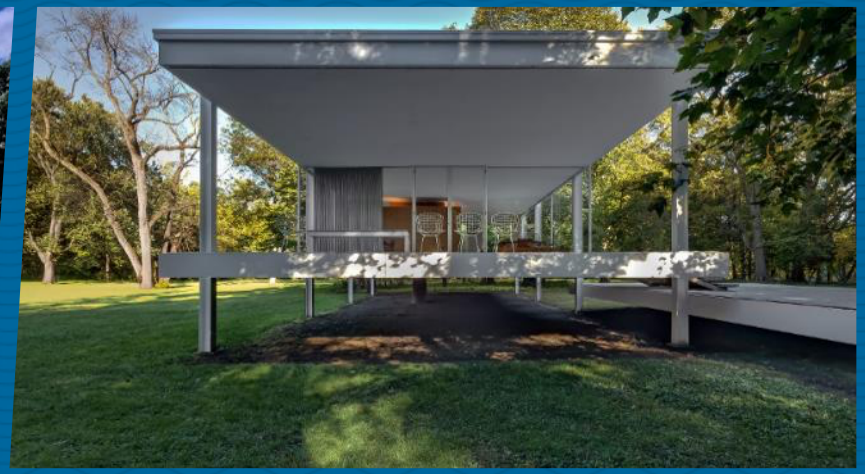
National Trust *for* Historic Preservation



Farnsworth House Flood Mitigation

The Search for a Flood Solution

Keeping History Above Water | Annapolis, Maryland

ASHLEY R. WILSON, AIA, ASID GRAHAM GUND ARCHITECT, NATIONAL TRUST FOR HISTORIC PRESERVATION

JENNA CELLINI BRESLER, PE, SENIOR PROJECT ENGINEER, SILMAN

OCTOBER 30, 2017

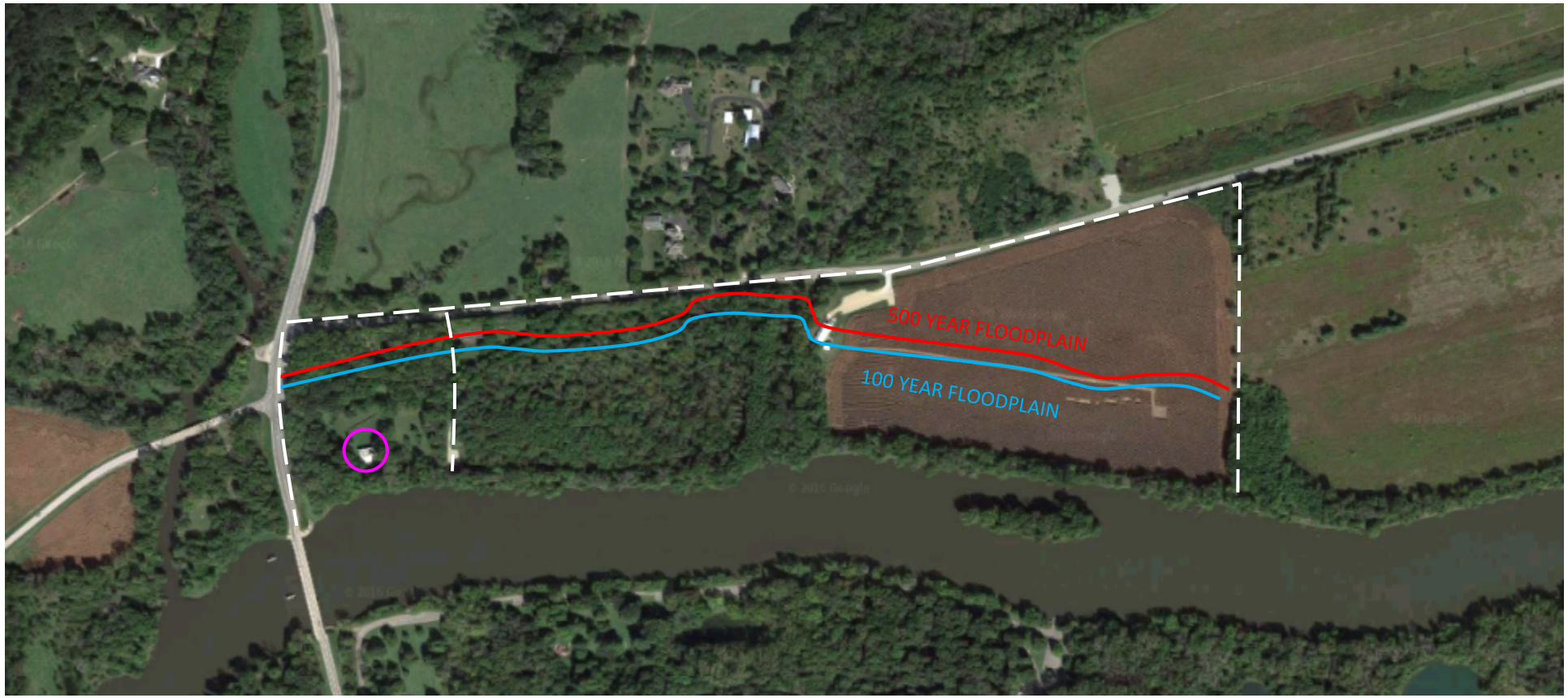
The Farnsworth House

Significance

The Fox River

Site: Plano, Illinois: Floodplain Zone AE

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



FOX RIVER BRIDGE NEAR PLANO.

