A Primer on Disaster Preparedness, Management and Response: Paper-Based Materials

October 1993
[Web Version]

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FORWARD

In the past several years, the United States has suffered major disasters ranging from earthquakes in California to hurricanes in Miami. These disasters often cause severe and ongoing destruction in the form of water damage to cultural property, the most vulnerable being books, documents, and other paper-based materials. On such occasions the Conservation Analytical Laboratory - Smithsonian Institution (CAL-SI), Library of Congress (LC), National Archives and Records Administration (NARA), and National Park Service (NPS) receive increased requests for information on disaster preparedness, management, and response for the salvage of books, documents, and other paper-based materials.

In order to facilitate a pro-active rather than reactive approach to disaster preparation with respect to cultural property, four basic references currently issued separately from CAL, LC, NARA, and NPS have been updated and combined into this single pamphlet. The editors hope that this streamlined publication will provide sound introductory information to private individuals and public institutions in preparing for either small or large scale events.

The SI handbook presents guidelines for general facilities preparation and response to a variety of events both natural (storms, floods) and man-made (hazardous material accidents). The NARA article addresses small-scale events and procedures for the general public to be used for the immediate response action for water damaged documents, photographs, etc. The LC booklet provides more in-depth information for both public and private collections dealing with a larger, longer-term coordinated program to salvage bound volumes. Finally, the NPS Conserve O Gram supplies specific information about dealing with the prevention and treatment of mold, a frequent consequence of water damage.

Since little information has been published in Spanish pertinent to the salvage and recovery of cultural property, this consolidated brochure will be published in Spanish as well as in English.

CAL-SI, LC, NARA, and NPS all have additional guidelines and publications on a variety of preservation and conservation topics available to the general and professional public upon request:

Information Office
Conservation Analytical Laboratory
Museum Support Center
Smithsonian Institution
Washington, DC 20560

Preservation Policy & Services Division
National Archives at College Park
8601 Adelphi Road
College Park, MD 20740-6001

Preservation Directorate, LMG-21

Library of Congress
101 Independence Avenue, SE
Washington, DC 20540-4500

Curatorial Services Division
National Park Service
800 North Capitol, Suite 230
Washington, DC 20013

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In commemoration of Arts and Humanities Month and Hispanic Heritage Month October 1993.

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Smithsonian Institution Staff Disaster Preparedness Procedures

prepared by SI Office of Risk Management, October 1992, revised, October 1993

Introduction

This handbook provides a brief overview of the types of disasters posing a potential threat to staff. NOTE: This handbook does not contain emergency procedures for cultural items. These emergency procedures are intended to assist individuals in understanding what to expect and what to do initially. The information in this booklet is provided primarily as guidance in the event a disaster occurs at work. However, these same procedures can be applied to situations at home and when traveling.

Should an emergency occur, evacuation of the facility may be necessary. Evacuation routes for facilities should be displayed throughout staff work areas. All personnel should study these procedures carefully.

Emergency Telephone Numbers...

Staff Evacuation Procedures

When evacuation alarm sounds or you are directed to evacuate the facility:

1. Remain calm.
2. Shut down all hazardous operations.
3. Follow instructions.
4. Assist disabled persons.
5. Leave the area in an orderly fashion. Close doors, but do not lock.
6. Follow established evacuation routes.
7. Move away from the structure. Go directly to the assembly area (map provided with plan). Report to the Evacuation Coordinator for a "head count".
8. Do not block the street or driveway.
9. Stay at the assembly area until instructed otherwise.

Assembly Area Locations...

Fire

In case of a fire:

1. Remain calm.
2. Contact the Fire Department.
3. If the fire is small, try to extinguish it with the proper type of extinguisher or other method. Do not jeopardize personal safety.
4. Do not allow the fire to come between you and the exit.
5. Disconnect electrical equipment if it is on fire and it is safe to do so.
6. Notify the supervisor and evacuation coordinator, if possible.
7. Evacuate if you can not extinguish the fire. Assist disabled persons.

8. Do not break windows.
9. Do not open a hot door. (Before opening a door, touch it near the top. If it is hot or if smoke is visible, do not open.)
10. Do not use elevators.
11. Do not attempt to save possessions.
12. Go directly to the assembly area.
13. Do not return to the affected area until told to by appropriate authorities.
14. Do not spread rumors.

Severe Storms

(These first procedures apply to thunderstorms, tornados, hurri- canes, etc.)

In the event of a severe storm watch within the surrounding area:

1. Listen to the local radio/TV or NOAA Weather Radio for instructions.
2. Plan ahead before the storm arrives.
3. Tie down loose items located outside or move them indoors.
4. Open windows slightly, time permitting, on the side away from the direction of the storm's approach.
5. Check battery-powered equipment and back-up power sources.
6. Fill vehicles with gas.

In the event of a severe storm warning within the surrounding area:

1. Disconnect electrical equipment and appliances not required for emergency use.
2. Do not use telephone except for an emergency or absolutely essential business.
3. Store drinking water in clean containers (e.g., jugs, bottles, sinks).
4. Avoid structures with wide span roofs (e.g., gymnasium).
5. Otherwise, take cover.

Hurricane Warning

1. Board up windows or protect them with storm shutters or tape. Some should be left slightly open to equalize the pressure.
2. Leave low-lying areas that may be swept by high tides or storm waves.
3. Stay in the building if it is sturdy and on high ground. If not -- and especially if local authorities order an evacuation -- move to a designated shelter.
4. Remain indoors. Don't be fooled by the calmness of the "eye." Remember, the winds on the other side of the "eye" will come from the opposite direction.

Hurricane Evacuation:

- Follow the instructions of local authorities
- If transportation is provided by local authorities, use it
- If you must walk or drive to another location:
-- Leave early enough so as not to be marooned,
-- If driving, ensure there is sufficient gas,
-- Use recommended routes rather than trying to find
short-cuts, and
-- Go to a designated location -- don't go anywhere else.

Tornado Warning

1. Go to the basement, if available, or an interior hallway.
2. Upper floors are unsafe. If there is no time to descend, go to a closet, a small room with strong walls, or an inside hallway.
3. Do not remain inside a vehicle. As a last resort, and if no ditch or ravine is nearby, crawl under the vehicle.
4. If in open country and time permits, locate suitable shelter. If not, lie in the nearest ditch or ravine. Be alert for flash floods.

Winter Storm

If a winter storm warning is issued for the area:

1. If at work --

- Listen to the local radio/TV for weather advisories and official permission to go home early.

- Plan ahead before the storm arrives.

- Move indoors any items located outside which might be damaged by the storm or become hazardous during high winds.

- Check all battery-powered equipment and back-up power sources.

- Fill vehicle gas tanks.

- If you must travel (business or going home), use public transportation if possible. If not and you must drive:

-- Make sure the vehicle is in good condition, equipped with chains or snow tires, and has a full tank of gas.

-- Take another person with you, if possible.

-- Leave an estimated itinerary (destination and estimated time of arrival) with someone.

-- Have emergency "winter storm supplies" in the vehicle (e.g., sand, shovel, windshield scraper, tow chain or rope, flashlight, flares. It's also good to have a blanket, heavy gloves, overshoes, extra woolen socks, and winter headgear).

-- Travel by daylight and use major highways, when possible.

-- Keep the radio on for weather information and advice.

-- Don't be daring or foolhardy. Rather than risk being stalled, lost, or isolated, stop, turn back or seek help if conditions threaten to test your ability or endurance.

-- If the vehicle breaks down, or you become lost, or stalled:

--- Don't panic! Think the situation through, and decide the safest and best thing to do. Then do it slowly and carefully.

--- If on a well travelled road, indicate you are in trouble (e.g., hazard flashers, raised hood, hanging cloth from radio aerial or window. Then stay in the car and wait for help to arrive. If you run the engine to keep warm, keep snow away from the exhaust pipe and keep a window open enough to provide sufficient ventilation.

--- Wherever you are, if there is no house or other source of help in sight, do not leave the car to search for assistance. It is very easy to become disoriented and lost during a severe storm.

2. If at home --

- Listen to the local radio/TV for weather advisories.

- Plan ahead before the storm arrives; prepare for possible isolation for a couple of days. Ensure you have on hand or the proper working condition of:

-- Blankets, some kind of emergency heating equipment and adequate supply of fuel

-- Food and water, emergency cooking equipment. (It's better to have some foods that do not require cooking or other preparation);

-- Battery-powered radio and extra batteries, flashlights/lanterns and extra batteries/fuel; and

-- Simple tools for fire fighting.

- Move indoors any items located outside which might be damaged by the storm.
- Fill vehicle gas tanks.
- Travel only if absolutely necessary and follow precautions shown above

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Utility Failure

In the event of a power outage in your area:

1. Remain calm.
2. Remain where you are and open all available blind/shades/curtains to receive more outside light.
3. If you are in an unlighted area, go cautiously to an area that has emergency lights.
4. If telephones are working, call and report the outage.
5. Wait for further instructions from the authorities.
6. If directed to evacuate, assist disabled persons and go to the Assembly Area.
7. If you are in an elevator, stay calm. Use the intercom or emergency button to alert Security or other persons.

