North Dakota Silver Jackets Program Overview

North Dakota State Water Commission
North Dakota Department of Emergency Services
Mike Hall, ND Silver Jackets Coordinator

North Dakota Silver Jackets

…are a Flood Risk Management Team formed for the purpose of enhancing intergovernmental partnerships that result in comprehensive and sustainable flood risk reduction measures for North Dakota.

Includes representatives from:

- North Dakota State Water Commission
- North Dakota Department of Emergency Services
- U.S. Army Corps of Engineers
- FEMA
- NRCS, NWS, USFWS, USGS, NDGS

North Dakota Silver Jackets

N.D. Silver Jackets Projects Include:

- Aerial Photography and LiDAR Data Collection
- Community Assistance w/ Levee Safety Issues
- Development of Hydrologic and Hydraulic Models for Flood Emergency Preparedness Planning

North Dakota Silver Jackets

N.D. Silver Jackets Projects Include:

- Basin-Wide Precipitation and River Gage Analysis
- Facilitating Development of Emergency Action Plans
- Facilitating Flood-Proofing Workshops
- Collection of Data for Rural Flood Risk Reduction (i.e. the StARR Program)

Souris River Joint Water Resources Board

Structure Acquisition, Relocation or Ring Dike (StARR) Program

Section Overview

- Mouse River Enhanced Flood Protection Project Overview
  - Part 1 – Urban Reaches
  - Part 2 – Rural Reaches
- StARR Program Overview
- Questions

Developing Part 1 (Urban Reaches)

- Following the 2011 Mouse River flood, residents within the valley needed information to make personal decisions

Developing Part 1 (Urban Reaches)

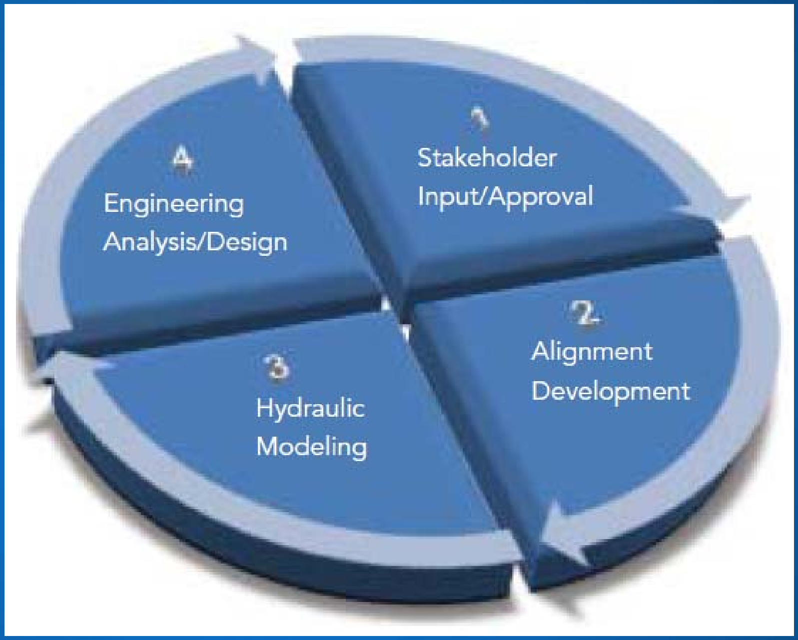
Initial Study Timeline was Condensed to 5 Months

Project award	Basin-Wide Stakeholder Workshop	First draft of preliminary alignment	Preliminary alignment for public review	Preliminary engineering report due
Sept. 26 2011	Oct. 5-7 2011	Nov. 3 2011	Nov. 30 2011	Feb. 29 2012

Developing Part 1 (Urban Reaches)

Iterative, Transparent Process

- Stakeholder Input / Feedback / Approval
- Alignment Development / Alternatives
- Hydraulic Modeling
- Engineering Analysis / Design
- Compile analyses, references, and assumptions into Preliminary Engineering Report (PER)



Developing Part 1 (Urban Reaches)

October 5-7, 2011

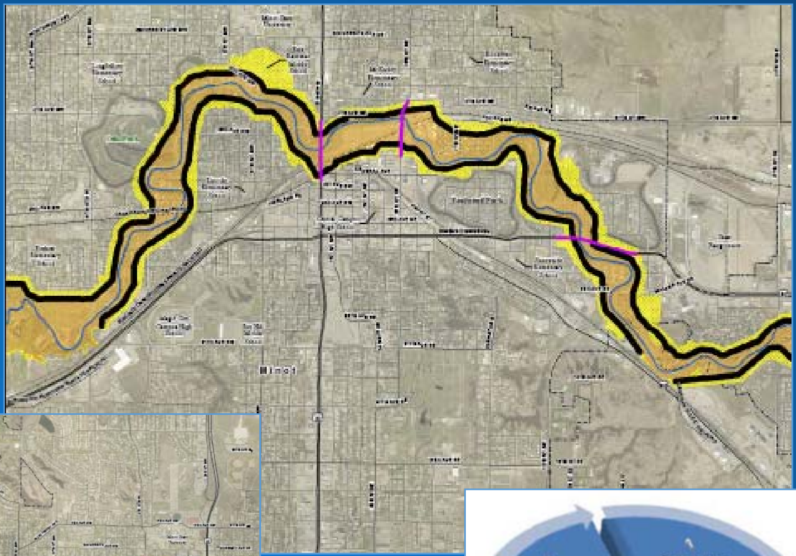
Stakeholder Workshop
Established Part 1 Constraints
(including, but not limited to):

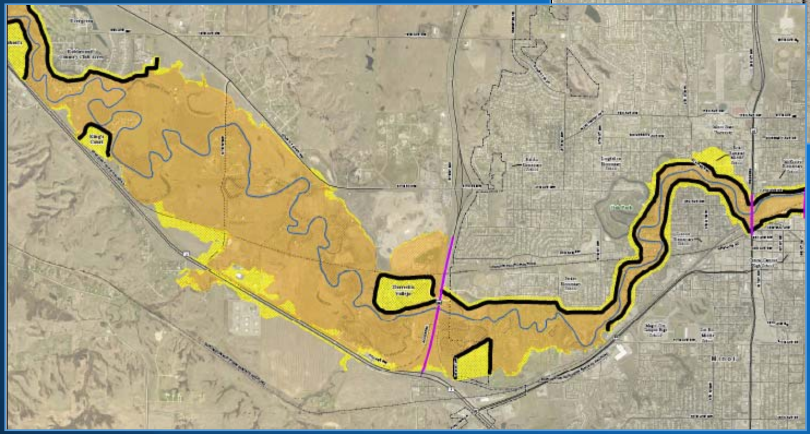
- Focus Initially on Developed Areas
- Design for 27,400 cfs
- Limit water surface elevation (WSE) increases over 2011 event
- Minimize impact to homes
- Incorporate 3 feet of freeboard
- Maintain critical transportation routes

Developing Part 1 (Urban Reaches)

November 3, 2011

Initial Concept Alignment was Released for Public Comment

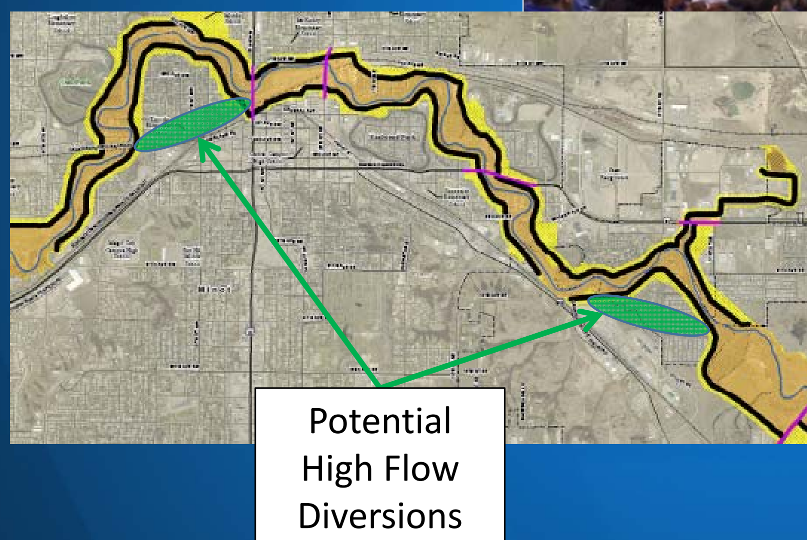




Developing Part 1 (Urban Reaches)

November 8-10, 2011

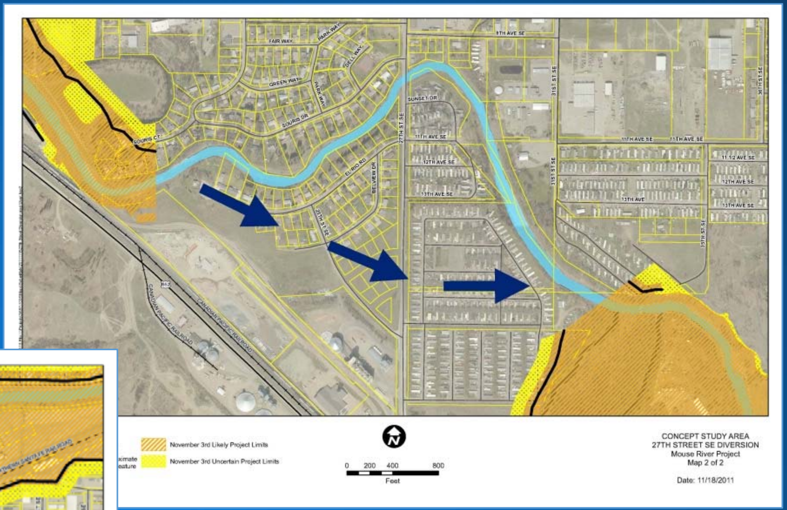
Public Input Meetings

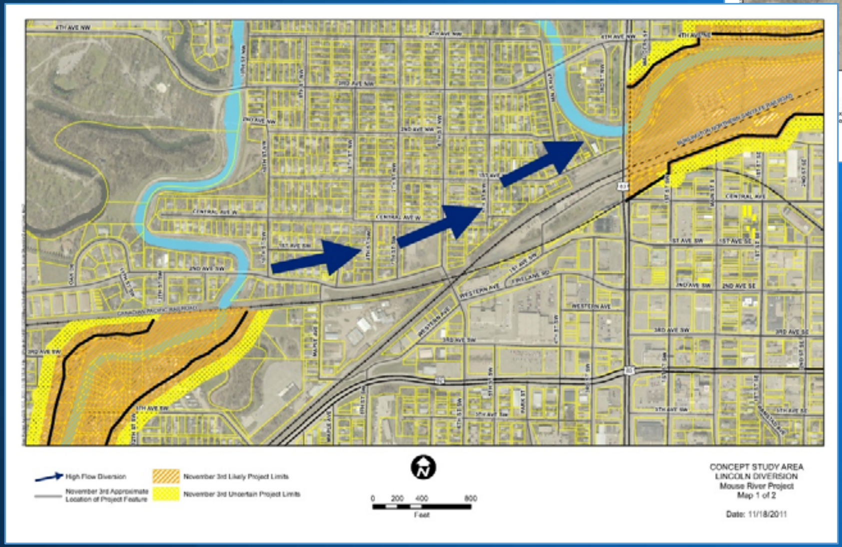


Developing Part 1 (Urban Reaches)

November 18, 2011

Potential High Flow Diversion Alignments Released

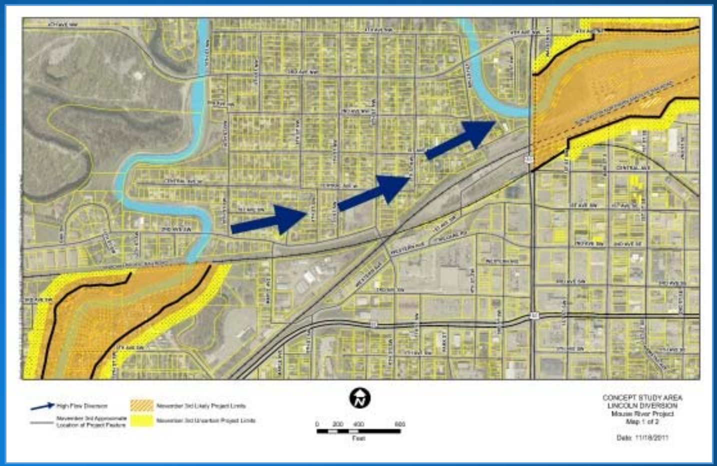




Developing Part 1 (Urban Reaches)

November 22, 2011

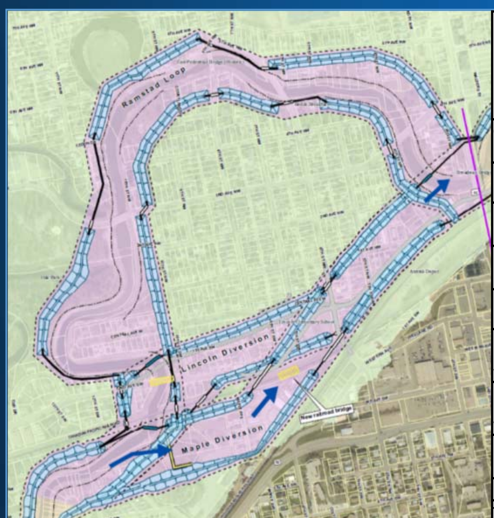
Public Input Meetings on Potential High Flow Diversion Alignments



Developing Part 1 (Urban Reaches)

January 31, 2012

Minot City Council Meeting & Public Input Meeting



Parcel Zoning	Number of Affected Parcels: Ramstad Alignment (Existing River Channel with Levees and Floodwalls)	Lincoln High Flow Diversion Alignment	Maple High Flow Diversion Alignment
General Commercial District	17	8	9
Light Industrial District	0	1	6
Limited Commercial District	1	1	1
Residential Zoned / Business Use	0	0	3
Residential Trailer Park	1	1	1
Residential Property with Buildings	188	156	96
Residential Property without Buildings	39	11	14
No Zoning / Undeveloped	9	9	9
Public Zoned	6	2	3
TOTAL	**261**	**189**	**142**

Developing Part 1 (Urban Reaches)

January 31, 2012

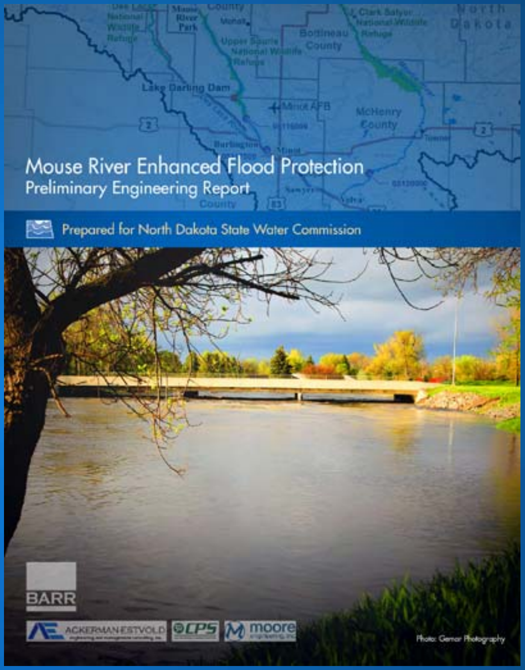
- City Council Selects Maple Diversion & 27th Street Diversion as Preferred Alignments

February 29, 2012

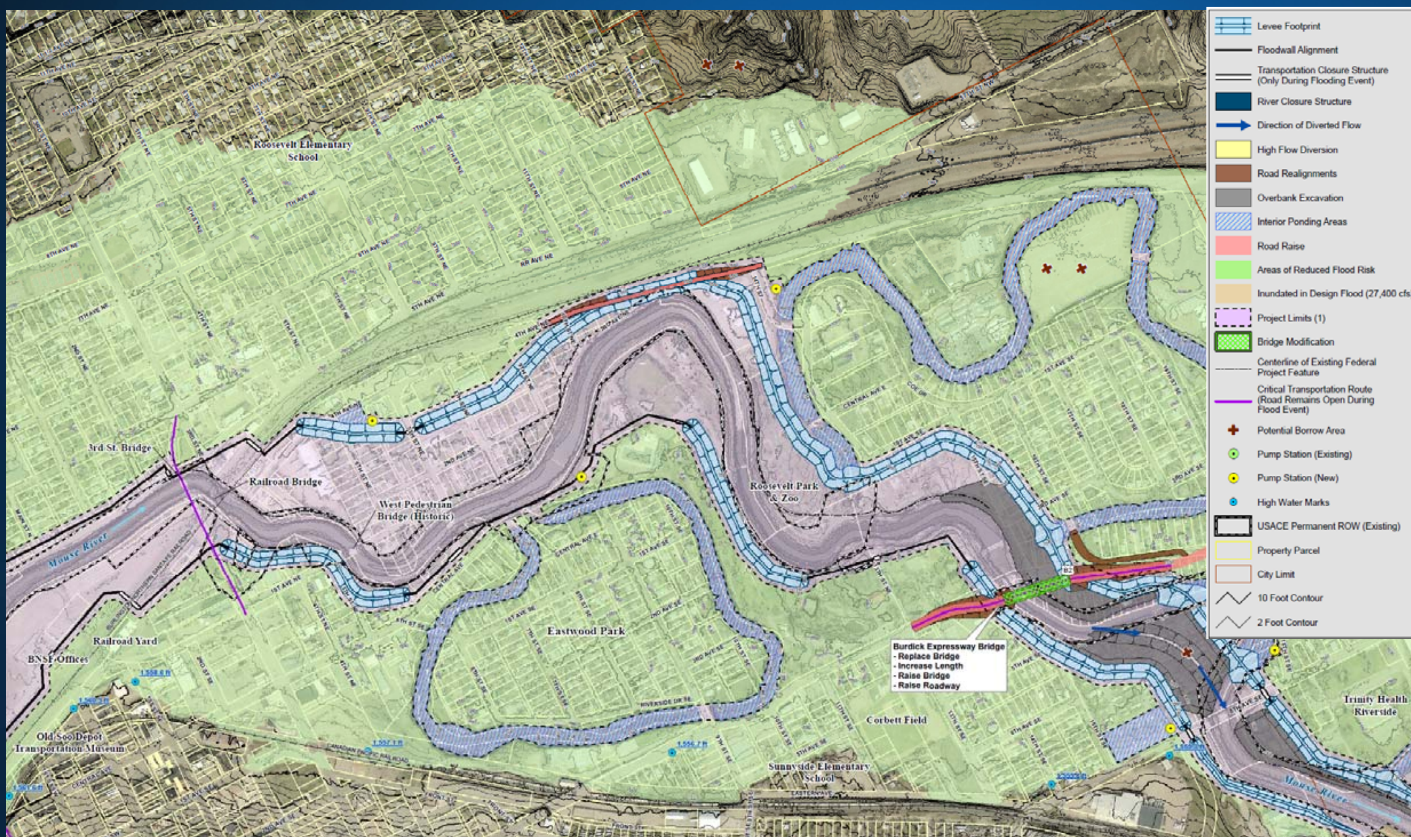
- Preliminary Engineering Report is Released

April 12, 2012

- Minot City Council Adopts Footprint of Preliminary Engineering Report
- Similar Actions Taken by Other Local Governments (Ward County, City of Burlington, etc.)

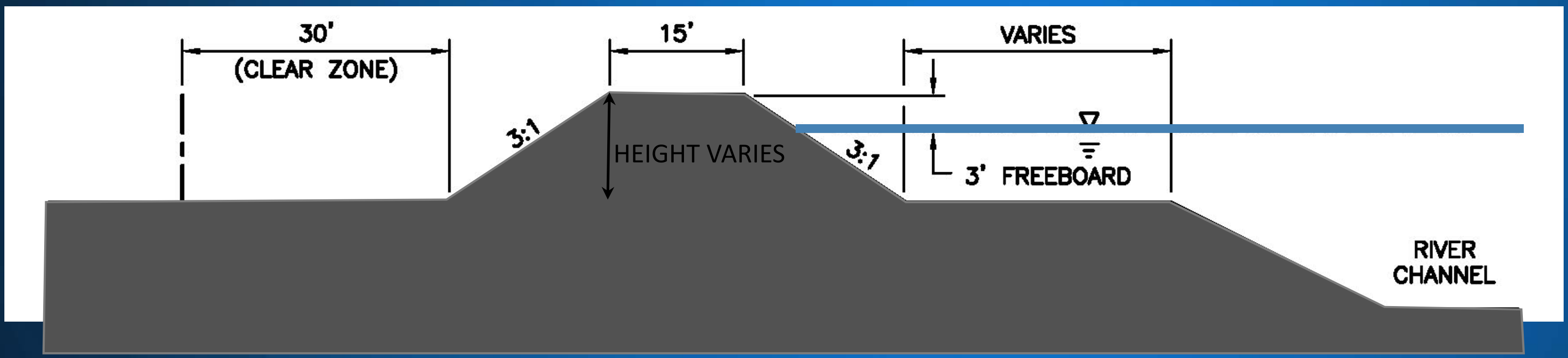


Part 1 – Alignment Features



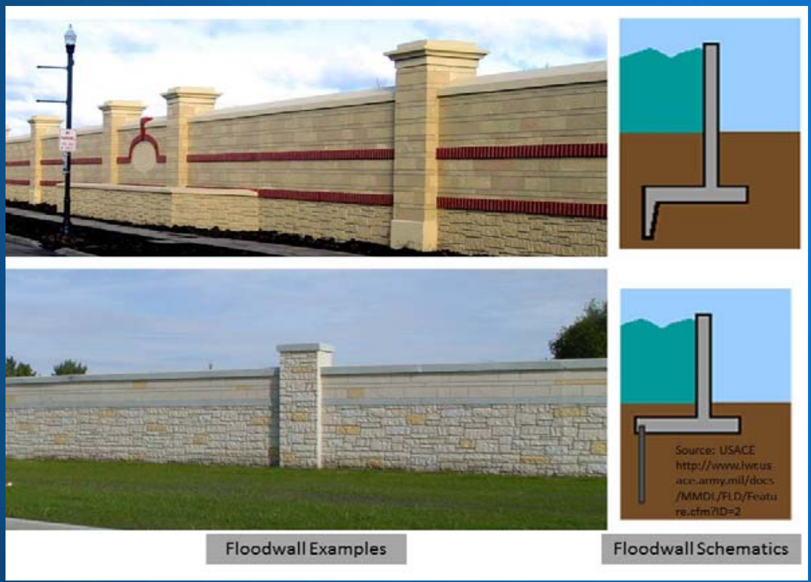
Preliminarily alignment contains 8 ¾ miles of levees in Minot

Item	Units	Reaches Upstream of Minot	Reaches Through Minot	Reaches Downstream of Minot	All Project Reaches
Length of Levee	feet	38,200	**46,300**	29,500	114,000

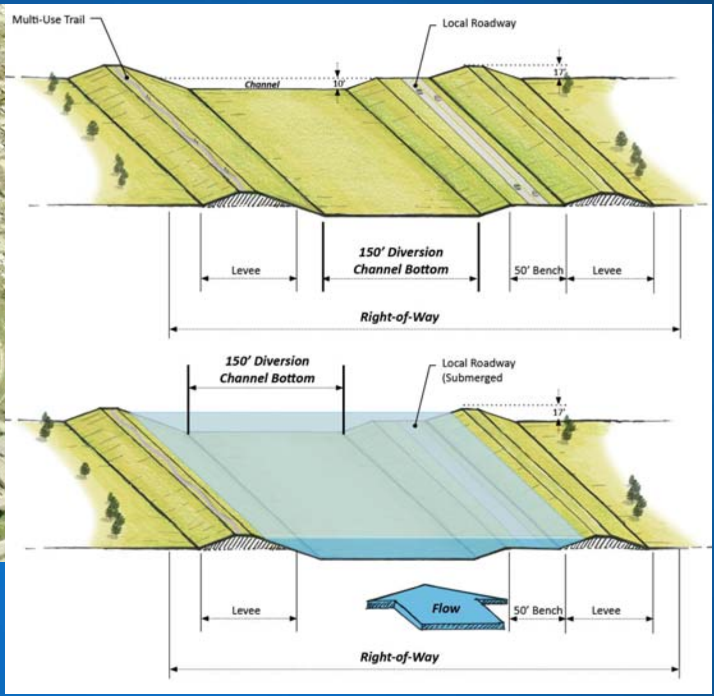


Preliminarily alignment contains 2 ¼ miles of floodwalls in Minot

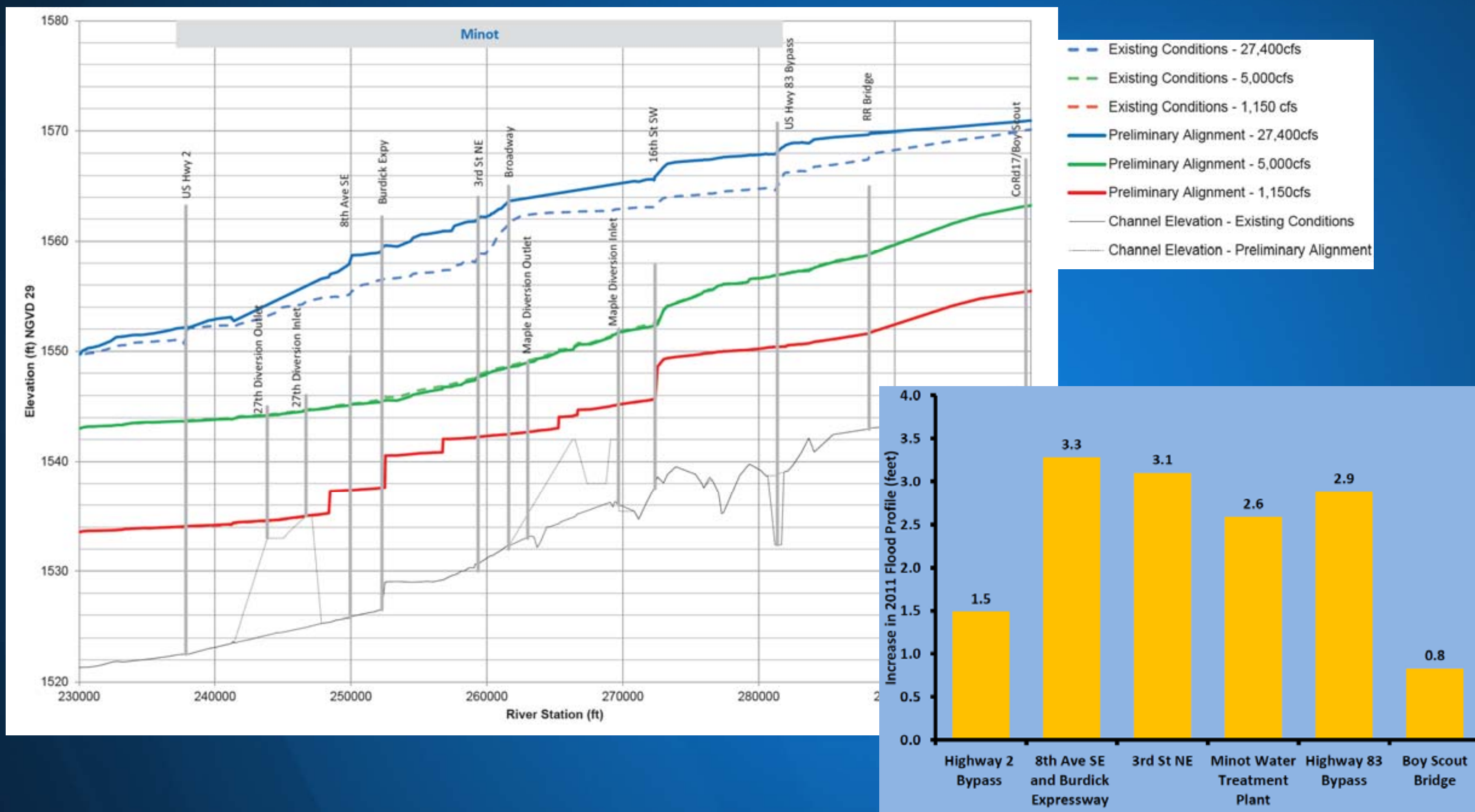
Item	Units	Reaches Upstream of Minot	Reaches Through Minot	Reaches Downstream of Minot	All Project Reaches
Length of Levee	feet	1,100	**11,800**	2,000	14,900