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

2004 celebration photo

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

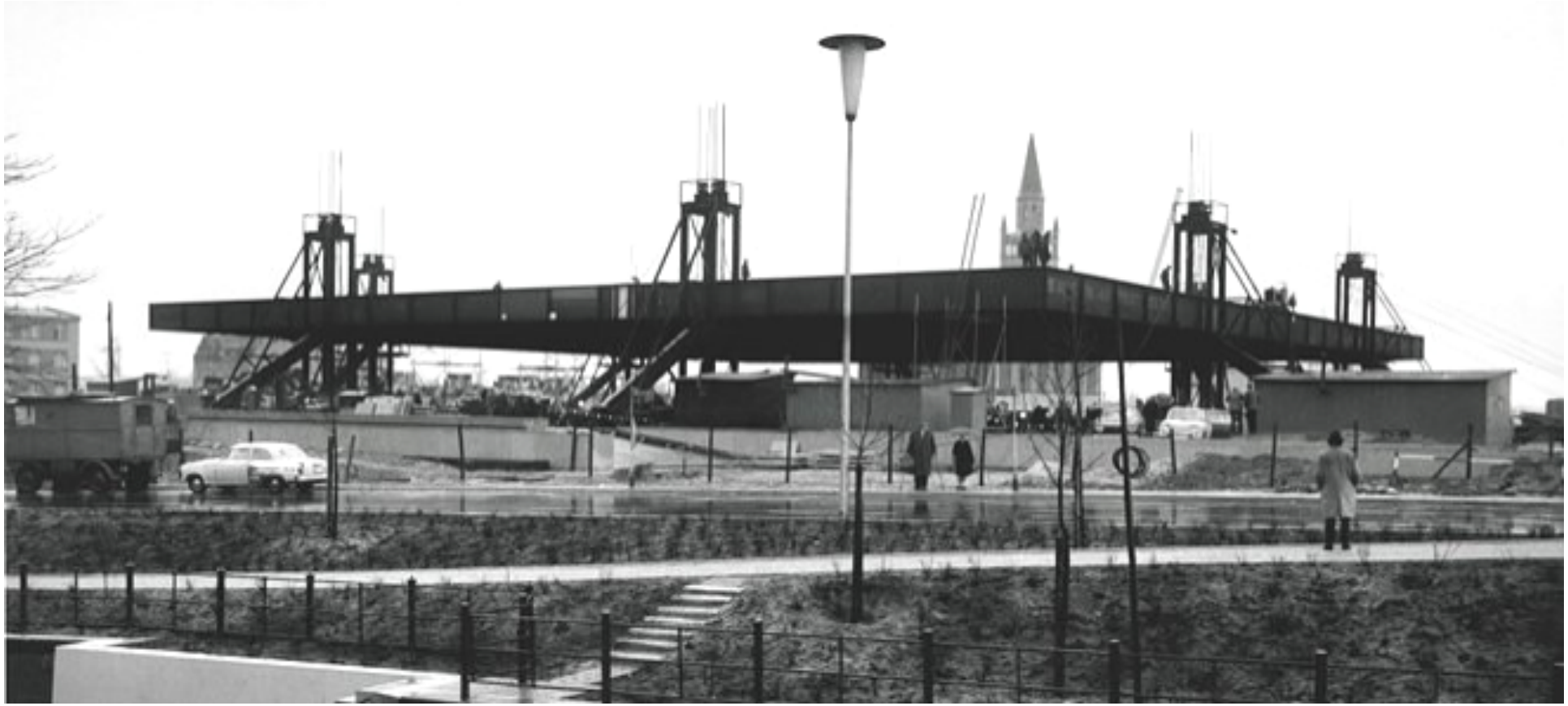
Other options explored

- Option D: Buoyancy
- Option E: Barrier Wall

Project Resources

- Project Overview
- Project Timeline
- Project FAQs
- Maps & Documents
- Photos & Videos

New National Gallery, Berlin (1967)

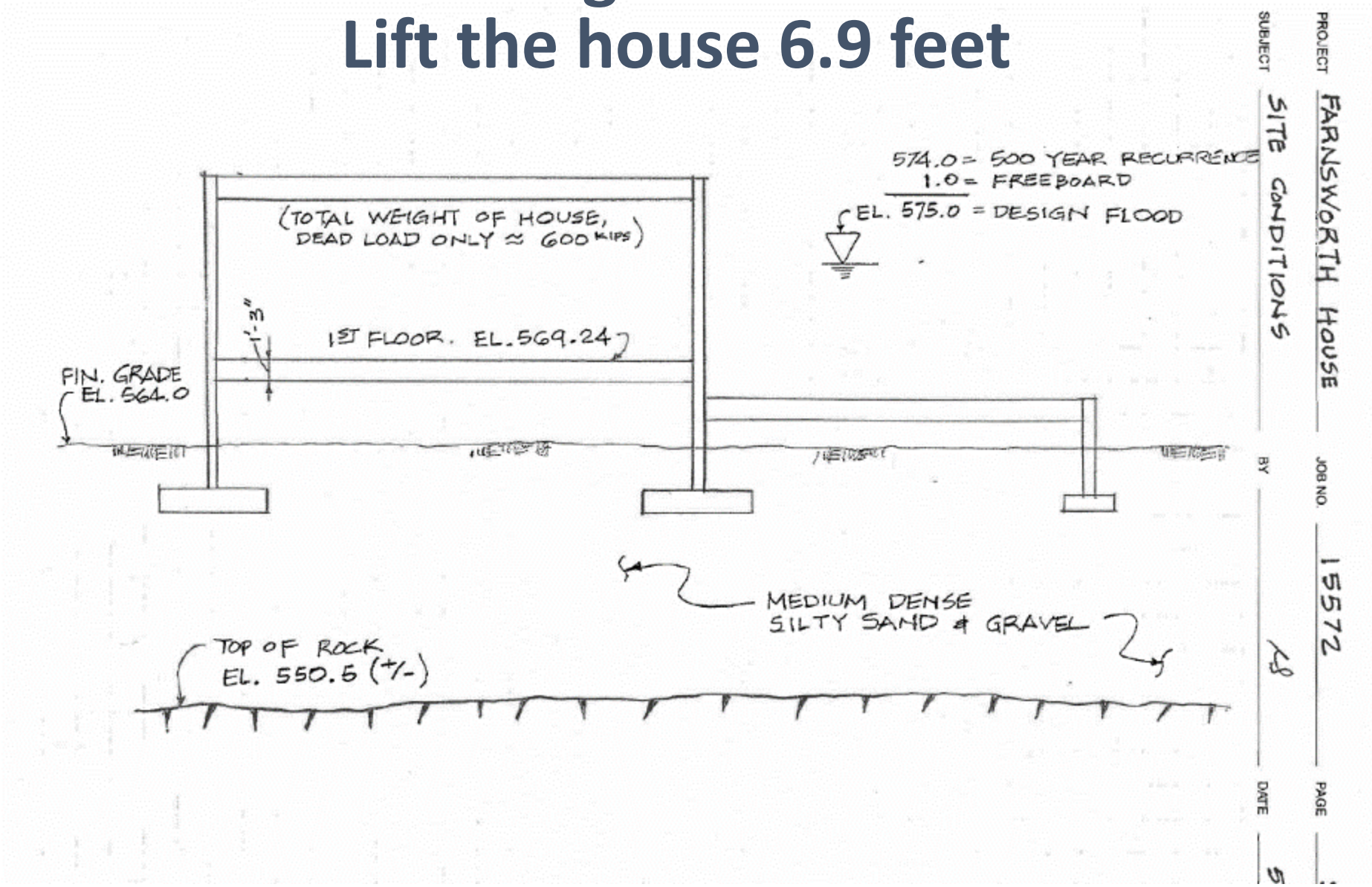


Solution Categories Analyzed

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

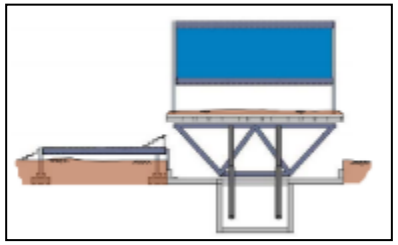
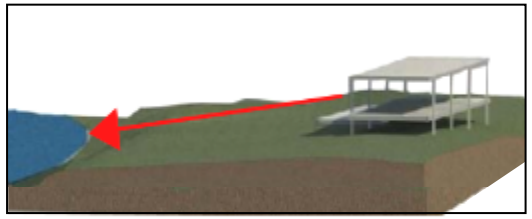
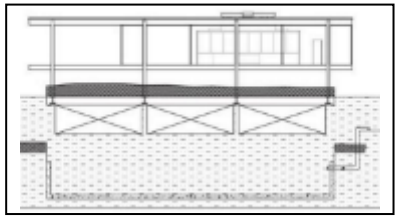
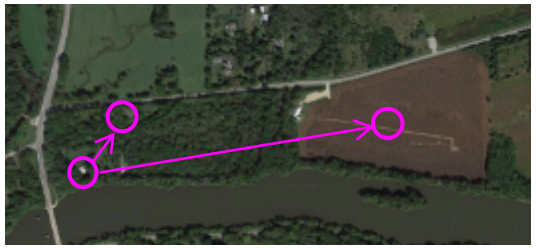
Panels, Peer-reviewers, public-forums, open-comment periods, academic forums, constructability analysis, local and national discussions

