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Understanding Consequences in the Dam Safety Periodic Assessment (PA) Process

03 September 2015

PCoP Webinar Series

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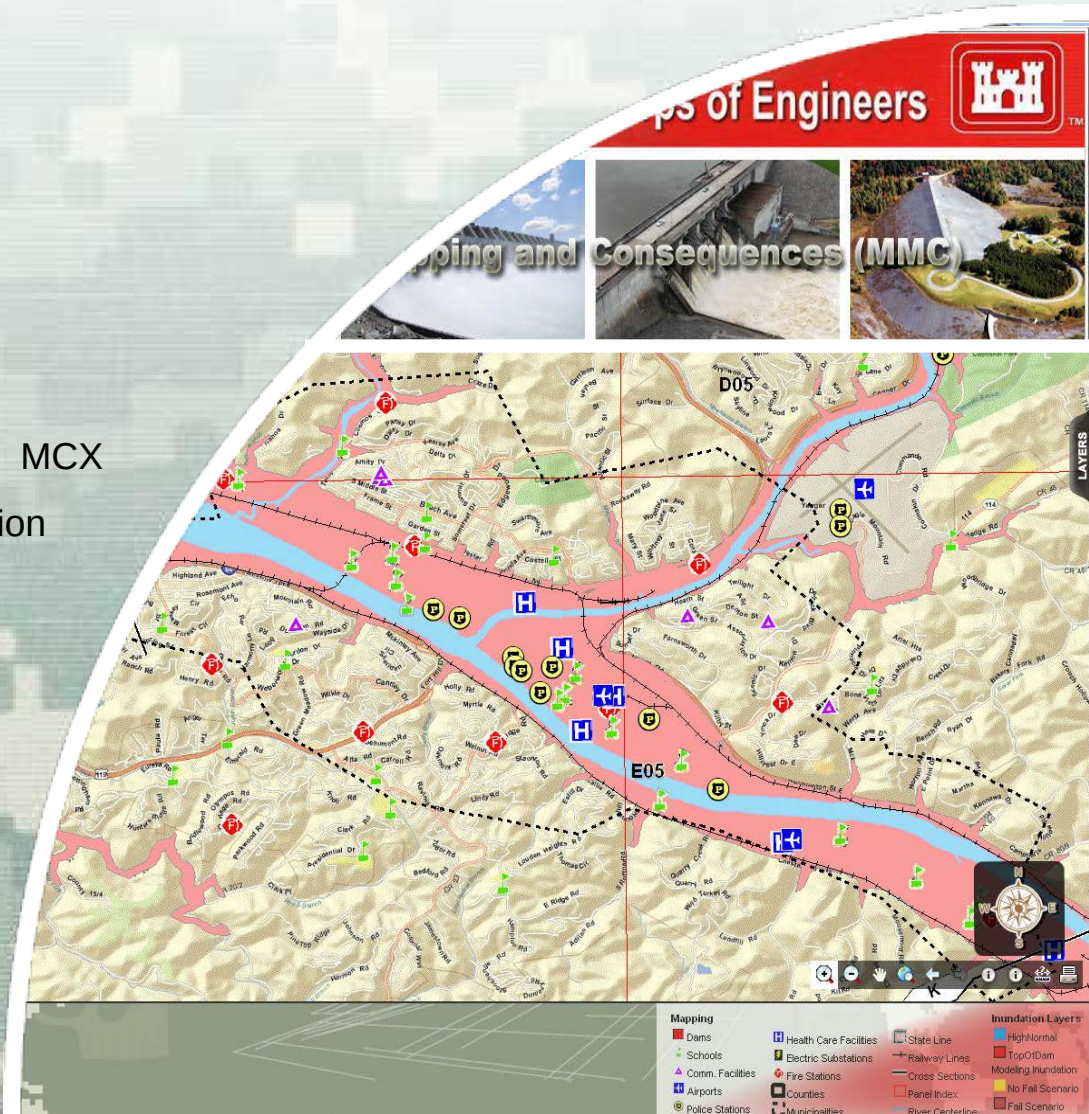
Modeling, Mapping and Consequences (MMC) MCX

Planning Center of Expertise for Inland Navigation

Huntington District



Agenda

- Overview of the Risk Assessment Process in Dam Safety
- Consequences in Risk Assessment
- Using MMC Products to Estimate Consequences
- The District Economist Role

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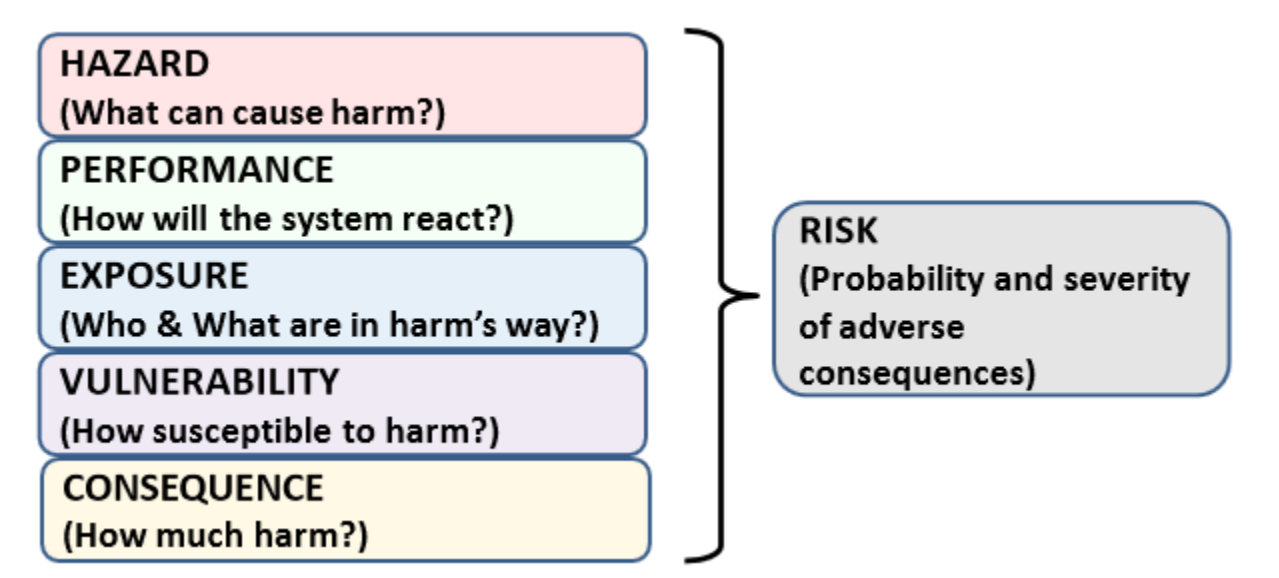
What is Risk?

