



Mould Assessment Recommendations

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Introduction

This report provides Public Health Inspectors (PHIs) and Environmental Health Officers (EHOs) with recommendations for evaluating buildings, residences, and other built environments for mould. This information is based on *Mould Assessment in Indoor Environments – Review of Guidelines & Evidence*, which includes available evidence from current research papers and mould assessment guidelines commissioned by the National Collaborating Centre for Environmental Health (NCCEH).

The focus of this report is mould assessment in the home environment and it does not address mould assessment or exposure in occupational environments. Although many mould assessment strategies contained in this report can be broadly applied, the investigation of large buildings may be complicated and will require additional skills and considerations.¹⁻⁴ In particular, mould growth in healthcare settings requires special attention; individuals with compromised health may be at additional risk from mould. Marijuana grow operations also present special challenges and risks that are not addressed in this report; refer to the NCCEH document, [Recommendations for Safe Re-occupancy of Marijuana Grow Operations](#).



Summary

- Excessive dampness and mould growth on building material surfaces and contents can pose health risks and should not be tolerated in indoor environments.
- A mould assessment determines if mould is present, but does not determine or estimate mould exposure.
- Health-based exposure limits for indoor mould in residential environments have not been established; inspecting for visible and hidden mould, removing mould where present, and repairing and controlling sources of excessive moisture is the best approach to controlling health risks.
- Visual inspection is recommended as the primary tool for assessing indoor moisture and mould. Mould sampling is recommended only when the results of a visual inspection are ambiguous or when more detailed information is necessary.
- Awareness and ongoing prevention activities for mould and moisture are important strategies for building occupants and homeowners.

evidence.
review

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Principles of indoor mould growth

Mould is a type of fungi, an eukaryotic organism that exists in a separate classification from plants and animals. For the purposes of this document, *mould* refers to any of the following that are present in the air or on surfaces in indoor environments: live or dead growth on indoor surfaces, viable or nonviable mould spores, mould structural components, or mould metabolic byproducts.⁵

Key principles widely accepted in the field and supported by research include:

- **Mould is everywhere.** Moulds are naturally occurring and widespread in the environment. It is not possible to eliminate exposures to all moulds, nor is it necessary from a health perspective.
- **Moisture is the key determinant of indoor mould growth.** The surfaces of most indoor environments provide appropriate temperature conditions and ample nutrients for moulds to grow; water is the only additional element required for mould growth.
- **Mould is associated with human health effects,** but dose-response relationships between the amount of mould in an indoor environment, the species of mould, and the level of mould exposure and human health are not clearly defined.^{5,6}
- **There are no recommended health-based exposure limits for mould.** Due to a lack of scientific data, most professional organizations

have not agreed upon or supported numerical limits for mould in residential environments.^{1,4,7}

