

REMEDIAL PROCEDURES FOR WATER DAMAGE IN BUILDINGS

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ABSTRACT

Within the life cycle of a facility, water damage due to plumbing leaks, flooding, major spills, sewer back-ups, etc. will occur. Water damaged building materials, interior furnishings, structural and mechanical components, if not appropriately managed, can become significant sources of microbial (bacteria and fungi) contamination. Exposure to these contaminants can lead to potential health problems ranging from simple irritation, allergic responses, infection, to environmental sensitivity. Depending on the source, extent and location of water intrusion, there are various clean-up and remedial procedures to effectively control the situation and minimise damage, microbial growth, and health risk. The intended audience for the management and remediation of water damage in buildings are building owners and managers, operators, project managers, abatement and restoration contractors, indoor air quality consultants, industrial hygienists and building occupants.

INDEX TERMS

Water damage, Flooding, Flood remediation procedures.

INTRODUCTION

There are many variables to consider when water damage occurs, however, the primary goal is to dry wet materials as quickly as possible in order to limit damages. Microbials are found in both the outdoor and indoor environment and growth will occur when moisture is present. As it is impossible to eliminate mould spores indoors, it is important to prevent moisture problems within a facility and remediate water damage before microbials can grow. The remediation of a water-damaged area must also be done under “universal precautions” and “controlled conditions”. Water quality must also be considered in the remediation process.

Universal precautions are used with the assumption that a hazard exists, whether it actually does or not, unless proven otherwise. Remediation workers must use protective measures until the hazard is defined. These measures incorporate appropriate respiratory and eye protection, gloves, boots, and disposable coveralls. Hard hats and safety shoes may also be required.

Controlled conditions require isolation or containment of the affected areas to prevent the dispersion of possible contaminants to other sections of the building. The work area should be placed under negative pressure to ensure that air flow is from the clean surrounding area to the area undergoing remediation using negative air machines, fans or exhaust systems. Minimise damage by covering or removing items not yet soiled. Remove debris and wet materials with care; bag and seal debris, cover garbage containers, and provide drop cloths and coverings from the work area to the exit. These materials can be discarded as ordinary construction waste. All equipment used inside the remediation zone must be cleaned before removal.

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Water quality is generally divided into three different categories: clean, grey, and black (sometimes referred to as sanitary, unsanitary, and black water). These categories are determined by the source of the water and not by the actual colour of the water. **Clean water** is from potable sources such as broken water supply lines, sprinklers, melting ice, snow, rainwater, fire-fighting efforts, steam leaks, sink overflows, and broken toilet tanks and bowls that do not contain contaminants. **Grey water** is from toilet overflows containing urine, discharges from washing machines, dishwashers, and from sump pits or wells. **Black water** includes sewage, broken water traps, and flooding from outdoor sources.

All water, including clean water, can result in the proliferation of bacteria and fungi in building substrates and contents. The materials that are most susceptible to microbial contamination are those which are porous, such as wallboard (drywall and gypsum), insulation, ceiling tiles, carpets, and textiles. As time lapses, wet materials become progressively contaminated and it is therefore critical to start the remediation process within 24 hours of the time of damage.

The Remediation Program

A water damage remediation program complies with the following steps:

1. Before entering the water-damaged area safety aspects such as structural integrity, potential for electrical shock, gas leaks, and exposure to toxic gases and biohazards must be evaluated. For grey or black water damage, persons must be equipped with the appropriate personal protective equipment. Individuals not immunised against tetanus, those with health problems such as asthma, allergies or respiratory disease, skin cuts or abrasions, and those with a suppressed immune system, should not be present or working in this area.
2. The damaged area should be isolated. Barriers and warning signs may be required.
3. The source of the water intrusion should be located, eliminated, repaired or contained.
4. Equipment and furnishings should be moved or protected against further damage and contamination. Perimeter air-handling units, exhaust systems, and return plenums should be sealed.
5. Initial water should be removed by extraction or absorption using mops, towels, squeegees, pumps, wet-vacuums, etc.
6. Dry damaged materials by wiping or vacuuming, using fans and heaters, dehumidifiers, and by running the HVAC system to ventilate and exhaust humid air. Dehumidifiers are more effective than ventilation in warm weather. Windows may be opened if outdoor conditions are favourable to assist in the drying process.
7. Remediate water-damaged structural components, furnishings, equipment and the mechanical (HVAC) system to avoid microbial contamination.