Design Criteria
Lift the house 6.9 feet



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


Farnsworth in Plano, Illinois

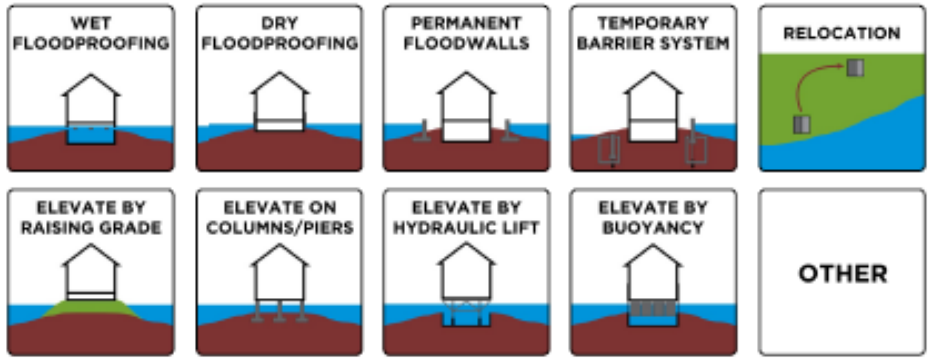
INTRODUCTION

Flooding has 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 Mies van der Rohe and constructed in 19XX, 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



LEARN ABOUT YOUR OPTIONS

IMPORTANT CONSIDERATIONS

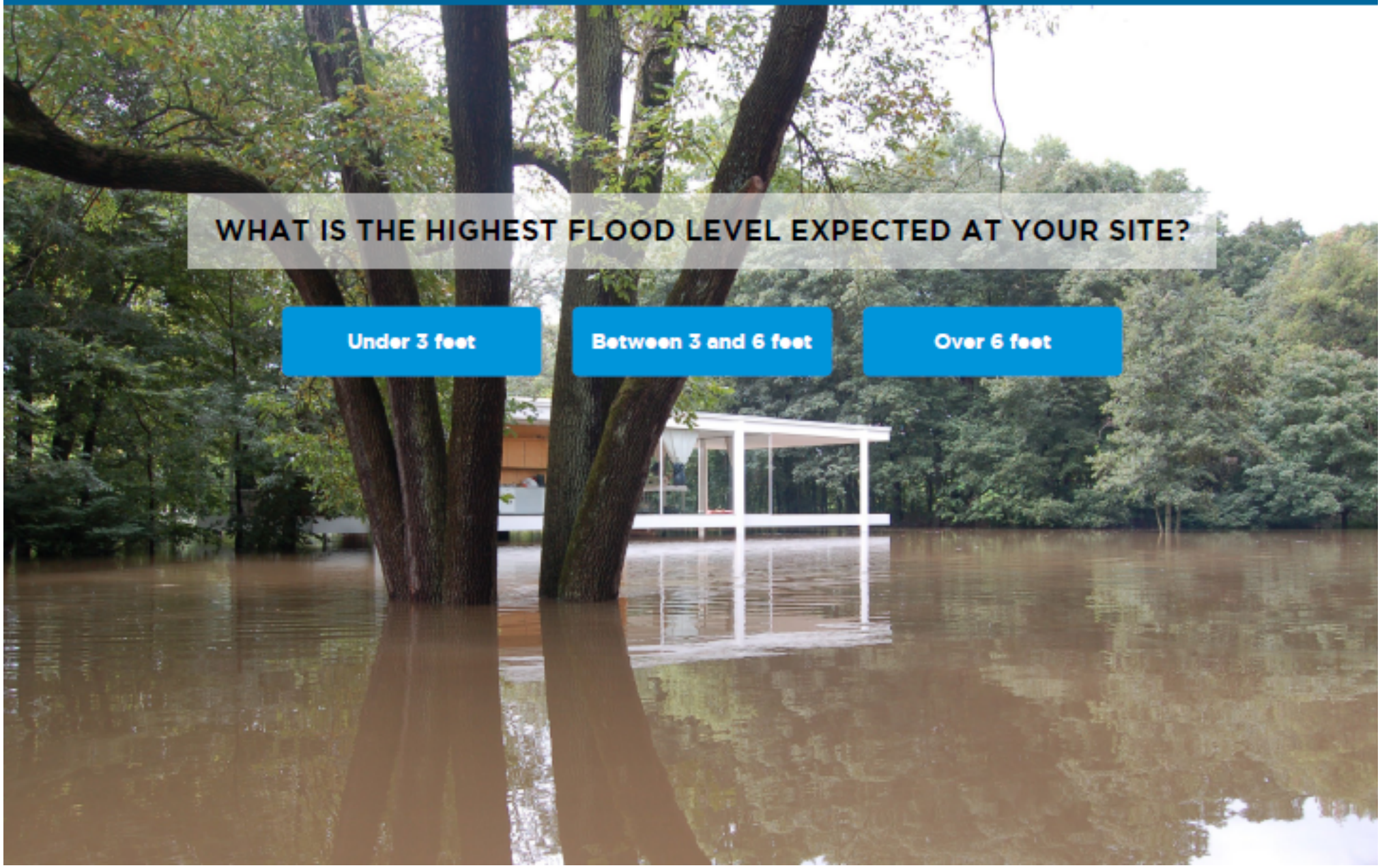
The flood protection options considered here are most relevant for buildings that experience floodwaters **less than 15 ft. deep**. For floodwater depths greater than 15 ft. deep, the only real option is relocation.

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.

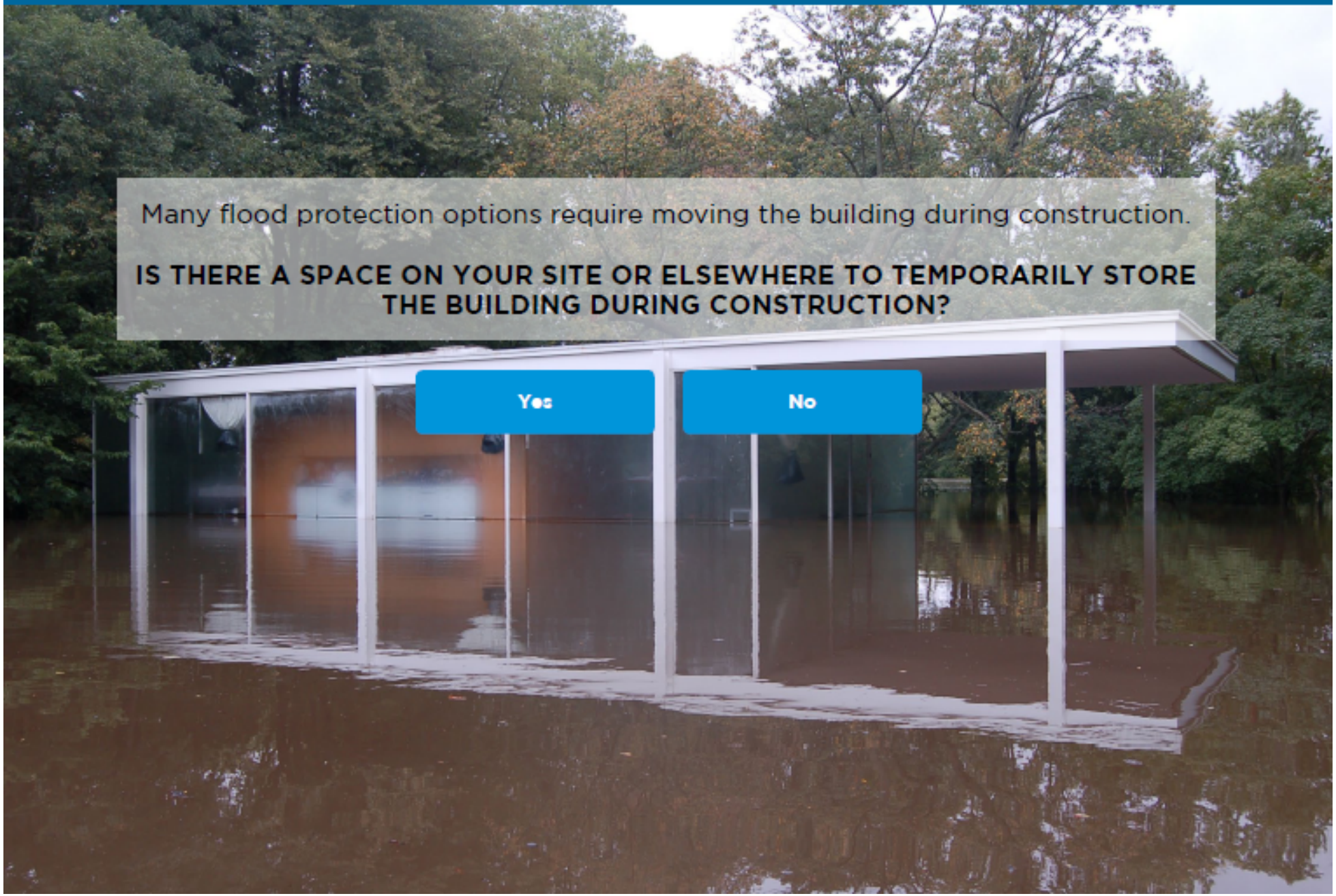
For all elevation options, it is assumed that the building will be elevated at least **above the highest expected flood level** (typically the 500-yr flood).

