Risk-Informed Decision Making Approach for Inflow Design Flood Selection and Accomodation for Dams

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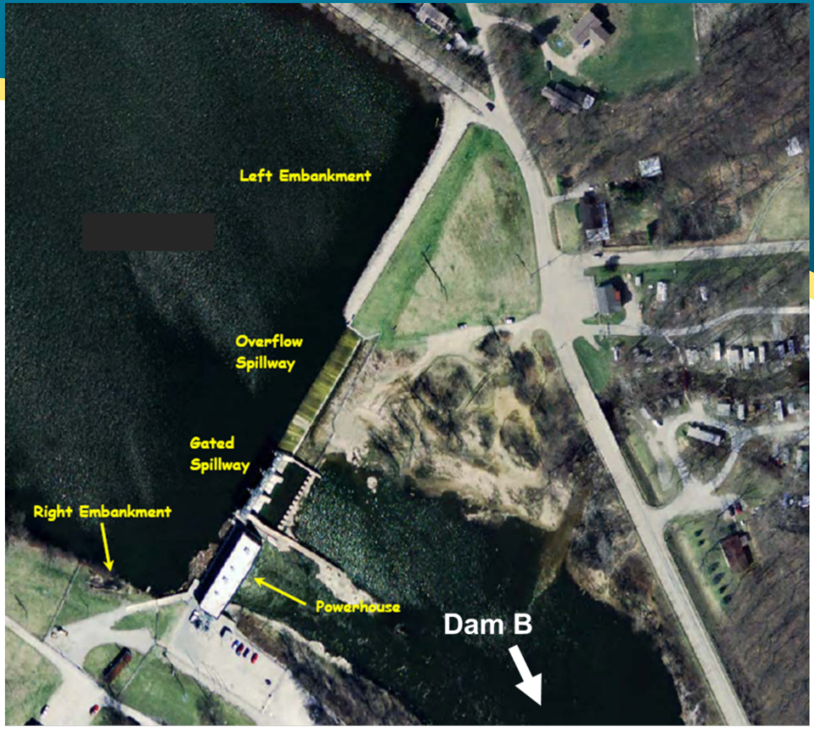
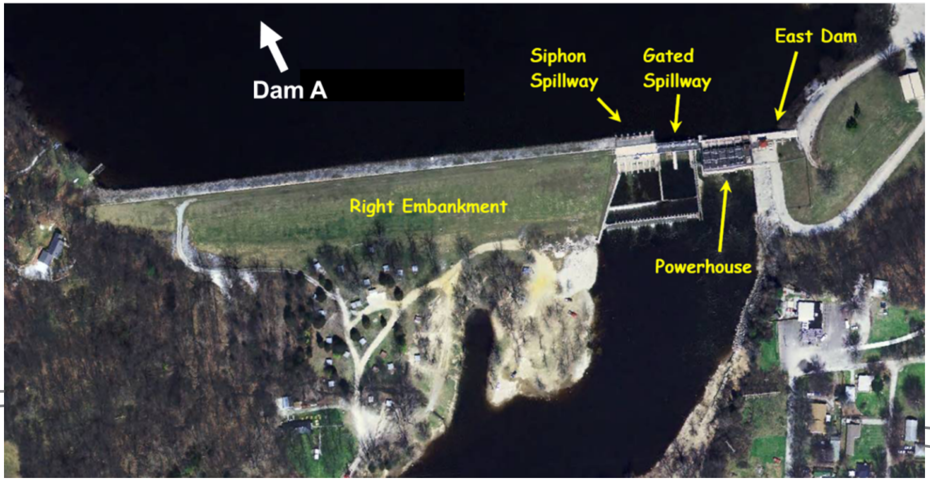
RIDM for IDF Selection for Dams

- Presentation Outline
  1. Background & Introduction
  2. Context and Scope
  3. Risk Assessment
  4. Decisions Made (RIDM)

