Household Water Conservation

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College of Agricultural Sciences • Agricultural Research and Cooperative Extension

Foreword

We want to give you the latest information on water-efficient plumbing fixtures and appliances for home water conservation. We will give you a glimpse at this equipment and illustrate how important conservation is in reducing water and energy use and wasteflows to sewage treatment plants and septic systems. Household water and energy conservation are inescapably linked: by saving water we preserve the energy needed to get it into our homes and treat it. By reducing our use of hot water we will save even more: the energy consumed in heating water ranks second behind that used for home heating and cooling. Energy conservation also helps alleviate major environmental problems such as global warming and acid rain. Although we use water more efficiently then we did a few years ago, much more can be done. This publication details water conservation methods that require little effort while producing significant results.

Household Water Conservation

Water, Water, Everywhere?

Pennsylvania has many water resources. In an average year, about 34 trillion gallons of precipitation falls on the state. Much of this water flows through 56,000 miles of surface streams and thousands of ponds, lakes, and reservoirs. At any given moment, approximately 47 trillion gallons of water are stored beneath the surface as groundwater. It's easy to see why Pennsylvania is referred to as a "water-rich" state. As a result, we have become accustomed to adequate supplies for all uses. For most of us, water is never more than a few steps away. We only need to open a faucet, press a button, or turn a cap to quench our thirst.

Water Use in Pennsylvania

In 1995, approximately 9,610 million gallons per day (MGD) of water were withdrawn in Pennsylvania (Table 1). Over half of it was used to cool thermoelectric power generators. Other major water users were industrial and domestic activities.

The values in Table 1 include the total amount of water withdrawn for a particular purpose. Included in this total are both *consumptive* and *non-consumptive* water uses. Non-consumptive use involves the withdrawal, use, and subsequent return of the water with little or no change in quantity. Consumptive use includes activities that evaporate water. These losses are relatively small around the home (usually less than 10 percent), but nearly all of the water used for irrigation is consumptive.

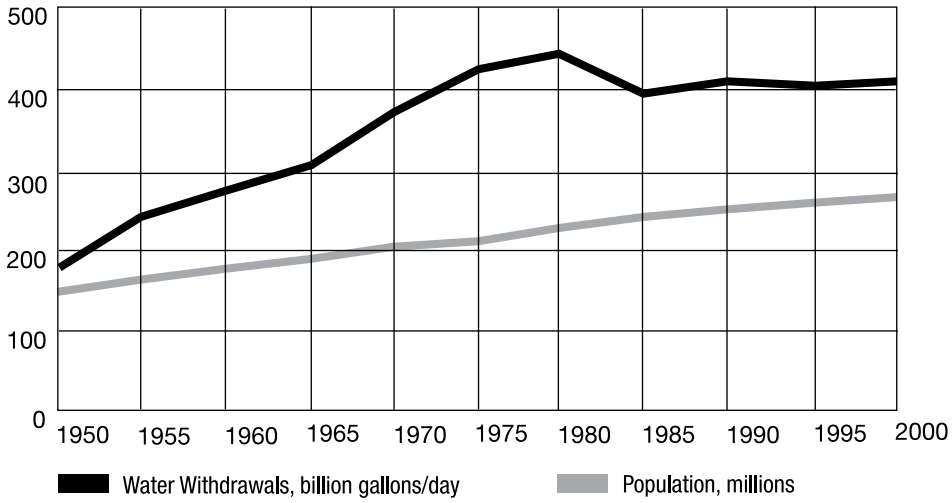
Table 1: Total water withdrawals and consumptive water use in Pennsylvania in 1995 (Data Source: Ludlow, R.A. and W.A. Gast. 2000. *Estimated water withdrawals and use in Pennsylvania*. U.S. Geological Survey Fact Sheet 174-99, Washington, D.C.). Values are given in million gallons per day (MGD).

