# Review of Fungal Hazards from Soil Disturbance in Excavations

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# Introduction

The purpose of this report is to provide an overview of the fungal hazards that occur from soil disturbances during excavations in Ontario.

Soil is the immediate surface of the earth located above bedrock. It can be very shallow, or it can be deep. Generally, it is defined as "up to" 200 cm deep, though anything deeper than around 20-30 cm may also be subcategorized as subsoil (Naylor et al., 2022, Soil Society of America 2024a). Soil is a complex mixture of solids, liquids and gases; the solids are made of a mixture of minerals, organic matter, and microorganisms, whereas the liquids are mostly water (Soil Society of America 2024a). Soil is most commonly categorized by particle size from largest to smallest as sand, silt, and clay. The subsoils and lower depths of soil generally have a higher clay content (Sing and Sing, 2006, Baumgardner, 2012, Naylor et al., 2022, Soil Society of America, 2024a).

Excavations that disturb soil can result in many safety hazards such as: cave-ins; falls into the excavation; and slips, trips, and falls while accessing, egressing, or working in the excavation (IHSA, 2024). In addition, many other safety hazards that are identified in risk assessments include: materials handling; housekeeping; heavy equipment hazards; struck-by incidents; confined spaces; among others (IHSA, 2024). In addition, when the soil is mechanically disturbed in an excavation, the soil itself can be rendered airborne. Whether or not the airborne biological agents and hazardous materials in the soil are hazardous will depend on many factors.

This report focusses on soil hazards in Ontario that cause risks during excavation, with an emphasis on biological agents.

# Occupational Exposures

## Microorganisms

The natural microbiome in soil includes archaea, bacteria, fungi, protozoa, and viruses, which can broadly be called microorganisms. The quantity and type of microorganisms will be determined by the temperature, sunlight, moisture content, nutrient, redox potential (how oxidized or reduced/anerobic), and pH level (Baumgardner, 2012). Inanimate matter, including water and soil, act as reservoirs of microorganisms (van Seventer and Hochberg, 2017), though exposure must occur through the correct mode of transmission for pathogenicity to arise.

The majority of microorganisms are not pathogenic in humans (Alberts et al., 2002). In pathogenic microorganisms, the risk of disease will depend on the mode of transmission and the infectivity. The mode of transmission is different for different microorganisms, divided into modes of direct and indirect transmission. Modes of direct transmission include direct contact (including ingestion), droplet spread, bite, and transplacental/perinatal. Modes of indirect transmission include biological (vector borne or intermediate host), mechanical (including vehicles such as fomites, and vectors such as fecal-oral spread, among others), or airborne (van Seventer and Hochberg, 2017). Infectivity will vary based largely on two factors: the microorganism's infectious dose 50 (ID50), or the amount of agent required to infect 50% of the exposed population, and the individual's underlying health and risk factors (van Seventer and Hochberg, 2017).

This section will address bacteria and fungi that are a risk during soil excavation in Ontario. The risk is dependent on the geography as well as individual susceptibility of each worker (Baumgardner, 2012). The literature review identified very limited-to-no risks from soil excavation for archaea, protozoa, or viruses.

There are bacterial hazards that are only an issue for someone who is manually digging in soil from anaerobic spores. The three bacteria listed in the literature are: botulism from a toxin produced by *Clotridium botulinum*; gas gangrene caused by several *Clostridium* bacteria; and tetanus from a toxin produced by *Clotridium tetani* (Doron and Gorbach, 2008). Botulism is only very rarely acquired from manually digging in soil when a deep trauma occurs (Baumgardner, 2012). Gas gangrene is most typically following a deep wound (Baumgardner, 2012). Tetanus is a risk in unvaccinated people when their non-intact skin, with even tiny scratches, is in contact with the bacteria such as during archaeological digs (Abraham, 2002, Baumgardner, 2012). The risk during an excavation with heavy equipment would be very low if workers are not manually digging in the soil. Any workers involved in excavations that have manual work being performed in the soil should be aware of these risks, wear gloves, and ensure their tetanus vaccination is up-to-date in accordance with Public Health Ontario and/or Public Health Agency of Canada guidance.

