RECOMMENDED BEST PRACTICES FOR MOLD REMEDIATION IN MINNESOTA SCHOOLS

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MINNESOTA
MDH
DEPARTMENT OF HEALTH

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Acknowledgments

This guidance document draws on a number of previously published guidance documents, listed in Appendix B. In text referencing is not provided because MDH assumes the recommendations provided in the utilized guidance documents cannot be attributed solely to those specific authors.

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EXECUTIVE SUMMARY

The Minnesota Department of Health (MDH) developed this guidance at the request of the Minnesota Department of Children, Families and Learning. It is a companion document to the MDH *Recommended Best Practices For Mold Investigations In Minnesota Schools* (November 2001). These two documents were prepared to assist staff of Minnesota public schools in identifying and correcting problems related to indoor mold contamination. The focus of this guidance is on practical, safe, and cost-effective methods to remove mold and associated contaminants. Planning and communication are also emphasized since these are key components of the mold remediation process. While principles of moisture control are described, a detailed description of how to address moisture problems and restore moisture-damaged materials is beyond the scope of this document.

Mold problems in schools range from simple situations that can be handled by in-house maintenance or custodial staff, to extensive contamination that requires professional assistance to safely and successfully resolve. This document provides health protective advice for the variety of mold problems that school officials may face. The advice is deliberately general in nature and based on best practices, since there is potential for great variability from one problem to another. Consequently, MDH recommends that school officials read this guidance, and then adapt the advice most applicable to their circumstances to formulate site- and situation-specific plans for the remediation of their mold problem.

Topics covered include communication strategies, pre-remediation assessment of the problem and causes, determining the scope of the remediation project, use of administrative controls, contaminant removal considerations, and post-remediation evaluation. Detailed remediation procedures for three categories ("Minimal", "Moderate" and "Major") of mold problem severity are also provided. These may be used as stand-alone remediation procedures but should be adapted according to site- and situation-specific issues.

An important point about mold problems in Minnesota schools is that school officials are ultimately responsible for how such situations are addressed in their facilities. In this guidance document, MDH attempts to acknowledge this autonomy by providing flexible recommendations based on principles and processes as opposed to strict standards or prescriptive requirements.

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1. INTRODUCTION

Mold contamination in the indoor environment is a complex issue. While scientific understanding about health effects and growth factors is evolving, there is currently considerable scientific uncertainty. Acknowledging this uncertainty, this guidance represents "best practices" advice that is general in nature for the types of situations many Minnesota school officials have struggled with recently.

There are no state or federal laws (as of June 2003) that specifically mandate how mold must be remediated. There are no consensus standards or laws about how much mold or what kind of mold is acceptable in a school or work place. Nevertheless, mold is a significant public health issue, and MDH has adopted a health-protective precautionary view that "no amount of visible mold growth is acceptable in occupied spaces". It is prudent for school officials to make a reasonable and good faith effort to address mold problems following the recommendations provided in this document.

MDH considers all molds potentially harmful when they are allowed to grow indoors. Dead or dormant mold may also be harmful when breathed. Mold contamination of the indoor environment (including schools) has been linked to discomfort and health problems including allergy reactions, asthma symptoms, irritant effects, respiratory problems, and a variety of other non-specific health complaints. In addition to these potential health effects, remediation workers whom do not use appropriate personal protection may develop hypersensitivity pneumonitis or organic dust toxic syndrome. The longer mold is permitted to grow indoors, the greater the likelihood it may become airborne and cause adverse health effects. When not corrected effectively, mold problems can spread to previously unaffected areas, which may increase health risks to occupants.

Remediation of mold refers to the process of removing contamination coupled with steps to modify the indoor environment to prevent the recurrence of growth. In many cases it is necessary for the remediation process to include engineering controls and other protective measures to prevent or minimize potentially harmful exposures to workers and occupants. The objectives of any mold remediation project are:

1) Correct the underlying moisture problem;
2) Effectively and safely remove fungal contaminated material, including the mold contaminants in settled dust;
3) Control contaminants during remediation; and
4) Repair property damage and prevent future loss to building materials and contents.

While it is best to address the moisture problem first, this may not be possible. In cases where solving the moisture problem must be delayed, it is still prudent to remove the mold. However, the moisture problem must be addressed as soon as possible—otherwise mold growth will likely return.

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School officials should ensure that remediation of contamination is planned and carried out carefully – especially when contamination is, or is suspected to be, extensive. When facing a suspected mold problem, school officials should consider the following:

- Are there immediate or likely health concerns?
- What is the extent of the problem?
- Are building materials structurally or functionally compromised?
- Can the moisture problem be remediated to prevent future mold problems?
- What are the school officials' liability concerns?
- What are the school officials' public relations concerns?
- What are the remediation options?

Since important details may vary from one situation to another, each mold problem can be uniquely complex. The ability to evaluate and respond to the many issues involved can also vary from school to school. Common sense and a considerable degree of judgment are necessary to determine how to best remediate a specific mold problem. Hence, this document intentionally allows school officials considerable flexibility in determining how to respond to mold problems within their facilities.

This document is organized into broad Sections 2 through 7 and appendices. All of the information is applicable to all but the very routine and small mold problems.

- Section 2 discusses communication first because this is often the first thing school officials must consider.
- Section 3 describes how to evaluate and use the investigative findings, highlighting the key issues described in "Recommended Best Practice for Mold Investigation in Minnesota Schools".
- Section 4 describes how to determine the scope of the problem and select the appropriate remediation methods. Detailed remediation procedures are located in Appendix A; these should be adapted to fit specific circumstances.
- Section 5 explains administrative controls that school officials may consider to limit worker and occupant exposure.
- Section 6 explains remediation practice considerations, such as seeking outside help, personal protection, proper cleaning and removal methods, and the use of disinfectants. Most of these issues are summarized in the Appendix A.
- Section 7 discusses evaluating a remediation project's effectiveness, which should be determined when planning the remediation project.
- Appendices provide example remediation procedures, references to additional information and a glossary of terms that explains the critical terminology used in this guidance.

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2. COMMUNICATION

When mold issues arise, school officials should expect staff, students, parents, teachers' unions, the media, or possibly the larger community to have a variety of questions. Underlying many such questions are concerns that need to be recognized and addressed. Open communication about health concerns can foster cooperation and early action vital to the efficient and successful resolution of mold problems. Without it, problems can be made worse and solutions delayed by frustration, anxiety, and distrust.

When a mold problem is perceived as a potential health threat (especially to children), it is predictable that people may become distrustful, anxious, and even openly hostile. This is especially true when parents feel that appropriate actions and safeguards are not being taken, that information has been withheld from them, or that their concerns are not being taken seriously. To manage expectations and prevent unnecessary anxiety, it is essential to effectively deliver complete and accurate information to affected stakeholders about the nature of the problem and the school officials' response. School officials should anticipate common questions and respond to all issues promptly and openly.

When mold problems are small and will likely be corrected through routine custodial practices, extensive communication efforts are often not necessary. However, due to the widespread attention recently given to mold, school officials should inform key stakeholders early whenever potential problems are noticed, such as water leaks, mold growth, or unusual complaints that could signal mold contamination. By acknowledging the existence of even simple problems and explaining how they will be handled, school officials can demonstrate their commitment to protecting building occupants. Early, proactive communication can avert rumors and the perception that information has been concealed.

When mold contamination is extensive, health concerns have been raised, or when remediation will disrupt normal school operations, school officials should develop a communication strategy and make sure it is followed. In all such cases it is critical to be open, honest, and direct. All findings regarding the problem should be fully and promptly shared with the community, especially interested members. It is best to create an opportunity for discussion of these findings. MDH has not identified any circumstances where information should be withheld when questions about mold in a school are raised.

The following are communication priorities:

1. Demonstrate that occupants' health and safety is of utmost concern and how potential risks are minimized;
2. Supply appropriate details of project goals, findings, and activities; and
3. Provide a mechanism for open, ongoing two-way dialogue between school officials and the affected groups or individuals including a means for occupants to share their observations and theories about problems and potential patterns.

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Communication methods that some schools have used effectively include meetings (include question and answer opportunities), press releases, memoranda, postings, and flyers. The frequency of messages, methods of communication, and degree of formality should be based on the scope of the project and the audiences' needs and interests (if in doubt, over-communicate).

If possible, school officials should identify and attempt to include key stakeholders in the communication planning process, such as building staff, teachers, union representatives, students, parents, the medical community, and the media. These persons may help school officials anticipate and more fully understand the community's concerns. They may also help identify ways to reach the appropriate audiences and become a part of the communication network. When respected community members are involved and they help to explain the issues, additional trust and credibility may be gained, enhancing the effectiveness of the messages.

To ensure that information is consistent and accurate, school officials should identify a single point person to whom all requests for information about the remediation project are referred. For example, the district's designated Indoor Air Quality Coordinator may be a logical choice since all Minnesota public school districts must have such a Coordinator, and this person should be knowledgeable of how the district handles indoor air quality issues.

Remediation plan details should be made available to all affected parties early so that their concerns are understood and may be accommodated before work begins. Once remediation has begun, school officials should continue to provide updates to keep the interested community members abreast of progress and target completion dates.

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3. EVALUATION OF INVESTIGATION FINDINGS

Correcting a mold problem requires understanding the extent of the problem and the underlying causes. In some cases, this is fairly simple, such as when an obvious moisture source has affected only a limited area resulting in easily observable visible mold. However, this can be difficult when the source(s) of moisture, their interaction with building conditions, or the location(s) of the growth are not readily apparent.

When the mold problem is relatively straightforward and can be corrected through routine custodial practices, it should be remediated as promptly as health and safety practices and procedures allow. When a complex mold problem exists, it is wise to carefully assess the problem thoroughly and objectively before beginning remediation. Resist temptation to address only the easiest, most obvious evidence of contamination without looking for hidden growth or reservoirs of contamination. To achieve a durable and effective solution, it is also imperative to understand the reason(s) for the moisture problem(s). Knowing the source of the excess moisture is vital to correcting it and preventing recurrence of the problem. Identifying the pathways the moisture may have taken can help locate hidden mold growth.

The success of remediating a large-scale mold problem ultimately depends on how well the moisture and contamination problem is understood. If planning the remediation relies heavily on reports of past investigations, the accuracy and completeness of those efforts should be objectively assessed. Review the findings of the reports and evaluate how completely the important issues were assessed. Do not assume that past findings necessarily reflect current conditions. Consider whether the conclusions and recommendations are logical in light of all available information, especially any recent findings. Several sections of the MDH guidance document “Recommended Best Practices For Mold Investigations In Minnesota Schools” may be helpful in critically reviewing investigation methods and reports.

