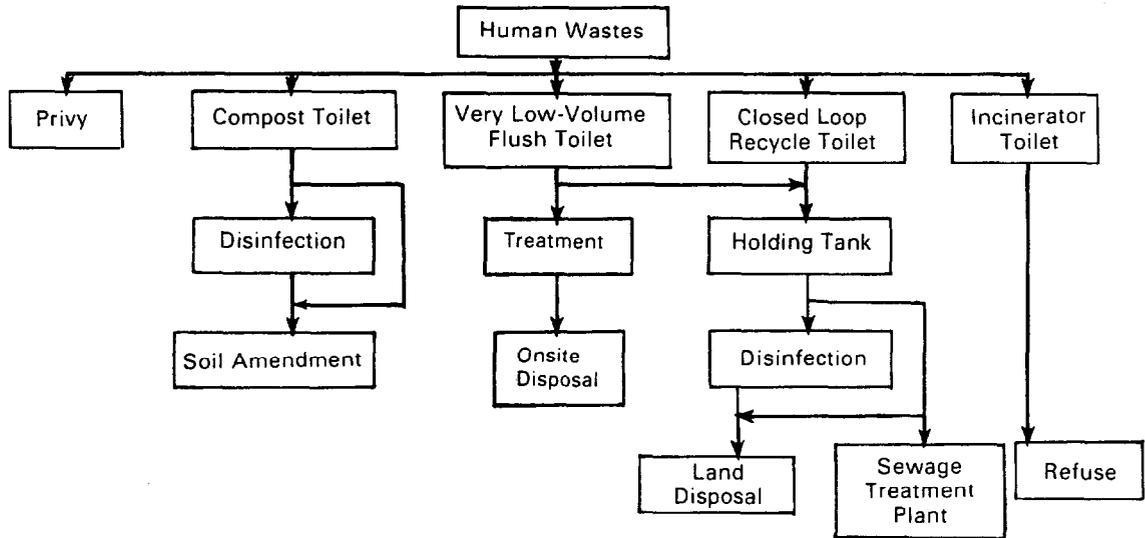


FIGURE 5-2

EXAMPLE STRATEGIES FOR MANAGEMENT OF RESIDENTIAL GRAYWATER

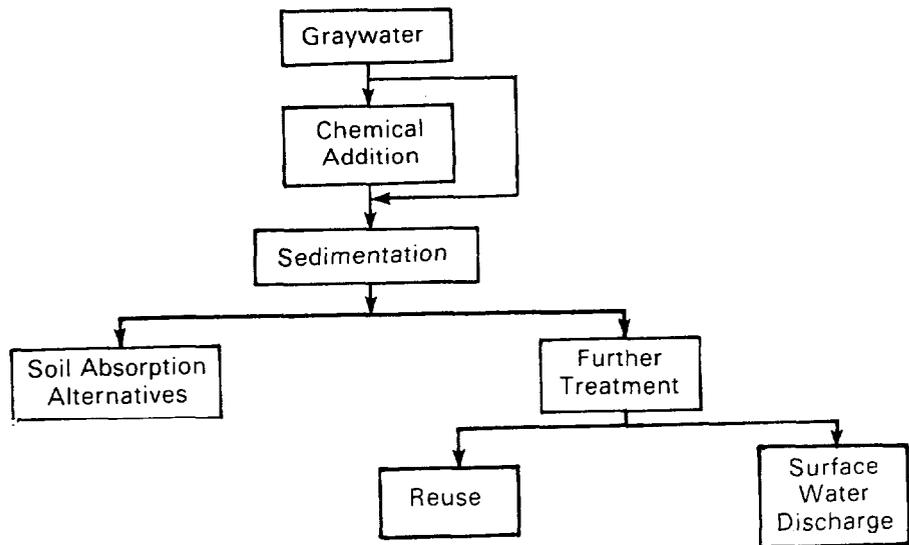


TABLE 5-8

ADDITIONAL CONSIDERATIONS IN THE DESIGN,
INSTALLATION, AND OPERATION OF HOLDING TANKS

<u>Item</u>	<u>Consideration</u>
Sizing	Liquid holding capacity >7 days wastewater flow generation. Minimum capacity = 1,000 gallons.
Discharge	There should be no discharge.
Alarm System	High water alarm positioned to allow at least 3 days storage after activation.
Accessibility	Frequent pumping is likely; therefore holding tank(s) must be readily accessible to pumping vehicle.
Flotation	Large tanks may be subject to severe flotation forces in high groundwater areas when pumped.
Cost	Frequent pumping and residuals disposal results in very high operating costs.

Assessing the reliability of wastewater modification methods is a complex task which includes considerations of a technological, sociological, economic, and institutional nature. Major factors affecting reliability include:

1. The actual wastewater characteristics prior to modification compared to the average.
2. User awareness and influence on method performance.
3. Installation.
4. Method performance.
5. User circumvention or removal.

In most situations, projections of the impact of a wastewater modification method must necessarily be made, assuming the wastewater characteristics prior to modification are reasonably typical. If the actual wastewater characteristics deviate significantly from that of the average, a projected modification may be inaccurate.

The prospective user should be fully aware of the characteristics of a method considered for use prior to its application. Users who become aware of the characteristics of a method only after it has been put into use are more likely to be dissatisfied and attempt to circumvent or otherwise alter the method and negate the wastewater modification expected.

In general, passive wastewater modification methods or devices not significantly affected by user habits tend to be more reliable than those which are subject to user habits and require a preconceived active role by the users. For example, a low-flush toilet is a passive device, while a flow-reducing shower head is an active one.