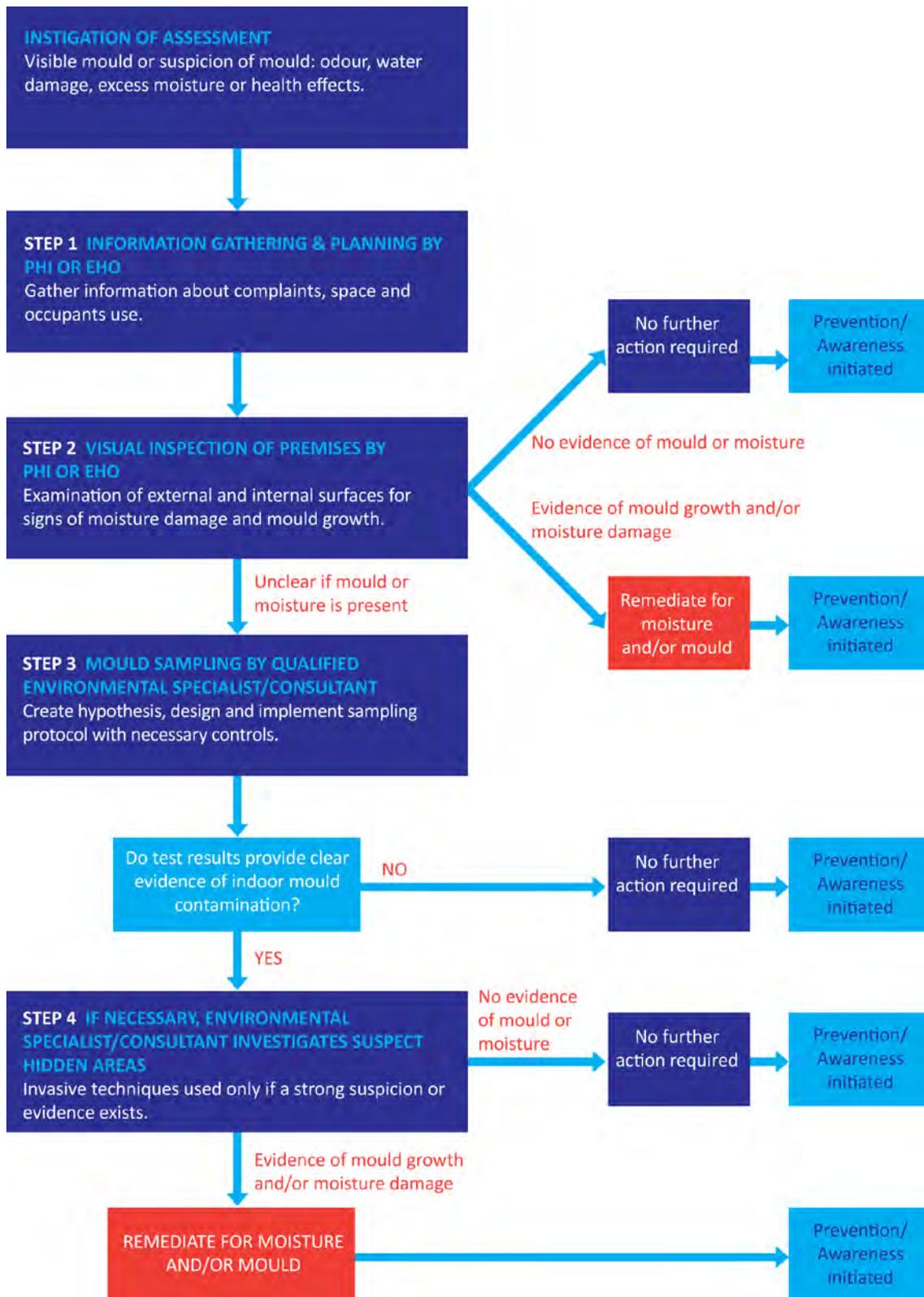
- **Mould is a mixture of live and dead organisms; both can be harmful.** Both live and dead mould and mould fragments contribute mycotoxins and other mould products, which have been shown to retain their antigenic and toxic properties over extended periods of time.^{4,5}
- **Determining mould exposure is complex.** Currently, there are no scientifically validated methods to measure mould exposure.

The approach endorsed by most guidelines is that the visible growth of mould indoors, regardless of the species or the amount, is inappropriate and needs to be removed.

Mould assessment: determining the presence, location and amount of indoor mould and moisture

The purpose of mould assessment is to: (1) determine the presence, location, and extent of past and current mould growth in buildings; (2) identify the source, cause, and extent of water ingress, condensation or dampness indoors; (3) determine if there are plausible and significant indoor mould exposure pathways for occupants; (4) use this information to make a mould-exposure risk management decision.^{1,8} A mould assessment decision process is shown in Figure 1.

Figure 1: Mould assessment decision flowchart



Notes: *Step 1: Information Gathering & Planning* and *Step 2: Visual Inspection of Premises* are normally conducted by PHIs. If additional analysis is necessary to determine the presence or absence of mould, the building owner or occupant is encouraged to hire a qualified

Environmental Specialist/Consultant to conduct a more detailed assessment described in *Step 3: Mould Sampling*, and if necessary, *Step 4: Investigate Suspect Hidden Areas*.

