CURRICULUM ON FLOOD DAMAGEASSESSMENT OF CULTURAL HERITAGE PROPERTIES

Relative to the Mississippi River floods of 1993

prepared for the National Trust for Historic Preservation
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December 15, 1994

INTRODUCTION

In the summer of 1993, due to record rainfalls in the Mississippi River basin, the Mississippi River and some of its tributaries rose to greater heights than previously experienced in recorded history. River communities in Wisconsin, Iowa, Illinois, Missouri, and other states were left devastated in the wake of the flooding. Much of the destruction was wreaked upon contemporary buildings that had been constructed within the traditional flood plains. However, landmark communities that had weathered past flooding in a relatively unaffected manner were also touched by the floods.

The Midwest Office of the National Trust for Historic Preservation embarked upon a program of flood damage assessments of National Landmark properties in communities in Illinois, Iowa, and Missouri. This project was funded as a part of a $5 million grant from the National Park Service, U. S. Department of the Interior, for historic preservation disaster relief projects resulting from the severe flooding in the Midwest during the summer of 1993. As part of this program, the Trust to lead multi-disciplinary teams of architects, engineers, contractors, and preservation consultants into historic communities to assess the damage brought about by the floods.

The following curriculum was developed as a result of that program and specifically as a result of four separate surveys that were led to the following:

- Sainte Genevieve, Missouri;
- Alton, Elsah, and Grafton, Illinois;
- Keithsburg, Illinois; and
- Keosauqua, Bentonsport, Farmington, and Bonaparte, Iowa

PURPOSE AND SUMMARY OF CURRICULUM CONTENTS

The purpose of the Curriculum is to set up a standardized approach to condition assessment. In this manner, with all the variables[1] that need to be considered the following can be achieved:

- Homogeneous assessment of all structures.
- High quality assessment of structures.
- Standard format for assessment reports

This curriculum contains the following sections:

I. **Historical background** of the Midwest region of the United States and its construction technology. This primer will aid in the proper identification and dating of structures as they are evaluated.

II. A primer on the **Types of Floods** that may be encountered and the effects of floods on building structures.

III. A resource on **Identification of Construction Materials** for the vintage of buildings found in the Midwest.

IV. A guide to **Assessment Techniques** for cultural properties damaged by floods.

V. A guide to some of the **Typical Problems** associated with flood damage on cultural properties.

VI. A list of **General Conclusions** based upon experience with previous assessments.

VII. A User's Manual for the **Computer Database** developed for the National Trust.

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1 Different locations (Sainte Genevieve, Missouri; Alton, Elsah, Grafton, and Keithsburg, Illinois; and Keosauqua, Bentonsport, Farmington, and Bonaparte, Iowa), different material types (wood, stone, and brick structures), different structure types (log houses, wood frame, balloon frame, masonry, etc.), Different ages (colonial, federal, victorian, early 20th century), different types of flooding conditions, and different assessment teams at each site.

I. HISTORICAL BACKGROUND

Spanish claims to the Mississippi River Valley date back to the Spanish funded "discovery" of the North American continent and consequent exploration. Spanish exploration of the North American Continent including the Lower Mississippi valley in what is now Arkansas was led by Hernando de Soto in 1541-43. However no evidence exists of Spanish explorations as far north as present day Ste. Genevieve. The first written accounts of Europeans in the area of Sainte Genevieve were made by Father Jacques Marquette. In 1673, he and Louis Jolliet, with five explorers, entered the upper Mississippi Valley from the Illinois Country. The expedition passed the mouth of the Missouri River and reached the mouths of the Ohio and Arkansas Rivers. The party turned back late in July, 1673 and headed northward into Canada.

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A. French Settlement and Vertical Log Structures

French settlement in the Illinois Country began at the end of the 17th Century. The Mission of the Holy Family was established at Cahokia (in Illinois near present day St. Louis, Missouri) in 1699 by priests of the Seminary of Foreign Missions. In 1703 the Jesuits moved the Mission of the Immaculate Conception to the Indian village of Kaskaskia, sixty miles to the south of Cahokia. Fort de Chartres was begun in 1718 and Prairie du Rocher was settled in 1725. Sainte Genevieve was established in the 1740's. The towns of Sainte Genevieve, Cahokia and Kaskaskia, soon became the centers of French life in the upper Mississippi Valley.