Further investigation needs may be identified if factors that may be critical to the remediation have not been examined adequately. When moisture problems or contamination are extensive, an informed and thorough inspection of the affected and possibly other related building areas and systems might be needed (including elements of the building envelope). An inventory should be made of all visibly moldy surfaces and materials that are water damaged. Consult “Recommended Best Practices For Mold Investigations In Minnesota Schools”, or seek assistance from a professional with experience in assessing buildings for mold and moisture problems if further investigation is needed.

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4. DETERMINING REMEDIATION SCOPE

After gaining a reasonable understanding about the extent of mold contamination and the source(s) of excess moisture, school officials should determine the scope of remediation best suited to the problem. MDH recommends a graded approach based on the criteria below and particular characteristics of the problem. School officials should consider site- and situation-specific details regarding the contamination severity and the nature of the underlying moisture problem, potential health and safety concerns related to remediation activities, and the availability of district resources to correct the problems.

Three categories “Minimal”, “Moderate”, and “Major” are used in this document to characterize the complexity of the contamination problem and the potential for exposure of building occupants. These categories are used throughout this document with specific reference to the definitions provided in this section. They are based on quantifiable and non-quantifiable factors; they are not intended to be applied strictly, but to describe and rank the hazards and remediation factors in a relative sense. This deliberate subjectivity underscores the need for school staff to develop remediation practices and procedures that are site- and situation-specific, yet can be adapted if new information arises during the remediation.

It is crucial to remember that the extent of hidden mold growth may be much greater than what is readily visible from within occupied spaces, if the moisture problem originated in or has impacted closed spaces or cavities. In such cases, destructive techniques may be used carefully to access and inspect inside surfaces of floor, wall, and ceiling cavities. Whenever there is information suggesting that additional contamination may be uncovered during remediation or investigation, increased contaminant control and personal protective measures should be used. Plans should be made flexible to allow for any necessary revision of the project’s scope, such as adjusting work practices and procedures if unforeseen contamination or other complications are encountered.

Persons responsible for planning the remediation should review and discuss the three criteria below (amount of mold growth, degree of contamination, and potential for releasing contaminants) to determine which category best describes the problem. Initially, the three criteria should be considered with roughly equal importance.

1. <u>Amount of Mold Growth</u> How to best remove mold contamination depends in part on how much is present. For practical reasons, estimating the surface area of visible mold growth and the density of the growth are adequate starting points to approximate and bound the problem. Heavily contaminated materials may contain many more mold particulates than very light and superficial growth over a larger area. Project managers should apply common-sense judgment and consider the amount of the mold growth in conjunction with the other two criteria. The estimated clean-up area should include at least two feet beyond that which is visibly impacted, because mold colonies may extend outward from the visible growth for some distance.

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- **"Minimal" Problem** should be applied to visible or anticipated surface contamination of less than 10 square feet ft^2;
- **"Moderate" Problem** should be applied to:
  - o areas larger than 10 ft^2 of surface contamination but less than 100 ft^2; or
  - o very heavy and continuous growth covering less than 10 ft^2.
- **"Major" Problem** should be applied to:
  - o visibly mold-contaminated surfaces that are larger in area than 100 ft^2, or
  - o very heavy and continuous growth covering less than 100 ft^2

  For "Major" problems, the possibility of extensive hidden contamination should be explored, at least qualitatively, during the investigation phase, to inform remediation planning efforts.

2. Degree of Contamination In addition to the surface area of mold growth, the density of mold growth should be considered in relation to the contaminated material and the potential for hidden growth. When hidden growth is possible or porous materials are contaminated, a higher problem category should be considered.
   - **"Minimal" Problem** should be applied to situations where visible growth is mainly limited to scattered small colonies, and evidence suggests that these are only present on easily accessible non-porous surfaces.
   - **"Moderate" Problem** should be applied to:
     - o light and spotty visible growth on porous or semi-porous materials, or
     - o when about half the area is covered by mold colonies on non-porous materials, or
     - o when other evidence (for example, a short-term moisture problem or some mold odors) suggests that additional hidden contamination may be present.
   - **"Major" Problem** should be applied to:
     - o a heavy distribution (covering half the area) of many large colonies on any type of material, or
     - o when evidence suggests that hidden contamination is present and may be well established (for example, knowledge of a long-term moisture problem and strong persistent mold odors).

3. Potential for Releasing Contaminants. Disturbance of contaminated materials by mechanical forces or invasive measures during remediation can release large quantities of mold particles to the air. The potential for disturbance of growth sites, which depends on the accessibility and nature of the material, should be considered.
   - **"Minimal" Problem** should be applied to:
     - o contamination on surfaces of items that can be cleaned easily in place, or
     - o smaller removable items that can be bagged (enclosed in plastic) prior to removal.
   - **"Moderate" Problem** should be applied to:
     - o areas requiring removal of larger items as individual components with negligible disturbance, or
     - o contamination that require cleaning with average force or handling (such as scrubbing)

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- **“Major” Problem** refers to situations where aggressive or destructive physical force (such as mechanized methods) will be needed for removal or cleaning of contaminated items, resurfacing, or gaining access to contamination. This category may apply to situations such as removing wallboard, partitions, and carpeting or sanding wood or concrete.

Other situation-specific issues may indicate a need for additional health and safety precautions. School officials must use their best judgment to anticipate if, and how, any additional factors may impact risks, affect perceptions of important stakeholders, or influence costs. The following are examples of such factors that may need to be considered:

- The skill and experience of the individuals who will perform the work;
- The presence of highly susceptible occupants or remediation workers[1];
- The duration and scope of the remediation project;
- The extent of public concern—it is prudent to treat the problem as a “Major” mold problem if distrust and anxiety has developed;
- Liability or other legal concerns; and
- The ability to control exposures through administrative or engineering controls.

After investigating and discussing the amount of mold growth, the degree of contamination, the potential for releasing contaminants, and the other factors, school officials should determine which of the three mold problem categories (“Minimal”, “Moderate”, or “Major”) best fits their understanding of the problem. If information is lacking to apply a category to one of the three criteria, it is prudent to assume the problem is “Major” until information is available to change that designation. If different categories are assigned to each criterion, it is prudent to apply the most cautious approach and pick the highest category. For example, if the amount of mold growth and degree of contamination are “Minimal” but the potential for releasing contaminants is “Moderate”, then MDH recommends designating the problem as “Moderate”.

To develop a remediation plan tailored to the specifics of the problem, school officials should read Sections 4-7, consider additional factors specific to the problem, and review the relevant example procedure in Appendix A. In addition, when “Major” contamination exists, MDH recommends skilled workers (preferably experienced and trained professionals) perform the bulk of remediation work following this or other comparable guidance listed in Appendix B.

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[1] Highly susceptible individuals include people with severe asthma, severe allergies, and compromised immune systems. Immune-compromised individuals include uncontrolled diabetics, people receiving immunosupressive drugs for organ transplants or cancer, leukemia patients, and people with immune deficiency diseases, such as advanced AIDS. A physician should be consulted about these issues.

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5. ADMINISTRATIVE CONTROLS

Administrative controls are decisions that can be made by school administrators to protect occupants from actual or perceived exposure to contaminants released during remediation activities. Controls may include measures such as removing or relocating occupants, and scheduling work during vacations, evening, or weekend hours. Practical and logistical considerations may also make it necessary to temporarily prohibit occupants from entering the work zone and possibly adjacent areas depending upon the nature and duration of the anticipated remediation project. If a medical or other health professional recommends the removal of certain individuals for health reasons, school officials should attempt to accommodate such advice whenever possible. School officials should make sure that the area occupants are being relocated to is more healthful than the area they were moved from.

For both health and practical reasons, administrative controls should be considered for any mold remediation project. School officials should consider the following questions to determine whether administrative controls are needed.

- How concerned are occupants about being near the remediation site?
- Is it likely that a lot of mold contaminants or construction dust will enter occupied areas?
- Are any occupants medically known to be susceptible to molds (medically recognized sensitivities of greatest concern are: asthma, mold allergy, compromised immune system, and hypersensitivity pneumonitis)?
- Are there any credible reports by occupants of adverse health effects attributed to the mold problem?

When evaluating the need for administrative controls during a remediation project, school officials should initially apply the most protective approach. Such a precautionary approach is usually prudent because the primary objective of any remediation project is to protect occupants' and remediation workers' health and there may be uncertainties, such as:

- the extent of the contamination problem has not been clearly identified; or
- there is less than ideal confidence in the engineering controls to be used during remediation work.

Following careful consideration of the control measures and other remediation practices that should minimize occupants' exposures, school officials may choose to relax on the administrative precautions. For example, it is prudent to relocate susceptible occupants in areas adjacent to the mold remediation work area, until it is verified that the work area is under appropriate containment (such as following measurements and visual observation of negative pressure relationships between the work area and adjacent occupied areas).

It is important to clarify that the most protective approach is not necessarily the evacuation of an entire school building. Most of the worst mold problems can be remediated while utilizing engineering controls of the affected areas and possible evacuation of occupants or susceptible individuals in directly adjacent areas, while maintaining normal operations in the rest of the

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building. However, school officials may choose to close a building in extreme cases. This might apply when the entire building is contaminated (or significant airborne contaminants cannot be controlled) **and** a medical professional has linked significant health effects to the mold problem. School officials may consider closing a school for political or liability reasons, even though the availability of engineering controls and health-based scientific analysis does not warrant such an action.

Whenever occupants have been moved, school officials should anticipate questions about re-occupancy and safety after job completion. Post-remediation evaluation findings are necessary for making re-occupancy decisions. Communicating these findings is essential to provide peace of mind to the occupants. Implicit is the need to determine (in the planning phase) specific clearance indicators or criteria that will be used to evaluate the effectiveness of the remediation. It may be useful to include stakeholders in high profile or "Major" contamination problems, since this can help anticipate questions and concerns that may need to be addressed and to manage their expectations[1]. After re-occupation, occupants should be informed about the process for reporting any future concerns to the appropriate school official(s) (e.g., the indoor air quality coordinator).

[1] It is understandable that school officials will be reluctant to involve certain stakeholders (such as certain affected parents or staff) because this may make discussions contentious and cumbersome. However, the views of these people will likely have to be addressed at some point. It is better to involve these people early on to minimize distrust and disappointment, and minimize the likelihood of performing additional work to please certain groups.

