U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

PRESENTATION TO THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: SOURCE TERM DEVELOPMENT

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PRESENTER'S TITLE AND ORGANIZATION: TASK LEADER, WASTE PACKAGE PERFORMANCE ASSESSMENT
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Source Term Development

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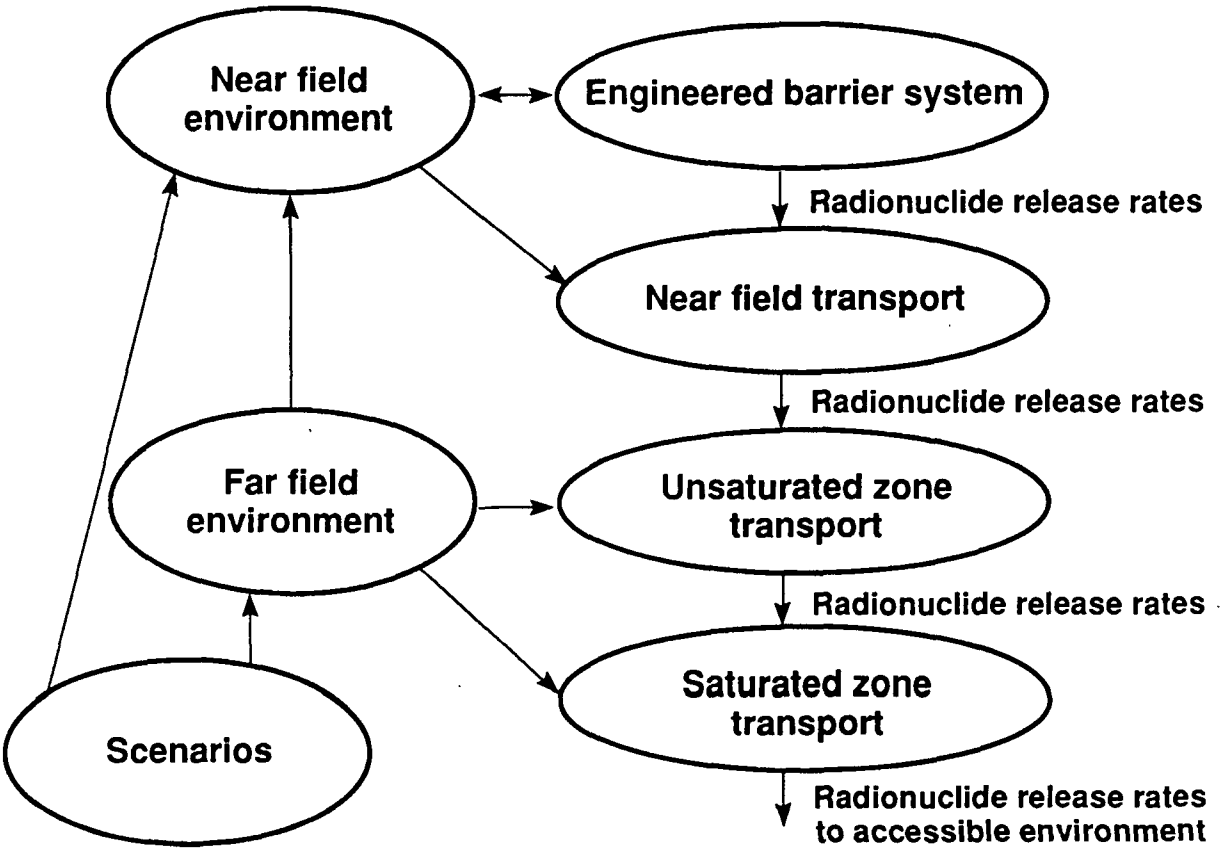
QT-PeR-U-16158-01

