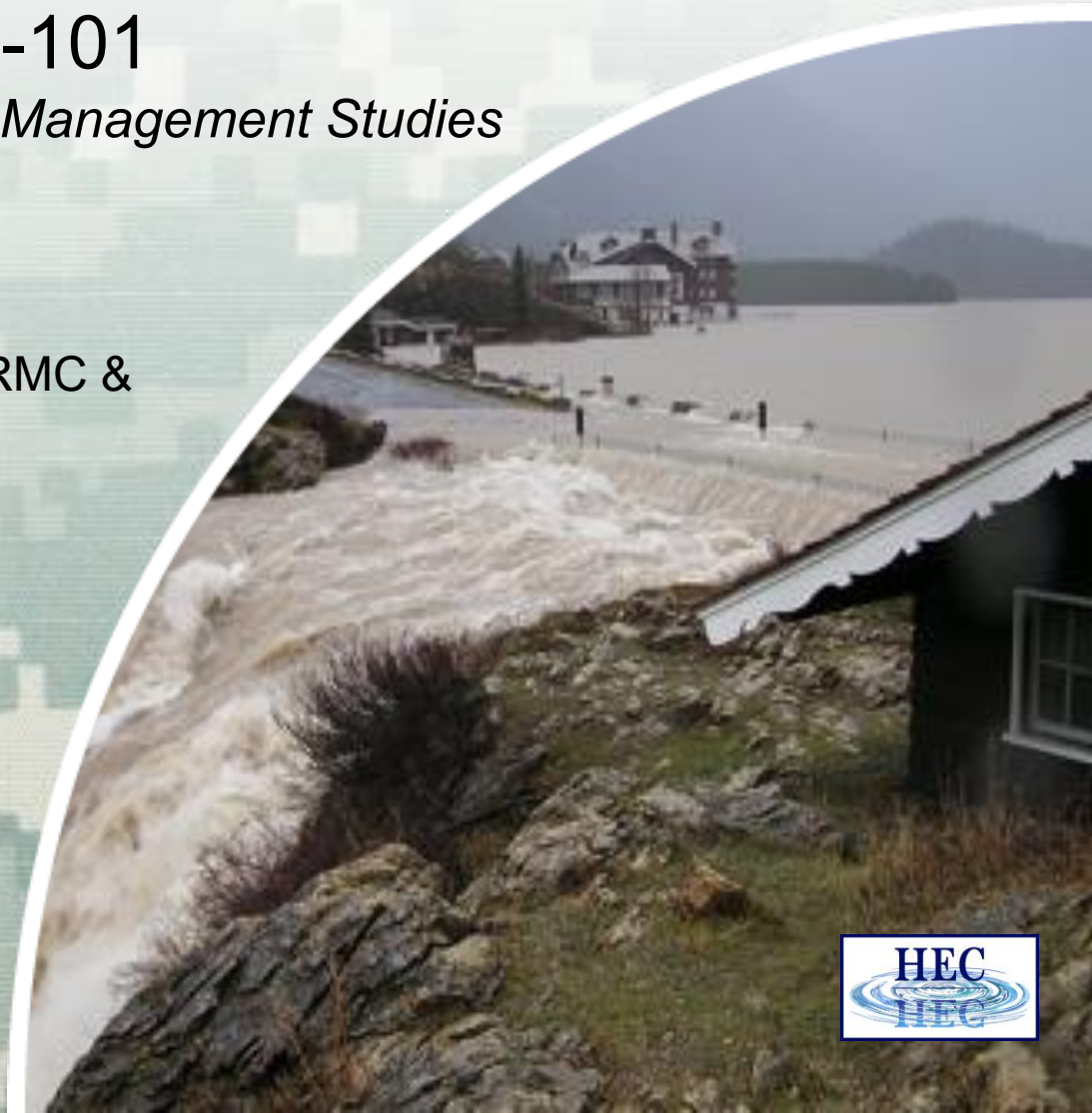
Background Policy & Regulations for Risk Assessments

Overview of ER 1105-2-101

Risk Assessment for Flood Risk Management Studies

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Risk-based Analysis for Flood Damage Reduction Projects



US Army Corps of Engineers
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Purpose of ER 1105-2-101

This regulation provides guidance on risk assessment requirements for flood management studies including but not limited to feasibility studies, post-authorization changes, general reevaluation studies, dam and levee safety studies, and major rehabilitation studies.

Covers riverine and coastal projects.

What's Included?