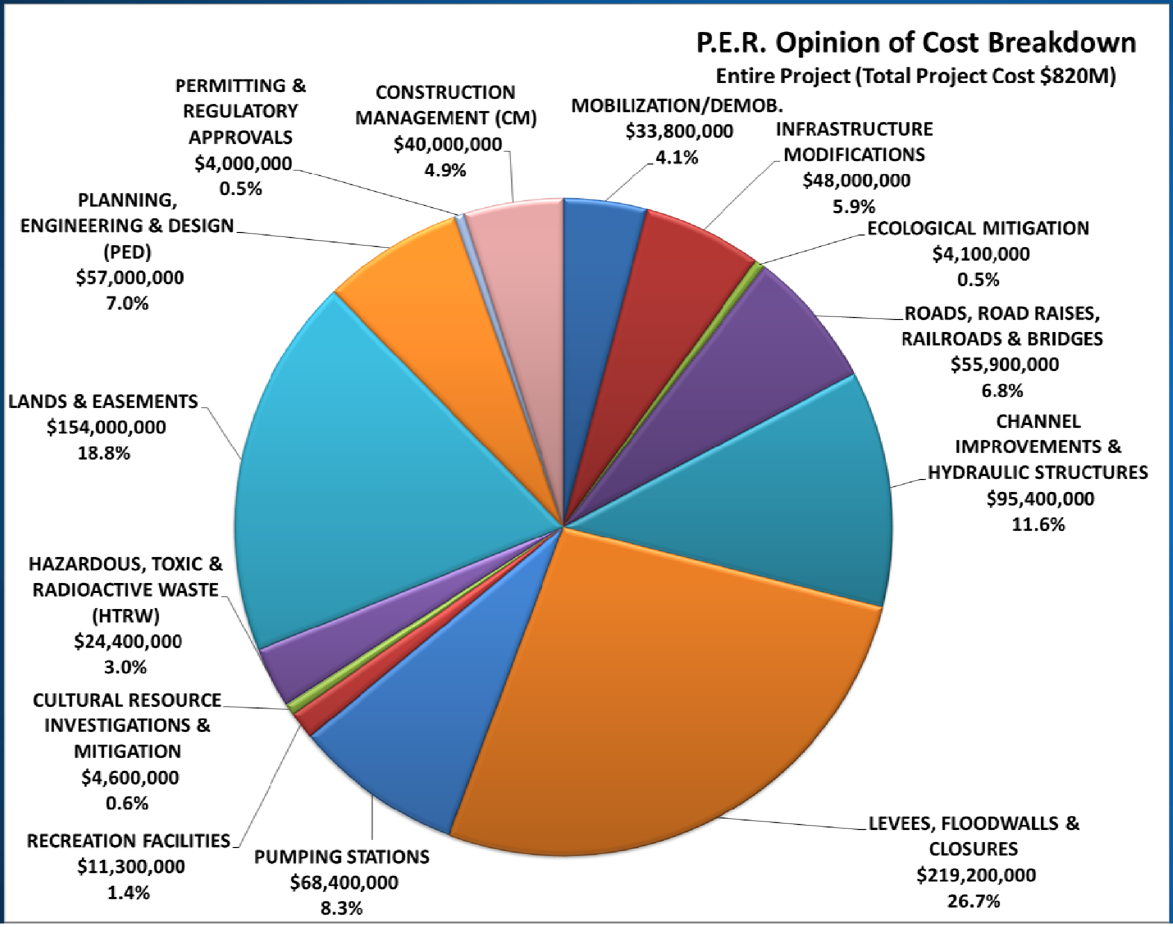
Preliminarily alignment contains 2 high flow diversions in Minot



Preliminary alignment will increase 2011 flood profile



Opinion of Probable Cost – Part 1
$820 Million (Burlington to Velva & MRP)



Developing Part 2 (Rural Reaches)
Rural Workshop February 16, 2012

- Identify issues for flow rate ranges
  - 500 cfs, 1,500, 3,000, 5,000, >7,000
- Discuss timing of dam releases
- Discuss infrastructure issues
- Discuss perceived impacts of wildlife refuges
- Discuss county-specific issues
  - Renville Co: Transportation
  - Ward Co.: Rural Subdivisions
  - McHenry Co.: Cropland and Hayland flooding & Sedimentation
  - Bottineau Co.: Conveyance

Developing Part 2 (Rural Reaches)
Rural Workshop February 16, 2012

Agricultural Impacts

Flow Classification	Velva Area (cfs)	Towner Area (cfs)
Bankfull	1,500	500
Problematic	3,000	3,000
Catastrophic	10,000	10,000

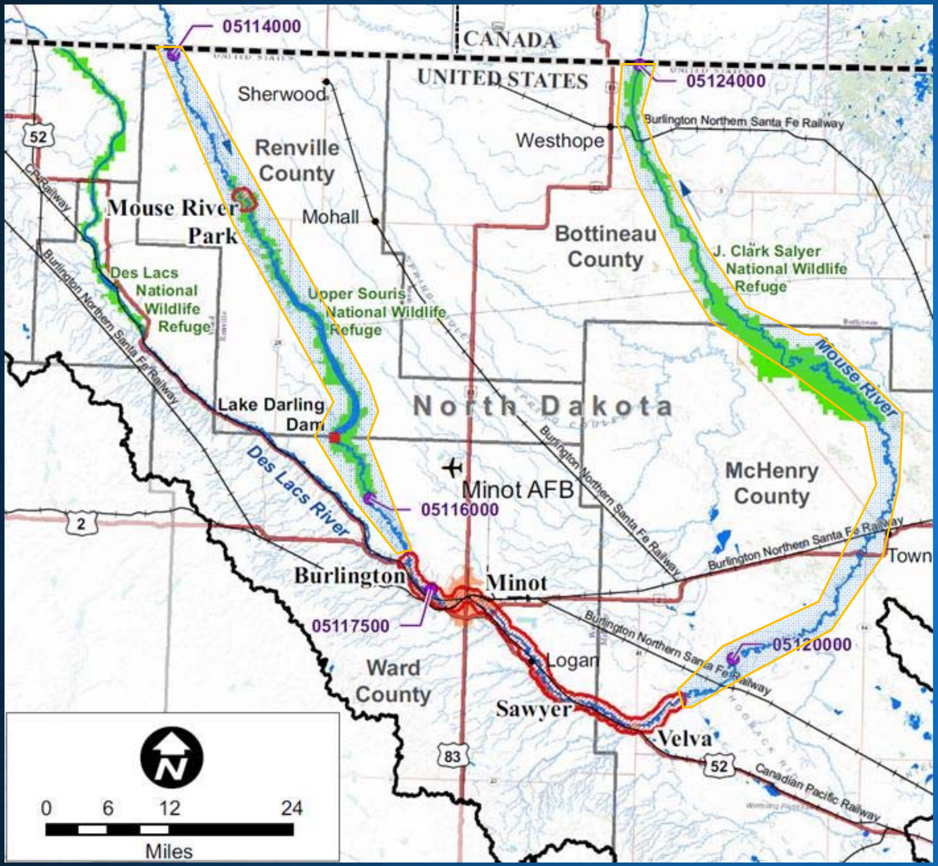
Infrastructure Impacts

Flows (cfs)	Degree of Severity
2,000 to 5,000	Manageable and relatively minor
5,000 to 7,000	Major
7,000 and up	Catastrophic

Target Flows at the Verendrye Gage

Date	Target Flow (or less)
May 1	1,500
May 30 through November 1	500

Developing Part 2 (Rural Reaches)



- Hydrologic and Hydraulic Modeling of Mouse River in ND
- Evaluation of 12 Alternatives to Reduce Flooding Impacts in Rural Areas
- Desktop Evaluation of Erosion and Sedimentation
- Ongoing Meetings and Coordination

Developing Part 2 (Rural Reaches)

Needed to obtain answers for three primary questions:

1. Is the alternative effective at reducing the risk of flood impacts? (impacts to agriculture and/or infrastructure)
2. Are there potential impacts to key resources or concerns if the alternative is implemented or constructed?
3. What is the relative cost of the alternative, as compared to the other alternatives?

Mouse River Rural Alternatives

	Effectiveness Assessment		Implementation Evaluation		
Alternative	Agricultural Impact Reduction	Infrastructure Impact Reduction	Overall Imple-mentability	Greatest Challenges	Anticipated Cost Range
ALTERNATIVE 1 Advanced Discharge from Lake Darling	Effective at reducing duration of inundation from Velva to Bantry during 1999 and 2001 floods; also somewhat effective for the 1975 and 1979 floods	Minor reduction of impacts for other select floods		Concerns about increased winter discharges; requires modification of Annex A; possible water rights and refuge compatibility issues	$ Minimal capital cost
ALTERNATIVE 2 Increased Target Discharge at Minot	Minor reduction of impacts for the 2011 flood; effective at reducing duration of inundation from Velva to Bantry for the 1975, 1976, and 1979 floods	Minor reduction of impacts for the 2011 flood; infrastructure impacts worsened for the 1975, 1976, and 1979 floods		Increased inundation for some floods; more homes in 100-year floodplain; possible water rights and refuge compatibility issues	$ Minimal capital cost
ALTERNATIVE 3 Non-Structural Flood Storage Increase in Lake Darling	Effective at reducing duration of inundation from Velva to Bantry for the 1970, 1974, 1975, 1976, and 1979 floods	Minor reduction of impacts for other select floods		Concerns about increased winter discharges; requires modification of Annex A; possible water rights and refuge compatibility issues (more so than Alternative 1)	$ Minimal capital cost

Mouse River Rural Alternatives

	Effectiveness Assessment		Implementation Evaluation		
Alternative	Agricultural Impact Reduction	Infrastructure Impact Reduction	Overall Imple-mentability	Greatest Challenges	Anticipated Cost Range
ALTERNATIVE 4 Structural Flood Storage Increase in Lake Darling	Minor reduction of impacts for the 2011 flood	Minor reduction of impacts for the 2011 flood	✗	Relocations, cost, coordination with Canada, recreational concerns	$$$ ($200-700 million)
ALTERNATIVE 5 Ring Dikes ☆	No agricultural impact reduc-tion (ring dikes only protect structures)	Effective at reducing impacts to buildings for floods up to the 2011 magnitude flood, but no reduction of impacts to roadways, railroads, or bridges	✓	Individual landowners must provide cost share and con-duct maintenance	$$ ($10-50 million)
ALTERNATIVE 6 Boundary Diversion	Effective at reducing impacts for the 2011 flood in all reaches	Effective at reducing impacts for the 2011 flood in all reaches	✗	Major negative impacts likely for many of the criteria, including permits, impacts to Canada, relocations, constructability	$$$$ ($2-8 billion)

Mouse River Rural Alternatives

	Effectiveness Assessment		Implementation Evaluation		
Alternative	Agricultural Impact Reduction	Infrastructure Impact Reduction	Overall Imple-mentability	Greatest Challenges	Anticipated Cost Range
ALTERNATIVE 7: Channelization Improvements Downstream of Velva	Minor reduction of impacts	For the Velva to Bantry reach, effective at reducing impacts to buildings for the 2009 flood; minor reductions in impacts to roadways and railroads for the 2009, 2010, and 2011 floods	✗	Likely difficulty in obtaining USACE permit for channel excavation	$$ ($100-400 million)
ALTERNATIVE 8 Bridge Modifications	Minor reductions of impacts	Effective at reducing impacts to bridges, but minor or no reduction of impacts to buildings, roadways, or railroads	✓	Some environmental and erosion/sedimentation impacts	$$ ($30-100 million)
ALTERNATIVE 9 Modify JCSNWR Dam Operations	Minor reduction of impacts for the 2010 flood in the Bantry to Westhope reach	Minor reduction of impacts to roadways and railroads for the 2010 flood in the Bantry to Westhope reach	✗	Likely difficulty in obtaining USFWS and USACE permits; compatibility issues with refuge missions	$ Minimal capital cost

Mouse River Rural Alternatives

	Effectiveness Assessment		Implementation Evaluation		
Alternative	Agricultural Impact Reduction	Infrastructure Impact Reduction	Overall Imple-mentability	Greatest Challenges	Anticipated Cost Range
ALTERNATIVE 10 Modify JCSNWR Hydraulic Structures	Minor reduction of impacts for the 2009, 2010, and 2011 floods in the Bantry to Westhope reach	Minor reduction of impacts for the 2009, 2010, and 2011 floods in the Bantry to Westhope reach		Likely difficulty in obtaining USFWS and USACE permits; compatibility issues with refuge missions	$$ ($30–100 million)
ALTERNATIVE 11 Remove Trapped Water after the Flood Recedes	Impact reduction is likely if (1) topography allows the trapped water to be conveyed back to the channel by gravity and (2) elevation of the river has receded below the drain outlet by approximately May 31	Minimal reduction of impacts expected; de-pends on final locations implemented		Concerns about erosion downstream of culverts; ongoing maintenance to maintain effectiveness	$ ($3-10 million)
ALTERNATIVE 12 Flood Storage on Tributaries to the Mouse River	50% and 70% reduction scenarios are effective at re-ducing inundation during the 2009 and 2010 floods	50% and 70% reduction scenarios are effective at reducing inundation dur-ing the 2009 and 2010 floods		Site identification; possible difficulty in obtaining permits	$$ ($10-340 million)

Mouse River Rural Alternatives

- Evaluation of 12 Alternatives

	Effectiveness Assessment		Implementation Evaluation		
Alternative	Agricultural Impact Reduction	Infrastructure Impact Reduction	Overall Imple-mentability	Greatest Challenges	Anticipated Cost Range
ALTERNATIVE 1 Advanced Discharge from Lake Darling ★	Effective at reducing duration of inundation from Velva to Bantry during 1999 and 2001 floods; also somewhat effective for the 1975 and 1979 floods	Minor reduction of impacts for other select floods	✔	Concerns about increased winter discharges; requires modification of Annex A; possible water rights and refuge compatibility issues	$ Minimal capital cost
ALTERNATIVE 2 Increased Target Discharge at Minot	Minor reduction of impacts for the 2011 flood; effective at reducing duration of inundation from Velva to Bantry for the 1975, 1976, and 1979 floods	Minor reduction of impacts for the 2011 flood; infrastructure impacts worsened for the 1975, 1976, and 1979 floods	✖	Increased inundation for some floods; more homes in 100-year floodplain; possible wa… compati…	$ Minimal capital cost
ALTERNATIVE 3 Non-Structural Flood Storage Increase in Lake Darling ★	Effective at reducing duration of inundation from Velva to Bantry for the 1970, 1974, 1975, 1976, and 1979 floods	Minor reduction of impacts for other select floods	!	C… …nter d… modification of Annex A, possible water rights and refuge compatibility issues (more so than Alternative 1)	capital cost
ALTERNATIVE 4 Structural Flood Storage Increase in Lake Darling	Minor reduction of impacts for the 2011 flood	Minor reduction of impacts for the 2011 flood	✖	Relocations, cost coordination with Canada, recreational concerns	$$$ ($200-700 million)
ALTERNATIVE 5 Ring Dikes ★	No agricultural impact reduction (ring dikes only protect structures)	Effective at reducing impacts to buildings for floods up to the 2011 magnitude flood, but no reduction of impacts to roadways, railroads, or bridges	✔	Individual landowners must provide cost share and conduct maintenance	$$ ($10-50 million)
ALTERNATIVE 6 Boundary Diversion	Effective at reducing impacts for the 2011 flood in all reaches	Effective at reducing impacts for the 2011 flood in all reaches	✖	Major negative impacts likely for many of the criteria, including permits, impacts to Canada, relocations, constructability	$$$$ ($2-8 billion)

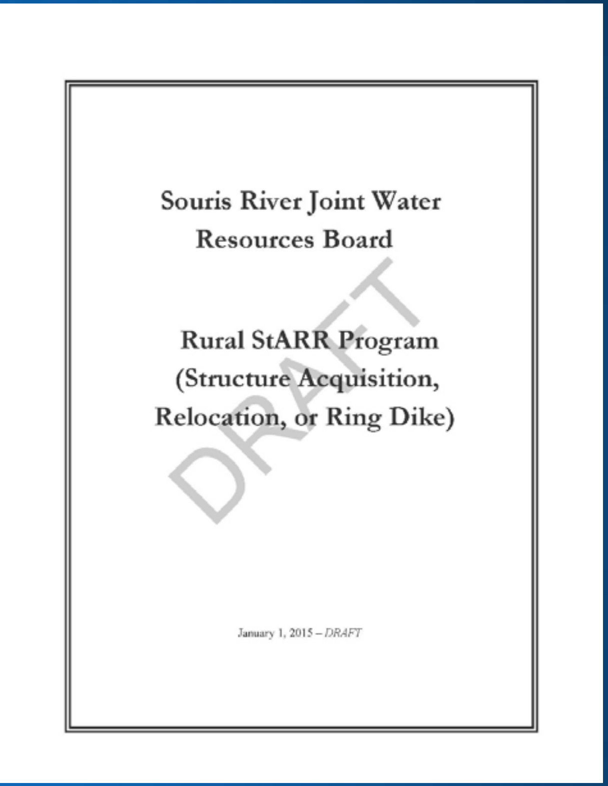
StARR Program

	Effectiveness Assessment		Implementation Evaluation		
Alternative	Agricultural Impact Reduction	Infrastructure Impact Reduction	Overall Imple-mentability	Greatest Challenges	Anticipated Cost Range
ALTERNATIVE 7: Channelization Improvements Downstream of Velva	Minor reduction of impacts	For the Velva to Bantry reach, effective at reducing impacts to buildings for the 2009 flood; minor reductions in impacts to roadways and railroads for the 2009, 2010, and 2011 floods	✖	Likely difficulty in obtaining USACE permit for channel excavation	$$ ($100-400 million)
ALTERNATIVE 8	Minor reductions of impacts	Effective at reducing impacts to bridges, but minor or no reduction of impacts to buildings, roadways, or railroads	✔	Some environmental and erosion/sedimentation impacts	$$ ($30-100 million)
Modify JCSNWR Dam Operations	…for the 2010 flood in the Bantry to Westhope reach	Minor reduction of impacts to roadways and railroads for the 2010 flood in the Bantry to Westhope reach	✖	Likely difficulty in obtaining USFWS and USACE permits; compatibility issues with refuge missions	$ Minimal capital cost
ALTERNATIVE 10 Modify JCSNWR Hydraulic Structures	Minor reduction of impacts for the 2009, 2010, and 2011 floods in the Bantry to Westhope reach	Minor reduction of impacts for the 2009, 2010, and 2011 floods in the Bantry to Westhope reach	✖	Likely difficulty in obtaining USFWS and USACE permits; compatibility issues with refuge missions	$$ ($30–100 million)
ALTERNATIVE 11 Remove Trapped Water after the Flood Recedes	Impact reduction is likely if (1) topography allows the trapped water to be conveyed back to the channel by gravity and (2) elevation of the river has receded below the drain outlet by approximately May 31	Minimal reduction of impacts expected; depends on final locations implemented	✔	Concerns about erosion downstream of culverts; ongoing maintenance to maintain effectiveness	$ ($3-10 million)
ALTERNATIVE 12 Flood Storage on Tributaries to the Mouse River	50% and 70% reduction scenarios are effective at reducing inundation during the 2009 and 2010 floods	50% and 70% reduction scenarios are effective at reducing inundation during the 2009 and 2010 floods	!	Site identification; possible difficulty in obtaining permits	$$ ($10-340 million)

StARR Program Overview

StARR Program Document and Rules Currently in DRAFT Form

- Modifications Based on Input from Rural Residents
- Modifications Based on Input from Funding Agencies
- Final Policy Determination by Souris River Joint Board


Souris River Joint Water Resources Board

Rural StARR Program (Structure Acquisition, Relocation, or Ring Dike)

DRAFT

January 1, 2015 – *DRAFT*

StARR Program Overview

SRJB Will Provide Financial and Technical Assistance to:

- Remove Structures from 2011 Flood Plain
  - Purchase and Demolition (Acquisition)
  - Relocation to Higher Ground
- Protect Structures within 2011 Flood Plain
  - Construction of Ring Dikes
  - Will not Remove Requirement for Flood Insurance

StARR Program Overview

Land Owners Will Agree to:

- Provide Access to the Property
  - Right of Entry Agreement
- Prevent Construction of Future Structures within 2011 Flood Plain
  - Funding Agency Requirements
  - No-Build Easements, Deed Restrictions, etc.
  - Acquisition of Property in Some Circumstances

StARR Program Overview

The Process:

1. Contact by Interested Land Owner / Right of Entry Authorized
2. Determine Eligibility of Structure(s)
   - In 2011 Flood Plain, In 100-Year Flood Plain, Previously Abandoned, etc.
3. Appraisals of Structure(s)
   - Establishes Maximum Participation from SRJB
4. Selection of Risk Reduction Method (Acquisition, Relocation, Ring Dike)
5. Implementation and Closing

StARR Program Overview

Current Unknowns:

- Final Policy Determination
  - Input from Stakeholders
  - Input from Funding Agencies (SWC, Minot, etc.)
  - Action by SRJB
- Local Cost Share
  - There will be a local cost share requirement (5%-25%)
  - SRJB is working to minimize local cost share through ongoing work with funding agencies (SWC, Minot, County Commissions, etc.)

StARR Program Overview

Preliminary Schedule:

- Rights of Entry Secured by May 2015
- USACE / Silver Jackets Field Work Completed August 2015
- USACE / Silver Jackets Final Report Completed October 2015
- Final Policy Determination October 2015
- Implementation Start November 2015
- Implementation Complete November 2017

StARR Program Status

http://gis.ackerman-estvold.com/apps/starr/

Questions?

[redacted]

USACE Nonstructural Flood Proofing Workshop

NFPC and Nonstructural Mitigation Overview

by Randall Behm
USACE - Omaha District
Chair, National Nonstructural Flood Proofing Committee

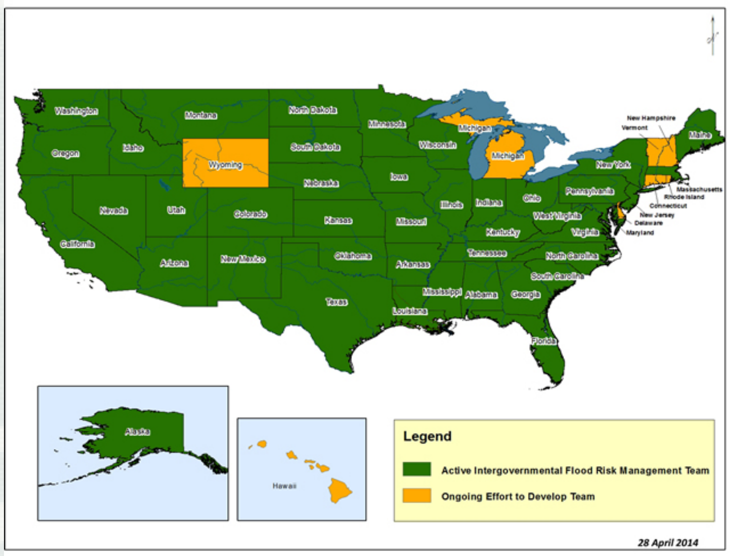
US Army Corps Of Engineers
Nonstructural - Flood Proofing
National Nonstructural / Flood Proofing Committee

BUILDING STRONG®

Silver Jackets State Team Development

The Silver Jackets program provides a formal and consistent strategy for an interagency approach to planning and implementing measures to reduce the risks associated with flooding and other natural hazards

- 44 Active Interagency Teams
- USACE Support:
  - USACE Authorities
  - Collaborative access to additional agency programs and authorities
  - Interagency and Peer networking: SJ Website, Newsletter, Annual Workshops, Periodic Webinars with Partner Agencies



Silver Jackets Website http://www.nfrmp.us/state/index.cfm

USACE Nonstructural Flood Proofing Committee

Committee Members and Advisors

The USACE National Nonstructural Flood Proofing Committee (NFPC) was established during 1985 to support nonstructural mitigation activities within USACE. The NFPC functions under the general direction of the Chief, Planning Community of Practice, Directorate of Civil Works, HQUSACE. Currently the NFPC consists of four active multidisciplinary members and four advisors.

Members

- **Chair: Randall Behm, Omaha District**
- **Secretary: Kim Gavigan, Los Angeles District**
- **Steve O'Leary, Huntington District**
- **Keven Lovetro, New Orleans District**

Advisors

- **Robert Finch, Honolulu District**
- **Mary Weidel, Detroit District**
- **Lea Adams, Hydrologic Engineering Center**
- **Brian Rast, Kansas City District**

National Nonstructural Flood Proofing Committee

web site: http://www.nwo.usace.army.mil/nfpc/

email NFPC committee: dll-cenwo-nfpc@usace.army.mil

Publications
Digital Nonstructural Video
Charts and Graphs
Photographs
Technical Support
National Flood Barrier Testing Program
USACE Program Authorities

USACE District Contact Information http://www.usace.army.mil/Locations.aspx

National Flood Barrier Testing & Certification Program

The **Association of State Flood Plain Managers (ASFPM),** in partnership with **FM Approvals** and the **USACE National Nonstructural Flood Proofing Committee (NFPC)** are implementing a National program of testing and certifying flood barrier products used for flood proofing and flood fighting. This program currently tests barrier products in two broad categories, **Temporary Flood Barriers** and **Closure Devices**.

The purpose of this Program is to provide an unbiased process of evaluating products in terms of resistance to water forces, material properties, and consistency of product manufacturing. This will be accomplished by testing the product against water related forces in a laboratory setting, testing the product against material forces in a laboratory setting, and periodic inspection of the product manufacturing process for consistency of product relative to the particular product that received the original water and material testing.

web: http://nationalfloodbarrier.org/

Nonstructural Flood Risk Management Definition

Nonstructural flood risk management can be categorized as a set of **physical** or **nonphysical** measures utilized for mitigating loss of life as well as existing and future flood damages.

The physical measures adapt to the natural characteristics of the floodplain without adversely affecting or changing those natural flood characteristics. These measures are generally compliant with the NFIP and cause no adverse affects to the floodplain, flood stages, velocities, or the environment.

Because of their ability to adapt to flood risk, these measures may also be referred to as **Flood Risk Adaptive Measures (FRAM)** and can be incorporated into existing or new structures to mitigate for potential future flood damages and life loss.

Definitions

Nonstructural: Measures such as elevation, relocation, and flood proofing adapt to the natural floodplain without changing flood characteristics.

FRAM: Flood Risk Adaptive Measures

Structural: Measures such as levees, dams and channel modifications tend to change the characteristics of flooding, by altering the frequency of flooding.

North Dakota Flooding; Deep, Fast, and Dangerous

BUILDING STRONG®

Is this the new Norm?

($38B - $54B Annually 2006-2013 or $10B annually 1985-2013)

Hurricane Sandy

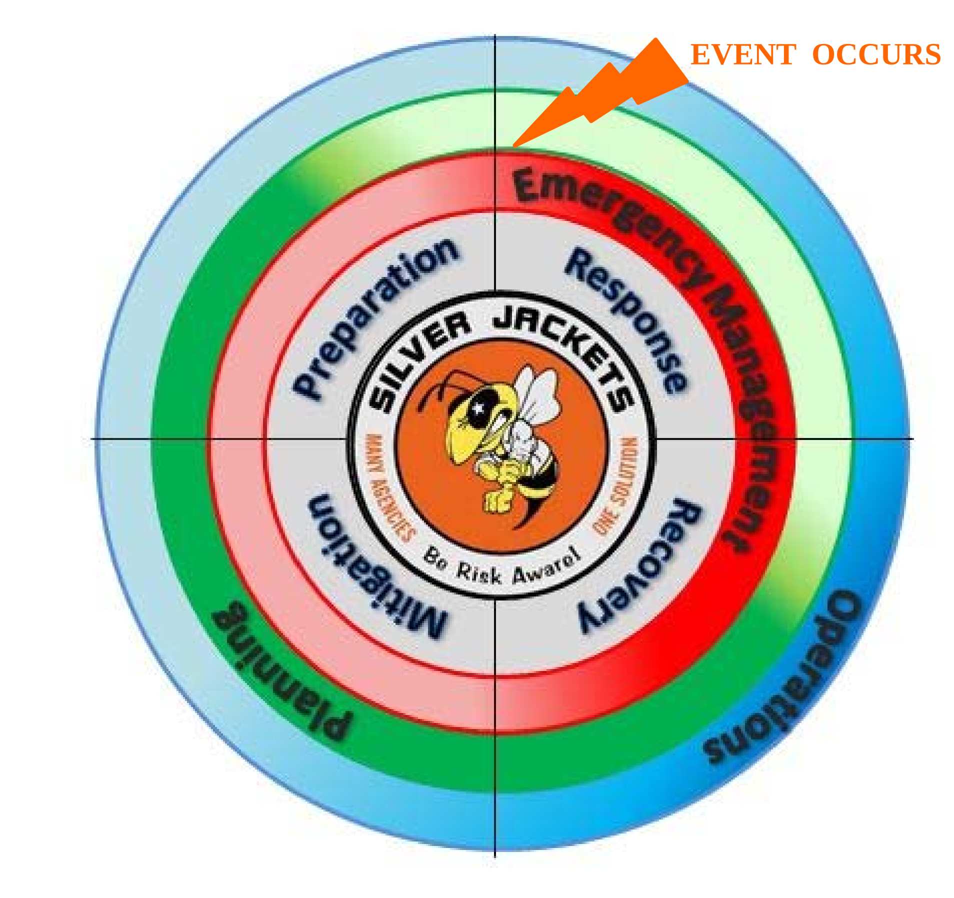
Colorado Flooding

Hurricane Katrina

Missouri River Flooding

BUILDING STRONG®

Disaster Merry-Go-Round



The Cycle will always exist, but to what extent is our purpose

BUILDING STRONG®

Flood Risk

Risk = *f* [(Probability of Flooding) x (Consequences)]

(Probability of Flooding) is the frequency of flooding or how often does flooding occur in a particular location. Reduce the frequency of flooding and risk is reduced.

