

# Nutrient and Microbial Movement from Seasonally-Used Septic Systems

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## Abstract

*Unsewered seasonal vacation communities present unique problems for on-site sewage disposal. Seasonal occupancy may promote the transmission of contaminants to groundwater due to incomplete formation of a biological clogging mat in the soil absorption system. Groundwater surrounding three seasonally-used septic systems was monitored to determine the movement and attenuation of nitrogen, phosphorus and two bacterial indicators of human fecal contamination, fecal coliforms and Clostridium perfringens. Nitrate-N concentrations were often three to four-fold greater than the drinking water standard at wells 6 m from the soil absorption systems. Minimal phosphorus migration occurred from these systems. Although more than 1.5 m of unsaturated soil separated the bottom of the soil absorption system from the groundwater, elevated numbers of both bacterial indicators were observed in groundwater at both 2 m and 6 m away from the absorption systems. Biological clogging mats, which are considered to be critical for even distribution of wastewater within a drainfield, were not found when the systems were excavated at the end of summer occupancy. Siting seasonally-used shoreline septic systems may require improved effluent distribution to achieve wastewater renovation.*

Unsewered lakeside or coastal vacation communities usually rely on on-site sewage disposal systems (septic systems) to treat household wastewater and to protect the quality of surface water and groundwater. The inherent proximity of beach communities to surface and groundwater coupled with the frequent placement of septic systems on sites with high groundwater tables and permeable, coarse sands developed from beach sediments suggests the potential for incomplete on-site wastewater treatment. Another factor which may alter the efficiency of on-site wastewater treatment is the seasonal summer use of the systems, rather than continuous year-round use typical of most residences.

A conventional septic system relies on a septic tank to settle solids and a gravity-fed soil absorption system (either a trench or bed type design) to treat and dispose of the clarified effluent (1). After eight to 15 months of continuous wastewater input, a conventional soil absorption system develops a biological clogging mat of reduced permeability at the interface between the native soil and the constructed absorption system (2). This clogging mat promotes uniform distribution of effluent throughout the field, thereby increasing reactive sur-

faces, interaction time and the system's ability to filter pollutants. In sandy soils, a clogging mat slows effluent movement into the soil and creates unsaturated, aerobic soil conditions as the effluent percolates to the groundwater. Removal of bacteria, protozoa, viruses and phosphorus appears to be enhanced by the conditions clogging mats create (3, 4).

For septic systems serving individual homes, contamination of groundwater has often been observed where saturated soil conditions exist at or near the depth of the absorption field (5, 6, 7). Groundwater contamination has also been documented in situations where uneven wastewater distribution caused elevated effluent loadings to selected portions of the absorption field (8). In porous soils without a clogging mat, effluent can leave the drainfield at localized regions. This concentrated hydraulic loading can promote a condition termed "fingering", where channelized, partially saturated flow allows effluent to travel rapidly through the unsaturated soil with little treatment before reaching the groundwater (2, 9, 10). Given that seasonal waterfront communities are occupied primarily during the summer months and remain inactive during much of the year, formation of a clogging mat seems unlikely.

The objective of this research project was to determine the migration and attenuation of two microbial indicators, fecal coliform and *Clostridium perfringens* and two nutrients, nitrogen and phosphorus, from seasonally-used septic systems. A second objective was to determine if a clogging mat capable of promoting uniform distribution developed during the system's period of seasonal use. The results of this study should aid in establishing recommendations for future designs in seasonal lake front or coastal communities.

## Site selection

Three seasonally-used conventional septic systems were selected for detailed study. Potential study sites were first delineated based upon the following geologic criteria: 1) coarse grained outwash or beach soils; and 2) unconfined piezometric surface (groundwater table) within 2 meters of the ground surface. Final site selection was determined by requiring that all septic systems meet modern design standards (11), that the homes be seasonally occupied and that the sites receive negligible nutrient and bacterial inputs from other sources. Three suitable sites (identified as Sites K, M and S) were found on a barrier spit complex between open ocean and a coastal lagoon in Charlestown, Rhode Island.

Overall development density in the immediate vicinity of the study area ranged between 0.1 and 0.4 hectares. The selected sites ranged in size from 0.5 to 1.2 hectares. Because of shallow water tables, the entire elevation of the building lot (excluding wetland areas) at each site was raised approximately 1 meter by the addition of poorly sorted gravelly sand fill material. The septic systems at each site were installed directly in this fill material in accordance with Rhode Island regulations (11). The native beach sediments underlying this imported fill material consisted of well sorted medium sands. Various characteristics of the three septic systems used in this study are shown in Table 1.

Groundwater tables, as determined by depth to free water, were 1.6 to 1.7 meters below the bottom of the absorption trenches at all sites. The ages of the systems ranged from seven to 10 years, which negated any