Risk = Likelihood x Consequences



ER 1110-2-1156 – Safety of Dams

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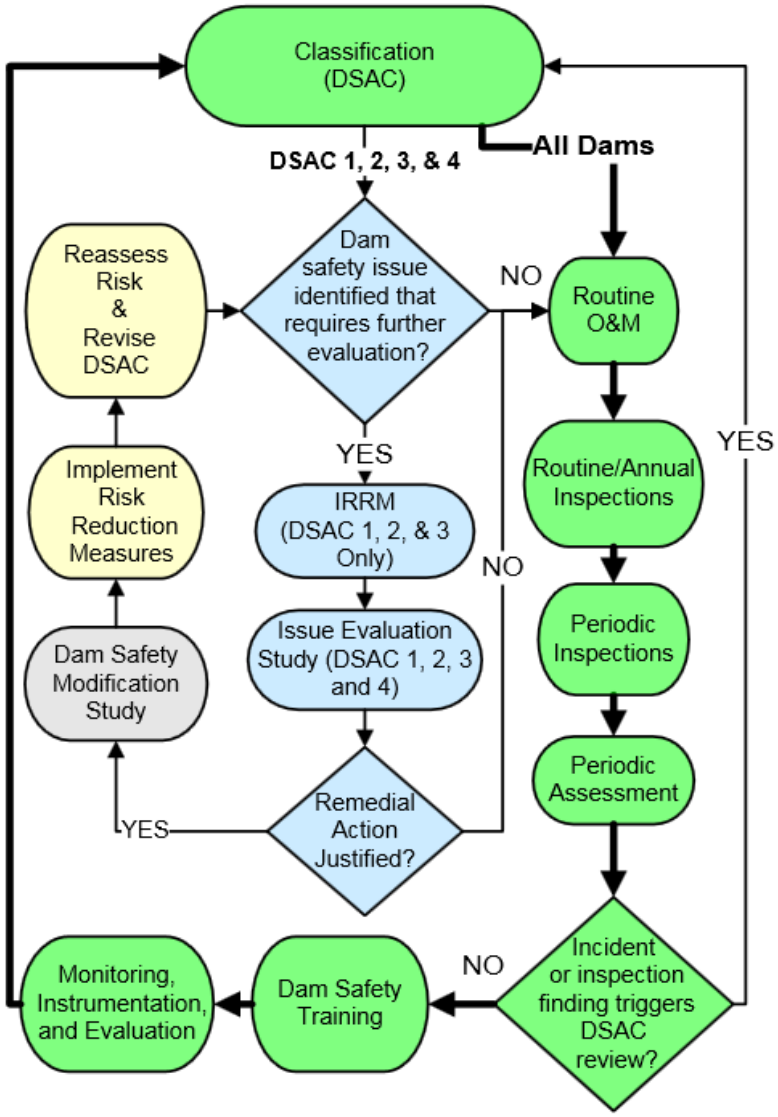
Generalized Dam Safety Portfolio Risk Management Process

U.S. Army Corps of Engineers



DSAC-Dam Safety Action Classification is a classification that depicts the degree of urgency in taking safety-related actions.

IRRM – Interim Risk Reduction Measures that are formulated and implemented for dams with risks that are not tolerable. IRRM are intended interim until more permanent risk reduction measures are implemented.

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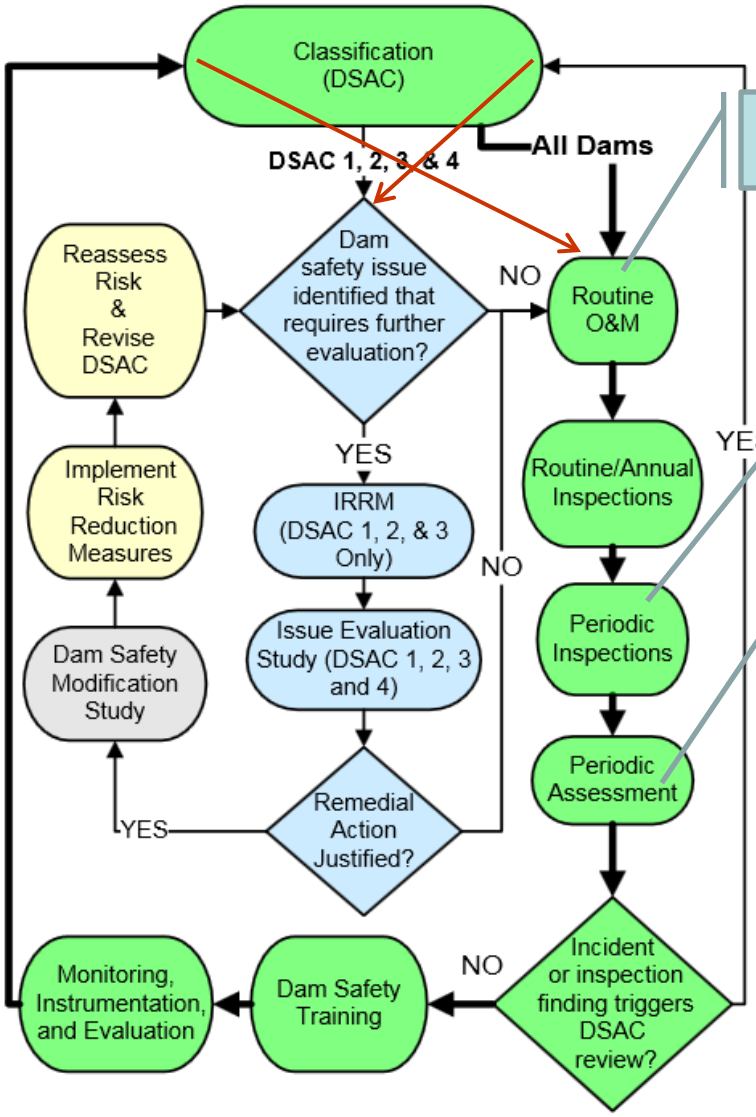
Generalized Dam Safety Portfolio Risk Management Process

U.S. Army Corps of Engineers



Safety
ification
ation
that depicts the degree of urgency in taking safety-related actions.

IRRM – Interim Risk Reduction
re
dams with risks that are not tolerable.
d
reduction measures are implemented.

Start

5 Years

10Years

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Types of Risk Assessment

- PI – Periodic Inspection
  - Every 5 years, no risk assessment
- PA – Periodic Assessment
  - Every 10 years
  - Semi-Quantitative Risk Assessment (SQRA)
- IES – Issue Evaluation Study
  - Triggered by an identified risk or high DSAC rating
  - Phase I – SQRA
  - Phase II – Quantitative Risk Assessment (QRA)
- Dam Safety Modification Study
  - Investigate alternatives to address risk