(Consequences) are the potential damages and life loss associated with flooding. The structures (critical, residential, commercial, public, and industrial), land use (agricultural, urban, public) , and infrastructure (highways, roads, rail, utilities) make up the potentially damageable assets. Reduce the consequences of flooding and risk is reduced.

Note: If critical facilities become inoperative during a flood event the area of severe impact extends beyond the area of flooding (electrical service, communications, water and wastewater, etc).

What is Risk?

The possibility of suffering harm or loss.

Uncertainty of probability of occurrence.

What is Risky Behavior???

BUILDING STRONG®

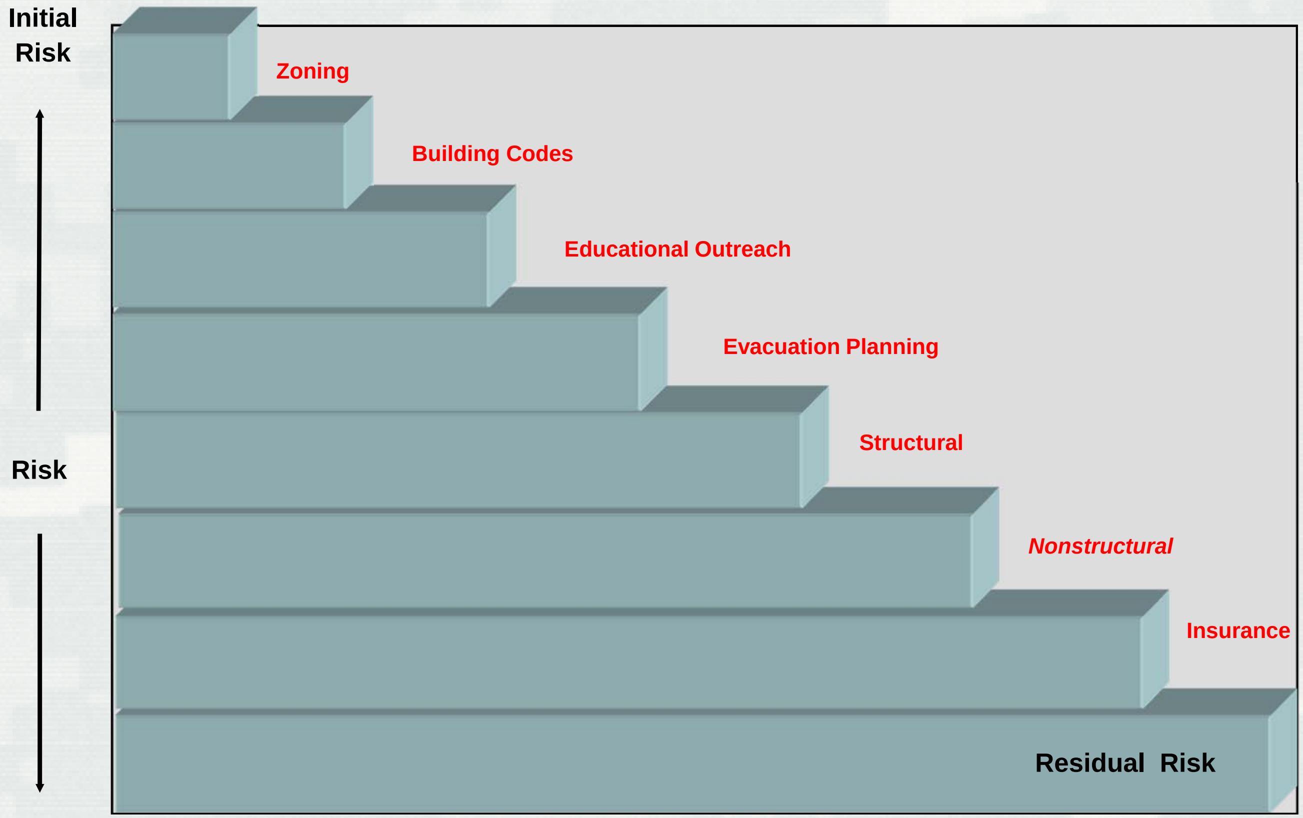
(Mis)Managing Flood Risk

Desperation Flood Response

Desperation Flood Proofing

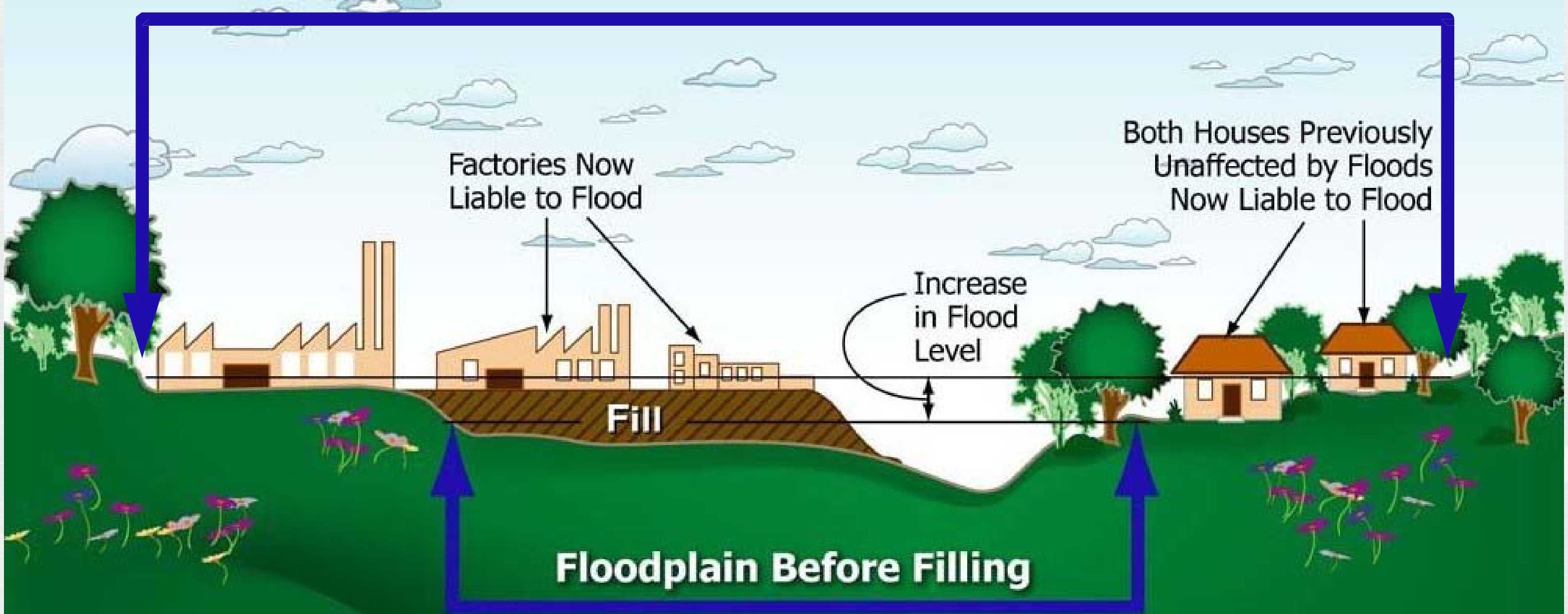
BUILDING STRONG®

Flood Risk = Probability of Flooding x Consequences



RISK REDUCTION TOOLS

Today's Floodplain
Is Not Necessarily Tomorrow's Floodplain

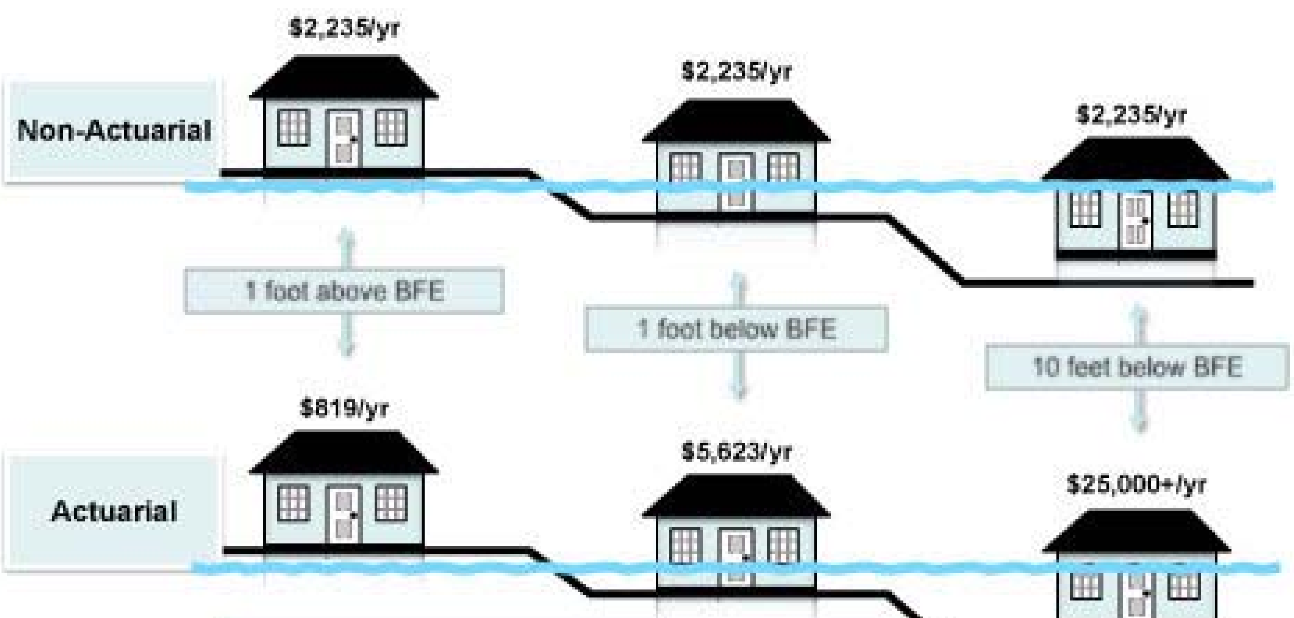


If large areas of the floodplain are filled, then there will be an increase in the land area needed to store flood waters.

This means your home or business may be impacted.

NFIP Rating Examples:
The Impact of Loss of Subsidies

Rate comparisons



Building- $200,000 Contents- $80,000 (2012 Rates)

BW-12 and Rebuilding Decisions

Elevation lowers premiums.

ZONE A" EXAMPLE

Under the Flood Insurance Reform Act of 2012, You Could Save More than $90,000 over 10 Years if You Build 3 Feet above Base Flood Elevation*

PREMIUM AT 4 FEET BELOW BASE FLOOD ELEVATION	PREMIUM AT BASE FLOOD ELEVATION	PREMIUM AT 3 FEET ABOVE BASE FLOOD ELEVATION
$9,500/year	$1,410/year	$427/year
$95,000/10 years	**$14,100/10 years**	**$4,270/10 years**

*$250,000 building coverage only (does not include contents), AE (high to moderate risk) zone, single-family, one-story structure without a basement at: 4 feet below Base Flood Elevation (BFE); at BFE; and at 3 feet above BFE. (Rating per FEMA flood insurance manual, October 1, 2012). The illustration above is based on a standard National Flood Insurance Program (NFIP) deductible.

FEMA

Nonstructural Flood Risk Adaptive Measures

- Elevation
- Relocation
- Buyout/Acquisition
- Wet Flood Proofing
- Dry Flood Proofing
- Individual Berms/Floodwalls
- Basement Removal

Floodplain Management Measures

While the following measures do not result in modification to structures to have them adapt to the characteristics of a flood, these measures provide benefits to large scale areas dealing with recurring and problematic flooding.

Flood Warning System

A flood warning system, when properly installed and calibrated, is able to identify the amount of time available for residents to implement emergency measures to protect valuables or to evacuate the area during serious flood events.

Land Use Regulations

Land use regulations within a designated floodplain are effective tools in reducing flood risk and flood damage. Based in the national principles of the National Flood Insurance Program (NFIP) which requires minimum standards of floodplain regulation, land use regulations may identify where development can and cannot occur, or to what elevation structures should locate their lowest habitable floor.

Flood Emergency Preparedness Plans

Local governments, through collaboration with USACE, FEMA and other interested federal partners, are encouraged to develop and maintain a Flood Emergency Preparedness Plan (FEPP) that identifies flood hazards, risks and vulnerabilities, identifies and prioritizes mitigation actions, and encourages the development of local mitigation. The FEPP should incorporate the community's response to flooding, location of evacuation centers, primary evacuation routes, and post flood recovery processes.

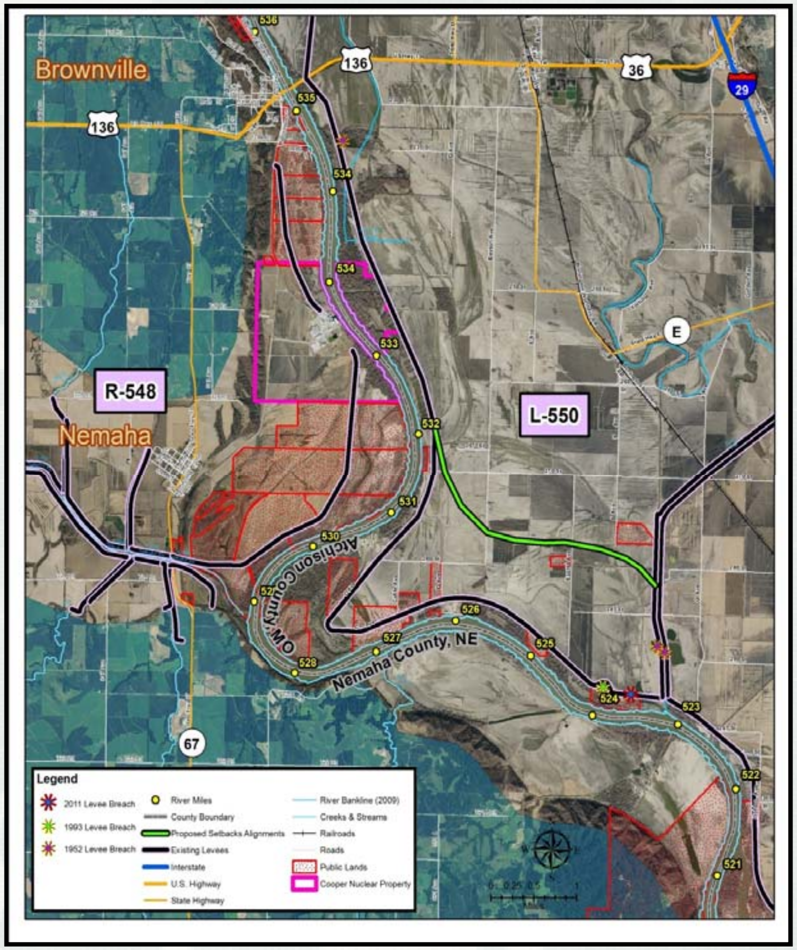
Flood Insurance (Biggert-Waters Flood Insurance Reform Act of 2012 / Homeowners Affordability Act 2014)

Flood insurance policies cover physical damage to property and possessions.

Floodplain Evacuation (levee setback)

Target levee segments which have encountered repetitive flood damages

- **Reduces Flood Stages**
- **Reduces Erosive Velocities**
- **Increases System Reliability**
- **Increases System Sustainability**
- **Restores Historic Floodplain**
- **Increases Habitat Benefits**
- **Potentially Economically Feasible when compared to Repairs In-Place**



* Caution Caution Caution *

While nonstructural flood risk adaptive measures <u>may</u> result in lower property damages, there could be potential restrictions which the property owner <u>needs</u> to investigate prior to implementation:

- **Local Ordnances**
- **State Regulations**
- **National Flood Insurance Program (NFIP)**

Not all of the methods shown in this workshop will comply with local code or the NFIP minimum requirements and may not be creditable for flood insurance savings. USACE is focusing on <u>damage reduction</u>.

Flood insurance is always recommended, even for structures which may have been retrofitted with nonstructural measures

NFPC and Nonstructural Mitigation Overview

Questions

Comments

[redacted]

USACE Nonstructural Flood Proofing Workshop

Overview of Nonstructural Techniques

by Mary Weidel

Detroit District

National Nonstructural Flood Proofing Committee Advisor

Nonstructural Flood Proofing Measures For Flood Risk Reduction

Options:

1) Elevation
2) Acquisition / Buyout / Demolish
3) Relocation
4) Berms, Levees, and Walls
5) Dry flood proofing
6) Flood Warning & Emergency Evacuation Systems
7) National Flood Insurance Program
8) Flood Plain Management
9) Regulation of Flood Prone Land
10) More Stringent Regulations (NAI)

Elevation Methods

Options:

- ► **Elevation Utilizing Fill**
- ► **Extended Foundation Walls**
- ► **Slab on Grade**
- ► **Piers, Posts, and Columns**
- ► **Pilings**

Elevation…

…is one of the most common and effective methods used to prevent flooding of living space.

…should be designed by registered engineers or architects and constructed by qualified contractors

Elevation Methods

Utilizing Fill to Elevate

Elevation Methods

Extended Foundation Walls

- Not permitted in V Zones
- Not recommended in Coastal A Zones
- Not permitted in regulatory floodway
- Acceptable in A Zones

Elevation by Extended Foundation Wall

Elevation Using Segmented Piles

Elevation Using Piers, Posts & Columns

Acquisition / Buyout

Partnerships - Combination

New Use Ecosystem

NG STRONG®

Relocations

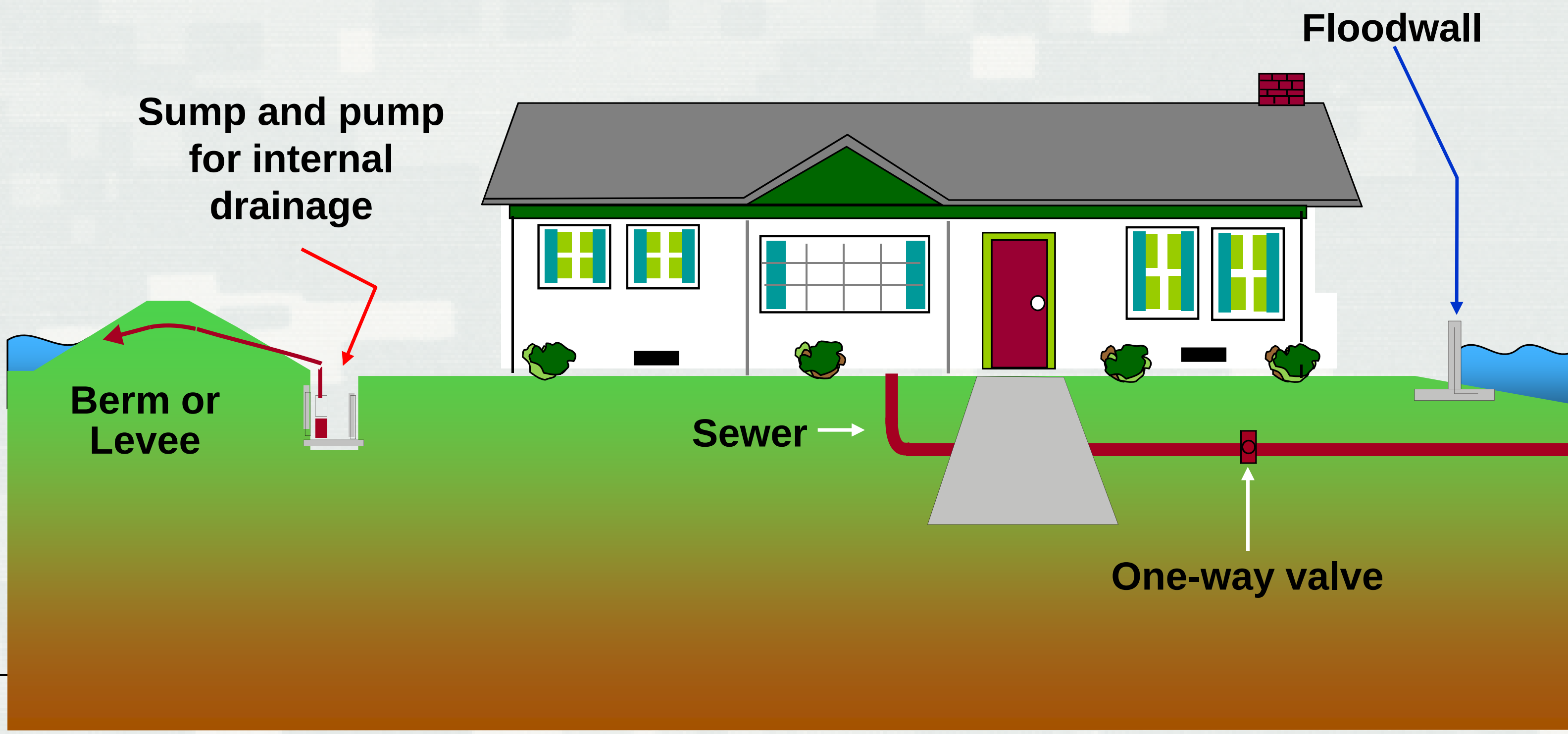
► Eliminates Risk

► New Use - Open Space

► Reduce Flood Insurance

NG STRONG®

Berms, Levees and Floodwalls



Levees / Berms

- ►Not FEMA Accredited
- ►Interior drainage
- ►Reduce Risk

Us Army Corps Of Engineers Nonstructural/ Flood Proofing National Nonstructural/ Flood Proofing Committee

Barriers / Walls

► **Closures & level of protection considerations**

Barriers / Walls

► Barriers/walls in action

► Understand Application

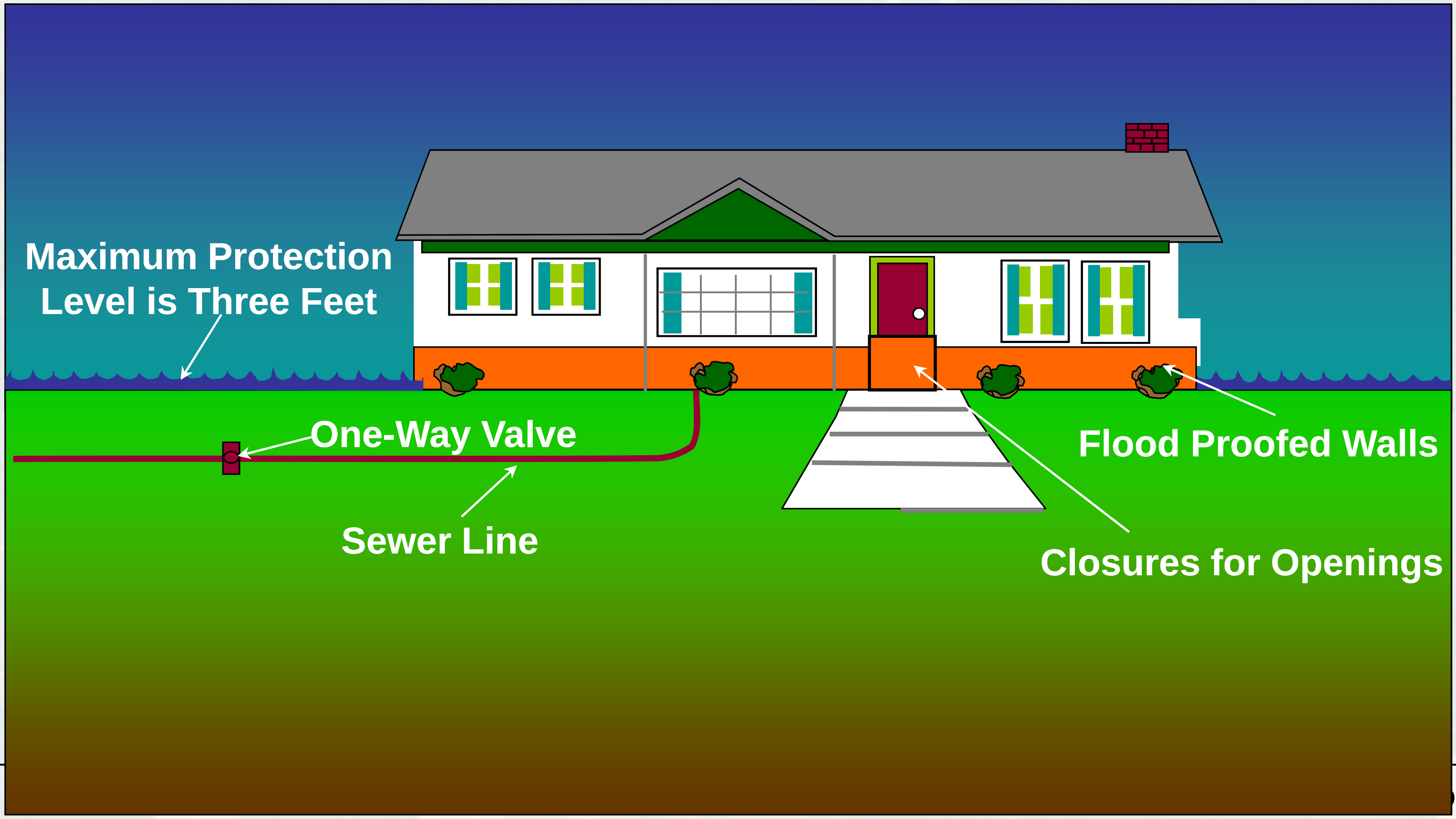
Dry Flood Proofing

This measure involves sealing the walls of a structure with waterproofing compounds, impermeable sheeting or other materials and using closures for covering and sealing openings from flood waters

Simply stated…Make the Structure Water Tight

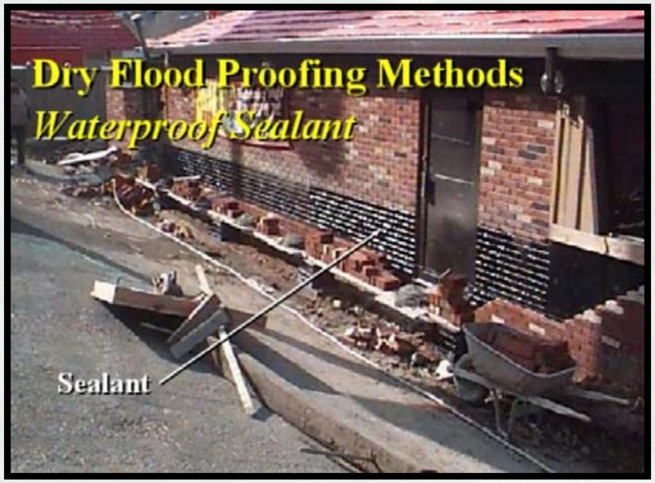
- **Flood depths 3 feet or less**
- **Structurally sound buildings**
- **New construction**
- **Retrofitting existing buildings**
- **No basement or crawl space**

Dry Flood Proofing



Dry Flood Proofing

Dry Flood Proofing



Wet Flood Proofing

" Permanent or contingent measures applied to a structure and/or it's contents that prevent or provide resistance to damage from flooding by allowing flood waters to enter the structure" FEMA TB 7-93