Purpose	Water Use (MGD)	Consumptive Use (MGD)
Thermoelectric	5,930	239
Industrial	1,870	158
Domestic	740	74
Commercial	247	11.5
Mining	182	14
Livestock	55.3	41
Irrigation	15.9	15.9

Domestic water consumption has changed dramatically in Pennsylvania during the last 100 years. In 1900, only 5 million people lived in the state and each used about 5 gallons each day (25 MGD). By 1995, there were over 12 million residents, each using about 62 gallons per day (740 MGD). While long-term consumption has increased significantly, we have made progress in conserving water in the United States (Figure 1). The advances made through improved water-use efficiency show the potential conservation possible with continuous effort.

In 1900, outhouses were widely used and people only consumed about 5 gallons of water per day.

Figure 1: Trends in population and water withdrawals in the United States from 1950 to 2000 (Data Source: Hutson, et al. *Estimated use of water in the United States in 2000*. U.S. Geological Survey Circular 1268, Washington, D.C.).



Water-use habits have changed dramatically since the early 1900s. Average water use by each Pennsylvanian has decreased slightly from 1985, when it was estimated to be about 65 gallons per person per day. Population shifted at that time, moving from urban centers to suburban and rural areas. These changes are adding pressure on water sources in some parts of the state while reducing use in others.

Sufficient quantities of high-quality water require a large investment in equipment, pipes, and storage facilities. A recent report by the General Accounting Office indicates that communities could save hundreds of millions of dollars on water and sewage facilities through water conservation.

Most water removes wastes. Washing clothes, dishes, and ourselves and flushing the toilet account for most water consumption in homes. Drinking and cooking are insignificant compared to the amount we use for waste removal. Table 2 details typical domestic use.

Table 2: Average domestic water use in the United States (Data Source Adapted from Mayer, et al. *Residential end uses of water*. 1999. American Water Works Association Research Foundation.).

Plumbing fixture or appliance	Use (Gal per person per day)
Toilet	18.5
Clothes washer	15.0
Shower	11.6
Faucets	10.9
Leaks	9.5
Other	1.6
Bath	1.2
Dishwasher	1.0
Total	**69.3**

Toilets utilize the most water; however, this use is much lower than it was before the advent of the low-flush (1.6 gal/flush) toilet. Washing clothes consumes the second largest amount of water.

After this water has been used, it becomes wastewater and drains to a sewer line. These lines run under the streets to sewage treatment plants. Wastewater usually flows in these pipes by gravity, and they are called gravity sewers. In older towns, storm drains are connected to this system so that rainwater also travels to the sewage treatment plant. Newer collection systems separate storm water into storm sewers and wastewater into sanitary sewers to avoid this problem.

At the sewage treatment plant, the wastewater is treated. This process includes removing nutrients. This high-level treatment is quite costly.

Septic tanks are also widely used. A septic tank is a concrete tank that wastes from an individual home flow into. In it, solids settle to the bottom and bacteria begin to break down organic matter. The overflow is piped to an underground drainage field where organisms complete the breakdown of the sewage. Unfortunately, septic tanks only work well in soils that can accept the effluent at an adequate rate. The less wastewater moving through this system, the better it works.

Outdoor Water Use

Outdoor water use in the United States averages about 32 gallons per person per day. This value varies considerably in different regions. In western states, where precipitation is low, outside consumption may exceed 100 gallons per person per day. In eastern states, like Pennsylvania, outdoor water use is much lower—generally less than 10 gallons per person per day—because natural precipitation is more abundant.

