

Flood Response and Mold Prevention Program

Prepared by Yale University's
Offices of Environmental Health and Safety,
Facilities Operations, Fire Code Compliance, and Risk Management

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A. Introduction

Yale University is committed to providing a safe and healthy place of work and study. To that end, it is committed to preventing floods and water intrusion events that themselves can damage sensitive equipment and irreplaceable materials as well as create conditions suitable for molds and other microorganisms to grow. While New Haven, CT, is not geographically located in a region of excessive mold susceptibility, high humidity conditions can occur through a variety of weather, building, and event conditions.

Successful flood responses and mold mitigation require the close cooperative interactions of many individuals and departments. They begin with prompt recognition of a problem, timely notifications to appropriate responders, corrective actions, and follow-up. Typically, physical plant, custodial, environmental health and safety, risk management, and security are involved, along with individuals from the affected location or department.

The purpose of this document is to provide those with responsibilities for flood and mold prevention and response with a ready and easily understandable source of information about these kinds of events and the steps that are needed to help prevent them as well as successfully respond to them. This document contains a contact list to key facility and emergency response personnel, generalized emergency procedures, prospective pre-event planning opportunities, and pre-approved contractors. As this document is meant to be a “living” one, it will be periodically reviewed and updated. Please direct any comments or suggestions to Yale Environmental Health & Safety.

B. Flood and Mold Hazards

Floods are water release or intrusion events that result in the presence of water in unwanted locations. They include all forms of water: “clean” potable water, drain waste vent wastes (“sewage”), steam condensate, high ambient humidity, process chilled water, and rain, ground, and surface run-off water. The uncontrolled presence of water can create a range of potential physical hazards, from minor slips or trips from unseen submerged objects, to the short circuiting of electrical devices and equipment with the potential for electrocution. Water can cause serious damages to porous and non-porous objects, equipment, and building materials. It can also dissolve or otherwise transport contaminants from one location to another, whether naturally occurring or from laboratory or other operations. The water source itself can be potentially harmful, especially if it is sewage-related. Floods are disruptive to all built environments, but are especially damaging in buildings with residential, healthcare, laboratory, library, and museum occupancies.

Regardless of source, prolonged moisture conditions can create an environment suitable for the rapid growth of microorganisms, most commonly in the form of molds and mildews. If these conditions persist long enough, other organisms may develop, bringing even more extensive problems (e.g., termites, mosquitoes). The severity, extent, and duration of such impacts are largely based upon the extent of the water intrusion and the speed with which water is removed.

C. Roles and Responsibilities

Physical Plant

Manages overall work order process for routine and emergency services and repairs, including customer service notification and dispatching, providing trained professional tradespersons and managers, assisting in the evaluation of damages to building materials and furnishings, and post-event return to normal operating conditions. Physical Plant also provides routine maintenance on critical building systems to ensure appropriate indoor conditions and prevent water infiltration and floods (e.g., clearing indoor plumbing and drainage systems, window repairs, and roof, gutter, and leader inspections and repairs).

Custodial Services

Provides routine cleaning and housekeeping, as well as prompt emergency clean-up to various emergencies including floods and other water intrusion events, using applicable techniques and personal protective equipment. For water events, custodial services are equipped with wet/dry vacuum cleaners, submersible pumps, water extractors, fans, and industrial-scale dehumidifiers for primary responses to floods, along with pre-approved disinfectants and cleansers. Custodial staff are also trained and equipped to clean-up small areas of mildew and other minor microbial contaminated surfaces and objects.

Grounds Maintenance

Provides routine and emergency landscaping and exterior building and grounds services, snow and ice removal, and other severe weather related services. Grounds Maintenance also provides routine maintenance services to avoid water infiltration and flooding from exterior sources, including clearing of catch basins and below-grade window wells, leaf and debris removal, and street and sidewalk clearances.

Project Management

Prepares, reviews, and implements capital renovation and new construction projects. As part of renovation projects, strong efforts are made to identify and ameliorate recognized pre-existing buildings conditions, including those involving water or moisture problems. During actual construction and renovation work, project managers periodically monitor work areas to ensure that applicable water management measures are correctly implemented, including any temporary site dewatering, trenching, or sheet pile activities.

