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Assessing Protection Afforded to the Microbiological Quality of Bedrock Groundwater from the Impacts of Septic Tank Effluent by Irish Glacial Till: A Field Study

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The rural population of Ireland relies almost exclusively on on-site treatment systems for disposal of waste water. Septic tank systems, which discharge effluent to ground, constitute the dominant means of waste water disposal. Many of the areas that employ this technology rely on private or small group groundwater supplies, often located in close proximity of septic tanks. Since many of these water supplies provide raw groundwater to consumers, septic tank effluent (STE) can pose a significant hazard to the microbiological quality of drinking water.

T-tests (infiltration testing) carried out prior to tank installation aim to assess the capacity of subsoils to receive STE. Tests completed across Ireland indicate that many existing septic tank systems are located in low permeability subsoils. These subsoils are assumed to afford significant protection to the microbiological quality of groundwater in the underlying bedrock units. A two year investigation in the Lough Muckno Catchment in Co. Monaghan, investigating the impact of STE on water quality, involved carrying out T-tests at three sites where effluent discharged to a dense, silty, 'fractured' glacial till derived from the underlying bedrock and containing clasts of low grade metamorphic Ordovician and Silurian sandstone and shale. Analysis of groundwater samples collected from 28 piezometers straddling the water table within the till, down-gradient of septic tank systems at two sites, permitted faecal indicator microorganism (FIO) levels in near-surface groundwater to be established. Associated hydraulic conductivity tests (slug tests) at all three sites permitted an evaluation of the levels of horizontal hydraulic conductivity heterogeneity present in the till.

Slug test results suggest that till median hydraulic conductivities range from 1.1x10-4 cm/s to 1.1x10-5 cm/s, with variability of up to 2 orders of magnitude across each site. On the other hand no significant differences in properties existed between sites. T-test results ranged from 37.96 min/25mm to 98.26 min/25mm, suggesting hydraulic conductivities of the order of 1.1x10-3 cm/s to 4.24x10-4 cm/s. The contrast in hydraulic conductivity between T-test and slug test results may reflect slight anisotropy within the till, with water flowing vertically a little more easily than horizontally, under equivalent gradients. Despite the low hydraulic conductivities and the low hydraulic gradients observed at each site, analyses of water samples collected from up to 115 metres from septic tank discharge points consistently detected FIOs.

The results of the study highlight the possibility of viable pathogenic microorganisms being transported considerable distances from septic tanks through fine-grained glacial tills. Given limited survival times of FIOs outside of their host organisms, study findings suggest that travel times in the till separating septic tanks from monitoring points are of the order of 10s of days, despite similarly low hydraulic conductivities determined independently by the T-test and slug test methods.

The microbiological results, coupled to hydraulic measurements, point to very low effective porosities in the till that may possibly relate to fracturing. Moreover, hydraulic conductivity anisotropy suggests that contaminants may flow equally easily to depth. However, the exact levels of protection provided by the till will be a function of effective porosity variation with depth; the role played by fractures remains to be investigated but could prove to be potentially significant. Overall, the results of the study suggest that the levels of protection afforded by fine-grained Irish tills to bedrock aquifers may be considerably lower than originally assumed.