1. Background and Introduction

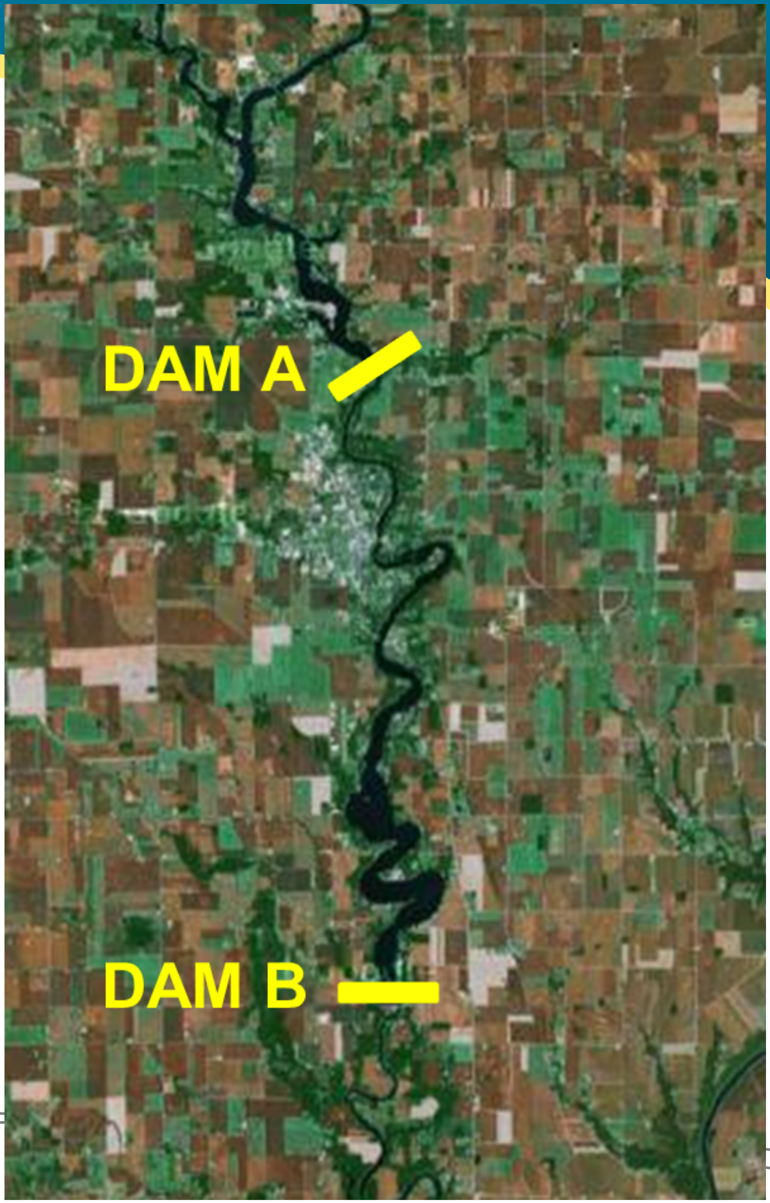
– Two run-of-river dams
  - Inflow = Outflow
  - No flood storage in reservoirs
  - Dams in series on same river
– Constructed for hydropower
– Located in rural Midwest
– Classified as high-hazard
– Regulated by FERC
– Existing dams would be overtopped by PMF
– Need to accommodate IDF
– RIDM approach utilized





2. Context and Scope

- Context of Risk Assessment
  - Significant percentage of population at risk around lakes
  - Flooding of dwellings around lakes occurs with small increases in lake levels
  - Significant difference in winter and summer populations
  - Significant difference in winter and summer flood hydrographs
  - Population impacted by floods before overtopping of dams
  - Well functioning EAP



