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Scenario Development in Performance Assessment

KHNP Training Program
Module 6: Assembly of a Safety Case

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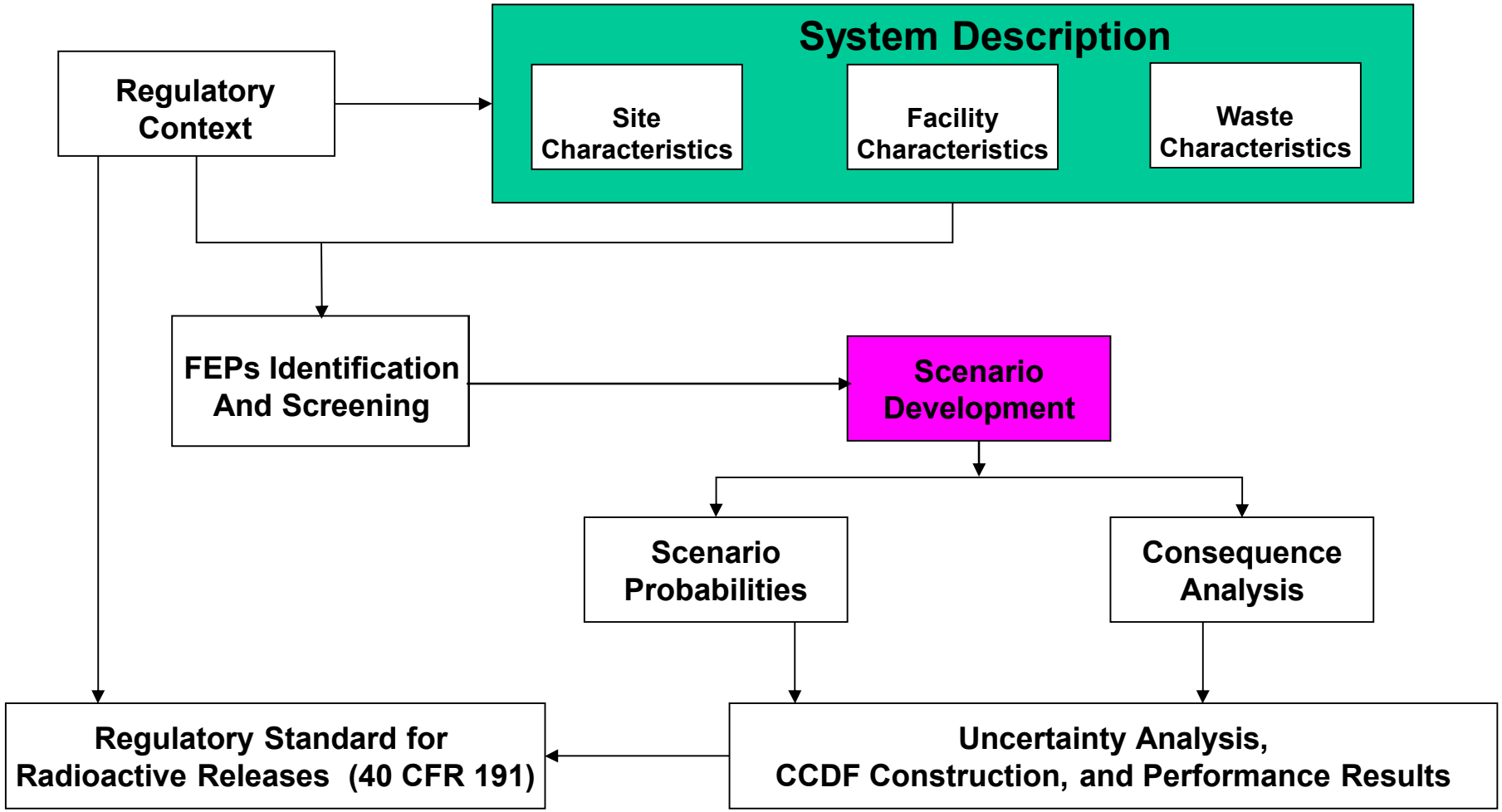
Outline