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 most often experience **flash flooding**.

THE QUIZ


WHAT IS THE HIGHEST FLOOD LEVEL EXPECTED AT YOUR SITE?
Under 3 feet
Between 3 and 6 feet
Over 6 feet

THE QUIZ



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?

Yes **No**

PERMANENT FLOODWALLS

An example of a permanent brick floodwall designed and constructed by Carl Canty at his home in Bubwith, England, along the River Derwent.

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.

IS THIS OPTION FOR YOU?

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 special permits to be constructed and take up much more space than floodwalls.

HELPFUL LINKS

- Louisiana State University Agricultural Center, Floodwalls: www.lsuagcenter.com/NR/rdonlyres/7A01F7C8-703B-47D1-BCCD-63CD0A57721F/2995/pub2745Floodwall6.pdf
- Floodwalls and Flood Embankments: evidence.environment-agency.gov.uk/FCERM/Libraries/Fluvial_Documents/Fluvial_Design_Guide_-_Chapter_9.sflb.ashx
- Homeowner's Guide to Retrofitting, Chapter 8: Barriers: www.fema.gov/media-library-data/1404150139578-ee3a6bc655a236dceba367adcfb8c982/FEMA_P312_Chap_8.pdf

Thoughtful preservation can be innovative and respectful

National Trust *for* Historic Preservation

The Hydraulic Lift

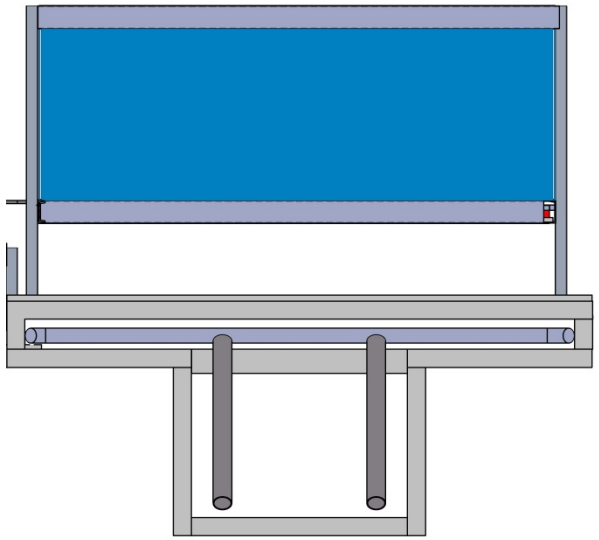
Jenna Cellini Bresler, PE, Senior Project Engineer

Silman

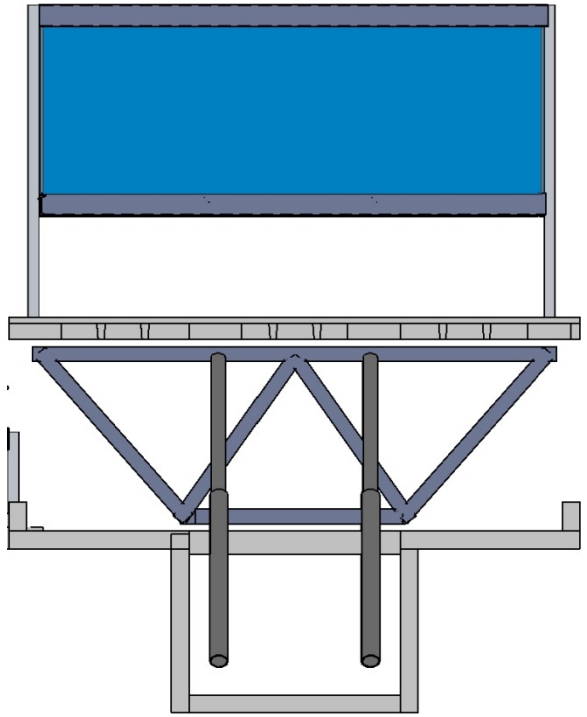
How to Prevent Future Farnsworth Flooding