2. Context and Scope

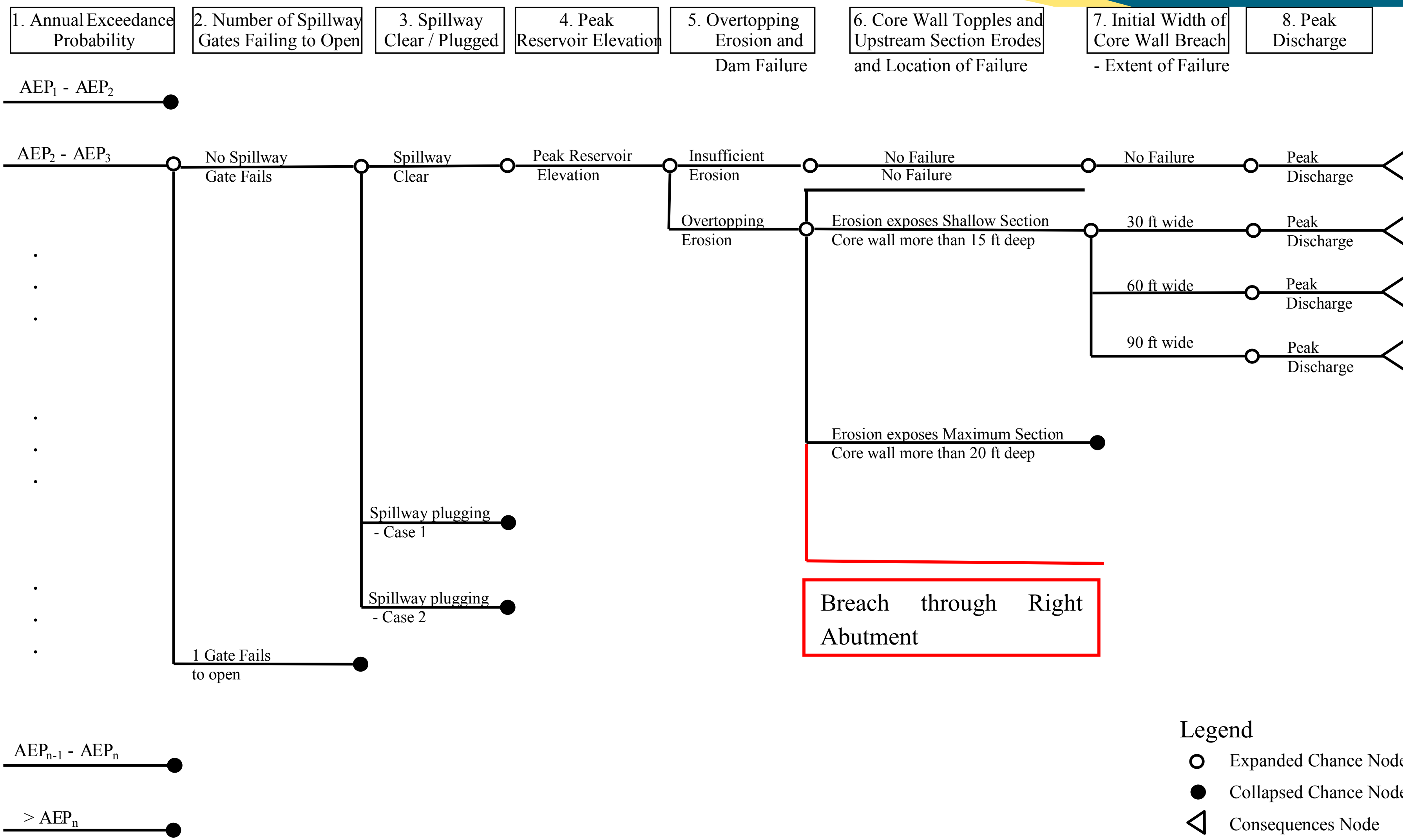
- Scope of Risk Assessment
  - Assess baseline risks (risks with dams in existing condition) (BRA)
  - Identify risk reduction measures
  - Assess risk reduction measures (RRA)
  - Evaluate risk reduction measures relative to FERC IDF definition

3. Risk Assessment

- Potential Failure Modes Analysis (PFMA)
  - Per FERC guidelines
  - Credible and Significant PFMs included in RA
    - Flood-related
    - Focused on overtopping and erosion of embankments at dams
- Risk Assessment Workshop
  - Same participants as PFMA
  - Develop event tree & system response probabilities (SRP’s)
    - Including a range of uncertainty
    - Spillway gate reliability and spillway plugging with debris