There are also microorganisms in soil that pose a hypothetical risk if soil is mechanically disturbed, but no reports have been made of disease, suggesting a very low risk. *Bacillus anthracis* produces anthrax spores, which are very common in soil and can remain dormant for several decades or even up to a century (Boron and Gorbach 2008, Finke et al., 2020). Despite a theoretical risk of inhalation during excavation, no sources of inhalation infection from disturbed soil were identified in two literature reviews (Baumgardner, 2012, Finke et al., 2020). The latter review concludes there is a hypothetical risk of inhaling anthrax when soil excavation or remediation is done, particularly if the site was a former animal processing sector such as leather processing, tanneries, rendering facilities, and any sites that processed diseased animals. However, the authors ultimately conclude that the risk is very low due to the high spore load that must be inhaled for infection to occur (Finke et al., 2020).

There are also soil hazards that occur in other geographic regions that are not addressed in this report, such as coccidioidomycosis, also called Valley fever, an infection caused by coccioides fungi. Coccioides fungi are not endemic to Ontario (Baumgardner, 2012, Brown et al., 2018, Bays and Thompson, 2021). There are reports of coccidioidomycosis occurring in Ontario, but all cases were believed to be from travel exposures to endemic regions in the United States of America (Sekhon et al., 1991, Nicolle et al., 1998, Brown et al., 2018).

Other potential ways of being exposed to microorganisms include direct ingestion (geophagia) or indirect ingestion (contaminated food), which will also not be addressed in this report.

The two infectious diseases identified in the literature as a risk during excavation in Ontario are blastomycosis and histoplasmosis, which are fungal infections. Blastomycosis rates vary widely in Ontario by region: the average from 1995-2005 is 0.41 cases per 100,000 people, though it is lowest in the southwest (0.05 cases per 100,000) and highest in the northwest (10.9 cases per 100,000) (Brown et al., 2018). Ontario data from 1992-1994 observed a histoplasmosis case rate of 0.059-0.124 per 100,000 people (Nicolle et al., 1998). Although the time periods and reference populations are not identical, this data suggests blastomycosis may be more common than histoplasmosis in Ontario. This is the opposite of data reported in the United States of America, confirmed and probable histoplasmosis cases were 5-times higher than confirmed and probable blastomycosis cases (Smith et al., 2022).

## Blastomycosis

Blastomycosis is a pulmonary infection with *Blastomyces*, a fungal (mould) species. This mould is endemic (naturally occurring) in parts of Canada and the United States of America (Nicolle et al., 1998, Morris et al., 2006, Saccente and Woods, 2010, Baumgardner, 2012, Smith et al., 2013, Miceli and Krishnamurthy 2023). *Blastomyces* growth is typically favourable in wet soil such as near bodies of freshwater, in soil that has a high content of organic material, and an acidic environment (Saccente and Woods, 2010, Health Canada, 2016). It is also favoured in areas with rotten wood near freshwater (Health Canada, 2016).

The majority of blastomycosis infections in Canada occur in Ontario, specifically in the Great Lakes and St. Lawrence River / Seaway region and select lakes in northern Ontario (Health Canada, 2016, Linger et al., 2023). Limited peer reviewed published literature has identified blastomycosis infections in Manitoba and Saskatchewan (Lohrenz et al., 2018); though Health Canada (2016) recognizes that Blastomyces may be found in Manitoba and Saskatchewan.

The majority of blastomycosis infections in Ontario are from infection with *B. dermatitidis* (Morris et al., 2006, Saccente and Woods, 2010, Smith et al., 2013, Linder et al., 2023, Miceli and Krishnamurthy, 2023). Blastomycosis infections can also be caused by *B. gilchristii* in some areas of western Ontario and western Wisconsin (Brown et al., 2013), and by *B. helicus* in parts of western Canada and western United States of American (Schwartz et al., 2019).

