

Fluvial Redistribution of Contaminated Tephra: Description of an Abstracted Model

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Introduction

- U.S. Department of Energy (DOE) — Repository Developer
- U.S. Nuclear Regulatory Commission (NRC) — Regulator
- Center for Nuclear Waste Regulatory Analyses (CNWRA) — Federally Funded Research and Development Center

Introduction (cont'd)

- DOE Total System Performance Assessment (TSPA) Model
- NRC Total-system Performance Assessment (TPA) Code

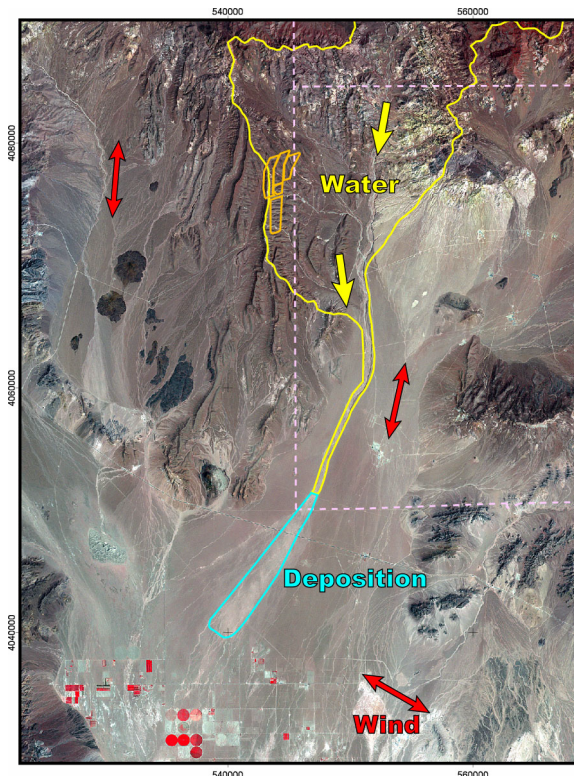
Significance to Waste Isolation

- Risk = Probability x Consequence
- Current Risk Insights on Key Factors
 - Inhalation of Resuspended Volcanic Ash
 - Remobilization of Ash Deposits
 - Wind Vectors During an Eruption
 - Volume of Ash Produced by an Eruption

Disruptive Scenario

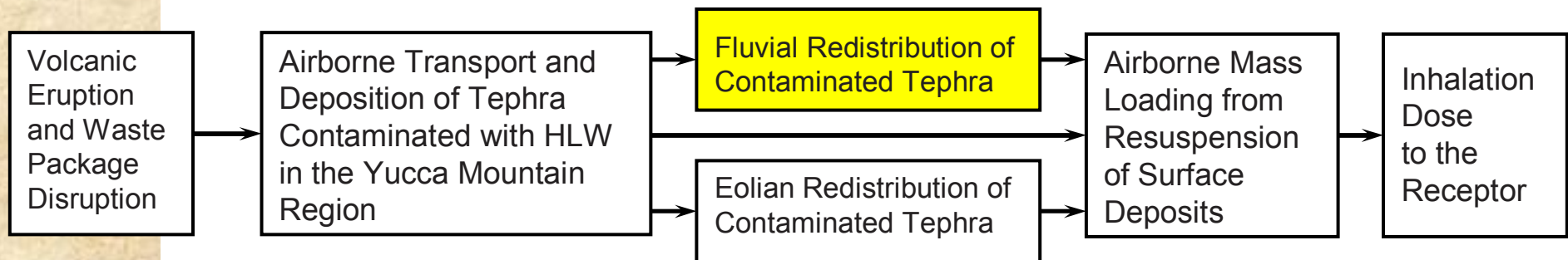
- Volcanic Conduit Intersection with Potential Repository
- Waste Package Disruption by Magma
- High-Level Waste (HLW) Incorporation into Erupting Tephra
- Direct Release into Biosphere

Disruptive Scenario (cont'd)



- Atmospheric Transport of Tephra
- Tephra Deposition within Yucca Mountain Region
- Redistribution of Deposited Tephra by Water (Fluvial) and Wind (Eolian)
- Resuspension of Contaminated Ash (Tephra < 2 mm [0.08 in])
- Inhalation of Airborne Ash

Consequence Modeling



- NRC TPA Code
- New Abstracted Model
 - Improve Realism
 - Reduce Uncertainty
- Fluvial Redistribution Modeling Component
 - HLW Concentration Factor in Tephra
 - Fluvial Dilution Factor
 - Duration of Fluvial Redistribution

HLW Concentration Factor

- Uniform Mixing of High-Level Waste in Tephra

$$C_f = \frac{m_{\text{HLW},f}}{m_{\text{ash},f}}$$

$m_{\text{HLW},f}$ Mass of high-level waste deposited in the Fortymile Wash catchment basin from the eruption [g]

$m_{\text{ash},f}$ Mass of ash deposited in the Fortymile Wash catchment basin from the eruption [g]

Fluvial Dilution Factor

- Uniform Mixing of Contaminated and Clean Sediments

$$d_f = \frac{1}{1 + \frac{Y_{\text{sediment},f}}{Y_{\text{ash},f}} \left(\frac{A_{\text{basin},f}}{a_{\text{ash},f}} - 1 \right)}$$

$Y_{\text{sediment},f}$

Preeruption sediment volume from the drainage basin that discharges through Fortymile Wash per unit area per discharge event [m/event]

$Y_{\text{ash},f}$

Posteruption volume of fluvial redistributed ash at the Fortymile Wash depositional region per unit area per discharge event [m/event]

$A_{\text{basin},f}$

Area of the drainage basin that discharges through Fortymile Wash [m²]

$a_{\text{ash},f}$

Area of the Fortymile Wash catchment basin with an ash deposit from the eruption [m²]

Duration of Fluvial Redistribution

- Time to Deplete Fortymile Wash of Contaminated Tephra

$$t_{\text{duration},f} = \frac{m_{\text{ash},f} T_f}{Y_{\text{ash},f} a_{\text{ash},f} \rho_{\text{ash},f}}$$

T_f Average time between significant flow events [yr/event]

$\rho_{\text{ash},f}$ Density of proximal ash deposit [g/m³]

Summary of Modeling Assumptions

- Uniform Mixing of High-Level Waste in Tephra
- Frequent Flooding Events
- Surface of Depositional Area Regularly Renewed with Fresh Fluvial Tephra Deposits
- Uniform Mixing of Contaminated and Clean Sediments
- Airborne Concentration of High-Level Waste Persists Until Fortymile Wash is Depleted of Contaminated Tephra

Conclusion

- New Abstracted Model
 - Improve Realism
 - Reduce Uncertainty
- Independent Capability to Evaluate Risk-Significant Processes
- Fluvial Redistribution Component
- Companion Paper on Process-Level Modeling

Companion Paper

- Process-Level Modeling Determines Input Values for Abstracted Model Parameters

Symbol	Description
$Y_{\text{sediment},f}$	Preeruption sediment volume from the drainage basin that discharges through Fortymile Wash per unit area per discharge event [m/event]
$Y_{\text{ash},f}$	Posteruption volume of fluvial redistributed ash at the Fortymile Wash depositional region per unit area per discharge event [m/event]
$A_{\text{basin},f}$	Area of the drainage basin that discharges through Fortymile Wash [m ²]
$\rho_{\text{ash},f}$	Density of proximal ash deposit [g/m ³]
T_f	Average time between significant flow events [yr/event]

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- The NRC staff views expressed herein are preliminary and do not constitute a final judgment or determination of the matters addressed or acceptability of a license application for a geologic repository at Yucca Mountain.