- Terminology
  - Resilience
  - Risk Assessment versus Risk Analysis
  - Transferred and Transformed Risk
- System Performance and System Features
- Focus on Life Loss
- Focus on Environmental Impact Considerations
- Climate Change
- Updated References
- Enhanced Definitions Section

RAPID Planning

8.b. The ultimate goal is a comprehensive approach in which the values of **all key** variables, parameters, and components of flood risk management studies are subject to probabilistic analysis.

- Not all variables are critical to project justification in every instance. In progressing toward the ultimate goal, the risk assessment and study effort should concentrate on the uncertainties of the variables having a **significant** impact on study conclusions and recommendations.

- The level of detail to make decisions will grow over the course of the study as you move to fewer alternatives.



Definitions

- **Risk**

  is the likelihood and severity of adverse outcomes; probability an area will be flooded, resulting in undesirable consequences.

- **Uncertainty**

  is the result of imperfect knowledge of parameters and functions used to describe the hydraulic, hydrologic, geotechnical, economic, and life loss aspects of a project plan.

Definitions

- **Annual Exceedance Probability**

  (AEP) is the probability that a certain threshold may be exceeded at a location in a given year considering the full range of possible values and, if appropriate, incorporation of project performance.

- **Residual Risk**

  is the flood risk that remains if a proposed flood risk management project is implemented. Residual risk includes the consequence of capacity exceedance as well as project performance.

Definitions

- **Transferred Risk**

  is a result of an action taken in one region of a system to reduce risk, where that action shifts the risk burden to another region in the system.

- **Transformed Risk**

  is new risk of flooding that emerges or increases as a result of mitigating another risk. The magnitude and nature of the risk of flooding is different with a levee compared with conditions without a levee.



Definitions

- **Long-Term Exceedance Probability** (LTEP) is the likelihood of exceedance at least once in the specified period and is computed as:

$$1 - (1 - AEP)^N$$

$$N = number\ of\ years$$

Decisions - Reporting Requirements

- AEP with associated description of uncertainty.
- LTEP over 10, 30, and 50 years.
- Assurance (also CNP) for the 0.2, 0.1, 0.02, 0.01, 0.004, and 0.002 events.
- The Assurance for specific historic floods.
- Economic average annual (EAD) and single event damage, potential life loss and environmental conditions and impacts as required by ER 1105-2-100.
- Qualitative and quantitative statement of residual, transformed, and/or transferred risk.

Standard Performance Report

Table 1
Project Performance: AEP, LTEP, and Assurance

Plan	Annual Exceedance Probability		LTEP			Assurance by Event				
	Median	Expected	10-yr period	30-yr period	50-yr Period	10%	2%	1%	0.4%	0.2%
NED Plan	0.019	0.018	17%	44%	62%	95%	90%	78%	8%	1%

Performance Indices

Table A-3. Performance described by AEP and LTEP

Alternative	Mean AEP	LTEP (Probability of Exceedance Over Indicated Time)		
		10 Years	30 Years	50 Years
Without	0.250	0.94	1.00	1.00
20-ft (6-m) levee	0.020	0.18	0.45	0.64
25-ft (8-m) levee	0.010	0.10	0.26	0.39
30-ft (9-m) levee	0.001	0.01	0.03	0.05
Channel	0.025	0.22	0.53	0.72
Detention basin	0.030	0.26	0.60	0.78
Relocation	0.020	0.18	0.45	0.64

Performance Indices

Table A-4. Performance described by AEP and LTEP (alternative display)

Alternative	Mean AEP	LTEP (Probability of Exceedance Over Indicated Time)		
		10 Years	30 Years	50 Years
Without	0.250	1 in 1.1	1 in 1.0	1 in 1.0
20-ft (6-m) levee	0.020	1 in 5.5	1 in 2.2	1 in 1.6
25-ft (8-m) levee	0.010	1 in 10.5	1 in 3.8	1 in 2.5
30-ft (9-m) levee	0.001	1 in 100.5	1 in 33.8	1 in 20.5
Channel	0.025	1 in 4.5	1 in 1.9	1 in 1.4
Detention basin	0.030	1 in 3.8	1 in 1.7	1 in 1.3
Relocation	0.020	1 in 5.5	1 in 2.2	1 in 1.6

Reporting Requirements

(Expected Value and Probabilistic Values of EAD and EAD Reduced)

