Farnsworth House Flood Mitigation
The Search for a Flood Solution
Keeping History Above Water | Annapolis, Maryland

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The Farnsworth House
Significance
Site: Plano, Illinois: Floodplain Zone AE

Special Flood Hazard Area with 1% chance every year (100 year) vs 5% (500 year)
Site Changes
Timeline

• Designed 1945, completed 1951
• Bridge built in 1969
• Sold to Lord Peter Palumbo in 1971
• Purchased by the National Trust and LPCI at auction in 2003
• Designated a National Historic Landmark in 2006
• Transitioned to NTHP as Stewardship Site in 2010
Designed for the Floodplain
Designed for the Floodplain
Studies

Project options explored in the main report
- Option A - Elevate
- Option B - Relocate
- Option C - Hydraulics

Other options explored
- Option D: Buoyancy
- Option E: Barrier Wall

Project Resources
- Project Overview
- Project Timeline
- Project FAQs
- Maps & Documents
- Photos & Videos
New National Gallery, Berlin (1967)
Solution Categories Analyzed

- Elevate
- Relocate on Site
- Hydraulic Lift
- Buoyant System
- Barrier Systems
  - Inflatable Bladders
  - Rigid Barriers
- Floodproof

Panels, Peer-reviewers, public-forums, open-comment periods, academic forums, constructability analysis, local and national discussions
Design Criteria
Lift the house 6.9 feet

- 574.0 = 500 year recurrence
- 1.0 = freeboard
- EL. 575.0 = Design Flood
- FIN. GRADE EL. 564.0
- 1ST FLOOR EL. 564.24
- TOP OF ROCK EL. 550.5 (ft.)
- MEDIUM DENSE SILTY SAND & GRAVEL

(TOTAL WEIGHT OF HOUSE, DEAD LOAD ONLY ≈ 600 KIPS)
Selection Criteria

- Leave the building on the site
- Fail safe design
- Simplicity favored
- Precedents, ease of procurement and repair
- Ease of use
- Testing, maintenance and cleaning
- Minimal environmental impact
NCPTT funded Flood Mitigation Quiz

THE PROJECT | HISTORIC BUILDINGS AND FLOOD PROTECTION

INTRODUCTION

Floods have been increasing in areas across the country, which is forcing many historic site owners to consider how to protect their historic buildings from rising water.

At the National Trust for Historic Preservation, one of the sites most greatly affected by increased flooding is Farnsworth House in Plano, IL. This modernist building, designed by Ludwig Mies van der Rohe and constructed in 1946, has in recent years experienced many floods that have inundated the interior of the building, causing damage to the building's materials and collections.

Through the study about how to protect Farnsworth House from rising floodwaters, a great deal of information about different flood protection options has been gathered. Through funding provided by an NCPTT grant, the National Trust has worked to expand what has been learned from Farnsworth House to help other owners of historic buildings to navigate the various flood protection options and determine which option is the best for their historic building.

FLOOD PROTECTION OPTIONS

WET FLOODPROOFING
DRY FLOODPROOFING
PERMANENT FLOODWALLS
TEMPORARY BARRIER SYSTEM
RELOCATION
ELEVATE BY RAISING GRADE
ELEVATE ON COLUMNS/BEAMS
ELEVATE BY HYDRAULIC LIFT
ELEVATE BY BUOYANCY
OTHER

IMPORTANT CONSIDERATIONS

The flood protection options considered here are most relevant for buildings that experience floodwaters less than 1.5 ft deep. For floodwater depths greater than 1.5 ft deep, the only real option is relocation.

For many of the options, the building footprint should be less than 5,000 sf. Building footprints much larger than this will require additional analysis to determine which options are viable.

For all elevation options, it is assumed that the building will be elevated at least above the highest expected flood level (typically the 500-yr flood).

For many of the flood protection options, warning time is needed to set up the protection system. For this reason, these options, except for relocation, are not relevant for buildings that must only respond to flash floods.

LEARN ABOUT YOUR OPTIONS
WHAT IS THE HIGHEST FLOOD LEVEL EXPECTED AT YOUR SITE?

- Under 3 feet
- Between 3 and 6 feet
- Over 6 feet
Many flood protection options require moving the building during construction.

IS THERE A SPACE ON YOUR SITE OR ELSEWHERE TO TEMPORARILY STORE THE BUILDING DURING CONSTRUCTION?
PERMANENT FLOODWALLS

DESCRIPTION
Permanent floodwalls are permanent barriers constructed on your site to prevent water from coming into contact with your building. Floodwalls must be specially designed to resist the pressure caused by the floodwater acting on one side of the wall. While floodwalls are often constructed of reinforced concrete, they can be faced with more attractive building materials or integrated into the landscaping of the site to be more attractive and less conspicuous.

ADVANTAGES
One of the main advantages of permanent floodwalls is that the building does not have to be disturbed at all.

DISADVANTAGES
The main disadvantage of permanent floodwalls is that you need sufficient extra land around your building on which to build the walls.

IMPORTANT CONSIDERATIONS
- Some localities restrict the construction of individual floodwalls. It is important to check your local zoning/building code to determine if it is possible to build floodwalls on your property.
- If the water levels rise above the highest expected flood level, floodwalls can overturn and fail.
- Floodwalls that are constructed close to property lines can negatively impact local drainage patterns, which may increase flooding for your neighbors.
- Depending on how floodwater encroaches on your site, you may only need to construct floodwalls in a certain area, rather than around your entire building.
- Any access openings in the floodwall need to be closed by temporary barriers during a flood event.
- An option similar to a permanent floodwall is a levee, which is a barrier constructed out of soil, but levees typically need permits to be constructed and take up much more space than floodwalls.