Installation of any devices or systems should be made by qualified personnel. In many situations, a post-installation inspection is recommended to ensure proper functioning of the device or system.

Method performance is extremely important in assessing the reliability of the projected modification. Accurate performance data are necessary to estimate the magnitude of the reduction, and to predict the likelihood that the method will receive long-term user acceptance. Accurate performance data can only be obtained through the results of field testing and evaluations. Since many methods and system components are presently in various stages of development, only preliminary or projected operation and performance data may be available. This preliminary or projected data should be considered cautiously.

The continued employment of a wastewater modification method can be encouraged through several management actions. First, the user(s) should be made fully aware of the potential consequences if they should discontinue employing the modification method (e.g., system failure, water pollution, rejuvenation costs, etc.). Also, the appropriate management authority can approve only those methods whose characteristics and merits indicate a potential for long-term user acceptance. Further, installation of a device or system can be made in such a manner as to discourage disconnection or replacement. Finally, periodic inspections by a local inspector within the framework of a sanitary district or the like may serve to identify plumbing alterations; corrective orders could then be issued.

To help ensure that a projected modification will actually be realized at a given site, efforts can be expended to accomplish the following tasks:

1. Confirm that the actual wastewater characteristics prior to modification are typical.
2. Make the prospective user(s) of the modification method fully aware of the characteristics of the method, including its operation, maintenance, and costs.
3. Determine if the projected performance of a given method has been confirmed through actual field evaluations.
4. Ensure that any devices or systems are installed properly by competent personnel.
5. Prevent user removal or circumvention of devices, systems, or methods.