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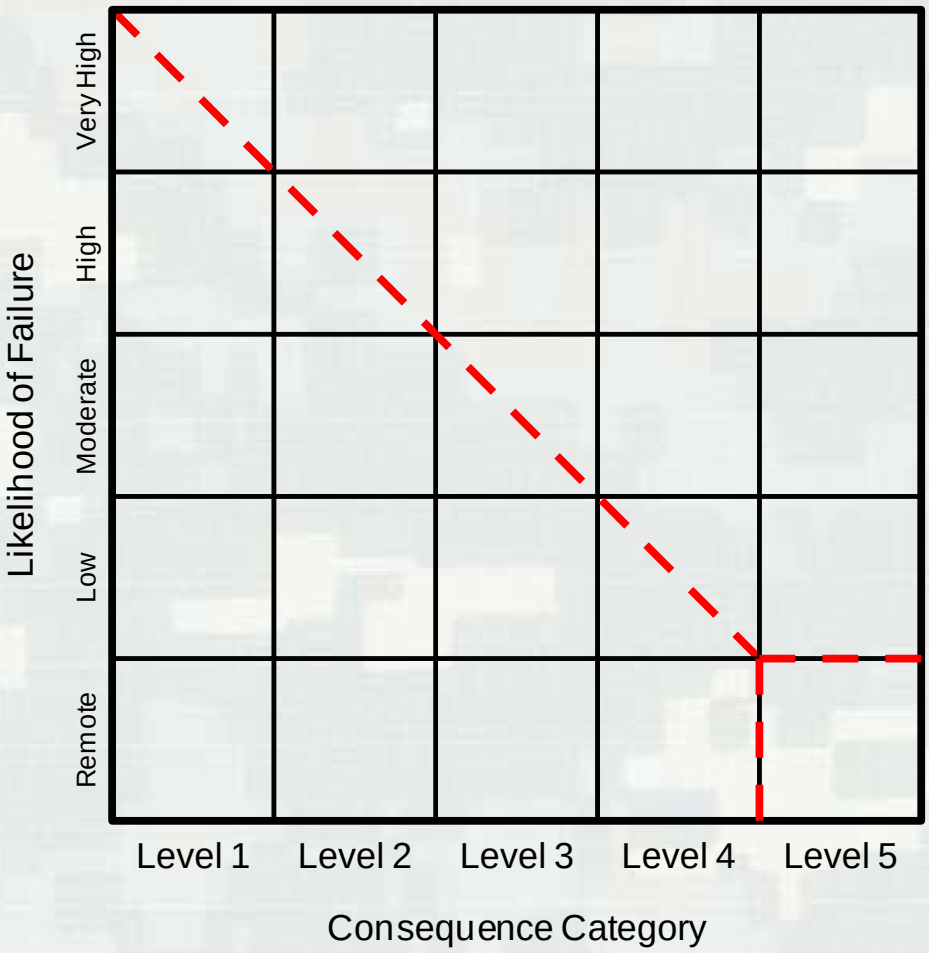
Semi-Quantitative Risk Assessment (SQRA)



Consequence Category	Severity of Consequences	Incremental Life Loss
1	Very Low	Unlikely
2	Low to Moderate	1 to 10
3	Moderate to High	10 to 100
4	High to Very High	100 to 1,000
5	Extremely High	> 1,000

Used for portfolio ranking and determination of whether further and more detailed analysis is necessary.

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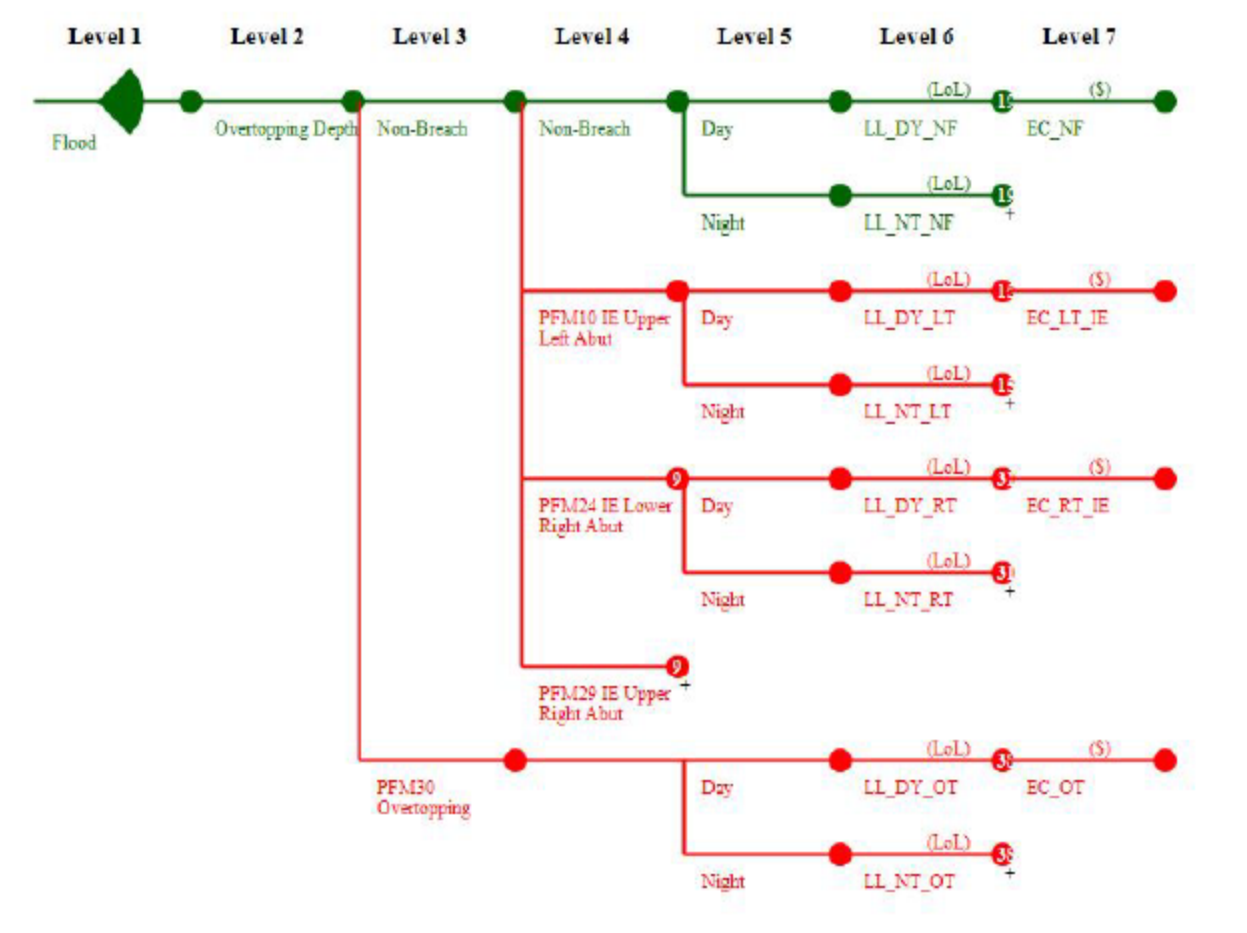
Quantitative Risk Assessment

Event Tree in DAMRAE (DAM-Risk Analysis Engine)



Level	Value
1	Probability of Pool
2 - 4	Probabilities of Breach and Overtopping
5	Time of Day
6	Life Loss (Day and Night)
7	Economic Damages

