Need for Innovation

- To address recommendations from:
  - The National Academy of Sciences
  - Technical Mapping Advisory Council
  - BW-12 and HFIAA 2014

- To explore additional initiatives that could help advance program objectives
Recap of ASFPM 2017 – Innovations Part 1

- Database-Derived Digital Display Environment: Geodatabase Gap Analysis
- Regulatory-Quality WSEL Grids (“Point & Click BFEs”): Feasibility
- Structure-Level Risk: Data and Methodology Investigations
- 2D Modeling: Zone AE Model Upgrade and Floodway Best Practices
- Flood Hazard Modeling Parameters: Impact on BFEs and Top Width
- Mitigation Decision Support System (MDSS) Scenario Templates
Recap of ASFPM 2017 – Innovations Part 1

Database-Derived Digital Display Environment: Geodatabase Gap Analysis

Regulatory-Quality WSEL Grids (“Point & Click BFEs”): Feasibility

Current Status: Additional Analysis

Current Status: FRP Integration and Pilots
Recap of ASFPM 2017 – Innovations Part 1

Structure-Level Risk: Data and Methodology Investigations

2D Modeling: Zone AE Model Upgrade and Floodway Best Practices

Current Status: Additional Analysis

Current Status: Additional Analysis
Recap of ASFPM 2017 – Innovations Part 1

Flood Hazard Modeling Parameters: Impact on BFEs and Top Width

- Structures on Streams?
  - Yes
    - Type of Terrain: Hilly
      - Variable of Concern: Top Width
        - Methods to Use: BCB Manning’s
    - Type of Terrain: Rolling / Flat
      - Variable of Concern: Depth or Top Width
        - Methods to Use: BCB Manning’s, No Structures
  - No

- Current Status: Complete

Mitigation Decision Support System (MDSS) Scenario Templates

- Current Status: Additional Analysis
Innovations Part 2

- Probabilistic Modeling Simulations
- Mitigation Decision Support System
- Point-and-Click WSEL Grid Pilots
Probabilistic Modeling
Innovation Purpose

- Although most Flood Risk Projects have typically used a “deterministic” analysis of multiple events, they have rarely considered the uncertainty that inherently exists in much of the hydrology and hydraulics of the analysis.
- By leveraging advances in hardware and software, the probabilistic modeling, mapping, and risk assessment approach is able to do a more comprehensive and credible analysis of the flood hazard than has traditionally been performed.
Probabilistic Approach

Hydraulics

Loss Calculations

Hydrology
Hydrologic Uncertainty

![Discharge-Probability Curve](image)

- **Typical modeled event**
- **95% Confidence (Upper Limit)**
- **5% Confidence (Lower Limit)**
Annual Exceedance Probability Grid vs. 1-Percent-Annual-Chance Line (Deterministic)

- **Probabilistic Approach**: uncertainties considered, wide range of possible flood scenarios, credible risk gradation
- **Deterministic (Current) Approach**: No uncertainties, focused on 1%-annual chance flood, no risk gradation
Risk Behind Levees

- Probabilistic approach can consider accredited, breaching, and natural valley levee scenarios (each with associated probabilities)

**Natural Valley**

<table>
<thead>
<tr>
<th>Annual Exceedance Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;50% (~2yr)</td>
</tr>
<tr>
<td>50-10% (~2-10yr)</td>
</tr>
<tr>
<td>10-4% (~10-20yr)</td>
</tr>
<tr>
<td>4-2% (~20-50yrs)</td>
</tr>
<tr>
<td>2-1% (~50-100yrs)</td>
</tr>
<tr>
<td>1-0.5% (~100-500yrs)</td>
</tr>
<tr>
<td>0.5-0.1% (~500-1500yrs)</td>
</tr>
<tr>
<td>0.1-0.0417% (~1500-3000yrs)</td>
</tr>
<tr>
<td>&lt;0.0417% (~2500yrs)</td>
</tr>
</tbody>
</table>

**Accredited (w/ Levee)**

<table>
<thead>
<tr>
<th>Annual Exceedance Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;50% (~2yr)</td>
</tr>
<tr>
<td>50-10% (~2-10yr)</td>
</tr>
<tr>
<td>10-4% (~10-20yr)</td>
</tr>
<tr>
<td>4-2% (~20-50yrs)</td>
</tr>
<tr>
<td>2-1% (~50-100yrs)</td>
</tr>
<tr>
<td>1-0.5% (~100-500yrs)</td>
</tr>
<tr>
<td>0.5-0.1% (~500-1500yrs)</td>
</tr>
<tr>
<td>0.1-0.0417% (~1500-3000yrs)</td>
</tr>
<tr>
<td>&lt;0.0417% (~2500yrs)</td>
</tr>
</tbody>
</table>

