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6.8 On-site Wastewater Treatment Systems

When the collection, treatment, and discharge (or reuse) of wastewater occurs on or near the site where the wastewater has been generated, it is called an "on-site" system. These systems are distinguished from a "centralized" system that has an extensive network of collection pipes feeding a central sewage treatment plant—an approach that relies on energy- and chemical-intensive treatment methods to quickly process large volumes of wastewater. On-site wastewater systems are typically designed to handle a few hundred to a few hundred thousand gallons per day. On-site technologies can range from compost privies in national forests, to high-tech membrane-filtration systems that recycle wastewater for toilet flushing in large buildings, to sophisticated yet elegant designs that use ecosystems, such as constructed wetlands, to treat wastewater. On-site treatment can reduce construction, operations, and maintenance costs while conserving resources and providing an aesthetically and ecologically attractive feature for the facility.

Opportunities

On-site wastewater treatment should be considered (1) when the Federal facility is distant from an existing treatment plant or sewer main, (2) when sewage treatment capacity is severely limited, (3) when topography necessitates expensive pumping and excavation, and (4) when the system can serve multiple functions. On-site systems are particularly suited for semi-arid and arid regions, and for locations that require riparian restoration, groundwater recharge, an increase in surface-water flow, on-site fire control storage, or irrigation of nearby landscapes (such as golf courses). When water is at a premium, treatment and reuse for toilet flushing and other purposes can be cheaper if handled on site. Many Federal facilities are part of larger communities that wish to manage sprawl, and on-site facilities are often the best option for serving a diverse matrix of greenbelts and developed areas. On-site systems can also provide safety advantages in difficult ecological conditions such as areas subject to earthquakes, slope movement, and rapid, repeated changes of grade (hilly areas). Keep in mind, however, that local codes and building departments may prohibit certain on-site wastewater treatment systems, or require costly and time-consuming permitting processes (because these systems are new and often poorly understood).

Technical Information

With almost all small-volume on-site wastewater systems, the flow first enters a septic (or Imhoff) tank for primary treatment. Secondary, or more advanced, treatment can be handled by:

- Modified septic tanks with an anaerobic/aerobic treatment device or a specially equipped aerobic tank;
- Specially designed filters, such as intermittent or recirculating sand filters;
- Constructed wetlands that rely on algae, microbes, macrophytic plants such as water hyacinths or bulrushes, and other organisms for wastewater treatment; or
- Membrane filtration (micro-, nano-, or ultra-filtration and reverse osmosis).

Very small daily volumes can also be treated on site by composting toilets and proper management of the resultant (composted) solids.

Most on-site wastewater systems utilize evapo-transpiration by plants for "disposal" of a portion of the treated effluent—this process "treats" the wastewater as well as disposing of it. At times, it is impossible to distinguish treatment from disposal and reuse processes. An on-site system may perform multiple tasks simultaneously—for example, a constructed wetland also provides wildlife habitat and recreational opportunities. Treatment/disposal/reuse options include the following:

- Shallow sand-filled beds and trenches that provide near-surface irrigation;
- Mound systems with vegetation;
- Wetlands (marshes) that discharge to connected riparian habitats;
- On-surface irrigation with restricted public access.
- After disinfection, treated effluent can be used for spray irrigation and nonpotable uses such as toilet flushing, steam heating, and industrial or coolant feedwaters (see *Section 6.5 – Reclaimed Water*).

An on-site wastewater management district is an organizational framework for community or larger-scale facilities such as military bases. Recent technical advances have helped make on-site districts more feasible. These include improved septic tanks; larger-volume

septic tanks fed from multiple sources via small-diameter sewers; and low-cost septic tank innovations—especially in-tank effluent filters and pressure-dosing pumps and chambers—that improve soil-based treatment and water-holding capacity, thereby extending drainfield longevity. In-tank modifications also improve flow through small-diameter sewers, which, in turn, reduce the required earthwork, materials, and energy costs.

Typical cluster-systems, managed by on-site districts, include the following:

- Septic tanks with effluent filters and small-diameter sewers for gravity-delivery to an on-site treatment facility;
- Septic tanks with pressure sewer lines for collection in hilly areas (STEP systems);
- Septic tanks with grinder pump and pressure sewer lines that actually begin to "pretreat" sewage before delivery to the on-site treatment facility; and
- Vacuum sewers with extensive in-line oxidation and pretreatment—these are more expensive but appropriate for areas subject to earthquakes and slope movement.

Another important addition to the on-site management toolkit is membrane filtration. Though energy-intensive, membrane filtration is appropriate for situations in which the wastewater may contain hazardous components—for example, low-level radioactive pollutants in wastewater from military facilities, nitrocellulose from ammunitions plants, or other contaminants in bilge water from ships and submarines. Membrane filtration can also be considered in areas lacking acreage for biological treatment, such as urban locations.

Peak usage periods, such as Labor Day or Memorial Day in Federal parks or visitors' day in prisons, require special attention. *Holding tanks* are a cost-effective component that feeds the on-site treatment system at a later time and at rates optimal for biological or soil treatment.

With soil-based treatment systems, the wettest season places limits on how much effluent can be effectively treated and discharged (hydraulic assimilation capacity). In biologically reliant systems, the coldest months can slow treatment processes.

Steps to Choosing a Technology: Federal facilities vary widely and include research facilities, prisons, military bases, office buildings, employee homes, and trailside comfort stations. Before deciding on a treatment option, characterize the waste and wastewater. Then set out ideal environmental goals and carefully evaluate the site. Finally, keeping in mind the water quality, site, and cost considerations, work with a knowledgeable engineer to examine and select from the menu of available technologies.

Retrofitting: Many existing on-site systems do not meet modern engineering standards. Retrofitting septic tanks with effluent filters and pressure-dosing pumps should be considered an option. Constructing artificial soil profiles and/or diverting graywater for on-site irrigation or riparian restoration may be appropriate alternatives for overloaded systems.

References

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Contacts

The Consortium of Institutes for Decentralized Wastewater Treatment; www.dal.ca/~cwrs/cdwt/.

EPA Center for Environmental Research Information, 26 W. Martin Luther King Drive, Cincinnati, OH 45268; (513) 569-7562. Publishes: *Onsite Wastewater Treatment and Disposal Systems Design Manual* and *Alternative Sewer Systems Design Manual*.

EPA National Small Flows Clearinghouse, P.O. Box 6064, Morgantown, WV 26506; (800) 624-8301; www.estd.wvu.edu/nsfc/.