This document references Chapters and Sections from the ITRC Vapor Intrusion Technical and Regulatory Guidance, and Fact Sheets and Technology Information Sheets from the ITRC Vapor Intrusion Toolkit, published January 2026. These resources can be accessed at: https://itrcweb.org/vapor-intrusion-toolkit.

MULTIPHASE EXTRACTION TECHNOLOGY INFORMATION SHEET

Applicability as a method of vapor intrusion remediation

Overview

Multiphase extraction (MPE) is a remediation technology based on the extraction of liquids (groundwater, nonaqueous-phase liquid) and soil vapor from the subsurface to reduce or eliminate a source of vapor-forming chemicals (VFCs). The soil vapor is extracted by creating negative pressure in the unsaturated zone using extraction wells or trenches connected to suction piping and a blower (Figure 1). This is similar in concept to sub-slab depressurization (SSD), and both technologies can provide means of mitigating VI into buildings. VI mitigation is the main objective of SSD, but MPE is concerned primarily with addressing the source, with VI mitigation a possible ancillary effect. To enhance the recovery of soil vapor during MPE, the thickness of the vadose zone is increased by depressing the water table through groundwater extraction. VFCs in the vadose zone undergo volatilization from the source material and are removed with the extracted soil vapor. VFCs in the saturated zone are recovered with the extracted liquid. Liquid and soil vapor can be extracted using the same source of suction or by separate pumps. The off-gas and the extracted liquid are typically treated before being discharged. MPE is applicable to sites impacted by VFCs where sufficient permeability exists to enable the vapor/liquid extraction. MPE can be used for depressing the groundwater table; therefore, it does not require that a vadose zone be present under ambient conditions and can be employed where a shallow water table exists. Drawdowns may be difficult to achieve in high-permeability soils.

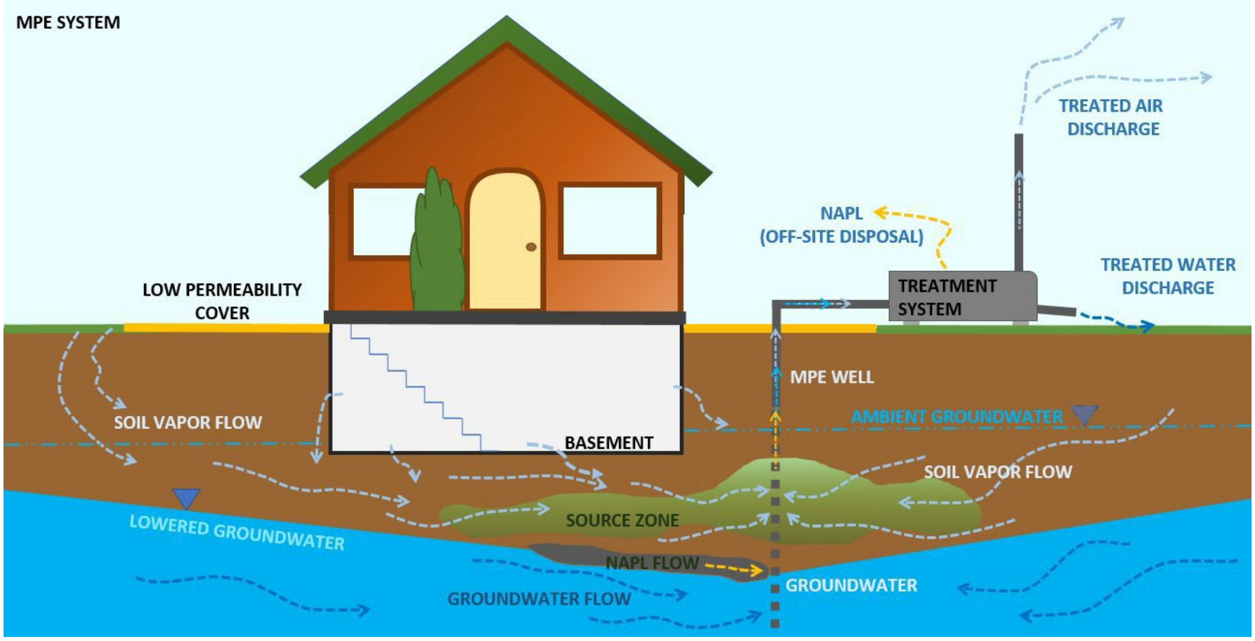

Figure 1. Conceptualization of a multiphase extraction system.

Source: L. Trozzolo, used with permission.

In the context of VI mitigation, an MPE system can prevent the migration of VFCs into a building from sources located both below and at certain distance from the building. In the former case, the mitigation mechanism is the development of a negative pressure zone in the subsurface below the building, resulting in an outward air flow across the building floor. In the latter case, the MPE system might intercept the VFCs before they reach the building footprint.