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6. REMEDIATION PRACTICES CONSIDERATIONS

Once the remediation scope and the communication strategy have been determined, and the administrative controls considered, school officials should then review the various possibilities and considerations relevant to the cleaning and removal of mold contamination. School officials may want to use the step-by-step example mold remediation procedures in Appendix A, but should supplement these generic procedures with enough site-specific details to provide specific guidance to those performing the work.

Remediation project plans should cover the following topics at a minimum:
1. remediation of excess moisture;
2. identification of possible hazardous materials (such as lead and asbestos) in abatement areas;
3. mold abatement practices and procedures;
4. health and safety precautions;
5. determination of project completion; and
6. repair and re-construction.

Note that this document provides limited guidance on topics 1,2, and 6 above[1].

Detailed written project specifications should be developed, especially when the problem is "Major", outside contractors are hired, or circumstances are high profile and emotionally charged. Specifications should clearly define the responsibilities of all parties involved in the work. The requirements for removal, salvage, cleaning, abatement of other hazards, and any modifications or repairs should be clearly described. A written procedure should be given and explained to the workers, and prohibitions should be emphasized (e.g., work hours, cleaning methods, chemical application, containment, etc.). Expectations for successful completion should be included in the project specifications. If measurable results are needed, then scientifically defensible criteria for successful completion need to be included (see Section 7).

School staff planning remediation of mold contamination problems should carefully review the following sub-sections for applicability to their circumstances.

6.1 Deciding Whether to Use Outside Help

Once the nature and extent of the problem is understood, school officials have to decide whether school staff can adequately perform the remediation work or if outside assistance is needed. School staff can usually remediate "Minimal" problems, and, if experienced, school staff may also be capable of remediating "Moderate" problems. However, "Major" problems should typically be remediated by experienced professionals who have the appropriate expertise and equipment, to protect workers and occupants and contain remediation areas. In addition, when district staff will remediate, it may be prudent to have a qualified professional review the mold problem and the work plan.

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[1] References to information about moisture damage restoration can be found in Appendix B. Contact the MDH about asbestos (651-215-0900) or lead (651-215-0890).

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There are two additional issues to consider before deciding to have school staff remediate the problem.

1. It is prudent for individuals who are immune-compromised, severely asthmatic, or suffering from hypersensitivity pneumonitis to avoid mold remediation work.
2. The MN Occupational Safety and Health Agency's (MNOSHA) Right to Know Act[1] (Rule 52.06) must be followed as a part of training provided to maintenance staff regarding the potential health hazards associated with mold and any chemicals used for remediation. Without such training, school staff should not undertake mold remediation activities.

6.2 Personal Protection

Physical disturbance of moldy materials can produce extremely high airborne levels of mold particles and contaminated dust. When handling moldy materials or working in the remediation area, people should be protected from being exposed to contaminants. School officials should determine what personal protective equipment to require for in-house staff, depending on extent of the contamination and OSHA requirements. While there are no legal respiratory protection requirements specific to handling indoor mold, there are OSHA requirements that an employer must follow if they mandate employees use personal protective equipment[2].

For "Minimal" to "Moderate" mold problems that are manageable by routine custodial or maintenance activities, MDH recommends workers be provided with an N-95 respirator[3], dust-proof goggles, and skin protection at a minimum. Remediation workers should be instructed to always wash their hands after working with moldy materials, in case any mold is unintentionally transferred to their hands. For some "Moderate" and all "Major" problems, it is prudent to use a High Efficiency Particle Air (HEPA) filtered full-face respirator. It is also important to select appropriate gloves. When applying a disinfectant or strong cleaning agent is used, use gloves made from natural rubber, neoprene, nitrile, polyurethane, or PVC; when handling sharp materials, use leather gloves.

If other hazards (such as asbestos or lead) will be disturbed, properly licensed professionals must perform the work and follow the appropriate regulatory requirements. Clean up of certain fungi, such as *Histoplasma capsulatum* or *Cryptococcus neoformans* that may be growing in bat and bird droppings require specific clean-up practices[4]

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[1] States with no state OSHA program must follow the federal OSHA Hazard Communication Standard (29CFR 1910-1200).

[2] See CFR 29 1910.134 and 1926.95-107 for details. In situations where the employer does not mandate use, but the employee volunteers to use an N-95 dust mask, employers must still follow some of these requirements. For information on statutorily mandated requirements, contact the Minnesota OSHA Workplace Safety Consultation unit at (800) 657-3776 or (651) 284-5060.

[3] Particulate respirator names refer to the ability to remove oil mists (N: not oil resistant, R: oil resistant, P: oil mist proof), and the filtering efficiency of particulates >0.3 μm (95, 99, or 100%). If oil mists are present, "P" rated respirators should be used. These respirators will not remove some odors since the gases released from mold may cause the odors. If odors are a significant concern during remediation, respirators with organic vapor cartridges may also need to be used.

[4] See the NIOSH Guidance Publication No. 97-146 at www.cdc.gov/niosh/97-146.html

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6.3 Contaminant Control

Remediation plans should include project- and site-specific instructions on how workers will minimize and contain the release and spread of mold particles to any occupied or non-contaminated areas. Contaminants may be spread by foot traffic, contaminated materials or equipment, or through air movement. More stringent contaminant control methods are necessary when large amounts of mold growth are being remediated or destructive techniques are used.

Workers should handle contaminated materials in a manner that minimizes disturbance of fungal particles, especially if their removal might uncover further contamination that has not yet been identified. To prevent or minimize the dispersion of particles beyond the work area, containment (i.e., engineering controls) and special cleaning practices are often necessary. This may include critical barriers (e.g., polyethylene sheeting), depressurization techniques (e.g., negative air pressure machines), dust suppression methods (e.g., damp wiping and HEPA vacuum cleaning) and decontamination procedures (e.g., showers, dirty rooms, clean rooms). Step-by-step recommendations are given in Appendix A. For further guidance on contaminant control, school officials should refer to the documents listed in Appendix B or seek advice from experienced mold remediation professionals.

In "Moderate" and "Major" problems, workers should "pre-clean" areas to minimize dispersion of contaminants while assembling engineering controls and applying aggressive force to contaminated materials. Pre-cleaning involves careful cleaning of easily accessible surface contamination with methods that can lift and capture fine dusts. Where possible affected materials should be enclosed in plastic and removed from the building using the shortest direct route leading to the outside of the building.

Containment should be designed according to the severity of the problem (see Section 4). During remediation of "Moderate" contamination, it may be adequate to enclose an area in plastic sheeting (a localized mini-enclosure or tent) and then bag and dispose contaminated items. In the case of "Major" contamination problems, physical isolation (total enclosure including at least one decontamination chamber) and depressurization may be necessary to separate work areas from non-contaminated spaces and the heating ventilation and air-conditioning (HVAC) system.

Depressurization of the work area is often used to ensure contaminants are confined within the work area. A pressure differential of > 5 Pa (0.02 inches water column), which is used for asbestos abatement, is usually adequate to contain airborne mold contaminants. In addition, remediation workers and project managers should routinely check to see that the separation barrier, typically plastic sheeting, billows inwards into the isolated area. The nozzle of one or more HEPA vacuums drawing from within a small containment area may provide adequate depressurization. When larger areas are isolated and a greater volume of air must be filtered, HEPA-filtered negative air machines are necessary.

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6.4 Cleaning and Removal of Contaminated Materials

The primary goal of effective mold clean-up is to capture and remove contaminants from the building. Sometimes the material that the mold has grown on must also be removed. As a general rule, it is best to clean and remove as much contamination as possible before the materials have completely dried. Following any mold clean up, it is necessary to periodically inspect areas of previous mold growth to ensure the problem has been corrected. The following guidelines should be followed for determining which materials can be cleaned and salvaged versus which should be discarded.

Discard porous materials with evidence of mold growth. Evidence of mold growth consists of visible mold or mold odors emanating from the material. Examples include, paper fiber gypsum board, ceiling tiles, insulation, wall coverings, carpet, leather, unprotected composite or engineered wood products. Such items are not easily salvaged and it is not often cost-effective to remove the mold. Instead, it is usually best to bag or wrap the materials in plastic and discard.

There may be instances where small areas of superficial mold growth on a porous material can be cleaned. For example, mold may be growing on a superficial organic nutrient, such as a spilt soda. Such growth can be cleaned with a HEPA vacuum, followed by water extraction, rapid drying, and finally HEPA vacuuming again. However, when in doubt it is best to replace the material.

Interior lined ductwork is also porous. If ductwork lining is colonized by mold, it should be removed and the duct cleaned down to bare metal or simply replaced. See also discussion under section 6.8 Heating, Ventilation and Air Conditioning (HVAC) Systems.

Porous materials without evidence of mold growth. Although not visibly moldy themselves, many rough-surfaced porous materials may also become reservoirs of settled fungal particles if they have been near heavy growth or high air concentrations. Examples include upholstery, carpet, modular furniture, books and files. These materials should be cleaned by careful HEPA vacuuming, laundering, or other methods that lift and capture fine dusts from the material's surface.

Semi-porous materials that have little surface growth or are structurally sound. Examples include solid wood furniture or structural components, protected composite and engineered wood products, concrete, cement, brick and some resilient floor coverings. Such items may be salvaged if they are structurally sound and can be kept dry in the future. Cleaning and remediation steps include one or more of the following: HEPA vacuuming, damp cleaning with soap and water, HEPA vacuuming again, resurfacing (in the case of wood), disinfecting, drying rapidly, and sealing or refinishing. If the above cleaning methods are ineffective a HEPA vacuum sander (simultaneous vacuuming and sanding) can be used, but do NOT attempt to sand without simultaneous HEPA vacuuming. When concrete surfaces cannot be cleaned by HEPA vacuuming or detergent and water, trisodium phosphate (TSP) can be used to clean concrete. TSP is a strong irritant and must be used with caution.

Semi-porous materials that have extensive fungal penetration or are structurally compromised. Examples include solid wood furniture or structural components, protected composite and engineered wood products, studs, paneling, and some resilient floor coverings. When extensively colonized, such items are not easily or cost-effectively cleaned and decontaminated. They should be removed, bagged, and discarded. If contaminated materials cannot be removed and the structural integrity of the material has not been jeopardized, it may be acceptable to clean and disinfect rigorously and take exceptional measures to prevent the return of moisture. In addition, it is critical to remain vigilant for signs of mold problems in the future and to respond rapidly if they return.

Non-porous materials. Examples include metal, ceramic tile, porcelain, glass, hard plastics, highly finished solid wood items and other hard smooth non-permeable surfaces. Cleaning steps include HEPA vacuuming, damp wiping with a detergent solution, and rapid drying.

