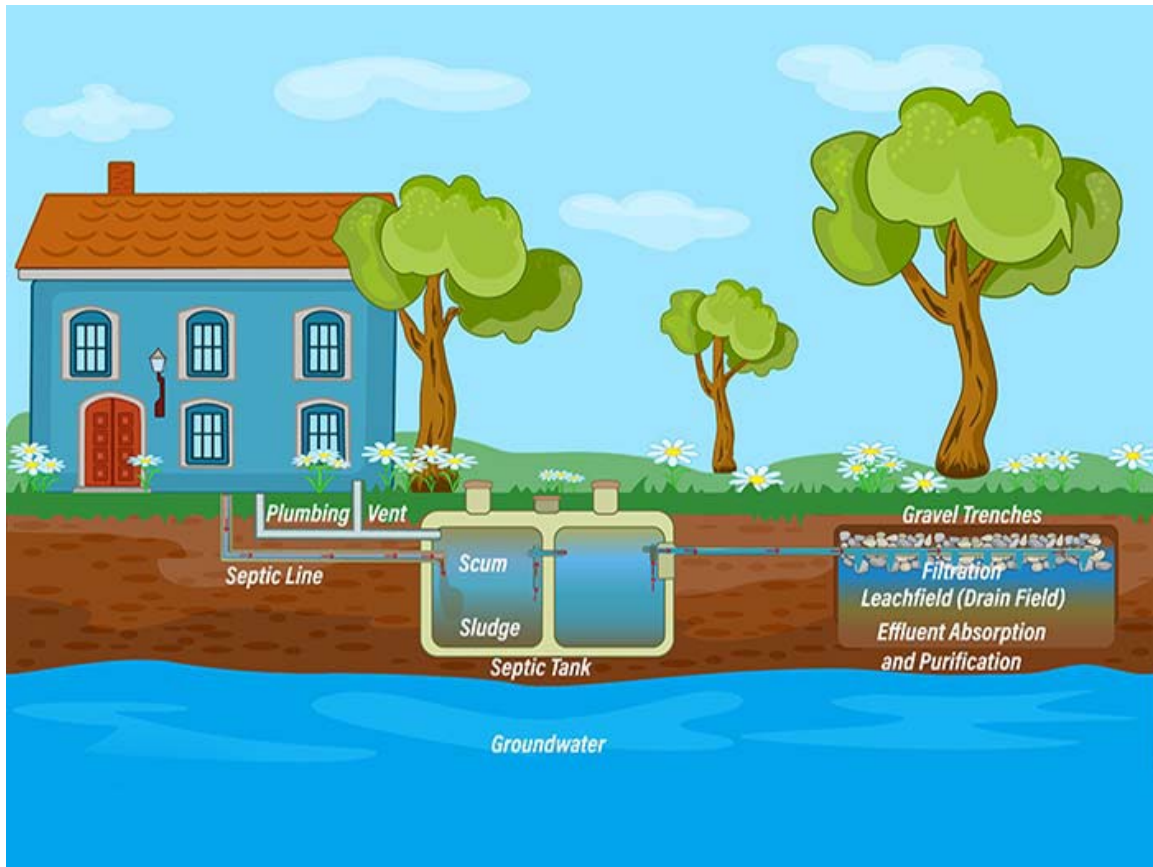


Protect Groundwater - Septic Systems Failures and Forever Chemicals



We worry about fracking, gas stations, and spills, but few are considering this type of groundwater pollution. In the U.S., groundwater supplies 35 percent of drinking water, with higher reliance in rural areas. Septic system failures can lead to the contamination of groundwater, which is a primary source of drinking water for many communities, especially in rural areas. Protecting groundwater resources is essential for long-term environmental sustainability. As freshwater sources become increasingly scarce, preserving our current water supplies becomes even more critical. ~ Dave Palmerton

Author: David Palmerton, SCS Engineers

Groundwater, a crucial human survival resource, provides drinking water, crop irrigation, and ecosystem support. Its value necessitates protection and conservation. Groundwater serves as the primary water source for domestic and agricultural purposes in many regions, especially where surface water access is limited.