Fire Code Compliance

Establishes and approves design criteria for fire suppression systems in all locations on campus, including those requiring alternative suppressants to avert potential water damages in highly water-sensitive locations. Routinely tests and services all fire prevention, detection, and suppression systems, and works to avoid catastrophic and incidental floods and leaks from such equipment.

Environmental Health & Safety

Provides training as well as direct emergency response to campus floods and other water intrusion events with the potential to involve or generate contaminated water or other serious hazards, and participates in post-flood monitoring and evaluation to minimize the potential for long-term negative consequences, including mold growth.

Risk Management

Interfaces with university insurer's on underwriting, emergency pre-planning, and recovery efforts. Facilitates claims for damages with end users.

Emergency Management

Responsible for overall campus emergency preparedness, management, and response, including convening the Emergency Operations Center for large/major impact events. Among other surveillance activities, provides regular campus notifications about severe weather forecasts and preparedness needs.

Employee Health Office

Provides medical consultative services and advice to employees concerned about allergies, sensitivities, and other medical conditions potentially associated with floods, molds, and other water intrusion events.

Yale Police Department and University Security Programs

Provides professional 24/7 dispatching and notification services for all campus emergencies, including floods, as well as on-scene access control, evacuations where needed, and coordination of other emergency responders.

Special Locations and Departments

Highly water-sensitive departments (e.g., museums, galleries, libraries, certain laboratories) are responsible for developing and implementing their own internal preventative measures against foreseeable floods and other water intrusion events. In addition, as the custodians for their special materials and equipment, these departments are also responsible for developing site-specific continuity of operations procedures to protect human health and their specialized holdings and equipment.

Service Providers

A small number of outside vendors have been identified as emergency service providers to the university. These have been reviewed by Yale's purchasing and materials management departments, and also reviewed and approved by the University's insurers. Selected contractors are responsible for providing timely, effective, and cost-appropriate responses to floods, other water intrusion events, and clean-up as needed to prevent or remove molds, other microbial growth, and other recognized hazards. These contractors are required to follow applicable University procedures, including the Contractor Safety Advisory.

D. Emergency Response Procedures

Floods and Water Intrusion Events

Most of the larger flood events on campus originate from fresh water supply line breaks, ground/rainwater infiltration, roof leaks, and drain leaks. Most are quickly identified and responded to by Physical Plant and Custodial Services. A small subset of flood events involve contamination by laboratory materials, and require additional assessment prior to finalizing clean-up. Although EHS is generally not the first responder to floods, it may need to be involved

in assessing potential hazards from contaminated flood water, and ensuring that flooded areas suffer no long-term health or safety problems (e.g., mold growth, residual hazardous materials contamination).

- a. Upon identification of a flood or water intrusion event, individuals should immediately contact Facilities Operations, Customer Service Center for assistance. If the event poses an imminent risk to life or health, the Yale Police or University Security department should be notified for emergency assistance.
- b. Responders should identify the potential source of the flood/intruding water and work to safely stop active flooding. It is important to determine the source of the water, i.e. whether it is clean water, sewage or other drain-waste-vent line effluent, rainwater, bulk chemical from equipment (e.g., film processor), etc.
- c. Evaluate liquid migration route and determine whether there was any potential for contamination along its path (e.g., direct travel across/through hazmat storage or use areas).
- d. Identify potential physical dangers (e.g., soggy/falling ceiling tiles, electrical shorts, chemical reactions) and safely attend to these, bringing in the appropriate departments/staff as necessary.
- e. For floods overhead, cover valuable equipment, objects, and supplies with plastic sheeting, if safely possible.
- f. Ensure that Facilities Operations, Customer Service Center, has been notified, who in turn will summon necessary custodial and specialized trades as needed, e.g., plumbers, HVAC mechanics. Floods of low hazard material or relatively small to moderate scale can generally be managed in-house; see Appendix B for a listing of flood response supplies and equipment available through Custodial. Larger events may require additional contracted services; see Appendix C for pre-qualified vendors.
- g. Also ensure that occupant representatives have been notified of the event, typically the Principal Investigator, area manager, or business manager/administrator. Many areas of campus are considered “Special Locations” that should have representatives on-scene before the next phase of active clean-up. Some of these Special Locations include:
 - Libraries
 - Museums and galleries
 - Animal research facilities
 - Residential settings
 - Healthcare/clinic occupancies
 - Sensitive/high-value core facilities
- h. Most flood liquids can be efficiently cleaned-up with wet vacuums and absorbent materials. Unless verified as clean water, clean-up crew should always wear safety eyewear (safety glasses, goggles, or faceshield), impermeable gloves, shoe covers or impermeable boots, and additional external garments as needed to minimize contact with the liquid.