<u>6.5 Moisture Control</u>

The importance of addressing moisture in any effort to solve a mold problem cannot be overstated. The presence of excess moisture is the primary underlying cause of indoor mold growth. Identifying and correcting sources of excess moisture is vital to resolving mold problems and preventing their reoccurrence. Judging the completion of a remediation job should include evaluation of steps taken to correct moisture problems and prevent their return.

If a catastrophic water problem occurs, it is critical to quickly correct the water source and to initiate restorative drying practices before mold growth occurs or spreads. Building materials should be dried rapidly ideally in less than 48 hours, preferably less than 24 hours, to a moisture content that does not support mold growth. Check that there is no visible mold growth before drying areas, because restorative moisture drying methods can pressurize materials (such as wall cavities) allowing mold particles (if present) to spread to uncontaminated areas. Tools used for drying include extraction, evaporation, dehumidification, and temperature control. Non-salvageable items that have been wetted or begin to show evidence of mold growth should be discarded promptly. As a precaution, fans and other devices that create airflow should no longer be used once visible mold appears, and drying should then proceed under more controlled conditions to avoid dispersing mold particles.

Moisture source(s) that have led to mold growth must be identified and understood to plan an effective mold remediation project. Finding the locations of excess moisture, identifying the mechanisms for its accumulation or infiltration and tracing pathways of its migration can also aid in finding and assessing the likelihood of encountering further growth. Staff responsible for correcting and preventing mold problems should recognize that moisture in any of its phases (ice, water, and vapor) must be adequately controlled. For example, moisture may be present at a material's surface as high relative air humidity. Moisture can also be absorbed into porous and semi-porous materials and may migrate under surface coverings, around furniture, and between components at joints. Understanding the moisture sources and dynamics involved in a particular situation may require professional assistance (see also Step □ in MDH's "Recommended Best Practices For Mold Investigations In Minnesota Schools").

During the mold remediation project itself, it is necessary to control the use or production of water. For example, cleaning techniques should use water-based solutions sparingly and must include rapid drying practice following the cleaning steps. Power washing should be used as a last resort, and only on non-porous materials or concrete (cementitious materials) if the material can be dried quickly. Power washing should not be performed if vulnerable material, such as wallboard and sheet rock, might get wet. In addition, significant amounts of moisture can be introduced into air from open flame heaters. These heaters should be avoided in remediation areas.

Mold will likely grow again where moisture issues are not addressed adequately. School officials planning and carrying out mold remediation should consider how to ensure and document that moisture problems have been resolved. See Section 7 Post-Remediation Evaluation for details.

6.6 Cleaning of Remediation Equipment

Equipment used during remediation, such as respirators and protective clothing, may need careful cleaning depending on how much mold was released during cleaning. In the case of a "Minimal" Problem, tools and personal protective equipment can usually be adequately cleaned by damp wiping or washing with soap and water. With "Moderate" and "Major" problems, a protocol for decontaminating workers and equipment should be developed[1]. In the case of "Major" problems, containment should be constructed to include a separate decontamination chamber (with plenty of room to work comfortably). All equipment should be HEPA vacuumed, damp wiped, and bagged before they are removed from the work area. This includes cleaning tools, negative air machines, waste containing bags, outer clothing, respirators, gloves, and goggles. Workers should wear at least an N-95 respirator when cleaning or replacing HEPA filtered equipment components. At the end of the removal effort, all materials used for containment should be bagged and the area decontaminated as part of the final job site cleaning.

If hazardous materials such as lead or asbestos are also handled as part of the removal work, applicable regulatory work practices and procedures must be followed.

6.7 Waste Disposal

Mold contaminated materials are not classified as hazardous waste, and they can be disposed in a sanitary landfill. However, mold-contaminated waste that is not immediately disposed of should be stored securely (e.g., in a covered and posted waste container) and located away from high traffic areas, entrances, and fresh air intakes. Any hazardous materials removed must be kept separate from the non-hazardous waste, labeled appropriately, and disposed of according to applicable rules and regulations.

6.8 Heating, Ventilation and Air Conditioning (HVAC) Systems

In this document, the term HVAC system refers to the entire air distribution system from points where air enters the system to points of discharge. This may include return plenums (including

[1] See the first 3 Appendix B resources for detailed decontamination protocols.

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ceiling plenums) and the mechanical room. The HVAC system(s) is relevant to mold remediation because it may be the source of mold growth or the route of disseminating mold particles from one area to another. Without regular inspection and proper maintenance of critical HVAC system components, dust, debris, and moisture may collect beyond the usual amounts expected. And since some HVAC system components may be inaccessible for periodic inspection, they are particularly susceptible to mold growth. Remediation of school HVAC systems are generally similar to those for other building components or systems, although additional precautions and hiring a professional may be necessary[1].

An evaluation of the HVAC system should be done for any severity of mold problem. In particular, the entire HVAC system should be assessed for its role in the moisture problem(s). However, such an evaluation can be skipped for suspected "Minimal" problems (due to the expense of hiring a ventilation professional) when the HVAC system is not accessible and when there are no signs or indications of HVAC system involvement. In some cases, a reservoir of spores or location of growth may be the acoustical insulation sometimes used to line interior air-stream surfaces of air-conveyance ducts. If such lining (or any other non-smooth or porous air-stream surface) is colonized by mold growth, it should be removed, discarded, and cleaned down to bare metal. Unit ventilators should not be overlooked as potential sites of mold contamination, since they are often poorly maintained and their operation hampered by misuse as storage areas.

The following HVAC system components should be inspected for growth, moisture, and relevant defects, and cleaned or replaced, as needed.

- Outdoor air intakes
- Filters
- Cooling coils, including evaporator fins
- Condensate pans, collectors and drains
- Humidifiers
- Air stream surfaces (baffles, dampers, include internal acoustical lining, fiberglass duct board, etc.)
- Blowers, fan components, and housings (supply, return and exhaust)
- Air distribution devices (registers, grilles, and diffusers)

MDH advises against the routine use of disinfectants and pesticides to "sanitize" ducts in school HVAC systems (see also Section 6.9 "Use of Disinfectants and Pesticides"). If cleaning and removal is done properly, disinfectant or pesticide application should be unnecessary. Furthermore, if organic materials (i.e., mold, dust, debris) are not removed first, it is unlikely that disinfectants or pesticides will achieve their intended level of killing anyway. The health effects of such chemical use in HVAC systems are poorly understood, and improper application

[1] For example, for "Moderate" problems in HVAC the New York City Department of Health and Mental Hygiene recommends constant negative pressure and particulate collection (e.g., vacuum collectors) in addition to the other considerations. For problems that cover >30 sq. feet, NYC also recommends full-face HEPA respirators, airlocks, and decontamination rooms.

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may lead to greater problems or complaints than the mold. Currently, there are few such chemicals that can legally and practically be used in ductwork, and there is a lack of compelling evidence regarding their effectiveness in field applications[1]. If school officials choose to use chemicals in their HVAC system, MDH cautions that such agents should **never** be applied in an **operating** HVAC system, and the manufacturer(s) of components that will be treated should be consulted before treatment to ensure compatibility.

MDH does not currently support the use of sealants or encapsulants as the primary remediation strategy to address mold problems in HVAC systems. There are important concerns about the toxicity and odors associated with sealants and encapsulants, and there are uncertainties about their long-term success in containing mold particles. While such a strategy is not a substitute for removing mold contamination or porous materials subjected to excess moisture, sealing or encapsulating colonized materials may be preferable to taking no action. If moldy materials are "locked down" in place, MDH recommends keeping a record to ensure appropriate care is taken to minimize the potential of future disturbance.

6.9 Use of Disinfectants and Pesticides

While usually unnecessary, disinfectants or pesticides may be used to try to kill any remaining mold following cleaning or material removal. Many conventional cleansers have disinfectant properties, such as household bleach, and are subject to limited regulations. Pesticides, on the other hand, are specifically regulated. Before using a disinfectant or pesticide, school officials should consider the following issues.

1. Whether the situation truly necessitate its use, or are other methods sufficient;
2. Whether the agent has been effective at controlling the target microbe, in schools, and on the same materials, when applied at levels that have negligible health risks;
3. Whether they are applying a disinfectant or pesticide; and
4. If it's a pesticide, whether the agent will be applied by an experienced and licensed applicator, according to laws and safety guidelines.

It is very important to review the labels of any cleaning or chemical agent used in mold remediation, to determine whether it is regulated as a pesticide and to ensure proper application. The term "biocide" refers to a legally defined group of pesticides used for managing microbial pests (such as mold). In Minnesota, pesticide applicators must have an antimicrobial commercial license to apply pesticides used to kill mold in schools. It is a common misconception to think that because a pesticide is "EPA registered" it is safe to use in variety of situations—pesticides are only registered for the specific use(s) described on the label. Contact the Minnesota Department of Agriculture for more information on pesticide regulations, applicator licenses, or other specific questions[2]. If applicable, the school's integrated pest management plan should be followed. MDH further recommends making written records available to interested parties in the

[1] See the U.S. Environmental Protection Agency's "Should You Have the Air Ducts in Your Home Cleaned?" for more information (www.epa.gov/iaq/pubs/airduct.html). The recommendations in this document also apply to institutional buildings.

[2] To identify a pesticide applicator license holder, go to http://www.mda.state.mn.us/lis/default.htm, or call the Department of Agriculture with additional questions at 651-297-2200 or 1-800-967-2474.

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school and community, which detail any use of disinfectants or pesticides during the remediation.

MDH's primary concern is for occupants' and remediation workers' health and safety. Even when handled according to label instructions, any disinfectant or pesticide should be considered potentially harmful to people, and, rightly or not, such agents may be blamed for health problems and odors. In addition, even if an agent does kill the mold, the agent does not usually destroy the allergens, irritants, or toxins that are present in the dead mold. Hence, dead mold particles from contaminated materials can still adversely affect health. Consequently, it is of questionable value to kill mold before removing it, but killing the mold without also removing the contaminants is not acceptable.

There may be circumstances in schools where judicious use of a disinfectant or pesticide could be beneficial to kill residual living mold growth, but only after cleaning and removal efforts have removed visible mold growth. First, MDH recommends the use of disinfectants or pesticides if severely immune-compromised individuals[1] are expected to occupy or re-occupy a previously moldy area. These individuals are susceptible to infection with the living mold spores--it is therefore useful to kill any residual mold that may still be present following cleaning and removal of moldy materials. Second, a disinfectant may be helpful on stubborn mold problems growing on non-porous or semi-porous surfaces that cannot be replaced (e.g., concrete blocks).