Step 1: Information gathering and planning

The assessment process begins with a suspicion of mould. This can be a complaint from the occupant about health effects, an odour, presence of visible mould or moisture damage, excess humidity, or a specific incident, such as a leak or flood. The objective of this step is to gather as much information as possible about the situation and to create an assessment plan. Factors influencing assessment planning include the magnitude of the observed or anticipated problem, available resources, documentation requirements, and inspector qualifications.^{1,9} Occupant interviews or questionnaires can be conducted prior to or during the site inspection, but should never replace an inspection. Occupants concerned about health issues or symptoms should be referred to a physician.^{1,7,10-12}

Step 2: Visual inspection of premises

A detailed visual inspection, coupled with information gathered about the building history and conditions, is the best method to identify the cause, location, and extent of mould within the occupiable spaces of a structure.^{1,3,5-7,13} Building characteristics, such as architecture, construction quality, age, history of prior water issues, and condition and repair of the building need to be considered. Personal protective equipment (PPE) is not usually required during a visual inspection. All observations and readings obtained during the inspection need to be documented in notes or photos; detailed instructions and checklists for performing visual inspections are provided in several guidelines.^{1,8,14} A visual inspection should include the following:

- **Identify sources of water damage and evidence of mould.** Indicators include visible mould growth, an earthy or musty odour, evidence of leaks or flooding such as water stains, wet areas, decayed wood, peeling paint, wrinkled wallpaper, cracks in plaster, warped wood, or white powdery salt crystals on the surface of walls or masonry. In addition, signs of water intrusion or chronic condensation, structural damage, previous repairs and renovations, as well as any structural defects, need to be identified.
- **Review of the building exterior.** Look for any obvious signs of external building deficiencies,

water intrusion, or failed materials or surfaces, including missing drainage elements or staining. The area surrounding the building should also be inspected for potential sources of aerosolized mould, including water sources, landscaping, and digging activities.

- **Review of building interior.** If applicable and appropriate, this includes a walk-through of all occupiable areas and others, such as attics, basements, crawl spaces, and storage spaces. Note that entry into confined spaces* requires specific training as well as appropriate protective clothing and breathing equipment. Inspection of confined spaces is not conducted during an initial building inspection, but may be conducted as part of a more detailed assessment (Step 4).

Inspect surfaces around plumbing, under and adjacent to windows, doors, and other penetrations through the building's exterior. Condensation observed on windows and pipes should be documented.

The number of occupants, living activities, characteristics, and contents of the building need to be considered.

- **Inspection of heating, ventilation, and air conditioning (HVAC) systems.** At a minimum, the furnace heating and air conditioning systems should be inspected; also any stand alone or integrated humidifiers. Larger or more complex systems may need to be evaluated by specially trained individuals.
- **Identify the source and extent of moisture.** Moisture measurements can be used to locate or estimate the extent of concealed or non-visible mould contamination and can include relative humidity (RH) measurements, as well as surface moisture measurement of building materials.^{1,4,6,8,9} Periodic or seasonal moisture sources, or those that occur within hidden areas such as wall cavities, are more difficult to identify as they may not be visible at time of inspection.¹ Regardless of mould, contaminated water containing soil, sewage, or pathogens may harm occupants so the type of water present needs to be determined.¹

* Confined spaces are defined as: (1) spaces large enough and configured so that an employee can enter and perform assigned work; (2) have limited or restricted means for entry or exit; (3) are not designed for continuous employee occupancy.^{7(p.29)}

- **Determine the presence, amount, and location of indoor mould.** If mould growth is identified, the size or area of the visible fungal growth needs to be estimated; this will dictate the best method for mould remediation. The most common thresholds for mould remediation are 1 m² of visible growth or less for small scale remediation projects, up to 10 m² for moderate projects, and greater than 10 m² for large scale remediation projects.¹⁴ Although often requested as part of an assessment, mould sampling is unnecessary if visible mould growth is observed^{5,14}; however, inspectors may make a decision to sample based on personal experience and risk management decisions.

Visual inspections lead to one of three possible outcomes:

- **No evidence of visible mould growth or moisture damage.** No remediation action is required, and no further action is required by the PHI. Prevention activities should be initiated.
- **Evidence of visible mould growth or moisture damage.** Remediation actions should be initiated to remove the mould and address the underlying cause of moisture.
- **Unclear if mould or moisture is present.** An environmental consultant/inspector should be engaged to proceed with *Step 3: Mould Sampling*.