Design Considerations

MPE systems are designed based on the findings of field investigations and a VI conceptual site model representative of site-specific conditions. Pilot testing is performed to establish the number and locations of the soil vapor and liquid extraction wells/trenches. The system must be capable of dewatering the area to expose the source zone and capable of developing sufficient venting rates within the remediation zone to affect the VFC mass removal in a reasonable time frame (typically assumed to be between one and five years). Therefore, primary indicators evaluated are the vapor flow rate in the subsurface (rather than the pressures) and the water table drawdown. The testing also provides information on the need to install a surface cover to reduce the short-circuiting of the vapor flow through the surface near the extraction facilities or to include air inlet wells/trenches to direct the flow and optimize venting. Furthermore, the VFC concentrations in the extracted vapor and liquid streams are measured and used to evaluate the need for the treatment and to design the treatment systems. Many MPE systems require atmospheric discharge and treated water discharge permitting in accordance with applicable federal, state, or local laws and regulations. Noise mitigation measures may also be necessary.

In the context of VI mitigation, the investigation should include an assessment of the MPE system's effect on the indoor air quality. This may include pre- and post-implementation sampling of the indoor air for the target VFCs and monitoring of the pressure differential across the floor slab.

Components and Operation

A typical MPE system (see **Figure 1**) consists of soil vapor and liquid extraction facilities (wells or trenches) and mechanical/treatment equipment (conveyance piping blower, liquid pumps, liquid separator, liquid treatment, vapor treatment, instrumentation, and controls). A surface cover (e.g., building or cap) and air supply (inlet wells or trenches) may also be included. An MPE system requires regular maintenance and monitoring, which can constitute a large portion of the remediation costs. Typical maintenance activities required for an MPE system include routine inspections of the liquid ring pump and blower and repair/replacement of components (e.g., seals, vanes) as needed, inspection of all gauges and valves for proper operation, inspection of the moisture separator tank and drainage of accumulated fluid as necessary, and inspection and replacement of carbon filters on the emission treatment system as necessary. MPE system closure typically involves achieving the site-specific cleanup goals of soil and groundwater quality. If used as a means of VI mitigation, additional closure requirements related to the indoor air quality may be necessary.

Applicability of MPE for VI Mitigation

MPE is directly applicable as a method of VI mitigation for relatively small sites, such as a single building, where rented mobile systems or repurposed systems from other sites can be deployed relatively quickly. MPE can also be effective as VI mitigation at larger sites. The permitting, design, and implementation time for larger sites may be longer than the VI mitigation time frames typically required by regulatory agencies. Temporary VI mitigation may be needed until the MPE starts operating. Refer to the **Active Vapor Intrusion Mitigation Systems Fact Sheet, Passive Vapor Intrusion Mitigation Systems Fact Sheet,** and **Rapid Response and Ventilation for Vapor Intrusion Fact Sheet** for information on possible temporary VI mitigation methods.

Advantages

The features of an MPE system are based on the specific components needed to accomplish source reduction / remediation, which is the main objective of this technology. Compared to dedicated VI mitigation systems, MPE systems have several advantages:

- Provides groundwater and soil remediation and exposure mitigation
- Can result in complete removal of the source of the impacts to soil vapor from groundwater and soil, limiting the total time frame of the system operation (providing site closure, limiting long-term cost)
- Can reduce or eliminate potential future liability and on-site or off-site contaminant impacts
- Typically more robust than sub-slab depressurization (negative pressure subsurface may be up to two orders of magnitude higher than in SSD systems)
- Can be applied to sites with a high groundwater table (wet basements)
- Can be less intrusive to building occupants
- Can be a suitable alternative when access is limited or denied

Limitations

The limitations of MPE systems include the following:

- Typically higher short-term cost than dedicated VI mitigation systems
- Permitting for off-gas discharge and treated liquid discharge may be needed
- Need for treatment of the off-gas and extracted liquids, which may include nonaqueous-phase liquid, in accordance with applicable federal, state, or local laws and regulations (increased long-term operation and maintenance costs)
- Need for additional sampling and reporting of sub-slab and indoor air due to the increased volatilization from the exposed source zone and possible fluctuations of the water level in response to the outside stresses that may result in potential rebound of dissolved contaminant concentrations in groundwater contributing to an increase in sub-slab soil vapor concentrations
- Greater likelihood for noise complaints
- Feasible only at sites with granular and relatively permeable soils

Cost Considerations

An MPE system is designed to address the source of the VFCs in the subsurface. The cost typically depends on the size and the logistics of the site, the nature of the subsurface, and the type of impacts. The added cost if MPE is used as an additional means of VI mitigation is typically negligible. If comparing to the cost of a dedicated VI mitigation system, the entire life-cycle costs should be included.

Occupant, Community, and Stakeholder Considerations

It is essential to develop and implement a site-specific community involvement plan that addresses how to win trust and gain access to properties, communicate risk to potentially exposed individuals, and minimize the disruption of people’s lives and businesses. For more details see **Chapter 3: Community Engagement**.