- i. If flood liquid was potentially contaminated with hazardous materials, segregate collected liquids and absorbent materials as well as all personnel and PPE until appropriately cleared by EHS.
- j. Soap or detergent and water are good for final cleaning of most floods; Virex 256, 10% bleach or other disinfectant may also be valuable for those involving possible biological materials and sewage. See Appendix D for additional information on disinfectants and cleansers.
- k. Prompt removal of water and thorough area drying is essential to avoid mold/mildew growth and minimize long-term damage to floors, carpets, wallboard, and other building materials. Use portable fans, dehumidifiers, increase area ventilation if possible, and consider special cleansers and deodorants. Additional specialized cleaning (e.g., water extraction from carpets and rugs, HEPA vacuuming, steam cleaning of carpeting and rugs) may also be beneficial.
- l. As soon as possible, the applicable Physical Plant manager should ascertain the level of damage to building surfaces and materials, and determine if replacement or repairs are immediately needed. Removal and replacement of damaged surfaces and materials can be minimized by drying down the affected area within 24 - 48 hours, potentially up to 72 hours depending upon the time of year and ambient humidity levels. Failure to effectively dry areas down within these timeframes can lead to mold growth and material damages that require full replacement. It is especially important to remove water thoroughly from carpeting within this timeframe, because mold will begin to form readily on the backing. If this is not possible or if the carpeting and/ or backing is damaged from mold, then it may need to be removed and replaced. Contact EHS before removing carpeting to determine whether there is any asbestos containing material in the mastic or floor tiles below. Note that clinical/healthcare occupancy areas generally need more extended and immediate removal of damaged/affected areas.
- m. Ceiling tiles that have been damaged by water will normally need to be discarded and replaced, because these tiles will normally stain after water damage and lose integrity and strength.
- n. Revisit the area in the near future to confirm the effectiveness of clean-up and drying steps. Contact EHS if additional monitoring or verification testing is needed as well.
- o. Where building materials and surfaces require removal or more aggressive cleaning, it is essential to communicate the work needs with occupants and provide temporary relocation. Standard Yale dust control practices should be implemented, and efforts made to protect all undamaged surfaces, objects and surrounding areas using the principal of containment, and negative exhaust pressure.

Mold Impacted Spaces

Mold, mildew, and other microorganisms will grow on continuously wet or damp surfaces, most often those consisting of porous organic material such as sheetrock wall board, plaster, particle board, and carpeting. They can also colonize HVAC air conditioning drain pans, insulation, and ceiling tiles. While molds are ubiquitous in the outdoor environment, indoors their visible appearance generally indicates problems with moisture and water. Some molds also produce toxins and allergens that can trigger allergic and hypersensitivity reactions or asthma attacks in some people. These symptoms can range from eye and respiratory irritation and allergic reactions to asthma and other potentially serious respiratory illnesses.

The prevention of mold growth and the immediate remediation of mold growth is necessary to prevent building occupants from experiencing these potentially serious health effects. Since mold requires water to grow, it is important to prevent floods and moisture indoors. If floods or moisture problems occur, prompt attention to finding and repairing the source of the water and rapid removal and drying of affected surfaces will help keep mold growth to a minimum.