I. Scenario Development Process

II. WIPP Scenarios

III. Group Exercise

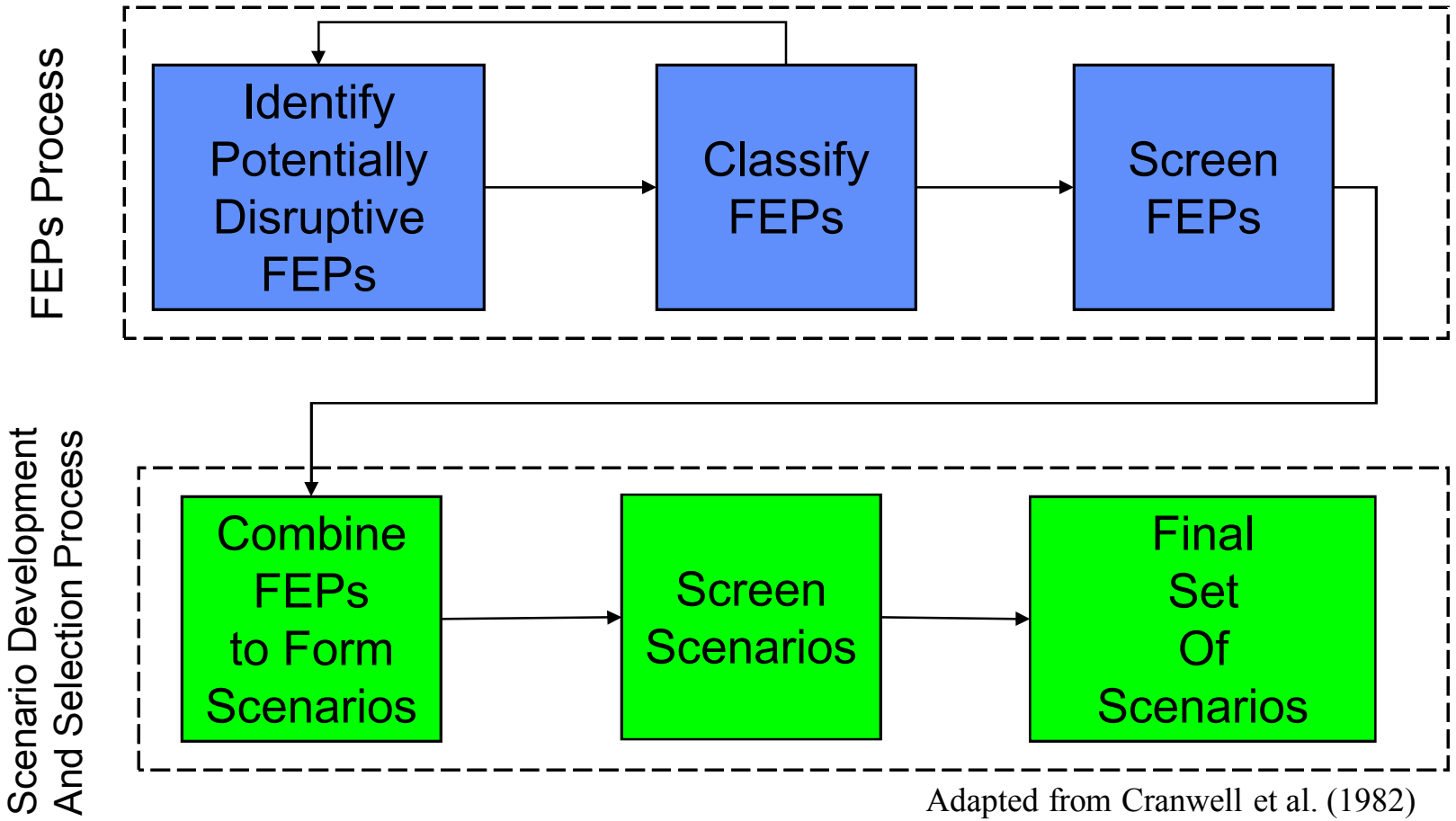
PA Methodology



What is a Scenario?