HELPFUL LINKS
- Floodwalls and Flood Embankments: [environment-agency.gov.uk/PCERMA/Repositories/Fluvial_Documents/Fluvial_Dation_Ikade - Chapter 9.pdf](environment-agency.gov.uk/PCERMA/Repositories/Fluvial_Documents/Fluvial_Dation_Ikade - Chapter 9.pdf)
Thoughtful preservation can be innovative and respectful.
The Hydraulic Lift

Jenna Cellini Bresler, PE, Senior Project Engineer

Silman
How to Prevent Future Farnsworth Flooding

Current

New – At Rest

HYDRAULICALLY LIFTING THE HOUSE

New – Deployed
Steel Trusses (vertical)

Piston Rods within Actuators extend out to push the truss upward

Concrete Beams (supports for actuator trunnions)

Hydraulic Actuators

Concrete Slab at base of house

Cavity within Concrete Pit that houses structural and hydraulic equipment
Steel Trusses

Concrete Beams

Concrete Subgrade Pit

Hydraulic Cylinders/Actuators

Piston Rods within Actuators

System at Rest

System Raised
Piston Rods within Actuators extend out to push the trusses upward.

Connection point for piston to truss via trunnion

Concrete Slab at base of house

Hydraulic Actuators (2 per truss)

Connection point for steel truss to concrete pit (trunnion/pivot connection)

Connection point for steel truss to concrete slab
Common Uses of Hydraulics

- Elevators (Skodtec, LLC)
- Performance Space (Radio City Music Hall Stage)
- Auto Service Centers
- Cars
- Bridges (Pedestrian and Traffic)
Understanding Hydraulics

Hydraulic Actuator

Hydraulic Power Unit
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<thead>
<tr>
<th>Item No.</th>
<th>Criteria</th>
<th>Hydraulically Actuated System</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Able to protect against highest flood water</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>Able to resist rising/deployment in minor floods</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>Able to lift on command for maintenance/testing</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>Known precision for return to exact required position</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>Able to control accelerations during deployment</td>
<td>Yes</td>
</tr>
<tr>
<td>6</td>
<td>Proven performance using substantially similar components including considerations for access to replacement parts</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>Profile exposed to wind and water currents / difficulty to resist</td>
<td>Small</td>
</tr>
<tr>
<td>8</td>
<td>Able to remove debris and mud prior to lowering</td>
<td>Yes</td>
</tr>
<tr>
<td>9</td>
<td>Impact to site appearance</td>
<td>Small</td>
</tr>
<tr>
<td>10</td>
<td>Impact to house</td>
<td>Yes</td>
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<tr>
<td>11</td>
<td>Potential permitting issue by changing the hydrology of the site</td>
<td>None</td>
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<tr>
<td>12</td>
<td>Depth of excavation</td>
<td>Medium</td>
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<tr>
<td>13</td>
<td>Failure modes</td>
<td>Benign</td>
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<tr>
<td>14</td>
<td>Effect and impact on visitor experience</td>
<td>Nil</td>
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<tr>
<td>15</td>
<td>Relative cost</td>
<td>High</td>
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*Without additional enhancements to the basic system*
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<tbody>
<tr>
<td>1</td>
<td>Able to protect against highest flood water</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>2</td>
<td>Able to resist rising/deployment in minor floods</td>
<td>N/A</td>
<td>N/A</td>
<td>No*</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>3</td>
<td>Able to lift on command for maintenance/testing</td>
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<td>N/A</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Known precision for return to exact required position</td>
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<td>Yes</td>
<td>Yes</td>
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<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>6</td>
<td>Proven performance using substantially similar components including considerations for access to replacement parts</td>
<td>N/A</td>
<td>N/A</td>
<td>No</td>
<td>Yes</td>
<td>Yes (mostly)</td>
<td>No</td>
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<td>Profile exposed to wind and water currents / difficulty to resist</td>
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<td>N/A</td>
<td>Large</td>
<td>Small</td>
<td>Large</td>
<td>Large</td>
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<tr>
<td>8</td>
<td>Able to remove debris and mud prior to lowering</td>
<td>N/A</td>
<td>N/A</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>9</td>
<td>Impact to site appearance</td>
<td>High</td>
<td>High</td>
<td>Small</td>
<td>Small</td>
<td>Moderate</td>
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<td>Impact to house (during construction)</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<td>None</td>
<td>Minor</td>
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<td>12</td>
<td>Depth of excavation</td>
<td>N/A</td>
<td>N/A</td>
<td>Very Deep</td>
<td>Medium</td>
<td>Deep</td>
<td>Deep</td>
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<tr>
<td>13</td>
<td>Failure modes</td>
<td>N/A</td>
<td>N/A</td>
<td>Significant</td>
<td>Benign</td>
<td>Significant</td>
<td>Significant</td>
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<tr>
<td>14</td>
<td>Effect and impact on visitor experience</td>
<td>High</td>
<td>High</td>
<td>Some*</td>
<td>Nil</td>
<td>Significant</td>
<td>Significant</td>
</tr>
<tr>
<td>15</td>
<td>Relative cost</td>
<td>High</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
<td>High (~2X HAS)</td>
<td>Not calculated</td>
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</tbody>
</table>

*Without additional enhancements to the basic system
QUESTIONS?
Thank you.

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bresler@silman.com