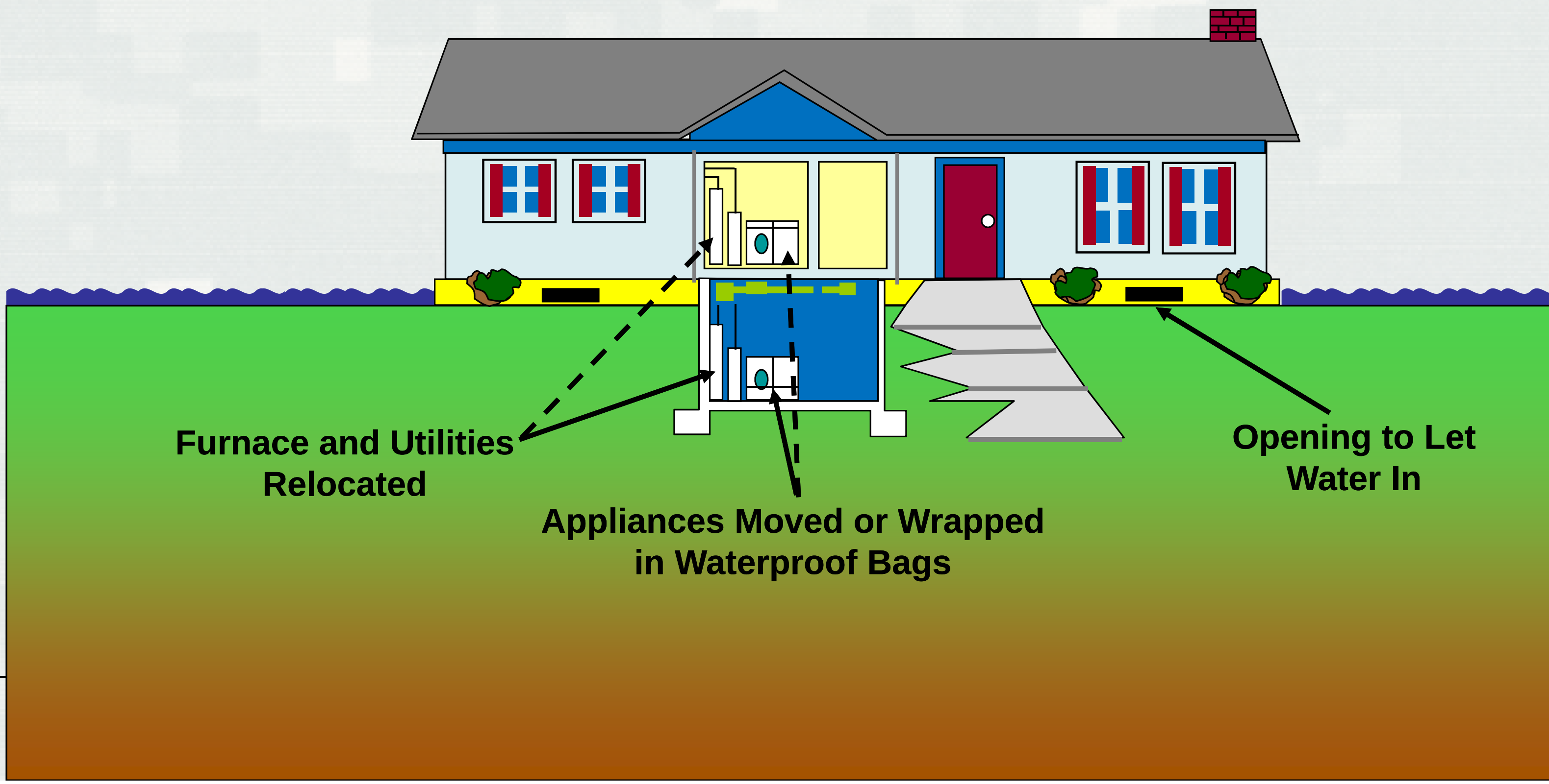
Use of this method is limited under the National Flood Insurance Program (NFIP):

- ► **Enclosed areas below the BFE that are used solely for parking, building access or limited storage**
- ► **Attached garages**

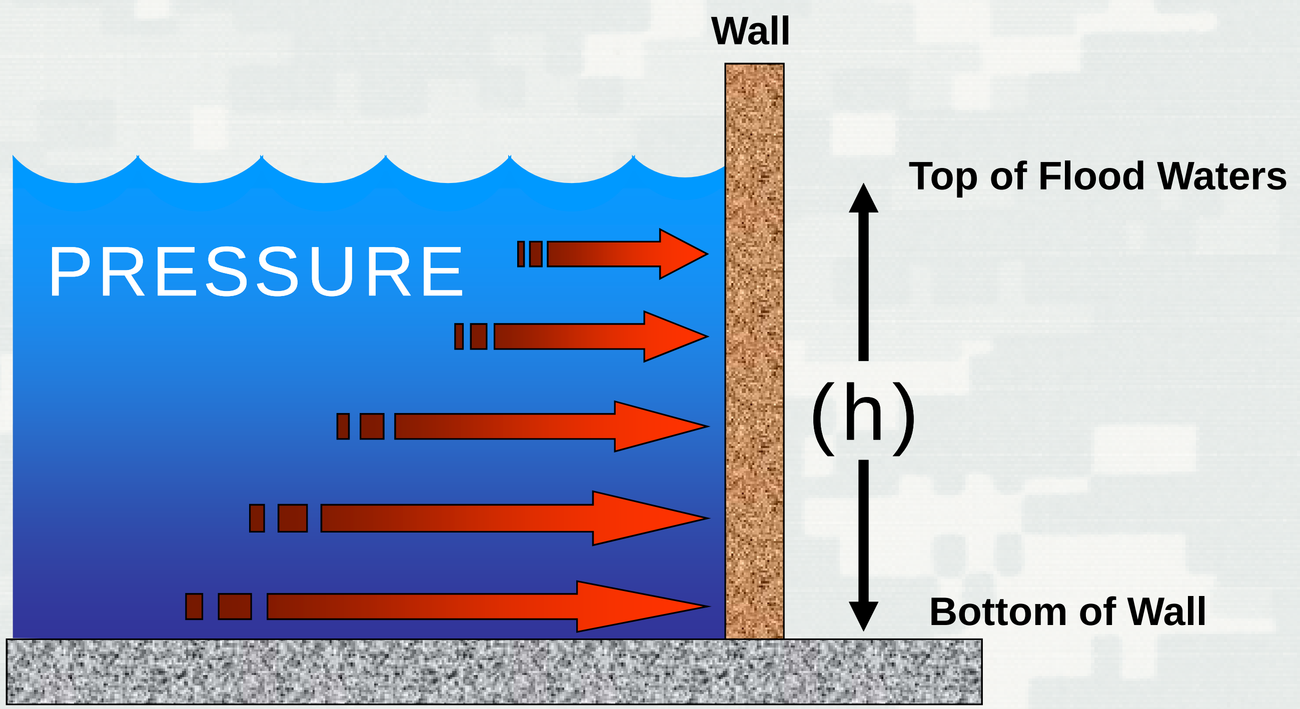
Variances may be issued for the following situations:

- ► **Structures functionally dependent on close proximity to water**
- ► **Historic buildings**
- ► **Accessory structures**
- ► **Certain agricultural structures**

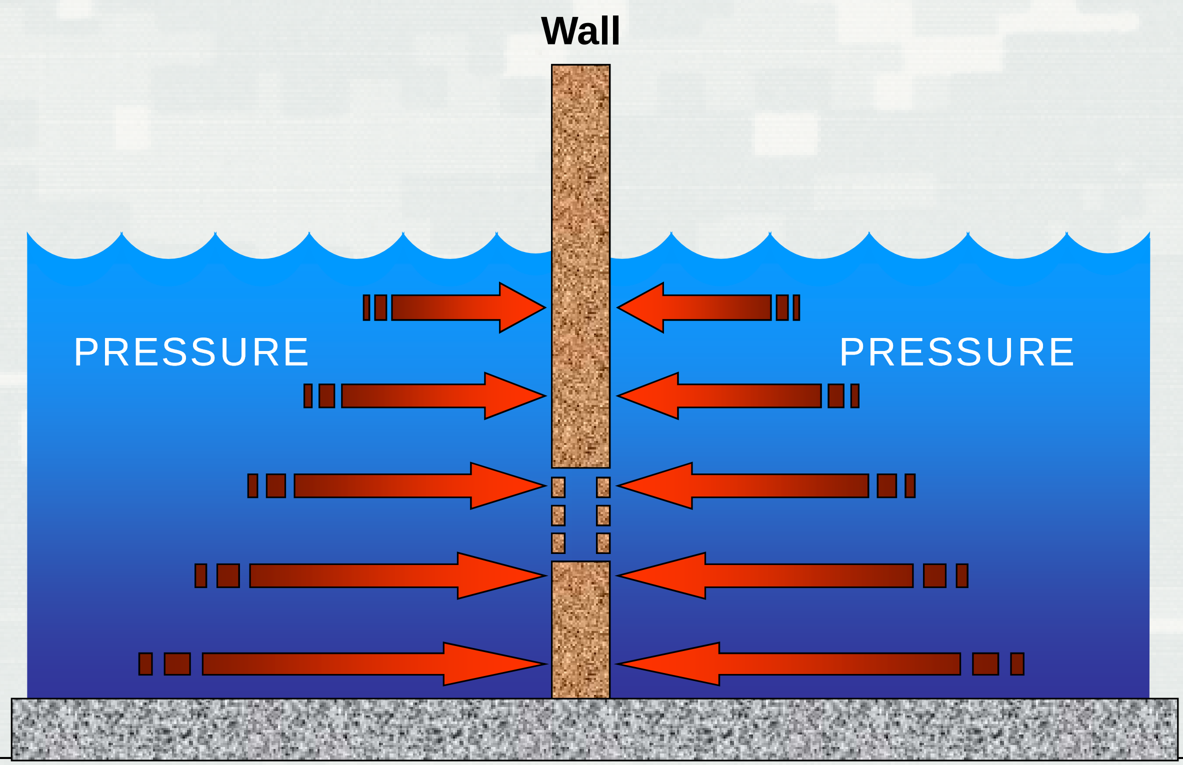
Wet Flood Proofing



Lateral Pressure Increases with Depth of Water (h)

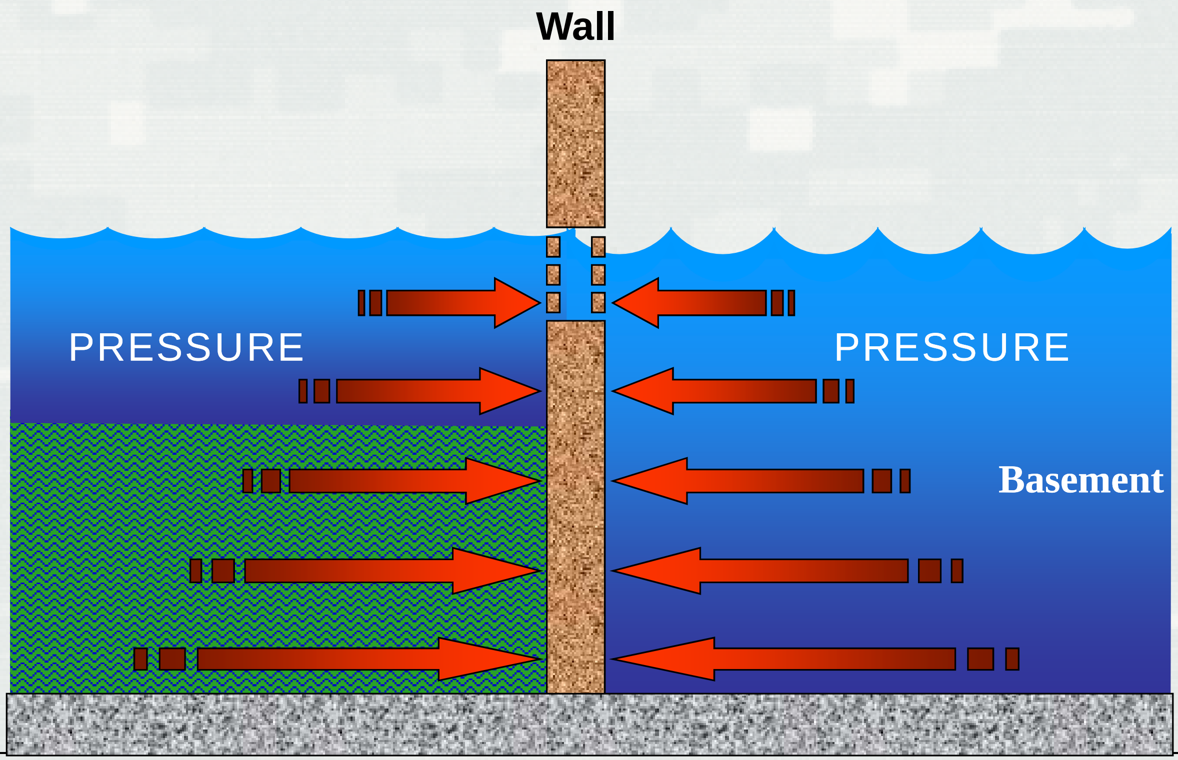


Wet Flood Proofing Equalizes Pressures on the Structure



BUILDING STRONG®

Wet Flood Proofing Equalizes Pressures on the Structure



Historic Areas

Flood Warning & Emergency Evacuation Plans

Warning Dissemination:

- ► Determine affected areas
- ► Identify affected parties
- ► Prepare warning message
- ► Distribute warning message
  - ► Weather radios
  - ► Media
  - ► Sirens
  - ► Public Education
  - ► Schools
  - ► Reverse 911

Flood Warning System – Flood Inundation Mapping

Who:

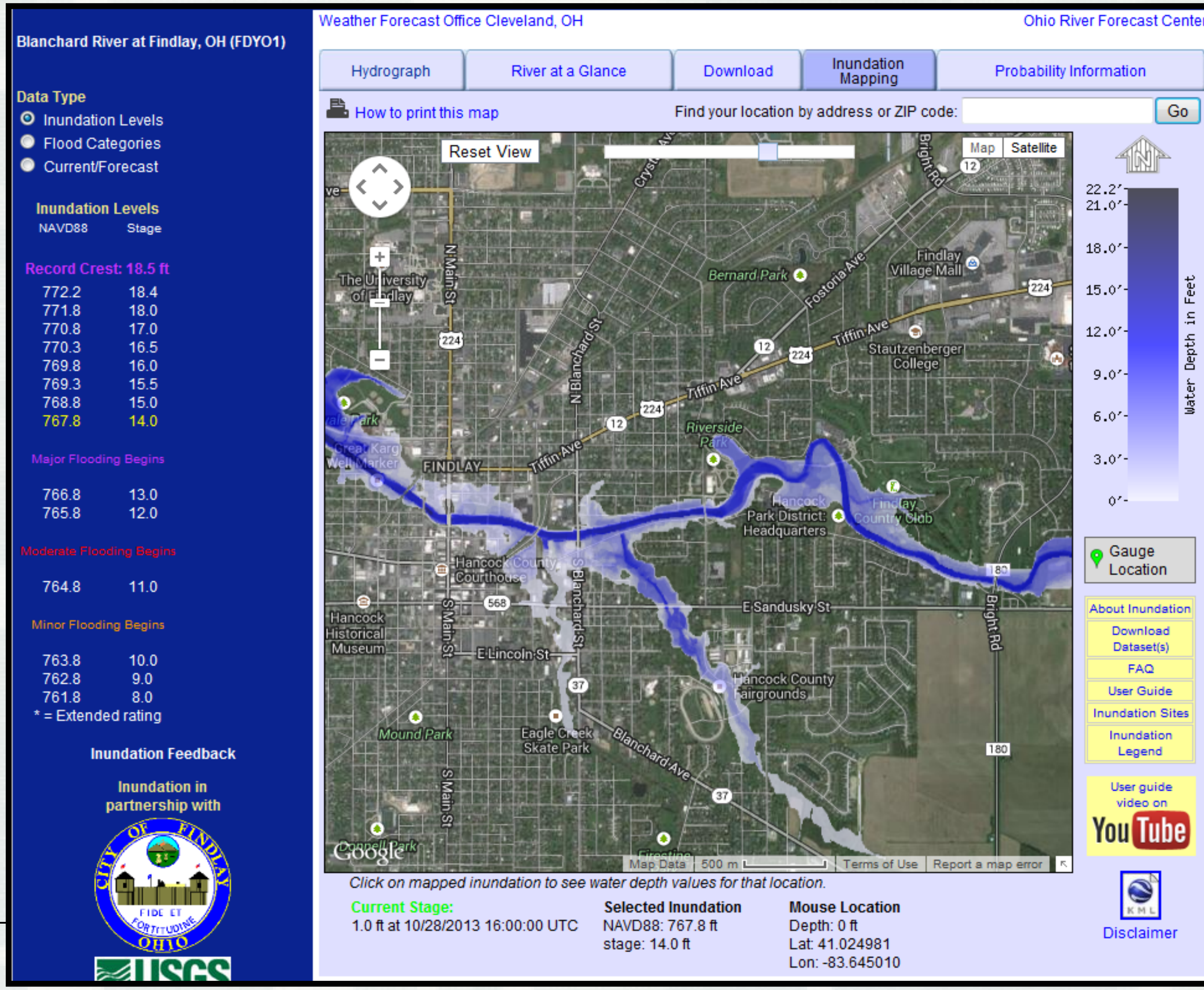
- ► Multi-agency Partnership: NOAA-NWS, USGS, State Agencies, Community
- ► USACE can assist

What:

- ► Creation of flood inundation maps through hydrologic analysis and hydraulic modeling
- ► Need USGS gage for this warning system

Flood Damages Savings:

- ► Warning of 24 hours can reduce damages up to 30%



Blanchard River at Findlay, OH (FDYO1)
Data Type
Inundation Levels
Flood Categories
Current/Forecast
Inundation Levels
NAVD88 Stage
Record Crest: 18.5 ft
772.2 18.4
771.8 18.0
770.8 17.0
770.3 16.5
769.8 16.0
769.3 15.5
768.8 15.0
767.8 14.0
Major Flooding Begins
766.8 13.0
765.8 12.0
Moderate Flooding Begins
764.8 11.0
Minor Flooding Begins
763.8 10.0
762.8 9.0
761.8 8.0
* = Extended rating
Inundation Feedback
Inundation in partnership with
Weather Forecast Office Cleveland, OH
Ohio River Forecast Center
Hydrograph
River at a Glance
Download
Inundation Mapping
Probability Information
How to print this map
Find your location by address or ZIP code:
Go
Reset View
Map
Satellite
FINDLAY
Tiffin Ave
Fostoria Ave
E Sandusky St
E Lincoln St
Blanchard Ave
Bright Rd
S Main St
N Main St
Findlay Village Mall
Bernard Park
Stautzenberger College
Riverside Park
Hancock Park District Headquarters
Findlay Country Club
Hancock County Courthouse
Hancock Historical Museum
Hancock County Fairgrounds
Mound Park
Eagle Creek Skate Park
The University of Findlay
Map Data
500 m
Terms of Use
Report a map error
22.2'
21.0'
18.0'
15.0'
12.0'
9.0'
6.0'
3.0'
0'
Water Depth in Feet
Gauge Location
About Inundation
Download Dataset(s)
FAQ
User Guide
Inundation Sites
Inundation Legend
User guide video on YouTube
Disclaimer
Click on mapped inundation to see water depth values for that location.
Current Stage:
1.0 ft at 10/28/2013 16:00:00 UTC
Selected Inundation
NAVD88: 767.8 ft
stage: 14.0 ft
Mouse Location
Depth: 0 ft
Lat: 41.024981
Lon: -83.645010

Blanchard River at Findlay, OH (FDYO1)

Data Type

- Inundation Levels
- Flood Categories
- Current/Forecast

Inundation Levels

NAVD88	Stage
Record Crest: 18.5 ft	
772.2	18.4
771.8	18.0
770.8	17.0
770.3	16.5
769.8	16.0
769.3	15.5
768.8	15.0
767.8	14.0
Major Flooding Begins	
766.8	13.0
765.8	12.0
Moderate Flooding Begins	
764.8	11.0
Minor Flooding Begins	
763.8	10.0
762.8	9.0
761.8	8.0

* = Extended rating

Inundation Feedback

Inundation in partnership with

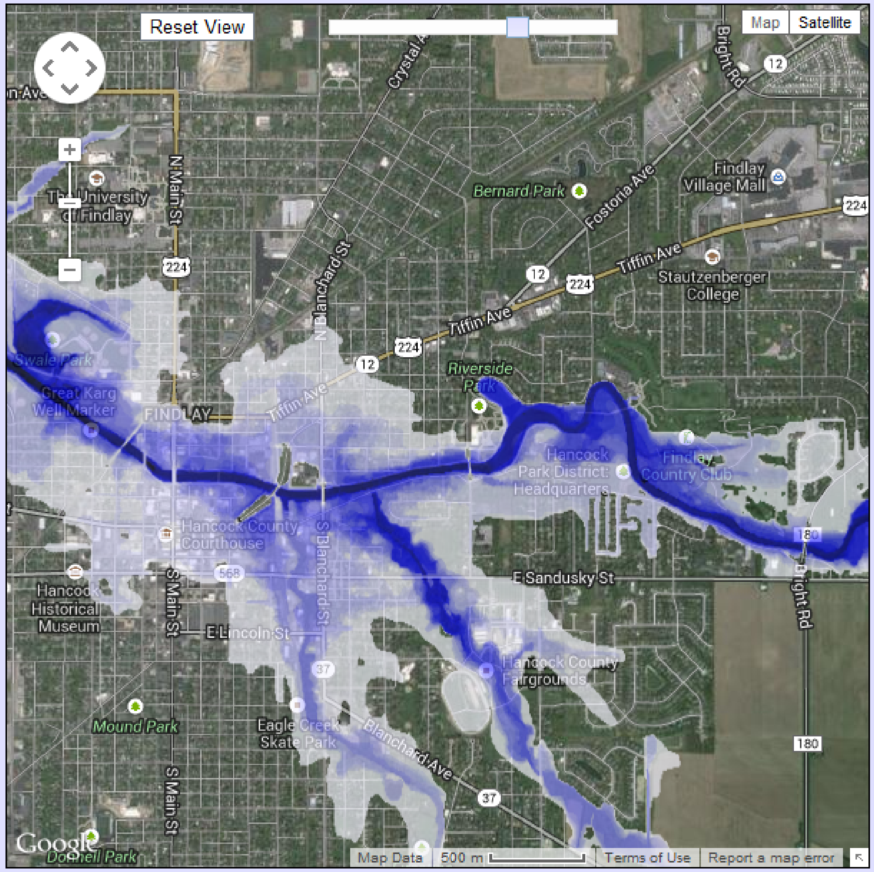
Weather Forecast Office Cleveland, OH

Ohio River Forecast Center

Hydrograph | River at a Glance | Download | Inundation Mapping | Probability Information

How to print this map

Find your location by address or ZIP code: Go



22.2′ 21.0′ 18.0′ 15.0′ 12.0′ 9.0′ 6.0′ 3.0′ 0′

Water Depth in Feet

Gauge Location

About Inundation

Download Dataset(s)

FAQ

User Guide

Inundation Sites

Inundation Legend

User guide video on YouTube

Disclaimer

Click on mapped inundation to see water depth values for that location.

Current Stage:
1.0 ft at 10/28/2013 16:00:00 UTC

Selected Inundation
NAVD88: 772.2 ft
stage: 18.4 ft

Mouse Location
Depth: 0 ft
Lat: 41.038384
Lon: -83.659000

BUILDING STRONG®

Flood Warning Reno, NV Truckee River
New Uses of Floodplain

Flood Plain Management

Effective and Responsible Flood Plain Management should be implemented through the following:

1) **National Flood Insurance Program**
2) **Flood Plain Management**
3) **Regulation of Flood Prone Land**
4) **More Stringent Regulations (NAI)**

Low Impact Development

Alternatives:

- ► Rain Garden
- ► Planter Box
- ► Green Space

Low Impact Development

Alternatives:

- ► **Green Vegetated Swale**
- ► **Porous Pavement**

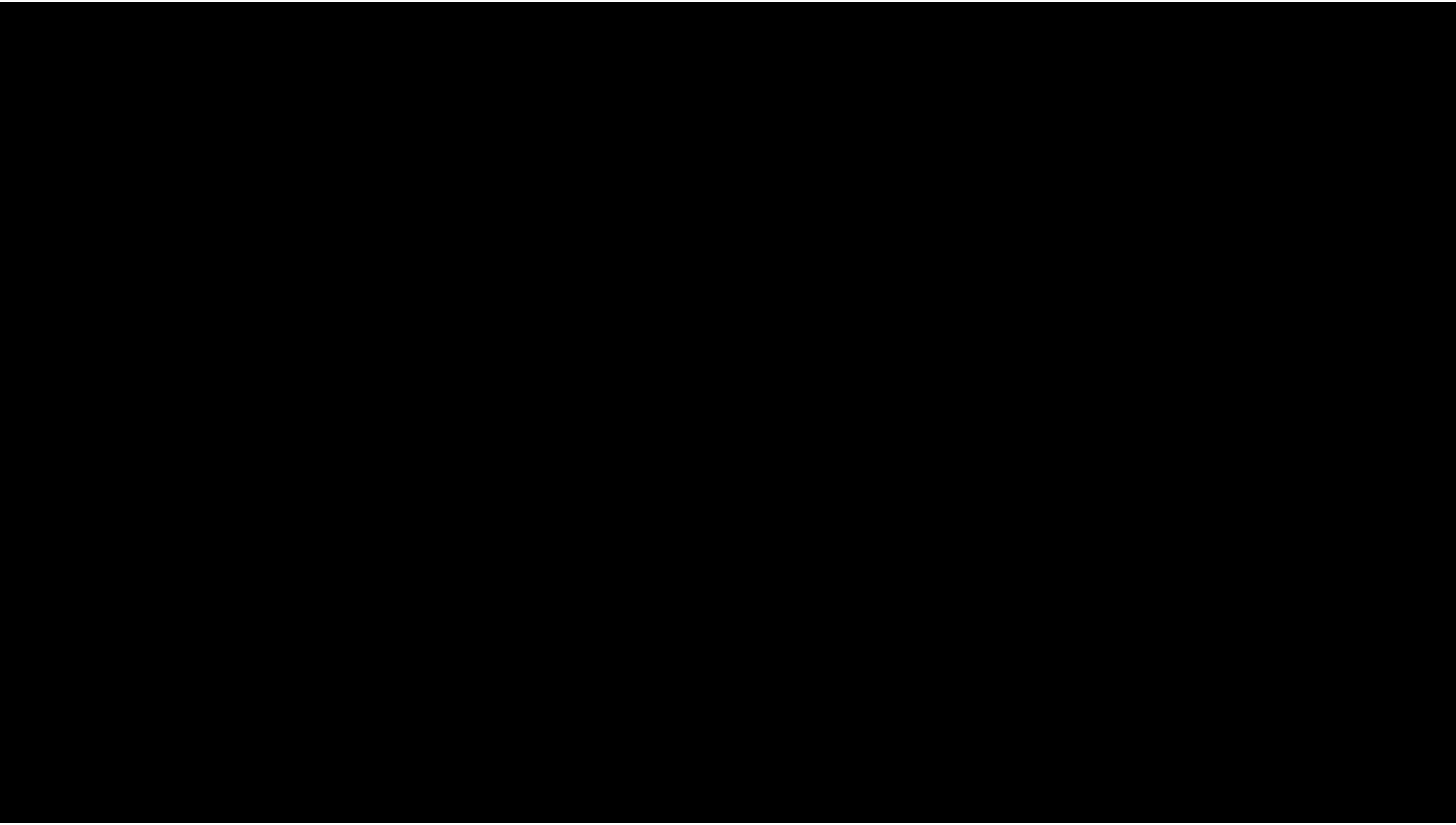

The Most Cost Effective Flood Risk Reduction Measure.
Don’t Build in an Area That Floods.