The introduction of septic tanks in the United States in 1884 marked the beginning of groundwater pollution. Septic tank systems are now the most common on-site sewage disposal.¹ Approximately 20 percent of homes in the United States use septic systems that locally treat

¹ Canter, Larry and Robert C. Knox, 1984, Evaluation of Septic Tank System Effects on Ground Water Quality: National Center for Ground Water Research, U.S. Environmental Protection Agency, EPA-600/2-84-107.

their wastewater, with half in rural areas.² These systems are particularly prevalent in the south, northwest, and northern New England.³

In the U.S., groundwater supplies 35 percent of drinking water, with higher reliance in rural areas.⁴ Lacking centralized public water systems, many rural households and communities rely on private wells drawing groundwater for their drinking water.

Groundwater reliance in rural areas brings challenges like potential contamination from septic systems, compounded by the lack of regular testing and treatment seen in public water systems.

Experts have recognized septic systems as potential groundwater pollution sources since the 1980s. The USEPA's 1984 report, "Evaluation of Septic Tank System Effects on Ground Water Quality,"⁵ identified septic systems as significant groundwater pollution contributors in the U.S., noting the rising use of synthetic organic chemicals in households. The report highlighted contaminants like bacteria, viruses, nitrate nitrogen, organic contaminants, metals, and inorganic substances.

Households contribute a range of chemicals to septic systems, including persistent substances like PFAS and PFOA, known for environmental longevity and potential health effects. Pharmaceuticals and Personal Care Products (PPCP), solvents, petroleum compounds, paints, mercury, and pesticides pose health risks if consumed in impacted groundwater. Additionally, households can inadvertently release heavy metals like lead, cadmium, and copper into septic systems and subsequently into groundwater.

Educating homeowners about their septic systems is fundamental for effective operation and averting groundwater contamination. A considerable number of septic system failures and consequent environmental issues arise from homeowners' limited knowledge about the workings and maintenance of these systems. Education could be obligatory when homeowners obtain a septic system permit, especially those installing new systems.

- Septic tanks should be inspected by a professional at least every 1 to 3 years.
- The tank should be pumped out every 3 to 5 years, depending on the number of people in the household.
- If the septic system includes an effluent filter, it should be cleaned regularly, typically during inspections.
- Keep a record of inspections, pumping, maintenance, and any repairs for future reference and to inform professionals during service visits.

Implementing a certification program for homeowners who complete educational courses on septic system management can be highly beneficial. This certification could link to appealing incentives like tax reductions or lower insurance premiums, motivating homeowners to

² <https://www.epa.gov/nutrientpollution/sources-and-solutions-wastewater>

³ U.S. Department of Commerce Economics and Statistics Administration. Bureau of the Census.

⁴ Degnan, J.R., Kauffman, L.J., Erickson, M.L., Belitz, K., and Stackelberg, P.E., 2021, Depth of groundwater used for drinking-water supplies in the United States: U.S. Geological Survey Scientific Investigations Report 2021–5069, 69 p., <https://doi.org/10.3133/sir20215069>.

⁵ Canter, Larry and Robert C. Knox, 1984, Evaluation of Septic Tank System Effects on Ground Water Quality: National Center for Ground Water Research, U.S. Environmental Protection Agency, EPA-600/2-84-107.

participate. Moreover, local governments have a vital role in educational initiatives. By integrating septic system education into their strategies for water quality protection, they can ensure that homeowners are well-informed and equipped to maintain their systems properly.

Septic system design typically involves assessing soil type, depth, and percolation rate. Despite well-designed systems, organic and inorganic constituents can still contaminate groundwater. In septic tanks, anaerobic bacteria decompose organic waste, reducing solids and allowing clarified water to exit the drain field. Aerobic soil bacteria then break down effluent organic material, with soil acting as a physical filter. However, the septic system will not effectively remove all chemical compounds.