- ***A set of naturally occurring and/or human-induced conditions that represent realistic future states of the repository, geologic systems, and ground-water flow systems that could affect the release and transport of radionuclides from the repository.***

Scenario Selection Process



Adapted from Cranwell et al. (1982)

Scenario Development Process

Step 1: Identify disruptive FEPs

Disruptive FEPs are defined as those FEPs that result in the creation of new pathways, or significant alteration of existing pathways, for fluid flow and, potentially, radionuclide transport within the disposal system.

Step 2: Classify FEPs

- Natural FEPs
- Waste and Repository Induced FEPs
- Human-induced FEPs

Step 3: Screen FEPs

Retained FEPs are included in one or more performance scenarios

Excluded FEPs are screened out based on screening criteria

Scenario Development Process

Step 4: Combine FEPs to form performance scenarios

- Undisturbed Performance (UP) scenarios are considered the "base case"
- Disturbed Performance (DP) include disruptive events
  - Includes the natural system, unaffected by disruptive events
  - WIPP Scenarios have no ***natural*** disruptive events such as:
    - Tsunamis
    - Earthquakes
    - Tornados

The Korean disposal project ***may need*** to include natural disruptive events…???

Scenario Development Process (Step 4 Continued)

- The UP scenario is considered "*base case*" and does not include any disruptive events.
  - Includes the natural system FEPs that are retained
  - Includes the waste related FEPs that are retained
  - ***May*** include certain Human FEPs if such activities are already underway (e.g., mining), at least for the near term.

- The UP scenario represents the starting point for the DP scenario
  - UP scenario results are combined with DP scenario results and compared to regulatory limits

Scenario Development Process (Step 4 Continued)

- DP scenarios build upon the base case.
  - Is *Mining* a FEP that has been retained during screening? If so, then you may need to develop a mining scenario.
  - Is *Drilling* a FEP that has been retained? If so, then you may need to develop a scenario.
  - Is an *Earthquake* on your list? If so…
- As possible scenarios are developed, begin refinement and decide the proper manner to represent scenario:
  - Some scenarios are single events
    - E1 (drilling intrusion with brine pocket intercepted)
    - E2 (drilling intrusion with no brine pocket intercepted)
  - Some scenarios are combined
    - E1E2
  - Others? EQ (earthquake?) EQE1, EQE1E2?
- ***Use unrestricted brainstorming*** at first…. Don't discount scenarios at the onset; this comes in Step 5
  - Err on the side of inclusion

Scenario Development Process

Step 5: Screen Scenarios

- Ask, "Is this a credible and realistic scenario?"
- Make adjustments as necessary
- Use peer groups, other repository programs to gauge applicability