Outputs annualized expected life loss and damages

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Corps Consequence Process

- Consequences of Dam Breach
  - **Life Loss**
  - Direct Damage to Structures, Contents, Vehicles
  - Lost Benefits provided by the dam (hydropower, navigation, flood control, water supply, etc.)
  - Indirect impacts to local/regional/national economy
- HEC-FIA (Flood Impact Analysis)
  - Estimates life loss, calculates direct damage and indirect impacts
- Lost benefits calculated by economist

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Life Loss Methodology

FIA Parameter

Structure Inventory

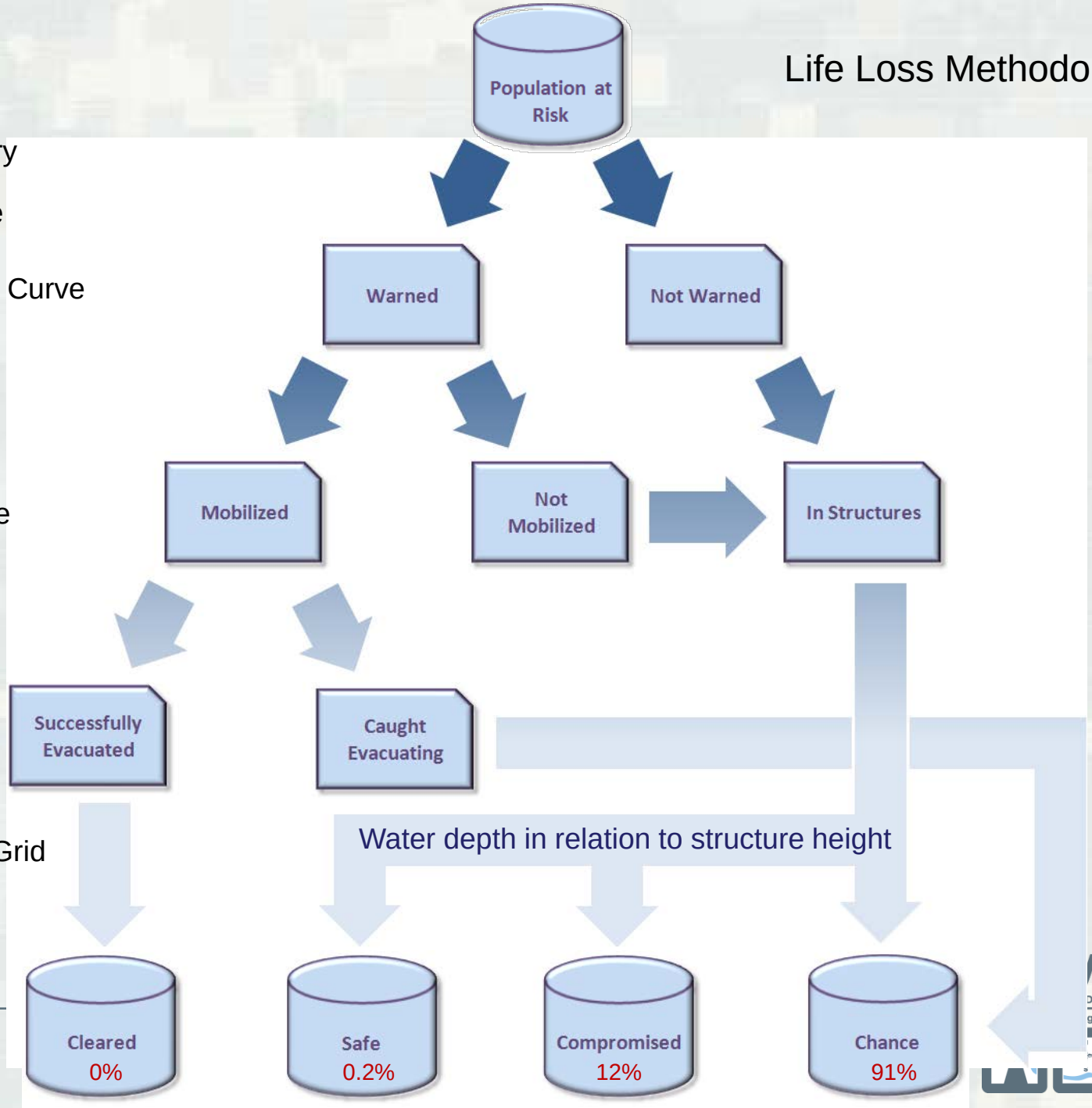
Warning Issuance

Warning Diffusion Curve

Mobilization Curve

Evacuation Time

Maximum Depth Grid



Level of Effort (Scope)

- Level of effort is proportional to the decision being made from the results
- Two main categories of consequence studies
  - **Standard Estimate**
    - Uses standardized data, parameters, and structure inventory
    - Used for portfolio risk ranking, semi-quantitative risk estimates (SQRA), and as a base for detailed estimates
  - Detailed Estimate
    - Hydraulics specific to probable failure modes
    - Structure inventory improvements (parcel data, point on structure, other data quality improvements)
    - Expert opinion elicitation of HEC-FIA/LIFESim parameters
    - Incorporation of uncertainty

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District Economist Tasks in PA

- Attend MMC webinar presentation of modeling
- Complete the Consequences Chapter of the PA Report (template on RADSII)
- Understand and be able to communicate the results from the consequence modeling
  - ► Where is life loss, what factors drive it
- Participate in Potential Failure Mode Analysis (PFMA) with PA team
- Help team estimate the consequence order of magnitude for each failure mode
- Understand uncertainty of the estimates

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MMC Standard Consequences

- HEC-RAS and HEC-FIA models developed and reviewed following MMC SOP
  - Statistical structure inventory based on census block level data and land cover
  - A range of warning times and mobilization curves are used
  - Lost benefits calculated from available data
- Consequence results are recorded in the CTS Worksheet
- MMC products presented to district PA team via webinar (~30 days prior to PA)