In the event of a water line/sewer failure:

1. Remain calm.
2. Notify utility immediately. Advise them of the severity and location of the problem. Indicate if any objects are in imminent danger.
3. If during work hours, notify your supervisor of the situation.
4. Use extreme caution if any electrical appliances/outlets are near the water. Inform Security of the electrical hazard.
5. If the source of the water is known and you are confident you can stop it safely, (i.e., unclog the drain, turn off water), do so cautiously.
6. Assist with protecting objects.
7. If directed to evacuate, assist disabled persons and go to the Assembly Area. Wait for further instructions.

Flood

In case of a flood watch in the area:

1. Listen to local radio/TV.
2. Prepare to take immediate precautionary actions.
3. If driving, watch for flooding at highway dips, bridges, and low areas due to rain not seen by you, but which may be indicated by thunder and lightning.

In case of a flood warning in the area:

1. Listen to local radio/TV.
2. Prepare to evacuate upon direction. (Note: If a flash flood warning is issued, get out of the area immediately.)
3. Assist disabled persons and follow instructions of emergency preparedness personnel.
4. Check any battery-powered equipment & back-up power sources.
5. Store drinking water in clean receptacles (e.g., sinks, jugs).
6. Inventory and move to the upper floors emergency supplies such as food, first aid items, blankets...
7. Secure all loose objects located outside.
8. Assist with protecting objects.

9. 9. Board up windows.
10. Disconnect utilities which are not absolutely essential.
11. Fill vehicle gas tank(s).
12. If driving, know the depth of the water in a dip or low area before crossing.
13. If vehicle stalls, abandon it immediately and seek higher ground.
14. Do not try to cross a stream on foot if water is above your knees.
15. Do not re-enter the affected area until directed by emergency preparedness personnel.
16. Do not spread rumors.

Hazardous Material Accident

In case of a hazardous material accident at the facility:

1. Evacuate the immediate area.
2. Initiate appropriate first aid and/ or other personnel protection measures, as required.
3. Notify Authorities as soon as possible.
4. Do not re-enter the affected area until directed by the emergency preparedness personnel.
5. If trained and properly protected, assist with the clean-up operations, as directed.
6. Do not spread rumors.

In case of a hazardous materials accident in the local community:

1. Listen to the local radio/TV.
2. Follow instructions of the emergency preparedness personnel.
3. Evacuate when directed. Follow the designated route to the Assembly Area.
4. Do not re-enter the affected area until directed by emergency preparedness personnel.
5. Do not spread rumors.

Civil Disorder and Demonstrations

In case of a demonstration or other form of civil disorder within the area:

1. Notify authorities immediately of any information received, factual or rumored, of a demonstration or other form of civil disorder which is planned or in progress in the vicinity of the facility.
2. Follow the instructions of building Security and the emergency preparedness personnel.
3. Assist with protecting objects.
4. If an explosion occurs, take cover immediately and anticipate there may be others.
5. Notify Authorities of any potential/actual hazards (e.g., fire, bomb threat) incurred during a threatening situation.
6. Stay indoors and away from windows unless directed to evacuate by the emergency preparedness personnel.
7. Evacuate when directed and follow the evacuation procedures included at the beginning of this handbook.
8. If released from work early, follow instructions of the emergency preparedness personnel and the local authorities.
9. Do not remain in the vicinity of the disturbance to sightsee.
10. Do not spread rumors.

Terrorism

Should an act of terrorism occur within the surrounding area:

1. Fellow the instruction of the Security and emergency preparedness personnel.
2. If an explosion occurs, take cover immediately and anticipate there may be other explosions.

3. Notify Authorities of any known hazards (e.g., fire, bomb threat).
4. Stay indoors and away from windows unless directed to evacuate.
5. Evacuate when directed and follow procedures included at the beginning of this booklet and any instructions of the Evacuation Coordinators.
6. If released from work early, follow the instructions of the emergency preparedness personnel.
7. Do not remain in the vicinity to sightsee.
8. Do not spread rumors.

Bomb Threat

If you receive a bomb threat telephone call:

1. Remain calm.
2. Listen carefully. Be polite and show interest.
3. Try to keep the caller talking to learn more information.
4. If possible, write a note to a colleague to call the authorities or, as soon as the caller hangs up, immediately notify them yourself.
5. Complete the attached Bomb Threat Checklist immediately. Write down as much detail as you can remember.
6. Do not discuss the threat with other staff.
7. Follow the instructions of the building Security.
8. Evacuate when directed and follow the procedures included at the beginning of this handbook.
9. Do not spread rumors.

Explosion

In case of an explosion in your area:

1. Remain calm.
2. Take cover under a table or desk.
3. Be prepared for possible further explosions.
4. Stay away from windows, mirrors, overhead fixtures, filing cabinets, bookcases, etc.
5. Follow the instructions of the security guards and emergency preparedness personnel.
6. Evacuate calmly, when directed, to the Assembly Area. Assist disabled persons.
7. Do not move seriously injured persons, unless they are in immediate danger (fire, building collapse, etc.)
8. Open doors carefully. Watch for falling objects.
9. Do not use elevators.
10. Avoid using the telephone, except in a life threatening situation.
11. Do not use matches or lighters.
12. Do not re-enter the affected area until directed by emergency preparedness personnel.
13. Do not spread rumors.

Major Transportation Accident

Major transportation accidents are those involving any of the various modes of transportation (e.g., highways, waterways, railways, and airways). Such accidents could occur at any time and any place, and often involve multiple injuries and/or deaths.

Many facilities are not prepared (and are not expected to be prepared) to cope with the type of problems created by a major transportation accident. Should such a disaster occur, initiate life-saving and property protection actions until assistance

can be provided from the community. For example, security personnel are trained to extinguish small fires and to ensure the safe evacuation of the public. The medical staff and/or persons trained in first aid can attend injured persons. Also, during regular work hours, the staff can implement appropriate measures to protect the collections and other physical assets.

Should a major transportation accident occur, many decisions regarding the appropriate emergency actions to take will have to be made "on-the-spot" based on the situation. For instance, are hazardous materials involved and/or are there casualties? Is there a need to evacuate? Is there damage to the facility itself and/or are the utilities functioning? For the appropriate protective actions to take for a specific hazard (i.e., fire, hazardous materials, explosions, utility failure, etc.) refer to the respective section in this booklet.

Earthquake

If an earthquake should occur:

During The Shaking ---

1. If indoors
    - Stay there.
    - Take cover under sturdy furniture (desks, work tables, etc.) or in a supported doorway.
    - Stay near the center of the building.
    - Do not run for the exit as the stairs may be broken or jammed with people.
    - Do not use elevators.
    - Stay away from glass windows, doors, display cabinets, bookcases, etc.
    - Do not use candles, matches, or other open flame as there may be gas leaks.
    - Extinguish all fires with the proper type of extinguisher or other method.
2. If outdoors
    - Move to an open area away from buildings, utility wires, trees, etc.
    - If forced to stand near a building, watch for falling objects.
3. If driving a vehicle
    - Stop as quickly as safety permits, avoiding overpasses and power lines.
    - Remain in the car until the shaking stops.
    - If able to drive on after the shaking stops, watch for hazards which may have been created by the earthquake (e.g., fallen/falling objects, downed utility wires, under-mined roadways, damaged bridges/overpasses).

The editors of this publication will be collaborating on additional projects. If there are issues which you would like to see addressed in the future please send your ideas to:

preserve@nara.gov or write to:

Preservation Policy and Services Division
National Archives at College Park
8601 Adelphi Road
College Park, MD 20740-6001

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Emergency Salvage of Flood Damaged Family Papers

National Archives and Records Administration
August 1993

As the national repository of the records of the Federal government, the National Archives & Records Administration recognizes the importance of family records. During the mid-west floods of 1993, the staff of the National Archives developed some technical tips to guide individuals in emergency stabilization and salvage of damaged documents, photographs, books, and other personal papers. It is important to note that flood damage to some items may be irreversible. The treatment of objects of high monetary, historic, or sentimental value should only be performed in consultation with a conservator.

MOLD

Many people are sensitive to mold. Also, some mold species are toxic. If any health effects are observed when treating mold consult a doctor or mycologist (the local extension service may be able to help) before proceeding.

The best way to prevent or stop an outbreak of mold is to remove items from environmental conditions that encourage mold growth: high temperature, high relative humidity, stagnant air, and darkness. The first priority is to dry moldy items (see instructions for drying below). If wet and moldy materials cannot be dried immediately they may be stabilized by freezing. Placing damaged items in a personal or commercial freezer will not kill mold. It will, however, put the mold in a dormant state until time and an appropriate treatment environment are available. Manageable quantities of frozen items may then be defrosted and treated at leisure.

Active mold looks fuzzy or slimy. Dormant mold is dry and powdery. Do not attempt to remove active mold; it may only spread or smear. Mold which remains active after freezing or after the host material appears dry may be treated with brief (1-2 hours) exposure to ultraviolet radiation from the sun. Extreme caution must be exercised when treating materials outdoors: too much radiation will accelerate deterioration and may cause fading; wind may cause physical damage if items are blown about; and high relative humidity or condensation caused by quick temperature changes may actually exacerbate mold growth.

Dormant mold spores will reactivate as soon as conditions are favorable. They should, therefore, be removed from items and may be brushed or vacuumed away. This treatment should be performed outdoors where other materials and spaces will not be "infected." When brushing mold use a soft, clean, light-colored brush and a gentle pushing motion. Change soiled brushes often to prevent spreading mold from one object to another. When vacuuming, screening material placed over the nozzle of a low suction vacuum will capture loose bits of the item which may inadvertently dislodge.