Key Take Away Points

Remember:

- ► Nonstructural methods can be done
- ► Nonstructural alternative analysis is required (USACE)
- ► Flood proofing WORKS
- ► Best option is don’t build in a floodplain
- ► There must be partnerships and collaboration
- ► Include nonstructural alternatives early
- ► Assistance is available

Questions / Comments



USACE Nonstructural Flood Proofing Workshop

Field Data Requirements

by Randall Behm
USACE - Omaha District
Chair, National Nonstructural Flood Proofing Committee

Nonstructural Flood Risk Adaptive Measures

The most common physical FRAM measures implemented for flood damage and life loss reduction are:

Acquisition	Relocation	Elevation
Dry Flood Proofing	Wet Flood Proofing	Basement Removal

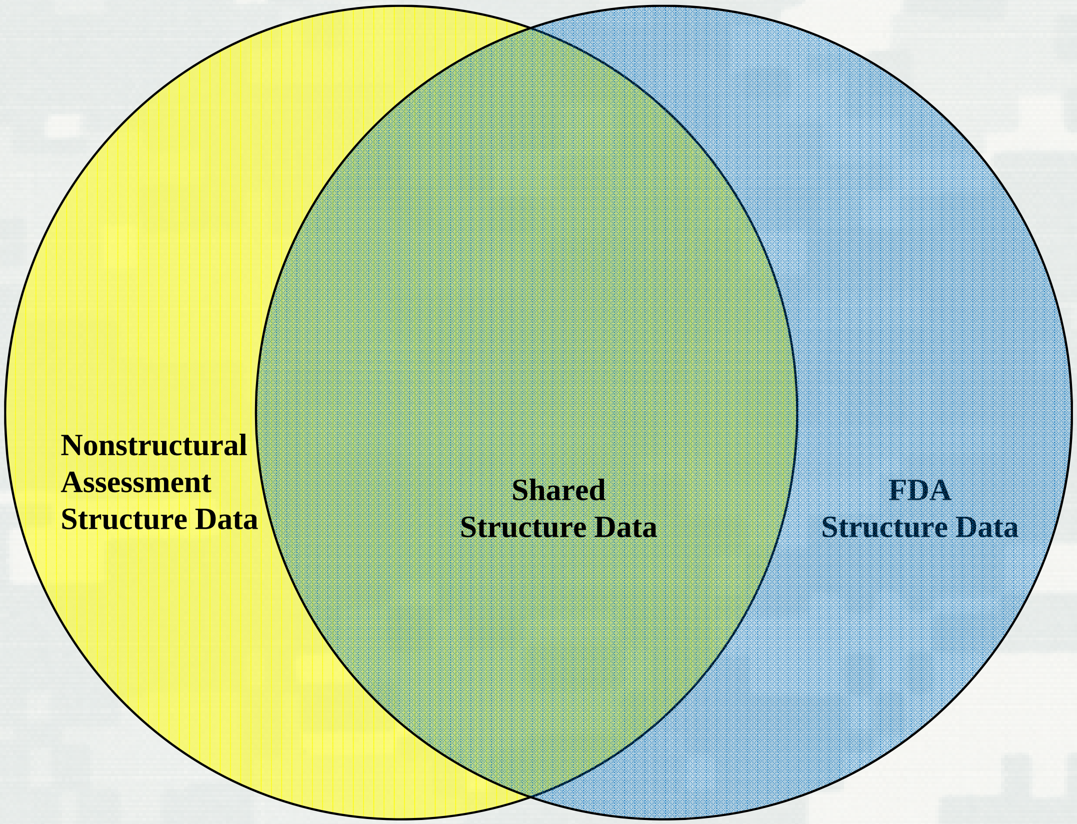
Nonphysical measures can be considered separately or as a combination of floodplain management and planning functions. Representative nonphysical measures are:

Floodplain Mapping	Land Use	Flood Insurance
Evacuation Plans	Flood Warning	Zoning
Operational Changes	Emergency Preparedness Plans	

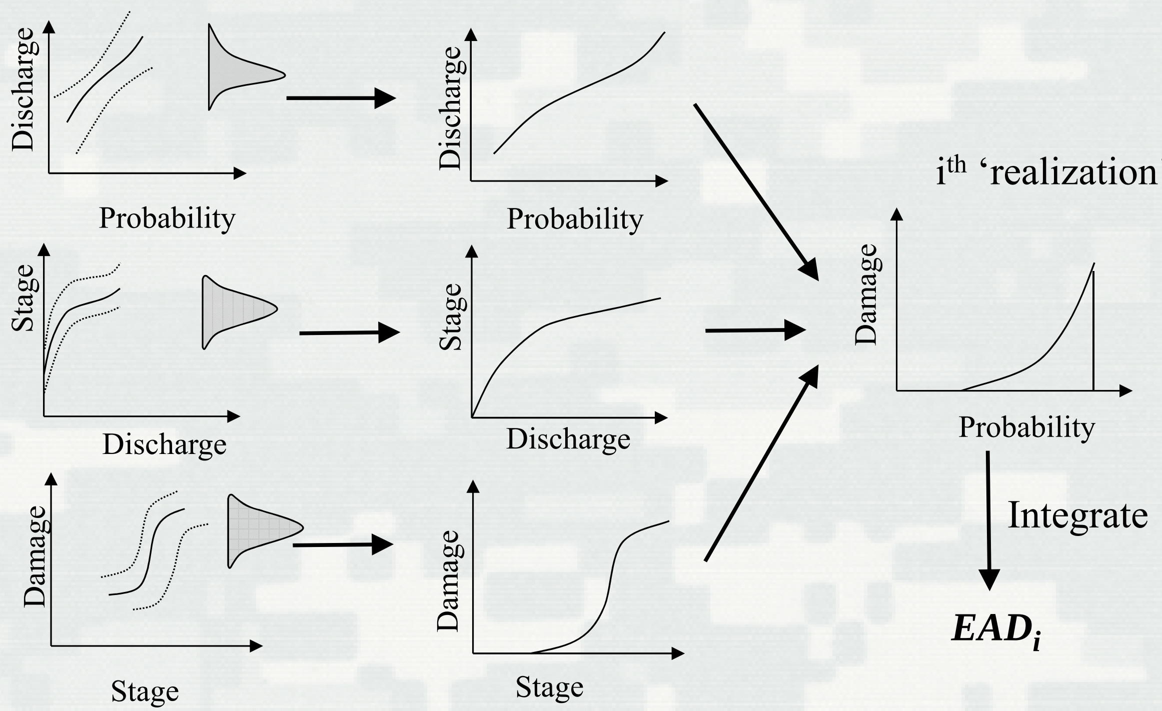
What Analyses are Required for Formulating Nonstructural FRAM Measures

- **Develop Hydrology (flow of water)**
- **Develop Hydraulics (depth and velocity of water)**
- **Conduct Structure Inventory (what gets flooded)**
- **Identify Potential Nonstructural FRAM Measures**
- **Cost Estimates for FRAM Measures**
- **Perform Economic Analyses (benefits determination)**
- **Implementation Plan**

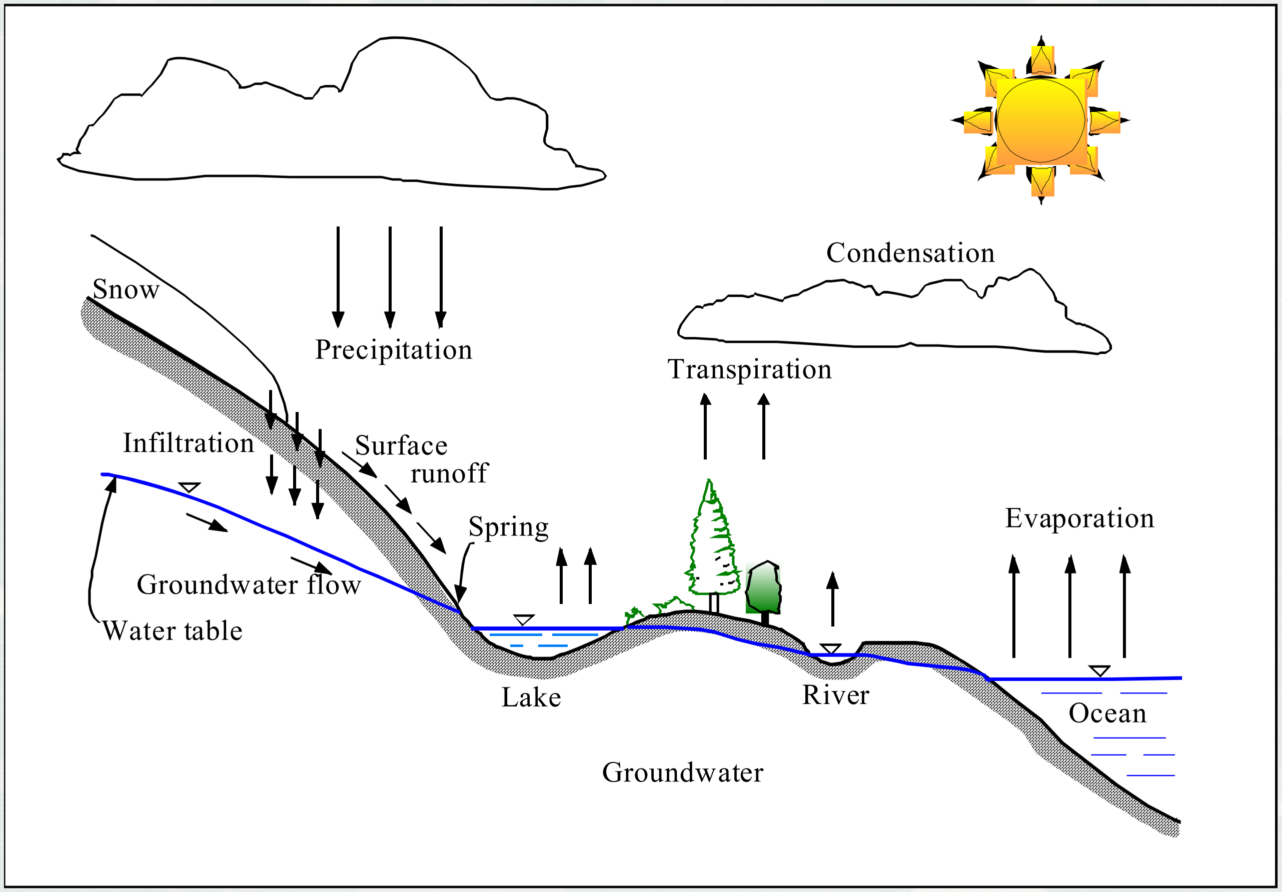
Data Needs Overlap Between Structural and FRAM



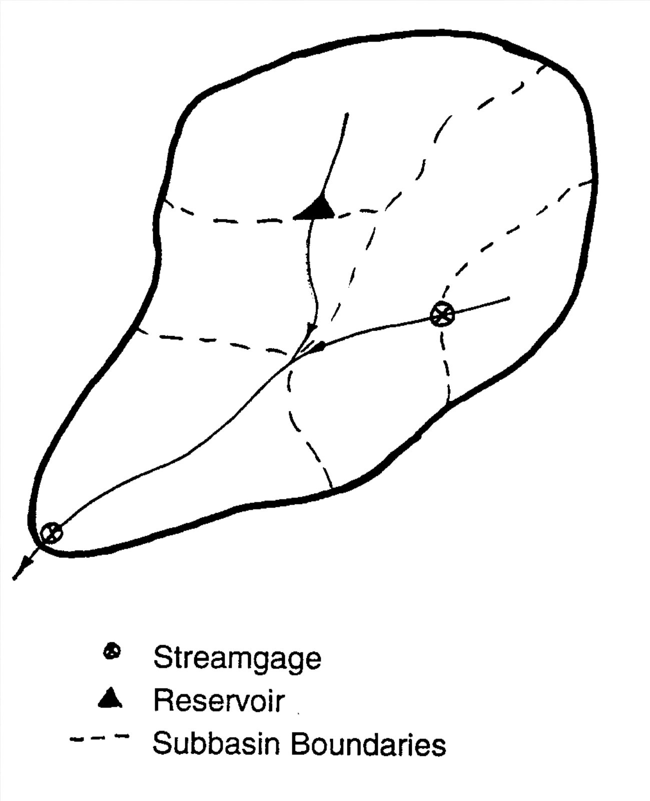
Flow-Frequency; Stage-Discharge; Damage-Frequency Relationships



Hydrologic Cycle

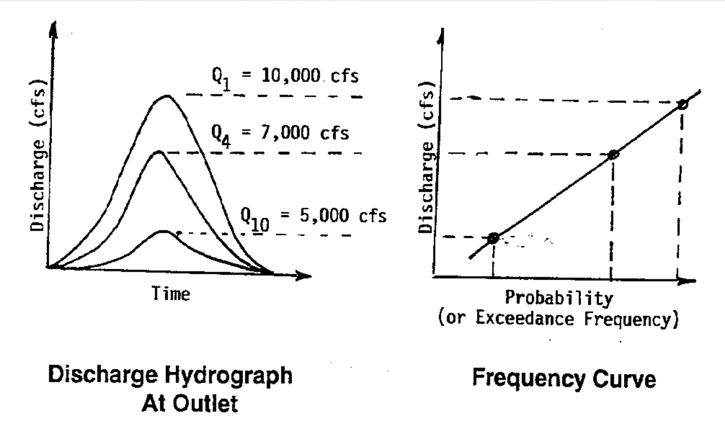


Hydrologic Studies

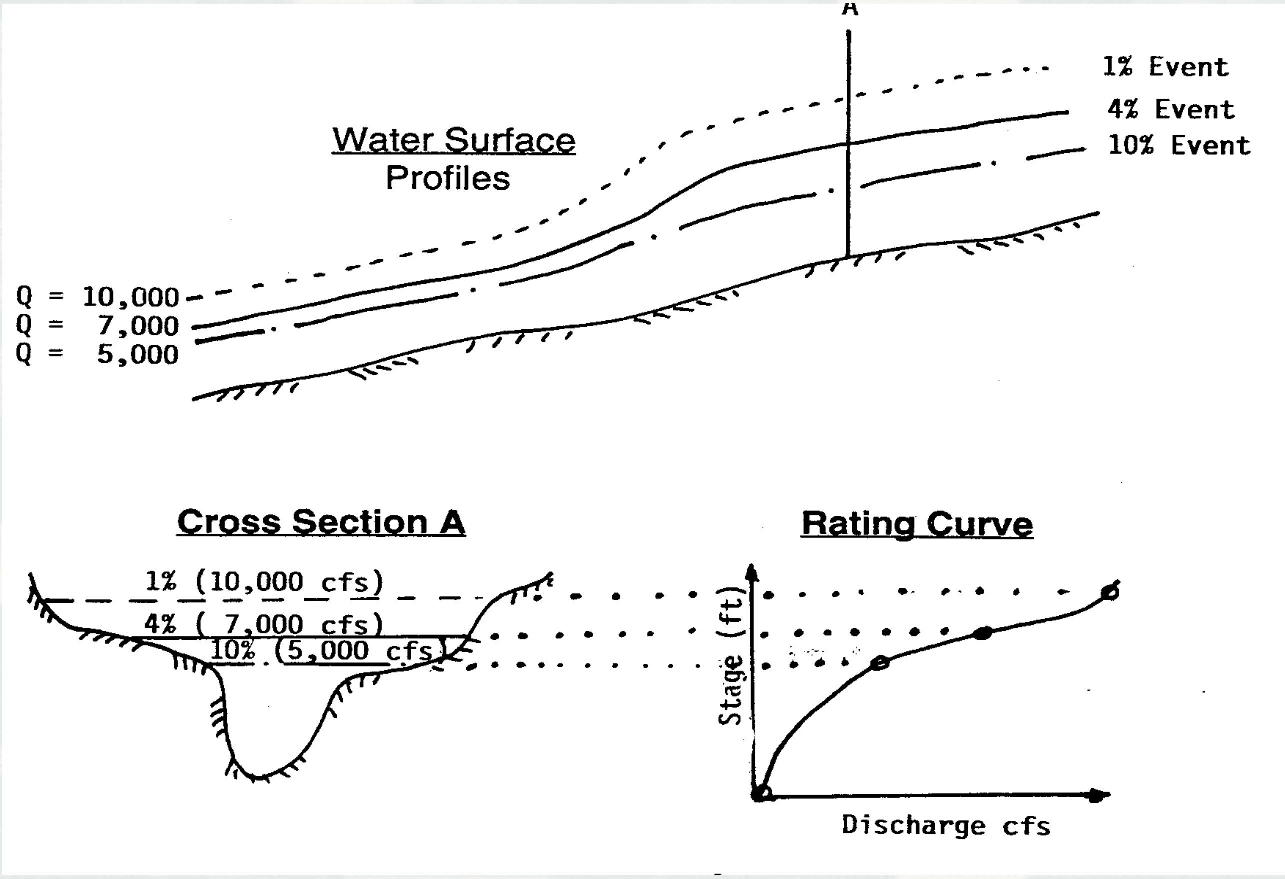


Sub-basin Delineations

- Stream Topology
- Streamgage Locations
- Project Locations



Hydraulic Assessment



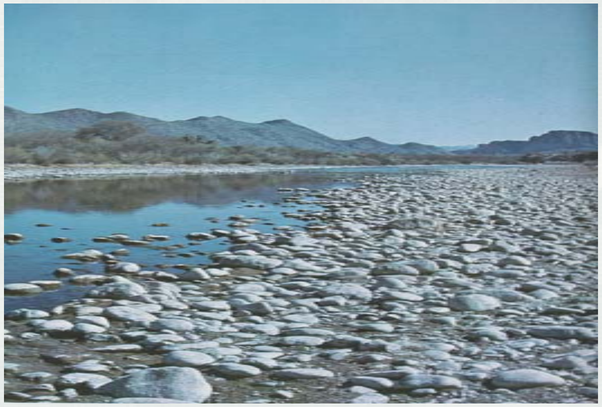
Uncertainty in Stage Estimates

Some Factors that can Cause Uncertainty:

- ► Cross section shape, area, and roughness
- ► Debris and other obstructions
- ► Sediment transport, scour, and deposition
- ► Bedforms (changing with depth and temperature)
- ► Backwater effects
- ► Bridges, culverts, and other hydraulic structures
- ► Survey error

Manning's "n" values of Roughness (friction factors)

$n = 0.032$



$n = 0.055$

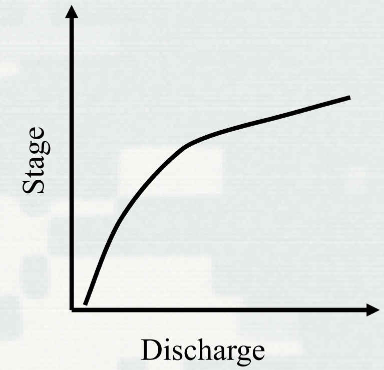
$n = 0.075$

$n = 0.097$

Stage-Discharge Curves

Stage-Discharge Curves can be developed by the following methods:

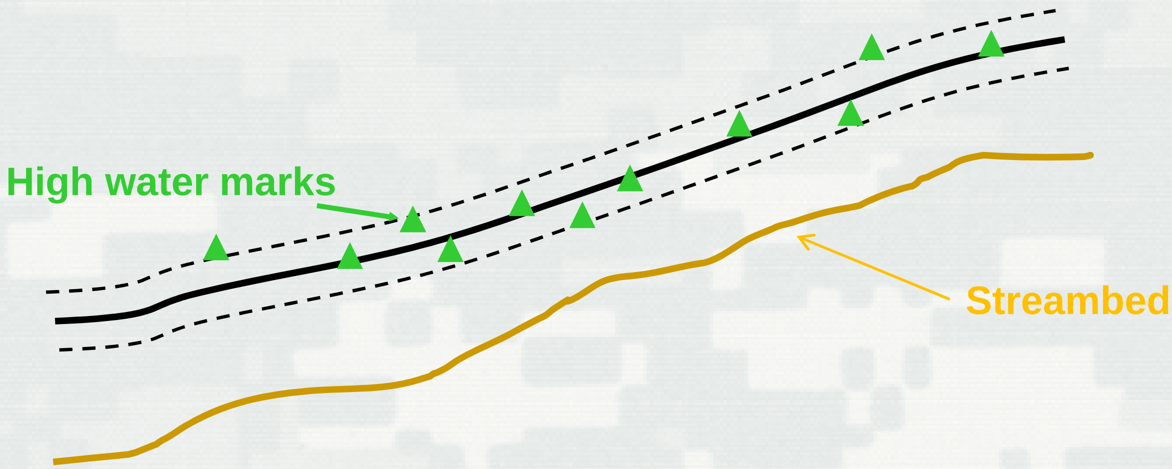
- ► **Measured Streamflow Data (gaged locations)**
- ► **Computed Water Surface Profiles**
  - **Steady flow analysis**
  - **Unsteady flow analysis**
  - **Movable-bed analysis**
  - **Multi-dimensional (2D) modeling**



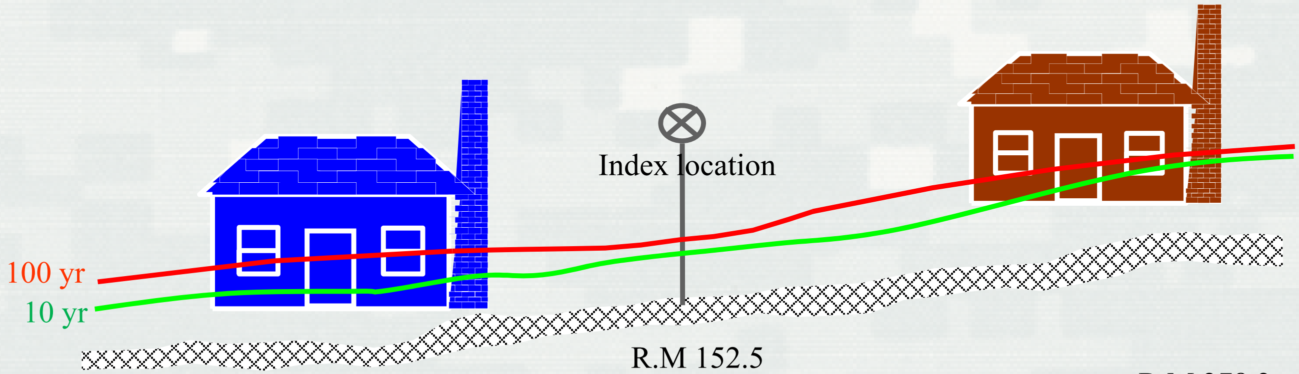
Calibration and Sensitivity Analysis

Calibrate to known elevations (adjust the computer model).

Perform sensitivity analysis of key parameters.



