Challenges in Design and Operation of a Sub-Slab Depressurization System at an Occupied, 150-Year Old Former Mill Building

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Background/Objectives. Retrofitting sub-slab depressurization systems (SSDS) in old, historic buildings poses significant challenges, especially in cases where building construction occurred in multiple phases, was poorly documented, and the buildings have been renovated for commercial and office use and are now fully occupied. State regulators initiated an investigation into subsurface impacts of chlorinated compounds, specifically trichloroethylene (TCE), in a suburban, mixed-use commercial and residential neighborhood in Massachusetts with a history of industrial and manufacturing operations. Elevated concentrations of TCE were detected in groundwater adjacent to a former industrial property, and a vapor intrusion pathway was identified at a five-story former mill building built in 1862 that currently provides about 92,000 square feet (sq ft) of office space. We outline special challenges and our solutions for completing the site evaluation and risk analysis, the design and implementation of complex SSDS to eliminate the TCE vapor intrusion pathway, and the effective communication of findings to stakeholders.

Approach/Activities. Pre-design activities included groundwater and soil gas profiling; sampling of sub-slab and exterior soil gas and indoor air, and performance of SSD pilot tests at several locations in the building. Ground-penetrating radar was used to identify subsurface building structures including a former cistern. Angled drilling was utilized due to spatial constraints, to assess impacts to soil and groundwater near the former cistern Three distinct SSD systems were designed to address five separate building zones over 16,000 sq ft to account for the variability in building construction (floor elevations, foundation types, roof types and heights) and subsurface conditions. A portion of the SSDS was designed to also serve as a soil vapor extraction (SVE) component to address potential residual source VOCs near the cistern. Indoor air, sub-slab soil gas, and SSDS effluent sampling was performed to assess the system effectiveness. The sampling results coupled with vacuum distribution monitoring beneath the slabs demonstrated effectiveness of the SSDS to reduce indoor air concentrations throughout the building, and effluent concentrations are decreasing.

Results/Lesson Learned. The age of the building and the numerous expansions provided challenges to identifying potential source areas, assessing potential migration pathways, and determining building construction details that are critical to the design of an effective SSDS. Combination SSD/SVE systems were designed to extract sub-slab vapors from several zones within the former mill building, where a complete vapor intrusion pathway was identified. Treatment zones included slab-on-grade and basement spaces segregated by foundational structures with limited or no subsurface pressure influence between zones. A complex SSD/SVE system was retrofitted to meet both aesthetic considerations and performance standards. Key SSDS design features included the use of multiple segregated SSDS zones and the use of customized vertical or horizontal extraction points based on the varying building structure, foundation types and floor elevations, and the target extraction area. Indoor air VOC concentrations were reduced to levels of no significant risk to human health after two weeks of active SSD/SVE operation, and significant VOC mass has been removed from the sub-slab vadose zone.