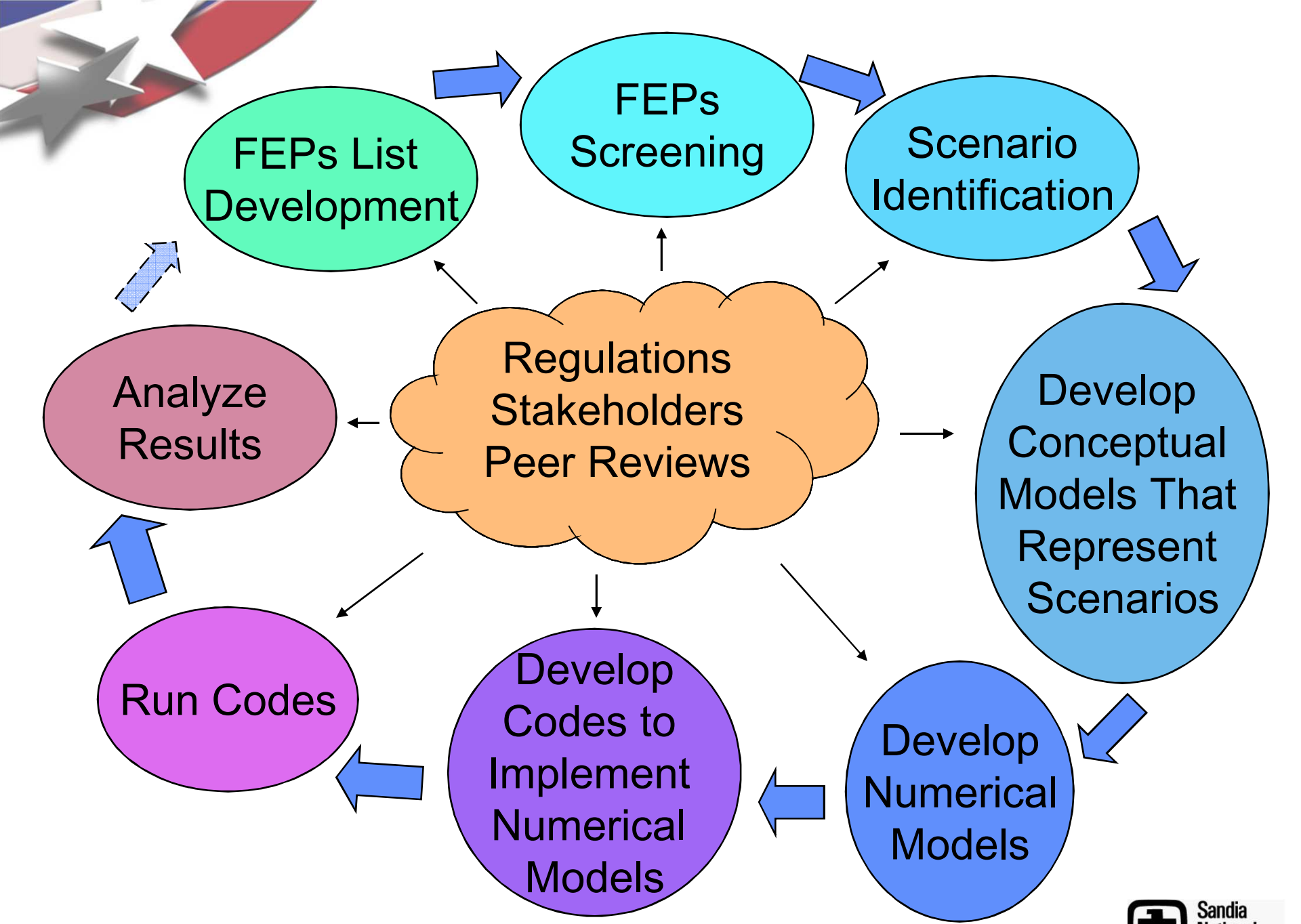
Step 6: Finalize Set of Scenarios

- Use these scenarios for performance assessment calculations.
- Perform sensitivity analyses to determine where most sensitive areas of the disposal system
- Make adjustments as necessary

- All components of PA benefit from an iterative process

Iterative Process

- **Initial FEPs list development occurred before scenario development, *but*;**
- **Preliminary PAs were used to refine, and make FEPs list more appropriate and meaningful**
- **Evolving Regulations also caused changes to FEPs (e.g., mandated human intrusion affected disturbed and undisturbed scenarios, specific screening criteria, etc.)**