Subsystems act as barriers in series



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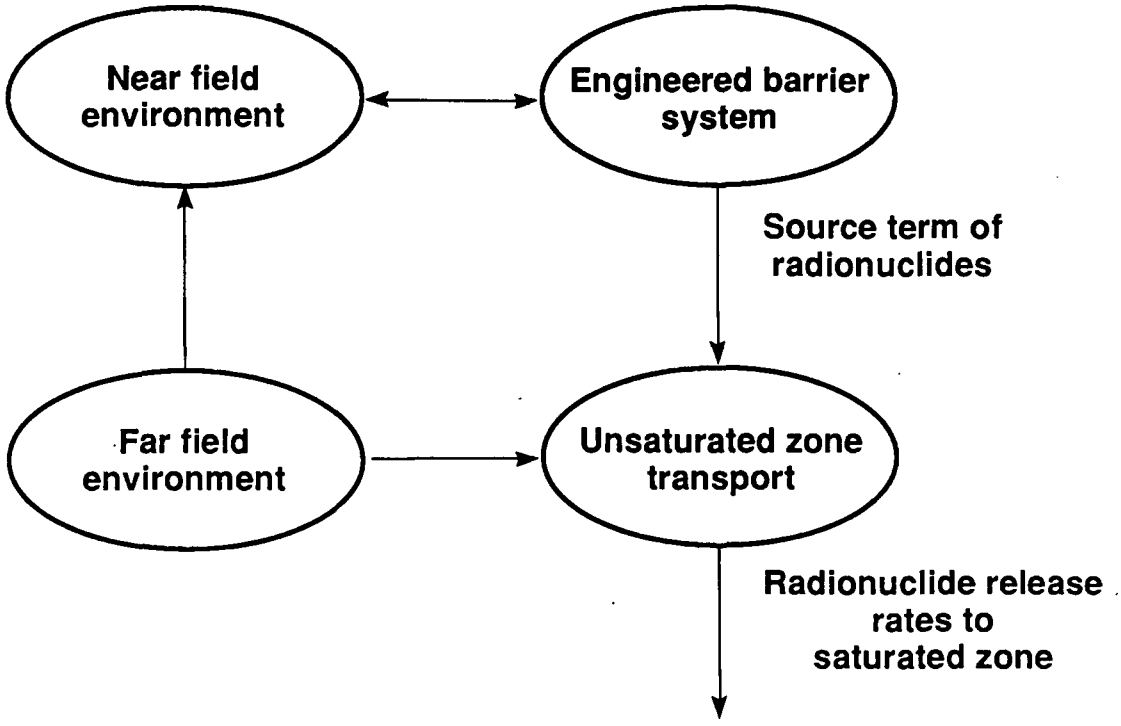
The PACE–90 nominal case focused on selected barriers



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DOE Working Group 2 collaborated to define and analyze a source term problem

Coauthors: Lawrence Livermore National Lab
Pacific Northwest Laboratories
Univ. of California/Lawrence Berkeley Lab

Approach:

- What do we need to know to analyze the problem?
- Focus on the final steps leading to releases from the EBS
- Use available data and some cautious assumptions
- Boundary condition on the cautious side:
  - — Assume areal average groundwater flux (Darcy) is 0.5 mm/y

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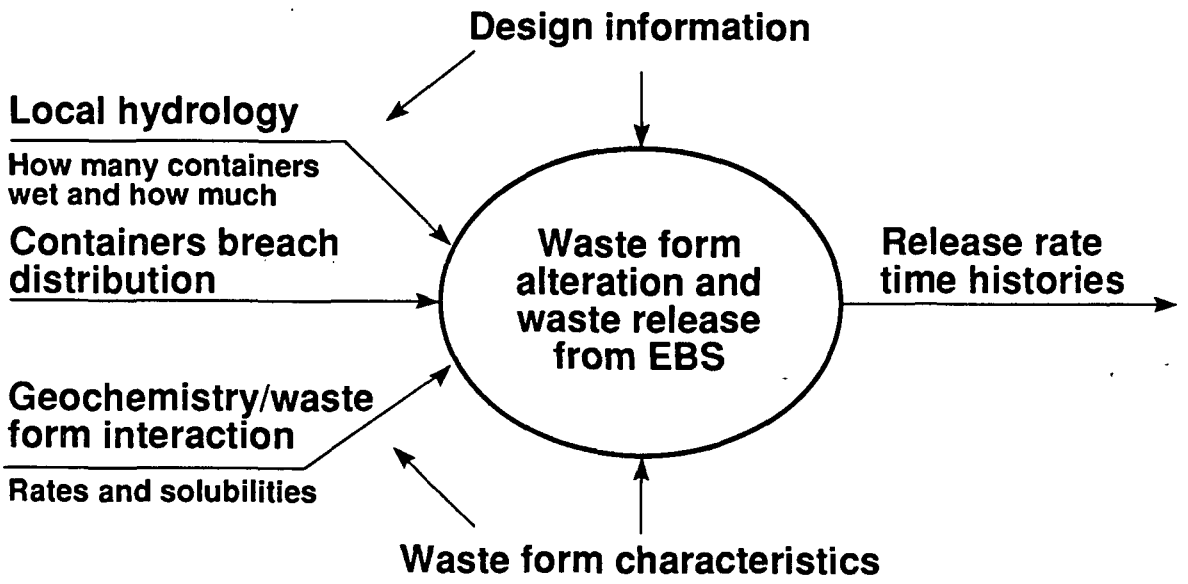
What inputs are required



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Input information considered
I. Hydrology at borehole scale

- General modes of water contact:
  - — Seepage, dripping into borehole
    - Flowthrough container state
    - Bathtub container state
  - — Static pathways for diffusion
    - Rubble in air gap
    - Rock block