Droughts and Water Planning

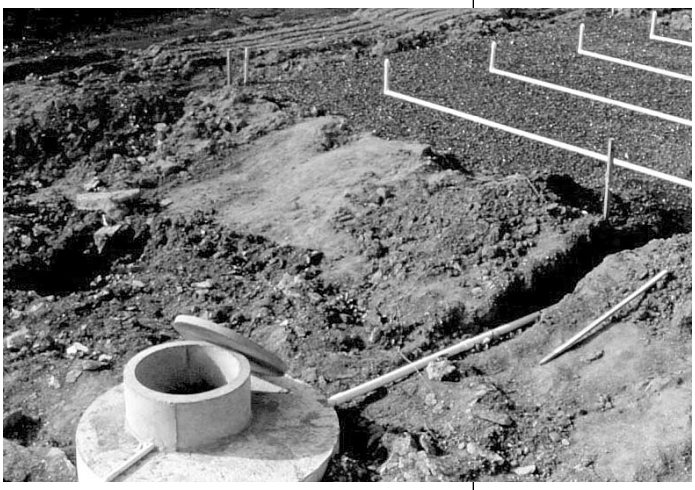
In addition to changes in use and population, recent droughts have stressed water resources throughout Pennsylvania. Severe droughts have occurred in 7 of the last 10 years. They strained water supplies to the point that voluntary or mandatory water conservation measures were necessary. In extreme cases, water rationing was needed to meet minimum demands. Declaration of a "Drought Emergency" by the state requires residents to reduce their water consumption, primarily through changing their habits and eliminating nonessential outside uses. Examples include taking shorter showers and flushing the toilet less often. The ban on nonessential uses usually means that outside watering of gardens, landscaping, and lawns must be limited, as well as filling swimming pools. Water may be collected from roof gutters, air conditioners, and dehumidifiers for outside purposes. For more ideas on how to save water during droughts and other emergencies, contact your county Penn State Cooperative Extension office and ask for the Extension publication *22 Ways to Save Water in an Emergency*.

While changing your habits can provide short-term relief during a drought, water conservation devices and practices are needed for long-term improvement. In response to this recent stress on water resources, the Pennsylvania legislature passed the Water Resources Planning Act in 2002 to develop a state water plan and to promote conservation. Domestic conservation will be an important component of future planning in Pennsylvania as our population grows and moves throughout the state.

Water Conservation

Keeping an adequate supply of high-quality water flowing from taps and disposing of wastewater requires considerable effort and expense. The less we use, the less effort and expense is required to supply us with water. The smaller the volume of wastewater produced, the less it costs to treat it. Where sewage treatment plants are already overloaded, this reduction would lessen pollution by improving waste treatment. Less energy use also means reduced air pollution and lower water heating bills. With today's high costs for water, sewer service, and energy, conservation through efficient plumbing fixtures and appliances can result in significant homeowner savings.

Water conservation reduces the hydraulic load on septic systems.



Water-Efficient Plumbing Fixtures

Toilets

Gravity Flush

Water-efficient toilets have evolved over the past 30 years, with much of the pioneering work occurring in the early 1970s. Many innovations have been introduced, including toilets with two flush volumes (one for liquid and one for solid wastes) and models that incorporate water pressure in the service line to flush. The ultra-low-flush models of today retain the basic design of the gravity-flush toilet. They look similar to conventional models, but use 1.6 gallons of water per flush versus the 3–5 gallons of older models. These low-flush toilets are required in new construction. Congress recently commissioned a review of low-flush toilets by the General Accounting Office (GAO) in response to efforts by some officials to repeal federal requirements. The GAO report concluded that homes with these toilets used 40 percent less water for flushing and requirements for these and other water efficient fixtures were "effective in saving water." This unbiased, nonpartisan review firmly established this toilet's place in conserving water resources.

Replacing conventional 4 gallons per flush (gpf) toilets with 1.6 gpf toilets throughout your home will save ap-

proximately 12 gallons of water per day per person, which translates into over 4,000 gallons each year (Table 3).

Low-flush toilets, like the 1.6 gpf model pictured below, are required in all new construction in the United States.

Air-Assisted

Air-assisted toilets, which require compressed air for waste removal, have been used for many years where minimal water use or waste flow reduction is at a premium. Highway rest stop facilities are a prime example. Use of these toilets in homes is less widespread because of the need for air lines, a compressor, and the higher initial costs of air-assisted units. However, domestic use of air-assissted toilets at present water and sewer rates can be cost-effective. Increased education and marketing efforts may result in wider adoption of these highly efficient toilets.

Water use per flush is only 0.5 gallons, roughly one-third of the volume of the low-flush toilets. With proper maintenance, air-assisted models remain serviceable for many years and more than return their significantly higher costs.

Installing air-assisted toilets is more involved, but not difficult. A small, ¼-horsepower compressor, with an air line to each toilet, must be located in your home's garage, basement, or utility closet. Approximately 20 flushes may be made before the compressor cycles on; noise is not usually an issue. More than one toilet can be operated with the same compressor.