HYDRAULICALLY LIFTING THE HOUSE

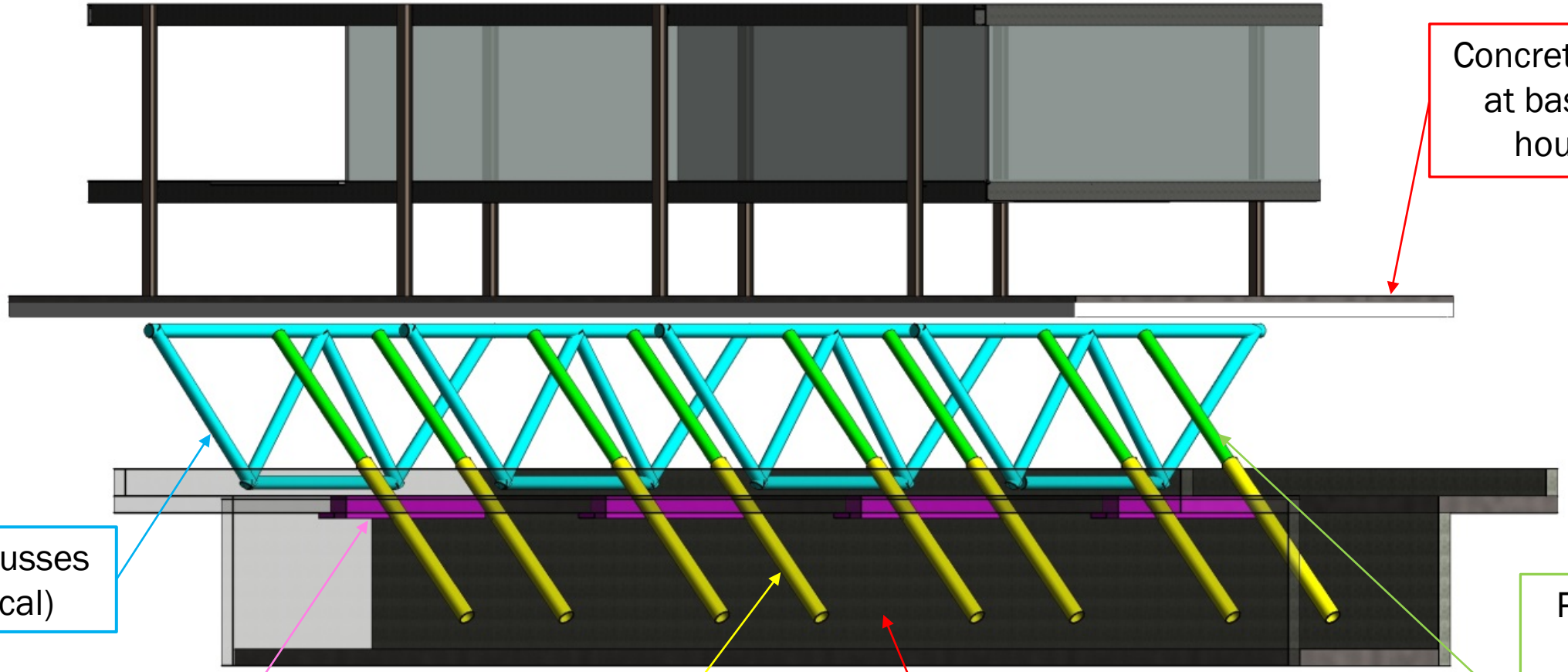
Current

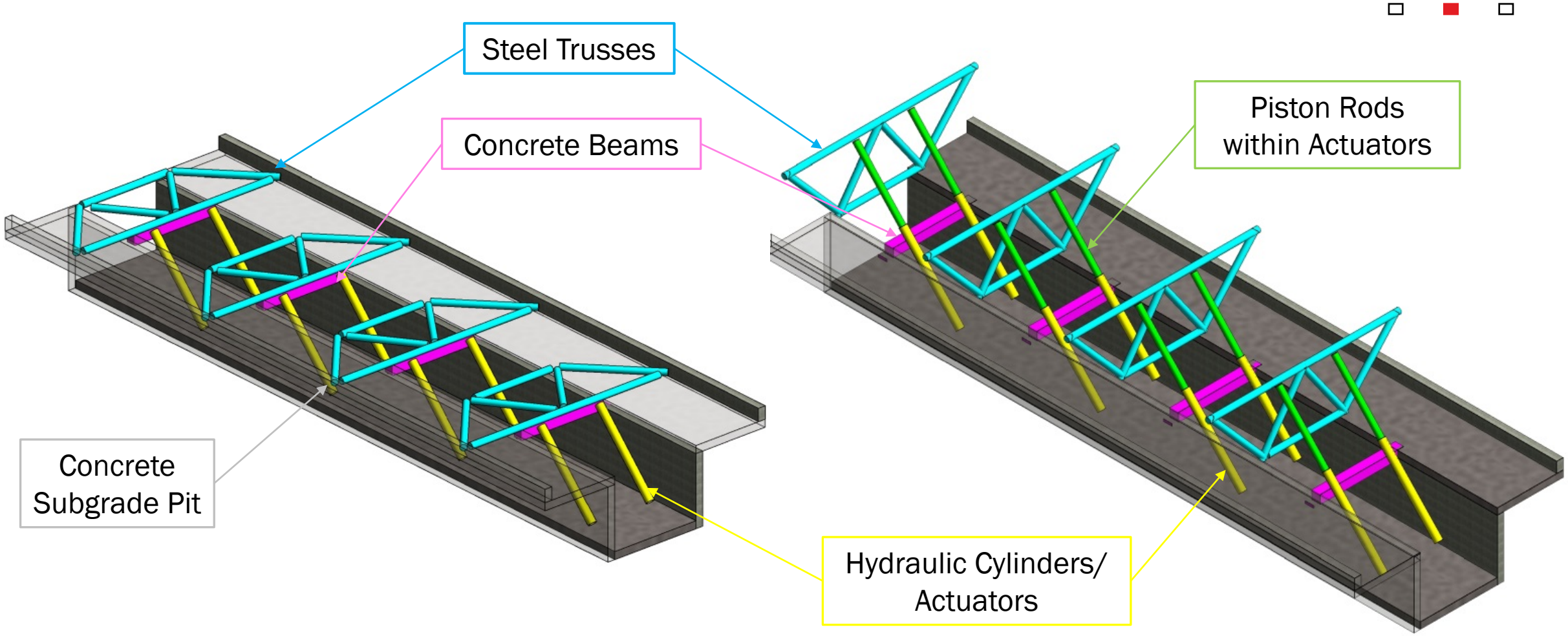


New – At Rest



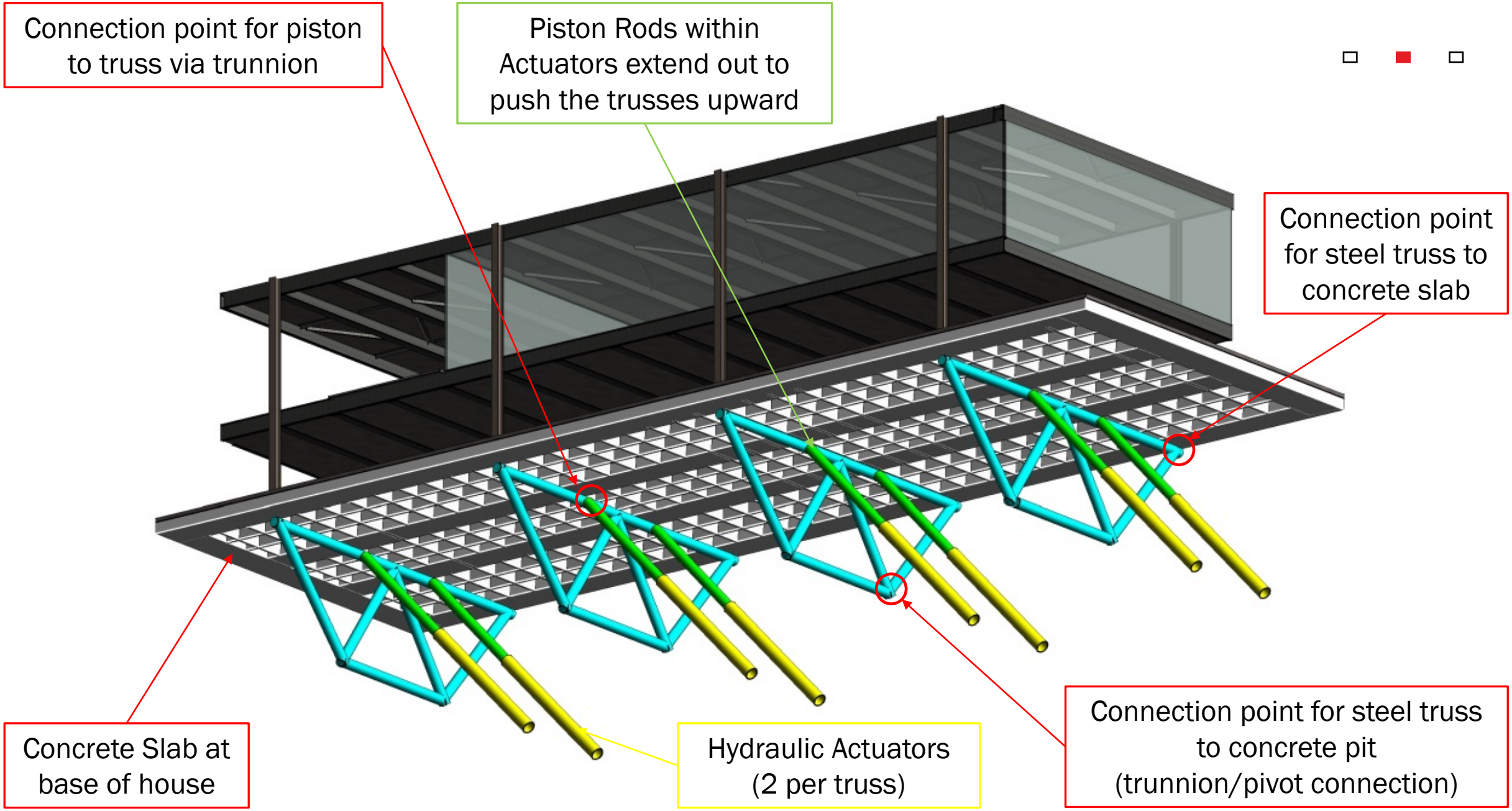
New – Deployed


Concrete Slab at base of house
Steel Trusses (vertical)
Concrete Beams (supports for actuator trunnions)
Hydraulic Actuators
Cavity within Concrete Pit that houses structural and hydraulic equipment
Piston Rods within Actuators extend out to push the truss upward

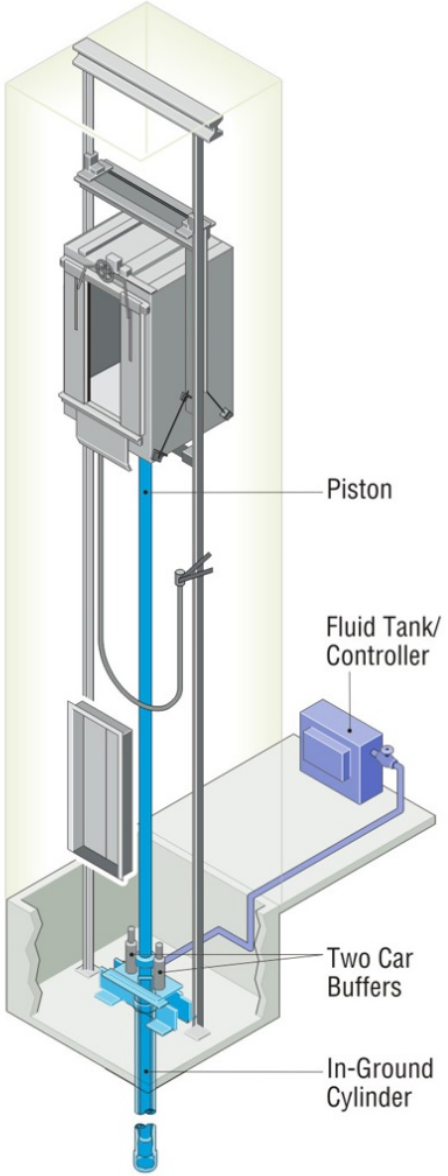


System at Rest

System Raised

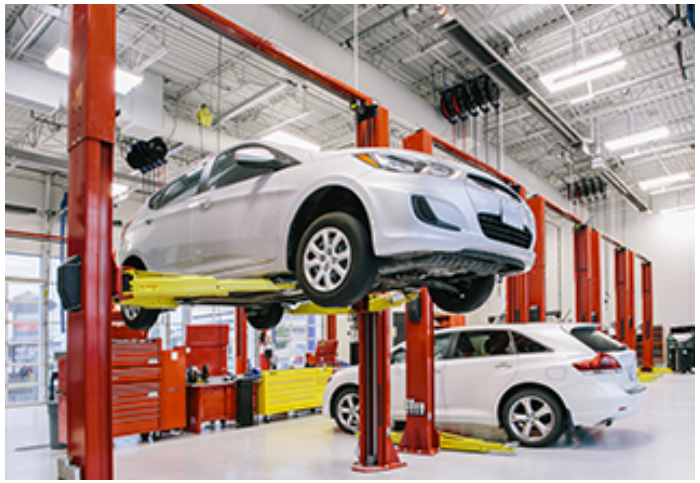