REMEDICATION OF MATERIALS

Listed below are the recommended remediation procedures for various materials exposed to either clean water or contaminated grey or black water. In most instances, porous materials that have been exposed to black water (sewage) must be discarded.

Wet vacuum to remove excess water and wet debris and use a HEPA-filtered vacuum to clean dry materials. High efficiency filtration will ensure that fungal spores are collected and not dispersed. Dispose of the contents in well-sealed plastic bags.

Note that the use of **disinfectants or biocides** (containing chlorine, bleach, peroxides, ammonia, formaldehyde, and other chemicals) are not generally recommended for cleaning hard, non-porous materials. Most disinfectants contain respiratory irritants and they must remain on the surface for 15 minutes or longer to be effective against microbial growth. A detergent is usually effective, however, avoid the use of scented cleaners as someone may find pine, lemon or other odours objectionable. When a disinfectant is used, it can be wiped or sprayed on but never misted, to avoid an inhalation hazard. Always use disinfectants in a well-ventilated area. Follow instructions on the label and on the Material Safety Data Sheets (MSDS).

Hard surfaces such as metal filing cabinets, desks, bookcases, and wood furnishings need to be wiped with water and detergent and dried completely. Mops, sponges or cloths must be kept clean so that no residual soiling remains on any exposed or hidden surface.

Furniture made of solid wood or veneer and having intact laminates should be dried and cleaned. Particle board or pressed wafer board furniture should be discarded, except when exposed to clean water. These items may be dried and cleaned, and monitored for subsequent microbial growth, odours, or delamination. If this becomes evident, discard the furniture.

Upholstered furniture wet with clean water should be dried and monitored for fungal growth and odours. Discard upholstered furniture and other highly absorbent stuffed fabrics such as wall partitions, when they become saturated with grey or black water. It may be cost effective to remove the upholstery from furniture and clean the wood or metal frame.

Carpets that have become wet with clean water (or grey water over a small surface area) are remediated by the following steps:

- Remove all materials (desks, furnishings, cabinets, etc.) from the carpet.
- Extract as much water as possible from the carpet using wet vacuums.
- Shampoo the carpet with a dilute surfactant.
- Soak with a 10 % bleach / water solution. (A biocide is not recommended.)
- Rinse with clean water and extract the carpet to remove residues.
- Instead of soaking with bleach and rinsing, the carpet can be steam cleaned.
- Dry the carpet immediately after treatment. If the carpet cannot be dried, it must be discarded.
- Verify that the carpet, the underlay, and the floor are dry. A section may have to be lifted or a moisture meter can be used. If the underlay or floor is wet, the carpet should be removed to facilitate drying. Swelling, buckling, ripples and cracks in the sub-floor will require removal of the carpet and underlay.
- Vacuum the carpet. Fine particulates will wick up the fibres during the drying process. Use an industrial grade vacuum with a beater bar.

If visible mould appears or the area smells of mould, the treatment process (cleaning and bleaching) should be repeated. This should be repeated only once. If complaints, mould growth, or odours persist, the carpet and underlay will have to be removed under controlled conditions. Carpets and under-padding saturated by grey or black water must be discarded.

Books, files and papers made wet by clean water can be air-dried. If possible, photocopy essential papers after they have dried and discard the originals. If you cannot tend to the papers promptly within 48 hours, then they can be wrapped in plastic bags or in wax paper and frozen until later. Books and files damaged by grey water can be rinsed, blotted dry, then air dried or frozen. A process of “vacuum freeze-drying” can be used in which controlled heat

and vacuum pressure is applied to frozen materials. HEPA vacuum any residue, debris, and dust off of all surfaces after drying.

