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On Performance of Covers and Liners In Performance Assessments

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DOE CERCLA On-Site Disposal Cells (OSDC)

- **DOE CERCLA OSDCs:**
  - Closed: Weldon Spring, Fernald, and Monticello
  - Active: Oak Ridge, Hanford, and Idaho National Laboratory (INL)
  - Proposed: Portsmouth, Paducah, and Oak Ridge
- **Final Disposition of Large Waste Volumes:**
  - Remediation of Contaminated Areas
  - Deactivation and Decommissioning (D&D) of Facilities
- **Regulatory Framework:**
  - CERCLA with Record of Decision (ROD) under EPA and/or States
  - DOE Order 435.1 Disposal Authorization Statement (DAS) under DOE
- **DOE CERCLA OSDC Design:**
  - RCRA Prescriptive Design based Standards under CERCLA (i.e. ARAR)
  - Performance based Standards under 435.1 (Performance Objectives)
  - Performance based Standard requires consideration of Cover and Liner Evolution for long-term performance

Covers and Liners in Performance Assessments

- **DOE-EM Office of Site Restoration formed CERCLA Working Group to address issues common to DOE sites with CERCLA OSDCs**
- **Accounting for Liners and Covers in 435.1 Performance Assessments was one issue addressed (i.e. Evolution of Covers and Liners over 1,000+ years in context of meeting Performance Objectives):**
  - Consideration of Liners and Covers in Performance Assessments

    SRNL-STI-2014-00409
  - Approaches to Consider Covers and Liners in a Low-Level Waste Disposal Facility Performance Assessment

    WM2015 Paper ID# 15300
- **May also be applicable to CERCLA Risk Assessments**

Credit for Covers and Liners in Performance Assessments

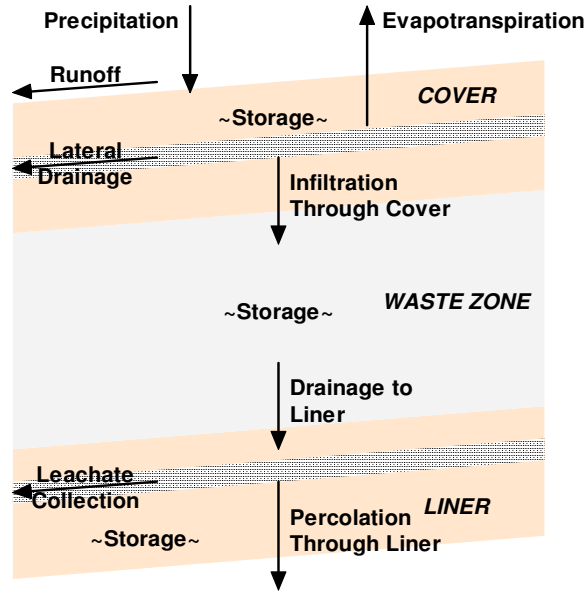
- **Credit for Covers and Liners defined Primarily in terms of Water Balance (i.e. Water Flow Driving Radionuclide Transport)**
- **How much Credit needed?**
  - Depends on the Anticipated Radionuclide Inventory:
    - *Activity and Daughter In-growth*
    - *Long half-life versus Short half-live*
    - *Mobile versus Immobile*
  - Depends on Site-Specific Conditions:
    - *Hydrogeologic Conditions (i.e. Time of Transport to Point of Assessment)*
    - *Climate (i.e. Background Infiltration due to Arid versus Humid Conditions)*
- **How much Credit can be taken?**
  - Depends on State of Scientific Justification
  - Depends upon Perspective of Regulators (can be influenced by Scientific Justification)
- **Bottom-line:**
  - Can needed Credit for Covers and Liners be adequately Justified to the Regulators?
  - Are the Covers and Liners simply a Defense-in-Depth?
- **Caveat: Conservative can only be defined in terms of Performance Objectives**