- a. Identify the potential source of the moisture and ensure that active steps are taken to stop it and make any necessary corrective repairs.
- b. If mold or mildew does develop, determine whether the impacted area is small or large. For the purposes of this program, a “small” area is one of about 10 square feet or less; a “large” area is greater than about 10 square feet. Small mold growths in discrete areas (small patch on wall, area directly below a dripping pipe, etc) may be remediated simply by disinfecting the surface with a mold-killing disinfectant, waiting for the contact time to elapse, and wiping it clean.
- c. For larger mold impacts or materials that are more invasively damaged by mold, contact Facilities Operations, Customer Service Center or EHS to assist in decisions about the scope of remedial work needed. It is essential that Physical Plant also be notified if the work will require removal or replacement of building materials such as ceiling tiles, wall boards, flooring, or other building components that need to be opened, removed, disposed of, or replaced. Those responding should wear basic personal protective equipment, and evaluate need for barrier protection/containment and negative exhaust.

For large areas requiring a more comprehensive mold remediation, consult EHS. The scope of work will be developed by EHS in consultation with one or more of the following, as applicable: Physical Plant, Custodial Services, Yale Project Manager, outside service providers. This work may require the temporary relocation of occupants, installation of filtered exhaust air to keep the space under negative pressure, erection of plastic barriers at doors, and either covering the diffusers or temporarily shutting down the supply and exhaust air systems. Ensure that there is sufficient fresh air ventilation in the area if large scale surface disinfection is needed.

- d. Floods and mold growth can have more serious impacts in many of the Special Locations and Departments due to the nature and sensitivity of their holdings, as well as the potential for damages to them during cleaning and abatement. Except for initial emergency response and

medical triage, clean-up and abatement efforts in these locations require direct consultation with professional conservation and care staff.

E. Preventative Measures

New Construction and Renovation

Designs for new construction as well as substantive renovation of existing buildings must incorporate water management and control steps. These require the recognition of regional and local water influences as well as the planned occupancy of the building and means for protecting against preventable events. Efforts must be incorporated to identify water-sensitive occupancies, and measures taken to minimize possible impacts from leaks, breaks, back-ups, and overflows. All designs must meet minimum IBC, State of Connecticut, and City of New Haven building codes, and also pass FM review.

Basic design criteria and guidance include:

- Assessment of hydrogeologic and surface water runoff setting as part of project planning phase, including identification of unusually high groundwater table and recognizable surface water issues.
- Permitted site dewatering, erosion control, and groundwater diversion as needed.
- Basement exterior wall damp-proofing and installation of applicable foundation drain systems.
- Installation and maintenance of permanent sump pumps and sewage ejectors with readily-accessible means of inspection and repair.
- Avoid the installation of floor carpeting systems in lieu of other less porous systems in basements and other areas subject to water intrusion, as feasible.
- Roof and building systems that reflect southern New England rainfall, snow and ice conditions, and high storm winds under guidance from FM Global Loss Prevention criteria, including:
 - Perimeter Flashing (FM 1-49);
 - Roof Deck Securement (FM 1-29);
 - Wind Design (FM 1-28).
- Gutter and leader systems that reflect roof, parapet, and other non-vertical surface precipitation catchments, directed to storm sewer, approved water detention devices, or rainwater water collection tanks with appropriate overflow devices. Drywells should be avoided to the greatest extent possible.

- Coordination of overhead piping and other potential water sources, with efforts to divert piping from passing directly over sensitive occupancies, storage areas, and water-sensitive utilities. As preparation for this work, perform vulnerability assessments in consultation with intended occupants and other end users.
- Installation of floor drains for emergency drainage, as well as with all emergency showers in laboratory areas.
- Installation and labeling an appropriate number of readily-accessible shut-off valves for all water supply and process supply lines, especially those near/servicing emergency showers.

Maintenance of Existing Buildings

Yale University operates a comprehensive Facilities Operations department to help ensure timely and appropriate maintenance of its buildings. Emergency and routine work is scheduled through a computerized work process system known as FAMIS, to track events, history, materials, and labor. Many of Yale University's buildings also have their own building attendants and occupant department facilities coordinators who keep alert to problem conditions.