CLEANING AND DRYING

Paper is very fragile when it is wet. Handle it carefully. In some cases it may be desirable to remove caked on mud and dirt. Dirt left by receding flood waters may be contaminated. Precautions such as the use of rubber gloves should be taken. If items are still wet, agitating them in a bath of clear water will remove excess dirt. This treatment should never be attempted for images which are blurred, feathered, or faded as a result of flood damage.

AIR DRYING

Wet books, documents, or photographs which cannot be air dried within two days should be frozen to inhibit mold growth. Circulating air will effectively dry most items. Physical distortions may result, but document information will be saved. To provide optimal air drying conditions, fans should be positioned for maximum air circulation (do not aim air flow directly at drying materials). Blotting material for air drying should be clean and absorbent. Options include: blotter paper, unprinted newsprint paper, paper towels, rags, mattress pads, etc. Screening material (such as window screens) well supported and stacked with space between them provide an excellent compact drying surface. The porous surface assists air circulation and promotes drying.

Without intervention glossy materials such as paperback book covers, magazines, art books, etc. are likely to stick together. If they are highly valued, these items should be the first priority for salvage. Loose glossy materials should be spread out in one layer for air drying. Bound glossy materials must be interleaved between every page to prevent sticking. Wax paper should be used as interleaving material. Volumes of glossy paper dried in this way may suffer considerable physical distortion.

Books

Place interleaving material between the text block and the front and back covers. If time and supplies allow interleaving material should be placed intermittently throughout the text as well. Fan volumes open and stand them on edge with the interleaving paper extending beyond the edges of the book. Evaporation of water as it wicks into the interleaving paper will enhance drying. Replace interleaving paper as it becomes soaked and invert the volume each time to insure even drying.

Documents

Air dry flat in small piles (1/2 inch) or individually if possible. Change blotting material beneath the materials as it becomes soaked.

Photographs, Negatives, Motion Picture Film

Several classes of photographs are highly susceptible to water damage and the recovery rate will be very low. Avoid touching the surface of photographic prints and negatives. If an old photographic process cannot be identified, observe the item carefully and contact a conservator for advice. Never freeze old photographs or negatives.

Most prints, negatives, and slides may successfully be individually air dried face up. Change blotting material beneath the photographs as it becomes soaked. Contemporary photographic prints and negatives which are still wet and have stuck together may separate after soaking in cold water. However, this type of treatment could cause irreversible damage. Highly valued items, especially prints for which there is no longer a negative, should be referred to a conservator immediately.

Framed Items

Remove the backing material from the frame. If the item is not stuck to the glass, carefully remove it from the frame and air dry. If the object appears to be stuck to the glass, do not attempt to remove it from the frame. Dry intact with the glass side down.

Occasionally object damage is irreversible. The treatment of items of high monetary, historic, or sentimental value should only be performed in consultation with a conservator. Decisions about the treatment of materials belonging to an institution should only be made by appropriate personnel. The American Institute for Conservation (202-452-9545) maintains a referral list of conservators who will be able to provide guidance for treating private collections.

The editors of this publication will be collaborating on additional projects. If there are issues which you would like to see addressed in the future please send your ideas to:

preserve@nara.gov or write to:

Preservation Programs
National Archives at College Park
8601 Adelphi Road
College Park, MD 20740-6001

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Salvage of Water Damaged Library Materials - part 1

The Library of Congress

"Procedures for Salvage of Water Damaged Library Materials" extracts from unpublished revised text, by Peter Waters, July 1993

INTRODUCTION

Since the first publication in 1975 of "Procedures for Salvage of Water-Damaged Materials" there has been no decrease in the frequency of accidents or unexpected disasters which have resulted in extensive water damage to library materials but there are many signs that we have begun to learn the immense value of disaster preparedness planning. Being familiar with the necessity of having to make a series of interrelated decisions promptly, understanding the effects of any particular course of action on subsequent ones -- this is the best kind of preparation needed in the event of major water-damage problems. A well-organized plan can greatly reduce the costs of salvage and restoration as well as the proportion of outright losses. This preparedness can also go a long way to lessen the emotional and stressful impact upon human beings.

The various courses of action discussed in this revised edition are designed to save the maximum amount of material with minimum amounts of restoration on the one hand or replacement on the other. However, it cannot be emphasized too much that no general instructions can take the place of an assessment of a given situation on site by a qualified, experienced library or archive specialist, who has proven experience in the reclamation of fire and water-damaged collections. It is strongly recommended that such assistance and advice be sought at the earliest moment after a disastrous event has occurred. In addition, the Conservation and Preservation Research and Testing Offices of the Library of Congress stand ready to serve as a technical information center and, if need be, a coordinating agency for emergency salvage efforts.

Library and archive staffs are now generally better informed about the mechanisms of drying cellulosic materials as well some of the technologies developed for this purpose. The use of vacuum chambers for drying large quantities of books and paper records has become an acceptable, almost common approach, but not without some confusion as to the differences and relative merits of vacuum drying and vacuum freeze-drying. Both methods effectively remove water but by quite different mechanisms and often with quite different results. An understanding of how these technologies function is essential in planning for a recovery operation, in order to make the best possible match between the nature, condition and needs of the materials and the capabilities of a particular drying system.

The use of fungicides to control the spread of mold growth has become an increasingly controversial subject because they may cause severe danger to workers and in some cases to the materials treated. Sterilizing by means of ethylene oxide and related chemicals has come under close scrutiny by the EPA, to the extent that we cannot recommend its use except by a commercial business firm which is fully insured and licensed to perform this service. Treatments involving the use of ethylene oxide (ETO), are best carried out under controlled conditions, as in vacuum chambers at the end of a drying cycle, and they must be guaranteed to leave no residual toxicity in the material. ETO remains the most effective treatment for severe mold attack resulting from major disasters, especially those exposed to river water.

The critical decisions that have to be made following water damage require knowledge of available drying technologies and their effects on a variety of composite materials. Ideally, materials removed from site, should be prepared and packed in a manner most suitable for the drying method to be used. Unfortunately, what tends to happen, particularly when no emergency plan exists, is that wet material is packed and shipped off to freezing facilities without knowledge of how the material will be dried. This may result in the material having to be re-packed before drying which adds considerably to the cost of drying and the potential for further damage.

The complete restoration of water-soaked documents, particularly bound items, can be a costly process even under the most favorable conditions. In the majority of cases, the high costs involved do not justify the salvage and restoration of books which are in print and can be replaced. However, decisions relating to these factors are virtually impossible to make during a salvage operation and even when a disaster plan exists. On the other hand it might be unwise not to attempt to salvage everything, if an insurance assessment is required and a claim is to be made.

Freezing, followed by vacuum freeze drying has been shown to be one of the most effective methods for removing water from large numbers of books and other paper records, but drying is not the final step in the reclamation process. In some cases, volumes which are only damp or which have suffered minor physical damage before freezing may come from a drying chamber in such good condition that they can be returned to the shelves. It is preferable that, where possible, the packing on site should be carried out in such a manner as to segregate very wet material from that which is partially wet and those that are damp from exposure to high humidity conditions This will not only result in cost savings during the drying operation but will help to avoid over drying of the least wet material. In the majority of instances, drying must be followed by restoration and rebinding, and therefore the technique and success of the drying method chosen will directly affect the final cost of restoration. This can be very expensive.

Thus, librarians and others faced with decisions which follow serious flooding and water damage from the aftermath of fire, and related water-damaged exposure, need to be reminded that replacement is nearly always much less costly than salvage and restoration. The necessity for making sound, on-the- spot, cost-effective judgments is the best reason for being prepared in advance by developing a pre-disaster preparedness plan. There are a number of such plans that have been drawn up, which can be found in the literature, to serve as models.

We encourage all of our colleagues who care about the integrity of library collections, including those who are difficult to persuade that a disaster could ever occur, to formulate disaster preparedness plans without delay so that it may never be necessary to refer to this document in times of distress!

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Salvage of Water Damaged Library Materials - part 2

HOW WATER EFFECTS BOOKS AND UNBOUND MATERIALS

Paper absorbs water at different rates depending on the age, condition, and composition of the material. Thus, some understanding of the mechanism of swelling action, as well as the development of mold, is essential to planning a successful salvage operation. In addition, when large collections are at stake, it is useful to be able to calculate in advance the approximate amount of water which will have to be extracted in a drying process. This will provide helpful data when selecting an appropriate drying method. Of equal importance is some knowledge of the length of time each type of material can be submerged in water before serious deterioration occurs.

ESTIMATING WATER ABSORPTION

Generally speaking, manuscripts and books dated earlier than 1840 will absorb water to an average of 80 percent of their original weight. Some may absorb as much as 200% of their original weight. Since there is a greater concentration of proteinaceous material and receptivity to water in such early books and papers, they are especially vulnerable to mold when damp. Modern books, other than those with the most brittle paper, will absorb an average of up to 60 percent of their original weight. Thus, in estimating the original weight of a collection, if one assumes an average of four pounds per book when dry for 20,000 books in each category, drying techniques must be capable of removing approximately 64,000 pounds of water from the earlier materials and 48,000 pounds from the latter.