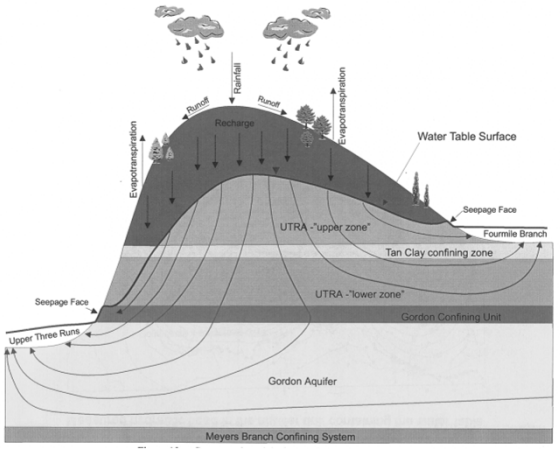
General Approach to Consider Covers and Liners

- **General Considerations:**
  - Graded and Iterative Approach
  - Total Systems Approach (Consider Functional Roles and Interrelationships in Terms of the Overall System)
  - Must Consider Implications of Credited Performance versus Expected Performance
  - Define Areas/Items of Importance and Refine as Necessary (Screening and Sensitivity)
  - Must manage Uncertainties (i.e. identify uncertainties that can be managed)
  - Appropriate Level of Regulator Engagement (Core Team Concept)
- **Steps of General Approach:**
  1) Develop Initial Representation of Total Disposal System (Overall Conceptual Model)
  2) Develop Initial Conceptual Models for each Layer
  3) Quantify Evolution/Degradation
  4) Identify Total System Scenarios to be Considered

Develop Initial Representation of Total Disposal System

- **Conceptualization of the Total Disposal System (Cover, Waste, Liner, and Natural System):**
  - Expected Water Balance and Bulk Flows Through the System
  - Expected Evolution over Time, for Example:
    - *Average Precipitation (P) over time*
    - *Near Background Evapotranspiration (ET) over time (unless significant Subsidence occurs)*
    - *P – ET = Split between Lateral Drainage (LD) and infiltration (I) through Cover (LD decreases and I increases over time)*
    - *I = Split between Waste Moisture (WM), Leachate Collection (LC), and Percolation (P) through Liner (WM high during operation, decreases with Cover, increases as Cover fails; LC eventually goes to zero; and P increases over time)*
  - In Arid Environments ET may be so high that P will always be insignificant

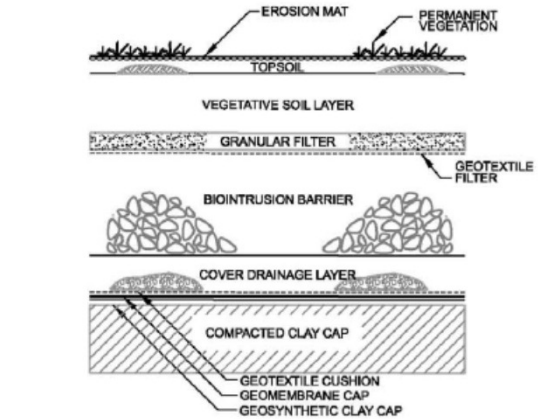


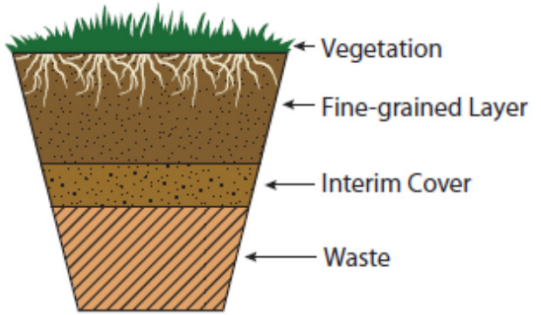


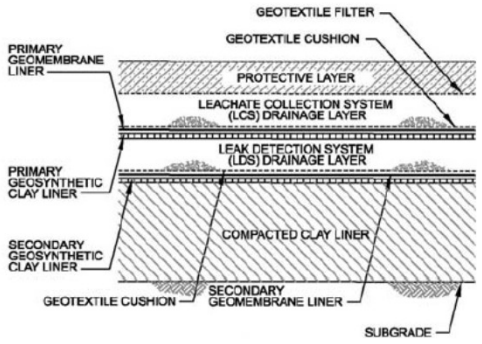
See Section 4.0 of Report

Develop Initial Conceptual Models for Each Layer

- Develop Functional Roles for each Layer in Relation to Water Balance and Radionuclide Migration
- Develop Assumptions for Layer Materials
- Determine Interrelationships between Layers in Relation to Water Balance and Radionuclide Migration
- Determine relative importance of each layer in Relation to Water Balance and Radionuclide Migration
- Determine which Layers will be Credited in the Model
- Develop required Material Properties
- Determine how Layers will be Linked in the Model