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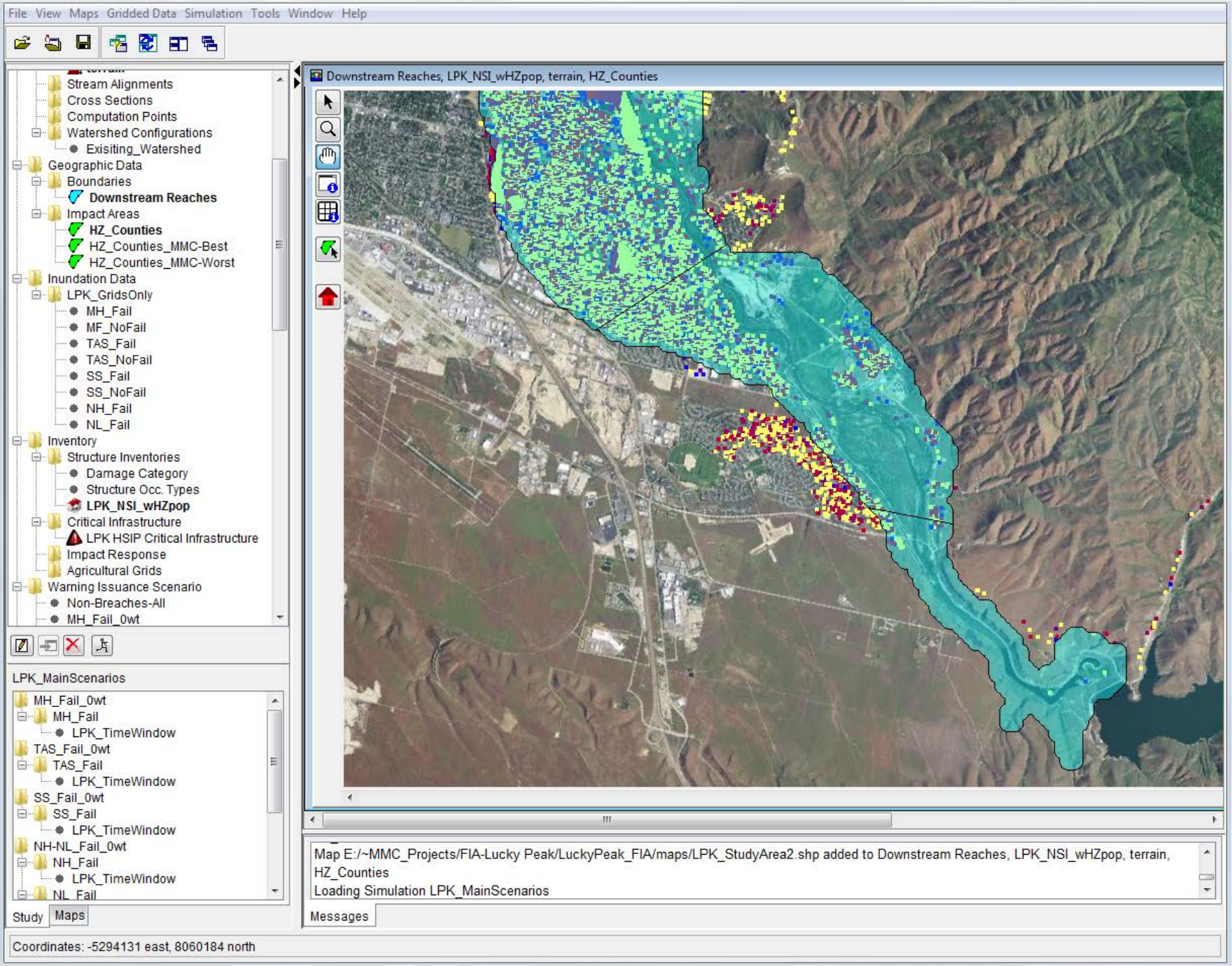
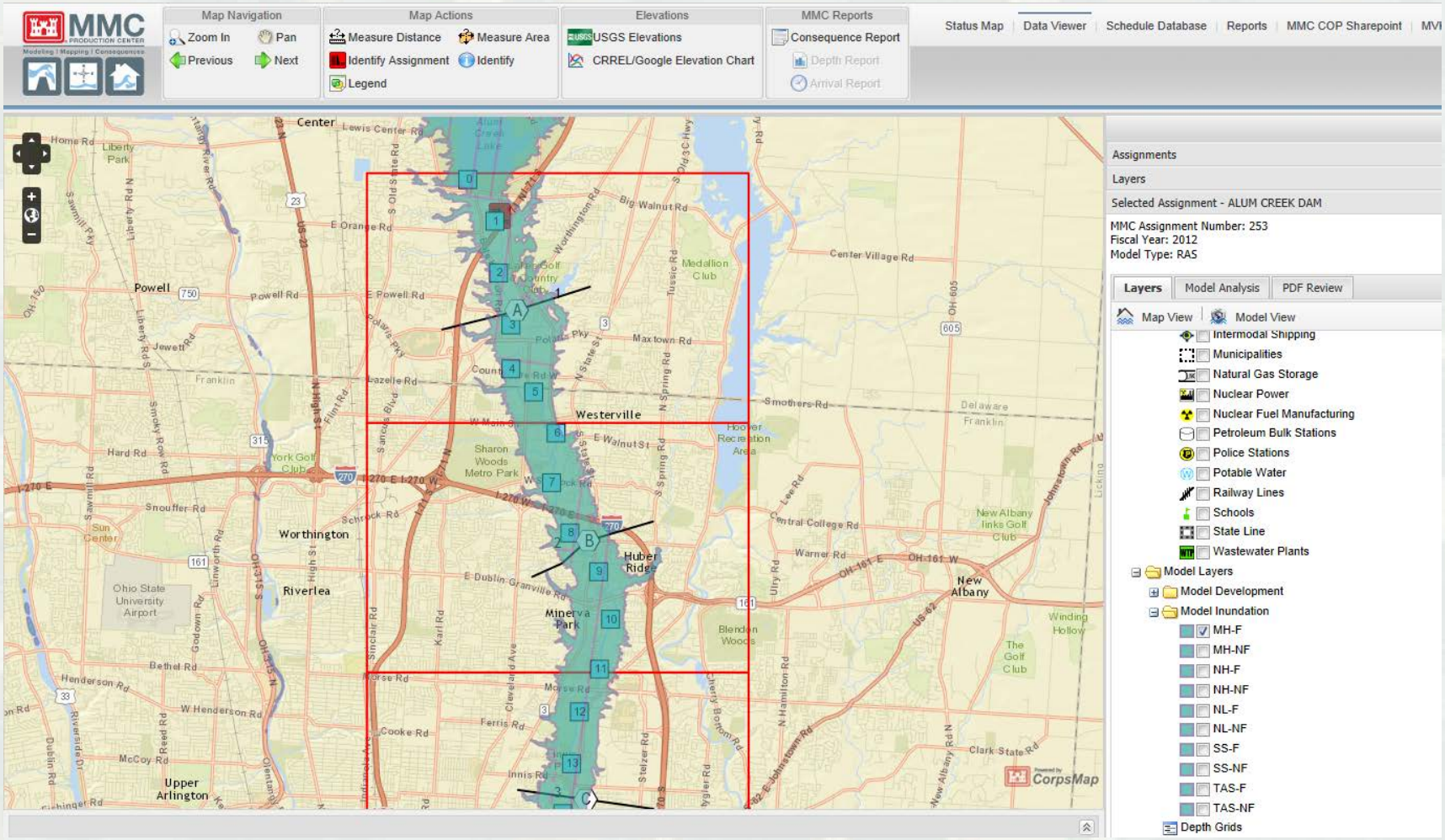