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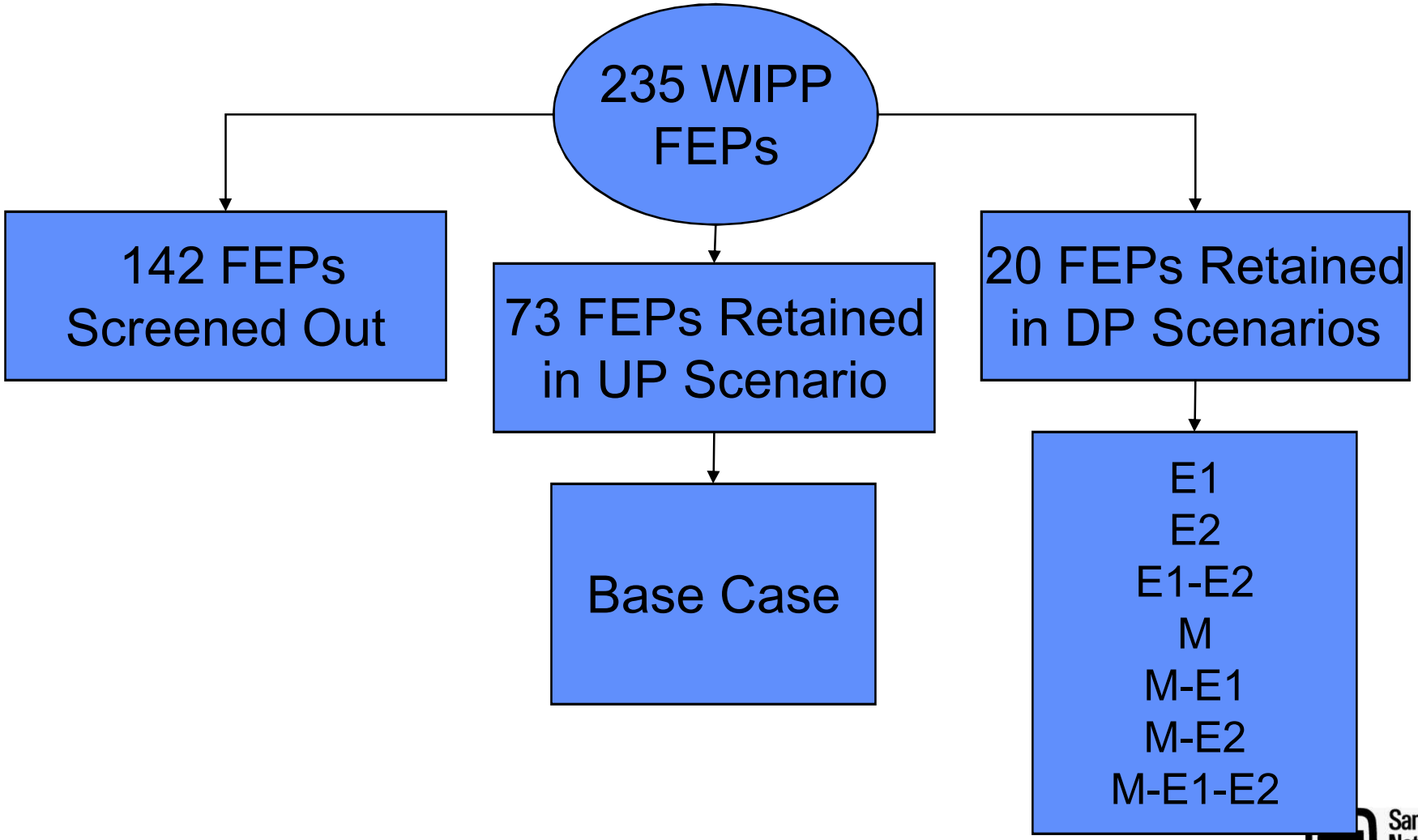
Refining Scenarios

- Use input from regulations, stakeholders, and peers to refine and further develop appropriate scenarios.
  - WIPP did not include a mining scenario until EPA required it with the promulgation of 40 CFR 194.
  - Stakeholder concerns that a brine pocket intrusion (E1) could be followed by a non-brine pocket intrusion into the same panel thereby producing more harmful effects, hence E1E2.

WIPP Scenario Development History

- Early scenario development process preceded regulatory guidance
- SAND80-1429 (Cranwell et al., 1982) documented a formal process for developing scenarios and the "Performance Assessment Methodology"
- Scenarios for WIPP PA "refined" from 1989 to 1996 based on input from scientific program, stakeholders, and regulator (EPA).

