Overview of Model Support (for Engineered Barriers)

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Overview

- Background
- Principles and Practices
- Examples
- Conclusions

Background

- Models are used to project the future performance of engineered covers.
- Model support is arguably the most essential element of confidence building.
- Desired performance can be much longer than engineering experience base.
- Spatial and temporal variability present technical challenges.
- A variety of types of information can be used to provide model support.

Performance Assessment - Context

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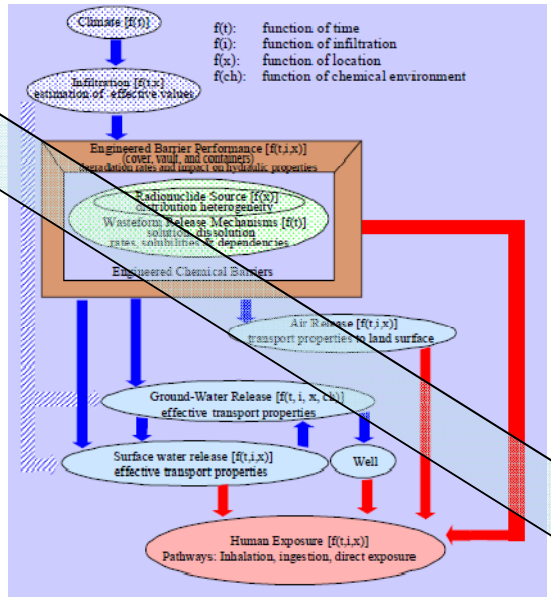
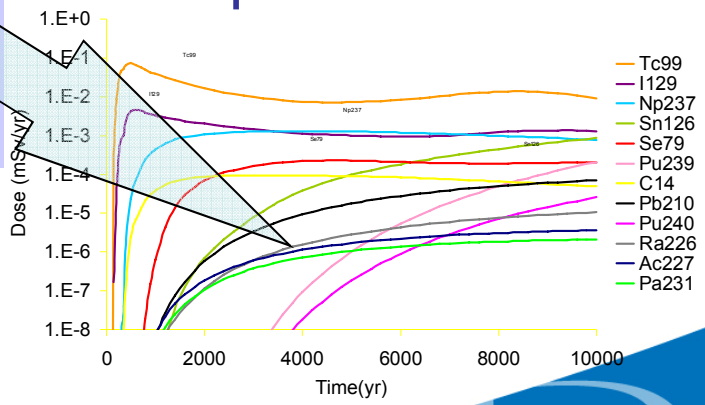
Real system



Mathematical model (abstraction)

Estimated future performance



Model Support Principles

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- Multiple lines of evidence preferred
- Direct observations preferred
- Level of model support ~ risk significance
- Longer experience ~ less support
- Natural analogs for very long term performance
- Support encompass full range of future conditions

Model Support

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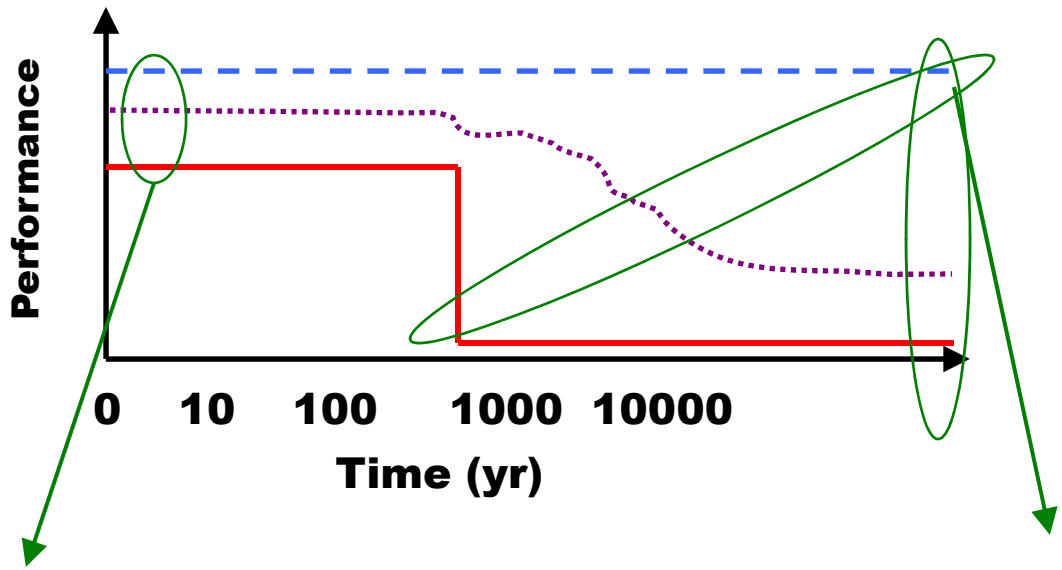
- At a minimum, should have elements of verification and validation:
  - Verification – Solving the equations right
  - Validation – Solving the right equations
- A variety of elements can be part of the model support process:
  - internal review (QA)
  - independent external review
  - documentation of verification efforts
  - multi-faceted validation effort: comparison to lab experiments, field experiments, analogs, etc.