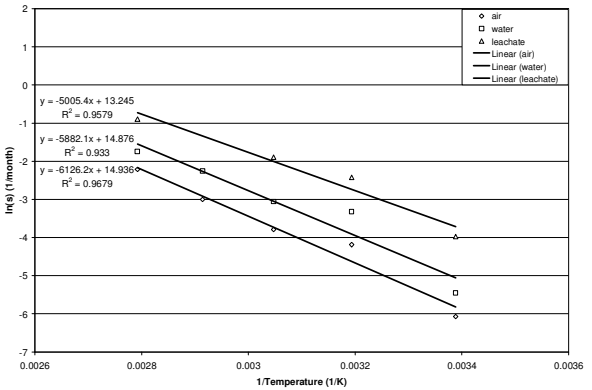


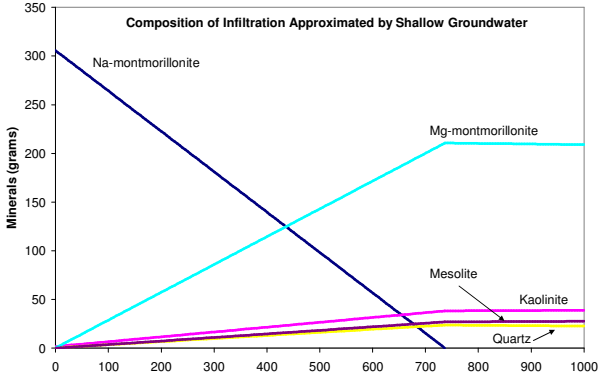


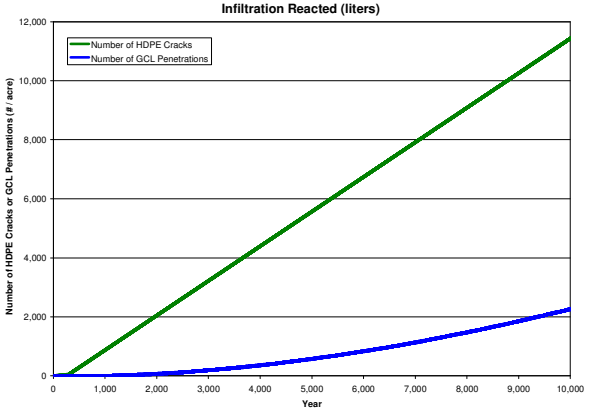
See Sections 5.0, 6.0, and 7.0 of Report

Quantify Evolution/Degradation

- Identify Events and Processes Resulting in Evolution/Degradation of each Layer to be Credited in the Model
- On the basis of Existing Experience and Scientific Justification, Quantify the Evolution/Degradation of each of these Layers in Relation to its Functional Roles (i.e. changes in Material Properties and Timing)
- This is the Aspect of Cover and Liner Consideration in PAs that is generally the most Challenging, most Uncertain, and of most Interest to the Regulators
- Care must be taken in making "Conservative Assumption". It is only conservative if it is conservative in relation to the Performance Objectives.



