

Assessment of Nitrogen and Fecal Bacteria Concentrations in 18 Septic Systems and Water Supply Wells in the Coastal Plain of North Carolina



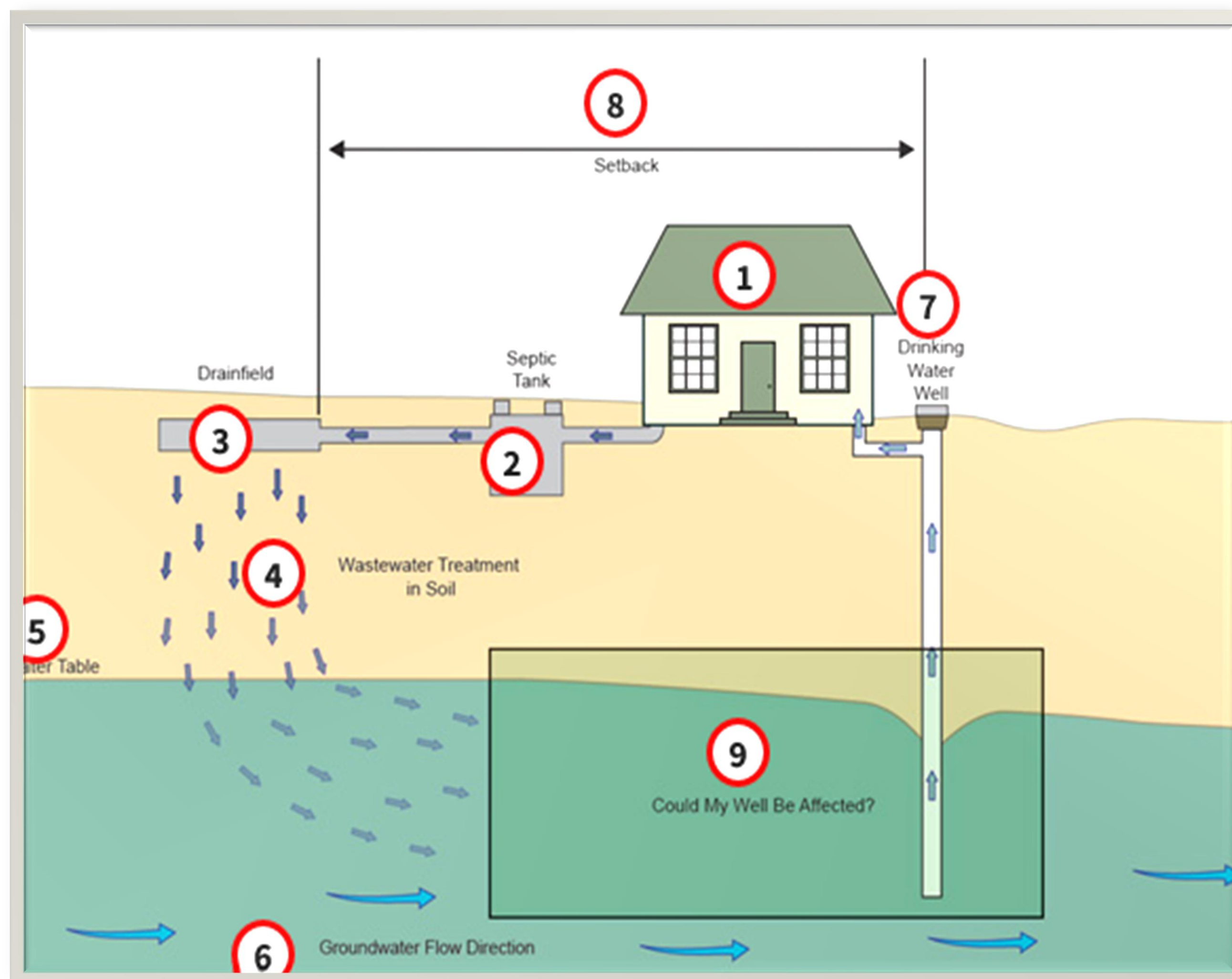
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Abstract