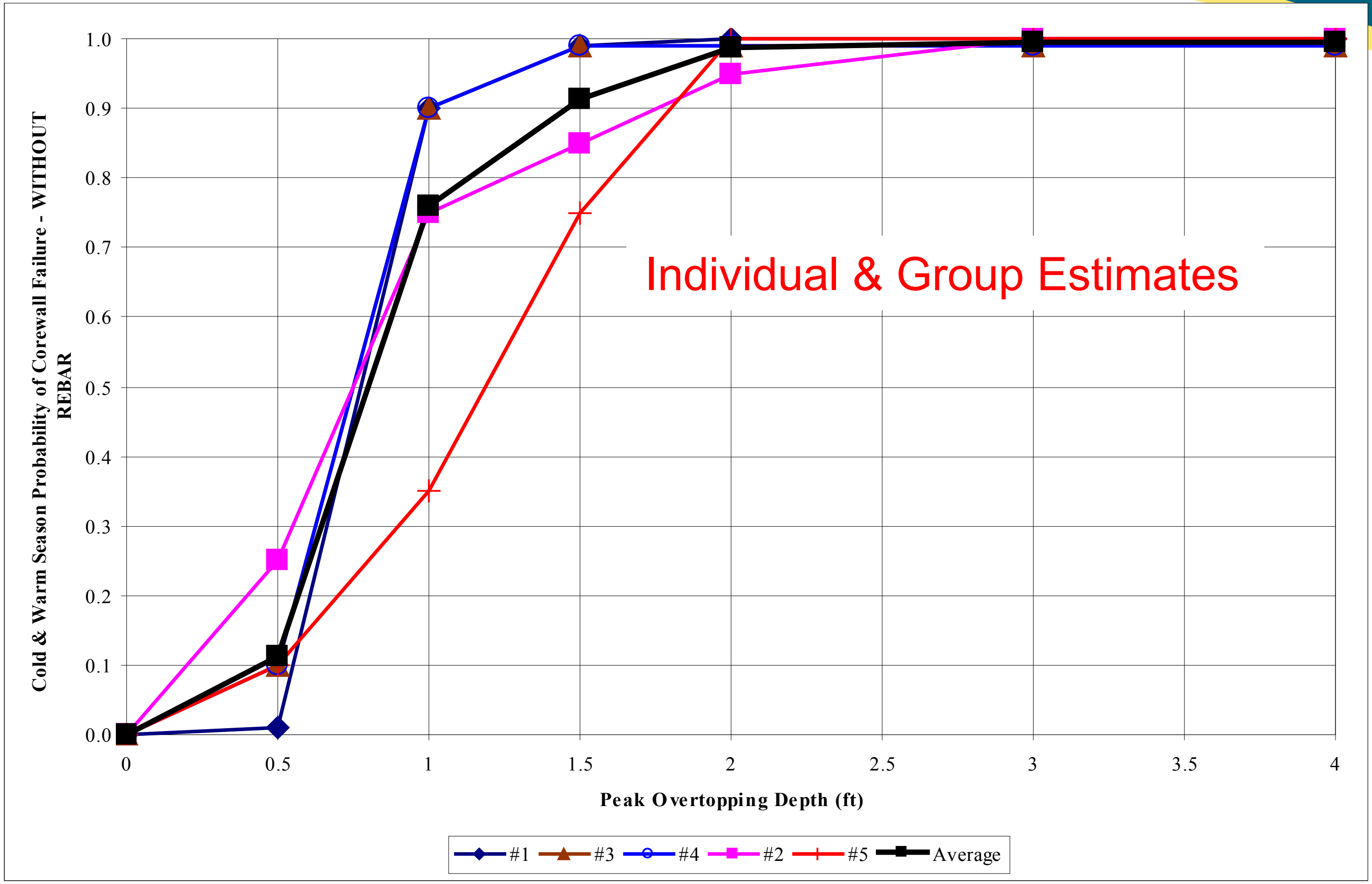
3. Risk Assessment

- Event Trees



3. Risk Assessment

- System Response Probabilities



3. Risk Assessment

- Estimating Consequences
  - Breach inundation runs
  - Affected structures
  - Population at risk
  - Life loss (LIFESim methodology by Aboelata and Bowles)