About 50% of blastomycosis infections are asymptomatic, meaning there are no symptoms. Of the people who have infectious symptoms, the majority have “flulike” symptoms such as fever, cough, malaise, and myalgia (muscle aches and pains) that resolve without medical intervention within a few days of onset (Wallace, 2002, Miceli and Krishnamurthy, 2023). More severe infections can result in pneumonia that can lead to acute respiratory distress, particularly in elderly or immunocompromised populations (Baumgardner, 2012, Miceli and Krishnamurthy, 2023).

Blastomycosis was a reportable disease in Ontario until 1989 (Morris et al., 2006), and it was reintroduced as a reportable disease in 2018 when O. Reg. 559/91: Specification of Reportable Diseases was replaced by O. Reg. 135/18: Designation of Diseases.

Prior to 1990, Ontario had an estimated 1.8 cases per year, but more recent data identified an average of 33.7 cases per year from 1994-2003 (Morris et al., 2006), suggesting its incidence may have increased. Cases per year does not reflect the rate based on the population size. Select Ontario data from 1992-1994 observed a case rate of 0.094-0.144 per 100,000 (Nicolle et al., 1998), Ontario data from 1994-2003 observed that Ontario had an overall rate of 0.30 cases per 100,000 (Morris et al., 2006), and data from Ontario from 1995-2005 observed a rate of 0.41 cases per 100,000 (Brown et al., 2018). The rates also vary by region, with the lowest rate in the southwest from 0.02 per 100,000 (Morris et al., 2006) to 0.05 per 100,000 (Brown et al., 2018). The highest rates occur in northern Ontario, with 2.44 cases per 100,000 reported (Morris et al., 2006), and 10.9 cases per 100,000 in northwestern Ontario (Brown et al., 2018). The rates overall increased in both studies’ monitoring periods; however, it is not clear if infections increased, or case reporting increased. The northern Ontario rates were impacted by the region of Kenora and Rainy River, which is described as “hyperendemic” with a rate of 117.2 cases per 100,000 population (Dwight et al., 2000).

Figure 1 is an excerpt from Morris et al. (2006) showing every region of Ontario's risk of blastomycosis with averages per 100,000 people per year from 1994-2003. Figure 2 is an excerpt from Brown et al. (2018) displaying Ontario's blastomycosis annualized incidence rates by region from 1990-2015.

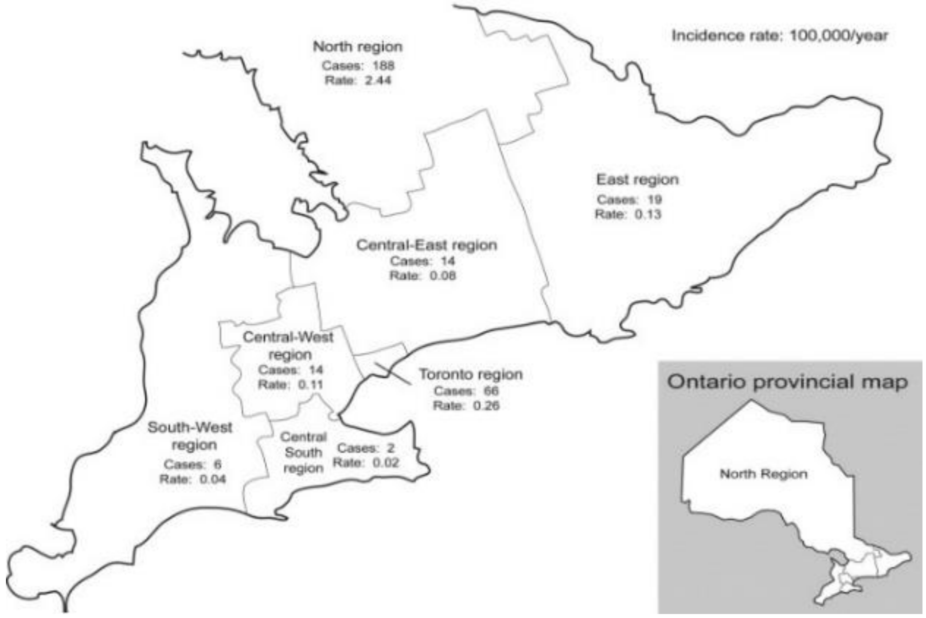


Figure 1: Ontario's case rate per 100,000 people of blastomycosis from 1994-2003; excerpt from Morris et al. (2006).