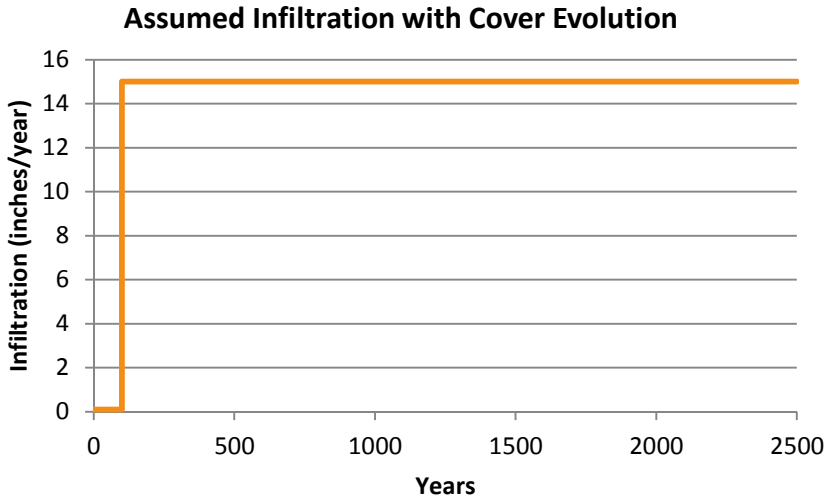


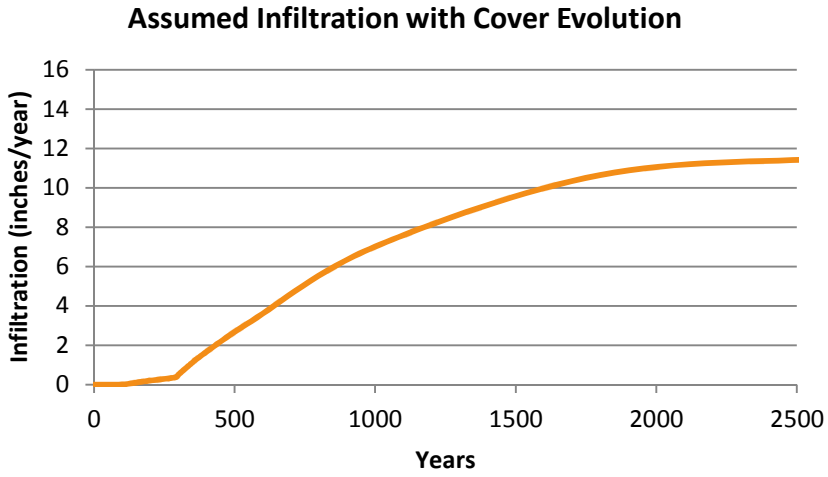


See Sections 8.0 and 9.0 of Report

Identify Total System Scenarios to be Considered

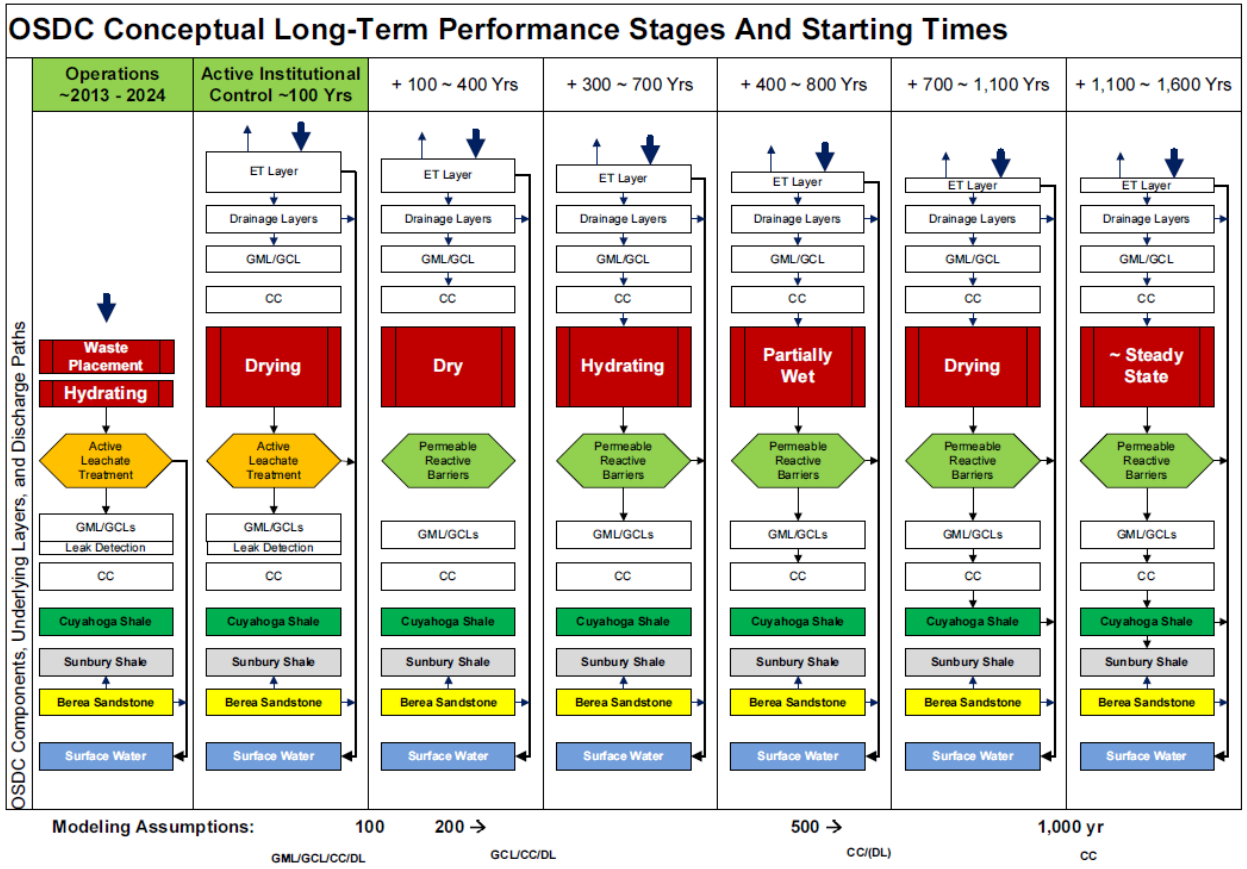
- Synthesize Information from first Three Steps into Integrated Scenarios that address Evolution over time
- Should consider a few "Realistic" Scenarios to Capture Impacts of Different Timing Assumptions in Relation to Water Balance and Radionuclide Migration
- This Aspect of Cover and Liner Consideration in PAs is also of significant Interest to the Regulators





Portsmouth Example

Portsmouth Water Balance Evolution Over Time



SRNL-STI-2012-00203

Key Words:
Portsmouth
Composite Barrier
Geomembrane
Geosynthetic Clay Liner
Compacted Clay Liner

Retention:
Permanent

COMPOSITE BARRIER LONGEVITY IN SERVICE AT THE POTENTIAL PORTSMOUTH ON-SITE DISPOSAL CELL (OSDC)

