U.S. Naval Academy

Flood Damage Reduction Project Using Structural and Non-Structural Measures

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Presentation by

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Why has this project received strong customer support?

- The project was customer-focused
- We used all of the “tools” in the “tool box”
- We developed an innovative solution that combines structural and non-structural measures
Background

- Hurricane Isabel struck Annapolis, Maryland in September 2003
- Storm surge created water levels equivalent to the 100-year flood event
- 18 buildings were flooded
- USNA incurred over $80 million in damages
- USNA had never experienced significant flooding prior to this event
To prevent floodwaters from disrupting operations and damaging the existing structures during the 100-year flood event, or higher
USNA Objectives

- Include the existing buildings as flood protection (dry flood proof to the extent possible)
- Recommend durable, low maintenance, low-tech, easy to use flood protection measures
- Consider and minimize historic and aesthetic impacts
- Recommend a plan that may be constructed incrementally
Orientation

U.S. Naval Academy

Scale: 1,000 Feet

[Map of the U.S. Naval Academy]
Hurricane Isabel Flooding
Study Process

- Step 1 – Conducted field reconnaissance
- Step 2 – Identified alternative solutions
- Step 3 – Evaluated and compared alternatives
- Step 4 – Recommended a plan for implementation
Step 1 - Field Reconnaissance

- 2 sets of teams were established
  - **Structural team**
    - investigated potential structural solutions (flood walls, berms)
  - **Non-Structural team**
    - comprised of representatives from the Corps’ National Non-Structural/Flood Proofing Committee
    - investigated each building to identify flood-proofing opportunities
Flood Damage Reduction Considerations

- Flooding characteristics – depth, velocity, duration
- Site characteristics – site location, soil types
- Building characteristics – foundation, construction, condition
Types of Non-Structural Flood Proofing

- Elevation
- Relocation
- Dry flood proofing
- Wet flood proofing
Elevation

- Raise the building so that floodwaters cannot reach damageable portions of it
- Construct new or extended foundation or elevate on piles or columns
Elevation

When raised 6-8 feet or more, a new story is created.

Lightweight or mobile items can be stored under the house and moved after the flood warning.

Openings on each wall ensure entry of water to prevent damage to WVd.

Utilities and electrical circuits moved above flood level.

Note: Car illustrates normal parking use. Car would be removed prior to flood.
Relocation

- Move the building to another location where floodwaters cannot reach it
Dry Flood Proofing

- Seal the building so that floodwaters cannot get inside
- Typically, can be done only where floodwaters are less than 3 feet deep
- Types of features include:
  - Sealing walls with waterproofing compounds or impermeable sheeting
  - Closing openings such as doors, windows, sewer lines, and vents with permanent closures or removable shields
Types of Flood Gates

Courtesy of Reelan Industries and PS Doors
Wet Flood Proofing

- **Wet flood proofing** – Modify the building to allow floodwaters inside, but ensure that there will be minimal damage to the structure and its contents.
- **Often only used when other measures are not possible or too costly.**
- **Types of features include:**
  - Protecting or moving utilities and furnaces to an area above anticipated flood level
  - Installing vents so that floodwaters can easily enter and exit the structure
  - Raising or moving critical items prior to the flood event
  - Retrofitting items below the flood level to make them water resistant
Step 2 – Identify Alternative Solutions

- Entire team gathered to develop comprehensive solutions to the flooding problem
- Team investigated flood proofing individual buildings and using sides of buildings as part of the flood wall
- Types of structural features investigated include flood walls, berms, and raising ball fields
- Due to numerous combinations of alternatives, the USNA was divided into 5 areas
Soccer Facility
Ricketts Hall
North side of Nimitz Library
Potential Flood Wall Location
Step 3 – Evaluate and Compare Alternatives

- **Evaluation Criteria:**
  - Construction Cost
  - Operation and Maintenance Activities
  - Actions Prior to Flood
  - Cultural and Historic Impacts
  - Aesthetic Impacts
  - Accessibility through Yard
  - Impact to facility/operations
  - Dual-use of flood wall as inner security fence
Alternatives for North Area
North side of Nimitz
Flood Proof Alumni Hall
Alternatives for North Area

*N1 – Flood wall along Nimitz and dry flood proof Alumni
- 4 closure structures
- Minimal impact to water view
- $5-6 million; highest cost
- McNair Rd closed during construction

N2 – Flood wall along sea wall and parking area and dry flood proof Alumni
- 4 closure structures
- Moderate impact to water view; sidewalk could be raised
- $4,200,000

N3 – Flood wall along sea wall and dry flood proof Alumni
- 2 closure structures
- Severe impact to water view; sidewalk could be raised
- $3,400,000; least cost
Alternatives for Southeast Area
Bancroft Hall
Alternatives for Southeast Area

*SE1 – Dry flood proof Bancroft and Levy
  - Only 1 closure structure
  - No impact to view; protection would be nearly “invisible”
  - Numerous flood gates across doorways
  - Larger area would be flooded; smaller pumps needed
  - $1,710,000; least cost

SE2 – Raise football fields
  - Only 1 closure structure
  - Minimal impact to view (field raised ~2 feet)
  - Would need to ensure safe slopes around fields
  - $3,620,000; highest cost

SE3 – Flood wall along Brownson Road
  - 4 closure structures
  - Severe impact to view (water and fields)
  - $1,770,000
NOTES:

1. RELOCATE OFFICES FROM 1ST FLOOR TO UPPER LEVEL

2. RELOCATE ELECTRICAL SYSTEM (OUTLETS, SWITCHES, PANELS, ETC...) ABOVE THE DESIGN ELEVATION

3. RING WALL EXTERIOR ELECTRICAL EQUIPMENT

4. ELEVATE/RELOCATE OFFICE HVAC EQUIPMENT

CLOSURE

WATERPROOF INTERIOR WALLS OF BOILER ROOM

SUMP PUMPS ON EMERGENCY POWER AT FLOOR OF BOILER ROOM

NORTH ELEVATION

HUBBARD HALL
BUILDING ELEVATION - NORTH
5% - CONCEPT DESIGN

ALTERNATIVE WET FLOOD PROOF
LEVEL OF PROTECTION ELEV. 10.8'
SCALE NTS
DATE MAR 05

NATIONAL NON-STRUCTURAL/ FLOOD PROOFING COMMITTEE
Alternatives for Hubbard Hall

H1 – No action
- No flood protection
- Similar flood damages would be incurred during similar flood event; Isabel damages were $500,000

*H2 – Wet flood proof structure and dry flood proof mechanical room
- Relatively low cost and damages would be minimized
- Building would still be flooded and clean-up would be required
- Critical items must be moved/raised prior to flood
- $160,000
Selected Course of Action

- Based on evaluation of alternatives, USNA selected a plan for implementation.
- Final selected plan includes:
  - Approx. 4000 linear feet of flood walls
  - 2 buildings entirely dry flood proofed
  - 6 buildings dry flood proofed on 1 or 2 sides
  - 1 building combination wet and dry flood proofed
Questions?
For More Information, Contact:

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