Standard household bleach (i.e., hypochlorite) is often used to clean and disinfect materials. Some hypochlorite solutions are regulated as pesticides. Bleach should not be used on materials that will corrode, for example stainless steel. For initial use, dilute the stock solution (if 5% hypochlorite) 20 parts water to1 part bleach to yield a 0.25% hypochlorite solution. Since many agents, including bleach, are rendered ineffective after reacting with microbial contamination or other organic soiling, they should be applied only to previously cleaned surfaces using clean applicators (buckets, mops, sponges, etc.) or dedicated equipment. Apply the solution with a damp cloth and leave it on for a period of time according to the manufacturer's direction (some disinfectants should be left on for 10 minutes or less, while bleach is usually left on for 30 minutes). After disinfecting, the remaining chemical residue should be damp wiped from the treated surface with clean water, and the material should be dried quickly.

Bleach should never be mixed with ammonia-containing products or applied to a hot surface—both will produce toxic chlorine gases. Bleach should only be mixed with other chemicals if this is permitted on the label. Since bleach and most disinfectants and pesticides are volatile chemicals, they should only be applied when adequate ventilation and appropriate respiratory protection are used. When bleach is handled, the respiratory protection equipment used must be effective against inorganic vapors. In addition, protective gloves and eye protection should be used when handling bleach to avoid burns.

[1] Immune-compromised individuals include uncontrolled diabetics, people receiving immunosupressive drugs for organ transplants or cancer, leukemia patients, and people with immune deficiency diseases, such as advanced AIDS. Individuals should contact their physician for more information.

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Treating moldy materials with disinfectants or pesticides can also complicate efforts to evaluate clean up. Treated materials may still release large numbers of mold particles that will not be measured by culture-based (i.e., viable) sampling and analytical methods. Evaluation of a remediation job should not rely solely on viable testing methods if disinfectants or pesticides were used. If viable sampling is used, it should be done after cleaning, but before disinfectant or pesticide application.

6.10 Use of Gas-Phase Ozone

Ozone-generating devices have been promoted to Minnesota schools as a solution to mold and other indoor air quality problems. There are significant concerns about applying ozone, a well-known respiratory health hazard, to occupied indoor environments. The limitations of using a disinfectant or pesticide described above also apply to ozone. In addition, as a general rule gas or vapor phase agents cannot effectively and safely remediate microbial building contamination—effective and safe application typically requires direct contact with the contamination. Because ozone may eliminate or mask odors, it can create the perception that the mold problem has been resolved. Yet research, including recent controlled laboratory studies, has confirmed that gas-phase ozone, applied at levels below health standards, is not effective at inactivating microbial contamination (including a variety of fungal organisms) on building materials or in air[1]. Consequently, MDH strongly opposes the intentional use of ozone to address school mold problems.

[1] See the U.S. Environmental Protection Agency's "Ozone Generators that are Sold as Air Cleaners" (www.epa.gov/iaq/pubs/ozonegen.html#are ozone generators effective in controlling pollution)

7. REMEDIATION EVALUATION

After the mold remediation work is completed an evaluation of its effectiveness should be performed. At a minimum, school officials should verify and document that moisture problems were corrected and the contaminated area is ready for occupancy. Evaluation findings can also help restore the confidence of all stakeholders. Outside contractors should be given a clear description of job requirements, including how successful completion will be determined. School officials and their contractors may also desire an independent third party's evaluation as a way to provide some protection against potential future liability. School officials must decide who will do the evaluation, how the results will be used to demonstrate that remediation goals have been met, and what next steps will be taken if clearance criteria are not satisfied.

7.1 Remediation Goals

Clear and achievable goals should be set during remediation planning. All parties involved in the project should understand and agree upon the goals. It may worthwhile for other stakeholders and affected parties to participate in setting goals, since they may better appreciate the costs and difficulties associated with expectations that are unrealistic and impractically strict. The ideal remediation goal is to restore the building to conditions in which occupants are free from health complaints or discomfort. It is, however, extremely difficult to achieve and maintain such a level of satisfaction given the many agents and conditions that can contribute to real and perceived indoor air quality problems and complaints. Some may demand that the goal should be a building free of all molds, but this is not possible or practical since, at a minimum, spores will always be detectable in settled dust and in the air.

A reasonable remediation goal is to restore the building to normal conditions, reflected by: a lack of visible mold growth; a lack of mold odors; and appropriate control of moisture. Another goal in some cases may be to confirm, through testing, that the types and amounts of mold particles in the air or settled dust are similar in type and amount to what is present in unaffected and outdoor areas. Finally, remediation goals should also fit into a holistic approach to improving and maintaining indoor air quality through preventive maintenance, rather than simply reacting to problems.

7.2 Evaluation Criteria and Methods

Once goals for the remediation have been determined, evaluation criteria and methods can be selected. The methods and extent of evaluation should depend on several factors, especially the extent of the contamination problem and the community's concerns. For "Minimal" contamination cleaned by routine housekeeping, a sensory inspection alone should be adequate to judge project completion. When "Moderate" or "Major" contamination is present or health concerns have elevated the importance of the issue, a more thorough evaluation and communication of findings are advised.

Setting evaluation criteria involves determining ahead of time how much contamination may remain after remediation is complete -- in other words, deciding what indicators or measurable results will be considered evidence of an acceptable outcome or job "clearance". These criteria

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need to be set before remediation work begins. Setting clearance levels too low will impractically increase costs without additional practical benefit. Instead, the criteria should be selected to show, in combination with other evidence and information about the remediation activities, that the remediated area was acceptably clean and dry at the time when the job was finished and that conditions that allowed mold growth were corrected. When using numerical criteria for clearance, it may be necessary to set material- and test method-specific criteria for interpreting testing results. This must be determined before the remediation work is begun and should ideally be understood and accepted by all key stakeholders.

7.2.1 Evaluation of Remediation Methods

The project manager should confirm with remediation workers that the previously determined remediation plan was followed. This should be confirmed during and after the remediation work by periodic inspections and a closeout documents that should be included in the final report. School officials may wish to perform this task or delegate the responsibility to a contracted professional. The following are examples of some common problems that may be identified by the project manager.

- incorrect mixing of chemicals;
- inadequate pre-cleaning before moving large items from or erecting walls in remediation area;
- overloaded HEPA filters in vacuum cleaners and negative air machines, which no longer draw enough air;
- insufficient negative pressure established;
- loss of negative pressure (apparent on manometer readings);
- complacency regarding use of respirators; and
- not bagging materials and cleaning off surfaces before leaving containment area.

If significant inadequacies are revealed, proper remediation should be resumed before remediation activities continue.

7.2.2 Sensory Approach

The sensory approach should be used to evaluate all mold remediation efforts, from the most routine “Minimal” problems to “Major” problems. The sensory approach involves using senses of sight and smell to determine the presence or absence of visual and olfactory signs of conditions that support mold growth. Combined with evidence that effective methods for removing mold contaminants were used and moisture problems were addressed, the sensory approach offers a practical and common sense option for evaluating whether remediation goals have been met. Sensory criteria should include, at a minimum, that there is no visible mold growth, negligible dust, no moldy odors, and no apparent dampness.

One very important indicator of mold removal effectiveness is the overall cleanliness of the work site after job completion. The presence of any remaining visible mold colonies indicates that cleaning and restoration was not adequate. Moreover, the presence of dirt, moisture, debris, and dust should not be tolerated in remediated areas after project completion. Methods to document a sensory evaluation include written testimonials, photographs, white glove/black glove inspection for dust, and confirmation by an independent third party. A white glove/black glove inspection involves allowing suspended matter time to settle, then wiping a finger over all or representative (previously determined) surfaces to demonstrate general cleanliness. In addition to the areas of contamination, areas that will underlie repaired or re-constructed structures should be assessed (cleared) before reconstruction, to verify contamination and moisture problems have been properly addressed.

7.2.3 Moisture Testing

In addition to the sensory approach, one common method to evaluate moisture control is to measure moisture levels of affected materials and surfaces and/or the indoor air relative humidity. Criteria for acceptable moisture levels in air or specific to certain materials should be established early in the project. These criteria can be used to verify that adequate drying has occurred before the replacement of damaged materials, refinishing, installation of surface coverings, or other re-construction efforts. In addition, they can be used to verify whether a moisture control method has been truly effective at controlling moisture. Equipment such as moisture sensors or detectors, thermohygrometers, and moisture meters may be used to evaluate drying progress and confirm moisture control. School officials should be familiar with moisture terms defined in Table 1 below. Moreover, they should expect contracted professionals who test for moisture to be very knowledgeable about these moisture concepts and their applications to moisture investigation and restoration.

When verifying acceptable moisture levels it is preferable to compare moisture measurements to published acceptable moisture content (MC) values for a particular material relative to a benchmark water activity (a_w). As a rule of thumb, an a_w of less than 0.65 is ideal because this is typically the minimum amount of available water necessary for microbial growth. Microbial growth is limited at a_w up to 0.75. Note that a specific a_w value corresponds to very different measured MCs, depending on the material. For example, an a_w of 0.75 corresponds to about 20% MC for pine wood and 5% MC for concrete[1]. If published moisture content and corresponding a_w are not available for a specific material, then background measurements from similar dry materials may be used for comparison to confirm a return to normal moisture levels. The use of relative humidity (RH) may be useful if measurements are taken directly next to the suspected material. However, RH measurements may fail to identify cold spots or local water intrusion that has caused a high localized a_w enabling mold growth.

Table 1. Terms Used to Describe Water in Air and Materials[1]

Medium	Term	Definition
Air	Absolute Humidity	The ratio of the mass of water vapor to the mass of dry air
Air	Relative Humidity (RH)	The ratio of the amount of moisture held in air to the maximum amount that the air can hold for a specific temperature and pressure
Materials	Moisture content (MC)	The mass of moisture held in a material, measured as the mass water as a percentage of the dry mass of a material
Materials	Water activity (a_w)	The ratio of the amount of water in a material at a particular moisture content to the maximum amount of water air can hold at the same temperature and pressure.
Materials	Equilibrium RH (ERH)	The a_w expressed as a percentage

[1] From ACGIH Bioaerosols: Assessment and Control. See Appendix B for further information on moisture assessment and control, such as the ACGIH and IICRC references.

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A complete discussion of moisture inspection and restoration is beyond the scope of this guide. School officials should refer to Appendix B for references.