Villages of this period were composed small log cabin communities. Banding together for the common defense against the hostile Osage Indians was a necessity, and early structures reflected this need for defense. The houses were patterned after those in Quebec and Normandy, of which examples remain in Sainte Genevieve. The French planters who settled the area brought with them the idea of the *galerie*--a wide porch which was added to all four sides of a house. The construction techniques used for many of these structures was *poteaux en terre* or posts in the ground. These buildings were constructed of logs placed vertically into the ground, five or six inches apart. Another common technique of construction was *poteaux sur solle* or posts on a sill. These were constructed with rubble stone foundations with or without a horizontal log plate on which the ends of the vertical logs rested.

B. British Settlement and Horizontal Log Buildings

At the end of the French and Indian War (1755-60), England had come into possession of all French territory on the North American continent, and, after the Treaty of Paris of 1763, the upper Mississippi valley territory east of the river had come under British Governance. However, due to British preoccupation with Indian problems along the Ohio River, French settlements were left relatively undisturbed, and settlement by the British did not begin at once.

There was widespread sympathy in the upper Mississippi valley territory for the American Revolution. As the war progressed, the strategic position of the territory as a link with Spanish and French allies, and as a base for attack on the British at Detroit, became apparent. Following the American Revolution, the Paris Treaty of 1783 ceded all British territorial holdings, excluding Canada, to the newly formed American Republic. In 1803 The Louisiana Purchase, Spanish-claimed lands recently ceded to the French that included the Upper Mississippi Valley territory west of the river, added these territories to American possession.

By the beginning of the 19th Century, English-speaking settlers were moving westward by way of the Mohawk Valley and around the southern end of the Appalachians. From the early British colonial period are several horizontal log cabin structures still extant in Sainte Genevieve. Like the French vernacular houses, these structures have been altered, expanded, and remain covered with siding.

C. Braced-Frame Structures

Trouble with the British and their Indian allies continued, and the Indians remained active throughout the War of 1812, aiding the British in gaining possession of most of the Northwest Territory. The end of the war brought the Northwest Territory into the American Republic. Parcels of land along the upper Mississippi River became part of a military entitlement for veterans of that war. Consequently, migration of English-speaking settlers into the territory increased dramatically.

Log buildings were replaced during and after this period with more permanent structures. Braced-frame wood framing techniques, a British import, were a common form of building construction. This type of construction, seen at the John McArthur House is characterized by heavy timber posts at the corners of the building, which extend continuously from a heavy foundation sill to a heavy girt at the floor or roof line. Diagonal braces were used at the corners of the frame to lend lateral support to the structure. Studs were installed between the corner posts. These were fastened by mortise into the sills and girts at regular intervals. The main framing members were connected by mortise and tenon, and fastened with wood pegs and tree nails.

Quarrying of dolomite limestone had begun in the Sainte Genevieve area as early as 1836. This stone was found to be extremely durable and was used extensively for house construction. In addition, brick masonry was becoming more readily available in some urban areas.

D. Balloon-Frame Structures

Settlement of the Midwest increased dramatically after the Black Hawk War of 1832 removed the threat of Indians. Balloon framing was developed during the 1830s, and was a distinctly American craftsman technique that fulfilled the requirements of a young and rapidly expanding country. It offered several advantages for frame construction, and was characterized by an economical use of wood, rapid construction, and limited skill required by workers. Relatively unskilled workmen were able to erect balloon framed buildings quickly because the labor intensive mortise and tenon connection of the structural members was supplanted by the use of cut nails. This system relies on the external sheathing rather than triangular bracing for lateral strength.

A period of prosperity came with steamboat transportation. This prosperity is reflected by the Victorian style. Victorian style structures made use of balloon frame construction techniques which facilitated quick erection of buildings. Brick masonry was readily available and was used widely for construction.

II. TYPES OF FLOODS

A. Flood types defined by FEMA[2]

1. Coastal flooding (waves greater than 3 feet, tsunamis, etc)
2. Riverine flooding (alluvial fans, ice jams, etc.)
3. Lacustrine (lake) flooding
4. Ponding of water

B. Flood types not defined by FEMA

1. mud flows
2. headwater, stormwater, and drainage flooding
3. structural failures of dams and levies
4. erosion
5. high water table
6. sewer back up
7. expansive soil problems

C. The Nature of Flooding and its impact on structures

1. Standing water is a common form of flooding that occurs at a historic site. On the Mississippi River, historic sites were normally well away from the flow of water. Otherwise, the sites would have been obliterated long ago. Standing water will cause entire buildings to be soaked, filled with silt, and subjected to fungal growth.