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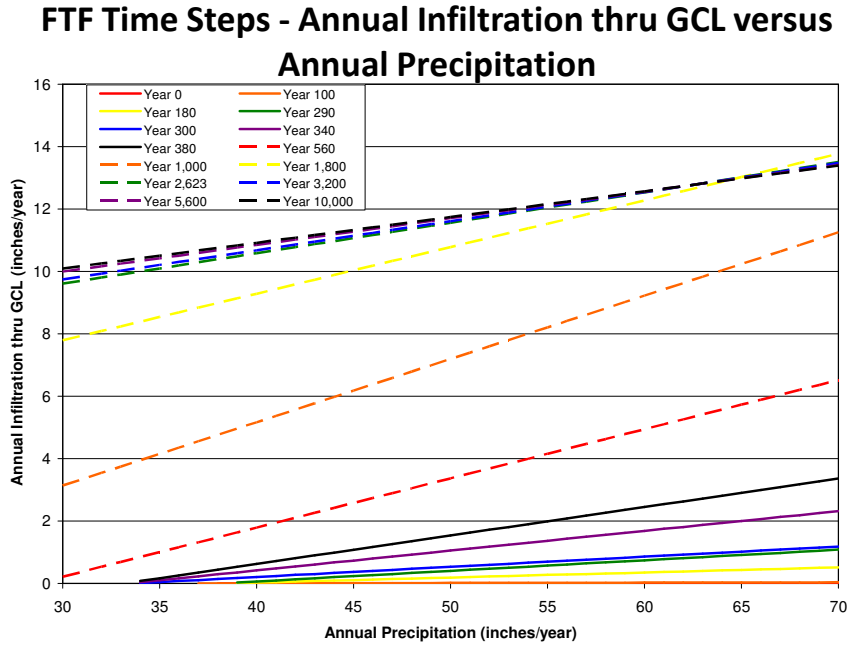
