

Purpose. This document is designed to provide general guidance for assessing potential petroleum vapor impacts as part of the [North Dakota Risk Based Corrective Action \(NDRBCA\)](#) process. Petroleum vapor intrusion (PVI) can occur when vapors emitted from petroleum contaminated soil and/or groundwater enter overlying (or nearby) structures, where they may be inhaled.

Investigation. Development of a conceptual site model (CSM) is necessary to determine if a risk for PVI exists. The investigation includes evaluation of the contaminant source extent, routes of exposure, and potential pathways.

- Delineation of the contaminant source extent is done by collecting soil, groundwater, and/or soil vapor samples.
- Compare contaminant concentrations in soil, groundwater, and soil vapor to risk-based levels under NDRBCA. If levels are exceeded, determine if a completed pathway to a receptor exists.
- Routes of exposure, such as inhalation, will include determining if there are any mitigating factors to consider. For example, if there is a vapor mitigation system already operating, a vapor barrier, or other hindrances/pathways that may exist.

Structure Screening. The following screening guidelines should be applied to determine if PVI may be a risk for structures at the site. A structure will screen in for further investigation if it is within the following screening areas:

- Lateral Inclusion Zone –The Lateral Inclusion Zone is defined as the area from the edge of the petroleum vapor source to the edge of a building foundation. A Lateral Inclusion Zone includes the area within 30 feet from the edge of the petroleum vapor source (in soil or groundwater).
- Vertical Separation Distance – The Vertical Separation Distance is defined as the vertical separation of the top-most edge of the LNAPL (free phase liquids) and dissolved phase contaminants to the bottom of a building foundation. For LNAPL, this distance is 15 feet, and for dissolved phase, the distance is 5 feet. If a structure is located within either of these distances, and located within the Lateral Inclusion Zone, the structure may be susceptible to PVI.

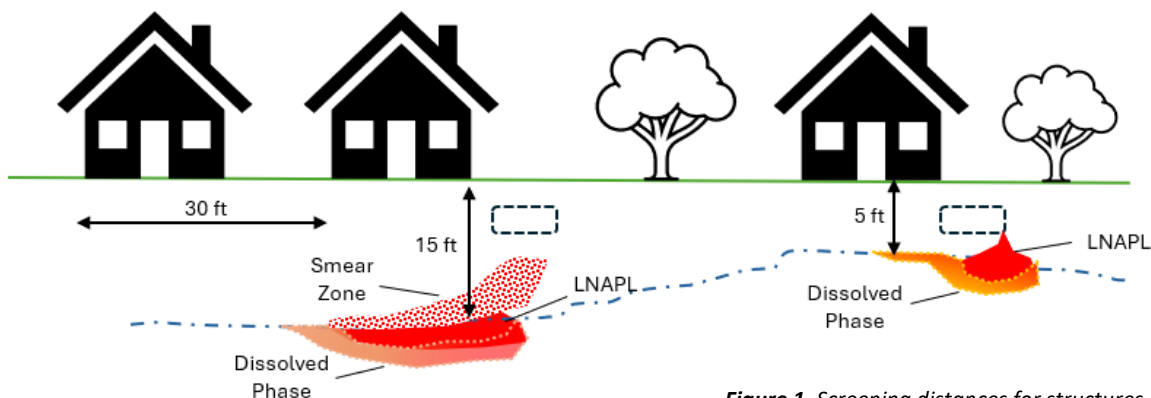


Figure 1. Screening distances for structures

Sampling. The contaminant source must be delineated in accordance with NDRBCA standards. This may include soil sampling, groundwater sampling, and soil gas sampling. The sampling methodology used for evaluation of the vapor source and attenuation factor (AF), the estimate of the decimal fraction of vapor phase chemicals that pass through a barrier, will depend on source contamination and delineation.