Connection point for piston to truss via trunnion
Piston Rods within Actuators extend out to push the trusses upward
Connection point for steel truss to concrete slab
Concrete Slab at base of house
Hydraulic Actuators (2 per truss)
Connection point for steel truss to concrete pit (trunnion/pivot connection)

Common Uses of Hydraulics



Elevators (Skodtec, LLC)

Performance Space (Radio City Music Hall Stage)

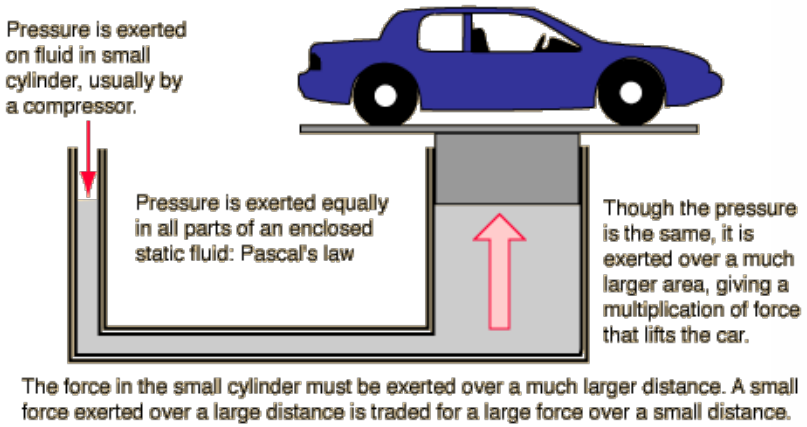


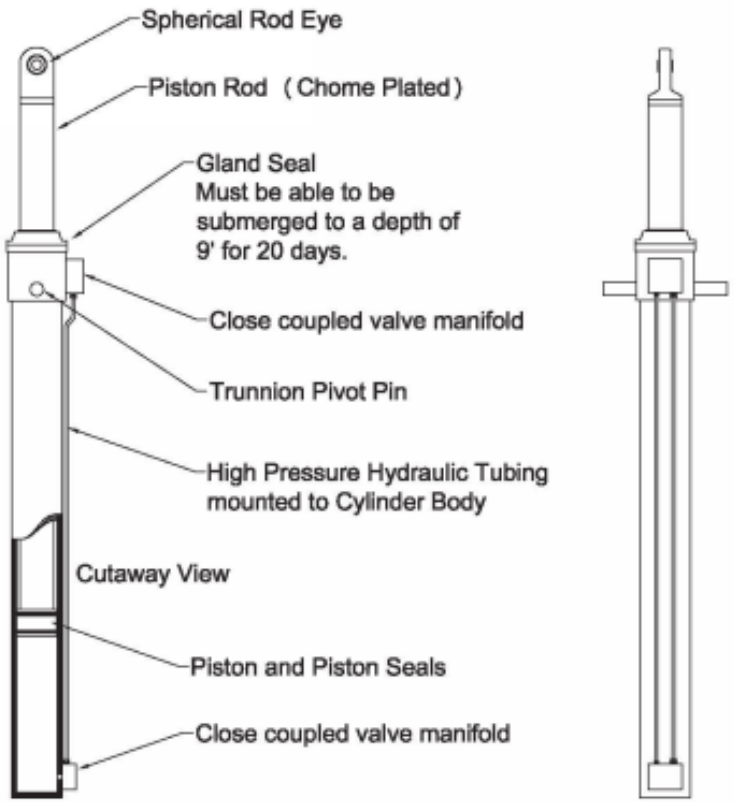
Auto Service Centers

Cars

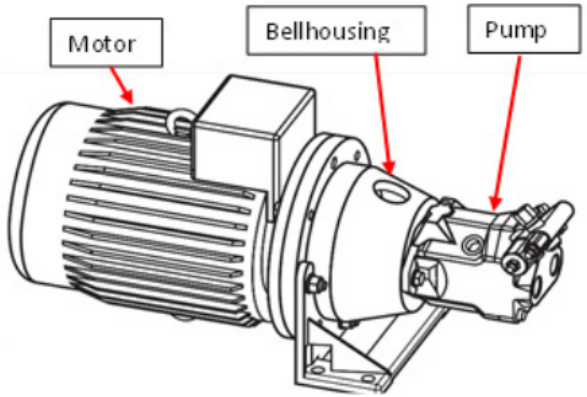
Bridges (Pedestrian and Traffic)