2. Flowing water can cause much of the same damage as does standing water. In addition, structures can be subjected to soil erosion, scouring, lateral displacement, and movement of building frames off of their foundations. This type of damage was the most dramatic damage of the Mississippi floods.

3. Water seepage was one of the most common forms of damage experienced within cultural properties during the Mississippi floods. With this type of flooding, the water level in the soil rises though actual standing water never reaches the structure. The consequence is water seepage into the basement, rising damp, and problems with hydrostatic pressure on foundation walls.

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2 The Federal Emergency Management Agency

III. IDENTIFICATION OF MATERIALS THAT MAKE UP STRUCTURES AND THEIR BEHAVIOR WHEN WET

Historic properties are composed of a variety of materials which all behave in a distinct manner if they become wet. This behavior may be short term such as degradation of drywall, loss of glue strength of plywood, or warping of wood floors. The behavior may be more long term such as peeling of paint, freeze thaw deterioration of masonry, or fungal growth on wood. Whether the effects are immediately apparent or prone to occur at a future date should be understood in order to perform an appropriate assessment.

A. Materials on the building exterior:

Stone, brick, and concrete masonry, Stucco, wood, metal, and composite board siding

Of these materials, composite board siding and celotex baking will be prone to immediate degradation if submerged in water and will probably require replacement. Ferrous metal sidings will be prone to rust if wetted in a way in which they were not wetted before. Metal sidings with insulation will hold moisture without drying. If the siding is against original wood clapboards, then the clapboards will degrade. Stucco may dissolve if wetted over a long period of time. Wood will be prone to warp as it dries and will promote fungal growth if not dried properly. Stone, brick, and concrete masonry may be prone to freeze-thaw cycling if soaked and then frozen.

B. Architectural finishes on the building interior:

Plaster, gypsum wall board, wood trim and paneling, wood flooring and subflooring

Plaster finishes hold up rather well to soaking, but promote fungal growth when wet. Wood trim and paneling may need to be removed, dried out and replaced. Some finishes on wood such as varnish will discolor and turn white in the presence of moisture. Gypsum wallboard degrades and turns to mud after soaking and is normally not salvageable.

Wood floors typically warp when wet, but can typically be removed, dried, and reinstalled. Wood subfloors can warp, but the boards are not normally installed tightly to each other, and will normally dry adequately in place. Subfloors will dry out much faster if the finish floor is removed. Floorings and subfloorings of composite materials such as particle board and plywood, will break down when soaked and will normally require replacement.

Some interior finishes mar require removal in order to facilitate the drying out process of basements, crawlspaces, and wall cavities.

C. Windows and doors

Wood windows and doors can normally be salvaged but will have a tendency to warp after drying and may not operate as easily as before the flood. These assemblies should be dried out slowly so as not to increase the chances of warpage.

D. Interior treatments:

Paint, wallpaper, carpeting, window treatments, etc.

These materials are usually sacrificial in nature and will be discarded after a flood. These treatments will require removal to speed up the drying process of the walls and floors. In cases, where these treatments are part of the original fabric of the structure, consultation from an appropriate conservator should be sought.

E. Insulation:

Asbestos, styrofoam, fiberglass, wood fiber, etc.

Insulation, when present within the walls of a structure, presents special problems after a flood. Most types of insulation (not styrofoam) will hold water and thus will retard the drying out process. Blown-in insulation will settle in the wall cavity and lose its effectiveness. Fiberglass insulation will also lose its effectiveness. In most cases, insulation that has become wet will require removal in order to preserve the long term integrity of the wall.

IV. THE ASSESSMENT

In the assessment process, it is of the utmost importance that the assessments be uniform, and a high quality as can be obtained when utilizing an ever changing team of assessors.

A standard is an established rule or basis of comparison, an accepted model or example, or a desired level of adequacy. In building technology, standards include written guides, regulations, and accepted construction practices. Standards have an influence on what buildings look like, and on how they are constructed. They also influence the priorities that are established for the care and maintenance of buildings.