The major part of all damage to bound volumes caused by swelling from the effects of water will take place within the first four hours or so after they have been immersed. Since the paper in the text block and the cardboard cores of book bindings have a greater capacity for swelling than the covering materials used for the bindings, the text-block of a soaked book usually expands so much that the spine assumes a concave shape and the fore-edge a convex shape, thus forcing the text block to become partially or completely detached from its binding. The board cores of bindings absorb a great amount of water in such circumstances and are usually the source of mold development between the board papers and fly leaves. This is especially apparent when the area in which water damage has occurred begins to dry out and the relative humidity falls below 70%. Although it is obviously important to remove as much moisture as possible from the environment, it is essential that the water content of the material be monitored because this will remain dangerously high, long after the area is apparently safe. Action taken to salvage the material should therefore be governed by the water content of the material and not by the relative humidity of the area. A water moisture meter, such as an Aqua Boy can be used to measure the water content inside books and box files. If such an instrument is unavailable a crude but quite effective way is to use a mirror within but not touching the text block. Condensation will cloud the mirror. A water content measuring less that 7% is considered dry.

Leather and vellum books, especially those of the 15th, 16th, and 17th centuries, can usually be restored successfully if they are dried under very carefully controlled procedures. Such materials are usually classified as rare and should be treated accordingly by not mixing them with less rare materials during preparations for salvage, stabilization and drying. The advice of a certified book conservator may be essential in order to safely carry out the most appropriate methods. If the material is frozen, freezer paper should be used between each volume to prevent sticking. (Refer to the section on freeze-drying for the special requirements needed for drying this type of material).

Unfortunately, modern manufacturing processes so degrade the natural structure of leather that, once water soaked, book covers are often impossible to restore. Some leather bindings will be reduced to a brown sludge, while others will severely shrink. Swelling of covering materials, such as cloth, buckram, and certain plastics is negligible, in some cases shrinkage occurs. Book covers, however, which are made of a highly absorbent cardboard, will absorb water to a greater degree than

an equivalent thickness of text block. Some book covering materials which have already deteriorated will absorb water at about the same rate as the text block.

Once access to the collection is gained, the external appearance of each volume and group of volumes is a useful indication of the degree of water damage. Those volumes found, usually in heaps, in the aisles will naturally be the most damaged. Not only will they have sustained the shock of falling, as rapid swelling caused them to burst from the shelves, but they will also have been exposed to water for a longer period than the volumes on the shelves above them. These will need special, flat packing and the most extensive restoration. The appearance of such volumes can be a devastating, emotional experience, but one must not panic since every volume worth the cost of salvage and restoration can be saved.

Above the floor levels there will be distinct signs among the shelves of the locations of the wettest material. Shelves which have expanded under the pressure of swollen paper and bindings will usually contain a mixture of evenly wet as well as unevenly wet material. The proportion of evenly wet material in these situations is usually less than those that are unevenly wet. This is because books, originally shelved closely packed together, will not easily be completely saturated especially if the paper is slow to absorb. This is the major reason why so many books become misshapen and distorted after water damage and also after they have been frozen and dried. If paper is unevenly wet, it will not dry without distortion. Misshapen volumes with concave spines and convex fore-edges can be immediately identified as belonging to the category of very wet. Others that have severely swollen text blocks but that still retain some spine and fore-edge shape may indicate that they were previously bound with library binding oversewing techniques and may have sustained irreversible sewing structure damage. Others may be relatively sound in shape and these stand the best chance of drying with the minimum of distortion.

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Salvage of Water Damaged Library Materials - part 3

COATED PAPERS

Coated papers are the most vulnerable to complete loss and should not be permitted to begin drying until each volume can be dealt with under carefully controlled conditions. The period between removal and freezing is critical. It may be necessary to re-wet them with clean cold water until they can be frozen. During the aftermath of the Corning Museum Library river flood of 1972, it was found that the highest percentage of water damaged books were printed on coated stock papers and that when they were frozen in the wet state most were dried successfully by freeze-drying.

ARCHIVAL BOX FILES

Archival box files often fare better than book material because their boxes are made of porous board stock which can be expected to absorb most of the water, protecting the contents inside. This would not be the case of course if they were completely immersed under water for many hours. During recovery, the contents of each box should be carefully inspected and the box replaced if it is water saturated. Failure to do so will increase the risk of physical damage as boxes collapse from pressure during recovery, shipment and cold storage.

ACCESS

Where water damage has resulted from fire-fighting measures, cooperation with the fire marshal, and health and safety offi- cials is vital for a realistic appraisal of the feasibility of a safe salvage effort. Fire officers and safety personnel will decide when a damaged building is safe to enter. In some cases, areas involved in a fire may require a week or longer before they are cool and safe enough to enter. Other areas may be under investigation when arson is suspected. There may be parts of a collection that can be identified early in the salvage planning effort as being especially vulnerable to destruction unless they receive attention within a few hours after the fire has abated. If the fire marshal appreciates such needs, he may be able to provide means of special access to these areas even when other parts of the building remain hazardous.

Perhaps the most important and difficult decision to make after an assessment of damage has been made, is whether to remove the wettest materials first or to concentrate on those that are only partially wet or damp. If the majority are in the latter category the best course may be to recover these first since they may develop mold if they are left in dank and humid conditions while the wettest material is removed. A balance must be struck between the reduction of moisture content in the affected areas and the time involved for the safe removal of the majority of the collections in the best condition. To remove the wettest material first will obviously lower the moisture content, but it is often the case that this can be difficult and time consuming owing to the fact that shelves become jammed with swollen wet books and boxes that may require special equipment to free them. The aim is always to recover the majority of the collection in the best condition to avoid additional harm and costs brought about by post-disaster environmental damage.

Once all entrances and aisles have been cleared, in addition to the above considerations, the most important collections, including rare materials and those of permanent research value, should be given priority unless other material would be more severely damaged by prolonged exposure to water. Examples of the latter are books printed on paper of types widely produced between 1880 and 1946, now brittle or semi-brittle. However, materials in this category which can be replaced should be left until last.

STABILIZING THE ENVIRONMENT

Salvage operations must be planned so that the environment of water damaged areas can be stabilized and controlled both before and during the removal of the materials. In warm, humid weather, mold growth may be expected to appear in a water-damaged area within 48 hours. In any weather, mold can be expected to appear within 48 hours in poorly ventilated areas made warm and humid by recent fire in adjacent parts of the building. For this reason, every effort should be made to reduce high humidities and temperatures and vent the areas as soon as the water has receded or been pumped out. Water-soaked materials must be kept as cool as possible by every means available and be provided with good air circulation until they can be stabilized. To leave such materials more than 48 hours in temperatures above 70 degrees Fahrenheit and a relative humidity above 60 percent without good air circulation will almost certainly result in heavy mold growth and lead to high recovery and restoration costs.

Damaged most by these conditions are volumes printed on coated stock and such highly proteinaceous materials as leather and vellum bindings. Starch-impregnated cloths, glues, adhesives, and starch pastes are affected to a somewhat lesser degree. As long as books are tightly shelved, mold may develop only on the outer edges of the bindings. Thus no attempt should be made, in these conditions, to separate books and fan them open.

As a general rule, damp books located in warm and humid areas without ventilation will be subject to rapid mold growth. As they begin to dry, both the bindings and the edges of books will be quickly attacked by mold. Archival files which have not been disturbed will not be attacked so quickly by mold. A different problem exists for damp books printed on coated stock, since if they are allowed to begin to dry out in this condition, the leaves will quickly become permanently fused together.

ASSESSMENT OF DAMAGE AND PLANNING FOR SALVAGE

Weather is often the critical factor in determining what course of action to take after any flood or fire in which archive and library materials are damaged. When it is hot and humid, salvage must be initiated with a minimum of delay to prevent or control the growth of mold. When the weather is cold, more time may be taken to plan salvage operations and experiment with various reclamation procedures.

The first step is to establish the nature and degree of damage. Once an assessment of the damage has been made, firm plans and priorities for salvage can be drawn up. These plans should include a determination of the special facilities, equipment and personnel required. Overcautious, unrealistic, or inadequate appraisals of damage can result in the loss of valuable materials as well as confusion during all phases of the recovery operation. Speed is of the utmost importance, but not at the expense of careful planning which must be aimed at carrying out the most appropriate, safe and efficient salvage procedure within the circumstances prevailing. An efficient record keeping system is a must. Inventory of call numbers, shelf location and packing box numbers will help make the task of receiving collections returned after drying so that their original shelf locations can be identified, as efficient as possible.

Maintaining a detailed photographic and written record of all stages in the recovery operation is an essential, but often overlooked task which will aid the process of insurance claims and demonstrate the condition of the material before it is frozen and dried. We have found that on receiving materials back from a drying process, some administrators are shocked by the appearance of distorted material, believing perhaps that the condition should be much better, or be somewhat restored! The photographic record can be a very helpful reminder that distortion is mostly the result of the initial water damage and not necessarily the result of the drying process. The photographic record should provide key evidence for the reasons and nature of additional damage resulting from any part of the recovery process.

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Salvage of Water Damaged Library Materials - part 4

THE RECOVERY TEAM

Conducting a successful and efficient recovery operation after a major flood or similar disaster requires, in addition to a good supply of dedicated labor, a team of experts who should be assembled before practical work begins.