Understanding Hydraulics

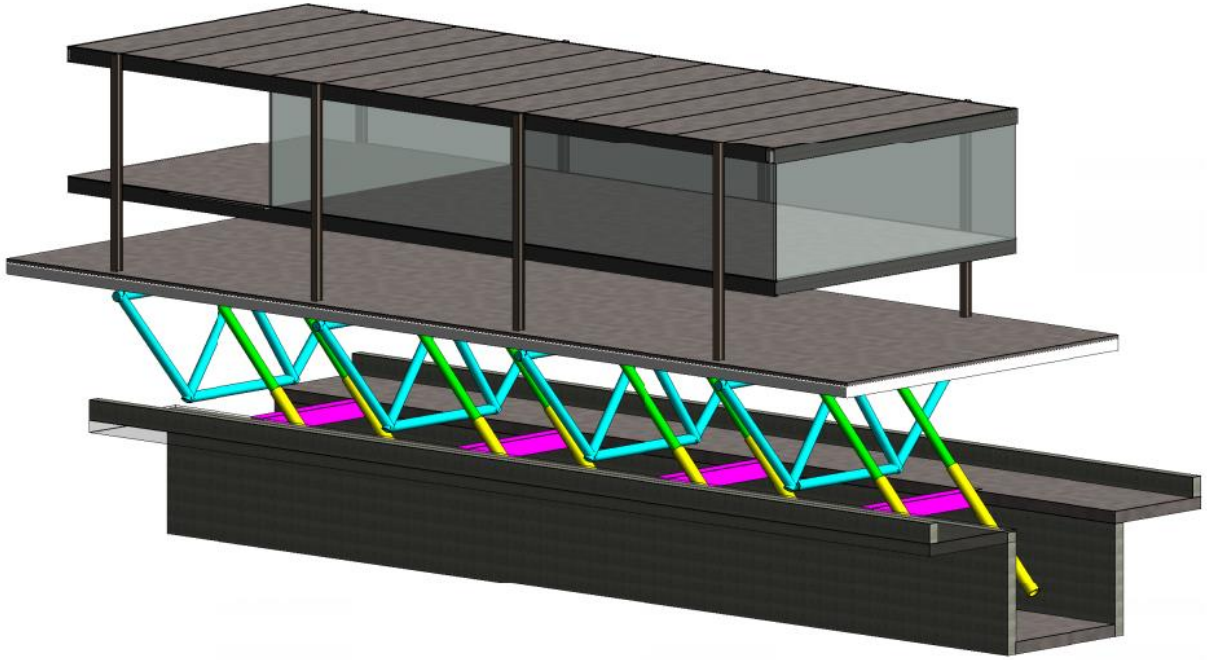


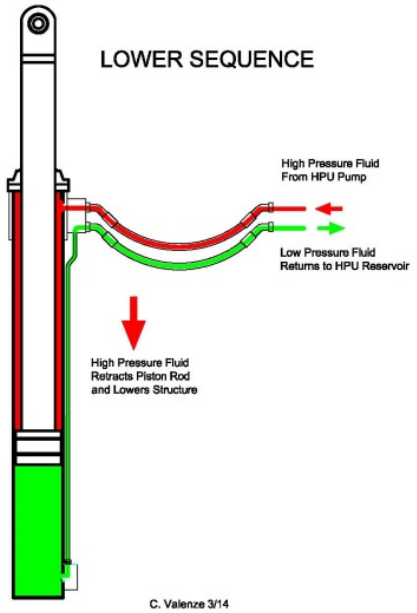


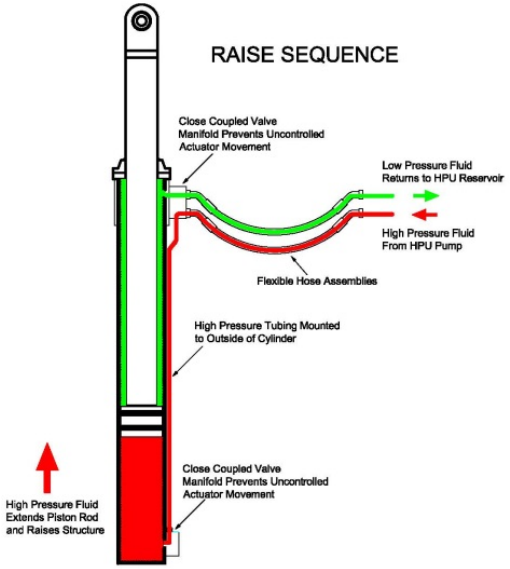
Hydraulic Actuator

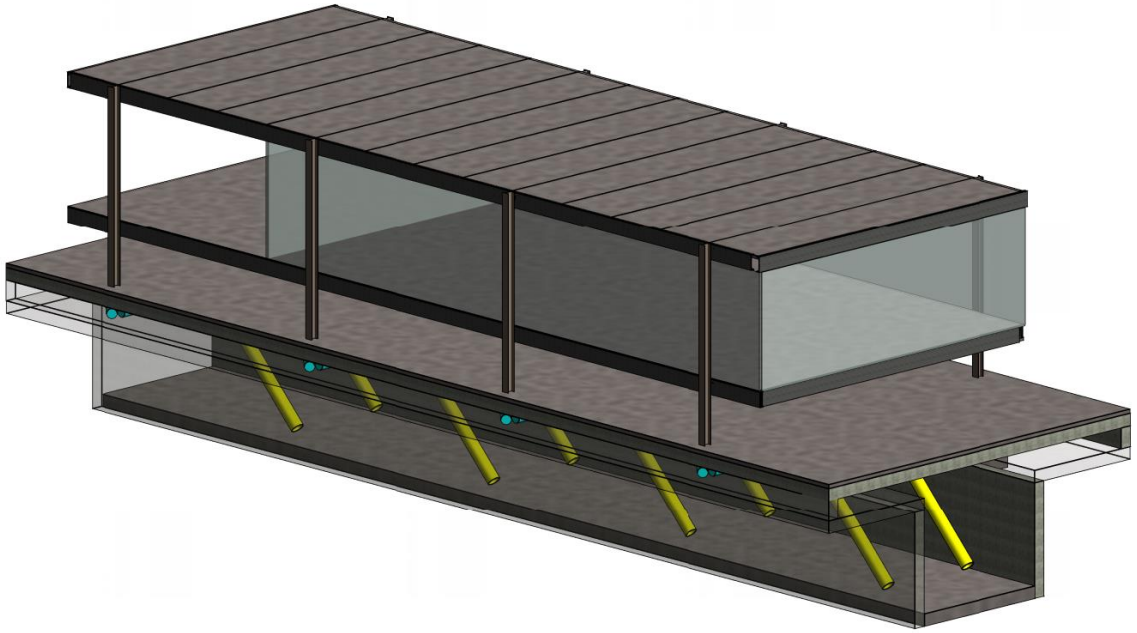


Hydraulic Power Unit




LOWER SEQUENCE
High Pressure Fluid
From HPU Pump
Low Pressure Fluid
Returns to HPU Reservoir
High Pressure Fluid
Retracts Piston Rod
and Lowers Structure
C. Valenze 3/14