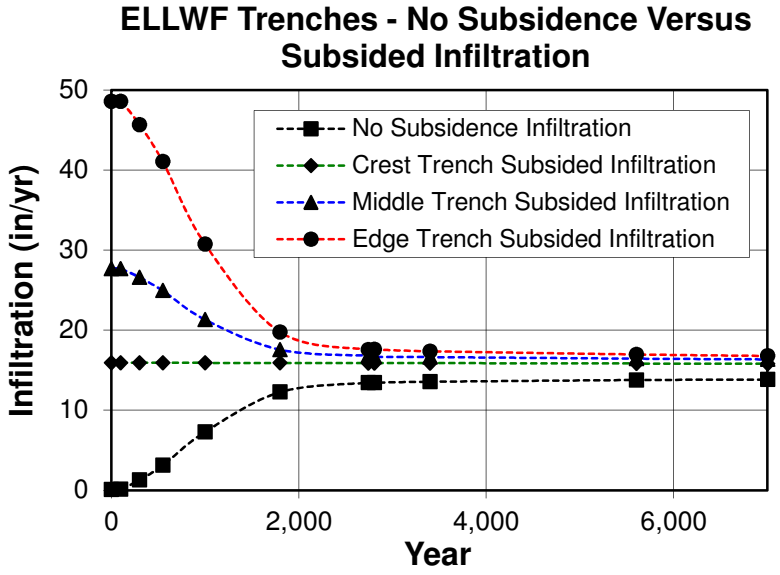
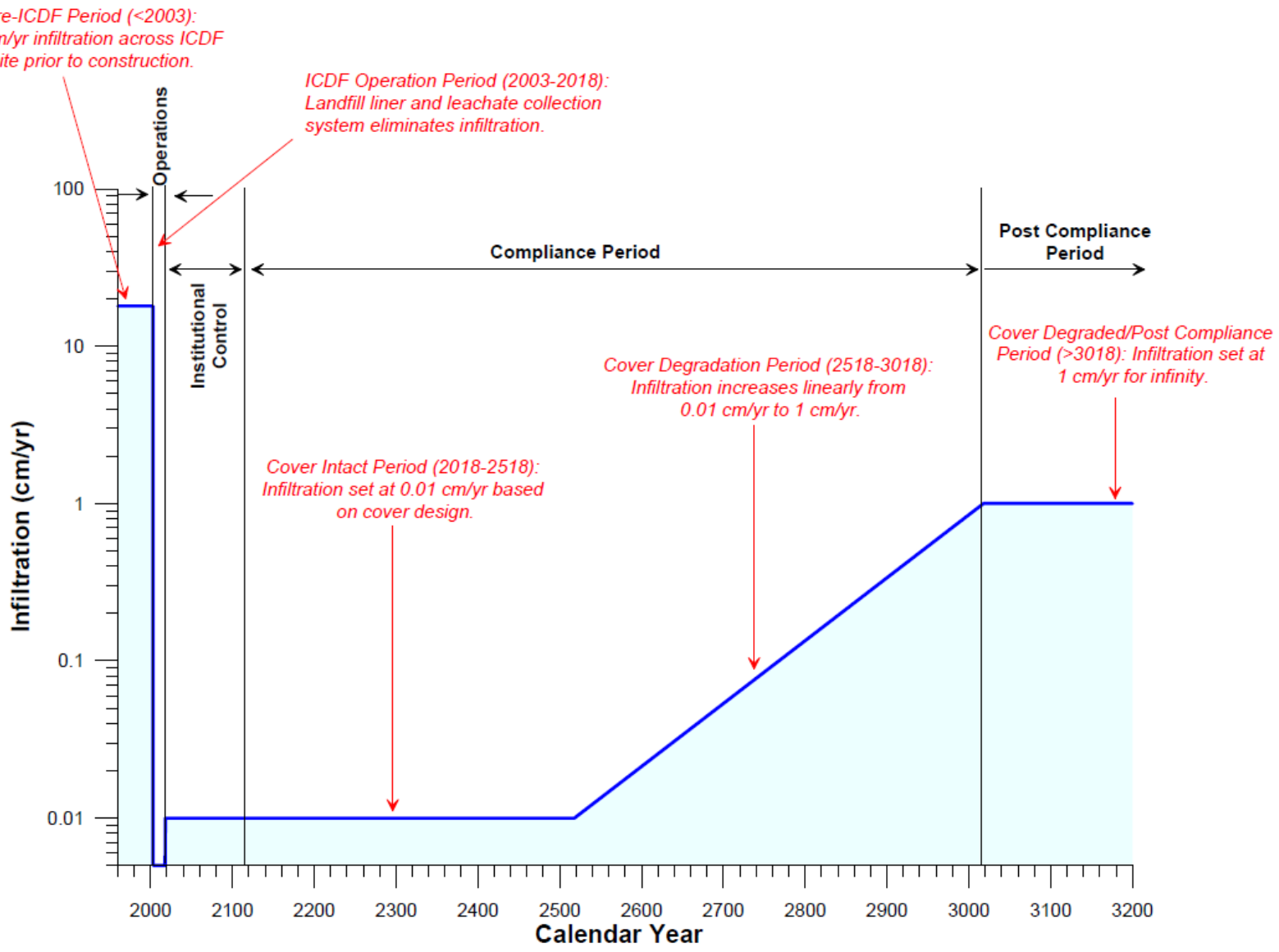
Savannah River Site (SRS) Examples