5.6 Impacts on Onsite Treatment and Disposal Practices

5.6.1 Modified Wastewater Characteristics

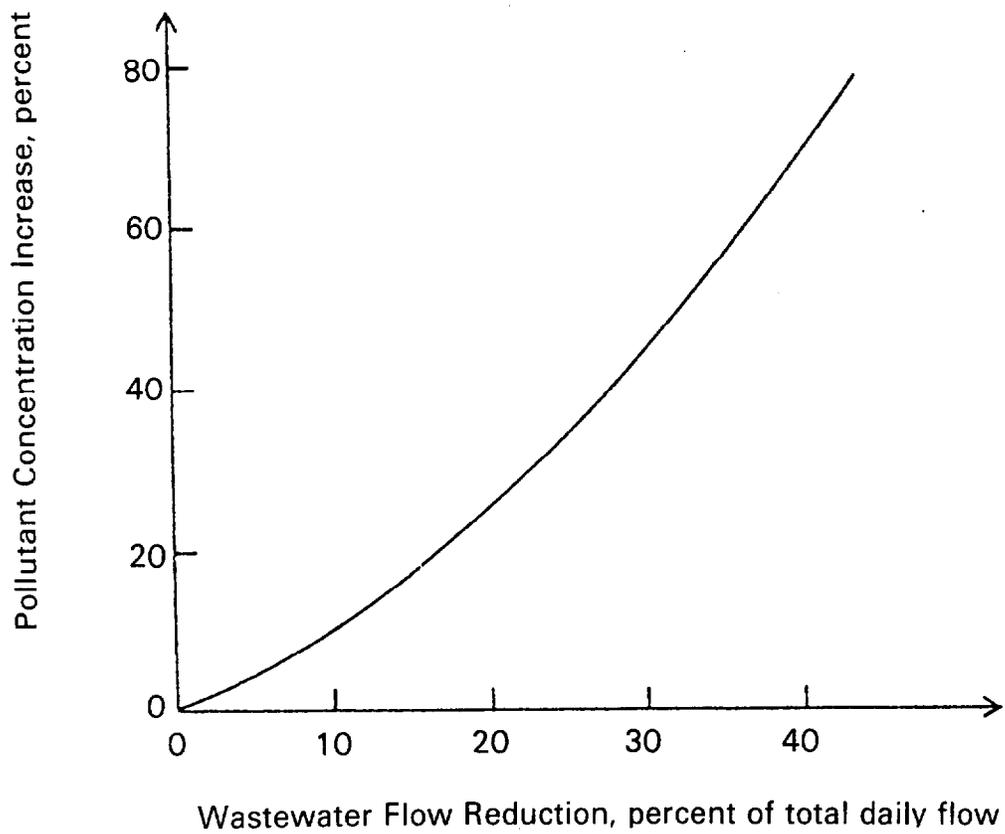
Reducing the household wastewater flow volume without reducing the mass of pollutants contributed will increase the concentration of pollutants in the wastewater stream. The increase in concentrations will likely be insignificant for most flow reduction devices with the exception of those producing flow reductions of 20% or more. The increase in pollutant concentrations in any case may be estimated utilizing Figure 5-3.

5.6.2 Wastewater Treatment and Disposal Practices

In Table 5-9, a brief summary of several potential impacts that wastewater modification may have on onsite disposal practices is presented. It must be emphasized that the benefits derived from wastewater modification are potentially significant. Wastewater modification methods, particularly wastewater flow reduction, should be considered an integral part of any onsite wastewater disposal system.

FIGURE 5-3

FLOW REDUCTION EFFECTS ON POLLUTANT CONCENTRATIONS



(Assumes Pollutant Contributions the Same Under the Reduced Flow Volume)

TABLE 5-9

POTENTIAL IMPACTS OF WASTEWATER MODIFICATION
ON ONSITE DISPOSAL PRACTICES

<u>Disposal System Type</u>	<u>Modification Practice</u>		<u>Potential Impact</u>
	<u>Flow Reduction</u>	<u>Pollutant Reduction</u>	
All Disposal	X	X	May extend service life of functioning system, but cannot quantify.
		X	Reduce water resource contamination.
		X	Simplify site constraints.
		X	Reduce frequency of septic tank pumping.
		X	Reduce sizing of infiltrative area.
		X	Remedy hydraulically overloaded system.
Surface Disposal	X	X	Reduce component O and M costs.
	X	X	Reduce sizing of components.
		X	Eliminate need for certain components (e.g., nitrogen removal).
		X	Remedy hydraulically overloaded system.
Evapotranspiration	X		Remedy a hydraulically overloaded system.
	X		Reduce sizing of ET area.
Onsite Containment	X		Reduce frequency of pumping.
	X		Reduce sizing of containment basin.

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