A standard that addresses the philosophical issues of preservation in the United States is the Secretary of Interior's *Standards for Rehabilitation.* This document provides a series of philosophical guidelines by which to approach the preservation of historic structures, as well as examples of applications of these guidelines. The *Standards for Rehabilitation* have been adopted by many municipalities in the United States as a basis for local preservation ordinances. The *Standards for Rehabilitation* should be followed during assessment and analysis of flood damaged properties.

Standard methodologies should be adopted for the assessment process keeping in mind that there will be standard patterns of distress which will need to be documented relative to building types, materials, and relative to past maintenance. A report format laid out in a standard manner will serve as an effective tool for the transfer of technology and for communication between various teams and other disciplines. In addition, typical maintenance techniques such as tuckpointing and sealant installation are still being performed improperly on a widespread basis. We are not learning from our past mistakes. Standards can serve as an effective means of technology transfer in this regard.

A. Development of Teams for the Assessment:

Teams of six to eight persons is a good number to perform assessments of 25 to 50 structures per day. Preferably these team members will come from various disciplines such as architects, engineers, contractors, and conservators. All team members should have a grounding in accepted preservation philosophy. In addition, it is helpful to have a state representative of the office of the State Historic Preservation Office in attendance to help interpret the *Secretary of the Interior Standards*.

The assessment should begin with the entire team performing an assessment of one to two structures together. In this manner, the assessment format can become standardized and questions of the group can be discussed and answered in the presence of all. Next the group should be divided into teams of two persons. With two persons, one can do the assessment while the other can be the note taker and photographer. It is advisable that these two partners share these responsibilities so that the larger team can benefit from the opinions and visual inspections of both persons.

About every four hours, perhaps over lunch, the entire team should meet and share the findings of each smaller team. At this time patterns of distress which characterize the town can be uncovered. As an example, in Keithsburg, Illinois scouring of footings, and damage to brick were types of distress that were prevalent to that area only. After the team has met, the members of the smaller teams should switch so that all members are working with a new partner.

All teams must be required to completely fill out and submit their survey sheets at the end of each day.

B. Tools that will be required for the assessment:

paper, pens, pencils, flashlight, extra batteries, moisture meter, sample bags, plumb bob, rubber boots, face mask, safety glasses, gloves, and drinking water.

C. Tools that may be useful as a supplement:

Sounding hammer and metal detector

D. The Assessment methodology

The methodology for assessment ranges from basic to sophisticated techniques. Assessments should always begin with the most basic and work its way up towards more sophisticated techniques as they become necessary. For assessment of flood damaged properties, the vast majority of the assessment will be composed of what is defined below as non-intrusive techniques.

Non-intrusive assessment techniques

The process begins with a review of available written information. It is rare when original construction documents will be available. However records from the local historical society may provide old news clippings and the like which can give an indication of a building's age, materials and construction methods used. Other sources that may prove useful are flood maps, historic photographs, tax assessor forms, etc.

Next, it is important to obtain an indication of the extent of the distress through a visual survey. Distress that is observed during the visual survey should be recorded on the survey sheets and with photographs.

Based upon the results of the visual survey, representative locations with typical distress conditions are selected for closeup inspection. During the closeup inspection, some hands-on investigative work may be performed. A metal detector can be used to locate any hidden metal with a wall that may be prone to corrosion. A moisture meter can be used to check the moisture content on wood, mortar, and plaster. Sometimes tapping or "sounding" a wall with a small hammer can provide an indication of delamination or loosening of masonry.

Intrusive (destructive) Assessment Techniques:
Other information may be obtained during the close-up inspection through the use of destructive (intrusive) assessment techniques that require the removal of parts of the building fabric. Removal would normally be done in areas that are distressed and would require repair anyway, preferably in areas that are not easily seen. Inspection openings provide a second benefit in that they can furnish sample material for laboratory testing.

In some cases, it may be determined that laboratory testing is necessary on mortar, brick, paint, wood, or the like. In these cases, it is best to take samples from affected as well as unaffected areas for means of comparison in the laboratory.

E. Format of the Report:

- Introduction: who is the client, what is the intent of the assessment, when was it performed, where is the site, and why is the assessment being performed.

- Historical background of the region including a discussion on the local architecture

- Attachment of assessment survey forms. Forms should be keyed into a directory.

- Summary that includes a discussion on the typical types of distress that were observed at the site.

- Recommendations on repair and mitigation scenarios.

- Cost Estimates - Although cost estimates are always requested, it is our experience that an accurate cost estimate can not be determined in the field for these types of projects. A more reasonable approach is to establish a scope of work that a local contractor can use to develop estimates for repair.