Conventional Septic Systems Fail to Filter Out Harmful Chemicals

Studies by Laurel A. Schaider et al.⁶ revealed various organic wastewater compounds in septage wastewater. They synthesized results from twenty studies of forty-five organic wastewater compounds in conventional drain field-based and alternative on-site wastewater treatment systems to characterize concentrations and removal.⁷ They found concentrations of prescription drugs, non-prescription drugs, other pharmaceutically active compounds, and organophosphate flame retardants and plasticizers.

Other studies also indicate organic and inorganic constituents leaching into groundwater from septic systems. It is reasonable to presume that chemicals disposed of down the drain into a septic system could find their way into groundwater.

Chemicals reaching groundwater can pollute drinking water sources, posing health risks to humans and wildlife. Chemical contamination can also harm aquatic and terrestrial ecosystems, impacting plant and animal life when discharged to the surface.

Appropriately designed, installed, and managed systems can remove pollutants effectively. On-site treatment can achieve high removal rates of oxygen-demanding substances, particulate solids, organic carbon, and pathogens.⁸

U.S. regions with shallow, unconsolidated sand and gravel aquifers face high contamination risks due to high hydraulic conductivity and lack of confining layers. Septic systems can fail when soil absorption exceeds capacity, leading to surface contamination, or when pollutants move too quickly through permeable soils, contaminating groundwater.

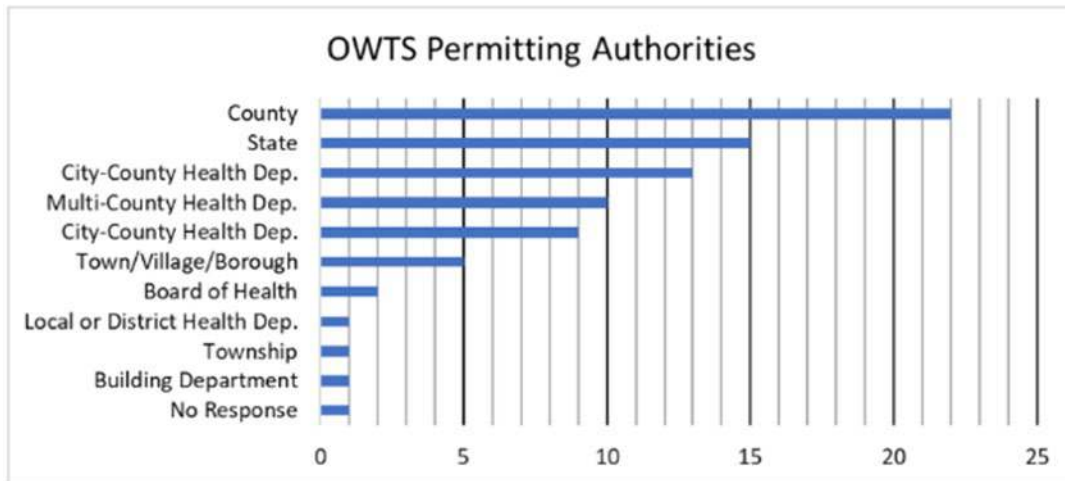
Poor Coordination Between Permitting Authorities

⁶ Laurel A. Schaider, Kathryn M. Rodgers, and Ruthann A. Rudel, Review of Organic Wastewater Compound Concentrations and Removal in Onsite Wastewater Treatment Systems, *Environmental Science & Technology* 2017 51 (13), 7304-7317 DOI: 10.1021/acs.est.6b04778

⁷ Laurel A. Schaider, Ruthann A. Rudel, Janet M. Ackerman, Sarah C. Dunagan, Julia Green Brody, Pharmaceuticals, perfluorosurfactants, and other organic wastewater compounds in public drinking water wells in a shallow sand and gravel aquifer, *Science of The Total Environment*, Volumes 468–469, 2014, Pages 384-393, ISSN 0048-9697, <https://doi.org/10.1016/j.scitotenv.2013.08.067>.