Culmination of Structure Damage to Index Location



R.M. 50.0

Stage	Damage
0	0
4.5	$15000
8	$85000

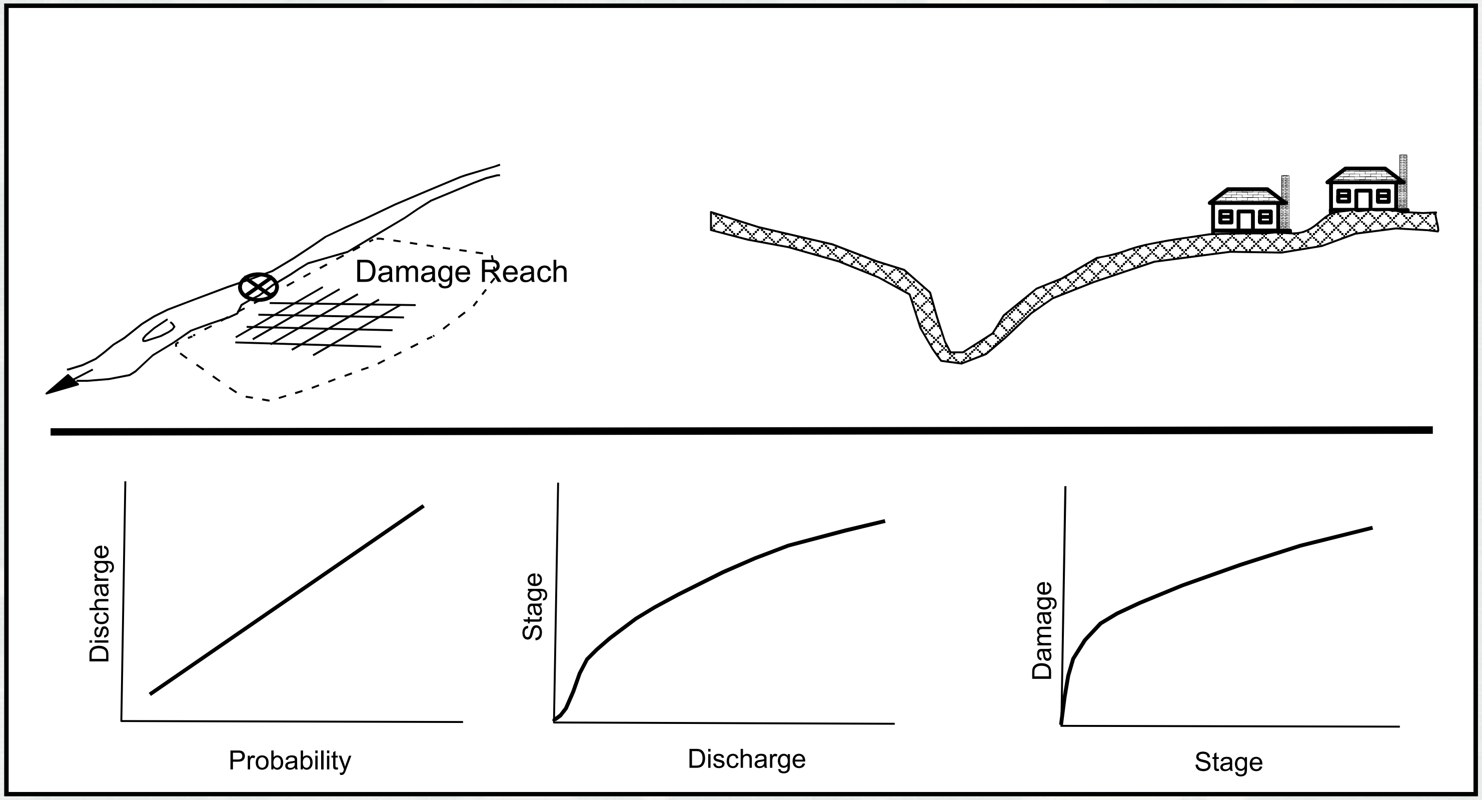
R.M 152.5

Stage	Damage
0	0
4	$20000
6	$130000

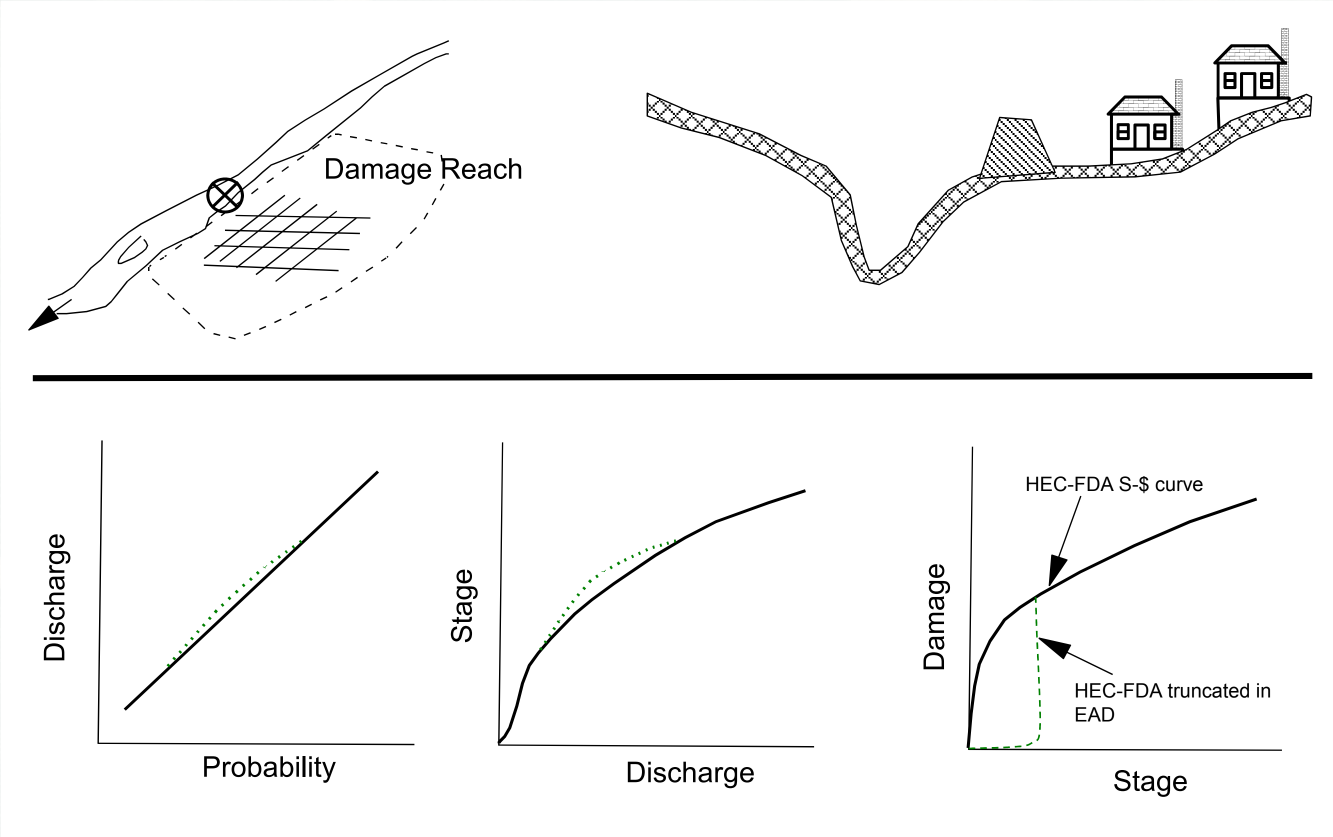
R.M 278.2

Stage	Damage
0	0
5	$5000
7	$45000

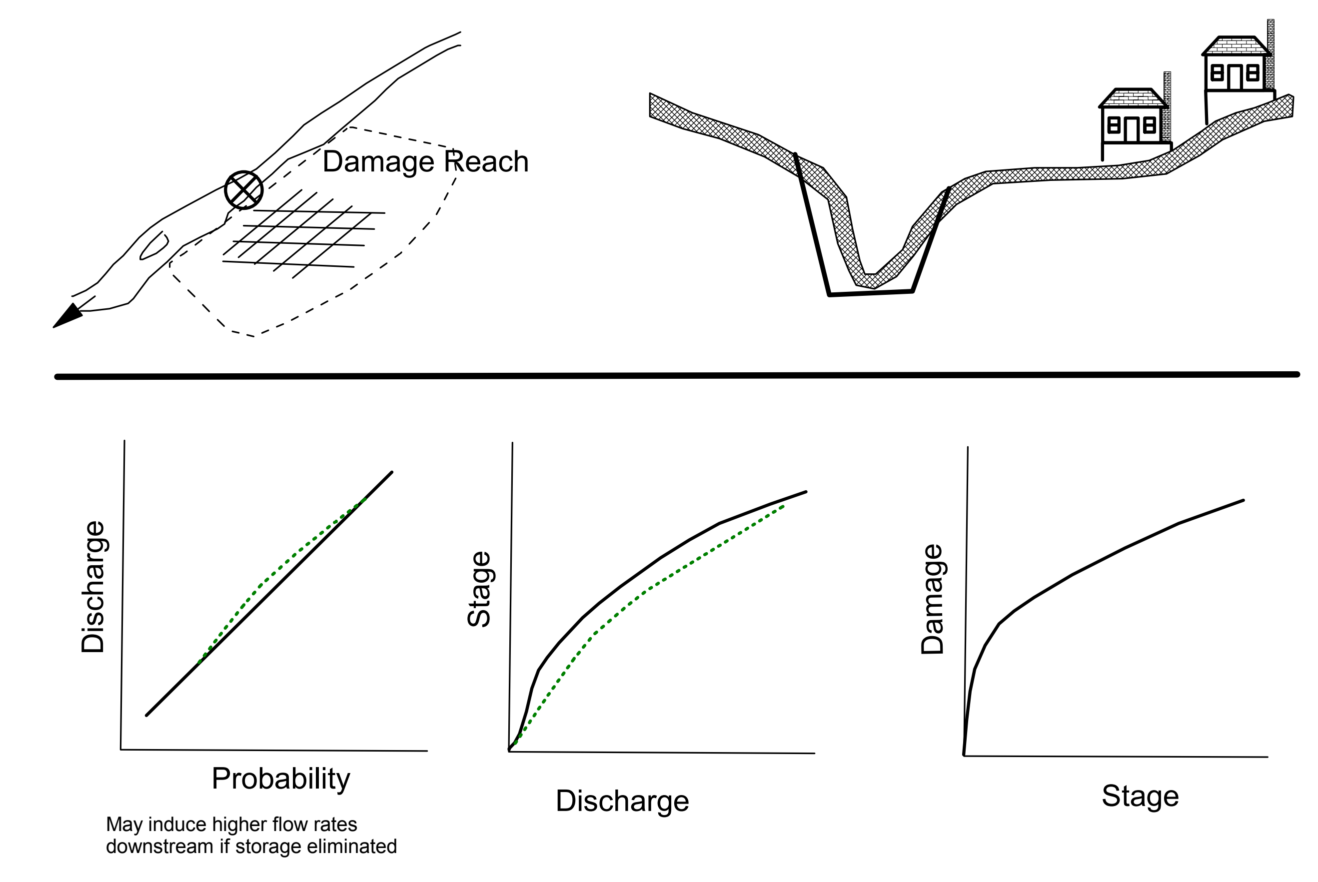
Evaluation of Existing Conditions



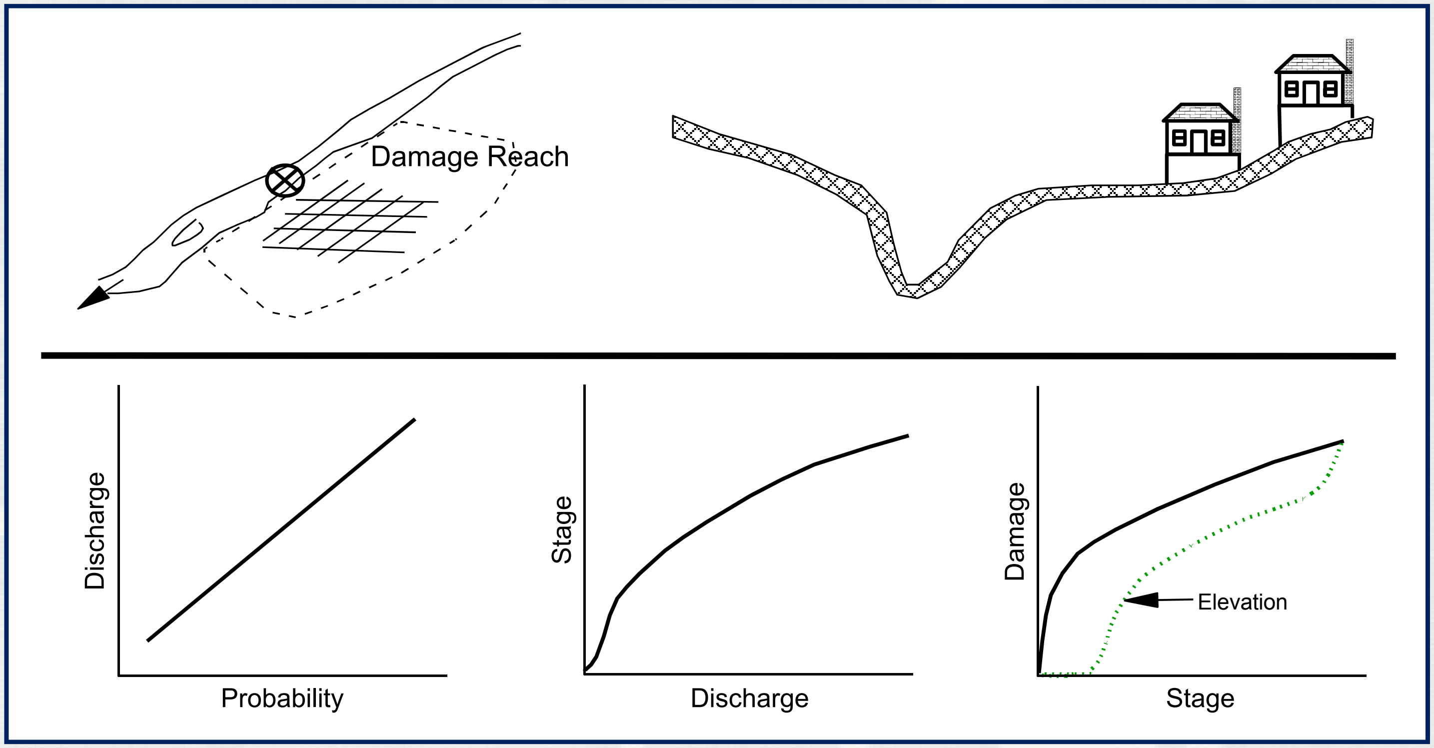
With Levee Conditions



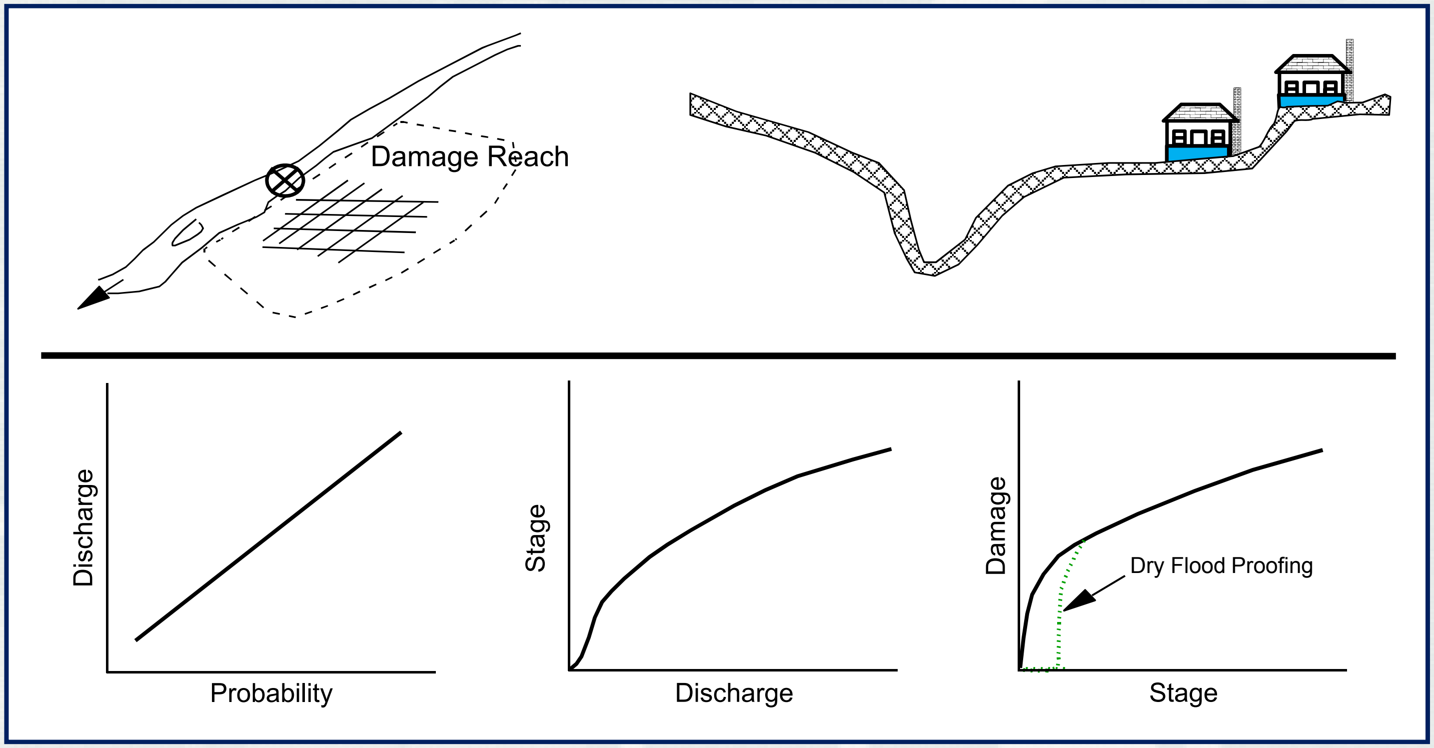
With Channel Modification Conditions



Nonstructural Measure
(Elevation)

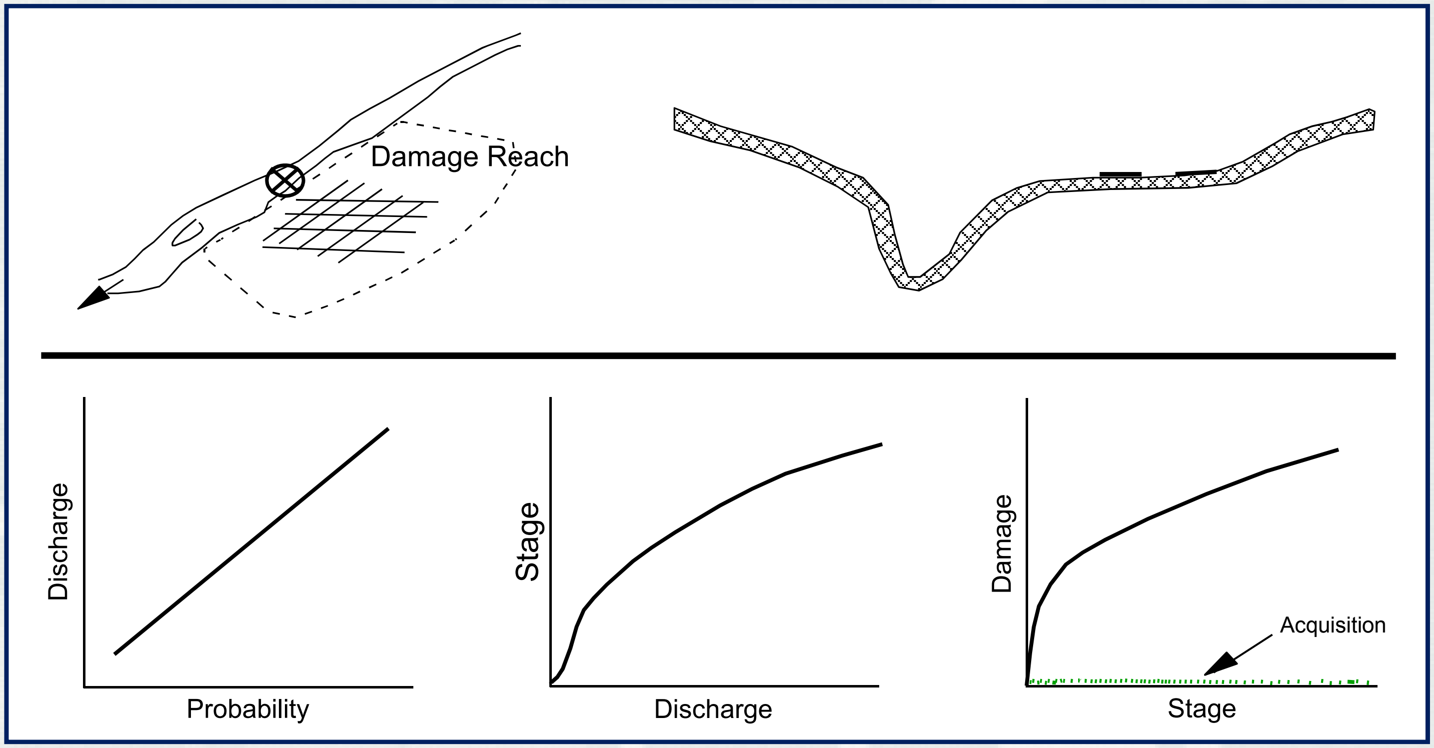


Nonstructural Measure
(Dry Flood Proofing)



Nonstructural Measure

(Acquisition)



Field Data Collection

Search for existing datasets:

County/City Assessors Database

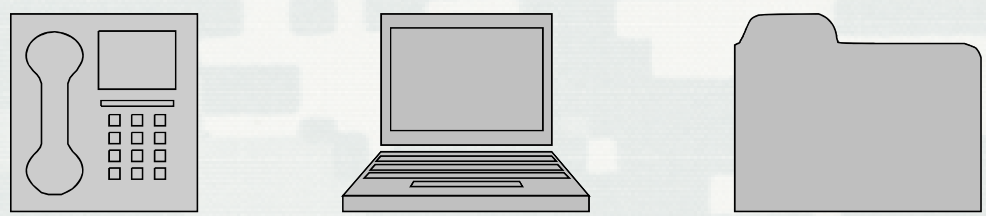
Previous Studies

LiDAR

Obtain new data:

Surveys

Homeowner / Business owner



Structure Inventory Data Collection

Structure Data	Data Definition
Building Identification Number	**Specific to Structure (geo referenced, coordinates, etc.)**
Structure Address	**Specific Postal Location of Structure**
Critical Facility	**Yes / No**
Lowest Adjacent Ground Elevation	**Elevation of Lowest Ground at Structure**
First Floor Elevation	**Elevation of Finished First Floor**
Structure Category	**Residential, Commercial, Industrial, Public**
Structure Use	What is the Specific Use of Structure
Total Stories	Total Number of Floors Above Grade
Structure Footprint	**Total Square Foot Area of At-Grade Floor**
Number of Structural Corners	**Total Number of Corners in Perimeter**
Structure Foundation Type	**Slab, Reinforced Slab, CMU, Piers, Columns, Posts, Stone**
Structure Perimeter Distance	**Total Length of All Exterior Sides of Structure**
Exterior Wall Construction	**Wood, Masonry, Brick, Metal, Stone, Concrete, Other**
Structure Visual Condition	**Good / Fair / Poor**
Garage	**Attached, Detached, None**
Doorways	**Number of Pedestrian Doorways**
Basement	**Full Basement, Half, Crawl Space, None**
Structure Photos	**Photograph of Four Sides of Structure**
Utilities Location	**Electrical, Gas, Water, Sewer, Oil, Propane, Coal, Other**
Structure Value	**Assessed Value of Structure**
Fireplace	Yes / No
Structure Owner	Who Owns the Structure
Year Structure Built	Year Structure was Constructed (Any Historic Significance)
Water Surface Elevation	Elevation or Depth of Water at Structure (H&H activity)
Water Velocity	Erosive Potential of Flood Waters (H&H activity)

Sample Structure

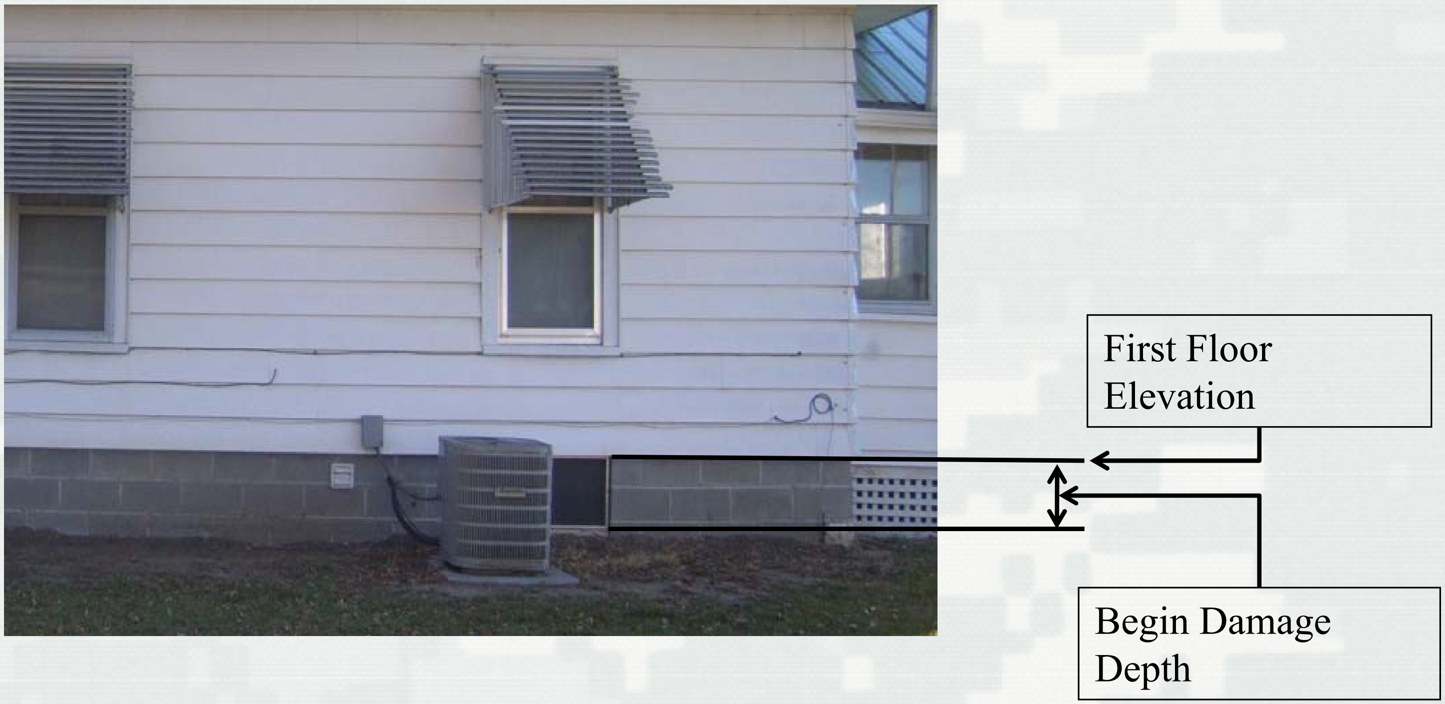
Front View

Left Side View

Sample Structure Field Data Collection

- 1 Story with Basement
- Block Foundation
- Basement Windows
- Wood Frame
- Detached Garage

Sample Structure Elevations (Stages)



Damages begin as water enters through the basement window

Sample Structure Inventory Sheet

Appendix A **Willow Park, Missouri Valley, Iowa**

Structure Address	1121 W. Huron St.
Structure ID	10
HEC ID	415

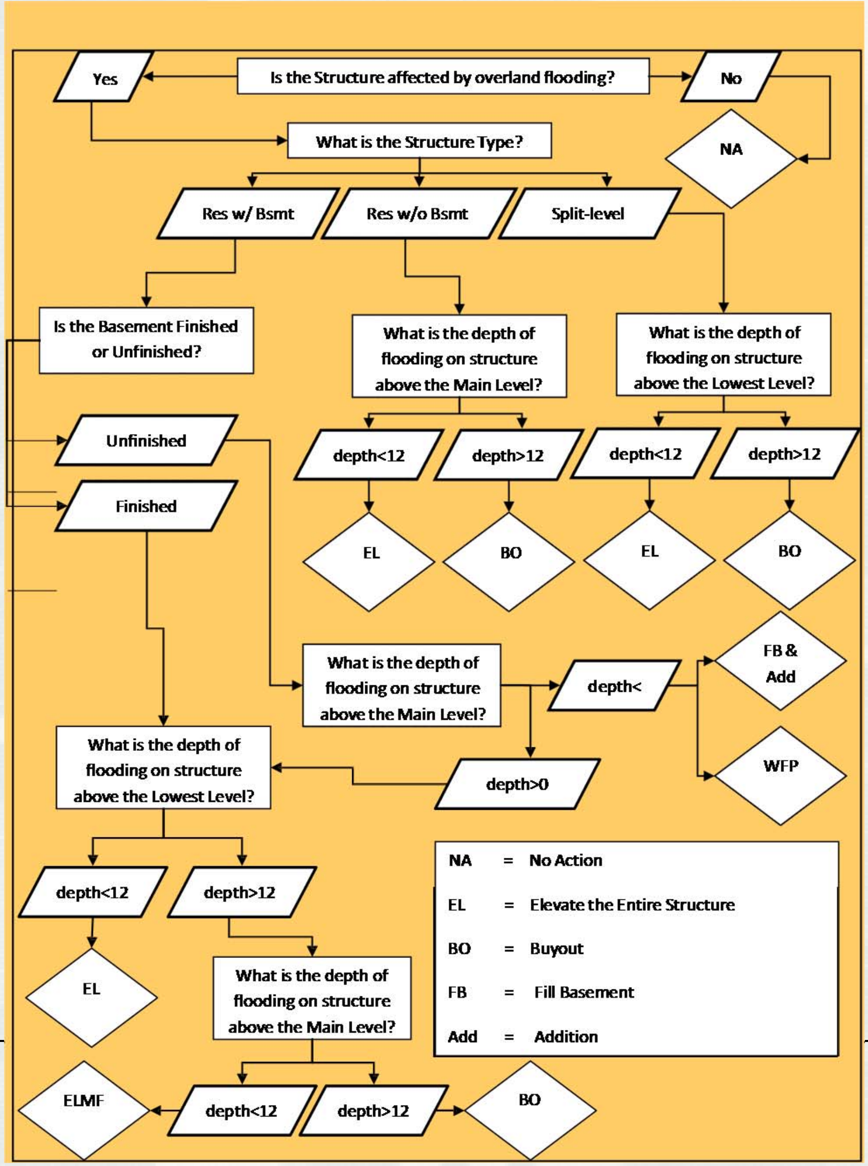
	
Front View	Right Side View
	
Back View	Left Side View

		Depth of Flooding (ft)		
Ground Elev. (NAVD)	1003.58	Flood Event	Ground	1st Floor
1st Floor Elev. (NAVD)	1005.61	100-yr	3.96	1.93

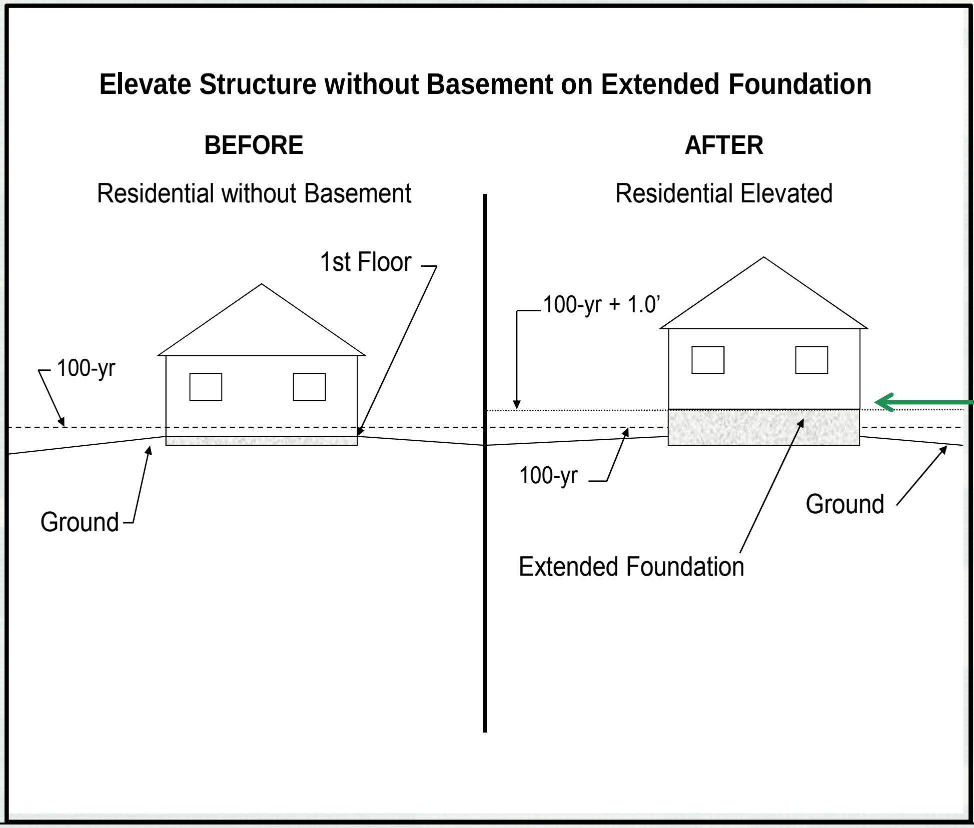
Field Notes

Date	12/1/2009
Time	8:53
Field Team	Lowell Blankers, William Williams, Larry Morong
Foundation Type	Block
Building Frame type	Siding
Design Style	1 Story Frame
Basement	Yes
Basement Fin/Unfin	No
Garage Attached	No
Egress Windows	Windows in basement
Additional Comments	