Air-assisted toilets use only 0.5 gallons per flush.

Photo courtesy of Microphor Corporation, Willits, California.

Table 3: Estimated water and energy savings from various water-saving fixtures. (Data Source: Adapted from Vickers, A. 2001. *Handbook of Water Use and Conservation*. WaterPlow Press, Amherst, MA.)

	Frequency of Use (per person)	Daily Water Use Without Water Conservation Device (gal/person)*	Daily Water Use with Water Saving Device (gal/person)	Daily Water Savings with Water Saving Devices (gal/person)	Annual Water Savings (gal/person)	Estimated Annual Energy Savings of kilowatt-hours (per person)
Low-flush Toilet (1.6 gpf)	5.1 flushes/day	20.4	8.2	12.2	4,453	0
Low-volume Showerhead (2.5 gpm)	5.3 minutes/day	15.9	13.3	2.6	949	123
Low-volume Faucet (rated flow 1.5 gpm)	4 minutes/day	12	6	6	2,190	125
Front-loading Washing Machine (27/gpl)	0.37 loads/day	18.9	10	8.9	3,249	316
Water-Efficient Dishwasher (7.0 gpl)	0.1 loads/day	1.1	0.7	0.4	146	36
Total		**68.3**	**38.2**	**30.1**	**10,987**	**600**

*Assumes conventional toilets at 4 gpf, showerheads at 3 gpm, faucets at 3 gpm, washing machine at 51 gpl, and dishwasher at 11 gpl.

Composting

Interest in composting toilets has continued for several decades. These toilets use no water and rely on a mix of human waste and other compostable organic matter. Proper maintenance is required to maintain aerobic decomposition and prevent odors.

Composting toilets are expensive and difficult to retrofit. They require a commitment to management and must be tended to ensure proper operation. Most on-lot sewage management jurisdictions do not relax permit requirements concerning composting toilets because the gray water portion of wastewater must be accommodated by a conventional treatment system. However, in the right situation, they may be valuable residential water conservation tools.

Composting toilets are the ultimate choice for water conservation.

Photo courtesy of Allen White, Bio-Sun Systems, Inc., Millerton, PA.

Showerheads

Conventional showerheads typically deliver 3–8 gallons of water per minute. Conservation is accomplished by restricting water's flow rate through the showerhead. Showerheads with reduced flows as low as 2 gallons per minute (gpm), at normal household water pressure, have been designed to give an acceptable shower and reduce water use. They can be sensitive to low water pressure and sudden changes in temperature; consequently, proper pressure-balanced mixing valves are necessary. Exiting water temperatures normally need to be slightly higher because the smaller droplets cool quickly. Slightly hotter water does not negate the substantial energy savings achieved by low-flow showerheads. Replacing conventional 3 gpm showerheads with the low-volume, 2.5 gpm models will save approximately 1,000 gallons of water per year per person in your home (Table 3).

Low-volume showerheads are inexpensive, simple to install, and can save large amounts of water and energy.

Faucets

Most faucets deliver 3–7 gallons of water per minute. Like showerheads, restricting a faucet's flow rate can save water. Where faucets are operated continuously, as in washing operations, significant savings are possible. Residential, low-volume faucets typically produce 1.5–2.5 gpm. In institutional settings, flow-restricted faucets with spray heads that turn off automatically are increasingly used. When combined with point-of-use water heating, significant energy savings are possible in addition to reduced water use. Maintenance is required to prevent water loss from malfunctioning units. Replacing typical 3 gpm faucets with 1.5 gpm models will save approximately 2,000 gallons of water per year per person in your home.

Low-volume faucets or aerators can reduce water use to 1.5–2.5 gpm.

Front-loading washers provide tremendous water and energy savings.

Water-efficient dishwashers use as little as 4.5 gallons per load.