Private wells are used as a water supply for approximately 30% of North Carolina's population. However, most wells are not tested for water quality after their initial installation. Furthermore, nearly 50% of North Carolinians use septic systems for wastewater treatment. Septic systems discharge wastewater with elevated concentrations of nitrogen and bacteria to the subsurface. If septic systems are not effective at treating wastewater and the private wells are not properly constructed and sealed, groundwater supplies may become contaminated. An objective of this study was to compare nitrogen and *E. coli* concentrations in wastewater sampled from septic tanks and groundwater sampled from water supply wells on properties in the Coastal Plain of North Carolina to determine if wastewater was influencing the quality of drinking water. Wastewater and drinking water from 18 different properties were collected and analyzed for total dissolved nitrogen, nitrate, and *E. coli*. Four of the 18 septic systems were exhibiting signs of malfunctions during the site visits. While the mean nitrogen and *E. coli* concentrations in wastewater were 66 mg L⁻¹ and 89,478 MPN 100 mL⁻¹ respectively, none of the drinking water samples contained *E. coli* and the NO₃-N concentrations were all below the maximum concentration level of 10 mg L⁻¹. Results suggest that groundwater sampled from the water supply wells was not influenced by wastewater discharges from the septic systems.

Introduction

- Wastewater contains elevated concentrations of nitrogen and pathogens
- Concentrations of nitrate nitrogen (NO₃⁻) that exceed 10 mg L⁻¹ in water supplies can cause blue baby syndrome if consumed by infants
- Some cancers have been linked to chronic consumption of water with elevated NO₃⁻ concentrations
- Excess nitrogen loading to surface waters can stimulate toxic algal blooms
- E. coli* is used as a fecal indicator bacteria when water supplies and recreational waters are tested for microbial contamination
- No *E. coli* should be present in water from supply wells
- Many homes in rural and suburban regions of North Carolina use septic systems for wastewater treatment and private water wells for a water source



US EPA (2002)

- Most septic systems are not required to be tested for their nitrogen or *E. coli* treatment efficiency
- Most new private wells are sampled and tested initially for water quality, but there is no requirement for ongoing monitoring
- Some studies have shown elevated concentrations of NO₃⁻ (Humphrey et al. 2010) and *E. coli* (Humphrey et al. 2011) in shallow groundwater near septic systems
- Sandy soils and shallow groundwater are common in the Coastal Plain of North Carolina where many communities rely on septic systems and private wells
- More research regarding well water quality near septic systems is needed
- The study goal was to determine if water supply wells in the Coastal Plain are influenced by adjacent septic systems with regards to nitrogen and *E. coli* levels