Alternative	EAD ($1000)		Damage Reduced ($1000)		Uncertainty in EAD Reduced; Probability Distribution Quartiles ($1,000)		
	Without Alternative	With Alternative	Mean	Standard Deviation	0.75	0.50*	0.25
20-ft (6-m) levee	575	220	355	57	316	353	393
25-ft (8-m) levee	575	75	500	77	451	503	555
30-ft (9-m) levee	575	5	570	98	502	573	626
Channel	575	200	375	65	328	370	415
Detention basin	575	250	325	93	263	325	388
Relocation	575	220	355	61	313	353	396

*The 0.5 quartile is the median estimate; it differs from the mean when the probability distribution is asymmetrical



Life Loss

Table A-6. Life Loss				
Alternative	Expected Annual Life Loss	Probable Life Loss for a Given Event		
		100 Years	250 Years	500 Years
Without	3.700	5.300	8.900	22.000
20-ft (6-m) levee	1.400	6.000	10.500	28.000
25-ft (8-m) levee	1.000	8.500	12.300	33.000
30-ft (9-m) levee	0.850	0.300	14.000	56.000
Channel	2.500	4.300	7.100	18.000
Detention basin	1.500	3.100	4.100	13.000
Relocation	0.010	0.250	0.850	1.200

Probability Comparison
(fire, wind, etc.)

Table A-5. Probability comparison	
Alternative	**AEP**
Without	**0.250**
20-ft (6-m) levee	**0.020**
25-ft (8-m) levee	**0.010**
30-ft (9-m) levee	**0.001**
Channel	**0.025**
Detention basin	**0.030**
Relocation	**0.020**
Comparable Probability	
Fire Damage	**0.003[1]**
Wind Damage	**0.005[2]**
Earthquake	**0.001[2]**

[1]Average 2002-2010 based on home structure fires National Fire Protection Association and US Census housing unit data.
[2]Annual probabilities for other hazards are region specific. Values provided here are for illustrative purposes only.

Special Guidance

8.j.(1) The use of freeboard or similar buffers to account for hydrologic, hydraulic, and geotechnical uncertainties will no longer to be used in levee planning and design.

Special Guidance

8.j.(4) Project performance will be described by annual exceedance probability, Assurance, and long-term risk rather than level-of-protection.



Special Guidance

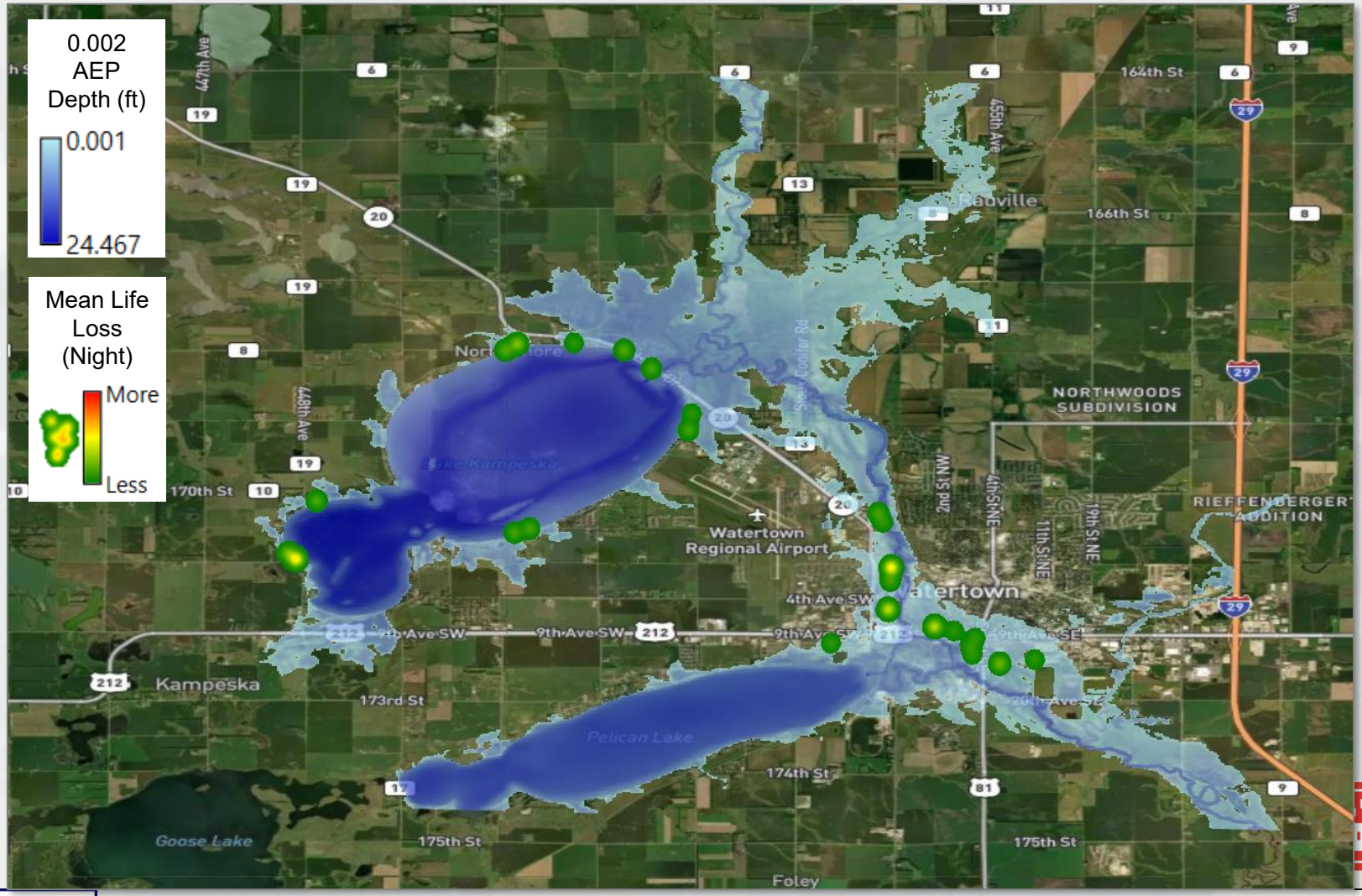
8.j.(5) When it is necessary to communicate performance in simpler terms for this plan, then **the exceedance probability at which the project performs with 90% Assurance must be used in feasibility, design, and in communications with the public.** Performance for a project having the example data in Table 1 may be communicated as: “Given irreducible uncertainties inherent in flood frequency analysis, the NED Plan will pass the 2% event with 90% assurance.” This is consistent with standard engineering practice and with the risk expectations of the public.