7.2.4 Mold Testing

When done in a scientific manner, mold testing can provide useful information that complements other post-remediation evaluation approaches, described above. School officials should try to understand the limitations, uncertainties, and nuances of mold testing to determine: whether it is a good investment of limited resources; whether it can answer the desired questions; and if it can be done in an objective, useful, and defensible manner. Mold testing is not something school officials should feel compelled to do in any and every mold remediation project. For example, mold testing is usually unnecessary for "Minimal" problems. Moreover, when testing cannot answer the desired questions or a scientific protocol cannot be afforded, it may suffice to rely on the other evaluation methods.

MDH strongly recommends that mold testing be performed only if it can be done adequately to answer a question with acceptable certainty. In general terms, the questions for post-remediation evaluation testing should be along the lines of "does the level of biological agents detected on this particular material indicate acceptable remediation?" or "does this environment contain more organisms than would normally be expected?". Based on the available science and lack of consensus standards, currently it is MDH's view that questions such as "is there a safe level of mold" or "is the kind of mold present more harmful than others" cannot be answered with acceptable confidence or certainty[1].

There currently is no widely accepted protocol for mold testing although a number of ways to estimate mold levels exist. Considerable expertise is needed, in most cases by an outside consultant, if sampling and interpreting results are to be done defensibly. Depending on the situation, type of contaminated material, and sample collection and analysis method, there are limits to what can be detected and quantified. For example, viable samples detect a portion of the live organisms present but provide no objective information on the amount or type of non-viable microorganisms that may also be present. This may be an important distinction if the predominant cause of complaints was non-living mold particles, or if remediation killed the mold but failed to adequately remove it. Further information about mold testing is available in MDH's "Best Practices for Mold Investigations in Minnesota Public Schools", the MDH fact sheet "Testing for Mold"[1], and the Appendix B resources.

Because mold contamination is not always visible, mold testing can serve an important and necessary role in evaluating remediation. Sampling can also be used to assess the possible spread of contaminants from a containment zone to adjacent areas during or after remediation. In cases involving extensive contamination or high profile situations, sampling has been used for post-remediation clearance when outside remediation contractors or consultants insist on testing. If sampling was done to investigate the problem, it may be prudent to test after the remediation

[1] See fact sheet "Testing for Mold", available at www.health.state.mn.us/divs/eh/indoorair/mold/moldtest.html

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because stakeholders may expect to see a significant decline in mold levels (however, changes in the molds' metabolic state or environmental conditions can also affect measured mold levels).

The costs of mold testing can be considerable since large numbers of many different types of samples are usually needed. Enough samples should be collected to allow statistical characterization of the likely variability in sample results. Mold colonization and deposition onto surfaces may be discontinuous, and releases of mold into the air may be intermittent. Sample results can vary dramatically depending on time and location and many samples are needed to account for this variability.

Depending on your question, different sampling methods are needed. If the question presented is whether a material has returned to a normal mold level, then preference should be given to a technique that determines if surface or dust levels pass or fail a specific clearance criterion. If a broader question is presented, such as whether mold levels in the overall environment (air and surfaces) has returned to normal, then typically three types of methods should be used: 1) spore trap screening of air for total mold (viable and non-viable); 2) sampling air for viable mold levels; and 3) sampling surfaces for viable mold. If only 2 of 3 methods are affordable or available, then MDH recommends aggressive spore trap and surface sampling--these are likely to yield more information about the total fungal load or the location of contamination than viable air samples alone.

After samples are collected, they are sent to a lab for analysis. The analytical method should be sensitive to low levels of a broad spectrum of environmental fungi, provide the level of taxonomic identification needed for the intended use of the data, and should not be so expensive to deter collecting an adequate number of samples. When the types and quantities of mold are essential for interpretation (for example, comparing amounts and types of mold in air samples to background or outdoor samples), MDH recommends using a laboratory accredited by the American Industrial Hygiene Association's Environmental Microbiology Laboratory Accreditation Program (EMLAP) program.

Interpretation of mold testing results is somewhat subjective because there are no widely agreed upon standards or criteria for acceptable levels of mold. This is primarily because there is no scientific consensus regarding an environmental concentration of mold that correlates with clear and consistent health risks. Therefore, it is overly simplistic and inappropriate to rely solely upon a comparison of test results to any published numerical standard or value to determine safety or health risks. Some numerical guidelines have been proposed and published for use as "screening guidelines" or "performance criteria" to determine unusual vs. expected amounts of mold. However, these values are specific to sampling and environmental factors such as: equipment make and model; culture media used; flow rate; sampling duration; operator handling and performance; building operations; and geographic location and season. Comparison of results to such values should always consider differences in the sampling method, techniques, and environmental factors.

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A superior alternative to interpreting air samples results strictly according to a published absolute numerical value is to compare air fungal estimates from problem areas to those from similar suitable background areas (i.e., unaffected indoor area air levels and outdoor air levels). This comparative approach tries to determine if the concentrations and diversity of molds present in the remediated area are similar to the outdoor and unaffected indoor area air levels.

The following general principles should be used when interpreting comparison sampling results.

Air Samples

Comparison is only valid between samples taken at similar times on the same day and using the same sampling method (e.g. flow rate, duration, culture medium, etc.). Some variation in the total fungal levels and the presence or absence of a few types from one sample to the next is expected. Where relevant, indoor areas should be sampled and compared when building operations are similar, such as ventilation, open windows, cleaning and occupant activity level prior to and during sampling, and weather conditions. The following suggests acceptable mold levels:

1. Total concentrations of mold (number of colony forming units and/or total spores detected per unit volume of air) in indoor samples should be similar to, or lower than outdoor and unaffected indoor area samples.
2. Indoor samples consistently contain types[1] of mold present in the outdoor and unaffected indoor area samples.
3. Indoor samples are not dominated by types[1] of mold (as a percentage of the total amount) unless the same types also dominate the comparable outdoor and unaffected indoor area samples.

Surface and Dust Samples

These should generally show similar levels and types of mold fragments expected on similar materials reported in the literature or measured on the same materials in unaffected indoor areas.

1. Total concentration of mold (number of colony forming units per unit area or gram of dust) in indoor samples should be similar to, or lower than, samples from the same kind of material in an unaffected area and/or what is reported for similar materials in the literature.
2. Samples should show a mixture of mold types – not dominated by a single type of mold unless unaffected area samples are also dominated by the same mold.
3. Microscopic examination of samples should indicate an absence of colony structures (spore producing structures and mycelial fragments) that indicate surface growth.

[1] If sample results are to be interpreted by comparison to background levels, MDH suggests species level identification because this permits greater confidence in interpretation . However, due to cost considerations, it may be adequate to distinguish and compare fungi at the genus level. Identification of many species requires viable sample techniques. The results should be considered "presumptive".

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APPENDIX A
EXAMPLE STEP-BY-STEP REMEDIATION PROCEDURES

The following are examples of step-by-step procedures on contaminant removal, engineering controls, and personal protection for three categories of mold problems ("Minimal", "Moderate", and "Major"). As described in Section 4 of this document, problem categorization is based on the amount of visible fungal growth observable on surfaces, the degree of contamination, and the potential for releasing contaminants. The procedures in Appendix A are for instructional purposes. The practices and procedures for each specific mold remediation project need to be defined according to the many intricate variables that are too complex to fully address in this document. The following procedures do not detail moisture control measures, which are critical to permanently address any mold problem. All the information in preceding sections should be read to fully understand all aspects of mold remediation. Professional evaluation or remediation services may be helpful or necessary—their work plan should be compared to MDH's and other reputable sources' recommendations.

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A.1 Practices and Procedures for "Minimal" Problem Remediation

Step 1. Select personal protective equipment. Workers should protect themselves with the following:

- Respiratory protection capable of filtering particles down to 1 microns (a NIOSH approved N-95 filtering face piece respirator is recommended at a minimum);
- Eye protection (goggles that exclude fine particles); and
- Gloves (impervious to any cleaning products used).

Step 2. Determine if contaminated materials can be cleaned or whether they need to be discarded.

- *Porous materials* (including drywall board, ceiling tile, insulation, unprotected "manufactured" or "processed" wood products, upholstered furniture, carpet and padding) that are contaminated with mold need to be removed from the building. This should include all materials and furnishings that have, or had: visible mold growth; strong mold odors; or remained wet for longer than *48 hours* and are not easily cleanable.
- *Hard surfaced semi-porous materials* such as tile, finished wood products, cement, and concrete can often be left in place and cleaned, if they are structurally sound, would be very difficult to replace, lightly contaminated on the surface, and can be successfully cleaned.
- *Non-porous materials* need to be thoroughly cleaned (includes metal, ceramic tile, porcelain, glass, hard plastics, highly finished solid wood items, and other hard smooth surfaces).

Step 3. Carefully clean mold contaminants by trapping or capturing as much of the visible mold growth as possible from accessible surfaces. Use component removal[1] methods where feasible; otherwise, select one or more of the following techniques.

- Vacuum all visible mold growth and materials surrounding the area of growth using a HEPA vacuum (*a standard shop vacuum is not adequate*); or
- Carefully and systematically damp wipe surfaces with soapy water to remove and capture surface growth *(work damp, not wet)*; or
- Bag or contain porous contaminated materials and remove from the work area.

Step 4. Perform a final cleaning and drying of non-porous surfaces, including surfaces surrounding discarded porous materials.

- Damp wipe the cleaned materials with clean water to remove any remaining contamination or soiling residue.
- Manage run-off and leave surfaces as dry as possible after cleaning.

Step 5. Clean surrounding areas as needed.

Step 6. Perform post-remediation evaluation to determine the effectiveness of remediation work, and document the findings.

Step 7. Periodically inspect for moisture and visible mold growth.

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[1] Component removal techniques involve enclosing or sealing the surfaces of whole assemblies or sections of building materials or furnishings in plastic or other impermeable materials before removal. For example, wrapping, removing and disposing of entire components of cloth cubicles or entire sheets of wall board in one piece.

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A.2 Practices and Procedures for "Moderate" Problem Remediation

Step 1. Select personal protective equipment. Workers should protect themselves with the following:

- Respiratory protection capable of filtering particles down to 1 microns (a NIOSH approved N-95 filtering face piece respirator may be sufficient. A HEPA filtered respirator (for example, P-100) is strongly encouraged, if available, or if heavy disturbance is likely.
- Eye protection (goggles which exclude fine particles) if half-face respirator is used.
- Protective covering (disposable or washable outer clothing, long sleeved tops, long pants, booties and head coverings).
- Gloves (impervious to any chemicals used, and, if applicable, protective against sharp objects).

Step 2. Determine if the material(s) supporting surface mold growth can be cleaned or should be removed and discarded.