Step 3: Mould sampling – collection, analysis, and interpretation

Mould sampling should be conducted only when a visual inspection reveals that unusual mould growth may be present, but cannot be confirmed visually. Sampling is appropriate when: (1) the presence of hidden mould is suspected and intrusive or destructive sampling may be required to locate it^{1,2}; (2) there are surface stains, but it is uncertain if the staining is mould; (3) there is a need to judge the effectiveness of remediation, or as part of a quality assurance strategy, to ensure there are no additional sources of contamination outside the remediation area.¹⁻³

Mould sampling has many significant limitations; it can be time consuming, expensive, and does not identify moisture sources or why a problem has occurred. None of the sampling methods can determine the duration of mould growth or provide information about

mould exposure. Disturbing mould growth to obtain samples may also increase the health risk for occupants. In addition, sampling results can be highly variable and difficult to interpret, due to a lack of standardization and objectivity; this leads to inconsistent conclusions, even among professionals.¹⁵

Mould sampling ideally leads to one of two possible outcomes:

- **No evidence of mould contamination.** No remediation action is required, and no further action is required by the environmental consultant. Prevention activities should be initiated.
- **Clear evidence of mould contamination.** Further investigative actions are required to identify the source and amount of mould present. In this case, a qualified Environmental Specialist/Consultant should be engaged to proceed with *Step 4: Investigate suspect hidden areas*.

Step 4: Investigate suspect hidden areas

If a strong suspicion of hidden mould is supported by mould sampling results, more invasive techniques may be employed to determine the location. Because of the complexity as well as additional risks, investigations for hidden mould should only be conducted by a qualified environmental professional.^{1,8}

Signs of possible hidden mould include stains at the base of walls and under carpet associated with possible leak locations, such as windows. Identifying mould in hidden areas may require small-scale destructive openings of walls or other surfaces, lifting carpets or flooring, and removing wallpaper, drywall, or paneling.¹ More extensive destructive inspections are limited to situations where there is no other method to locate hidden mould and moisture. Because destructive inspections may involve the dismantling of building structures and can compromise the integrity of building materials, appropriate containment strategies and the involvement of other professions are required.

The potential for exposure to microbial contaminants in spaces such as attics, crawl spaces, exterior sheathing, and garages is poorly understood.^{1,5,16} As a result, qualified industrial hygienists and other building health professionals do not fully agree on the potential

impact of hidden mould growth on indoor air quality. While hidden moulds do not present a health risk for the building occupants if there are no identifiable pathways of significant exposure, exposure pathways are often difficult to identify.

Decisions and recommendations

A mould assessment needs to be conducted in a stepwise process (Figure 1), concluding with a decision about the presence of mould and moisture. The discovery of either mould or moisture suggests that additional investigation and remediation should follow.

At the end of this process, an indoor occupied space is considered to be acceptable for mould and moisture if: there is no visible mould growth on building surfaces (excluding naturally damp areas such as bathroom tiles and window sills); no indication of hidden mould or any unusual moisture sources identified, such as ongoing leaks, moisture infiltration or excessive condensation.

Prevention and awareness activities include reducing or controlling the sources of moisture that can support mould growth and educating occupants about how their activities can contribute to indoor moisture and mould. Regular indoor environmental maintenance activities, such as use of exhaust fans vented to the outside, use of HEPA vacuum cleaners, vigilance regarding mould growth and moisture infiltration, and

