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Soil Vapor Mitigation: Urban Complexities for Depressurization System Design

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Background/Objectives. As our industry advances the understanding of soil vapor transport and the impacts of contaminant vapor exposure, soil vapor intrusion continues to be recognized as a significant exposure concern. Human health assessments are generally leading to decreasing permissible exposure concentrations and the available guidance on soil vapor has grown from a mere 10 states with guidance documents in 2003 to 48 states with guidance documents in 2016. With decreasing permissible contaminant concentrations and an increasing guidance available, there is a need to highlight how urban challenges can complicate otherwise "standard" soil vapor mitigation design.
This presentation will highlight successful engineering solutions to mitigate soil vapor intrusion with particular focus on urban challenges including:

- Differential settlement beneath large pile-supported buildings resulting in variable and changing sub-slab void space conditions and failing piped networks;
- High-rise tower construction with shallow bedrock conditions with integration into under-drain systems;
- Fluctuating groundwater elevations resultant from development dewatering operations and compromised infrastructure in densely urban areas; and
- Preferential flow paths induced by elaborate subsurface utility networks and highly variable subsurface building space and structures that create transport barriers or additional points for intrusion.

Approach/Activities. Most depressurization system designs and guidance documents are developed around a required number of air volume exchanges through even distribution of a negative pressure field beneath an occupied structure. Air volumes are determined by soil and sub-grade porosity and flow rate immediately below the building slab. The effective soil vapor volume can be bounded by the groundwater table (e.g., no soil vapor beneath the groundwater table) or perhaps a bedrock condition. What often go unevaluated are the additional complexities common in urban environments that can dramatically affect air volume and flow rate calculation and groundwater elevation.

Elevated property values combine with filled land (e.g., New York, Chicago, San Francisco) and insufficient bearing capacity often drive urban development toward tall buildings to maximize square footage supported on deep foundation elements. This development scenario creates the potential for significant void space beneath the building as the land settles and the pile-supported building remains at the original build elevation. The increased void space can result in a higher potential for soil vapor intrusion exposure if not property accounted for in the mitigation system design. Significant settlement can cause a depressurization system to short-circuit if the sub-slab piping network is not designed to accommodate the settlement.

Furthermore, groundwater elevations in densely-populated urban environments are known to fluctuate significantly due to nearby dewatering operations or compromised utilities (e.g., water and sewer). Calculations on air volume can change significantly as water levels fluctuate.

Results/Lessons Learned. This presentation will focus on urban soil vapor mitigation design solutions including flexible system connections, integrated under-drain systems, and air volume modifications to address differential settlement and a fluctuating groundwater table.