Example: Model Support/ Engineered Barriers



Analyst
Regulator
Actual?

Laboratory experiments
Field experiments
Observations – working systems
Monitoring

Analogs
Accelerated experiments
Expert elicitation
Comparison to other models

Multiple Lines of Evidence

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- Performance complex
- Variable initial conditions and boundary conditions
- Coupled processes
- Reduce errors
- Increase Confidence

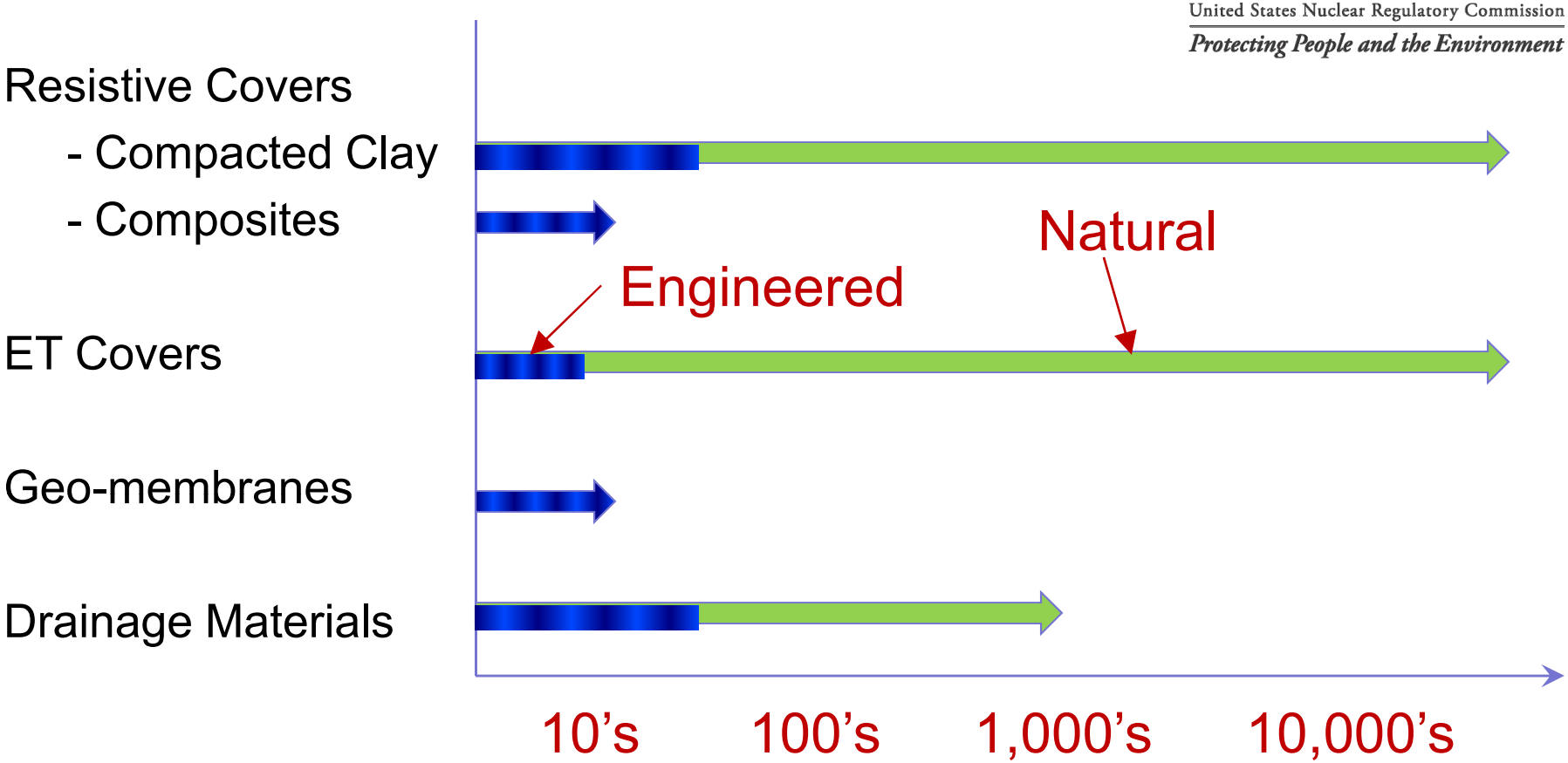
Direct

- Field experiments
- Monitoring data (PI's)

