



## 7 Alternative Wastewater Systems

Water discharged from toilets, sinks, bathtubs, washing machines and other fixtures in homes and businesses becomes wastewater. In urban areas, wastewater is typically collected in sewers, which run underground to wastewater treatment facilities, where it undergoes biological and chemical treatment and is discharged into lakes and rivers. The effluent is not pure water and can cause problems for the balance of life in the receiving body of water.

Sewage treatment plants are expensive to build and maintain, especially in small remote towns or dispersed suburban areas. In some older cities, stormwater is carried in the same sewers as wastewater. Heavy rainfall then may inundate treatment plants and send untreated sewage into buildings or streams.

Rural and suburban areas without large-scale wastewater collection and treatment systems commonly depend on septic systems. Wastewater is collected in a tank, then distributed to the surrounding soil through perforated pipes. Septic systems work effectively only in very low-density development. In higher-density developments, septic systems can severely impair groundwater quality.

Orange County will find it difficult to provide ecologically sound wastewater treatment systems for new developments (especially remote villages) using conventional wastewater treatment methods. Villages would not be large enough to justify the cost of large-scale wastewater collection and treatment systems, but would be too densely populated for septic systems to work effectively. Fortunately, numerous alternative wastewater treatment technologies are available to small communities (NC RCAP, 1994). These natural treatment technologies typically require less maintenance and consume less electrical power than conventional wastewater treatment plants. They offer high levels of treatment and resiliency in aesthetically pleasing facilities.

Passive treatment technologies include constructed wetlands, recirculating sand filters, and other types of attached-growth biological wastewater treatment processes (see below). Picayune, Mississippi, investigated this option, and found that “constructing a new wastewater treatment system would cost \$10 million. Instead, the town built a constructed wetland treatment system at a cost of \$1.2 million” (Wilson et al., 1998). The town gained a visual amenity and saved money. Money saved on such passive technologies can then be used to implement even broader conservation strategies such as open space protection.

Combinations of natural/passive and mechanical wastewater treatment technologies often achieve levels of treatment even higher than conventional methods. For example, constructed wetlands combined with other filtration systems have been extremely effective for a small company in rural Chatham County, NC (House, 1999). The courtyard of the facility contains the constructed wetlands, solarium, and aquatic chambers that treat the wastewater. A portion of the effluent from this system is reused for toilet flushing, landscape irrigation, and aesthetic water features.



*Constructed wetlands in Chatham County, NC*

In some areas, water treated in a conventional wastewater plant goes to constructed wetlands for “polishing.” One Florida municipality protects a sensitive estuarine river with large constructed wetlands that remove the small amounts of organic material and nutrients remaining in the effluent of its advanced biological plant. Boardwalks give birders and other nature enthusiasts access to the wetlands where they can view all manner of wildlife attracted to the new habitat (D’Amato, 1998).

Compared to conventional systems, alternative collection systems such as pressure sewers, small-diameter gravity sewers, and vacuum sewers are less expensive and require less excavation. Reduced excavation means that less polluting sediment is disturbed into streams. Alternative sewers also tend to resist leakage better than conventional gravity collection systems.

## 7.1 Cluster systems

A cluster system provides each development or subset thereof with a dedicated wastewater system. Cluster systems can serve a handful of homes or small communities of 1,000 homes or more. Whereas very low-density development favors traditional individual onsite wastewater treatment systems such as septic tanks, cluster systems are the best option for dense, isolated developments.

A group of homeowners can pool their resources to install cluster systems capable of high levels of wastewater treatment, a relatively advanced technology that might be prohibitively expensive for the individual homeowner. Water reclaimed from advanced wastewater treatment might be reused for lawn irrigation, toilet flushing, and other nonpotable uses. Beneficial reuse of treated wastewater reduces demand on drinking water resources. Where local soils allow, treated wastewater can be applied by ground absorption systems such as spray irrigation, drip irrigation, and subsurface distribution, all of which would recharge the groundwater aquifers that are our primary sources of drinking-quality water.