The leader should be a person who has had practical experience and understands the effects of different environmental conditions on water-soaked materials of all types, conditions, and ages. The team leader should to be assisted by custodians who know the collection intimately; conservators who can provide additional advice and guidance as well as help in training workers in safe removal procedures; procurement specialists; building maintenance engineers; electricians; carpenters; plumbers; a chemist if available, and health and safety experts.

One or more persons familiar with national and local resources are highly desirable to assist in locating and procuring the special facilities, equipment and supplies needed during the operation. They should be familiar with using the Yellow Pages to track down materials and equipment, able to seek out the key chemical supply companies in the country, if necessary, and generally have the authority to cut through administrative red tape.

The assembled team should be carefully briefed on the recovery plan and procedures to be followed as well as various contingency alternatives which might have to be adopted, priorities to be observed, and their own specific responsibilities.

Team leaders need to be identified and instructed in the details of the recovery plan and its main aims and goals. They in turn should brief all workers so that they too will understand the purpose of the plan and what is expected of each of them. A well briefed and dedicated team works much better than enthusiastic individuals who are allowed to carry out actions which may be disruptive to the main purpose of the team plan.

The major objectives of this team should be:

> To stabilize the condition of the materials before removal by creating the environment necessary to prevent further damage.
>
> To recover the maximum number of material from the damaged collections in a manner which will minimize future restoration and its costs.

PRIMARY CONSIDERATIONS FOR RECOVERY OF WATER-DAMAGED COLLECTIONS

Seek the advice of specialists who can assist at the site of the disaster.

Organize a disaster team and prepare a comprehensive plan of action, as well as plans for different contingencies.

Do not attempt to remove materials from the area until an overall plan with a schedule of priorities has been established and all personnel thoroughly briefed and trained.

In winter, turn off all heat in the building. In summer, reduce temperatures as much as possible through air-conditioning.

Create maximum air flow through all affected areas by opening doors and windows. If electrical facilities are operational, use as many fans as can be acquired to create a current of air so directed as to expel humid air from the building. Use de--humidifiers together with air conditioning and a good air flow. The objective is to avoid pockets of stagnant air and to

reduce moisture content.

If house electricity is not available, hire portable generators to provide electricity for lights, fan, dehumidifiers, and other electrical services. For safety purposes, all electrical lines should be waterproofed and grounded and be administered by health and safety personnel.

Do not permit anyone to open wet books; to separate single sheets; to remove covers when materials are water-soaked; or to disturb wet file boxes, prints, drawings, and photographs. Such handling can result in extensive and often irreparable damage to materials that otherwise might be salvaged. Reducing the cost of future restoration must be one of the top priorities of the salvage operation.

Canvass the community to locate freezing and storage space.

Locate sources of one cubic foot milk crates and corrugated board boxes.

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Salvage of Water Damaged Library Materials - part 5

PRELIMINARY STEPS IN THE EVACUATION FROM WATER-DAMAGED AREAS

If the materials are to be frozen, prior arrangements should have been made to ship the packed materials immediately to freezing facilities. Packed materials must not be allowed to remain on or near the site for more than a few hours, since such delay will further increase the possibility of mold development. Before actual removal of the water-soaked material begins, lighting, fans, dehumidifiers, and all possible venting should be fully operational. All work surfaces should be covered with polyethylene sheeting. Areas selected for packing or drying should be prepared for the operation by emptying them of all unnecessary equipment and furniture.

REMOVAL AND PACKING OF WATER-DAMAGED MATERIALS -- THE WORK FORCE

Safety of the materials and future restoration costs will depend largely on the competence and dedication of the salvage crews. The work will be arduous, dirty, and often frustrating. Team leaders should not hesitate to dismiss careless and thoughtless workers. Experience has shown that well-disciplined crews having brief rest periods with refreshments about every hour and a half are the most efficient. Working salvage crews to exhaustion pays no dividends.

REMOVAL FROM WATER-DAMAGED AREA -- THE CATALOG AND OTHER RECORDS OF THE COLLECTION

High priority should be given to salvaging the catalog and other records of the collection. Salvage operations should avoid any action that might remove or deface identifying marks and labels.

During the pre-recovery planning stage a decision needs to be made on whether or not to use a location number identification system which could be used after the material is returned from the drying operation to reassemble the collection in similar shelf order. There will be a need to identify and segregate materials which are very wet from partially wet; mold contaminated from uncontaminated; rare and sensitive items from the less rare and sensitive etc. If an orderly, efficient and safe recovery is to be achieved, together with a control over the choice of drying and other special measures needed to save rare and sensitive materials, a box coding system is indispensable.

At least one person should be assigned specific responsibility for making an þinventoryþ at each location where the materials are taken from the shelves and boxed. This person might also be given charge of supervising the boxing and box coding process.

Conveyor belts and þhuman chainsþ are normally used to remove large numbers of material from each shelf, pack them in corrugated boxes or plastic milk crates and to move them to the loading site for shipment to cold storage facilities. It is at this time that a great deal of additional damage and confusion can occur. The number of people involved in this operation and their behavior needs to be closely supervised. Try to initiate a rhythm when using human chains that keeps everyone busy without being over taxed. Too many helpers will hamper progress, encourage þloafingþ and generally reduce the efficiency of the operation. It is highly desirable to instruct the team daily on the tasks to be carried out and to keep them informed as to the major objectives of the recovery operation and as to any changes that have been made to the master plan.

An efficient and dedicated work force needs to be provided with all the accouterments of human survival, such as regular rest periods, a place to eat, a convenience to wash and clean up and a immediate access to medical attention.

Manuscripts and other materials in single sheets create particularly difficult problems if they have been scattered. An indication of the approximate location in which they are found during the salvage operation may be extremely helpful at a later date. Materials should never be moved from the site in large batches or left piled on top of each other, either at the site or in adjacent temporary housing, since the excessive weight of water-affected books and paper records can lead to severe physical damage.

When flood-damaged books were removed from the Biblioteca Nazionale in Florence following the river flood disaster of 1966 substantial numbers were piled high outside the library building while awaiting shipment to drying facilities. This action caused significant damage to the books from the weight of water saturated volumes and lead to very high costs of post disaster restoration.

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Salvage of Water Damaged Library Materials - part 6

REMOVAL AND PACKING

The aisles between stacks and main passageways will probably be strewn with sodden materials. These must be removed first, separately, by human chain, in the exact condition in which they are found. Open books will be greatly swollen, but no attempt should be made to close them. Closing them will cause further damage by tearing the leaves, since paper will not slide when wet. Instead, books should be passed undisturbed to an adjacent dry area where an awaiting team may pack them without disturbing their shape. This particular type of material must not be packed tightly but should be packed flat in boxes and separated with at least one layer of freezer paper and one sheet of 1/2" polystyrene between each open book.

The packing team should have approximately the same number of people as the team which passes the damaged material to them. This will avoid bottlenecks and stacking materials on the floor awaiting packing. If a sufficient number of people and conveyor belts are available, the most efficient place to pack damaged materials will be on site. Teams will have to be organized to assemble packing materials and supply them to the packers in a smooth flow. Use of a second human chain or conveyor will reduce bottlenecks and the likelihood of incoming supplies interfering with the flow of packed materials being passed out of the building. After the isles have been completely cleared, the main work of recovery can begin. Hopefully, a decision will have been made as to which material to remove first: the wettest or the ones in the best condition. As stated earlier, if the majority is only damp and in relatively sound condition, these could be removed first and more rapidly than other materials. In these circumstances de-shelving and packing will be a relative quick operation and will help to establish a smooth worker flow. As each line of shelves is emptied, an assistant should code each box and record the box number and its general contents in a notebook. The contents of archival storage boxes are unlikely to be saturated with water if they were previously positioned close together. However, since certain types of boxes have a corrugated inside layer, they may be very wet, even though the major portion of the contents is only damp. In such cases, it is best to repack the contents in new boxes or in plastic milk crates. This will not only make each unit lighter to lift and prevent the collapse of a wet box but will also speed the drying process. When repacking it is important that the new boxes be properly identified.

DISPOSITION OF REMAINING MATERIALS AND CLEANING OF WATER-EXPOSED AREAS

If the wettest materials were removed first the drier material will usually be above the first four or five shelves and packed closely together. On no account should this third category be separated or spaced out during the earlier salvage efforts. Closely packed materials will not readily develop mold internally.

However, since these will have been in a very humid atmosphere for, maybe several days, it is likely that some mold will have developed on the outer edges of bindings and boxes. This is less like to occur if, during the evacuation of the wettest materials every effort had been made to reduce temperatures and humidity levels and establish a good air flow.

There may be books and box files in such good condition that they need not be sent to freezing facilities but can be dried in ambient conditions. On no account however should the drying be attempted in the location in which they were found because the environment will be totally unsuitable. They should instead be removed to a controlled environment while shelves, wall, floors, and ceilings are sterilized and necessary maintenance work is being done to return the site to its normal condition. If moved, materials should be stacked with air spaces between them provided that the drying area has a good circulation of air, together with airconditioning and dehumidification. If air-conditioning is not available, fans and dehumidifiers should be used to keep air moving and to extract moisture from the area. The relative humidity of a drying area is no guide to the actual moisture content of cellulose materials. The normal water content of paper is between 5 and 7 percent by weight. Materials which feel relatively dry to the touch as they come out of a humid, flood-damaged area, may

actually contain moisture from above 10 to 20 percent.

