Flooding Issues:
Guidance Inquiry Process, Hazard Re-evaluations

July 11, 2012

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Discussion Points

- NRC TI and Audit Process
- Loss of UHS
- Dam Failures
- Hazard Screening
- Other FAQs

NRC TI

- Industry comments
  - Contents of walkdown package
  - Implication of expected licensee actions upon observation of a small APM with significant consequences
    - Should be normal practices
  - Scope of significant consequences
    - Challenge to risk significant vs loss of safety function

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Loss of UHS

- On June 26th NRC informed the FFTF that evaluations of loss of UHS was expected if the UHS was impounded by a down stream dam
  - Determine affect of calculated flood conditions on the downstream dam (flood only)
- This is a change in the industry's understanding of the staff's position on this issue

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Loss of UHS

- Industry NRC steering committee meetings in December 2011 decided that loss of UHS water source would be addressed later (tier 2 or 3)
- FFTF NRC meetings in January addressed the question of evaluating loss of UHS during a flood
- FFTF understood that flood evaluations would only address loss of the equipment that was needed to move the water from the UHS to the plant (pumps, valves, and possible piping)

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Loss of UHS

- **March 2012 50.54(f) letter contains the following statement in the context of integrated assessment (emphasis added)**

> ***"The scope also includes those features of the ultimate heat sinks (UHS) that could be adversely affected by the flood conditions and lead to degradation of the flood protection (the loss of UHS from non-flood associated causes are not included)."***

  - **Loss of UHS impounded by an upstream dam should be addressed because it affects flood protection**
  - **Loss of a downstream dam cannot possibly lead to degradation of flood protection**

- **The 50.54(f) letter is not consistent with the Staff's request**

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Loss of UHS

- Industry concerns
  - Utilities have not accounted for the effort needed to address downstream dam failures. This will affect completion of flooding analyses.
    - A number of sites are affected (12 known so far)
  - The steering committee agreed that addressing loss of UHS water source is a tier 2 or 3 issue
    - The integrated assessment will move a tier 2 or 3 issue into tier 1

Dam Failures - June 13th meeting

- Three levels of agreement
  - Can dam failure possibility be evaluated as opposed to assumed? - YES
  - What factors must be addressed to assess the credibility of a dam failure? – White Paper
  - What guidance is acceptable to consistently evaluate dam failure? - White Paper
- Security threats need not be considered

Dam Failure - June 13th meeting

- Seeking acceptance of methods/approaches for defining breach parameters for dam failure evaluations - OK
  - Breach geometry
  - Failure time
  - Type of breach
- Examples of breach development methods - OK
  - Army Corps of Engineers 2007
  - Bureau of Reclamation 1998 (Wahl)
  - Dept of Interior 2009 paper (Xu, Zhang)
- Techniques (such as HEC-RAS, HEC-HMS, various proprietary models) determine failure results - OK