## 7.2 Greywater Recycling

Wastewater from toilets is called blackwater; wastewater from all other uses — dish, shower, sink and laundry water — is called greywater. Current systems squander greywater by mixing it with blackwater. In a typical household, 50–80% of wastewater, up to 50 gallons per day, is greywater that could be reused (Wilson et al., 1998). While reuse of greywater is relatively easy, safe, and cheap, blackwater or sewage from toilets is more difficult to process. Composting toilets, discussed below, eliminate blackwater.

Art Ludwig, a leading authority on greywater systems and author of “Create an Oasis with Greywater,” offers these design principles for wastewater systems (Ludwig, 2000):

- We must consider the whole picture.
- Ecological designs are context specific.
- We should choose the solution that is inherently simplest, and implement it as well as possible.
- Flow reduction is beyond compare for improving overall impact [of wastewater on the environment], and flow reduction techniques tend to be far simpler and cheaper than alternatives.

Ludwig also notes the following benefits of greywater recycling:

- lower fresh water use;
- less strain on septic tank or treatment plant;
- highly effective purification;
- ability to build in areas unsuitable for conventional wastewater treatment;

- less energy and chemical use;
- better groundwater recharge;
- increased plant growth; and
- reclamation of otherwise wasted nutrients.

Greywater can be treated by passing it through a treatment system such as a reedbed, sand filter, or soil filter before reuse. Or it can be untreated before reuse, going straight from the house to the garden, for example. Untreated greywater systems are simple and inexpensive to install and maintain, yet they are reasonably efficient. Treated greywater systems are more expensive than untreated systems, but they provide higher quality water for reuse (Ludwig, 2000).

## 7.3 Composting toilets

Composting toilets dehydrate human waste, which is then broken down by a variety of organisms into a usable by-product. They can also process food scraps, lawn clippings, paper, and other wastes. Composting toilets could save the 5 billion gallons of potable water flushed away every day in the United States. With that water, 1.4 billion pounds of nitrogen, 456 million pounds of potassium, and 194 million pounds of phosphorous go down the drain every year.

Sewage treatment plants have had only moderate success in removing those nutrients, and 1.2 billion pounds of chlorine must be used per year to kill infectious microorganisms (Earth Island Journal, 1996, cited in Wilson et al., 1998). Using no harmful chemicals, composting toilets recycle nutrients into fertilizer, which can be applied instead of chemical fertilizers to gardens and farms. Sewage collection and treatment systems that must be built can then be smaller and cheaper, with less environmentally damaging effluent.

More information on composting toilets is available at <http://www.compostingtoilet.org>.

## 7.4 Sand filters

Smaller developments might also find intermittent or recirculating sand filters much more cost-effective than conventional wastewater systems. The sand filter is installed between a septic tank and a downsized leaching field or filtration trench. In the sand filter, a concentrated bacterial ecosystem oxidizes organic matter and removes nutrients from the wastewater effluent. Sand filter systems are successfully used throughout the western and midwestern United States (Wilson et al., 1998).

## 7.5 Constructed wetlands

Interest has been growing in treating and recycling wastewater with constructed wetlands. These systems effectively integrate wastewater treatment and resource enhancement at a competitive cost, in some cases a

reduction of 60 to 95% from the cost of conventional mechanical systems (Wilson et al., 1998). Because chemical treatment of the wastewater is not necessary, the effluent is far less environmentally damaging. In addition to their ecological advantages, constructed wetlands offer open space and visual amenities. The EPA, in reviews of 17 wetland treatment systems from across the country, found that they significantly improve water quality and provide many additional benefits such as wildlife habitats (U.S. EPA, 2000).

The two types of constructed wetlands are subsurface flow systems and free-water surface systems. In subsurface flow systems, a permeable medium creates subsurface flow; the water being treated is kept below the surface, limiting

*Orange County could lead the nation in comprehensive, progressive water and wastewater management programs.*

odors and other nuisances. Free-water surface systems simulate natural wetlands and allow the water to flow over surfaces at shallow depths. Both systems are constructed in basins or channels, with a natural or constructed subsurface barrier to limit the water's spread beneath the soil. A variety of biological and physical processes purify the water.

Compared to constructed wetlands, conventional systems are less ecologically sound because they use chemical and mechanical rather than natural processes. Their effluent is discharged directly into waterways before plants can replenish waterborne oxygen and consume nutrient byproducts.