V. TYPICAL CONDITIONS OBSERVED

The following conditions have been observed at flood damaged buildings. It is likely that other conditions not listed below will also be encountered:

- Structures that were subjected to direct water flow shifted on their foundations. Other structures developed precarious leans.
- Foundations walls were undermined due to the flood. Sand was washed from beneath the foundations as water drained out of or into the basement.
- The rapid rise in hydrostatic pressure due to a rise in the water table during flooding caused mortar joints to blow out of masonry foundation walls. Water subsequently squirted into the basement under high pressure.
- Where water circumvented the levees and flooded the towns, the water was contained within the towns long after the water subsided.
- Basements that were flooded had a strong chemical smell indicating that they may have been flooded with polluted water. In addition, hazardous materials already in the building such as friable asbestos had become wet facilitating its removal or encapsulation.
- Buildings protected from direct contact with the flood waters suffered from flooding due to water seepage from the ground into the basement. Other structures may have been damaged by the levee itself.
- A condition peculiar to some masonry structures was the poor condition of the exposed common brick walls. This common brick was apparently fired in low heat, was like adobe in hardness, and apparently had a high Saturation Coefficient. This brick was typically spalling away at approximately four feet above grade, indicating its relation to rising damp. More damage from freeze-thaw cycling was expected in the upcoming winter due to the saturation of these bricks.
- There was a general lack of adequate ventilation of the crawl spaces, basements, and interior spaces of many of the structures examined. Lack of ventilation made it difficult to dry out.
- There were numerous pre-existing conditions of the original construction within the buildings inspected. These conditions were brought about by a general lack of maintenance. Examples include poor mortar joints in masonry walls, the presence of termites, and advanced fungal growth.

VI. GENERAL RECOMMENDATIONS

The comparative condition of elements of the buildings inspected offer an interesting comparison between archaic and contemporary building materials. The original construction of the buildings, which include plank flooring, has typically allowed the flood water to drain away from the floor construction. Newer floor construction, such as plywood, takes a much longer time to dry out. Celotex and particle board subfloors have swelled and require removal. Plaster walls have held together fairly well while wallboard walls have disintegrated. Fiberglass batt insulation in wall and floor cavities has typically retained moisture which necessitates removal of interior finishes and the insulation to accelerate the drying process. Natural ventilation systems, when intact, aided the drying process. When these systems had been removed, their replacement became necessary.

In general, it is recommended that repairs proceed with more traditional rather than contemporary materials where deemed feasible and appropriate. For instance, it is recommended that plank sub-flooring be utilized whenever possible rather than sub-flooring made of composition materials. In the case of walls, it is recommended that dry wall and insulation, if re-utilized, be considered a sacrificial material that can be easily be removed and replaced in the event of future flooding. If insulation is installed, it is recommended that moisture inert insulating materials such as closed cell polystyrene be used in lieu of fiberglass batt insulation. It is also recommended that any possible toxic chemicals be identified and removed from the flooded buildings. In addition friable asbestos containing materials were observed to have become saturated. An asbestos encapsulation or abatement project should be commenced at these structures.

VII. TYPICAL MITIGATION PROCEDURES

- relocation of structures to higher ground
- raising structures above the flood level
- installing flood control measures into the building or constructing levees around the building
- human adjustment: Adjust oneself to the floods rather than fighting the floods. Examples would include selection of proper materials that are easily dried out or disposable, increasing basement ventilation systems, and wet flood proofing.

Of the four mitigation measures listed above, the last, human adjustment, is the only sensitive approach to flood mitigation with historic structures. Specific mitigation procedures that would fall under human adjustment would include:

- emergency repairs for unstable conditions from the shifting of structure and the undermining of foundation systems.
- tuckpointing of leaky basement walls with compatible mortars. Waterproofing of the walls may lead to their full scale failure during future flooding and is not recommended. It is preferable to allow the basements to flood during a rise in the water table so that the hydrostatic pressure will be counteracted by the basement waters.
- deal with toxic pollution from the flood. In addition, begin abatement or encapsulation procedures on hazardous waste materials present in the building that have been disturbed by the flood.
- deal with original material failure problems. Treatments may include the introduction of sacrificial materials rather than replacement.
- restore systems that were part of the original building design such as basement ventilation.
- perform maintenance that has been deferred.