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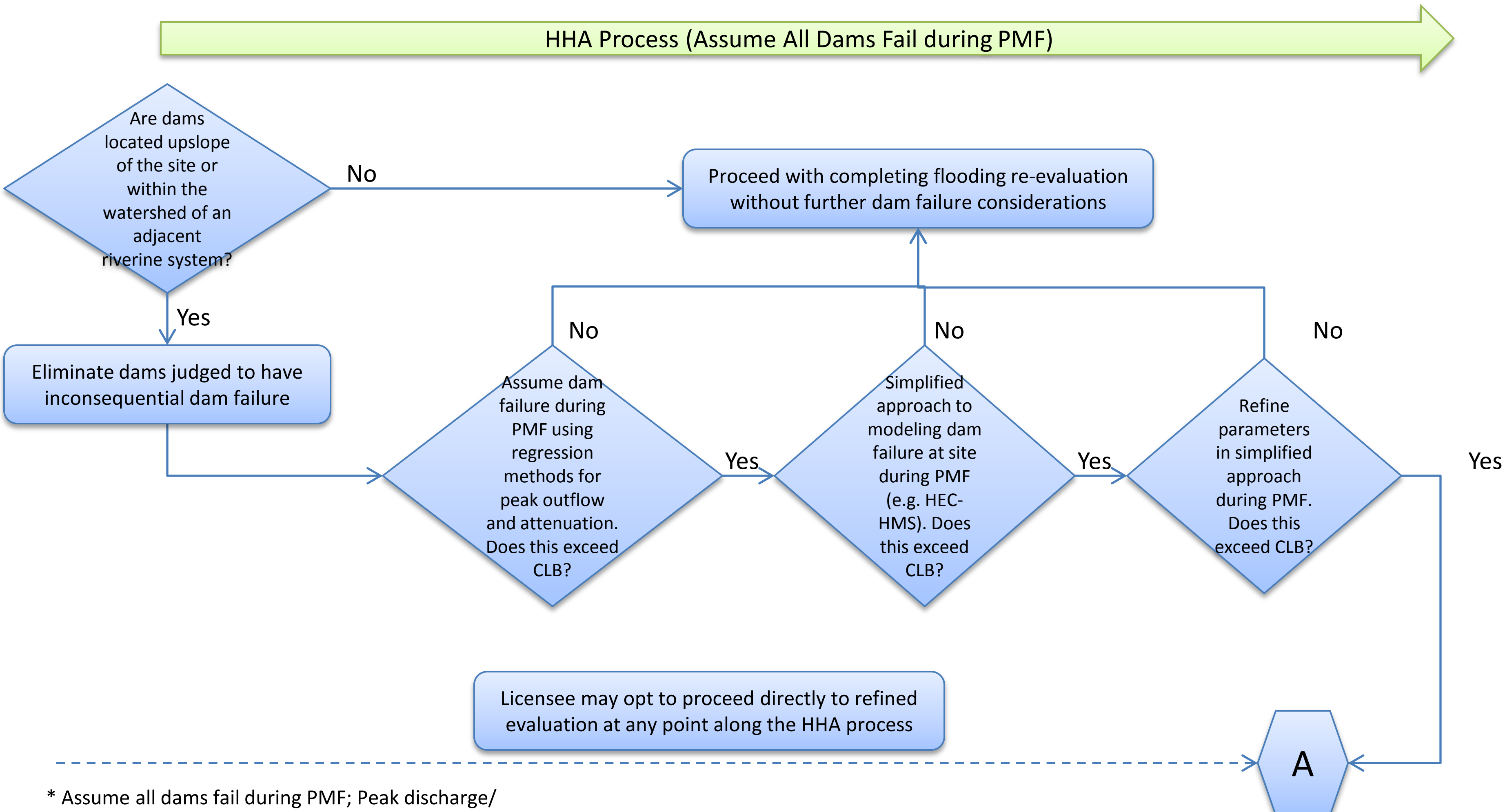
Dam Failure

- Based on June 13th meeting
  - Dam failures need not automatically be assumed for all failure modes when supported by engineering justification
  - Failure mode analysis should be physics based and realistic but conservative
  - Industry is developing a dam failure white paper for guidance and will seek NRC endorsement

Dam Failure Evaluation Decision/Process Flow Chart



* Assume all dams fail during PMF; Peak discharge/ hydrographs at site should consider individual and cascading failures as applicable. Use conservative dam breach parameters.

Assessing Dams w/ Inconsequential Failure

- Dam inventories and classification systems can be used to identify dams that can be eliminated from further consideration (e.g. small, low-hazard dams)
- When in question, a relationship can be developed between the size of dam (e.g. height) and distance to site to further screen out dams from further consideration. For example, use the USBR (1982) equations for attenuation and peak outflow estimates, respectively, as follows:

$$Q_r = 10^{\log(Q_p) - 0.01X} \left(Q_p \; in \; cfs; X \; in \; miles\right)$$

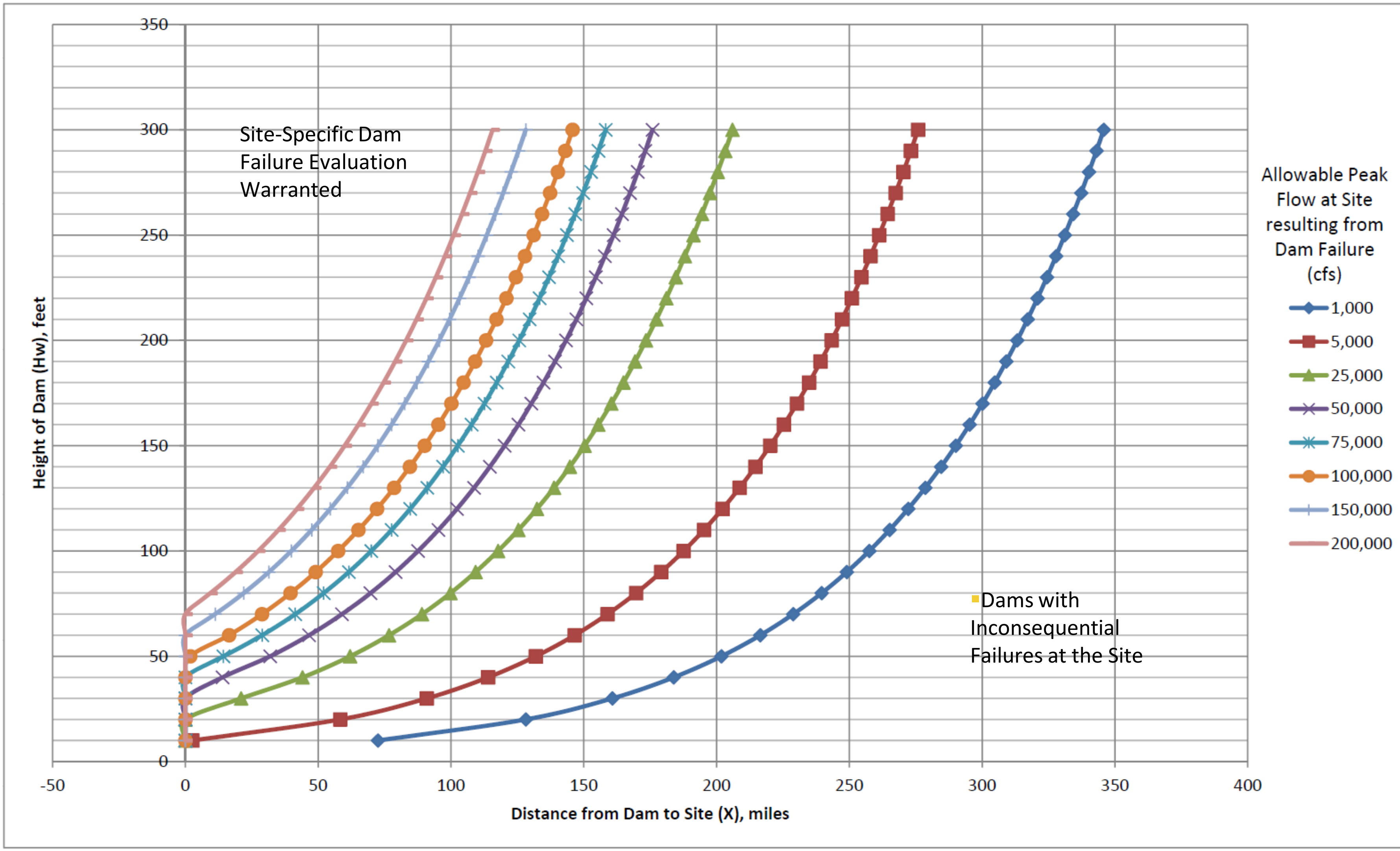
$$Q_p = 19.1 H_w^{1.85} \left(Q_p \; in \; cms; \; H_w \; in \; meters\right)$$

- Converting to English units, combining and simplifying,

$$X = 100(log(74.980 H_w^{1.85}) - log Q_r) \left(Q_r \; in \; cfs; H_w \; in \; feet; X \; in \; miles\right)$$

- Math needs to be checked.
- See chart on next slide.