- *Porous materials* (including drywall board, ceiling tile, insulation, unprotected "manufactured" or "processed" wood products, upholstered furniture, carpet and padding) that are contaminated with mold need to be removed from the building. This should include all materials and furnishings that have, or had: visible mold growth; strong mold odors; or remained wet for longer than *48 hours* and are not easily cleanable.
- *Hard surfaced semi-porous materials* such as tile, finished wood products, cement, and concrete can often be left in place and cleaned, if they are structurally sound, would be very difficult to replace, lightly contaminated on the surface, and can be successfully cleaned.
- *Non-porous materials* need to be thoroughly cleaned (includes metal, ceramic tile, porcelain, glass, hard plastics, highly finished solid wood items, and other hard smooth surfaces).

Step 3. Prepare parts of the work area, to minimize mold disturbance that will occur during containment set-up. Mold growth that such preparatory work would significantly disturb should be included in the containment area and cleaned after containment is erected.

- Remove easily accessible surface growth by HEPA vacuuming (*a standard shop vacuum is not adequate*) and damp wiping.
- Clean areas and materials by HEPA vacuuming or damp wiping, such as
    - items that will be covered by critical barriers (e.g., air supply and return grilles);
    - surfaces that will become inaccessible once the containment is erected (e.g., flooring under a containment wall);
    - uncontaminated furniture and materials that will be removed from the work area (if this can be done without agitating the visible mold growth).

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Step 4. Locally contain the affected area to minimize contaminant dispersal.

- Enclose areas of visible contamination and areas of suspected hidden growth with critical barriers (4-6 mm polyethylene sheeting or comparable non-permeable materials). The containment should be extended at least a few feet beyond areas of growth to ensure materials with heavy spore deposition are contained and to enable ease of remediation work. Critical barriers should block all openings so that mold particles cannot be carried outside the remediation area by air movement or through the mechanical ventilation system.

Step 5. Perform mold remediation activities, including detailed cleaning and/or removal of mold contaminated materials.

- *Porous materials*: wrap or bag the materials in plastic sheeting and discard in a secure disposal container. Clean surrounding non-porous materials, at least two feet beyond visible growth. Securely bag waste and dispose.
- *Semi-porous materials*: remove if necessary, or thoroughly clean as described for non-porous materials, disinfect, and dry. For stubborn problems, consider using HEPA vacuum filtered sander, trisodium phosphate as a cleanser, or seal if the material can be kept dry.
- *Non-porous materials*: clean using a repeatable pattern of motions moving downward and from the cleanest areas to the dirtiest (not random washing or visually based), to ensure all surfaces have been thoroughly cleaned. Don't use methods such as sweeping, dry dusting or brushing). Perform cleaning in the following order.
  1. HEPA vacuum slowly and carefully.
  2. Damp wipe with a water and an all-purpose non-ammonia based cleaner or detergent (*work damp not wet*).
  3. Once all surfaces have been dried from the initial cleaning, perform a second HEPA vacuuming in the opposite direction.
  4. Manage runoff and leave surfaces as dry as possible after cleaning.

Step 7. Decontaminate equipment and containment by thoroughly cleaning with a non-ammonia based all-purpose cleaner followed by application of a mild bleach solution.

Step 8. Disassemble containment materials.

Step 9. Initiate additional drying if needed.

Step 10. Clean surrounding area as needed.

Step 11. Perform post-remediation evaluation to determine the effectiveness of remediation work and document findings.

Step 12. Periodically inspect for the presence of excess moisture and/or return of mold growth before rebuilding or refurnishing. If growth reappears, the moisture problem typically has not been properly addressed or corrected. Perform further investigation to determine moisture problem, correct the moisture problem, and remediate mold growth.

Step 13. Re-construct and replace removed materials after moisture control has been achieved.

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A.3 Practices and Procedures for "Major" Problem Remediation

Step 1. Select personal protective equipment. Workers should protect themselves with the following:

- Respiratory protection capable of filtering particles down to 0.3 microns. A full-face HEPA filtered respirator, such as a P-100 or powered air purifying respirator (PAPR), is strongly recommended;
- Protective covering (disposable or washable outer clothing, long sleeved tops, long pants);
- Eye protection (goggles which exclude fine dusts) if half-face HEPA respirator is used;
- Anti-contamination garments; and
- Gloves (impervious to any chemicals used and, if applicable, sharp objects).

Step 2. Determine if the material(s) supporting surface mold growth can be cleaned or should be removed and discarded.

- *Porous materials* (including drywall board, ceiling tile, insulation, unprotected "manufactured" or "processed" wood products, upholstered furniture, carpet and padding) that are contaminated with mold need to be removed from the building. This should include all materials and furnishings that have, or had: visible mold growth; strong mold odors; or remained wet for longer than *48 hours* and are not easily cleanable.
- *Hard surfaced semi-porous materials* such as tile, finished wood products, cement, and concrete can often be left in place and cleaned, if they are structurally sound, would be very difficult to replace, lightly contaminated on the surface, and can be successfully cleaned.
- *Non-porous materials* need to be thoroughly cleaned (includes metal, ceramic tile, porcelain, glass, hard plastics, finished solid wood items, and other hard smooth surfaces).

Step 3. Prepare parts of the work area, to minimize mold disturbance that will occur during containment set-up. Mold growth that such preparatory work would significantly disturb should be included in the containment area and cleaned after containment is erected.

- Remove easily accessible surface growth by HEPA vacuuming (*a standard shop vacuum is not adequate*) and damp wiping.
- Clean areas and materials by HEPA vacuuming or damp wiping, such as
  - items that will be covered by critical barriers (e.g., air grilles);
  - surfaces that will become inaccessible once the containment is erected (e.g., flooring under a containment wall);
  - uncontaminated furniture and materials that will be removed from the work area (if this can be done without agitating the visible mold growth).

Step 4. Contain work area and limit access to authorized personnel.

- Erect containment around the area of visible and suspected hidden mold growth, extending several feet beyond the affected area. This should be designed to seal off the contaminated area in an air-tight manner. An effective decontamination

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unit system should also be constructed for entering and exiting the remediation work area.

- Isolate the air handling system from work zone by sealing off supply and return grills with plastic sheeting and duct tape. If the area being remediated is served by an HVAC system, it should be shut down prior to any remedial activities.
- Use critical barriers (e.g., double layer of polyethylene and duct tape) to isolate the moldy area from clean occupied zones. Critical barriers should block all openings so that mold particles cannot be carried outside the remediation area by air movement or through the mechanical ventilation system.
- Establish a negative air pressure differential of >5 Pa or >0.02 in. water column at all times between indoor areas external to the containment barriers and the enclosed remediation area. Establish negative pressure using HEPA-filtered ventilation equipment. Provide make up air and test or monitor containment for leakage.

Step 5. Perform mold remediation activities, including detailed cleaning and/or removal of mold contaminated materials.

- *Porous materials*: wrap or bag the materials in plastic sheeting and discard in a secure disposal container. Clean surrounding non-porous materials, at least two feet beyond visible growth. Securely bag waste and dispose.
- *Semi-porous materials*: remove if necessary, or thoroughly clean as described for non-porous materials, disinfect, and dry. For stubborn problems, consider using HEPA vacuum filtered sander, trisodium phosphate as a cleanser, or seal if the material can be kept dry.
- *Non-porous materials*: clean using a repeatable pattern of motions moving downward and from the cleanest areas to the dirtiest (not random washing or visually based), to ensure all surfaces have been thoroughly cleaned. Don't use methods such as sweeping, dry dusting or brushing). Perform cleaning in the following order.
  1. HEPA vacuum slowly and carefully.
  2. Damp wipe with a water and an all-purpose non-ammonia based cleaner or detergent (work damp not wet).
  3. Once all surfaces have been dried from the initial cleaning. Perform a second HEPA vacuuming in the opposite direction.
  4. Manage runoff and leave surfaces as dry as possible after cleaning

Step 6. Decontaminate equipment and containment by thoroughly cleaning with a non-ammonia based all-purpose cleaner followed by application of a mild bleach solution.

Step 7. Determine if use of disinfectants is needed or desirable (see Section 6.9 "Use of Disinfectants and Pesticides"). Carefully follow the directions provided with the disinfectant. A dilute bleach solution may be adequate. The solution should be applied by light misting or wiping on (avoid runoff); treat the entire area that supported visible growth. The surfaces should be kept damp with the solution according to the manufacturer's recommendations. Allow to air dry. Wipe off residue.

Step 8. Clean surrounding area as needed.

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Step 9. Allow or facilitate complete drying of all materials wet from excess moisture, cleaning activities, or disinfection solution. Dehumidifiers, fans, heat lamps and ventilation with dry warm air are among the methods that may be used to speed drying. Complete drying to normal levels may take days or weeks.

Step 10. Perform a thorough post-remediation evaluation and document work performed. Evaluate cleaning practices using previously identified evaluation methods to determine if clearance requirements have been satisfied.

Step 11. Once post-remediation criteria have been achieved, deconstruct containment and then remove air-handling equipment. Air-handling equipment should be left running until entire containment has been completely taken down and removed.

Step 12. Periodically inspect for the continuing presence of excess moisture and/or return of mold growth before rebuilding or refurnishing. If growth reappears, the moisture problem has not been corrected. Perform further investigation to determine moisture problem, correct the moisture problem, and remediate mold growth.

Step 13. Re-construct and replace removed materials after moisture control has been achieved.

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APPENDIX B
MOLD REMEDIATION REFERENCES

Other mold remediation guidance documents also describe or recommends various control measures based upon the extent or type of mold contamination. Schools may wish to use such materials if they feel additional advice on mold clean-up and removal is needed -- such as when very heavy or widespread contamination is encountered. The MDH Best Practices documents are generally consistent with the guidelines below.