Heat is one of the best means of drying, but since it increases the risk of mold development on humid books and documents, it should be used only if a good circulation of air and dehumidification can be established. Hygrothermographs for recording temperature and relative humidity should be installed to monitor the general area, and moisture-content meters used to measure the moisture in the materials themselves.

CLEANING AFTER A RIVER FLOOD

The safest time to clean materials is after they have been dried. If water-damage is the result of a river flood then the following might, under certain circumstances, be considered. The Florence experience demonstrated that the best time to remove mud was after the books were dry. However some books did benefit from partial cleaning in the wet state.

If adequate assistance is available, mud deposits on books which will not be further damaged by water may be washed off in clean, running water. Closed books may be held, one at a time, under water and the excess mud removed with a hose connected to a fine spray head. Similar washing should not be attempted with opened volumes, manuscripts, art on paper, or photographs.

Rubbing and brushing should be avoided, and no effort be made to remove oil stains. Anything which is hard to remove is better left until after drying, when techniques for removal can be worked out during the restoration stage. In some cases, printed books bound in cloth or paper can be left immersed in clean running water for as long as two weeks. Although this should be avoided if possible, it is preferable when the only alternative is leaving such books in warm, humid air while awaiting attention.

THOROUGH WASHING TO REMOVE HEAVY DEPOSITS OF MUD

A more thorough washing procedure, intended to remove as much mud and slime as possible from books, requires six to eight tanks big enough to accommodate the largest volumes in the collection. This process is obviously wet and messy and needs to be set up outdoors in fair weather or in an area fitted out to use and remove large quantities of water. Since large quantities of water are required, the area will be wet and dirty throughout the operation, and good drainage is therefore essential.

Any rustproof receptacles may be used if they are large enough, but plastic garbage cans (20 or 30 gallons) are recommended. Each can should be equipped with a hose to provide low-pressure, continuous water flow to the bottom so that dirty water, as it overflows the rim, will be constantly replaced by fresh. Each hose should be fastened securely to prevent damage to the books being washed. Wooden duck-boards, rubber boots, gloves and aprons are recommended for the protection of workers.

Keeping a book tightly closed, a worker should immerse one book at a time in the first can and remove as much mud as possible by gentle agitation under the water. Workers should not use brushes and or any tool which would cause an aggressive rubbing action. Books should be passed from one can to the next and the same operations repeated until most of the mud has been removed. At the last can, books should be rinsed by spraying them gently with a fine stream of water. No effort should be made to remove mud which continues to cling after sponging under water. This is much better done when the books are dry.

Finally, excess water can be squeezed from books with hands pres- sure; mechanical presses should never be used. It must be emphasized that the above procedure should be attempted only by a carefully instructed team and in a properly fitted-out area. If there is any doubt about the ability of the team to follow directions, washing should not be attempted. There are many classes of books which should not be washed under any circumstances, and it is therefore imperative to have the advice of an experienced book conservator who can recognize such materials and who understands their treatment requirements.

PRINCIPLES OF STABILIZATION BY FREEZING

The most generally accepted method of stabilizing water-damaged library and archival materials before they are dried is by freezing and storing at low temperatures. This buys time in which to plan and organize the steps needed to dry the

material and to prepare a rehabilitation site and the building for return of the collections after drying. Freezing provides the means for storing water damaged material safely and for an indefinite period of time in similar physical condition in which they were found, preventing further deterioration by water and mold while awaiting treatment.

Freezing is not a drying method, nor can it be expected to kill mold spores, but it is highly effective in controlling mold growth by inducing a dormant state in the spores. If mold damaged material is frozen it is important that the drying method chosen must prevent mold spore activity during the drying process. For this reason it is important to segregate such material during removal and packing operations.

Stabilization by freezing also provides important advantages when it is not possible to immediately assess the value of the damaged materials or to determine which items can or cannot be replaced. In other words, stabilization gives time in which to estimate recovery costs, to prepare adequate environmental storage conditions, and to restore the building. In some cases, it may be necessary to restore or rebuild the original facilities - a process which can require a long period of time.

Had freezing technique been used after the catastrophic Florence flood in 1966, thousands of additional volumes could have been saved completely or would have suffered significantly less damage. The Florentine libraries which sustained the greatest losses contained mostly 19th and 20th-century materials. In these collections, losses were heaviest among books printed on coated stock, whose leaves stuck together during drying and could not be separated afterward. These losses could have been largely prevented if the materials had been frozen while wet, and if drying methods now known had been used to prevent adhesion of the leaves.

The effect upon freezing water soaked volumes which have lost their shape or have had their binding structures damaged by immersion, will be to slightly increase the thickness of volumes by the physical action of ice crystals, but this additional increase in thickness has been found to contribute no significant problems to already damaged books. Studies conducted by the Research and Testing Office of the Library of Congress have uncovered no evidence of any damage to cellulosic and proteinaceous materials caused solely by the action of freezing.

Freezing as a salvage method has other advantages. It can stabilize water-soluble materials such as inks, dyes, and water stains etc. which would otherwise spread by wicking action if they were dried from the wet state by conventional drying methods. Freezing provides the means by which water-soluble compounds will remain stable during a freeze-drying process which involves the removal of water by sublimation. This is the only known drying method capable of drying without further spreading of water soluble compounds, provided that the frozen state of the material is maintained before and throughout the drying process.

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Salvage of Water Damaged Library Materials - part 7

COLD TEMPERATURE STORAGE CONDITIONS

The size and formation of ice crystals is governed by the rate and temperature of freezing. Blast freezing used for certain types of food-stuffs is designed to quickly freeze in a few hours, often involving temperatures in excess of -50 degrees Celsius. The advantage of quick freezing is that ice crystals are kept very small, resulting in a limited amount of swelling. Availability of blast freezing facilities may not be possible following water damage, so in normal circumstances, freezing will be slower and therefore the formation of ice crystals larger, but this should not cause problems for the majority of library and archive collections.

Once frozen, cold temperature conditions should be maintained at about 0ø Fahrenheit (-18ø Celsius). Lower temperatures will do no harm but higher temperatures may increase the size of ice crystals.

PREPARATION FOR FREEZING

Before freezing, it may seem tempting to wash away accumulated debris particularly if this is the result of a river flood, but this is rarely advisable or safe because of lack of time, skilled workers and a pure water supply, and the quantity of material to be handled. (Aqueous washing to remove smoke damage should never be attempted under any circumstances).

Washing should never be attempted by untrained persons as this will cause further damage, nor should time be taken for this purpose if so little skilled help is available that any significant delay in freezing the bulk of the materials would result. The washing of materials containing water-soluble components, such as inks, watercolors, tempera or dyes should not be attempted under any circumstances.

Experience has shown that such materials, as well as those that are fragile or delicate, can be seriously or irreparably damaged by untrained workers attempting to clean and restore on-site. Such materials need expert attention and hours of careful work if damage is to be kept to a minimum. The period of emergency action and þfirst aidþ is a dangerous and unsuitable time for the careful work required to restore materials to near-original state. The general condition of the damaged material will determine how much time can be spent in preparation for freezing. At the very least, bound volumes should be wrapped with a single fold of freezer paper, or silicone paper, if it is likely that their covers will stick together during the freezing process.

All rare, intrinsically valuable and delicate material should be prepared for freezing separately from other materials and also in separate categories so that each can be located and identified before they are dried. Each category may require a different type of drying than used for the other less sensitive materials. For instance, early printed books and manuscripts are made up of a variety of material including vellum, leather, paper, wood metal, ivory, inks and water color media. Others will be delicate and or highly water sensitive. These will need to be dried very carefully and if freeze-drying is used it should be undertaken with the minimum amount of internal chamber heating. If only a few items are involved it may be preferable to send them directly to a certified conservator for immediate treatment.

CONTAINERS AND METHODS OF PACKING FOR FREEZING

The choice of packing containers should be carefully considered. Although corrugated board boxes are cheaper to purchase, locate and store on site than plastic type milk crates, they may restrict the rate and efficiency of drying and also be prone to collapse when filled with wet material. If it is possible to decide in advance what method of drying is to be used, be guided by the technical requirements of the vendorþs drying system. For instance, if freeze-drying is to be used,

one cubic foot plastic milk crates might be preferred, since these provide open spaces within the interlocking crates to aid in the efficient out-gassing of ice by sublimation.

With some forms of vacuum drying where sublimation does not occur, corrugated boxes may be quite suitable, depending on the location of the heat source in the chamber. In either case, containers should not be larger than approximately one cubic foot, to avoid excessive weight, a vital consideration for workers removing material from site and also to help reduce damage from collapsing boxes. Usually boxes will be prepared for freezing on pallets and this is where the weight of heavy wet boxes can collapse and cause additional damage to material within the pile. To avoid this, use plastic milk crates or very sturdy corrugated boxes for the wettest material and re-box file records if their original boxes are saturated with water. Endeavor to use one size and type of box. If this not possible, do not mix sizes when packing on pallets. The number of boxes per pallet should be no more than can be supported without collapse.