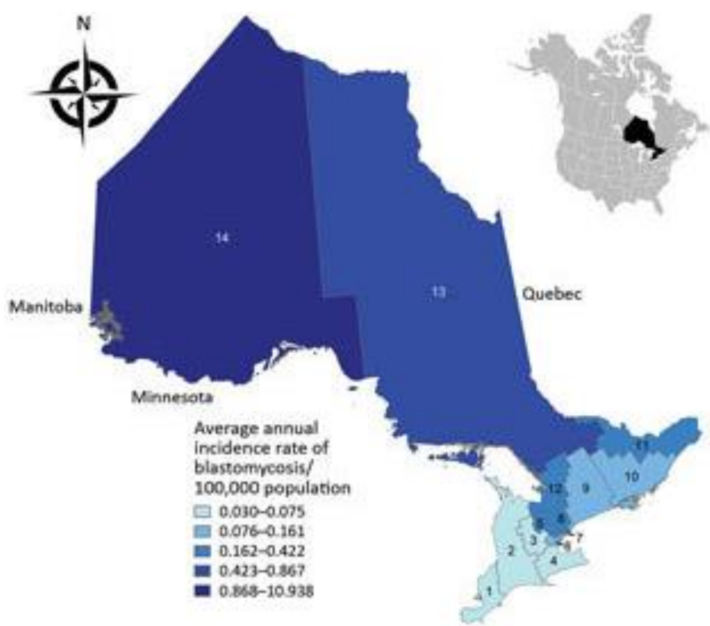


Figure 2: Ontario's annualized incidence of blastomycosis from 1990-2015; excerpt from Brown et al. (2018).

The rates published in both Figures 1 and 2 are likely underestimates since asymptomatic and minor infections are unlikely to be reported despite accounting for the majority of blastomycosis cases.

Select combined Ontario and Manitoba data from 1992-1994 observed that 8% of those with blastomycosis died of the infection, though this population also includes immunocompromised individuals (Nicolle et al., 1998). The case-fatality rate of blastomycosis in one study was observed to be 10% of reported infections (Ireland et al., 2020). One study analyzing 2019 data reported to the United States Centers for Disease Control and Prevention (CDC) observed a case-fatality rate of 9% (Smith et al., 2022). As noted earlier, the case-rate likely underrepresents actual infections, which in turn would lower the case-fatality rate of actual infections. Patients were most likely to be male (60-75%) with a median age of 41-44. Patients who died were over 5-times more likely to have a concurrent medical condition (Ireland et al., 2020).

Most infections are sporadic environmental infections (Morris et al., 2006). However, some well described outbreaks have occurred due to construction, mostly environmental (non-occupational) exposures, though occupational exposures are possible. The peer-reviewed literature search identified blastomycosis case reports and outbreaks traced to construction sites (Tosh et al., 1974, Kitchen et al., 1977, Baumgardner et al., 1991, Frye et al., 1991), such as residing or driving near Chicago road construction excavation sites (Kitchen et al., 1977), an airborne dust downwind from a hotel excavation in Wisconsin (Baumgardner et al., 1991), and an outbreak of 34 cases was traced to a major highway construction project (Carlos et al., 2010).

In a large study of community-acquired infections in Minnesota from 1999-2018 (where blastomycosis is a reportable disease), Ireland et al. (2020) reported that 33% of men diagnosed with blastomycosis and 32% of women diagnosed with blastomycosis were reported as being "near" an excavation, but an odds ratio was not calculated. A large number of these cases were relating to one excavation for a new neighbourhood in 1999. Other exposures identified in this study as being commonly reported by those who contracted blastomycosis included: occupational exposure to soil, wooded or boggy areas (21%), specific soil exposure (78%), owning a dog (53%), participating in outdoor activities (59%), fishing (30%), gardening (38%), among others.