- Contamination in direct contact with building – indoor air sampling is recommended. Sub-slab (less than one foot below the bottom of the slab) sampling may not be possible because of pore space saturation.
- Contamination not in direct contact with overlying building – Paired sampling is recommended to account for an AF that is building specific. Some paired sampling options include:
 - Exterior near-slab (less than ten feet from a building) shallow (less than five feet below slab) soil gas samples with deep (greater than five feet below slab) soil gas samples; or,
 - Sub-slab soil gas samples with indoor air samples.
- To quantitatively evaluate the indoor inhalation pathway, use the following approach:
 - Tier 1 evaluation: Compare maximum soil vapor and groundwater concentrations to soil vapor and groundwater NDRBCA Tier 1 RBSLs.
 - Tier 2 evaluation: Develop Tier 2 SSTLs for soil vapor and groundwater with site-specific data. Compare these concentrations with the corresponding representative concentrations.
 - Tier 3 evaluation: Develop Tier 3 SSTLs for indoor air, soil vapor and groundwater, with site-specific data and/or fate and transport models and compare these concentrations with the corresponding representative concentrations.

Mathematical models or empirical attenuation factors are used to estimate the soil vapor and groundwater concentrations protective of indoor inhalation. Refer to Appendix A for the development of Tier 2 and Tier 3 SSTLs and Appendix B for Tier 1 and Tier 2 Report Forms (NDRBCA Technical Guidance).

Please refer to [Table G-6](#) of the [ITRC Petroleum Vapor Intrusion – Fundamentals of Screening, Investigation and Management](#) guidance for advantages, disadvantages, and additional information regarding sampling methods.

Utilities. Sanitary and storm sewers, electrical and communications conduits, and other utility tunnels can serve as preferential pathways. Sites at higher risk for PVI from preferential pathways include sites where contaminated groundwater enters the sewer or where the conduit passes through a petroleum contaminated area. If petroleum vapor impacts on nearby building(s) are suspected, refer to [Section 4.13 Distribution of Chemicals of Concern in the Vapor Migration to Indoor Air Pathway](#) (NDRBCA Technical Guidance). If a PVI investigation of utilities is warranted, risk-based screening levels (RBSLs) for Tier 1 and site-specific target levels (SSTLs) for Tier 2 and Tier 3 for soil gas and indoor air should be used.

Remediation & Mitigation. Remediation methods can be utilized to remove the source of contamination from soil and/or groundwater. When remediation may not resolve PVI issues, management may be necessary. Multiple technologies are available, including:

- Active System (e.g., sub-slab depressurization, sub-slab ventilation/crawl space venting, submembrane depressurization, sub-slab pressurization, building pressurization).
- Passive Barrier (e.g., asphalt/latex membrane, thermoplastic liner, epoxy floor sealant system).
- Passive Venting (e.g., sub-slab venting, aerated flooring)
- Other (e.g., indoor air treatment, sealing the building envelope).

Mitigation approaches for sewers and tunnels include preventing contaminants from entering the conduit, ventilating the line, or correcting plumbing defects. Institutional controls may also be used in conjunction with PVI mitigation.

Please refer to Figure 2. PVI Flow Guidance.

Community Engagement. In some instances, community engagement may also be needed when addressing PVI. PVI-specific concerns and questions may arise during any phase of investigation, mitigation, or remediation. These activities can disrupt daily routines, create added stress and questions for those who frequent and/or live in the buildings subject to these activities. For each confirmed release that requires a corrective action plan, the NDDEQ must notify those members of the public directly affected by the release and the planned corrective action (North Dakota Administrative Code 33.1-24-08-57).

Resources. Information in this guidance is based on recommendations from the U.S. Environmental Protection Agency's [Technical Guide for Addressing Petroleum Vapor Intrusion at Leaking Underground Storage Tank Sites](#) (June 2015, EPA 510-R-15-001) and the Interstate Technology & Regulatory Council – Petroleum Vapor Intrusion Team's [Petroleum Vapor Intrusion – Fundamentals of Screening, Investigation and Management](#) (October 2014, PVI-1).