Indirect

- Accelerated laboratory experiments
- Natural analogs
- Expert judgment
- Alternative models
- Past experience

Experience Base



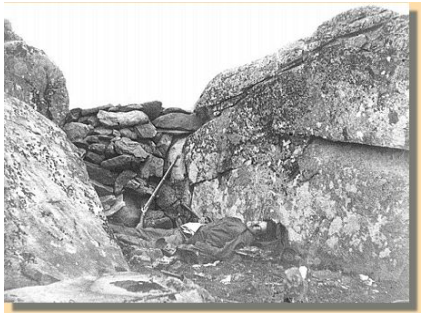
Natural Analogs

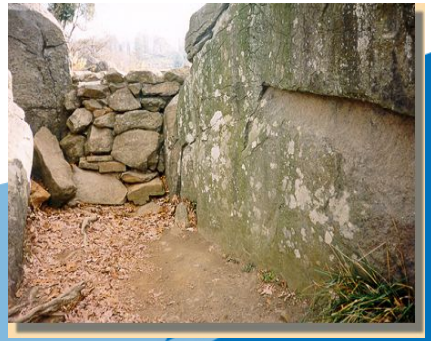
- Data for very long term
- Confirmation bias
- Unknown exposure conditions (past, current, future)

Photos – Terry Johnson (NRC)

Table 3.1 Examples of Surviving Native American Mounds

Mound	Location	Approximate Age (years)
Grave Creek Mounds	Moundsville, WV	2500
Hopewell Culture Mounds	Chillicothe, OH	2000
Cahokia Mounds	Collinsville, IL	1000
Poverty Point Mounds	Epps, LA	3500
Watson Break Mounds	Monroe, LA	5500

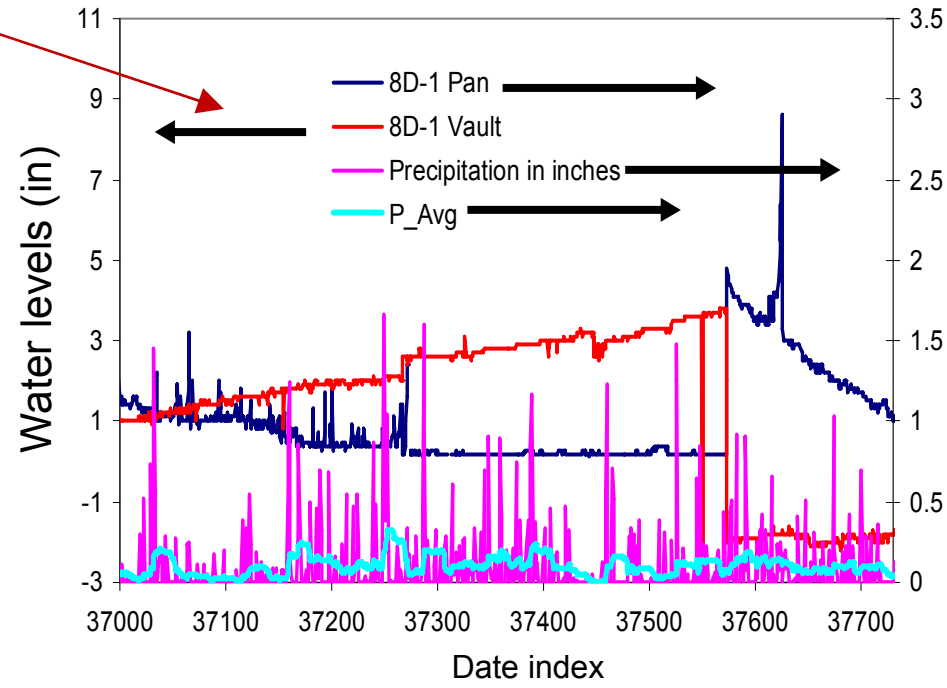




NUREG 1757 Vol2, Section 3.5

Expected Future Conditions

- Exposure conditions can be highly dynamic
- Long timeframes -> consider natural climate cycles
- Support should be provided for full range
  - Hanford barrier controlled fire