"Mold Remediation in Schools and Commercial Buildings", U.S. EPA Indoor Environments Division. April 2001. www.epa.gov/iaq/molds/mold_remediation.html

"Guidelines on Assessment and Remediation of Fungi in Indoor Environments", New York City Department of Health Bureau of Environmental & Occupational Disease Epidemiology. April 2000. NYC.gov/html/doh/html/epi/moldrpt1.html

Standard and Reference Guide for Professional Water Damage Restoration *IICRC S500*, The Institute of Inspection, Cleaning and Restoration Certification. Second Edition 1999. Available for purchase by contacting IICRC: www.iicrc.org

Bioaerosols: Assessment and Control. American Conference of Governmental Industrial Hygienists (ACGIH). 1999. Available for purchase by contacting ACGIH: www.acgih.org

"Assessment, Cleaning, and Restoration of HVAC Systems (ACR-2002)". National Air Duct Cleaners Association (NADCA) of Washington, DC. Available for purchase by contacting NADCA: www.nadca.com

"Fungal Abatement Safe Operating Procedure". University of Minnesota Dept. of Environmental Health and Safety. www.dehs.umn.edu/iaq/sop.html

"Fighting Mold: The Homeowner's Guide". Canada Mortgage and Housing Corporation. www.cmhc.ca/en/burema/gesein/abhose/abhose_50.cfm?renderforprint=1

"Fungal Contamination in Public Buildings". A Guide to Recognition and Management. Health Canada. www.hc-sc.gc.ca/ehp/ehd/catalogue/bch_pubs/fungal.pdf

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APPENDIX C
MINNESOTA CONTACT INFORMATION

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phone: 651/201-4601 or 800-798-9050
www.health.state.mn.us/divs/eh/indoorair/schools/index.html

Minnesota Department of Children, Families and Learning

Phil Allmon
Health, Safety/Risk Management Coordinator
phone: 651/582-8748
email: phil.allmon@state.mn.us

Minnesota Department of Labor and Industry

Minnesota Occupational Safety and Health Administration
Workplace Safety Consultation Unit
800/657-3776
Note: OSHA does not regulate mold in the workplace, but does regulate personal protection use, training, and other workplace practices associated with hazards.

Minnesota Department of Agriculture

Pesticide licenses and questions
651-297-2200 or 1-800-967-2474
www.mda.state.mn.us

APPENDIX D
GLOSSARY OF TERMS

AEROSOL: small liquid or sold particle, which can remain suspended in air for some time.

ALLERGEN: a substance (such as a mold spore) that can elicit an excessive immune response such as hay fever, rashes, sinusitis, or asthma symptoms.

AMPLIFIER: An item (material, substrate, etc.) that supports the active growth and proliferation (increase in numbers) of mold.

ANTIMICROBIAL: an agent used to suppress or retard microorganisms on direct contact (e.g., a fungistatic agent is used against fungi).

BIOAEROSOL: Airborne particles or matter of biological origin (derived from a live or formerly living organism). For example, mold spores or fragments of a mold growth that are suspended in the air.

CLEANING: The science and practice of controlling contaminants by locating, identifying, containing, removing and disposing of unwanted substances from the environment.

COLONY: A uniform mass of cells all derived from a single cell and which is growing on a solid surface. A colony is usually the smallest unit of mold that can be observed with the naked eye.

CONTAINMENT: Barriers, seals, air-locks, negative air filtration systems and other methods used to control the movement of airborne materials or agents and avoid secondary contamination. For example, plastic sheeting used to enclose a work area to prevent disturbed mold particles from drifting from the containment zone into adjacent or connected areas.

CONTAINMENT BARRIER: polyethylene sheeting (or other nonpermeable materials) used to completely seal off work area to prevent the airborne distribution of contaminants to areas outside the containment zone.

DETERGENT: A cleaning agent. Detergency refers to the ability to remove soil.

DISINFECTANT: Any agent that significantly reduces the numbers of undesirable or infectious microorganisms, but may not eliminate all (e.g., not all bacteria or fungi spores).

DISINFECTION: The elimination and destruction of microorganisms, which may allow for survival of some resistant organisms (e.g., bacterial endospores or fungal spores).

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ENCLOSURE: The practice of attaching a rigid and durable barrier to building components, with all edges sealed for the purpose of permanently enclosing contaminants.

EQUILIBRIUM RELATIV HUMIDITY (ERH): The a_w of a material expressed as a percentage where a_w = equilibrium relative humidity/100. This can be estimated in the field by a relative humidity measurement at a material's surface using a hygrometer.

FUNGI: A biological kingdom of organisms that includes among many others, mushrooms, puffballs, yeasts, and molds. There are between 1000,000 and 10 million species of fungi.

FUNGISTATIC: A chemical agent incorporated into or applied onto a material to suppress or slow the growth of fungi on direct contact.

GENUS: A biological level of classification directly above the species level. In the practice of naming mold, the genus is indicated first and is capitalized (e.g., Aspergillus is the genus of the mold named, Aspergillus fumigatus). There often are many different species within a single genus. The plural form is genera.

HEPA: High efficiency particulate air. Capable of removal and capture of 99.97 % of dispersed particles greater than or equal to 0.3 microns in size. See the Dept. of Energy standard DOE-STD-3020-97 for details.

HEPA-FILTERED VACUUM: A high-efficiency particulate air filtered vacuum with a properly installed filter capable of collecting and retaining particulate matter 0.3 microns or larger at an efficiency rate of 99.97%.

HIDDEN MOLD: Mold growth on building materials or assemblies of building components that are obscured from the view of an observer within building spaces normally intended for occupancy. Common examples include contamination beneath carpeting or padding, behind fixed cabinetry or shelving units, in spaces above a drop ceiling, in air handling or distribution systems, or within a wall cavity.

HYPERSENSITIVITY PNEUMONITIS: (aka extrinsic allergic alveolitis). A syndrome characterized by inflammation of the lungs, caused by inhalation of certain allergens. Typically occurs in the occupational setting following the repeated inhalation of very high levels of an allergen(s), including mold allergens (e.g., farmer's lung).

METABOLITE: A chemical produced by the metabolism of a living organism; produced by enzymatic action.

MICROBE: a microorganism, including types of fungi and bacteria that are usually not visible to the naked eye. Indoor biological contamination can include other microbes in addition to mold, and this may affect the remediation strategy.

MICRON: A unit of measure equal to one millionth (10^{-6}) of a meter; also known as a micrometer and written as "□m". Approximately equal to 1/25,000 inch.

MOISTURE CONTENT: The mass of moisture held in a material, relative to the material. Measured as the mass of water as a percentage of the dry mass of a material. Expressed as a percentage [(wet mass – dry mass) (100)]/(dry mass), or in terms of mass of water over material volume. Moisture content can be measured in the field using a moisture meter that is appropriate and calibrated for the material. Different moisture content values can be tolerated, depending on the material, before mold growth occurs.

MVOCs: Microbial Volatile Organic Compounds: chemicals that can be produced by actively growing molds and bacteria, which are released as gases into the air and are responsible for the characteristic moldy or musty odor .

MYCOTOXIN: A harmful substance produced by a fungus, which affects the structural or functional integrity of cells or tissues. Mycotoxins are usually found in the spores, filamentous structures, and/or the surrounding growth material.

MYCOLOGIST: A microbiologist who studies or has "expert" knowledge of fungi.

NADCA: National Air Duct Cleaners Association. Trade group that publishes the standard Assessment, Cleaning, and Restoration of HVAC Systems (ACR-2002).

NEGATIVE PRESSURE: An atmosphere created in an enclosure such that the air pressure within the enclosure is less that that outside the enclosure resulting in the tendency for airborne particles to be drawn in rather than out.

NIOSH: National Institute for Occupational Safety and Health

ODTS: Organic Dust Toxic Syndrome (same disease as humidifier fever; also referred to as silo unloader's disease and pulmonary mycotoxicosis). Illness characterized by chest tightness, flu-like symptoms, and possibly other symptoms following a single very heavy microbial exposure (including mold). Such extreme conditions are rarely found in homes, schools, or offices.

PATHOGENIC: A microbe capable of causing disease by direct contact, typically through infection. The molds most often regarded as pathogenic are those most frequently known to cause opportunistic fungal infections, primarily among immune-compromised individuals (e.g., Aspergillus fumigatus). A microbe that produces toxins that cause disease in the absence of the microbe is not defined as pathogenic.

POROUS: Strictly defined, porous refers to the ability of a material to allow fluids to pass through (permeability to liquids or gases). For the purposes of this document, porous materials are items that absorb moisture (liquid water or humidity). Examples include wood products, paper products, fabric, carpet and pad, plasterboard, drywall, insulation, and ceiling tiles. In

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contrast, non-porous materials include Formica, vinyl, plastic, glass, some tile, metal and many other similar hard surfaced durable or sealed materials.

PROPAGULE: Particles that are capable of germinating and producing a colony (for example, mold spores or fragments of hyphae).

PROTECTIVE CLOTHING: garments worn by workers to keep gross contamination from contacting skin surfaces and reaching underlying clothing layers.

RELATIVE HUMIDITY (RH): A ratio quantifying the actual amount of water present in air to the maximum amount of water that air (at the same temperature) is capable of holding; this ratio is expressed as a percentage.   Warmer air has a greater capacity to hold water in the vapor form than does cooler air.

REMEDIATION: The spectrum of measures intended to correct a problem and restore the environment to a useable state. For the purposes of this document, MDH regards mold remediation as any combination of activities which: a) remove indoor mold growth and mold-contaminated materials, b) eliminate and prevent excess moisture that allows growth, and c) rebuild or refurnish.

SANITIZER: An agent with cleansing and antimicrobial properties that reduces or inhibits microbial growth.

SPECIES: The next most specific level of biological classification below genus. In the practice of naming mold, the species follows the genus and its first letter is always written in the lower case (e.g., fumigatus, in Aspergillus fumigatus).

SPORE: A specialized reproductive cell. Mold spores are individually microscopic and many are very buoyant. As such, they readily stay suspended in the air and can be dispersed by air movement. Some spores of mold and bacteria may be highly resistant and able to survive adverse environmental conditions.

STERILIZE: Kill or inactivate all microorganisms.

STERILANT: An agent or process used to sterilize a surface or media.

TAXONOMY: An orderly system for classifying and naming living organisms based upon how closely groups or individuals are related. See also GENUS and SPECIES.

TOXIC: Toxic refers to the inherent ability of a substance to cause harm to living cells or biological tissues.

TOXIGENIC: An organism that can produce one or more toxins. Examples of fungi that can produce toxins under certain conditions include the certain species of *Aspergillus*, *Penicillium*,

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Fusarium, *Trichoderma*, *Memnoneniella*, and *Stachybotrys chartarum* (note other species may also produce toxins).

VIABLE: Able to reproduce under appropriate conditions (the opposite of non-viable). Some mold testing methods only detect molds that will grow on the specific culture medium used--molds that are non-viable or don't grow on that medium will be missed. Some mold spores can remain viable for many years.

WATER ACTIVITY (a_w): A physical-chemical concept that describes the moisture in a solid material and can be used to express the availability of free moisture for the growth of microorganisms. It is expressed as a decimal fraction less than or equal to 1; where a material's water activity is 1.0 when it is saturated. There is no direct field technique to measure water activity and it can only be related to moisture content for a specific material (see EQUILIBRIUM RELATIVE HUMIDITY).

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