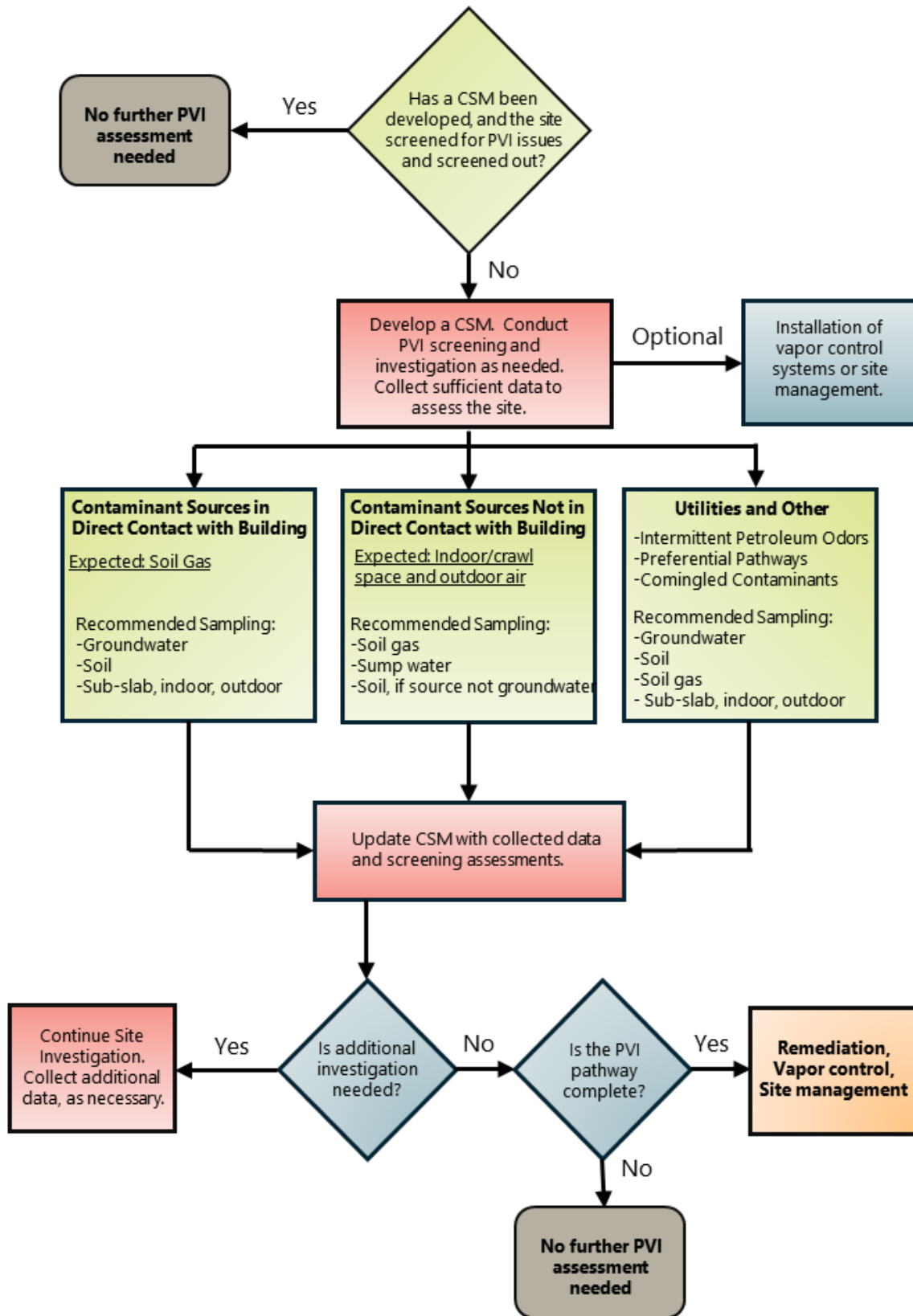


Figure 2. PVI Flow Guidance. Adapted from ITRC PVI (2014).