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Residual Risks

8.g. Residual human health and safety risks will be displayed. To aid this display and to improve the understanding of the residual risk, inundation maps showing flood depths, should the project be exceeded, shall be provided.

Residual Risks



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Narrative

8.g. To improve the understanding of the residual risk, a narrative scenario for events that exceed the project design shall be provided.

Narrative – the "so what?"

Should the levees surrounding My City south of the Your River be loaded by floodwaters, residents could attempt to move to nearby higher ground. The depth of flooding in the neighborhoods in this area would generally not exceed that at the river's edge although a few areas would experience flooding of more than 10 feet. New Town, on the other hand, is ringed by levees so that residents trying to leave the area would have to find their way across the main highway system to areas of higher ground. Limited routes of egress would make this difficult and thus negatively impacting **life safety**. Moreover, because New Town is in a depression, a third of the area would flood to depths over 10 feet. Some areas would flood to as much as 35 feet. Because of the lengthy duration of flooding and the lack of natural drainage from this area, **flood water would likely remain in New Town for 2 weeks or more**. With the proposed levee, New Town is subject to a 1 in 100 chance of being flooded in any year but **a 1 in 2.5 chance in 50 years**. Therefore, the probability of a catastrophic event within the lifetime of most residents is **nearly the same as flipping a coin and getting heads**. An emergency action plan **(EAP) has been developed** for the communities **including response training exercises**. Additionally, the low areas contain many acres of **environmentally valuable wetlands that would be severely damaged** from high velocities generated from a levee failure. **Resiliency measures could be considered** for each of these communities. These measures address the ability to avoid, minimize, withstand, and recover from the adverse effects of a flood. For example, both communities have developed and implemented EAPs including response training exercises. An EAP speaks to the ability to avoid or minimize damage to structural inventories or reduce the population at risk. **Resiliency measures for a levee can be provided by adding superiority increments** to the levee in higher hazard areas and surface hardening in planned levee overtopping reaches adjacent to low hazard areas. Resiliency provides a higher degree of predictability for levee performance that can be useful for floodplain managers and project operators.

SOURCE: Adapted from: National Research Council. 1995. Flood Risk Management and the American River Basin: An Evaluation. Washington, DC: National Academy Press.

- ER 1105-2-101 covers FRM, CSRM, and navigation studies – T or F
- Define residual risk.
- Conditional Non-Exceedance probability is also known as what?
- When it is necessary to communicate performance in simpler terms with the public, the exceedance probability at which the project performs with ___% Assurance must be used.

QUESTIONS?





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