## 7.6 Living Machines

Internationally recognized biologist Dr. John Todd pioneered the development of "Living Machines," also known as Solar Aquatics systems. Living Machines are effective and economical systems for biological treatment of even high-strength industrial wastewater and sewage. Finished water from a Living Machine is suitable for irrigation, toilet flushing, and similar reuse. Living Machines incorporate and accelerate natural processes to purify water. Sunlight and a carefully managed array of organisms, including bacteria, plants, snails, and fish, break down organic pollutants. They can be housed in protective greenhouses, under light shelters, or in the open. Since they are odor free and remove nitrogen, pathogens, and other contaminants, they can be located near municipal centers.

Since the mid-1990s, dozens of Living Machines have been successfully operating throughout the U.S. and overseas. Many are high-capacity systems that have no major adverse environmental impacts. Instead, compared to conventional wastewater treatment systems, Living

Machines reduce the quantity and improve the quality of wastewater treatment discharge.

## 7.7 Conclusion

Orange County should consider the many viable options for wastewater treatment in new development. Decentralized wastewater treatment is a cost-effective and ecologically holistic alternative to centralized sewage systems. Collecting wastewater for transport to a centralized facility would be particularly costly for small, remote rural villages. Orange County should consider both individual onsite systems (in which each establishment has a wastewater treatment system) and small-community cluster systems for the service needs of villages.

To protect human health and water quality, wastewater treatment systems must be carefully managed and properly operated. Currently, the EPA is developing voluntary onsite wastewater management guidelines to help local communities address their wastewater needs (U.S. EPA, 2000). With strong existing water and wastewater management programs and entities such as OWASA and the Orange County Health Department, Orange County could be a national leader in implementing comprehensive progressive water and wastewater management programs.

Orange County should explore all of the wastewater collection, treatment, reuse, disposal, and management systems discussed in this section. We recommend that the County:

- enlist community input into water and wastewater management policy decisions;
- work with water/sewage treatment experts and local consultants who appreciate the wide variety of options for managing water and wastewater;
- Be open to trying new treatment methods that are appropriate to local soil and hydrological conditions; and
- incorporate sound principles of holistic watershed planning into water resource management decisions.

## 7.8 References

- Allen, G.H. and Gearhart, R.A. (eds.). 1988. Proceedings of a Conference on Wetlands for Wastewater Treatment and Resource Enhancement. Humbolt State University, Arcata, CA.
- Beatley, T. 2000. "Urban Ecocycle Balancing: Toward Closed Loop Cities." In Green Urbanism: Learning from European Cities. Washington: Island Press.

D'Amato, V.A., Hixson, M. and Hong, S.N. 1998. "Environmental protection through innovative wastewater and sludge treatment strategies in Florida." Proceedings of the 71st Annual Water Environment Federation Conference.

House, C.H., Bergmann, B.A., Stomp, A.M. and Frederick, D.J. 1999. "Combining Constructed Wetlands and Aquatic and Soil Filters for Reclamation and Reuse of Water." *Ecological Engineering* 12:27-38. [Also available online: <http://www.waterrecycling.com/index.htm>].

Living Machines, Inc. Available online: <http://www.livingmachines.com/htm/home.htm> [cited January 15, 2001].

Ludwig, A. Oasis Design. Santa Barbara, CA. Available online: <http://oasisdesign.net> [cited January 15, 2001].

Municipality of Kolding. 1996. "Urban Renewal of Solgarden/Kolding A." Technical Administration.

North Carolina Rural Communities Assistance Project. 1994. "Considering the Alternatives: A Guide to Wastewater Management for Small Communities in North Carolina." NC RCAP, Inc. Pittsboro, NC.

U.S. Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds. "Constructed Wetlands for Wastewater Treatment and Wildlife Habitat." Available online: <http://www.epa.gov/owow/wetlands/construct/content.html> [cited January 15, 2001].

U.S. EPA. 2000. "Draft EPA Guidelines for Management of Onsite/Decentralized Wastewater Systems."

Wilson, A., Uncapher, J.L., McManigal, L., Lovins, L.H., Cureton, M., and Browning, W.D. 1998. *Green Development: Integrating Ecology and Real Estate*. Rocky Mountain Institute. New York: John Wiley & Sons, Inc.



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