Performance Evaluation of Advanced Onsite Wastewater Treatment Options

A study sponsored by the U.S. Environmental Protection Agency's Chesapeake Bay Program evaluated appropriate technologies to achieve an end-of-pipe performance standard equal to or less than 14.0 mg/L total nitrogen (average) and a net reduction in phosphorus. These standards support the 1987 Chesapeake Bay Agreement strategy to reduce the nutrients, nitrogen and phosphorus, entering the Bay by 40% by the year 2000.

The Problem

Pollution in the form of excess nutrients, primarily nitrogen & phosphorus, entering the Chesapeake Bay are creating significant water quality problems. These excess nutrients fuel the growth of dense algae blooms that block sunlight and deprive the water of dissolved oxygen which aquatic species need to survive. The current levels of nutrients entering the Bay ecosystem are causing millions of dollars of damage and lost revenue annually. Excess nutrients enter the Bay from many sources including individual septic systems which can be a significant source.

Wastewater Treatment

Central sewerage treatment systems are often not available in rural and suburban areas requiring homeowners to rely on individual septic tanks or other systems to dispose of household waste on-site. Natural treatment of biological wastewater has been practiced for centuries, however engineered aerobic treatment of wastewater has been practiced in the United States for only a few decades.

Aerobic Wastewater Treatment

Unlike traditional septic systems, which are anaerobic, the basic aerobic treatment process involves providing a suitable oxygen-rich environment for organisms that can reduce the organic portion of the waste into carbon dioxide and water. Aerobic systems can provide a higher level of treatment and better protect water resources than conventional septic systems.

Because these systems require pumps and aerators they can be more expensive to install and operate and require more regular maintenance than conventional septic systems. Recent advances in technology, however, have made aerobic treatment systems efficient and affordable for homeowners.

Background

Residential dwellings with engineered systems located adjacent to the Bay, or within critical areas, were identified. Homes with 2-4 year-round residents whose owners were willing to participate in the study were selected. The four onsite wastewater treatment systems used in the study had already been in operation for at least a year. The systems were modified to a configuration of multi-compartment septic tank, plastic media, aeration, recirculation and disposal to a drainfield. The phosphorus reducing system included low pressure pipe distribution into an expanded shale media in the dispersal area.

Project Objectives

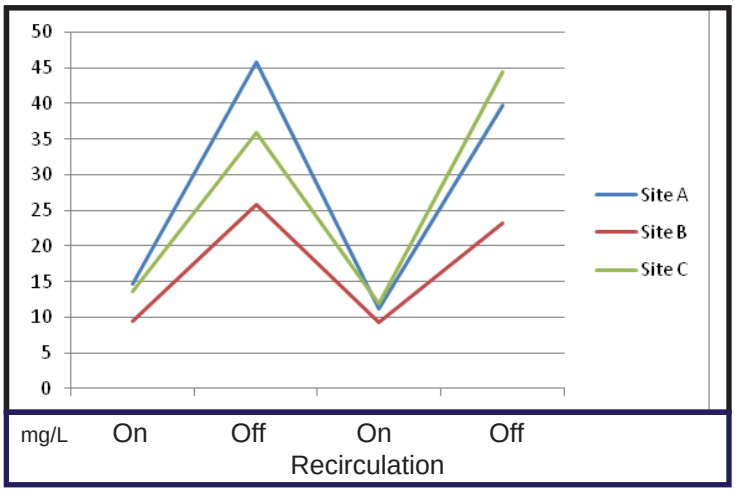
The three primary objectives of this study included:

1. Identify new and alternative nitrogen and phosphorus reducing onsite wastewater treatment system technologies.
2. Select 3-6 currently operating residential onsite wastewater treatment systems, design, and retrofit with selected nutrient-reducing technologies.
3. Develop sampling protocol, collect, and analyze samples for selected parameters to determine effectiveness of systems.

This study site represents a typical Chesapeake Bay residence where the drainfield is located in the back yard adjacent to the Bay.

Methods

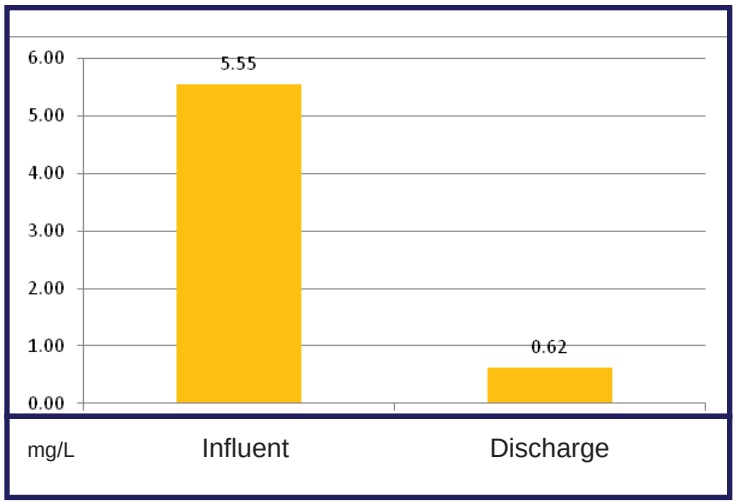
• Automatic composite samplers were set up at influent and effluent ports on each system's nitrogen-reducing tank for a 24-hour period once each week. This continued over the duration of the one year study.
• Samples were collected and analyzed by an EPA-certified laboratory.
• Samples from three sites were analyzed for NO_3/NO_2 (mg/L), and TKN (mg/L).
• Samples from one site were analyzed for total phosphorus (mg/L)
• Recirculation was purposely disengaged for periods of time to compare results of nitrogen reduction between modes of recirculation on versus off.



Total average nitrogen with recirculation on versus off.

Results

• When recirculation was activated, levels of nitrogen decreased.
• When recirculation was deactivated, levels of nitrogen increased.
• When the systems were recirculating and operating properly, they achieved less than 14.0 mg/L average nitrogen, or a 68% reduction.
• The system monitored for phosphorus reduction achieved an 89% net reduction in average phosphorus declining from 5.55 mg/L to 0.62 mg/L.



Average total phosphorus measured from the influent and at the discharge to the drainfield.

Conclusions

• When the systems were operating properly, the technologies used in this study consistently and reliably reduced average nitrogen and phosphorus.
• Periodic maintenance is necessary to ensure systems are operating properly.
• Engineered systems using these technologies can significantly reduce nitrogen and phosphorus.

Contacts:

Tamara Vandivort, Environmental Geologist
West Virginia Water Research Institute
West Virginia University
304-293-2867
Tamara.Vandivort@mail.wvu.edu

Clement Solomon, Ph.D., Wastewater Engineer
Director of Sustainability
West Virginia University
304-293-7916
csolomon@mail.wvu.edu

West Virginia Water Research Institute
http://wvwri.nrcce.wvu.edu