RAISE SEQUENCE
Close Coupled Valve
Manifold Prevents Uncontrolled
Actuator Movement
Low Pressure Fluid
Returns to HPU Reservoir
High Pressure Fluid
From HPU Pump
Flexible Hose Assemblies
High Pressure Tubing Mounted
to Outside of Cylinder
Close Coupled Valve
Manifold Prevents Uncontrolled
Actuator Movement
High Pressure Fluid
Extends Piston Rod
and Raises Structure

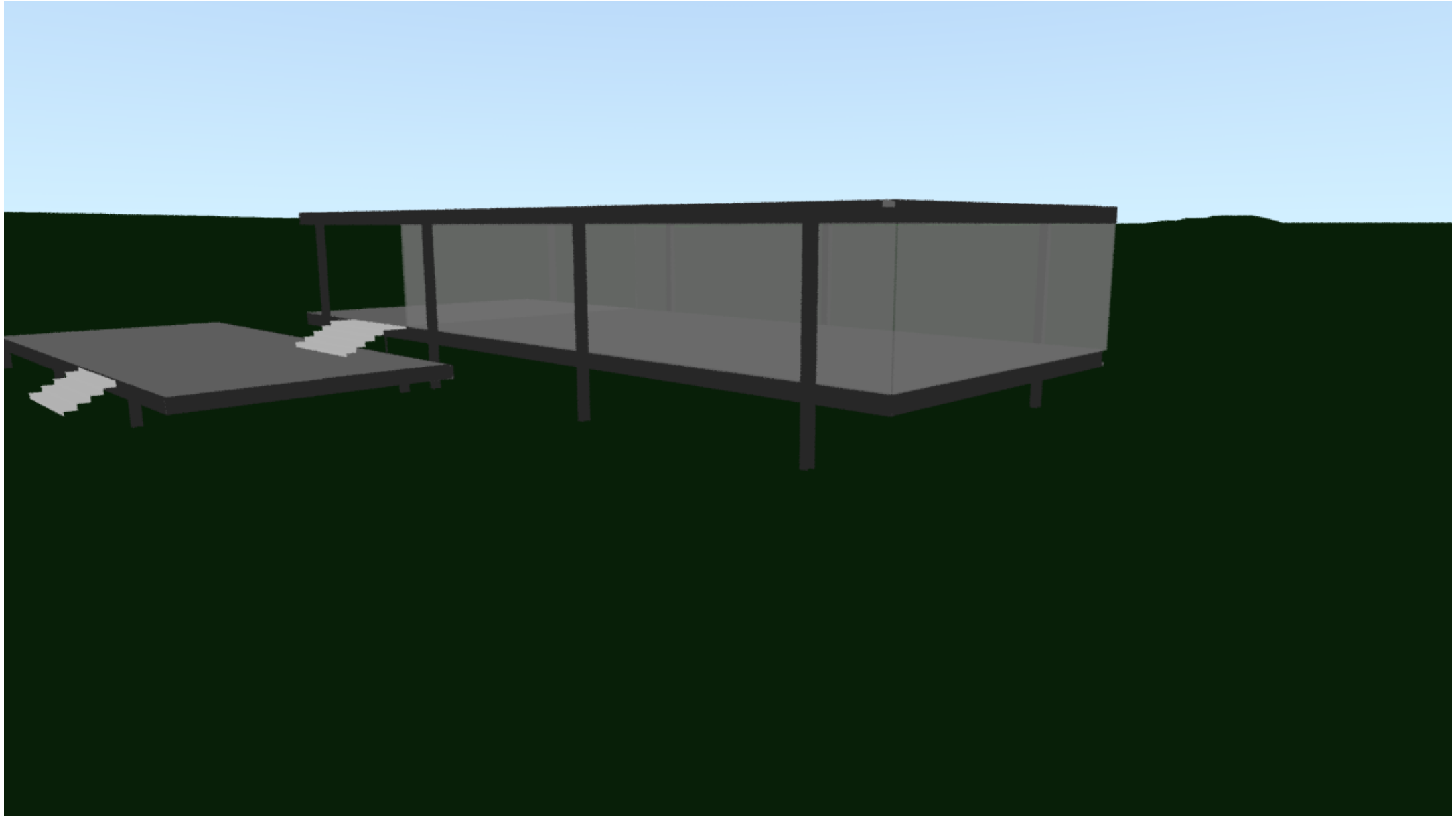


Item No.	Criteria	Hydraulically Actuated System
1	Able to protect against highest flood water	Yes
2	Able to resist rising/deployment in minor floods	Yes
3	Able to lift on command for maintenance/testing	Yes
4	Known precision for return to exact required position	Yes
5	Able to control accelerations during deployment	Yes
6	Proven performance using substantially similar components including considerations for access to replacement parts	Yes
7	Profile exposed to wind and water currents / difficulty to resist	Small
8	Able to remove debris and mud prior to lowering	Yes
9	Impact to site appearance	Small
10	Impact to house	Yes
11	Potential permitting issue by changing the hydrology of the site	None
12	Depth of excavation	Medium
13	Failure modes	Benign
14	Effect and impact on visitor experience	Nil
15	Relative cost	High
*Without additional enhancements to the basic system		

Item No.	Criteria	Option A.1: Raising Grade	Option A.2: Relocating House	Option B: Buoyant Amphibious System	Option C: Hydraulically Actuated System	Option D: Hydraulically Actuated Concrete Barrier	Option E: Inflatable Bladder System
1	Able to protect against highest flood water	Yes	Yes	Yes	Yes	Yes	Yes
2	Able to resist rising/deployment in minor floods	N/A	N/A	No*	Yes	Yes	Yes
3	Able to lift on command for maintenance/testing	N/A	N/A	No	Yes	Yes	Yes
4	Known precision for return to exact required position	N/A	N/A	TBD	Yes	Yes	No
5	Able to control accelerations during deployment	N/A	N/A	No	Yes	Yes	Yes
6	Proven performance using substantially similar components including considerations for access to replacement parts	N/A	N/A	No	Yes	Yes (mostly)	No
7	Profile exposed to wind and water currents / difficulty to resist	N/A	N/A	Large	Small	Large	Large
8	Able to remove debris and mud prior to lowering	N/A	N/A	No	Yes	Yes	Yes
9	Impact to site appearance	High	High	Small	Small	Moderate	High
10	Impact to house (during construction)	Yes	Yes	Yes	Yes	No	No
11	Potential permitting issue by changing the hydrology of the site	Very	N/A	None	None	Minor	No
12	Depth of excavation	N/A	N/A	Very Deep	Medium	Deep	Deep
13	Failure modes	N/A	N/A	Significant	Benign	Significant	Significant
14	Effect and impact on visitor experience	High	High	Some*	Nil	Significant	Significant
15	Relative cost	High	Moderate	Moderate	High	High (~2X HAS)	Not calculated

*Without additional enhancements to the basic system

QUESTIONS?



Thank you.

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