Existing buildings are subject to the following range of preventative maintenance activities:

- Regular exterior groundskeeping services include periodic removal of leaves and other debris from drains, drywells, and window wells.
- Periodic drain purging on AC condensate pans and cleaning of slime accumulations on pans.
- Routine filter replacement on all HVAC systems.
- Aggressive sampling and monitoring program of cooling towers and related non-potable water sources on campus for *Legionella* and other bacteria to verify chemical disinfection regime, coordinated by EHS and outside water treatment chemical contractor.
- Routine contracted pump-outs from dining service grease traps and settling tanks, as well as emergency services for back-ups anywhere on-campus.
- Annual (or more frequent) safety inspections of all laboratories and most non-laboratory locations on-campus, by EHS and Fire Code Compliance. Inspectors identify and act upon evidence of excessive moisture or leaks/floods by initiating work orders with Physical Plant.
- Areas normally subject to elevated humidity (e.g., hockey rink, gymnasium locker rooms, indoor pool) have enhanced cleaning schedules with the regular use of special cleansers and disinfectants.
- Room-by-room dormitory inspections prior to extended cold weather holidays by Custodians to ensure windows are closed, heat levels are appropriate, and water sources are off.

- Prepare for possible extreme weather emergencies by increasing on-site and on-call staff.

In addition, Facilities Operations annually develops lists of buildings requiring additional contracted inspections, maintenance, repair, or construction to ensure that their exterior envelopes are intact. This work includes, but is not limited to, roof inspections and repairs, gutter and downspout clearing, and exterior drainage systems. Building selection is based upon historical issues relating to roof construction and gutter details as well as records of reported problems involving water infiltration and exterior drainage problems.

Appendix A. Emergency Contact List

All Area Code 203

Department	Business Hours	Off-Hours
Facilities Customer Service 24/7: Yale Medical School	785-4620	785-4620
Central/Science/West Campus	432-6888	432-6888
Yale Security Programs: Main Campus	785-5555	785-5555
West Campus	479-1414 or 737-3111	479-1414 or 737-3111
Yale Police Department Dispatch	911 or 432-4400	911 or 432-4400
Risk Management	432-0140 or 432-6606	Via YPD Dispatch
Environmental Health & Safety	785-3555	Via YPD Dispatch
Yale Fire Code Compliance	432-9925	Via YPD Dispatch
Emergency Management	436-8597	Via YPD Dispatch
Employee Health Office	432-7978	Via YPD Dispatch

Appendix B. In-House Flood Preparedness Equipment and Supplies

Payne Whitney Gym Sub-Basement TS12 Custodial Services	
Dehumidifiers (4)	Industrial wheeled, built-in pumping and accessory hoses
Wet/Dry Vacuums (4)	Industrial wheeled, built-in pumping and accessory hoses
Fans	Axial fans (4) Low carpet drying style (6)
Carpet Extractors (4)	Industrial wheeled
Pumps (2)	Submersible, with extra hoses
Disinfectants and Cleansers	Virex 256 disinfectant concentrate Microban mildewcide concentrate Household bleach
Sprayers	Hudson sprayers – 4 and 2 gal capacity Hand spray bottles – quart size
Kits	Bloodborne pathogens kits First aid kits
Personal Protective Equipment	Tyvek suits Safety glasses and faceshields Disposal exam gloves (nitrile) Work gloves Rubber boots N95 face masks
Electrical and Lighting	Extension cords Portable GFCI units Portable lighting Flashlights
Miscellaneous	Caution tape Shovels and brooms GE moisture meter instrument Spill pigs, pads, and wipes Tongs Heavy plastic trash bags

Appendix C. Service Providers

Medium-Scale Floods

Larger-scale events as well as smaller events with difficult internal staffing due to time of day, holidays, or other competing events. Consider external service providers in consultation with Customer Service manager. Vendors include:

- Absolute Cleaning (860) 665-0166
- Munters (800) 686-8377
- Service Master (203) 753-0666
- ServPro (203) 234-1100
- Steamatic (203) 985-8000
- United Cleaning & Restoration (860) 349-2448
- Woods Restoration (800) 385-2122

Catastrophic Events

Catastrophic, large-scale events, those in highly sensitive locations, as well as those involving extensive smoke damage, water intrusion, widespread mold/mildew removal and surface replacement, or other recognized hazardous materials.