Assessing Structures for Nonstructural Mitigation Measures



Elevation Height



Elevation Height

=

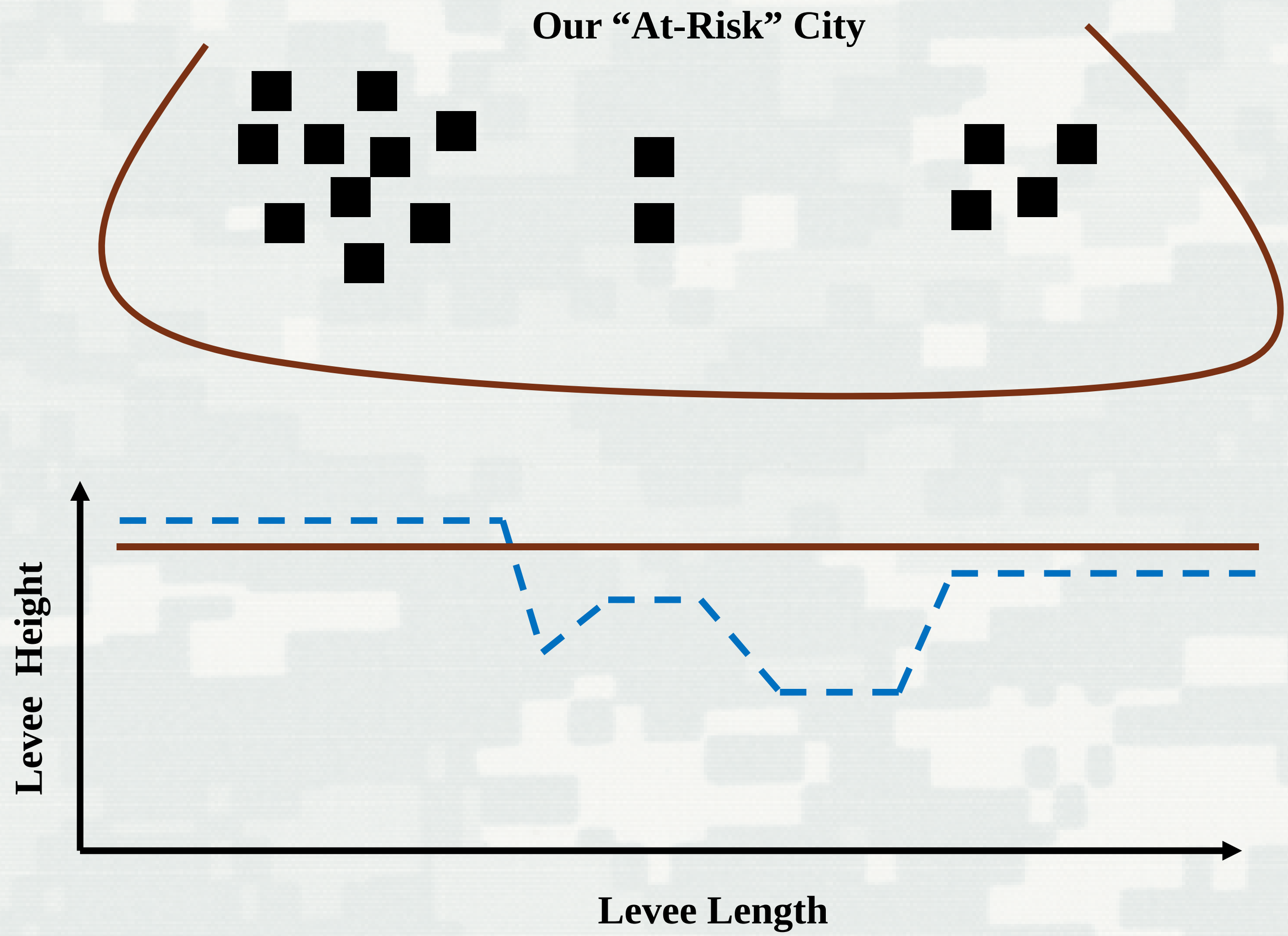
100-yr Elevation + 1.0 Ft

−

1st Floor Elevation

Elevation on Extended Foundation

(before)



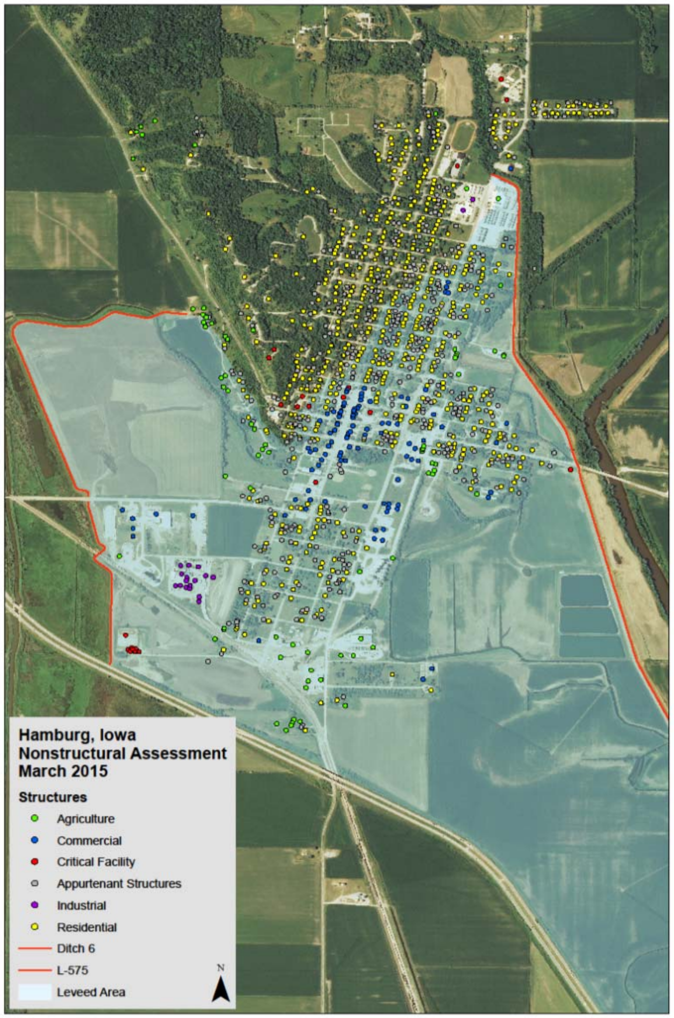
Our “At-Risk” City
Levee Height
Levee Length

Nonstructural Economic Results

ID	STREET	CITY	Nonstructural Technique	100yr Cost	Annualized Cost	Benefits (x1000)	BCR	Net Benefit
400802	110 FREEDLAND DR	Harwood	Flood Wall	348,000	19,245	10.761	0.56	-8,484
400667	438 LIND BLVD	Harwood	Elevate Structure	123,330	6,820	10.181	1.49	3,360
400707	106 RIVERSHORE DR	Harwood	Elevate Structure	112,176	6,203	2.100	0.34	-4,103
400754	324 RIVERTREE BLVD	Harwood	Elevate Structure	118,513	6,554	10.363	1.58	3,809
400007	17373 25 ST SE	Harwood Twp	Buy Out	129,564	7,165	12.832	1.79	5,667
400008	2551 173 AVE SE	Harwood Twp	Buy Out	113,870	6,297	10.018	1.59	3,721
400009	2623 173 AVE SE	Harwood Twp	Buy Out	147,854	8,177	10.397	1.27	2,220
400025	2769 173 AVE SE	Harwood Twp	Buy Out	123,074	6,806	4.205	0.62	-2,601
400009	2623 173 AVE SE	Harwood Twp	Buy Out	147,854	8,177	10.397	1.27	2,220
400001	17369 25 ST SE	Harwood Twp	Elevate Main Floor	112,176	6,203	14.768	2.38	8,565
400002	17135 25 ST SE	Harwood Twp	Elevate Main Floor	113,114	6,255	13.632	2.18	7,377
400004	17201 27 ST SE	Harwood Twp	Elevate Main Floor	112,661	6,230	21.166	3.40	14,936
400005	2569 172 AVE SE	Harwood Twp	Elevate Main Floor	113,566	6,280	12.193	1.94	5,913
400006	17283 26 ST SE	Harwood Twp	Elevate Main Floor	111,885	6,187	12.316	1.99	6,129
400010	2675 173 AVE SE	Harwood Twp	Elevate Main Floor	109,137	6,035	19.609	3.25	13,574
400011	2651 173 AVE SE	Harwood Twp	Elevate Main Floor	110,236	6,096	20.908	3.43	14,812
400012	17321 27 ST SE	Harwood Twp	Elevate Main Floor	108,070	5,976	16.894	2.83	10,918

Costs	Benefits	
124,706	212,740	BCR = 1.71

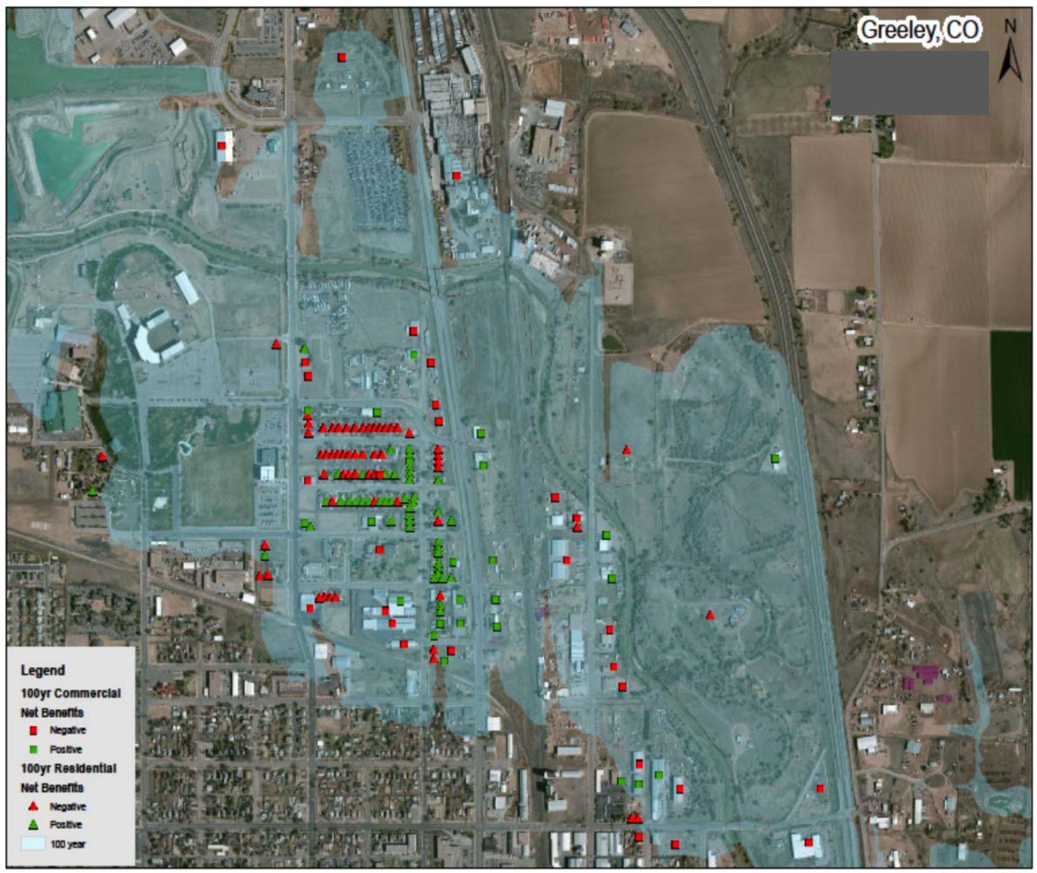
Remember to use all of the benefits for the entire damage area, not just the buildings with a positive BCR



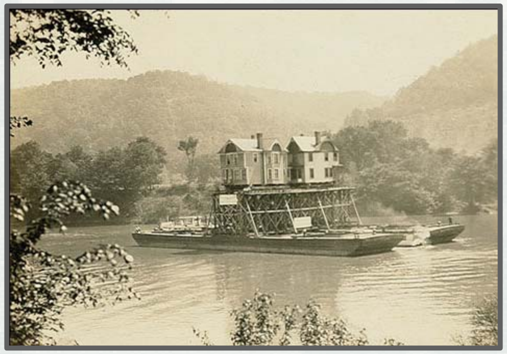
Nonstructural Investigations with GIS

- Geo-reference structure location
  - Residential
  - Commercial
  - Industrial
  - Agricultural
  - Critical Facility
- Tie to Assessor's Data
- Flood Hazards

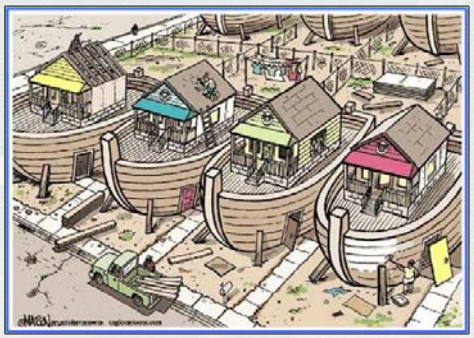
Nonstructural Investigations with GIS

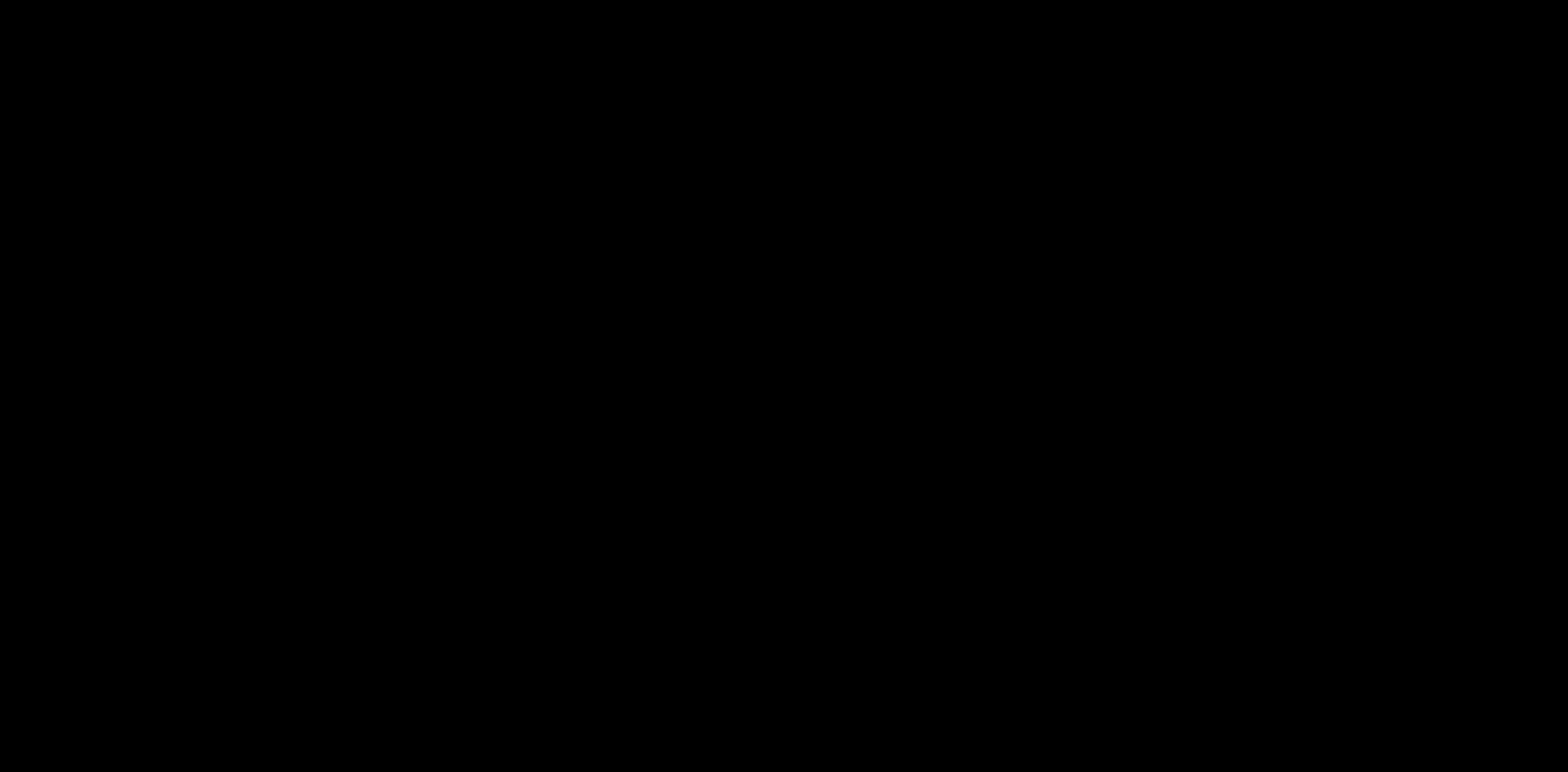


Area of Flooding
Detailed Structure Inventory
Residential Assessment
Commercial Assessment
Net Benefit Based
Benefit to Cost Ratios



QUESTIONS?





Nonstructural Flood Risk adaptive Measures for Flood Risk Management

Economic Considerations for Nonstructural Analysis

Randall Behm P.E., CFM
USACE-Omaha
Flood Risk and Floodplain Management

ꓡDING STRONG®

We know that there are structures at risk of flooding, why do we need to perform economics?

The federal government will partner on a study to determine economic feasibility, but implementation will require that the feasibility study determines the benefits to be greater than the costs.

The Chief of Engineers makes recommendations to Congress for flood risk reduction projects that are supported by economic feasibility studies.

These studies evaluate the performance of an array of engineering alternatives with respect to a “no-action” alternative.

Engineering alternatives can be structural, nonstructural, or a combination of both.

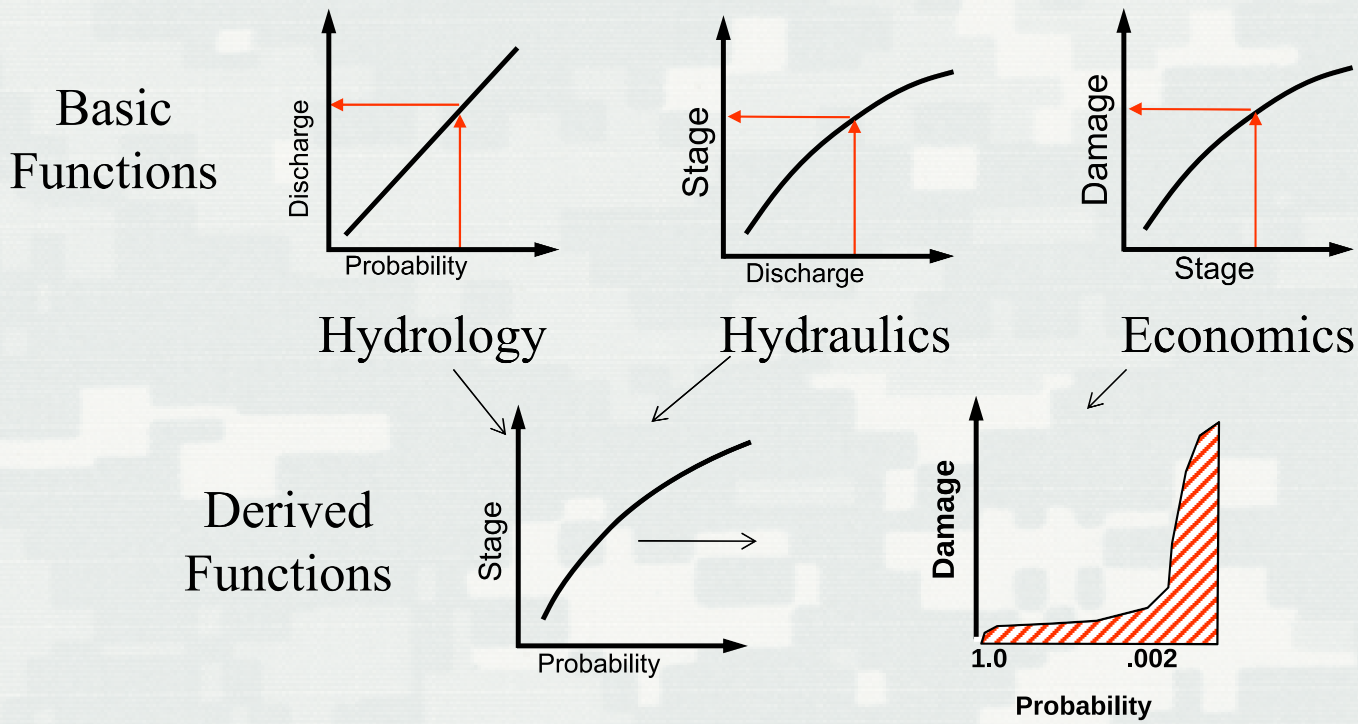
Flood Risk

Flood Risk = *f* [(Probability of Flooding) x (Consequences)]

Probability of Flooding is the frequency of flooding or how often does flooding occur in a particular location.

Consequences are the potential damages and life-loss associated with flooding. Structures (residential, commercial, critical, public, and industrial), land use (agricultural, urban, public), and infrastructure (highways, roads, rail, utilities) are the potentially damageable assets. Reduce the consequences of flooding and risk is reduced. Nonstructural measures are invaluable wherein the goal is to reduce flood damages without modifying the characteristics of the flood event.

Derived Probability-Damage Relationship



BUILDING STRONG®

Economic Consequences of Flood Risk

- Damage to Property
- Potential for Life Loss
- Emergency Costs
- Business Losses
- Social Effects

Damage to Property

- Residential
- Commercial
- Industrial
- Critical Facilities
- Critical Infrastructure
- Public
- Agricultural

Acceptable Emergency Costs

- **Public: Response, Relief, Overtime and Debris Removal**
- **Private: Evacuation, Clean-up, Restoration**

Business Losses

- Higher Operating Costs
- Lost Production

Social Effects

- Mortality
- Vulnerability
- Sustainability / Resiliency
- Cohesion (neighbors and neighborhoods)
- Historical/Cultural

Investment in Public Infrastructure

- The Federal government in an investor in public works infrastructure
- Similar to businesses investing in production facilities and services with the goal of earning a return on investment
- The expected return on investment is expressed in monetary terms

Measurements of Return on Investment

- **Annual income (or benefits) as a percentage of the initial investment amount**
- **Net Benefit Estimate**
- **Benefit-to-Cost Ratio**

Note: The above are different techniques that fundamentally measure the same investment performance

Measurement of Economic Benefits

- For flood risk management studies, future flood damages can only be estimated based on the statistical probability of occurrence.
- The “when” and “where” of future flood events cannot be known with absolute certainty.
- The history of specific past flood events is not a reliable indicator of flood damages that may occur in the future for a full range of possible flood events

Measurement of Economic Benefits

- Using statistical probabilities, an estimate of the average damages per year for a given area under the "no-action [existing conditions]" scenario can be derived.

- Similar estimates of average damages per year for the same area can be made assuming a Federal investment in flood risk measures is in place

- The reduction in annual damages between the two scenarios is the definition of economic benefits of the project (annual national income generated)

Measurement of Economic Costs

- The economic costs of a project is the sum of all resources committed to generating economic benefits
- These costs are estimated as the monetary equivalent of include all lands needed, environmental damages created, and pubic or private monies expended.
- Costs also include the “interest cost” incurred since these resources can no longer be used or invested for other purposes that earn a similar rate of interest (opportunity costs.)
- The interest rate used to estimate these interest costs are revised annually by the U.S. Department of the Treasury

Measurement of Economic Costs

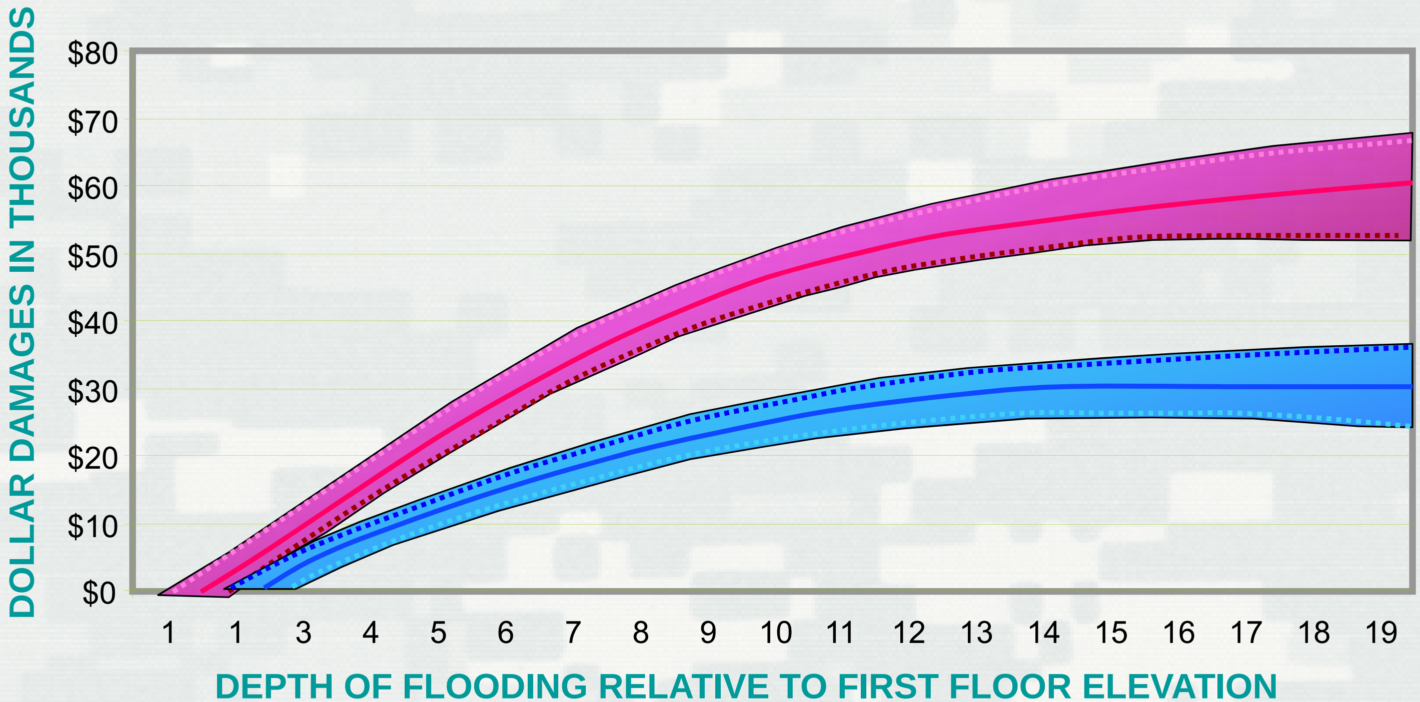
- **The sum of all economic costs must be converted to an average annual equivalent for the purpose of establishing a common basis for comparison to economic benefits**

- **Total costs are converted to an annual equivalent through a technique called "amortization"**

- **Amortization is exactly the same technique used to calculate the monthly or yearly payment on a loan (car, house)**

- **The size of the annual cost (or payment) is influenced by the interest rate and the number of years over which the payments are spread out--- typically the economic life of the project**

Depth-percent Damage Curves with Uncertainty
Residential, One-story, No Basement, $75,000 Value



Without Project Depth-Percent Damages

(One-story, No Basement Residential Valued at $75,000)

Depth of Flooding	Flood Stage	Depth Damage Curve	Mean Structure Damage	Depth Damage Curve	Mean Content Damage
-2	84.5	0.000	$0.00	0.000	$0.00
-1	85.5	0.025	$1.88	0.024	$1.80
0	86.5	0.134	$10.05	0.081	$6.08
1	87.5	0.233	$17.48	0.133	$9.98
2	88.5	0.321	$24.08	0.179	$13.43
3	89.5	0.401	$30.08	0.220	$16.50
4	90.5	0.471	$35.33	0.257	$19.28
5	91.5	0.532	$39.90	0.288	$21.60
6	92.5	0.586	$43.95	0.315	$23.63
7	93.5	0.632	$47.40	0.338	$25.35
8	94.5	0.672	$50.40	0.357	$26.78
9	95.5	0.705	$52.88	0.372	$27.90
10	96.5	0.732	$54.90	0.384	$28.80
11	97.5	0.754	$56.55	0.392	$29.40
12	98.5	0.772	$57.90	0.397	$29.78
13	99.5	0.785	$58.88	0.400	$30.00
14	100.5	0.795	$59.63	0.400	$30.00
15	101.5	0.802	$60.15	0.400	$30.00
16	102.5	0.807	$60.53	0.400	$30.00

Net Project Benefits

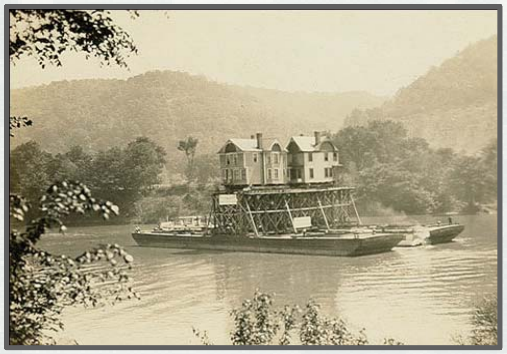
- **Net project benefits are simply the numerical difference between the annual benefits and the annual costs**

- **The project is economically justified if the value of net benefits is greater than or equal to "zero"**

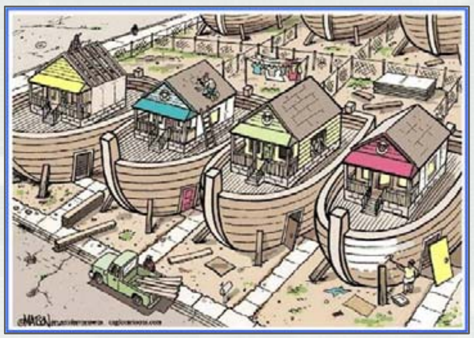
- **Even if net benefits are "zero", the project is creating a return that is at least equal to the "interest rate" used in calculating the "interest cost". This means that the project is earning annual income that is at least equal to other investment opportunities.**

Benefit-to-Cost Ratio

- The benefit-to-cost ratio is calculated by dividing annual benefits by annual costs
- The project is economically justified if the benefit-to-cost ratio is greater than or equal to 1.0 to 1.0
- Even if the benefit-to-cost ratio is exactly 1.0 to 1.0, then, again, the project is creating a return that is at least equal to the "interest rate" used in calculating the "interest cost". This means that the project is earning annual income that is at least equal to other investment opportunities.



