SUB-SLAB DEPRESSURIZATION SYSTEM RETROFITS TO EXISTING BUILDINGS: TWO CASE STUDIES

Theresa M. Phillips
exp Services Inc., Canada

Ronald Taylor
exp Services Inc., Canada

Darko Strajin
exp Services Inc., Canada

EXTENDED ABSTRACT

Ontario Regulation 153/04 outlines the process wherein a property impacted by soil and/ or ground water contaminants is evaluated for risks to human and ecological health, and may be redeveloped for more sensitive land uses. Under the Regulation, once a property has been sufficiently characterized, a Record of Site Condition (RSC) may be filed, to document the condition of the property. Owners of contaminated lands may choose to remediate the property, to meet the Ontario Ministry of Environment and Climate Change (MOECC) generic soil and ground water Standards, or develop new site-specific Standards via the Risk Assessment (RA) process.

Many of the soil and ground water contaminants of concern (COC) frequently identified during the environmental site assessment process are volatile. If an RA is undertaken to address volatile COC, it must take into consideration the potential for vapour intrusion. The fundamental underlying principle for vapour transport is based on observations that small but persistent pressure differences established between the exterior and interior of buildings may cause infiltration of soil air through the substructure of buildings. When this occurs, the COC have the potential to cause an adverse effect on the health of building occupants, via the inhalation pathway. If the conclusions of the RA are that an adverse effect is likely, vapour mitigation will be proposed as a risk management measure (RMM) and mandated by the MOECC by describing them on a Certificate of Property Use (CPU) which is registered on the title of the land, thus obligating all current and/ or future property owners to comply.

In practice, vapour mitigation options are limited, particularly for sites with existing buildings and where redevelopment is not planned. In some cases, buildings are not fitted with HVAC systems suited to increased air exchange rates or maintenance of a constant positive pressure, which would serve to “push back” against upward vapour movement. Nor can an existing building be fitted with vapour barriers, or easily equipped with an extensive sub-grade vapour venting system. In many cases, a sub-slab depressurization (SSD) system, retrofitted to the building, is the best option. Such a system would consist of one of more vapour extraction points, connected to a blower with the capacity to generate a slight negative pressure within the porous sub-grade media. However, the success of such a system depends to a large extent upon the characteristics of the sub-grade fill material, in addition to the building configuration and features such as the presence of footings and foundation thickness and quality. As such, there are many risks associated with uncertainties when the building sub-slab environment is not fully understood and each project is unique, where existing buildings are concerned. Two case studies will be presented, describing the process of designing and constructing SSD systems within existing buildings, to mitigate vapour intrusion by chlorinated volatile organic compounds (VOCs).

The first case study is a warehouse with generally open concept layout and relatively unrestricted air flow throughout most of the building. The SSD system was constructed using vertical slotted pipes, capped at the ends, as the extraction points. In this case the sandy soil itself was a major source of vapours, and impacts lay just below the building slab. Because of the presumed porosity of the sand, and absence of footings to separate sections of the building, it was assumed that good communication would be achieved between the extraction points. A favourable

pilot test supported this assumption. However, this was not the case and, thus, the project required additional tests and a trouble-shooting program to extend the zone of influence of each point. Once adequate communication was verified by vacuum testing, a screening level indoor air quality test was performed as a measure of system efficacy. The results of the test are provided in Table 1. Indoor air concentrations were reduced for the VOC parent COC. However, measured values still exceeded the MOECC indoor air criteria. These exceedances were likely due to damage to a key extraction point, situated in the centre of the building and next to a former trichloroethylene bath, during building renovations. Therefore, it was recommended that the missing point be replaced prior to any further testing.

Table 1: Indoor Air Quality Results – Case Study 1

Contaminant	Concentration (Oct. 2013) (μg/m^3)	Concentration (Jan. 2016) (μg/m^3)	Criteria (μg/m^3)
Trichloroethylene	11.5	3.4	0.4
Perchloroethylene	14.1	6.9	14

The second case study describes a multi-tenant strip mall constructed with several additions, resulting in demising walls which extend to subgrade footings and presumably interrupt vapour movement beneath the building. In this case the source of chlorinated VOC vapours, specifically perchloroethylene (PCE) was a ground water plume, at an approximate depth of 5 metres below grade. The SSD system was constructed using two plenum boxes with the intent for more localized vapour mitigation within units of highest concern. The system design was limited by unique building features including the layout itself, presence of a vault in one unit of interest, and inconsistent fill thickness beneath the building slab.

Following pilot tests to verify that communication in the sub-grade fill was possible, the SSD system was installed in a unit immediately next to the most highly impacted unit of the building. During construction, a demising wall (footing), extending to approximately 15 cm below the top of floor, was found to separate the two units. Anticipating restricted vapour floor due to the wall, two holes were cut and piping installed to connect each plenum box to the unit on the other side of the wall. Indoor air quality testing was performed in both units, to verify the efficacy of the SSD system, once installed. A dramatic decrease in the concentration of PCE was observed post-construction (Table 2), in the most highly impacted unit (Unit #1). Exceedances of the MOECC criteria persist in this unit, however an SSD system could not be installed in that particular space. A second system on the opposite side of the affected unit has been proposed.

Table 2: Indoor Air Quality Results – Case Study 2

Contaminant	Concentration (Mar. 2015) (μg/m^3)	Concentration (Jan. 2016) (μg/m^3)	Criteria (μg/m^3)
Unit #1			
Trichloroethylene	0.46	<0.27	0.4
Perchloroethylene	120	16.8	14
Unit #2			
Trichloroethylene	<0.27	<0.27	0.4
Perchloroethylene	71	7.82	14

Keywords: vapour intrusion, environmental contaminants, building design, sub-slab depressurization