- **Cover Performance Considered in SRS Performance Assessments:**
  - F and H-Area Tank Farms (FTF and HTF)
  - Saltstone Disposal Facility (SDF)
  - E-Area Low Level Waste Facility (ELLWF)
- **Regulators for FTF, HTF, and SDF included LFRG, EPA, SCDHEC, and NRC**
- **LFRG sole regulator for ELLWF**





Idaho National Laboratory (INL) Example



Idaho National Laboratory (INL) Example (Continued)

Case	Institutional Control Year 2018–2118 (INL Site boundary) (mrem/yr)	Compliance Year 2119–3018 (100 m downgradient) (mrem/yr)	Post-Compliance Year >3018 (100 m downgradient) (mrem/yr)
Base case	<0.0001	0.0008	0.58
Sensitivity Case 1 (0.1 cm/yr for ∞)	<0.0001	0.000004	0.064
Sensitivity Case 2 (1 cm/yr for ∞)	<0.0001	0.048	0.61
Sensitivity Case 3 (failure of HDPE liner system)	<0.0001	0.0043	0.59
Sensitivity Case 4 (absence of bentonite clay layer)	<0.0001	0.0028	1.0
Sensitivity Case 5 (alternative conceptual model – missing interbed)	<0.0001	0.0067	0.68
Sensitivity Case 6 (liner does not fail until facility fills with water 850 yr after closure)	<0.0001	0.0025	0.53
Sensitivity Case 7 (cover fails after 100 yr and liner fails after facility fills with water 230 yr after closure)	<0.0001	0.046	0.55
Sensitivity Case 8 (liner never fails and the facility fills with water and overfills [bathtub effect])	<0.0001	0.58	7.8

Typical Regulator Items of Interest/Concern

- Conceptual Model (Water Balance and Radionuclide Migration)
- Assumed Evolution of Cover and Liner Properties over time
- Assumed Timing of Changes in Cover and Liner Performance
- Taking too much Credit for Covers and Liners (i.e. artificially extending impacts beyond 1,000 year Assessment Period)
- Variability in assumed Precipitation and PET over long time frames
- Bathtub Effect
- Subsidence

Questions?

For copies of Consideration of Liners and Covers in Performance Assessments, SRNL-STI-2014-00409, contact:

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