REMEDICATION OF STRUCTURAL COMPONENTS

It is important that building materials be allowed to dry. Drywall covered with vinyl wallpaper or with wood panelling will act as a vapour barrier and impede drying. During the remediation process, it may be necessary to access hidden areas such as wall and ceiling cavities, crawl spaces, and shafts, to investigate the extent of water damage.

Ceiling tiles – remove and dispose of all wet ceiling tiles within 24 – 48 hours after water damage. The only exception would be if 1 to 3 tiles had become wet due to a small steam or clean water leak and the shape of the tiles was not altered and there was no discoloration.

Drywall and insulation that has become wet should be removed within 24 hours. A moisture meter should be used to identify the extent of water damage and drywall should be cut at least 30 centimetres (12 inches) above the moisture mark. Wet fibreglass, mineral wool, and cellulose lose their insulation properties and tend to compress or mat. Foam insulation can be decontaminated by cleaning and drying. After cleaning, a bleach solution can be sprayed on and left in place. If water has penetrated the insulation, the insulation should be removed.

Lathe and plaster that has become wet with clean water should be dried within 24 hours. Minerals from the wall may leach and form a chalky surface. This loose material will need to be removed under controlled conditions and the surface allowed to dry. Lathe and plaster exposed to grey and black water must be evaluated for physical damage and degree of contamination. If water has penetrated the material, removal is warranted. If a small surface area has been affected, cleaning using a disinfectant or biocide, is recommended. If the surface develops an odour, with or without visible mould growth, the water-damaged area should be replaced under controlled conditions.

Wall panelling made from wood laminates or vinyl can be cleaned and dried. Particle or wafer board that has been saturated with black water should be discarded. Damaged, stained, or swollen walls should be replaced.

Concrete floors (and walls) when cleaned using a detergent or rinsed with bleach, and dried are not usually susceptible to microbial growth. If contaminated with black water, cleaning with tri-sodium phosphate (TSP) is recommended; cover the entire surface with TSP.

Vinyl, laminate, and hardwood floors are usually non-porous and can be cleaned and dried. Remove dirt between cracks. It should be verified that water has not seeped underneath the seams, along the walls, or under mouldings. The underfloor must be dry, or allowed to dry.

Plywood and particleboard subfloors saturated by water are usually not salvageable.

REMEDICATION OF THE MECHANICAL SYSTEM AND OTHER COMPONENTS

Mechanical systems that have been flooded by grey or black water should be shut down to avoid the transmission of contaminants to other areas of the building. When cleaning system components, protect motors, bearings, belt drive assemblies, filters, ducts, and other non-damaged items from water intrusion and airborne debris.

Vacuum clean the entire internal space of the HVAC system, including all components, supports, frames, mounts, etc. to remove loose dirt and debris. Hand scrub to remove residual dirt. Pressure wash the hard to clean system components. There should be no standing water or wet surfaces within the system after all components have been cleaned.

Wet **fibreglass** or other wet porous insulation in the air handling system (including supply ducts) should be discarded.

Filters that have become wet should be replaced. Filters can be removed and stored during system remediation. However, at no time should the system be in operation if the filters are not in place.

Hard surfaces can be cleaned with a detergent or bleach solution by hand wiping, or with a spray / pressure washer.

Heating and cooling coils exposed to water damage should be cleaned using a pressure washer and cleaning agent at both the upstream and downstream face.

Floor **drains** and **sumps** should be cleaned, disinfected and flushed. During a flood, the water pressure in plumbing systems can reverse, and water in **hot** and **cold pipes** can be contaminated with floodwater. A plumber should inject bleach into the lines to disinfect them.

Air supply and exhaust ducts that have been damaged with clean water will need to be inspected. Clean ducts may not pose a problem when they are dried. If water and dirt is visible, the entire affected system, including vertical sections, should be cleaned. If the system has been penetrated with grey or black water, ducts will have to be decontaminated. (It may be cost effective to replace the ductwork.) It is not advisable to apply biocides or sealants on dirty surfaces. External duct and system insulation and wrapping that can be dried, can remain in place. Verify that the insulation is dry through its entire depth and monitor for microbial growth. Waterlogged areas must be removed and replaced.