Automatic Clothes Washers

Conventional, top-loading clothes washers use about 40–50 gallons of water per load (gpl). Great strides have recently been made to improve the reliability and ease of front-loading automatic clothes washers, which use less water and energy. Durability was previously an issue, especially with regard to significantly increased costs. However, newer models have resolved this issue. Front-loaders are more efficient and wash with much less water and detergent. The tumbling action of the laundry reduces water requirements for equivalent load sizes and for cleanliness. Possible savings are shown in Table 3. The reduction in hot water use saves significant energy.

Automatic Dishwashers

Automatic dishwashers have relieved us of this unpleasant mealtime chore; however, they use large amounts of water. If dishwashers are fully loaded for each use, water can be saved. Newer, more efficient models may use as little as 4.5 gpl. However, units that are competitively priced use 6–7 gpl. Automatic dishwashers save water, as well as energy, by limiting hot water use. Potential savings are shown in Table 3. Water and energy savings quickly repay the higher cost of these machines.

Saving Money

Reducing domestic, indoor water use saves money in two ways. Homes using public supplies typically pay for each gallon delivered to them. The average cost for this water is about $5 for each 1,000 gallons, or about half a penny per gallon. As illustrated in Table 3, installing water-saving devices can save about 11,000 gallons of water per person per year, which translates into about $220 per year for a family of four.

Devices that reduce hot-water use (such as efficient clothes washers, dishwashers, faucets, and showerheads) also save money because they consume less energy. These savings, in kilowatt-hours per person, are shown in Table 3. Installing these appliances could save about 600 kilowatt-hours of electricity per person annually in your home. Assuming an average energy cost of about $0.08 per kilowatt hour, this conservation translates into about $200 per year for a family of four!

Outdoor Water Conservation

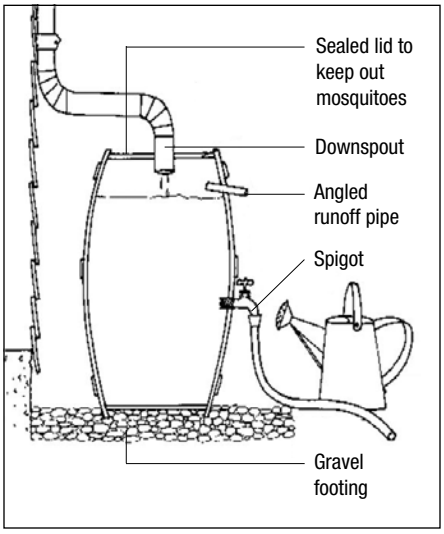
Although outdoor water use is small compared to indoor uses in Pennsylvania, opportunities to save water still exist, especially during periods of dry weather when they may be most critical. Outdoor conservation is especially important since a much larger percentage of water is lost through evaporation.

Since most water outside is used to water plants, landscaping with drought-tolerant (called xeriscaping) and native plants can greatly reduce consumption. Studies in the western United States have found that residential, xeriscaped lawns use half as much water as traditional landscapes. Using mulch around outdoor plants also helps to trap moisture and reduce watering. Efficient drip irrigation systems, rather than conventional sprinklers, can produce water savings of 25–75 percent. Proper scheduling and techniques can reduce water used on lawns. This outdoor watering should be done only in the early morning (before 8 A.M.) or in the evening after sunset to minimize loss from evaporation. Ten to fifteen minutes of watering is usually enough to saturate most soils.

Rainwater harvesting, or using rain barrels, is a simple way to conserve water outdoors. Rainwater harvesting can be accomplished by placing a plastic container (such as a heavy-duty garbage can) under a downspout to collect water running off of the roof. The rain collection container should be tightly covered to prevent mosquitoes from laying eggs and small animals from being trapped inside.

Rain barrels can be used to catch water from rooftops for outdoor use. An insect proof cover is recommended.

Suggested rain barrel design.



Summary—Why Conserve?

Installing water-efficient plumbing fixtures and appliances contributes to conserving water and energy and reducing wastewater flows.
Benefits include reduced utility bills for homeowners; deferred capital expenditures for system expansions for the utilities providing water, energy, and sewer services; and a cleaner, higher-quality environment for all.

Prepared by William E. Sharpe, professor of forest hydrology, and Bryan Swistock, extension associate.

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