In case-control studies, some increased risks have been found, though the risk varies widely. A case-control study in Missouri investigating risk factors for blastomycosis in 93 laboratory-confirmed cases compared to 1:4 randomly selected matched controls in the same geographic region found that working in construction did not increase the risk: odds ratio (OR) = 1.33, 95% confidence interval (CI) 0.26-5.95 (Cano et al., 2003). A large outbreak in Wisconsin included analysis of case matched 1:3 with household controls and neighbourhood controls and found an increased risk of blastomycosis in those who were near excavation or construction sites: OR = 4.2, 95% CI 1.1-19.9 (Roy et al., 2013). A case-control study of historical cases matched by gender and age group to randomly selected controls in Wisconsin did not find an increased risk with outdoor occupational activities (OR = 0.3, 95% CI 0.1-1.0), but that non-occupational digging or excavation had an increased but not statistically significant risk of blastomycosis (OR = 5.3, 95% CI 0.9-44.0) (Pfister et al., 2011).

Overall, blastomycosis is a low likelihood and low severity risk for most workers involved with soil excavations, but it can be a low likelihood and high severity risk in some workers. Working in wet soil or rotten wood near freshwater in *Blastomyces*-endemic areas will increase the likelihood of blastomycosis. Control measures will be briefly summarized later in the report.

## Histoplasmosis

Histoplasmosis is an infection with *Histoplasma capsulatum*, which is a fungal (mould) species related to *Blastomyces* (Baumgardner, 2012). The mould is a risk in soil, particularly when there is bird or bat guano present (Sorley et al., 1979, Stobierski et al., 1993, Staffolani et al., 2018, de Perio et al., 2021, Dingle et al., 2021).

Approximately 60-90% of residents in eastern and central United States have been exposed to the fungus *H. capsulatum* (Baumgardner, 2012, CDC, 2024), though this does not necessarily indicate 60-90% of residents have had histoplasmosis. No similar immunological/serological data was identified in the literature review for Ontario; however, since *H. capsulatum* is also endemic to Ontario (Staffolani et al., 2018), it is biologically reasonable that many Ontarians have been exposed to the fungus. *H. capsulatum* cases are mostly reported in Alberta and Ontario (Brown et al., 2018, Dingle et al., 2021, CCOHS 2023). Within Ontario, the highest case rates are found along the St. Lawrence River / Seaway (Brown et al., 2018, CCOHS, 2023), with high total cases occuring in the Toronto-area (Brown et al., 2018).

If exposure to *H. capsulatum* results in an infection, it is generally an asymptomatic infection in immunocompetent (healthy) individuals (Knox and Hage 2010, Baumgardner, 2012, Wheat et al., 2016, Staffolani et al., 2018, Benedict and Moody, 2016, Benedict et al., 2020, de Perio et al., 2021, CCOHS, 2023), though subacute pulmonary syndrome is also possible (Wheat et al., 2016, Staffolani et al., 2018). When very high exposures to *H. capsulatum* occur in immunocompetent individuals, it results in a more severe histoplasmosis infection called acute syndrome (Wheat et al., 2016, Staffolani et al., 2018). Histoplasmosis symptomatic infection is primarily a pulmonary infection (50-80% of cases), though it may be disseminated to other organs including the liver, skin, spleen, bone, lymph nodes, central nervous system, among others (Baumgardner, 2012, Brown et al., 2018, Staffolani et al., 2018). Different genotypes have been investigated as having different virulence (severity or harmfulness) factors (Knox and Hage, 2010, Taylor et al., 2022).

Histoplasmosis is not currently a reportable disease under O. Reg. 135/18: Designation of Diseases, and was also not reportable under the previous O. Reg. 559/91: Specification of Reportable Diseases.