Although faster freezing and drying will result if boxes are not packed tightly, the contents will distort during the drying operation. To achieve the best drying results for books, they should be packed closely together so that drying is done under some restraining pressure. A book should never be packed foredge down as the weight of the text block will cause an inversion of its natural round shape. Pack books spine-down or flat and avoid placing larger volumes on top of smaller ones to avoid sagging which will be costly to correct during restoration.

The decisions taken at this stage will greatly affect the outcome and costs of the processes used for cold storage, drying and restoration. It has, unfortunately, not been sufficiently appreciated in the past that care in packing at this stage will significantly reduce post-recovery costs.

High costs certainly occur if boxes are stacked on pallets in mixed sizes which will increase the potential for collapse under the weight of water, crushing and damaging the material in the process.

It should be possible to move the wet materials directly from library to freezing facility, preferably in refrigerated trucks which can be drawn up to the loading site. For small collections of books and documents, dry ice may be used to freeze the material for transport in un-refrigerated trucks to long-term freezing facilities. (Gloves should be worn at all times when handling dry ice).

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Salvage of Water Damaged Library Materials - part 8

VACUUM AND FREEZE DRYING TECHNOLOGIES

It is important to understand that the processes used by vacuum and freeze-drying companies differ considerably depending on the specific requirements of the material to be dried. The majority of these companies have developed their technologies for food. Few have had experience in drying paper and books and therefore may not know if their normal operating system would be safe, or cost effective for this purpose. Freeze-drying has a number of significant advantages over vacuum drying since water remains in the frozen state during sublimation, a process which removes water from the solid state to the gaseous state. This avoids most of the problems associated with expansion, sticking and wicking of water sensitive and soluble media. Vacuum drying, generally considered to be a process that changes a liquid to a vapor, will result in a much greater risk of expansion, distortion, sticking, and staining.

Although both drying methods have been found to produce satisfactory results in a number of disaster recovery events, comparison between the two following a disaster has not been made. Our preference is for freeze-drying because it is the least aggressive of the two methods. However, there are situations where for instance, archival documents have been affected and where there is a low percentage of intrinsically valuable material, where vacuum drying has provided satisfactory results. The choice between the two should be governed by the nature, value and condition of the damaged material. Rare collections of significant value need to be dried with due regard to the sensitivity of the substrate and media and it is for this reason why we suggested earlier that such materials be segregated form the less rare.

Freeze-drying which is used to dry animal specimens, does so at very low internal chamber temperatures, lower than is used for most food processes. One animal specimen may take several weeks to dry. At this slow rate of drying the costs are high. Most paper and book material can withstand higher temperatures than those used to dry delicate animal specimens and there is a need for thermal energy to make the process efficient and cost effective.

If a vacuum or freeze-drying chamber is designed to operate with internal chamber heat sources, these must not touch the material to be dried, to avoid over heating and scorching. The internal temperature of a chamber should be no greater than 100 degrees Fahrenheit (37.8 degrees Celsius). For sensitive materials, including early book material where there is a mix of paper, vellum leather and wood etc., below ambient temperatures or those used to dry animal specimens should be used, to dry the material slowly and under carefully monitored conditions. (Note: In specifying an upper limit of 100 degrees Fahrenheit we consider this to be a safe temperature. There is insufficient data at this time to evaluate the effects of higher temperatures).

It is important to realize that the success of any large drying system depends on the ability of the system to stop the develop- ment of mold during and after the drying process. Be aware of the risks in accepting material returned from commercial drying processes unless there is a guarantee that none will be returned damp or wet. If mold develops after return, it may not be possible to detect it, if the material remains boxed. If care was taken to segregate mold-contaminated from non-contaminated items during recovery, boxing and freezing, this will help determine if the drying was carried out properly. If mold develops in the non-contaminated material, the chances are that either the drying was not done correctly or that drying was not complete.

Mold-infected material, if dried completely under freeze-drying conditions, can be safely controlled for a short period of time, so that the spores remain quite dormant if stored after drying in an air conditioned environment maintained at 50 to 55 degrees Fahrenheit and a relative humidity of 35 percent or lower. However they must not be returned to the library or archive shelves until the mold contamination has been treated. For this reason we recommend that at the end of the drying cycle and while still in the drying chamber all mold-contaminated material be sterilized. If extreme care was not taken to separate contaminated from non-contaminated materials before the drying operation, we recommend that each drying load

be sterilized.

REHABILITATION AFTER DRYING

If maximum benefits are to be gained from stabilization by freezing, every effort should be made, first, to identify and assess the value, condition, and total numbers and types of materials damaged, and second, to draw up comprehensive lists of those materials which can be replaced and those which should be reclaimed and restored. Replacement is nearly always cheaper than restoration. Volumes to be reclaimed will need to be evaluated in terms of the amount of restoration needed and probable costs. The best time to make such judgments, if a disaster preparedness plan does not exist, is after the volumes have been dried and before they are returned to the library or archive shelves.

The following represent basic steps that need to be taken after drying in order to begin returning the material to normal housing environments.

Unless a drying company can guarantee in writing that no material will be returned boxed if it has a water content exceeding 7% by weight, there is a high possibility that some boxes will contain damp material that will add to the risks of post drying mold development, and which, if allowed to develop, will quickly spread to other uncontaminated material, if left unchecked and therefore undetected.

It is important when preparing specification for a drying contract that acceptable water content is not specified as an average of a books total water content. For instance the text block of a book may be measured at far less than 7% but the water content of the book cover boards may contain higher 7% of water. Therefore it is necessary to specify that the waters content of all the books composite materials be less than 7%.

Do not store the material in un-opened boxes immediately upon return from the drying facilities, even if this seems to be the most convenient action to take.

All books and paper file records should be unboxed and placed on open shelving in a well ventilated, air-conditioned rehabilitation area, well separated from the main collections. The rehabilitation area makes it easier to assess the condition of the dried materials, as well as to identify those that can be replaced and those that must be cleaned and restored.

A carefully organized, random inspection of mold- infected materials should be conducted daily by personnel trained to carry out this important task.

Whether materials have or have not been sterilized during the drying process, it is necessary to monitor their behavior as a check against the effectiveness of drying and sterilization and to identify any potential for mold growth and to take the appropriate action, before the return of these materials to the main collections.

We are concerned here with monitoring the dried volumes while they are in the rehabilitation area, and after their return to the main stacks. This monitoring should be continued at regular intervals for at least a year after they are returned to the main library shelving.

In preparing the rehabilitation area, provide about twice the number of shelves as would be needed for normal book requirements. This will compensate for the effects of distorted and expanded books and provide sufficient air space to allow the material to regain their moisture equilibrium content which, depending upon circumstances, may take a week or two.

Theoretically, equilibrium moisture regain can be accomplished at the end of a drying run while the material is contained in the drying chamber. The chamber can be back filled with moisture to achieve the desired result. However this is only possible and safe if the drying method has been guaranteed to dry the material completely. If there remains some partially damp material at the end of a drying run, back filling the chamber with moisture would make such material more vulnerable to mold growth.

The rehabilitation area should be maintained at a relative humidity of 30 to 40 percent and a temperature of less than 65ø Fahrenheit. Both humidity and temperature controls must be adjustable.

It is desirable to maintain the collection in the rehabilitation area for a period of at least six months. At this time, temperature and humidity in the rehabilitation area can be gradually changed to duplicate conditions in the stack areas to

which they will be returned. At the end of this time, if no mold growth has occurred, the volumes can be returned to the main stacks and monitored as indicated above. It is highly desirable but usually not practical to leave volumes in the rehabilitation area for an added six months in an environment that duplicates normal stack conditions, as a check against post drying mold growth.

No materials should be returned to the main library shelves without very careful inspection, and preferably not before all necessary cleaning and restoration has been completed.

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Salvage of Water Damaged Library Materials - part 9

EVALUATION OF LOSS

When a flood or fire-damaged collection is covered by insurance, full settlement of a claim cannot be realized until the lost and damaged materials have been listed and their values established. The extent and success of possible restoration must also be determined. In the event that a claim is anticipated as a result of such damage, every item should be salvaged, frozen, and dried. After drying, the affected materials should be shelved in a specially equipped environmental storage area, isolated from the main stacks, and there inspected and monitored over a period of time. Such a policy is the best guarantee of sound judgments by custodians, consultants, and adjusters when they must calculate the degree of loss as a basis for compensation.

SUMMARY OF EMERGENCY PROCEDURES

Seek the advice and help of book and paper conservators with experience in salvaging water-damaged materials as soon as possible.

Turn off heat and create free circulation of air.

Keep fans and air-conditioning on day and night and use dehumidifiers and insure a constant flow of air is necessary to reduce the threat of mold.

Brief each worker carefully before salvage operations begin, giving full information on the dangers of proceeding except as directed. Emphasize the seriousness of timing and the priorities and aims of the whole operation. Instruct workers on means of recognizing manuscripts, materials with water-soluble components, leather and vellum bindings, materials printed on coated paper stock, and photographic materials.

Do not allow workers to attempt restoration of any items on site. This was a common error in the first 10 days after the Florence flood, when rare and valuable leather and vellum-bound volumes were subjected to scrubbing and processing to remove mud. This resulted in driving mud into the interstices of leather, vellum, cloth, and paper, caused extensive damage to the volumes, and made the later work of restoration more difficult, time consuming, and extremely costly.)