Air-handling units along the perimeter and within the ceiling that have been exposed to moisture, must be re-conditioned. Remove all fibreglass lining and filters. If damaged by clean or grey water, use detergent to clean surfaces by either hand wiping or by using a pressure washer. Do not get surrounding areas wet, and vacuum after spraying. It may be best to clean removable components off-site. Coils and fins can be cleaned using a pressure washer or a HEPA-filtered vacuum. Air-handling units contaminated by black water should be dismantled and re-conditioned. A 10 % bleach solution should be used to clean all surfaces. Porous materials must be discarded. **Registers, grills and diffusers** exposed to clean or grey water should be wiped clean and dried. Items exposed to black water should be removed and disinfected before reinstallation.

Before the HVAC system is put back into operation, a **final purge** is recommended. All supply air diffusers and air-handling unit grills should be covered with 30 % or greater efficiency filter media and taped to eliminate air leakage. Start the system and run at variable speeds to dislodge dirt and debris for at least one hour. Remove all filter media, vacuum, and clean any locations if necessary.

Electrical appliances and other unique specialised components require inspection and repair by a qualified person. An electrician should turn off the power in the flooded area at the service panel before electrical appliances are removed. **Electric circuit breakers** and **fuses** that were wet should be replaced. **Switches** and **outlets** that were under water can be cleaned and reused if still functional. Electric **motors** and **appliances** need to be cleaned, dried, and inspected. All damaged **light fixtures** need to be opened, cleaned, dried and checked before being put back in service.

Computers, radios, and televisions that have been water damaged may be unsalvageable. Items soaked in black water should be discarded. Disks and CDs can be washed in clean, distilled water and dried with lint-free towels.

CONCLUSIONS

Water damaged materials, structural components, and mechanical systems can be remediated using established techniques and sound principles. However, it should be recognised that there are occasional events that will require a unique resolution; one that is outside the scope of these guidelines (see www.pwgsc.gc.ca/rps/iaq/.)

There is specialised expertise that can be utilised to advantage. For example, a person trained in moisture measurements can accurately indicate where hidden moisture lies and how much area has to be removed. Professional water damage, recovery, and restoration firms have specialised equipment (desiccant dehumidifiers, heaters, fans, etc.) and skills to manage flood remediation projects. Medium to large jobs may require a manager and a remedial action plan.

Microbial contamination does not need to follow water damage. A rapid response to contain and limit water damage, and the removal, cleaning and drying of contaminated or wet materials, will provide limited opportunity for microbial growth. Post cleanup inspection and clearance sampling by a trained indoor air quality or environmental health professional is useful to ensure that the affected space is within established health and safety standards and guidelines. A pre-occupancy evaluation of the remediation effectiveness is warranted and prudent and this may include microbial sampling before final assurance is given

Finally, because of actual and perceived health risks, open communication with all concerned building constituents through a single, informed contact person is recommended.

REFERENCES

- Alberta Transportation and Utilities Disaster Services Branch. 1998. Flood disaster: detailed information about what to do before, during and after flooding. [Web Page]. URL <http://www.health.gov.ab.ca/>
- Carlson, N., & Quraishi, A. 1998. Managing water infiltration into buildings. [Web Page]. URL <http://www.dehs.umn.edu>
- EPA. 2001. Mold Remediation in Schools and Commercial Buildings, Washington, DC: United States Environmental Protection Agency. [Web Page]. URL www.epa.gov/iaq
- IICRC S500. 1999. Standard and Reference Guide for Professional Water Damage Restoration, Vancouver, Washington: Institute of Inspecting Cleaning and Restoration Certification. [Web Page]. URL www.iicrc.com
- NYC DOH. 2000. Guidelines on Assessment and Remediation of Fungi in Indoor Environments, New York City: New York City Department of Health. [Web Page]. URL <http://www.ci.nyc.ny.us/html/doh/html/epi/moldrpt1.htm>