Assessing Dams with Inconsequential Failure



Regression Methods for Peak Outflow and Attenuation Estimates

- USBR (1982) Peak Outflow (Case Study for 21 dam failures)
- Froehlich (1995b) Peak Outflow (Case Study for 22 dam failures)
- National Weather Service (NWS) Simplified Dam Break Model (for dam heights between 12 and 285 feet)
- Natural Resources Conservation Service (NRCS); formerly the Soil Conservation Service (SCS)

Simplified Dam Failure Modeling (e.g. HEC-HMS)

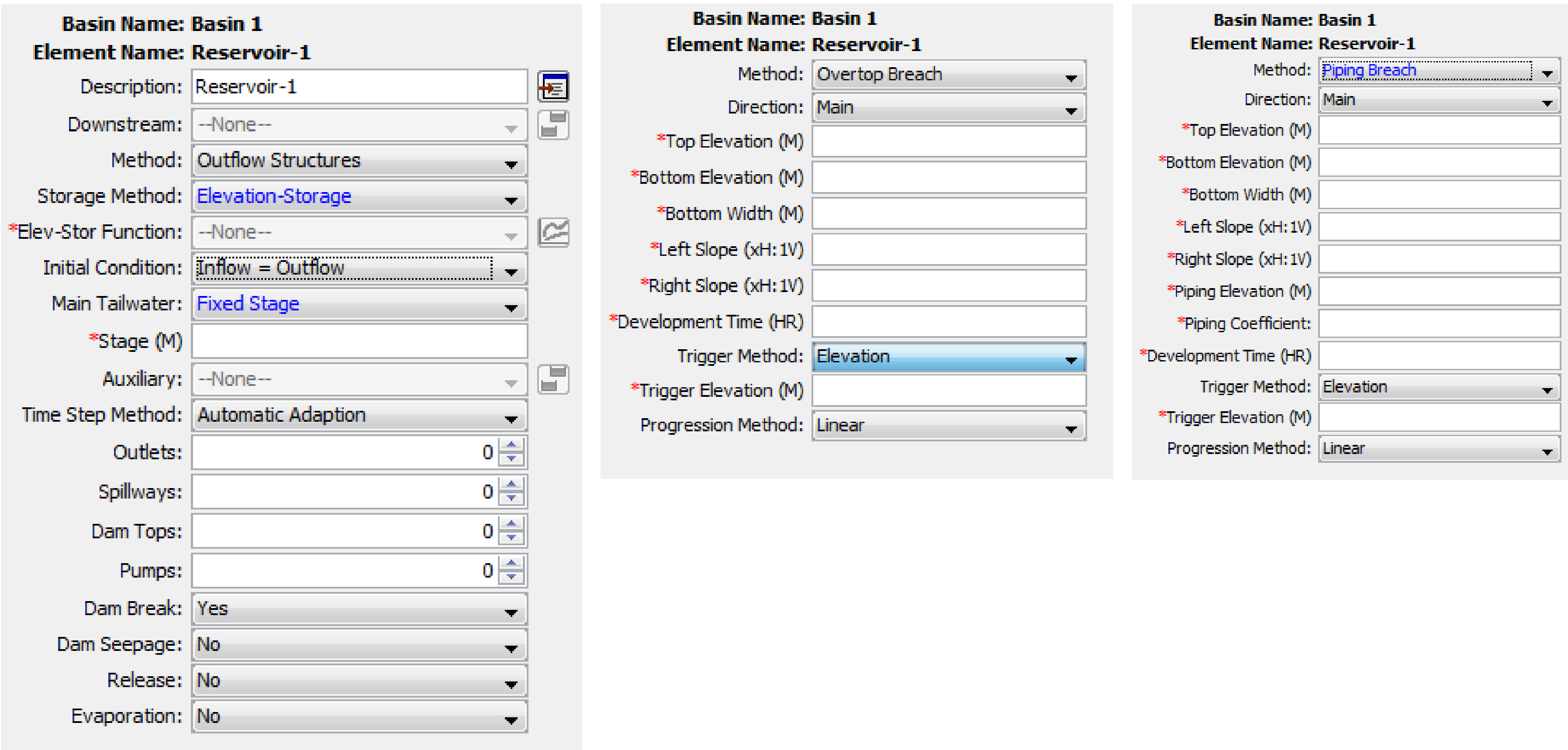
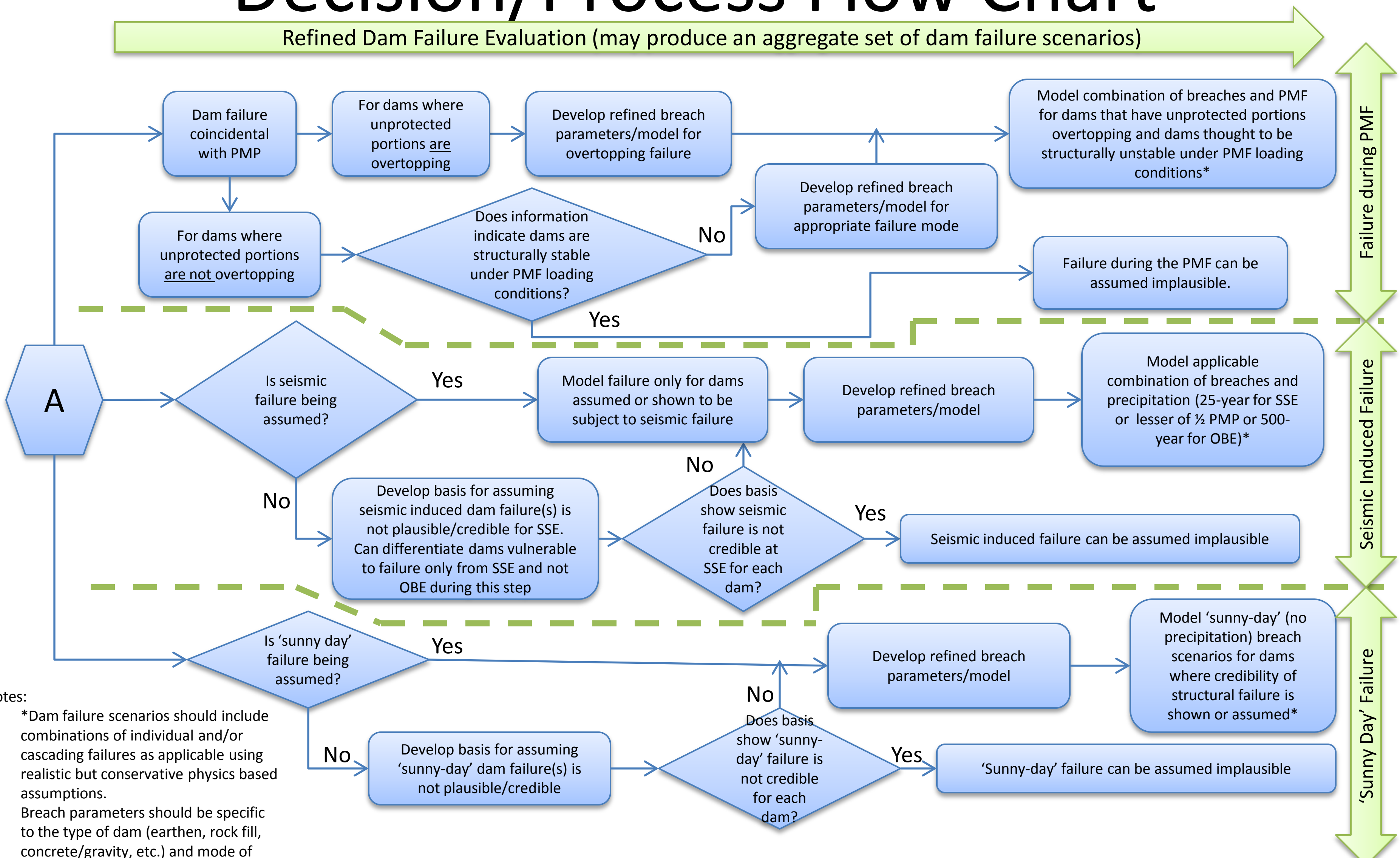