Ontario had 211 cases of laboratory-confirmed histoplasmosis from 1990-2015, for a median of 7.5 cases per year (range 3-13 cases per year). No seasonal trends or yearly changes in rate were observed (Brown et al., 2018). Select Ontario data from 1992-1994 observed a case rate of 0.059-0.124 per 100,000 (Nicolle et al., 1998).

Select combined Ontario and Manitoba data from 1992-1994 observed that 17% of those with histoplasmosis died of the infection, though this number includes immunocompromised individuals (Nicolle et al., 1998). An analysis of histoplasmosis in Alberta observed a 100% survival rate among 15 individuals, including several immunocompromised individuals (Dingle et al., 2021). One study analyzing 2019 data reported to the CDC observed a case-fatality rate of 5% (Smith et al., 2022). In a meta-analysis of multiple studies, 99.8% of immunocompetent people with histoplasmosis recovered, representing one death out of 727 people infected. The one individual who died had a co-infection with typhus (Staffolani et al., 2018). Although this study is a large analysis, it did not include analysis of individuals with histoplasmosis in Canada.

Figure 3 is an excerpt from Brown et al. (2018) displaying Ontario's histoplasmosis annualized incidence rates by region from 1990-2015.

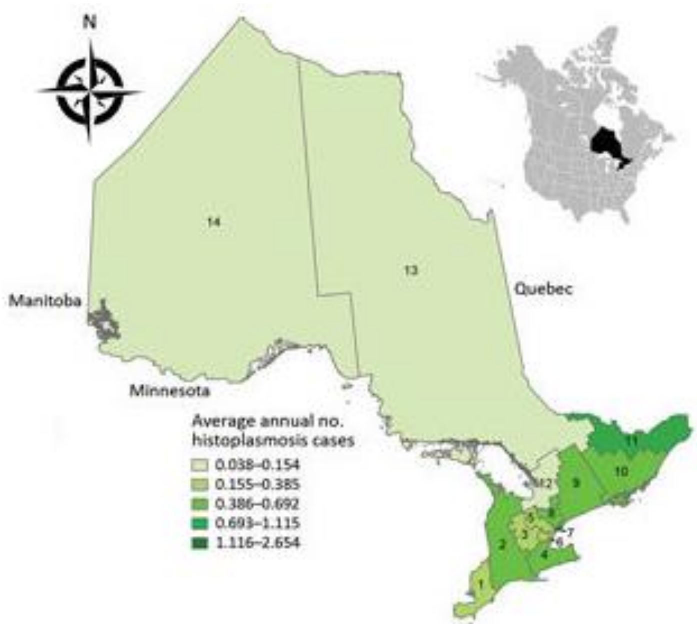


Figure 3: Ontario's annualized incidence of histoplasmosis from 1990-2015; excerpt from Brown et al. (2018).

The incident rates published in Figure 3 are likely underestimates since asymptomatic and minor infections are unlikely to be reported despite accounting for the majority of histoplasmosis cases.

Some well described outbreaks include: heavy equipment operators moving topsoil of a former barn due to bird guano being converted to a landfill; bridge workers; living downwind of a bridge undergoing demolition due to bat guano; cleaning chicken coops and sweeping bird guano; excavation; renovation; demolition; and various tasks that disturbed areas where birds or bats currently or formerly roosted (Huhn et al., 2005, Benedict and Moody, 2016, de Perio et al., 2021). Exposures can happen from simply walking on contaminated soil, though large construction sites tend to result in outbreaks among workers and/or among people residing downwind (Benedict and Moody 2016, de Perio et al., 2021).

Presence of bird or bat dropping accumulations was described in 40% of investigated work-related outbreaks, and 25% of work-related outbreaks described demolition or construction activities. Overall, this review found 77% of all outbreaks in the United States of America reported evidence of bird or bat guano (Benedict and Moody, 2016). Among an outbreak of bridge workers dismantling a bridge with visible bat guano, the following characteristics were associated with a positive, statistically significant risk of histoplasmosis: jack- or air-hammering (relative risk (RR) = 4.0, 95% CI 1.2-13.3), waste disposal (RR = 4.0, 95% CI 1.2-13.3), saw or had contact with bats (RR = 7.0, 95% CI 1.1-43.0), and contact with bat guano (RR = 4.0, 95% CI 1.2-13.3); whereas excavation or finishing were not associated with an increased risk (Huhn et al., 2005).