QUESTIONS?



[redacted]

USACE Nonstructural Flood Proofing Workshop

Implementation of Nonstructural Measures

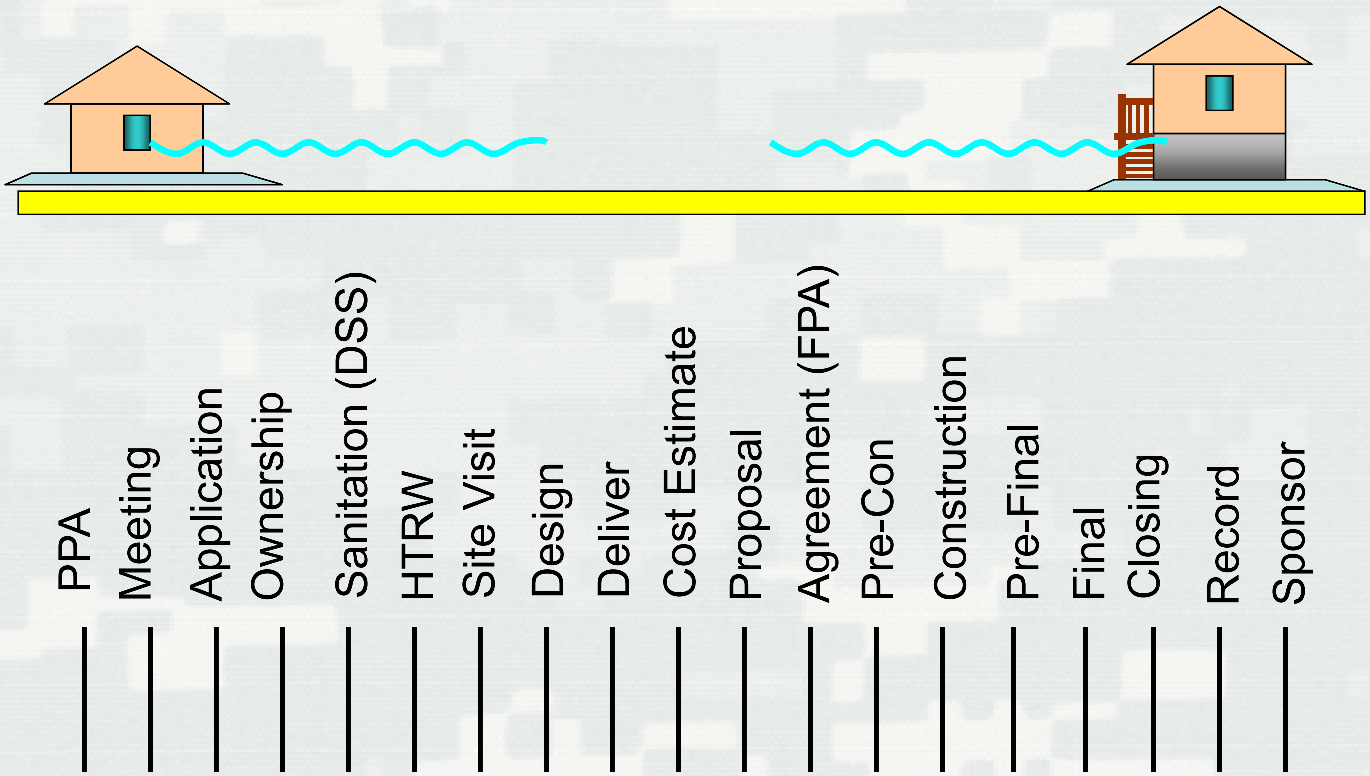
by Mary Weidel
USACE - Detroit District
National Nonstructural Flood Proofing Committee Advisor

Implementation…How Did We Get Here?

USACE Project Implementation Requirements:

- Economic Feasibility (requires positive BCR)
- Federal Interest
- Local Partner (cost-share, administration, project support)
- Implementation Plan
- Project Partnering Plan

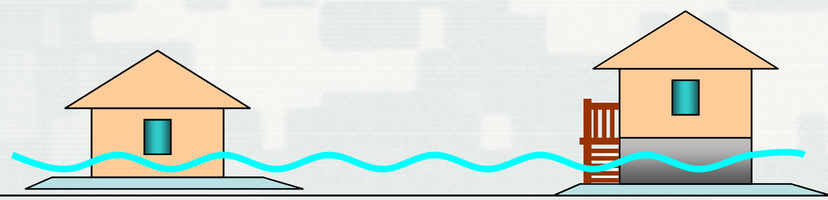
Flood Proofing Implementation Process



Suggested Implementation Process

19 Potential Steps to success

- Project Partnering Agreement (PPA)
- Meeting
- Application
- Ownership
- Decent, Safe and Sanitary (DSS)
- HTRW
- Site Visit
- Design
- Deliver
- Cost Estimating
- Proposal
- Flood Proofing Agreement (FPA)
- Pre-Construction
- Construction
- Pre-Final
- Final
- Closing
- Record
- Sponsor



Project Partnering Agreement (PPA)

- Agreement between government and the nonfederal sponsor
- Identifies the provisions of the project
  - ► Scope, cost, cost share, responsibilities
  - ► Limits deviation
  - ► Requires participation in NFIP
  - ► Describes use of evacuated lands
- PPA drafter should be PDT member – involved with the formulation and familiar with project

Post PPA Activities

- **Communication with sponsor and public**
- **Aerial photography to document existing conditions**
- **Mapping**
  - Tracts / Parcels
  - Structures
  - Verification of data (It will change)
- **Project Coordination Team (PCT)**
- **Implementation procedures**

Project Coordination Team (PCT)

- **Required by PPA**
- **Purpose**
  - Provide consistent and effective communication
  - Oversight of project implementation Acquisition
  - Make recommendations to District Engineer
- **Participants**
  - Project Manager
  - Senior representatives (sponsor & government
  - Co-chaired by PM & sponsor
  - Technical expertise as required

Implementation Procedures

- **Required by PPA**
- **Purpose**
  - Provide consistent and effective communication
  - Oversight of project implementation Acquisition
  - Make recommendations to District Engineer
- **Participants**
  - Project Manager
  - Senior representatives (sponsor and government)
  - Co-chaired by PM and Local Sponsor
  - Technical expertise as required

Implementation Procedures Manual

- **Purpose**
  - Describes and documents how project will be implemented
  - Allows for consistent implementation
- **Contents**
  - Description of processes
  - Samples of all working documents
- **Execution - Memorandum of Agreement (MOA)**

Determination of Implementation Procedures

- Design
- Cost Estimates
- Construction (Contracting Procedures)
- Construction inspection
- Method of Payment
- Closeout
- Operation and Maintenance (O&M)

Design – General Overview

- **Methods**
  - Traditional (USACE)
  - Nontraditional (USACE)
  - Nontraditional (Homeowner)

- **Advantages/Disadvantages**
  - Cost
  - Liability
  - Quality
  - Timeliness

Design – Traditional (USACE)

- **Traditional - Detailed design and specifications (USACE or AE)**
- **Advantages**
  - Total control of design
  - More accurate Independent Government Estimates (IGE) and contractor proposals
  - Easier inspections
  - Timeliness
- **Disadvantages**
  - Longer preparation time Liability
  - Higher design cost
  - Increased risk of change order
  - Limited flexibility
  - Liability issues

Design – Nontraditional (USACE)

- **Nontraditional** – Guide Plans and Specifications provided to homeowner (USACE or AE).
  - Utilizes a scope of work, diagrammatic drawings, and standardized details and specifications.
  - Relies on competent contractors.

- **Advantages**
  - Design consistency
  - Standardized design/details
  - Reduced design cost
  - Less time to prepare
  - More flexible
  - Reduced liability

- **Disadvantages**
  - Inconsistency in final product
  - Difficult to do change order

Design – Nontraditional (Homeowner)

- **Nontraditional** – Homeowner's AE prepares design.
  - Flood proofing criteria provided to homeowner.
  - Based on Flood Proofing criteria, NFIP and building codes.
- **Advantages**
  - Total control of design
  - More accurate/consistent cost estimates and contractor proposals
  - Easier inspections
  - Reduced liability for Government
  - Reduced design cost
- **Disadvantages**
  - Inconsistency in final product
  - Timeliness

Cost Estimating (USACE)

- **Independent Government Estimate (IGE)**

- **Methods**
  - Manual
  - Combination Manual/computer generated
  - Computer generated (cost model)

- **Advantages / Disadvantages**
  - Cost
  - Quality
  - Consistency
  - Timeliness

Construction-Traditional (USACE Contract)

- **Traditional** – Construction performed by Government Contractor (USACE)
- **Advantages**
  - Multiple structures under one work order
  - Ability to assure reputable contractors
  - Warranties, bonding, release of liens, etc
- **Disadvantages**
  - Higher costs
  - Increased government liability
  - Meet FARS & Davis Bacon wages
  - Increased administrative cost
  - Limited opportunity for local (small) contractors

Construction
Nontraditional (Homeowner Contract)

- **Nontraditional** – Construction performed by homeowners' contractor (Real Estate Flood Proofing Agreement). Homeowner responsible for contractor performance
- **Advantages**
  - Government liability significantly reduced
  - FARS/Davis Bacon not required
  - Lower construction cost
  - More opportunity for local (small) contractors
- **Disadvantages**
  - Usually one structure per agreement
  - Limited economy of scale
  - Limited quality control
  - Timeliness

Inspection – Traditional (USACE)

- **Traditional** – Government inspector required to regularly be on site (USACE or AE)
- **Advantages**
  - Excellent Quality control
- **Disadvantages**
  - High cost
  - High government Liability

Inspection - Nontraditional (USACE/Homeowner)

- **Nontraditional** (Inspection by homeowner)
  - Homeowner and local code enforcement (where applicable) responsible for contractor performance
  - Government inspection (verification) required at designated stages of construction
- **Advantages**
  - Low cost
  - Low government Liability
- **Disadvantages**
  - Poor quality control

Inspection – Nontraditional (Homeowner/AE)

- **Nontraditional** – Inspection performed by homeowner's AE
  - Homeowner's AE and local code enforcement (where applicable) responsible for contractor performance

- **Advantages**
  - Low cost
  - Minimal government liability

- **Disadvantages**
  - Inconsistent quality control
  - Possible coercion

Payment Process

Traditional

- Progress payments
- Potential delays due to processing
- Significant documentation required

Nontraditional

- No progress payments
- Full payment made at closing
- Minimal documentation required

Landowners Meeting

- After Executed PPA and post PPA activities
- Required by PL 91-646 (for acquisitions only)
- Public meeting, workshop or both
- Project scope
- Acquisition procedures described
- Flood Proofing procedures described
- Identification of eligible structures
- Initiation of application process for participation

Application Process (Real Estate)

- Homeowner must apply to participate (unless mandatory)

- Tenants must also apply

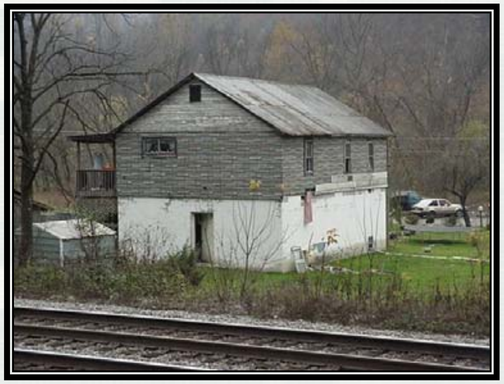
- Application acts as right-of-entry
- Real Estate verifies ownership and identifies any deed problems (tax liens, mortgages etc.)

HTRW / Asbestos Inspections

- Concurrent with verification of application
- Conducted during implementation for residential structures
- Phase I inspections conducted during study phase for NR
- Asbestos impacted by flood proofing removed at project cost
- HTRW to be impacted by flood proofing must be remediated by homeowner prior to initiation of project, structures may drop out at this point (possible impact to BC)

Decent Safe and Sanitary Issues

- Required by PL 91-646 for acquisitions
- Flood Proofers provided with same benefits
- Typically involves sanitary disposal
- Potable water
- Inspections conducted by local health departments



Implementation Process

- Site Visit (Implementation Team)
- Prepare design (GP&S)
- Deliver design to homeowner
- Homeowner solicits proposals
- Prepare Government estimate (IGS)
- Compare IGS, Contractor proposals & negotiate.
- Flood proofing Agreement

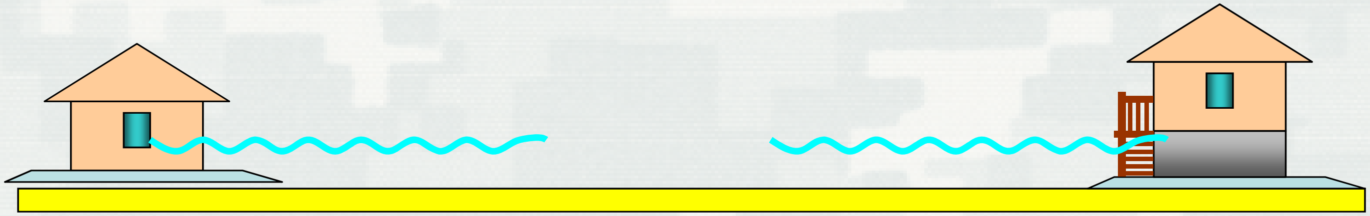
Construction Cost Estimate

- Micro Computer Aided Cost Engineering System (MCASES), 2nd Generation (MII)
- Districts moving toward using a Cost Model specifically developed for Flood Proofing Implementation.
  - Based on detailed design or guide plans
  - Models based on structure specific information
  - Estimates meet all cost estimating requirements and guidelines in current Corps regulations and technical publications. (ER 1110-2-1302 Civil Works Cost Engineering)
  - Produces a labor, equipment, material, and supply breakdown for line items of work in construction cost estimates
  - Estimates will support any contracting method.

Flood Proofing Agreement

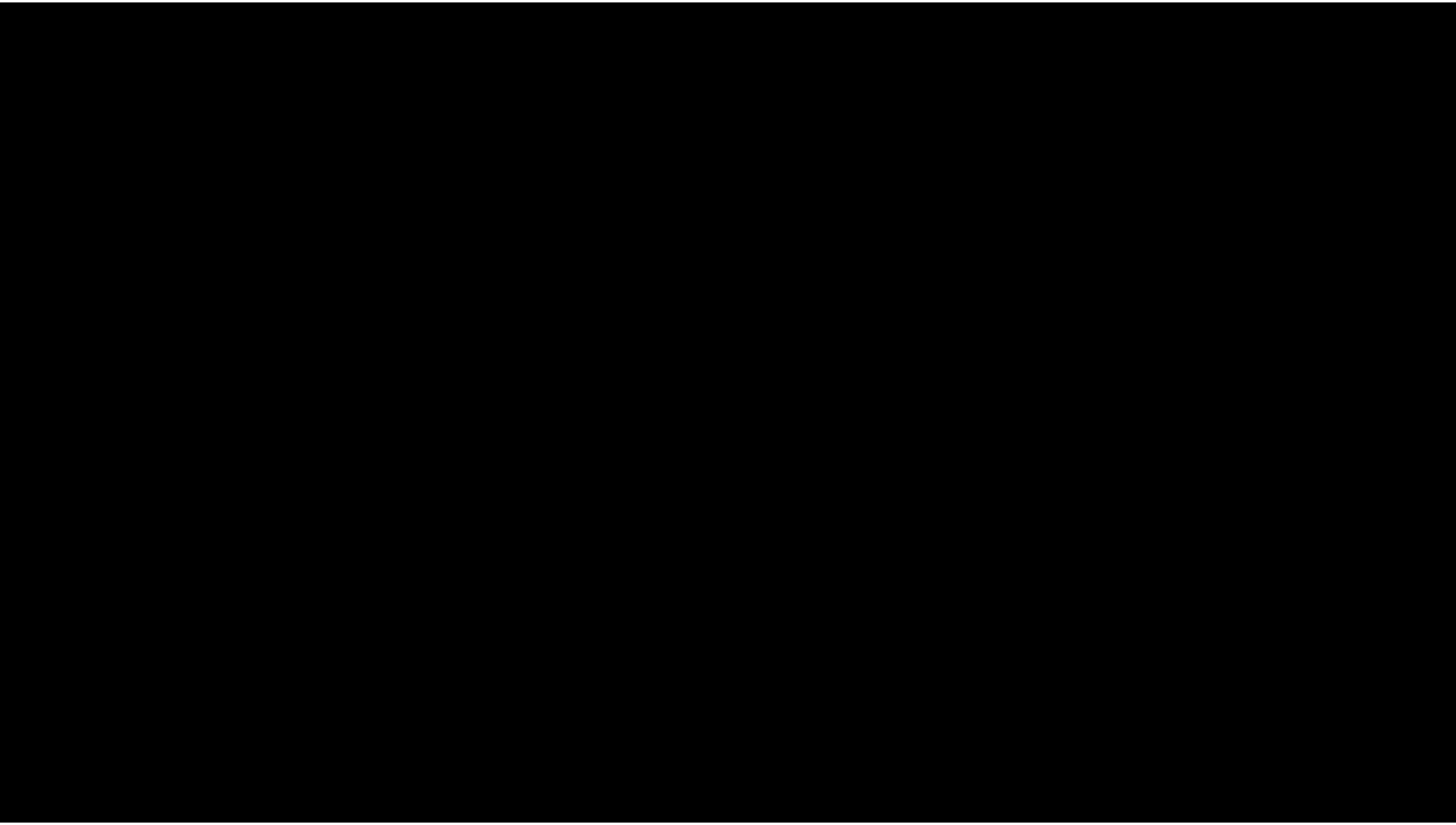
- Must have RE administrative approval from HQ
- Contract between government and homeowner
- Authorizes homeowner to have structure flood proofed
- Identifies not-to-exceed amount
- Identifies contractor
- Restricts future development
- Recorded with elevation certificate

Flood Proofing Implementation Process



PPA
Meeting
Application
Ownership
Sanitation (DSS)
HTRW
Site Visit
Design
Deliver
Cost Estimate
Proposal
Agreement (FPA)
Pre-Con
Construction
Pre-Final
Final
Closing
Record
Sponsor

Questions / Comments



Flood Risk Management with Nonstructural Flood Proofing Techniques

Pocket Tool: Planning Matrix for Screening Alternatives

Randall Behm P.E., CFM
USACE-Omaha
Flood Risk and Floodplain Management

US Army Corps of Engineers
BUILDING STRONG®

DING STRONG®

FLOOD DAMAGE REDUCTION MATRIX

	FLOOD DAMAGE REDUCTION MATRIX	FLOOD DAMAGE REDUCTION MEASURES																		
		NON-STRUCTURAL MITIGATION MEASURES															STRUCTURAL MITIGATON MEASURES			
														NFIP						
		Elevation on Foundation Walls	Elevation on Piers	Elevation on Posts or Columns	Elevation on Piles	Elevation on Fill	Relocation	Buyout/ Acquisition	Floodwalls and Levees	Floodwalls and Levees with Closures	Dry Flood Proofing	Wet Flood Proofing	Flood Warning Preparedness	Flood Plain Regulation	Flood Insurance	Flood Mitigation 1	Channel	Levee/Wall	Dams	Diversions
Flooding Characteristics	**Flood Depth**																			
	Shallow (<3 ft)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Moderate (3 to 6 ft)	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Deep (greater than 6 ft)	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Flood Velocity																			
	Slow (less than 3 fps)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Moderate (3 to 5 fps)	N	N	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y
	Fast (greater than 5 fps)	N	N	N	Y	N	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y
	Flash Flooding																			
	Yes (less than 1 hour)	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
	No	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Ice and Debris Flow																			
	Yes	N	N	N	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y
	No	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Site Characteristics	**Site Location**																			
	Coastal Flood Plain																			
	Beach Front	N	N	N	Y	N	Y	Y	N	N	N	N	Y	Y	Y	Y	N	[illegible]	N	N
	Interior (Low Velocity)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N
	Riverine Flood Plain	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Soil Type																			
	Permeable	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Impermeable	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Building Characteristics	**Structure Foundation**																			
	Slab on Grade	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Crawl Space	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Basement	Y	N	N	N	N	Y	Y	Y	Y	N	Y	Y	y	Y	Y	Y	Y	Y	Y
	Structure Construction																			
	Concrete or Masonry	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Metal	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Wood	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Structure Condition																			
	Excellent to Good	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Fair to Poor	N	N	N	N	N	N	Y	Y	Y	N	N	Y	Y	Y	[illegible]	Y	Y	Y	Y
NED/NER/Recreation/Social Characteristics	**Economic**																			
	Structure Protected	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	[illegible]	N	Y	Y	Y	Y	Y
	Cost to Implement	M	M	M	M	M	H	H	M	M	L	L	L	L	L	H/M	H	H	H	H
	Potential Flood Insurance Cost Reduction (Residential)	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	Y	-	Y	Y	Y	Y	Y
	Potential Flood Insurance Cost Reduction (Commercial)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	-	Y	Y	Y	Y	Y
	Potential Adverse Flooding Impact on Other Property	N	N	N	N	Y	N	N	Y	Y	N	N	N	Y	N	N	Y	Y	Y	Y
	Reduction in Admin Costs of NFIP	N	N	N	N	Y	Y	Y	N	N	N	N	N	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Reduction in Costs of Disaster Relief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Reduction in Emergency Costs	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	3	Y	Y	Y	Y
	Reduction in Damage to Public Infrastructure	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	3	Y	Y	Y	Y
	Potential for Catastrophic Damages if Design Elevation Exceeded	N	N	N	N	N	N	N	Y	Y	Y	N	N	N	N	N	N	Y	Y	N
	Promotes Flood Plain Development	N	N	N	N	N	N	N	N	N	N	N	N	N	[illegible]	N	Y	Y	Y	Y
	Environmental																			
	Ecosystem Restoration Possible	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N
	Potential Adverse Environmental Impact	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y
	Recreation																			
	Recreation Potential	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	3	N	N	Y	N
	Social																			
	Community Remains Intact	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	[illegible]	Y	Y	Y	Y
	Population Protected	N	N	N	N	N	Y	Y	N	N	N	N	Y	N	N	3	Y	Y	Y	Y
	Potential Structure Marketability Increase	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	[illegible]	N	Y	Y	Y	Y	Y

Flood Damage Reduction Matrix

- Planning Tool
- Quick Reference Guide for Field Assessment
- Considers Nonstructural as well as Structural Measures
- Automation in Progress
  - http://www.usace.army.mil/Missions/CivilWorks/ProjectPlanning/nfpc.aspx
  - Assess one structure at a time
  - Laptop accessible
  - Future capability as app for downloading to tablets and phones

Flood Damage Reduction Matrix

February 2015	FLOOD DAMAGE REDUCTION MEASURES																		
	NONSTRUCTURAL MITIGATION MEASURES															STRUCTURAL MITIGATON MEASURES			
													NFIP						
FLOOD DAMAGE REDUCTION MATRIX	Elevation on Foundation Walls	Elevation on Piers	Elevation on Posts or Columns	Elevation on Piles	Elevation on Fill	Relocation	Buyout/ Acquisition	Floodwalls & Levees	Floodwalls & Levees w/ Closures	Dry Flood Proofing	Wet Flood Proofing	Flood Warning Preparedness	Flood Plain Regulation	Flood Insurance	Flood Mitigation 1	Channel	Levee/Wall	Dams	Diversions

Flood Characteristics

Flooding Characteristics	**Flood Depth**																			
	Shallow (<3 ft)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Moderate (3 to 6 ft)	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Deep (greater than 6 ft)	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Flood Velocity																			
	Slow (less than 3 fps)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Moderate (3 to 5 fps)	N	N	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y
	Fast (greater than 5 fps)	N	N	N	Y	N	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y
	Flash Flooding																			
	Yes (less than 1 hour)	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
	No	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Ice and Debris Flow																			
	Yes	N	N	N	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y
	No	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Site Characteristics

Site Characteristics	**Site Location**																			
	Coastal Flood Plain																			
	Beach Front	N	N	N	Y	N	Y	Y	N	N	N	N	Y	Y	Y	Y	N	2	N	N
	Interior (Low Velocity)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N
	Riverine Flood Plain	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Soil Type																			
	Permeable	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Impermeable	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Building Characteristics

Building Characteristics	**Structure Foundation**																			
	Slab on Grade	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Crawl Space	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Basement	Y	N	N	N	N	Y	Y	Y	Y	N	Y	Y	y	Y	Y	Y	Y	Y	Y
	Structure Construction																			
	Concrete or Masonry	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Metal	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Wood	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Structure Condition																			
	Excellent to Good	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Fair to Poor	N	N	N	N	N	N	Y	Y	Y	N	N	Y	Y	Y	3	Y	Y	Y	Y

Economic, Environmental, Recreation, and Social Characteristics

NED/NER/Recreation/Social Characteristics

Economic																			
Structure Protected	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	5	N	Y	Y	Y	Y	Y
Cost to Implement	M	M	M	M	M	H	H	M	M	L	L	L	L	L	H/M	H	H	H	H
Potential Flood Insurance Cost Reduction (Residential)	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	Y	-	Y	Y	Y	Y	Y
Potential Flood Insurance Cost Reduction (Commercial)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	-	Y	Y	Y	Y	Y
Potential Adverse Flooding Impact on Other Property	N	N	N	N	Y	N	N	Y	Y	N	N	N	Y	N	N	Y	Y	Y	Y
Reduction in Admin Costs of NFIP	N	N	N	N	Y	Y	Y	N	N	N	N	N	6	-	3	7	7	7	7
Reduction in Costs of Disaster Relief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Reduction in Emergency Costs	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	3	Y	Y	Y	Y
Reduction in Damage to Public Infrastructure	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	3	Y	Y	Y	Y
Potential for Catastrophic Damages if Design Elevation Exceeded	N	N	N	N	N	N	N	Y	Y	Y	N	N	N	N	N	N	Y	Y	N
Promotes Flood Plain Development	N	N	N	N	N	N	N	N	N	N	N	N	N	8	N	Y	Y	Y	Y
Environmental																			
Ecosystem Restoration Possible	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N
Potential Adverse Environmental Impact	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y
Recreation																			
Recreation Potential	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	3	N	N	Y	N
Social																			
Community Remains Intact	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	4	Y	Y	Y	Y
Population Protected	N	N	N	N	N	Y	Y	N	N	N	N	Y	N	N	3	Y	Y	Y	Y
Potential Structure Marketability Increase	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	5	N	Y	Y	Y	Y	Y

Matrix Example Residential Structure

Example Use of Nonstructural Matrix

Matrix Characteristic	Assessment
Flood Depth - Shallow (less than 3 feet)	Y
Flood Velocity – Slow (less than 3 fps)	Y
Flash Flooding – Yes (less than 1 hour)	Y
Site Location – Riverine Floodplain	Y
Soil Type - Permeable	Y
Structure Construction – Wood	Y
Economics – Potential Flood Insurance Cost Reduction	Y
Social – Community Remains Intact	Y

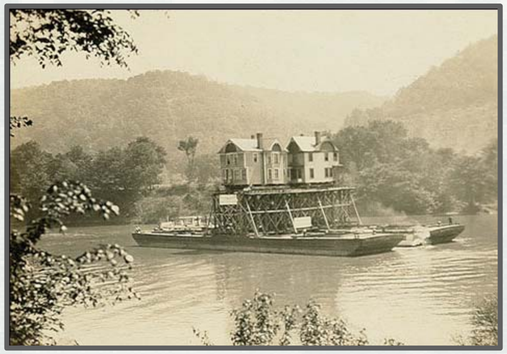
Potential Measure = Elevation on Extended Foundation Walls

Matrix Example Result: Elevation on Foundation Walls

1st Floor Shifted with Elevation

Elevation on Foundation Walls

(before)



QUESTIONS?