File View Maps Gridded Data Simulation Tools Window Help
Stream Alignments
Cross Sections
Computation Points
Watershed Configurations
Exisiting_Watershed
Geographic Data
Boundaries
Downstream Reaches
Impact Areas
HZ_Counties
HZ_Counties_MMC-Best
HZ_Counties_MMC-Worst
Inundation Data
LPK_GridsOnly
MH_Fail
MF_NoFail
TAS_Fail
TAS_NoFail
SS_Fail
SS_NoFail
NH_Fail
NL_Fail
Inventory
Structure Inventories
Damage Category
Structure Occ. Types
LPK_NSI_wHZpop
Critical Infrastructure
LPK HSIP Critical Infrastructure
Impact Response
Agricultural Grids
Warning Issuance Scenario
Non-Breaches-All
MH_Fail_0wt
LPK_MainScenarios
MH_Fail_0wt
MH_Fail
LPK_TimeWindow
TAS_Fail_0wt
TAS_Fail
LPK_TimeWindow
SS_Fail_0wt
SS_Fail
LPK_TimeWindow
NH-NL_Fail_0wt
NH_Fail
LPK_TimeWindow
NL_Fail
Study
Maps
Downstream Reaches, LPK_NSI_wHZpop, terrain, HZ_Counties
Map E:/~MMC_Projects/FIA-Lucky Peak/LuckyPeak_FIA/maps/LPK_StudyArea2.shp added to Downstream Reaches, LPK_NSI_wHZpop, terrain, HZ_Counties
Loading Simulation LPK_MainScenarios
Messages
Coordinates: -5294131 east, 8060184 north

MMC Map Viewer



https://maps.mmc.usace.army.mil:9443/DataViewer/map

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Life Loss Considerations

- Antecedent flooding may reduce life loss
  - Infrequent events with spillway flow typically have more advance warning and slower rates of rise, meaning many people will already be evacuated by the time a breach occurs
  - Non-breach is important to model so incremental values can be used for risk
  - “Double Warning” is often used to model how people will react to an early warning for spillway flow

- Breach prior to spillway flow often has highest potential life loss due to minimal advance flooding (Top of Active Storage scenario)

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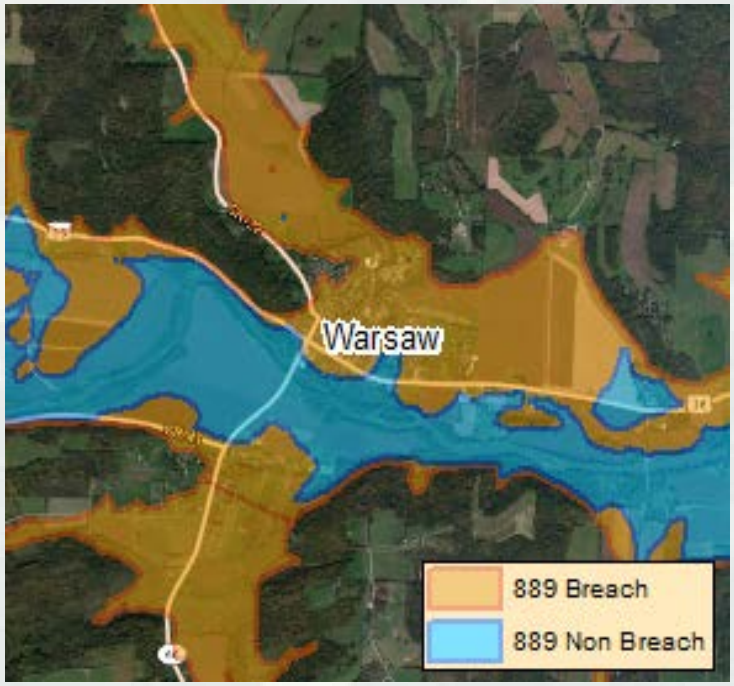
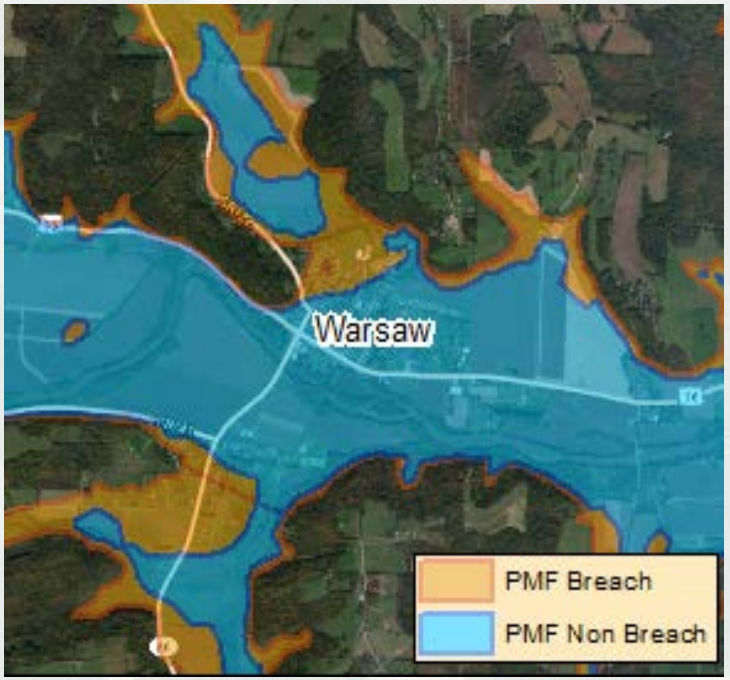
Example of Spillway Flow Effect



Minimal flooding before the breach



Most of the town flooded before the breach

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Life Loss Considerations

Remember: the MMC uses *standards*

What makes your area at risk unique?

- Dense urban areas vs. isolated rural areas
- Emergency response plans and regular exercises
- Critical Infrastructure (hospitals, schools, nursing, power, etc)
- Evacuation routes and available places to go
- Percent of populated areas that get flooded
- Availability of emergency resources, local trust in them
- Prior experiences of flooding or other emergencies
- Warning opportunity time (can depend on the type of breach or flow scenario and the size of upstream drainage)
- Flood characteristics (depths, rate of rise, velocities)