⁸ Van Cuyk, S., R. Siegrist, A. Logan, S. Masson, E. Fischer, and L. Figueroa. 2001. Hydraulic and purification behaviors and their interactions during wastewater treatment in soil infiltration systems. *Water Research*. 35: 953-964.

Enhanced permitting coordination among government agencies, industry professionals, and the public is essential for effective septic system regulation and public health and environmental protection. Coordination and regulation among various government agencies is needed to ensure consistent enforcement of septic system standards.



Source: Level of governing authority related to on-site wastewater treatment system permits.⁹

Regular review and update of septic system standards and permits are needed to incorporate advancements in septic system technology, design, and evolving environmental and public health considerations.

Solutions

Septic system design, materials, and operation advancements enhance reliability, efficiency, and environmental sustainability. However, there are widespread implementation lags.

Treatment train approaches, using sequential technologies for specific contaminant mitigation, include pretreatment, primary, secondary, tertiary treatment, disinfection, and advanced treatment stages.

Advanced septic system implementation faces challenges like cost, awareness, regulatory hurdles, resistance to change, and technical complexity.

Implementing advanced septic systems, which involves a higher upfront cost, can significantly benefit from various financial incentives such as grants, subsidies, or low-interest loans. These financial aids can alleviate the economic burden on homeowners and promote the adoption of environmentally friendly and efficient wastewater treatment technologies.

⁹ <https://actat.wvu.edu/topics-of-interest/assessment-of-u-s-onsite-system-installations-2015-through-2018>

Financial incentives can encourage homeowners to upgrade non-compliant or failing septic systems, ensuring adherence to environmental standards. By funding advanced septic systems, innovation in wastewater treatment technologies is strengthened. Continuous advancement in septic system technologies will lead to more effective and affordable solutions in the future.

Government Facilitation

Governments could consider providing financial aid for advanced septic systems and fostering public-private partnerships to support these initiatives.

Funding from the government is predominantly allocated to wastewater treatment plants, often overlooking the on-site septic systems that many homeowners rely on. As a result, the average homeowner facing the need to replace their septic system does not benefit from the grants typically mentioned in discussions about wastewater management. These homeowners are left to bear the significant financial burden of installing new septic systems. It is essential to reorient grants and tax benefit opportunities toward homeowners with septic systems.

These homeowners can receive much-needed assistance in upgrading and maintaining their septic systems by redirecting financial support. This shift in funding priorities would alleviate the financial strain on individuals and promote broader environmental benefits by ensuring proper waste management at a more localized level. The allocation of government funds in wastewater management must reflect the needs of all sectors, including the substantial number of households that depend on septic systems.

Connecting to public sewer systems and offering more effective contaminant removal is a preferable long-term solution. When a public sewer system is unavailable, and a septic system is required, several design advancements are available for improved wastewater filtration.

- Aerobic treatment units and advanced filtration systems, sand filters, and peat filters offer more efficient and effective wastewater treatment before it reaches the drain field.
- Biodegradable filters and permeable membranes promote natural filtration and reduce the potential for contamination.
- Eco-friendly alternatives or enhancements, such as constructed wetlands.
- Nutrient removal technologies, such as denitrification filters and phosphorus-absorbing media.
- Integrating intelligent monitoring systems to gather real-time data on various aspects of drain field health and performance, feeding the information to the homeowner for maintenance or repairs.

Pair advanced systems that better protect groundwater quality, reducing nutrient levels and other contaminants, with best management practices.

A Better Outlook for the Future of Groundwater

Understanding the history of septic systems, groundwater risks, and emerging solutions is crucial. Advanced septic systems enhance groundwater quality, emphasizing the need for rapid, broad implementation. Collective efforts and strategic investments are vital for protecting groundwater resources, public health, and ecological resilience.