AAL: $1,420

AAL: $24
Probabilistic Modeling – Pilot Areas

- **Souris River**
  - Minot, ND

- **Red River**
  - Bossier Levee, LA

- **New River & Burnt Mill Creek**
  - Wilmington, NC

- **Meramac River**
  - St. Louis, MO

- **Mississippi River**
  - East St. Louis, IL
  - Multiple Leveed Areas in Southern Louisiana
Probabilistic Mapping – Benefits

▸ More comprehensive analysis of the flood hazard –
  • 50% (2-yr) to the 0.05% (2000-yr) annual chance or greater

▸ More credible analysis of the flood hazard –
  • Modeled scenarios consider multiple uncertainties

▸ Increased confidence in the probability at which a flood would reach a structure’s first floor elevation

▸ More accurate flood risk and annualized loss estimates

▸ Improved way to look at risk behind levees

▸ True multi-frequency grid outputs
  • WSEL, depth, velocity, and depth * velocity
  • Applications in both pre- and post-disaster environments
More In-Depth Discussion:
Session E1: 1:30pm on Wednesday, June 20
Mitigation Decision Support System (MDSS)
Innovation Purpose

- The Mitigation Decision Support System (MDSS) is being designed to help communities select the best options for mitigation. The tool, designed to be deployed on an iPad, allows creation of what-if scenarios, and evaluation of those scenarios using detailed flood data.
MDSS – Estimating Flood Depth from Storm Size

1. Flood depth rasters for 10, 25, 50, 100, and 500 year storms

2. Real Structure – frequently flooded

3. Identify tool on the structure gives depth at each return period

4. NOAA Atlas 14 gives 24 hour rain for given return period. Eg. 6.02" for 10 year return period/24 hour storm

5. Assessment provides a rain-to-flood depth curve for the structure in question.
MDSS – Incorporating Climate

- Simulate Storm Events from present to 2050
- Rain projection is built from latest general circulation model projections from multiple centers around the world. All models run UN IPCC Green House Gas control scenarios.
- Includes shifts in storm size and frequency – capturing never before seen storms and droughts.
- Uses “ensemble” prediction to capture uncertainty: incorporates all model-scenarios as well as stochastic bootstrapping to create 1000 projections that are all evaluated.

Flooding threshold after elevation
Rainfall from 500-yr storm
Flooding threshold before elevation

Hurricane Matthew
Comparing Mitigation Options

- Add multiple scenarios to compare options
- Final comparison shows cost, losses avoided, and ROI comparison.
- Uncertainty is shown through providing distributions of Losses Avoided and ROI.
- A list of “Plain English” observations is provided to help interpret the results.
MDSS - Process

Community selected structure to elevate

Using online databases of housing value and cost, replacement costs, rain forecast, and flood risk, the tool can automatically build input data for a long terms flood forecast simulation.

Tool evaluates ROI for multiple elevation levels.

Tool evaluates results and summarizes finding automatically

Based on findings, community can specify the elevation level they want to use for each structure.
Point-and-Click WSEL Grid Pilots
Innovation Purpose

- Identify and produce Water Surface Elevation (WSEL) Grids that meet the quality requirements of the new FEMA standard on WSEL Grids (SID 415), and that can be used as an input to help CDS build a tool that can automate the checking of those grids.
WSEL Grid Pilots

- Duval Co, FL
- Harris Co, TX

and Others…

(based on Effective data)
WSEL Grid QC Checks

- Development of a WSEL Grid QC Checklist
- Collaboration between PTS and CDS on ongoing development of an automated WSEL Grid QC tool (version 1.0 planned for Summer/Fall of 2018)
Upcoming/Ongoing Innovations

▸ Additional Probabilistic Modeling Pilots
▸ Urban/Pluvial (Rainfall) Flooding Pilots
▸ Continued Evaluation, Analyses, and Piloting of Transition Towards Database-Derived Digital Display Environment
▸ MDSS Development Advancement
▸ Continued Advancement Towards Point-and-Click WSEL Data and Structure-Level Risk
▸ Velocity Grid Creation Pilots and Impacts on Building Science Use