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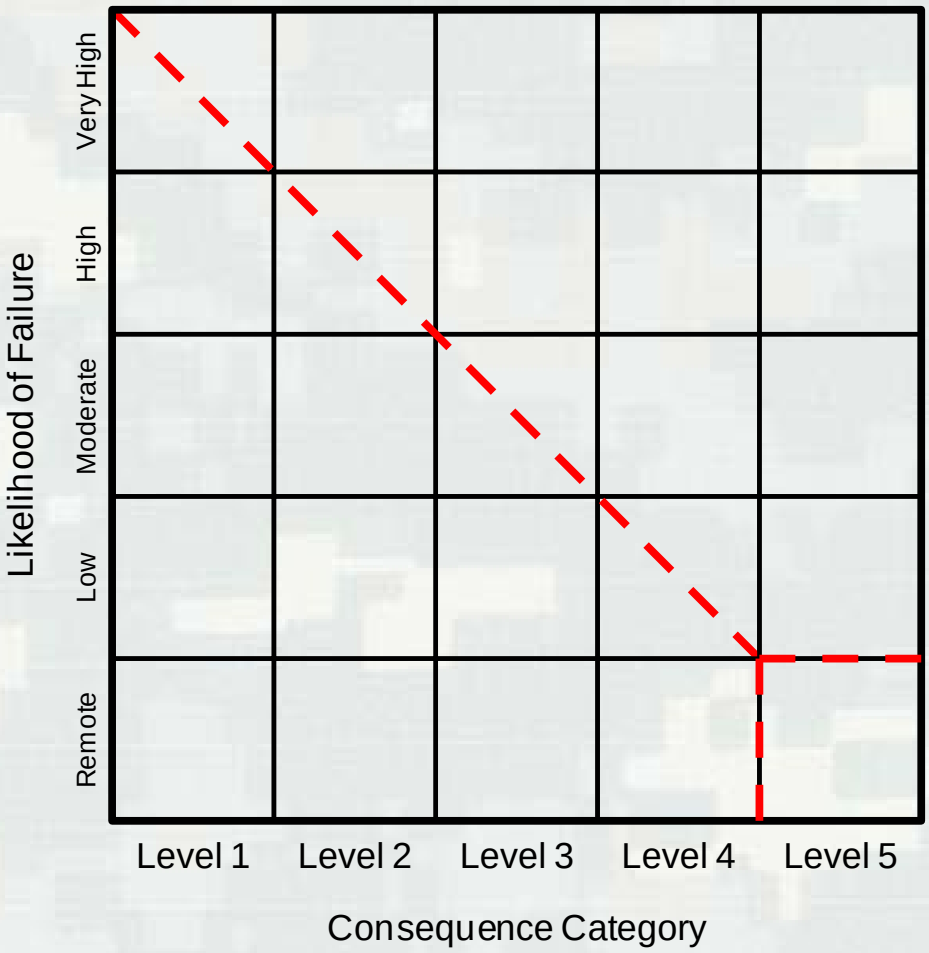
Semi-Quantitative Risk Assessment (SQRA)



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FIA results are not the ONLY reason why these categories are picked!

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Lessons Learned

- Be able to “Tell the story”
  - You need to understand why you get the results you get, and what factors might change them
  - Find ways to convey that story to the rest of the team and the decision makers

