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Field Study of Pathogen Transport in a Fractured Aquifer

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This study focuses on the fate and transport of various pathogens in the Nardò aquifer in the Salento Peninsula, Italy, which is located approximately 8 km from the Ionian Sea coastline. Hydrogeological studies of the Nardò aquifer show that the aquifer consists of significantly fractured and very permeable limestone rock formations. The rock fractures are interconnected and partly filled with calcspar or terra rossa. The Nardò aquifer supplies fresh water to numerous households along the Ionian Sea coastline. Consequently, the water quality of the Nardò aquifer should be maintained continuously at acceptable levels. The fate and transport of pathogens that possibly can be introduced in the aquifer during the injection of treated municipal wastewater was investigated with field scale experimentations and model simulations. All necessary parameters required for accurate description of the aquifer were determined by appropriate tracer tests, borehole dilution and drawdown-recovery pumping tests. The spatial variability of the mean fracture aperture was evaluated with well-established geostatistical procedures. A numerical flow model was developed to determine the distribution of the piezometric heads throughout the aquifer for each realization of the fracture aperture field. Furthermore, a finite difference transport model was developed for the simulation of pathogen migration in the fractures based on the piezometric head distributions provided by the flow model. The pathogen concentration data, collected at two sampling locations were adequately fitted by the transport model. The fitted model parameters include the longitudinal and transverse coefficients, the initial inactivation rate, and the pathogen resistivity coefficient. Based on the slowest initial inactivation rate coefficient, the estimated safe setback distance is approximately

8000 m. This distance corresponds to a time period required by the pathogens present in the reclaimed wastewater used for the artificial aquifer recharge during the winter of 2002 to undergo at least a 7-log decrease in concentration. The estimated setback distance is relatively large and suggests that in fractured aquifers, such as the Nardò aquifer, the recycled water should undergo prior extensive pretreatment so that possible waterborne disease outbreaks from incomplete groundwater disinfection can be avoided.