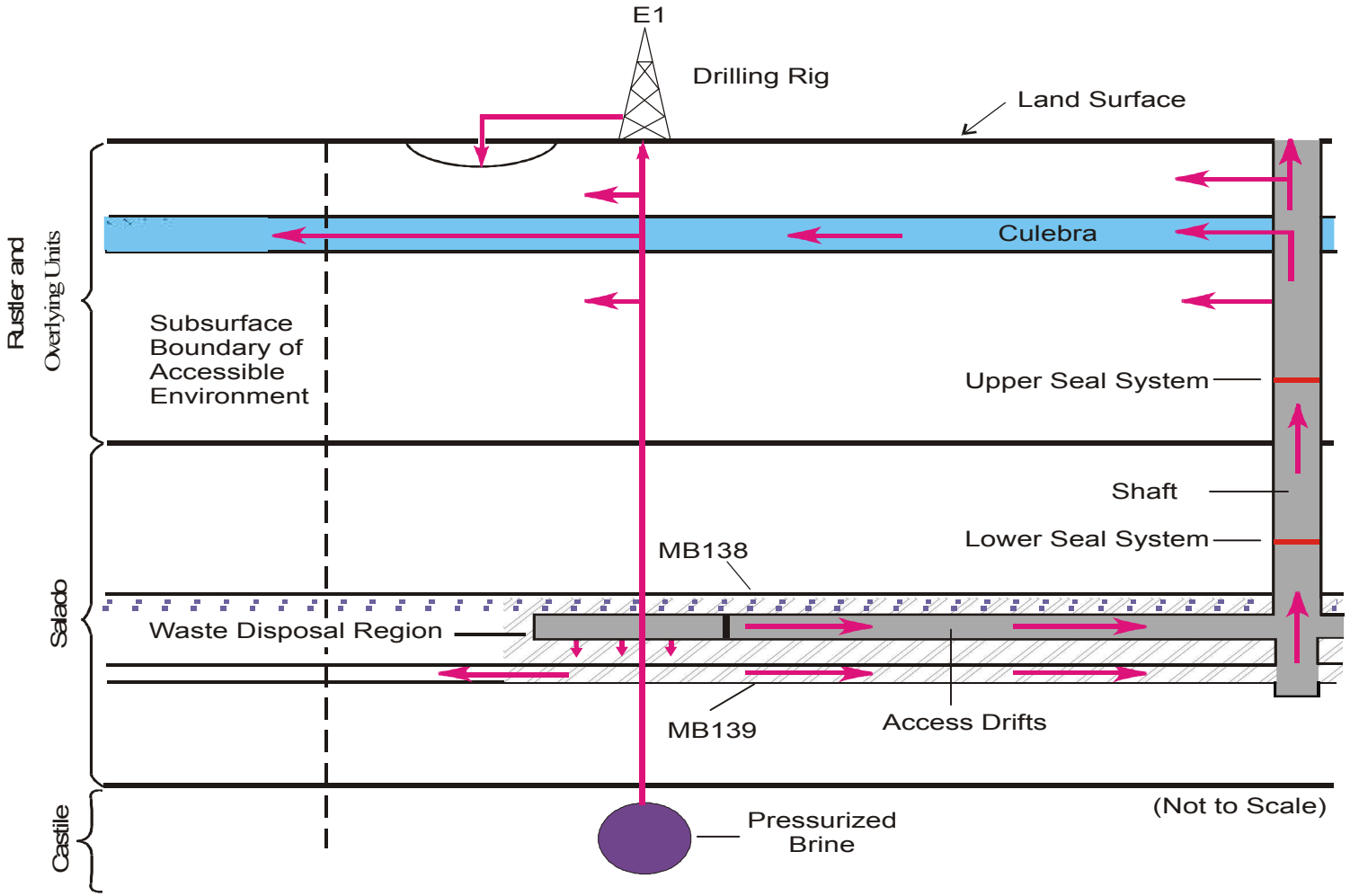
WIPP Scenarios



WIPP DP Scenarios

- E1 – drilling intrusion into pressurized brine pocket
- E2 – drilling intrusion that does not hit brine
- E1-E2 – drilling intrusion into the repository that was previously hit by an intrusion that intercepted a brine pocket
- M – mining
- M-E1 – mining in combination with E1
- M-E2 – mining in combination with E2
- M-E1-E2 – mining in combination with E1-E2