References

1. Prezant B, Weekes DM, Miller JD. Recognition, Evaluation and Control of Indoor Mold. Fairfax, VA: American Industrial Hygiene Association; 2008.
2. Health Canada. Fungal Contamination in Public Buildings: Health Effects and Investigation Methods. Ottawa, ON: Health Canada, Environmental and Workplace Health; 2004. Available from: <http://www.hc-sc.gc.ca/ewh-semt/pubs/air/fungal-fongique/index-fraeng.php>.
3. U.S. Environmental Protection Agency. Mold Remediation in Schools and Commercial Buildings. Washington, DC: EPA, Office of Air and Radiation, Indoor Environments Division; 2001. Report No.: EPA 402-K-01-001. Available from: http://www.epa.gov/mold/mold_remediation.html.
4. Macher J, editor. Bioaerosols: Assessment and Control. Cincinnati, OH: American Conference of Governmental Industrial Hygienists (ACGIH); 1999.
5. Institute of Medicine, Committee on Damp Indoor Spaces and Health. Damp indoor spaces and health. Washington, DC: National Academies; 2004.
6. World Health Organization. WHO Guidelines for Indoor Air Quality: Dampness and Mould. Copenhagen, Denmark: WHO, Regional Office for Europe; 2009. Available from: <http://www.euro.who.int/document/E92645.pdf>
7. Institute of Inspection Cleaning and Restoration Certification (IICRC). IICRC S520 Standard and Reference Guide for Professional Mold Remediation. Vancouver, WA: IICRC; 2008.
8. Scott JA. Clean-up Procedures for Mold in Houses. Ottawa, ON: Canada Mortgage and Housing Corporation Press; 2005.

immediate clean up of moisture can all contribute to better indoor environments.

Evidence Gaps

The mould assessment field has many points of controversy, mostly due to a lack of objective data and the potential risk presented by mould in the built environment. Areas for future research include:

- Development of better exposure assessment methods, so health risks of mould exposure can be determined and risk-relevant exposure metrics can be developed.
- Determining the impact of mould exposure outdoors and how this compares to mould exposure indoors.
- Development and validation of sampling and analytical methods to identify and accurately measure all microbial agents in indoor environments.

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9. Health Canada. Exposure Guidelines for Residential Indoor Air Quality. A Report of the Federal-Provincial Advisory Committee on Environmental and Occupational Health. Ottawa, ON: Health Canada, Environmental Health Directorate, Health Protection Branch; 2004. Available from: http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/air/exposure-exposition/exposure-exposition-eng.pdf
10. World Health Organization. Damp and Mould. Health Risks, Prevention and Remedial Actions. Information brochure. Copenhagen, Denmark: WHO, Regional Office for Europe; 2009. Available from: http://www.euro.who.int/_data/assets/pdf_file/0003/78636/Damp_Mould_Brochure.pdf.
11. Storey E, Dangman KH, Schenck P, DeBernardo RL, Yang CS, Bracker A, et al. Guidance for Clinicians on the Recognition and Management of Health Effects related to Mold Exposure and Moisture Indoors. Farmington, CT: University of Connecticut Health Center, Division of Occupational and Environmental Medicine, Center for Indoor Environments and Health; 2004. Available from: <http://oehc.uchc.edu/images/PDFs/MOLD%20GUIDE.pdf>.
12. Occupational Safety and Health Administration (OSHA). Preventing Mold-related Related Problems in the Indoor Workplace. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration; 2006. Report No.: 3304-04N. Available from: http://www.osha.gov/Publications/preventing_mold.pdf
13. Brandt M, Brown C, Burkhardt J, Burton N, Cox-Ganser J, Damon S, et al. Mold prevention strategies and possible health effects in the aftermath of hurricanes and major floods. MMWR Morb Mortal Wkly Rep. 2006;55(RR-8):1-27.
14. New York City Department of Health and Mental Hygiene. Guidelines on Assessment and Remediation of Fungi in Indoor. New York, NY: Environmental and Occupational Disease Epidemiology Unit; 2008 November. Available from: <http://www.nyc.gov/html/doh/downloads/pdf/epi/epi-mold-guidelines.pdf>.
15. Johnson D, Thompson D, Clinkenbeard R, Redus J. Professional Judgment and the Interpretation of Viable Mold Air Sampling Data. J Occup Environ Hyg. 2008;5(10):656-63.
16. Krstic G. Airborne Mould Concentrations in the Indoor Environment of "Mouldy Buildings." 9th Canadian Conference on Building Science and Technology; February 27-28; Vancouver, BC: National Building Envelope Council (NBEC); 2003.

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