Among sporadic cases (individual cases, not part of an outbreak) of histoplasmosis analyzed in nine states, the following were reported as the most common potential exposures: gardening, landscaping, or planting trees; digging soil; participating in or even being near construction, demolition, or renovation; or handling bird or bat guano. However, nearly one-quarter (22%) did not recall any exposures (Benedict et al., 2020). When this dataset was analyzed for the incidence rate ratio (IRR), working in construction and extraction occupations had an increased

IRR = 4.8, 95% CI 2.1-11.2, compared to the referent category of administrative and office support workers. This data identifies that histoplasmosis can also occur sporadically in occupational settings.

Overall, histoplasmosis is a low likelihood and low severity risk for most workers involved with soil excavations, but it can be a low likelihood and high severity risk in some workers. Working in soils that contain bird or bat guano, even decades later, will increase the likelihood. Control measures will be reviewed later in the report.

## Brief Review of Chemical Contaminants in the Soil

When soil is contaminated, excavation can render these hazardous agents airborne resulting in inhalational risks. Skin absorption is possible if the soil is handled with bare hands or with contaminated gloves. Secondary ingestion is also possible, though not as likely if hand hygiene using clean water is available.

The hazards in the soil will vary depending on both its natural contents and the site's former uses. Soil can naturally contain harmful levels of arsenic and lead (IDPH, 2023, Soil Society of America, 2024b). In addition, past uses may result in soil that contains asbestos, corrosive agents, insecticides or pesticides, lead, metals / metalloids, petroleum-based chemicals such as gasoline and diesel, and volatile organic compounds (VOCs), among others (Soil Society of America, 2024b).

Soil pollution is defined as soil contamination at higher than normal concentrations. Some heavy metals / metalloids may be naturally occurring in the soil and/or may be present due to past or current human activities (Münzel et al., 2023). For instance, arsenic, cadmium, and lead may all be naturally occurring in soil and/or may be present in soil due to industrial activities. Pesticides, fungicides and herbicides may all remain in the soil after they've been applied. Other past uses of the site must also be researched to understand the excavation risks. For instance, a former chemical site may have buried chemicals from leaks or spills, any former internal combustion engines may have results in petroleum leaks or spills, and demolished buildings may result in buried asbestos-containing materials or paints with elevated metals / metalloids under the soil.

The review by Lupolt et al. (2022) primarily assessed ingestion hazards for agricultural workers. Chemicals can be made airborne when the soil is disturbed, resulting in both particulate and volatile (gas) exposures (Soil Society of America, 2024b). Ingestion is expected to be lower in construction activities since manual disturbances with hands is less frequent. Nevertheless, ingestion is possible via the mucociliary escalator from inhalation or via dirty hands if manual activities occur.

In addition, materials buried in the soil can result in hazards when the soil is disturbed. The most common hazard includes asbestos-containing materials. Some of these hazards are only a risk when the soil is disturbed, as can occur during excavations.

This is not an exhaustive list: anything that is either buried in the soil or spilled into the soil can contaminate the soil. It is important that the previous uses of the soil be researched before starting an excavation.

# Brief Discussion of Control Measures

There is not a single list of necessary control measures that will prevent all risks and are appropriate for all situations. The risks must be considered for each project. The soil itself can be a source of hazards in excavations and other construction activities that mechanically disturb the soil. As a best practice, activities to prevent dust-generation could reduce risk, such as water spray, daily site clean-up (housekeeping) activities, barriers around work sites, and coverings over dirt can be employed as a minimum level of precaution.