E1 Scenario



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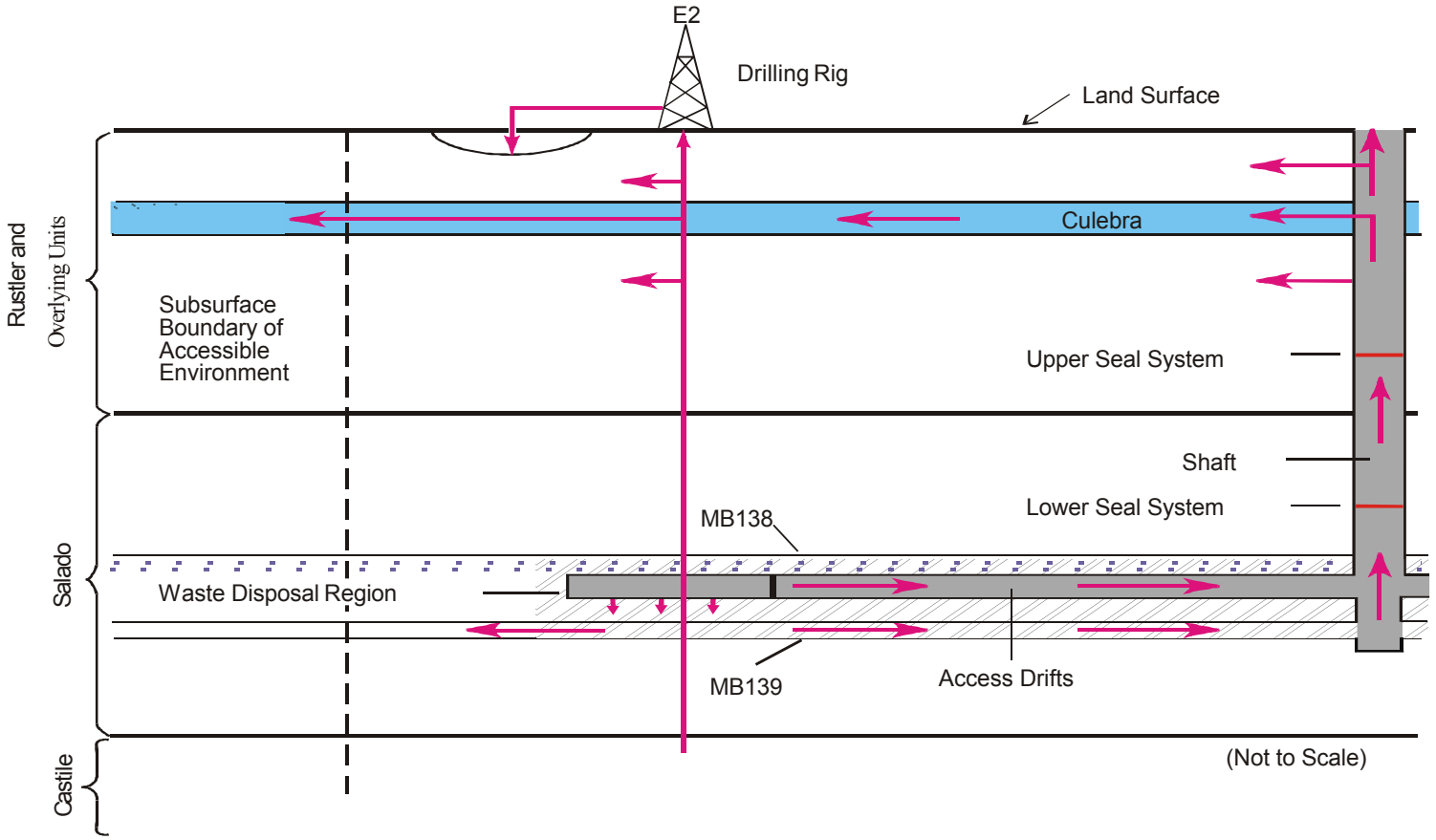
E2 Scenario