Water inside buried vault

Model Support – Erosion

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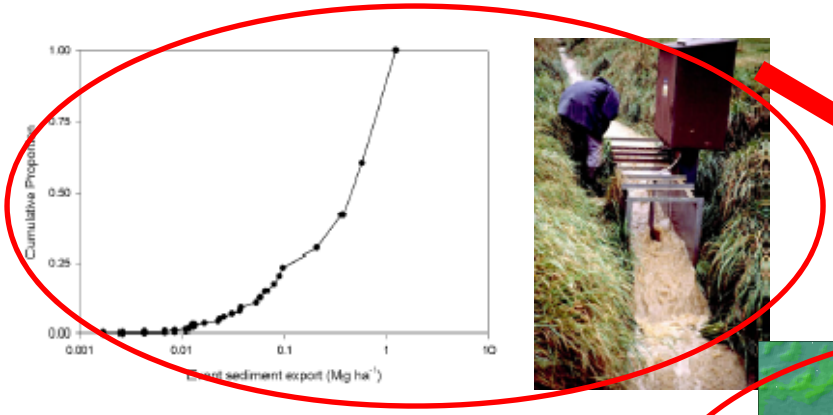
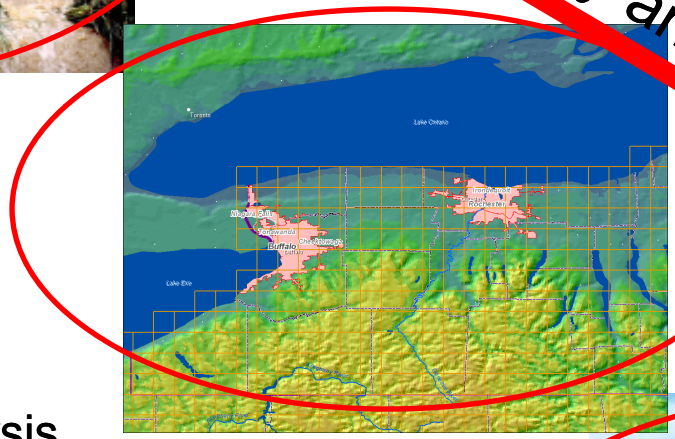
Model Complexity
>>
Model Support!



Comparison of features
Mass balance (watershed)

Complexity and Effort



GIS based analysis
Model comparisons
Analogs

Long-term field experiments
Isotopic studies

Uranium Mill Tailings

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Original Conceptual Model:

-Use Resistive Covers to limit infiltration and waste release

-Low hydraulic conductivity soil layers will limit water contact with the waste

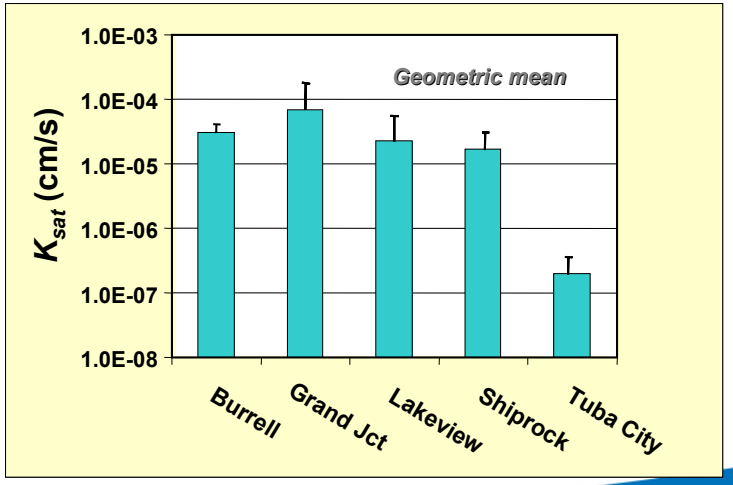
-Covers will slowly change over time

A)

FIELD

LAB

B)



Observations:

A) –Plant encroachment occurred more rapidly

B) -Resistive properties difficult to achieve at the field-scale

-Pedogenesis and other processes can alter hydraulic properties

Courtesy Jody Waugh - Stoller

Low-Level Waste

Observation:

Disturbance of natural system by man and nature result in higher infiltration than anticipated and lateral transport

Observations:

-Clive and Hanford appear to be functioning as envisioned

-Rapid/deep transport of tritium observed at Beatty (believed to be from liquid waste disposal)

-Synergistic effect from processes resulted in fissure in closure cap at Beatty (design modified)

Conclusions

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- Following basic principles for model support will increase acceptance of modeling of engineered cover performance.
- Collaboration and synthesis of experiences would be beneficial.
- Model support is essential to successful decision making.