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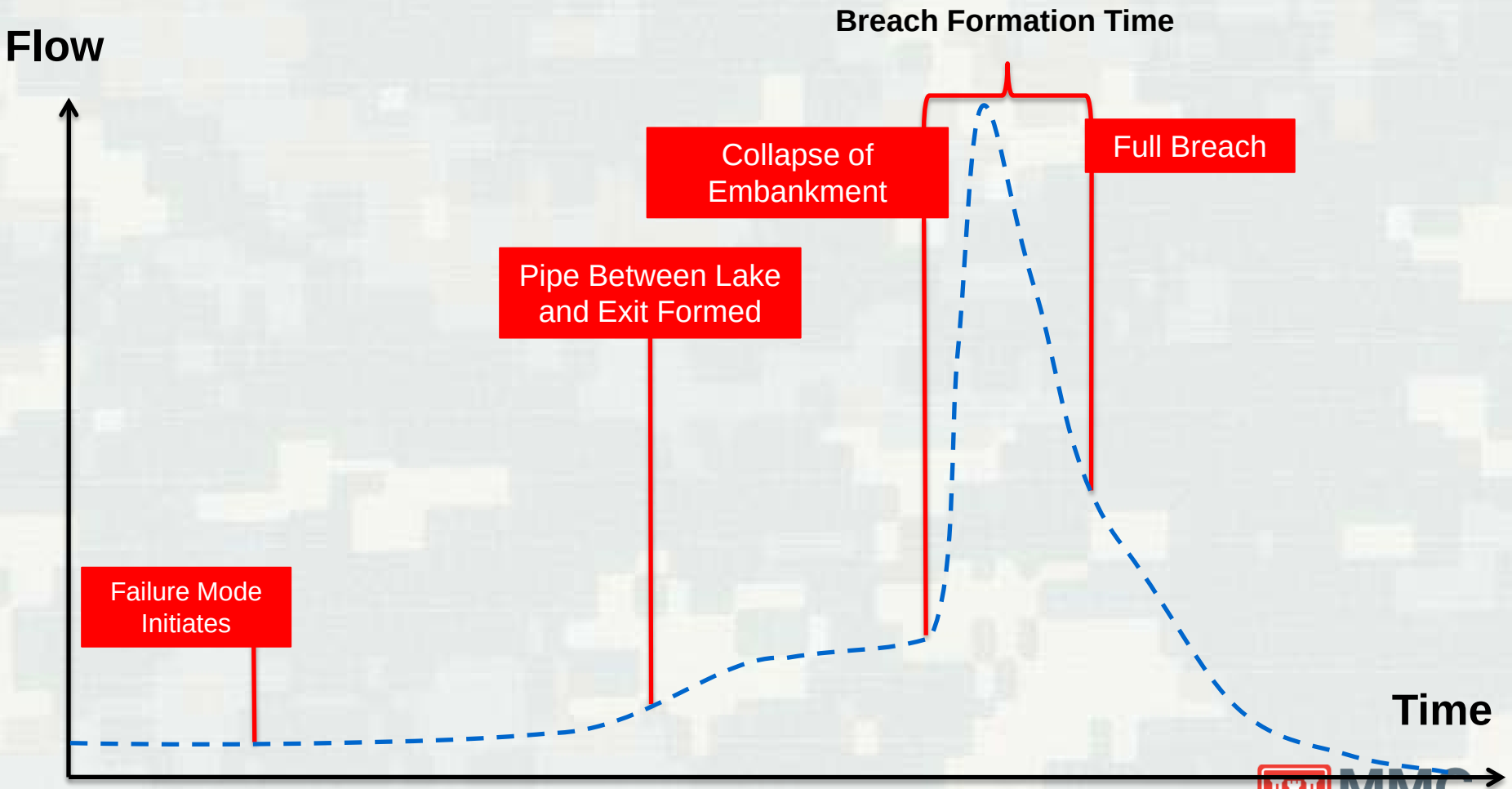
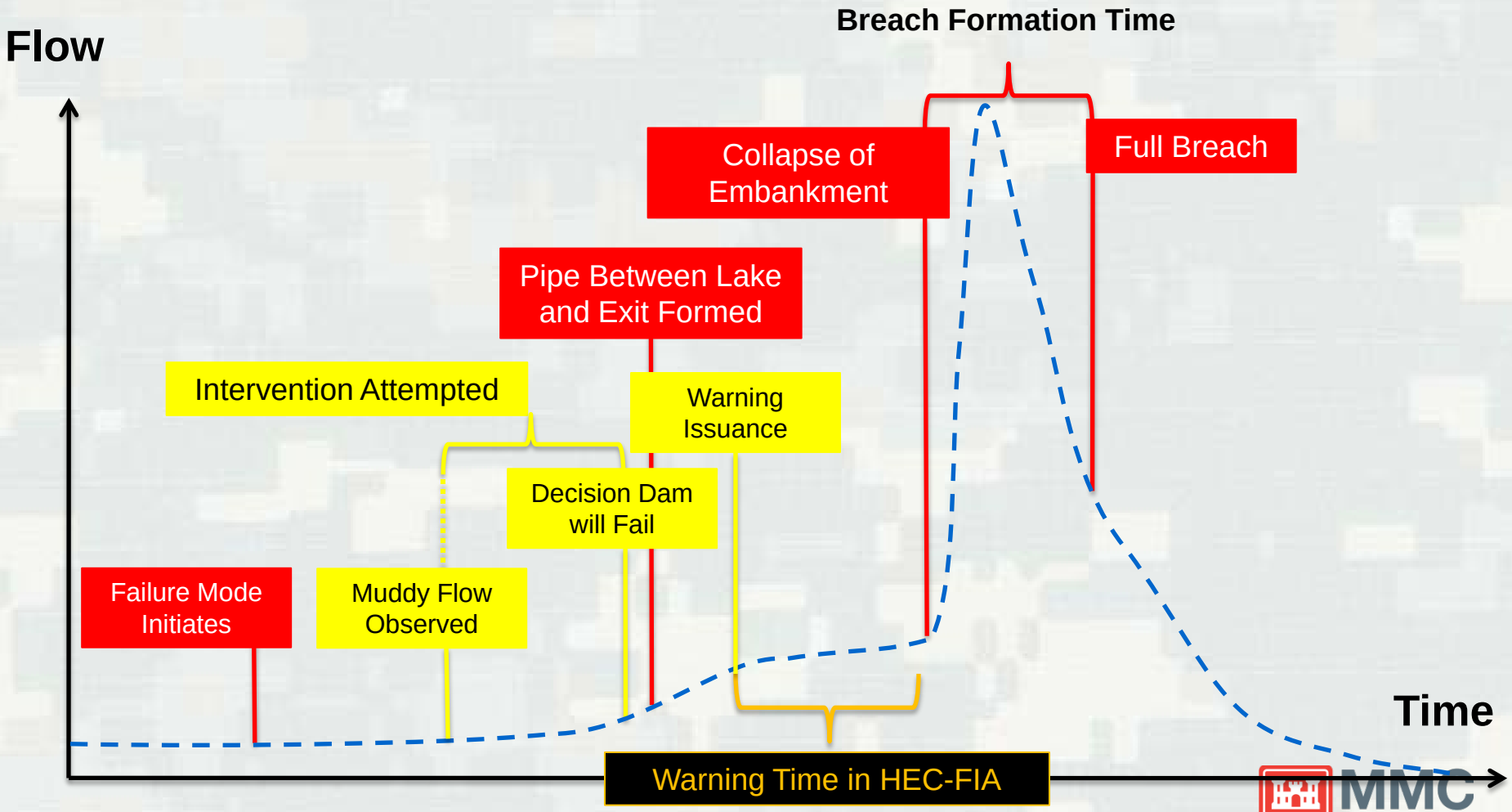
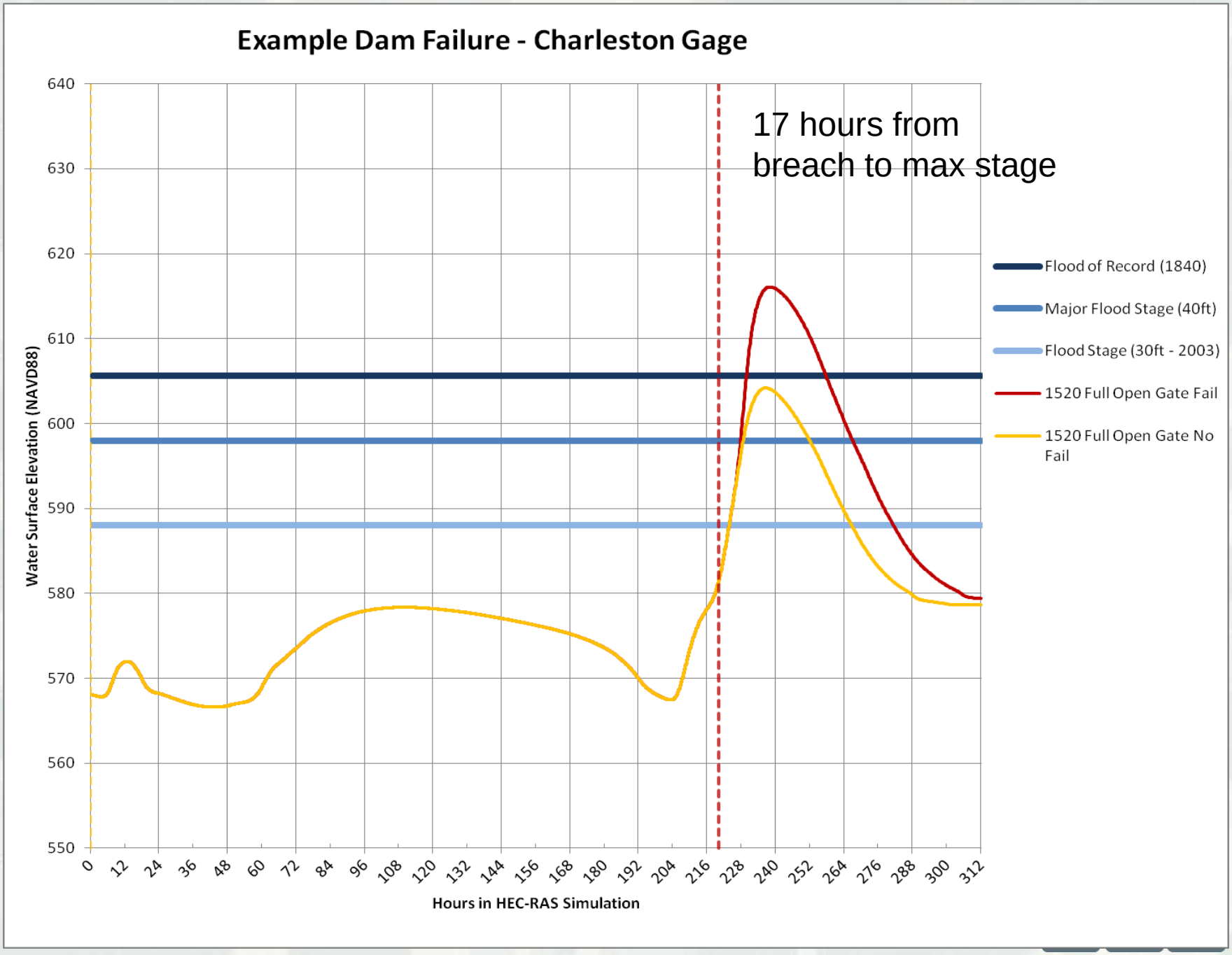
Breach Timeline



Warning Timeline




Example Dam Failure - Charleston Gage
17 hours from breach to max stage
Water Surface Elevation (NAVD88)
640
630
620
610
600
590
580
570
560
550
0
12
24
36
48
60
72
84
96
108
120
132
144
156
168
180
192
204
216
228
240
252
264
276
288
300
312
Hours in HEC-RAS Simulation
Flood of Record (1840)
Major Flood Stage (40ft)
Flood Stage (30ft - 2003)
1520 Full Open Gate Fail
1520 Full Open Gate No Fail

How bad could it be?

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How bad could it be?

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Q & eh?

Thank you for your time!

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