The risk of *Blastomyces* or *H. capsulatum* should be assessed before each project. Personal protective equipment (PPE) may include impervious footwear that can be cleaned with soap-and-water (such as rubber safety boots), coveralls (not laundered at home) or disposable coveralls, safety glasses or goggles, and gloves when handling soil. Engineering control interventions such as wetting may be inadequate when guano is high (Huhn et al., 2005), so respiratory protection is required for all medium and high-risk activities. For medium risk activities including general demolition or general excavation, a fit-tested half-face N95 air-purifying respirator is recommended. If desired, a higher level of particulate respiratory protection is also acceptable, such as a half-face filtering facepiece elastomeric respirator with any 95-series, 99-series, or 100-series filter (e.g. N95, R100, P100, etc.). For high-risk activities such as remediating sites with large accumulations of bird or bat droppings, then a full-face filtering facepiece elastomeric respirator with 100-series filters (N100, R100, P100) or a power air-purifying respirator with any approved filter (HE, PAPR100-N, PAPR100-P) is required. For further information, refer to the review published by de Perio et al., 2021 that outlines respiratory protection levels; and the regulations R.R.O. 1990, Reg. 833: Control of Exposure to Biological or Chemical Agents (Reg. 833) for respiratory protection requirements, and O. Reg. 213/91: Construction Projects for dust control and general training requirements, both made under the Occupational Health and Safety Act (Ontario) (abbreviated as OHSA).

If exposure to arsenic, asbestos, benzene, lead, mercury, silica, or vinyl chloride (or the other designated substances) may exceed the time-weighted average limits (TWAs) defined by Reg. 833, then the control measures and procedures prescribed by O. Reg. 490/09: Designated Substances (O. Reg. 490/09) made under the OHSA may be consulted to identify the control measures and procedures required for occupational health and safety at the site. Even if on a site where O. Reg. 490/09 does not apply, there is still a requirement to keep exposures below the TWA defined by Reg. 833, and for the employer to “take every precaution reasonable in the circumstances for the protection of a worker” as defined by S. 25(2)(h) of the OHSA.

If exposure is likely to occur to other metals / metalloids and the TWAs defined by Reg. 833 may be exceeded, then the control measures prescribed for lead by O. Reg. 490/09 will likely also be acceptable to control for all other metals’ and metalloids’ exposures. Exposures must be below the TWA defined by Reg. 833, and every precaution reasonable in the circumstances must be taken for the protection of a worker defined by S. 25(2)(h) of the OHSA.

# Conclusions

The soil itself can be a source of hazards in excavations and other construction activities that mechanically disturb the soil. As a best practice, to reduce risk, activities to prevent dust-generation can be employed, such as water spray, daily site clean-up (housekeeping) activities, barriers around work sites, and coverings over dirt.

Blastomycosis was a reportable disease in Ontario until 1989, and it was reintroduced as a reportable disease in 2018. It is likely that blastomycosis is underreported since most cases have either no or mild symptoms in most who are infected. The rate in Ontario is an average from 1995-2005 of 0.41 cases per 100,000 people, though it is lowest in the southwest (0.05 cases per 100,000) and highest in the northwest (10.9 cases per 100,000).

Histoplasmosis is not a reportable disease in Ontario. Select Ontario data from 1992-1994 observed a case rate of 0.059-0.124 per 100,000 people, with a higher rate in the south particularly along the St. Lawrence River / Seaway region.

Although the time periods and reference populations are not identical, this data suggests blastomycosis may be more common than histoplasmosis in Ontario. However, this could be an artefact of reporting requirements, since histoplasmosis is not a reportable disease in Ontario. A Canada-wide study observed there are more histoplasmosis infections when evaluating all ages, but blastomycosis is more common in those ages 20-65. Notably ages 20-65 is the common age demographic of most working people.

The case-fatality rate of blastomycosis is 8-10% of reported infections, comparable to 5-17% for histoplasmosis reported infections. These reported case-fatality rates are of the entire population, including immunocompromised and vulnerable populations. Among healthy, immunocompetent populations, the case-fatality rates for both diseases are typically lower.

If bird or bat guano is suspected or confirmed, appropriate PPE including respiratory protection is recommended (Huhn et al., 2005, de Perio et al., 2021).

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