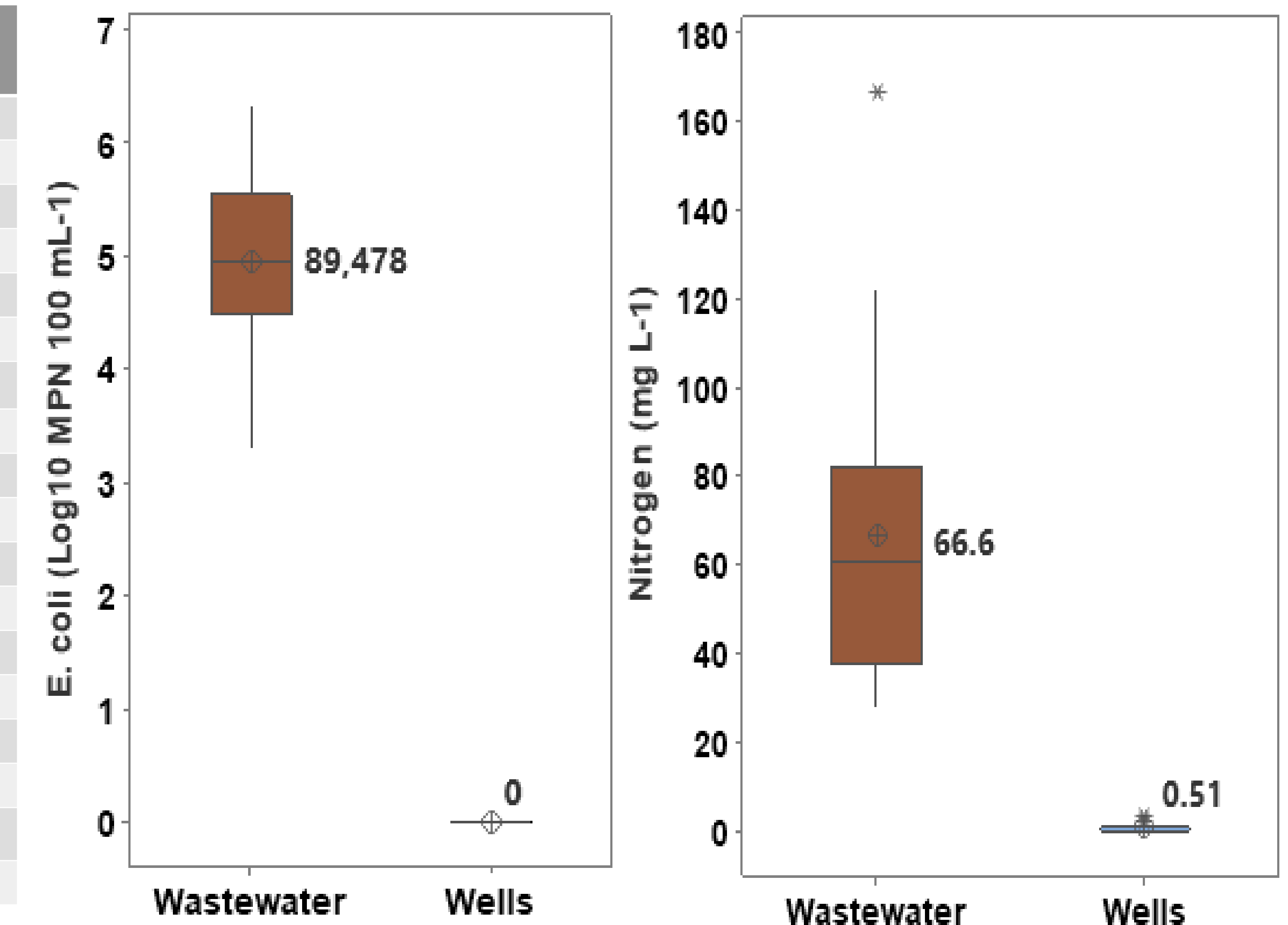
Methods and Materials



The lids were removed from the septic tanks at each of the 18 study sites. If excessive solids (1), encroachment of the freeboard (2), intrusion of roots (3), or other potential issues were observed with the tank, then the owners were notified. All septic tanks were pumped as part of the study. The drainfield for each system was located and if any potential problems such as unequal distribution of effluent were observed (4), the findings were communicated to the owner. The soil profile near the drainfield of each system was characterized (5) and pictures were taken to document the conditions. A wastewater sample from the septic tank (6) and a water sample from the well (7) at each site was collected in bottles for analyses of *E. coli* and nitrogen (total dissolved and nitrate) in labs at East Carolina University. The pH, temperature, and specific conductance of wastewater and well water samples were determined on site using hand-held multi-parameter meters.

Results and Discussion

Site	System Type	Install Date	Repair History	Soil Series
1	Gravity, conv.	1997	N/A	Candor
2	Gravity, conv.	1999	New drainfield (< 2 years)	Candor
3	Gravity, conv.	1997	N/A	Candor
4	Gravity, conv.	1994	N/A	Candor
5	Gravity, conv.	2002	Uneven distribution	Wagram
6	Gravity, conv.	1999	Deep drainfield, bad soil	Roanoke
7	Gravity, conv.	1998	Unequal distribution, < 3" freeboard	Wagram
8	Gravity, conv.	1970	Excessive solid layer thickness	Lakeland
9	Gravity, conv.	1987	N/A	Lakeland
10	Gravity, conv.	1987	N/A	Lakeland
11	Gravity, conv.	1988	N/A	Centenary
12	Gravity, conv.	1988	Wastewater near top of inlet pipe	Leon
13	Gravity, conv.	1992	N/A	Norfolk
14	Gravity, conv.	1972	N/A	Wagram
15	Gravity, conv.	1980	N/A	Lakeland
16	Gravity, conv.	2003	Roots in tank, thick sludge/scum	Lakeland
17	Gravity, conv.	1960	New drainfield trenches (< 2 years)	Centenary
18	Gravity, conv.	1961	Tank had hole in bottom < 1 ft wastewater	Centenary



Three of the 18 septic systems were malfunctioning as a result of either inadequate free board in the tank (2) indicating wastewater backup, or a wastewater level below the outlet pipe indicating a leak. One tank exhibited root penetration and a few others had excessive solid layers indicating a lack of routine maintenance. Two of the 18 septic systems were showing signs of unequal distribution of effluent based on differences in grass growth and color in the drainfield. A few other systems had been repaired recently (within 3 years of the study). Wastewater from the septic tanks had a geometric mean concentration of *E. coli* of 89,478 MPN 100 mL⁻¹ but none of the water samples from the water supplies tested positive. The mean total dissolved nitrogen concentration in wastewater was 66 mg L⁻¹ while the water supplies had an average of 0.5 mg L⁻¹ of NO₃-N. These data suggest that wastewater from the 18 septic systems was not adversely affecting the nitrogen or *E. coli* concentrations in the water supplies for the properties. It is possible that the water supply wells were installed in a confined aquifer and properly sealed, thus separating shallow and deeper groundwater.

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