Company	Contact	Phone Number	e-mail
Belfor	Teresa Williams	817-535-6793	theresaw@us.belfor.com
BMS Cat	Charlie Cook	817-437-8040	charliecook@bmscat.com
LVI	Matt Fay Ron Nardone	203-877-0125 617-389-8880	rnardone@lviservices.com
Marcor	John Brandstetter	212-447-6767	jbrandstetter@Maxons.com
PDG	Shawn Regan	412-243-3200	sregan@pdge.com

Grease, Septic, and Sewage Tank/Pumping

- McVac (203) 498-1427
- Sanitrol (203) 315-3202
- Shoreline Industries (203) 619-3834, 488-1532, or 871-3000

Emergency Rooftop/Building Envelope Repairs

- Barrett Roofing (203) 744-2780
- F.J. Dahill (203) 469-6454
- Silktown Roofing (203) 735-0552
- Techno Construction (203) 234-2746

Appendix D. Recommended Disinfectants

- 10% Bleach
- Virex 256
- Microban Mildewcide

Material Safety Data Sheets available from EHS website (www.yale.edu/EHS).

Appendix E. EHS Monitoring Equipment

Equipment	Capabilities	Units	General Utility/Comments
Lumidor Micro-Max Multi-Gas Meter (Yale Fire Code Compliance and NHFD also own this unit)	Oxygen	%	Oxygen deficiency potential, including confined space entry, cryogenic gases, etc.
	Lower explosive limit	%	Confined space entry, first approximation for unknowns
	Carbon monoxide	ppm	Confined space entry, combustion sources, IAQ
	Hydrogen sulfide	ppm	As above, plus sewer gas, sulfides
RAE Photoionization Detectors (Mini and ppb Rae)	Non-specific organic vapors and some gases with ionization potential ≤ 10.6 eV (no R-Xs)	ppb - ppm	First approximation for unknowns, quantifying knowns, IAQ/odor assessments (ppb RAE). Humidity interferences.
Indoor Air Quality Meters (TSI Q-Track, or Metrosonics IAQ-5000)	Carbon dioxide	ppm	IAQ – assessment of occupancy/fresh air
	Temperature	degrees F	IAQ – comfort
	Relative humidity	%	IAQ – comfort, steam leakage
	Carbon monoxide	ppm	IAQ - combustion sources
TSI Dust-Track	Non-specific total and respirable airborne particles	mg/m ³	Comfort/nuisance dusts, first approximation of exposure limit with known airborne dusts. Must calibrate flow rate for cyclone (respirables)
Miran Sapphir Infrared Spectrophotometer	Specific organic vapors and many gases	ppm	Unknowns, quantifying knowns, IAQ/odor assessments (internal library > 100 cmpds). Must field calibrate, sensitive to CO2 and humidity
Draeger “CMS” Chemical Monitoring System	Current inventory	ppm, mg/m ³	Quantifying knowns
Color Indicating Tubes (Sensidyne, Gas Tech & Draeger)	Current inventory	ppm, mg/m ³	Presence/absence (remember only $\pm 25\%$ accuracy!). Sensitive to temperature extremes, color stains difficult to read, each compound requires different tube
Anderson 2-Stage Microbial Sampler	Culturable bacteria or fungi (media selective)	colonies per unit volume (air)	IAQ assessments, post-emergency releases (biological aerosols). Calibration critical as airflow determines particle size deposition.
Moisture Meters	Moisture in concrete, sheetrock, and wood materials	% moisture	Post-flood events

Appendix F. Analytical Laboratory Service Providers

ChemScope North Haven, CT (203) 865-5605	Asbestos, lead
CT Testing Laboratories Meriden, CT (203) 634-3731	Water analysis (drinking and waste)
EarthWise Laboratories New Haven, CT (203) 787-6662	Multi-media chemical and bulk analyses
Environmental Health Laboratory Cromwell, CT (800) 243-4903	Industrial hygiene, bulk analyses, unknowns
Northeast Laboratory Berlin, CT (800) 826-0105	Microbiological
EM Lab P & K Laboratories Cherry Hill, NJ (866) 871-1984	Microbiological