Carry out all cleaning operations, whether outside the building or in controlled environment rooms, by washing gently with fresh, cold running water and soft cellulose sponges to aid in the release of mud and filth. Use sponges in a dabbing motion; do not rub. These instructions do not apply to materials with water-soluble components. Such materials should be frozen as quickly as possible.

Do not attempt to open a wet book. (Wet paper is very weak and will tear at a touch. One tear costs at least one dollar to mend!) Hold a book firmly closed when cleaned, especially when washing or sponging. A closed book is highly resistant to impregnation and damage.

Do not attempt to remove mud by sponging. Mud is best removed from clothes when dry; this is also true of library materials.

Do not remove covers from books, as they will help to support the books during drying. When partially dry, books may be hung over nylon lines to finish drying. Do not hang books from lines while they are very wet because the weight will cause damage to the inside folds of the sections.

Do not press books and documents when they are water soaked. This can force mud into the paper and subject the materials to stresses which will damage their structures.

Use soft pencils for making notes on slips of paper but do not attempt to write on wet paper or other artifacts.

Clean, white blotter paper, white paper towels, strong toilet paper, and unprinted newsprint may be used for interleaving in the drying process. When nothing better is available, all but the color sections of printed newspapers may be used. Care must be taken to avoid rubbing the inked surface of the newspaper over the material being dried; otherwise some offsetting of the ink may occur.

Under no circumstances should newly dried materials be packed in boxes and left without attention for more than a few days.

Do not use bleaches, detergents, water-soluble fungicides, wire staples, paper or bulldog clips, adhesive tape, or adhesives of any kind. Never use felt-tipped fiber or ballpoint pens or any marking device on wet paper.

Never use colored blotting paper or colored paper of any kind to dry books and other documents.

Used and damp interleaving sheets should not be reused.

Frequent changing of interleaving material is much more effective than allowing large numbers of sheets to remain in place for extended periods.

Newsprint should not be left in books after drying is complete.

A good grade of paper toweling is more effective than newsprint, but the cost is much greater.

The editors of this publication will be collaborating on additional projects. If there are issues which you would like to see addressed in the future please send your ideas to:

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Mold and Mildew: Prevention of Microorganism Growth In Museum Collections

National Park Service - Conserve O Gram, Number 3/4

"Mold and Mildew: Prevention of Microorganism Growth In Museum Collections"

Formerly issued as Conserve O Gram 3/6. Revised, July 1993.

Mold is the common term used to describe a downy or furry growth on the surface or organic matter, caused by fungi, especially in the presence of dampness and decay. A fungus (pl. fungi) may be any of a large number of microorganisms that are parasites feeding on living organisms or dead organic matter.

Mold is often used interchangeably with the word mildew. They are the generic terms that describe a variety of microorganisms, including fungi, algae, rusts, yeasts, and bacteria, that are agents of deterioration for museum objects. They produce irregular stains that can permanently damage an object. Collection managers must be able to recognize signs of these problems and be prepared to take preventive actions.

The Microorganisms

Fungi are simple-celled organisms that do not need energy from light for growth. The fungi bear microscopic spores that are produced in enormous quantities, are always present in the air, and spread via air currents. They are often water repellant and are resistant to desiccation (drying out). Extreme cold and heat will destroy them.

When the spores are in favorable environment, they will germinate. What constitutes a favorable environment is different for each species. After landing on a host material, a spore must obtain sufficient moisture to germinate and find enough food. Without moisture, the spores will lie dormant until favorable conditions occur.

For this reason, it is important to control the environmental conditions where museum collections are stored or exhibited. The NPS "Museum Handbook," Part I (Rev 9/90), Chapter 4, recommends that temperatures not exceed 24øC (75øF) and relative humidity (RH) not rise above 65%. These conditions are maximum levels and only reduce the potential for microorganism growth. They do not eliminate he threat. Some microorganisms can grow in significantly lower temperatures and at lower RH levels. Certain materials need to be stored with lower RH levels to prevent growths. Refer to the NPS "Museum Handbook," Part I (Rev 9/90), Figure 4.3, chart for the RH target levels for various materials and types of objects that are housed in park museum collections.

NOTE: Some species of microorganisms cause health risks in the form of chronic lung irritation. Always exercise caution when handling badly infested materials, i.e. wear a high-efficiency particulate air (HEPA) filter respirator and disposable gloves. (See also "Conserve O Gram" 16/1).

Susceptible Materials

Microorganisms need organic materials to supply nutrients and, therefore, museum objects composed of organic materials are potentially at risk. Cellulose-based materials, such as cotton, linen, paper and wood, and proteinaceous materials such as leather and hair loth are particularly susceptible to direct attack by microorganisms.

Inhospitable materials, such as plastics, are not immune from fungal growths but how they support these growths is not fully understood by biologists. Certain mites feed on fungi and can carry spores onto normally resistant materials. As the mites die, they become the nutrients for a new fungal colony. This ability to exist on almost any material characterizes

microorganisms as primary agents of deterioration.

Damage

Microorganisms will permanently damage the materials supporting them. They will stain textiles and decrease the strength of the fabric. The scattered spots known as foxing on paper prints or drawings is damage resulting from these growths. Leather is particularly susceptible to the actions of microorganisms and will be stained and weakened by them. As a by-product, fungi can produce organic acids that will corrode and etch inorganic materials.

Detection

Often the first indication that a microorganism problem exists is a characteristic musty odor. A careful visual examination will generally locate stains that are clearly visible as pigmentations on a surface.

Another means of detection is by the use of ultraviolet (UV) light. Under UV light, a microorganism growth will appear luminescent.

Prevention

The best means to prevent or control the spread of microorganism growth is to deny the spores the moisture necessary for germination. Therefore, regulating the environment, especially the RH, is essential for preventing the deterioration of a museum collection from microorganism growth.

RH levels should be routinely monitored. Spore germination is less likely to occur if RH is controlled between 45% and 55%, but RH should be kept below 65%. When RH levels rise above 65%, the use of portable dehumidifiers will be necessary to reduce the moisture content of the air. A temperature between 18øC and 20øC (64øF to 68øF) should be targeted. These levels only decrease the potential of germination and growth; they do not eliminate it. Therefore, other factors, such as adequate aircirculation should be maintained; a fan will help to increase circulation.

Problem environmental conditions that may contribute to higher humidity levels need to be corrected. Repair leaking pipes, gutters and downspouts, cracked windows, a problem roof, deterio- rated brick, masonry pointing, or cracked walls.

It is also important to keep any area that houses museum collections clean and free of dust and dirt and organic debris that can nourish spores.

Silica gel and other buffers can help adjust RH conditions within a sealed space, such as in a storage cabinet or exhibit case. These buffers will absorb or release moisture into the surrounding atmosphere. The quantity of buffering material to place within the space must be customized for each situation and a conservator should be consulted for assistance in determining this need. It takes time, experience, and careful monitoring to ensure that the buffers are performing as intended. (See NPS "Museum Handbook," Part I (Rev 9/90), Appendix I, for additional guidance on the use of silica gel.)

Treatment

Collections should be inspected regularly for signs of microorganism growth. If an object shows signs of infestation, the piece should be sealed in a polyethylene bag or enclosed in polyethylene sheeting to prevent the spread of spores to other objects. Remove the object to an isolated space where the RH can be lowered by running a dehumidifier.

A conservator should be contacted for assistance in dealing with the infested material. However, as a general procedure, vacuuming is appropriate in most situations. The object should be removed from the polyethylene and the bag or sheeting discarded. The object should then be vacuumed using a vacuum cleaner which will not exhaust the spores back out into the room. A vacuum fitted with a HEPA filter is recommended; however, the water bath filter vacuum cleaner, such as the Rainbow brand vacuum, that many parks have been using, is acceptable for this purpose. Follow all precautions when vacuuming an object: use the lowest effective suction and protective screening. (See NPS "Museum Handbook," Part I (Rev 9/90), Appendix K, for vacuuming procedures.) Wear disposable gloves when handling a contaminated object. Seal the vacuum cleaner bag, gloves and other contami- nated materials in a plastic bag and dispose of them in the trash outside the building. Also dispose of storage materials, i.e., acid free box or tissue, that were used to store the object. Chemical eradication of a microorganism infestation with a biocide capable of killing the growths may only be considered in consultation with the Regional Integrated Pest Management (IPM) Coordinator and the Regional Curator. A proposal for

chemical use must be submitted and receive final approval from the Service-wide IPM Coordinator in Washington, DC. (See NPS "Museum Handbook," Part I (Rev 9/90), Chapter 5, for guidance.) Use must conform to all NPS and Environmental Protection Agency restrictions and guidelines. In addition, a conservator with a specialization in the specific materials to be treated would be consulted to review the potential effects of any chemical on the object.

Sources UV lamps are available through hardware stores.

Silica gel is available from conservation and archival-quality materials suppliers.

HEPA filter respirators and disposable gloves are available from laboratory supply companies, such as Lab Safety Supply, P.O. Box 1368, Janesville, WI 54547-1368, (800)356-0783.

HEPA filter vacuum cleaners are available from laboratory supply companies, such as Lab Safety Supply, and from Nilfisk of America, 300 Technology Drive, Malvern, PA 19355, (213)647-4620.

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