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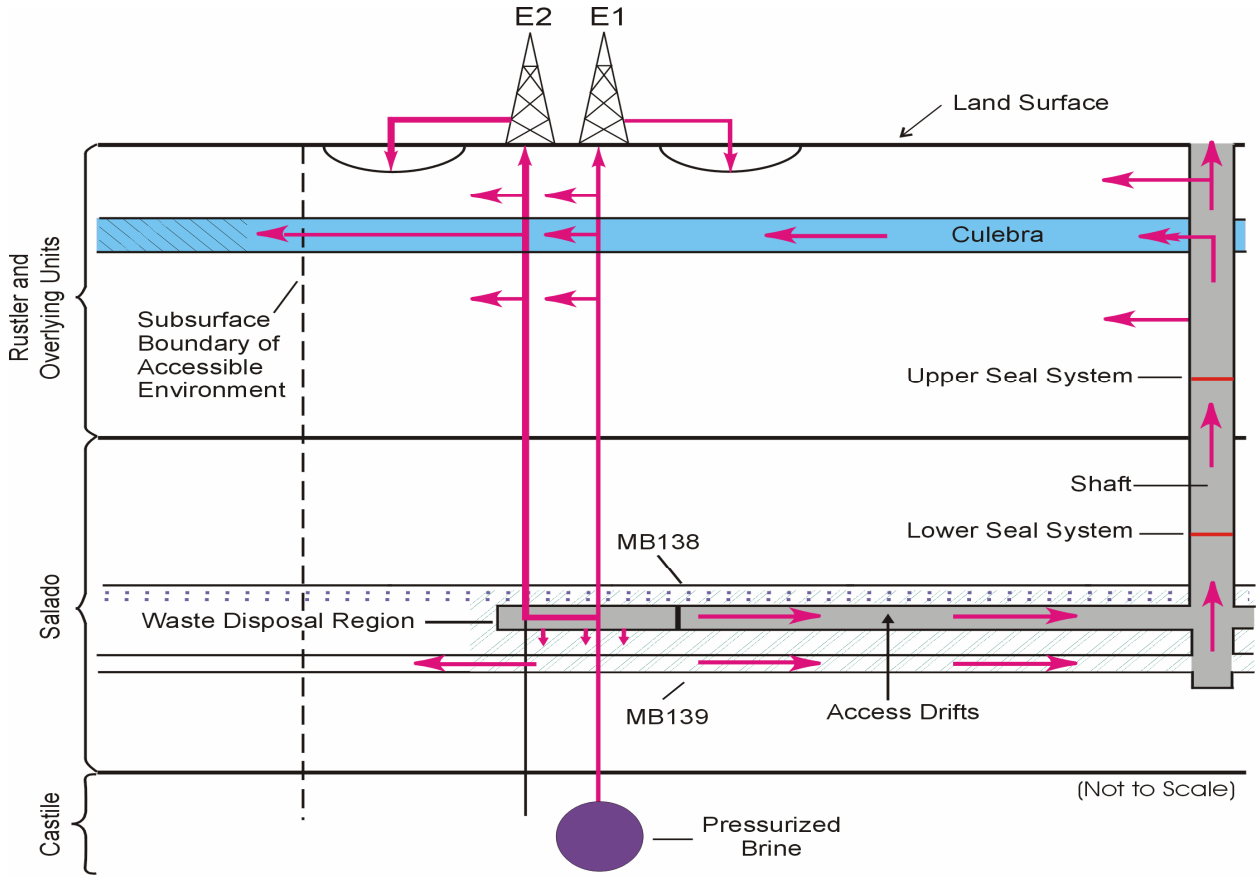
E1E2 Scenario



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Mining Scenario

- **Specified by 40 CFR 194.32 (b)**
  - ***Mining shall be assumed to occur with a one in 100 probability in each century of the regulatory time frame.***
- **Supplemental Information, 40 CFR 194 Subpart C**

  …*DOE may use the location-specific values of hydraulic conductivity, established for the different spatial locations within the Culebra dolomite, and treat them as sampled parameters with each having a range of values varying between unchanged and increased 1,000-fold relative to the value that would exist in the absence of mining.*

Group Activity

Brainstorming Activity