Season	Peak Discharge at Norway (cfs)	Width of the first breach (feet)	Depth of breaches (feet)	Case (new numbering)
Cold	39000	No failure	No failure	**NF1**
		30	20	**NF2**
		120	20	**NF3**
		30	15	**NF4**
		120	15	**NF5**
		R. Embkmt. F	8.3	**NF6**
	51000	No failure	No failure	**NF7**
		30	20	**NF8**
		120	20	**NF9**
		30	15	**NF10**
		120	15	**NF11**
		R. Embkmt. F	8.3	**NF12**
	70000	No failure	No failure	**NF13**
		30	20	**NF14**
		120	20	**NF15**
		30	15	**NF16**
		120	15	**NF17**
		R. Embkmt. F	8.3	**NF18**
	90000	No failure	No failure	**NF19**
		30	20	**NF20**
		120	20	**NF21**
		30	15	**NF22**
		120	15	**NF23**
		R. Embkmt. F	8.3	**NF24**
		No failure	No failure	**NF25**
		30	20	**NF26**
			20	**NF27**
			15	**NF28**
			15	**NF29**
		nt. F	8.3	**NF30**
		re	No failure	**NF31**
			20	**NF32**
			20	**NF33**
			15	**NF34**
			15	**NF35**
		nt. F	8.3	**NF36**
		re	No failure	**NF37**
			20	**NF38**
			20	**NF39**
			15	**NF40**
			15	**NF41**
		nt. F	8.3	**NF42**
		re	No failure	**NF43**
			20	**NF44**
		120	20	**NF45**
	(PMF)	30	15	**NF46**
		120	15	**NF47**
		R. Embkmt. F	8.3	**NF48**

Flood Zone	Rate of Life Loss (Range)	Rate of Life Loss (Average)
Safe	0 - <1%	0.02%
Compromised	0 – 50%	12%
Chance	50 – 100%	91.45%

3. Risk Assessment

- Tolerable Risks
  1. F-N Charts (ANCOLD & HSE)
  2. f-N Charts (Reclamation)
  3. Summary Tables

Rating Code	Explanation
N-StrongL&S	Strong justification for long- and short-term risk reduction measures
N	Strong justification for long-term risk reduction measures
Y-ALARP?	Diminished justification for long-term risk reduction measures, but ALARP (as low as reasonably practicable) still needs to be evaluated
Y	Meets tolerable risk guideline and meets ALARP

3. Risk Assessment

- Risk Reduction Assessment
  - Improve warning & evacuation effectiveness (not explicitly evaluated, but measures being implemented anyway)
  - Remove dams (not feasible)
  - Land acquisition (not feasible)
  - Improve gate reliability (not explicitly evaluated)
  - Trash/debris booms (not explicitly evaluated)
  - Raise embankment dams (not considered further)
  - Re-evaluate East Dam at Dam B to determine whether stability improvements are needed
  - **Add additional spillway capacity**
  - **Armor embankments**
  - **Do nothing (baseline case)**
  - Appropriate changes to event tree inputs to represent each alternative

3. Risk Assessment

Dam A Summary of Annual Probabilities of Failure

Alternative:	Description:	Discharge (cfs):	Estimated Total Annual Probability of Failure: Baseline Case:	Estimated Total Annual Probability of Failure: No Blockage & 100% Gate Reliability:
A	**Do nothing**	**39,000**	**1 in 700**	**1 in 1,300**
B	Provide functional flashboards on overflow spillway	43,700	1 in 1,400	1 in 2,800
C.0	Lower overflow spillway crest and add gates to pass additional flow over the overflow spillway	75,500	1 in 41,800	1 in 62,300
C.1	Lower overflow spillway crest and add gates	53,000	1 in 5,400	1 in 10,500
C.1R	**Same as C.1, but includes contribution of trash gate to overall discharge.**	**57,000**	**1 in 8,200**	**1 in 14,500**
C.2	**Lower overflow spillway crest and add gates**	**60,000**	**1 in 11,700**	**1 in 18,500**
D	Add gated spillway on left embankment and lower overflow spillway crest (maximize capacity through Dam A).	100,600	1 in 181,000	Not computed
E	Armor left embankment and right rim	39,000	1 in 8,000,000	Not computed

4. Decisions Made

- Selected alternatives a result of RIDM
- Alternative C.2 at Dam A:
  - 60,000 cfs capacity ~ 103% warm PMF/27% cold PMF
- Alternative B.2 at Dam B
  - 65,000 cfs capacity ~ 108% warm PMF/28% cold PMF
- Meet all tolerable risk guidelines
- Spillway capacity additions accepted by FERC
- Very low cost effectiveness for reducing life loss for risk reduction alternatives (ALARP satisfied)
- Alternatives in design and construction phase

END