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Modeling and Measurement of VOC Mass Transfer within Sewer Lines that Act as Preferential Pathways

Mohammadyousef Roghani (m.roghani@uky.edu) , Evan J. Willett (evan.willett@uky.edu), Elham Shirazi (elham.shirazi@uky.edu), and Kelly G. Pennell (kellypennell@uky.edu)
(University of Kentucky, Lexington, KY, USA)

Background/Objectives. Classically, vapor intrusion (VI) has been studied based on the concept of volatile organic compound (VOC) vapor migration through subsurface soil and entry into indoor areas through building cracks. However, evidence has suggested other conduits for VOC migration, with sewer lines being an important preferential pathways. To date, this pathway has not been well characterized; and consequently, standard procedures for assessing the pathway have not yet been developed. Failure to conduct a comprehensive assessment of this pathway during VI site studies could lead to misidentification of VOC sources and ineffective VI mitigation strategies. This study investigates the potential of the sewer system to act as a conduit for VI and assesses characteristic parameters of this pathway.

Approach/Activities. By investigating the characteristics of known VI sites at which the sewer system has been reported as a preferential pathway, this study assesses conditions that together increase the potential of this conduit for VOC migration. Through the application of a numerical model and use of accurate liquid-gas mass transfer mechanisms in various structures of the sewer system, we analyze parameters that can have significant spatial and temporal effects on VOC concentrations and subsequently potential exposure risk. Finally, this study compares numerical model results to field data. Field data has been gathered using novel field techniques to assess the temporal and spatial variability of VOCs within sewer gas.

Results/Lessons Learned. Close proximity to a potential VOC source (e.g., historical industrial facilities), shallow groundwater, and a faulty sewer system are all conditions that increase the probability of VOC infiltration into the sewer system and thereby VOC migration through this pathway. The results suggest that, while existence of intersections between contaminated groundwater and sewer lines may increase VOC concentrations in the sewer headspace, a lack of these intersections does not necessarily minimize the potential for the sewer to act as a preferential pathway. The numerical results suggest suggest that geographic characteristics, sewer headspace velocity, and sewer liquid depth in the pipe relative to the pipe diameter are all parameters that can have a substantial effect on VOC emission rates to indoor environments. Field samples (e.g. sewer gas concentrations, sewer liquid depth, and sewer gas pressures) collected from a sewer provide context for the modeled scenarios. Conceptual model scenarios developed based on field data and the numerical model provide an improved understanding of this preferential pathway.