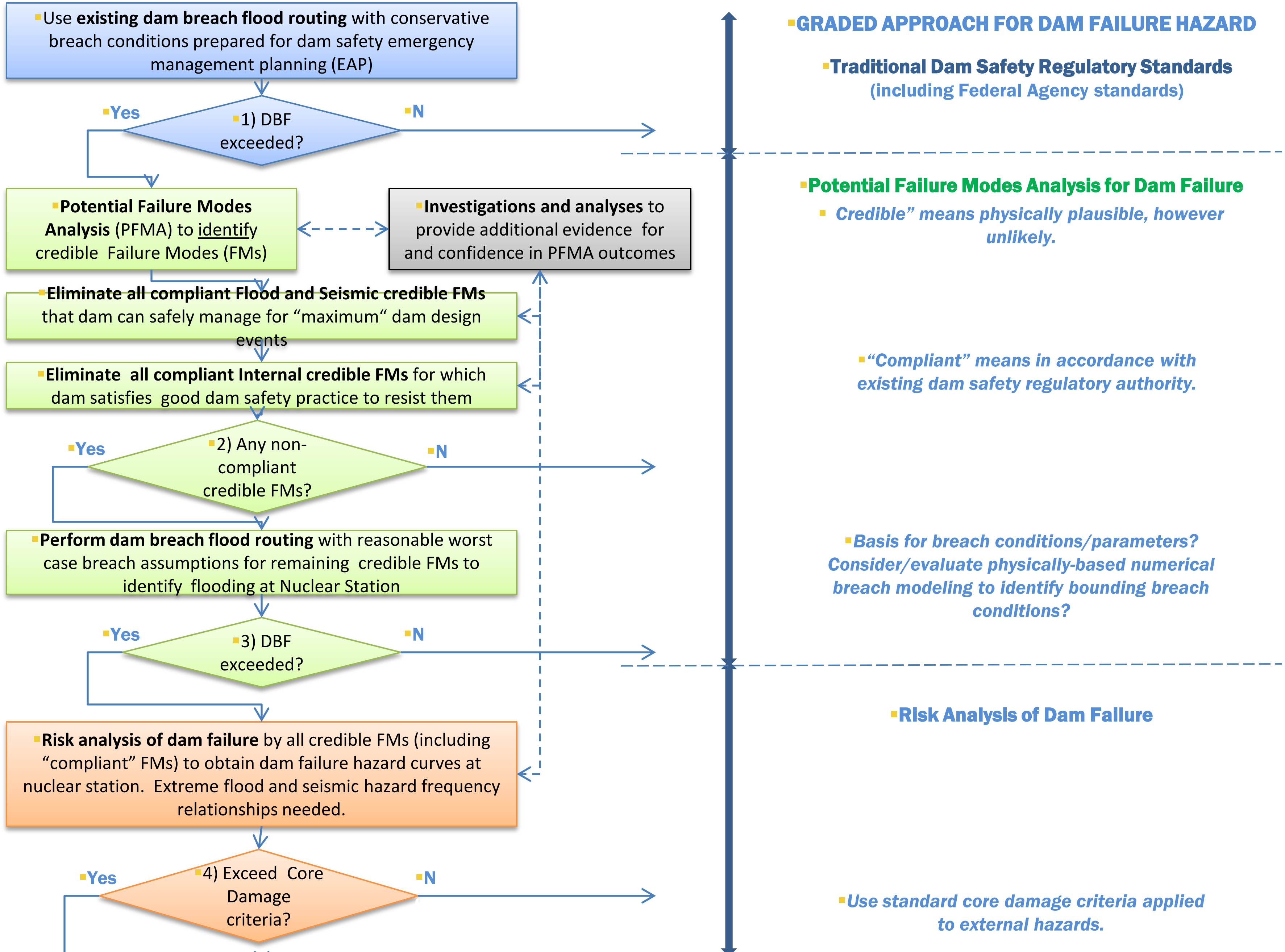
Figure 3- Dam Breach Menu Options in HEC-HMS

Dam Failure Evaluation Decision/Process Flow Chart



Notes:

1. *Dam failure scenarios should include combinations of individual and/or cascading failures as applicable using realistic but conservative physics based assumptions.
2. Breach parameters should be specific to the type of dam (earthen, rock fill, concrete/gravity, etc.) and mode of failure (overtopping or piping).



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Hazard Screening

- Screening (as opposed to analysis) is acceptable for some hazards
- Justification required
  - Based on facts and data
  - Addresses causal mechanisms – absent or insignificant
  - Demonstrates incapability of producing a flood
  - No historical record of causal mechanism
  - Geographical area in vicinity of site is considered

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Potential FAQs

- Sea level rise