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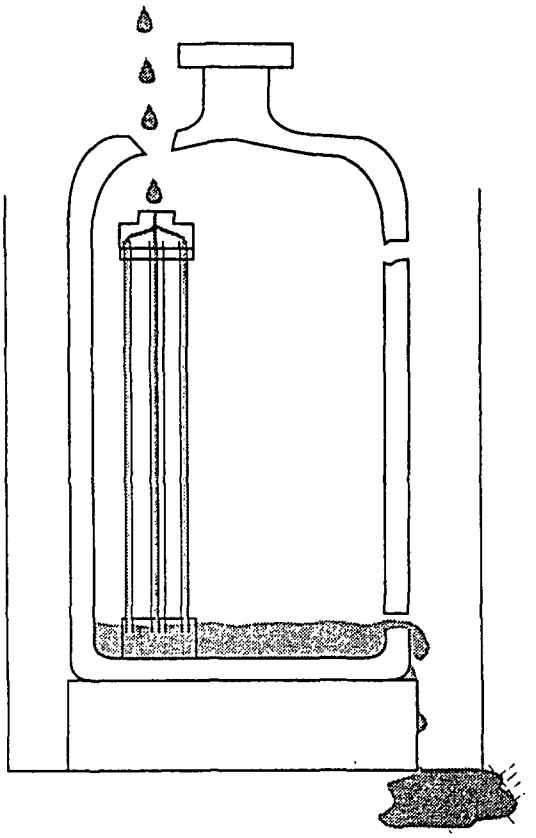
"Bathtub" and "flowthrough" water contact modes



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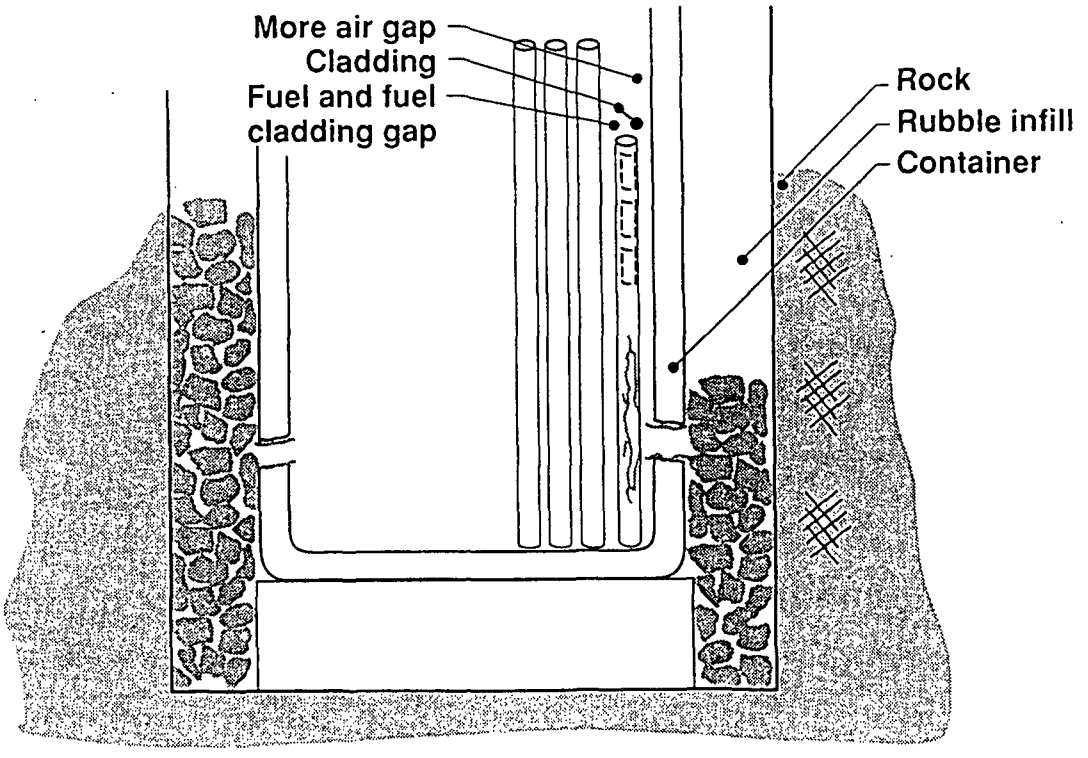
Diffusion requires a continuous water pathway



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Input hydrology (continued)

- Experimental and analytical information considered:
  - — Prototype and lab tests of heatup/cooldown/rewetting
  - — Lab tests of effective diffusion coefficients in gravels
  - — Coupled fluid and heat flow analysis
  - — Single–fracture infiltration flow analysis
- We analyzed and compared flowthrough, bathtub, and rubble diffusion contacts
- We used heatup/cooldown across the repository as a control on water contact times
- Water flux variability across the repository will be added in the future

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Input information considered
II. Spent fuel/groundwater interaction

- Multiple–cycle tests available
  - — Uranium reaches an apparent solubility limit, but dissolution of Tc, I, Cs does not stop
- Conceptual models
  - — Forward alteration of UO_2 matrix
  - — Crack and grain boundary release
  - — We used an upper bound on two concepts and two experiments
  - — Additional tests are planned to resolve processes
- Solubilities
  - — Measured and calculated
  - — Solubilities of actinides are uncertain but quite low

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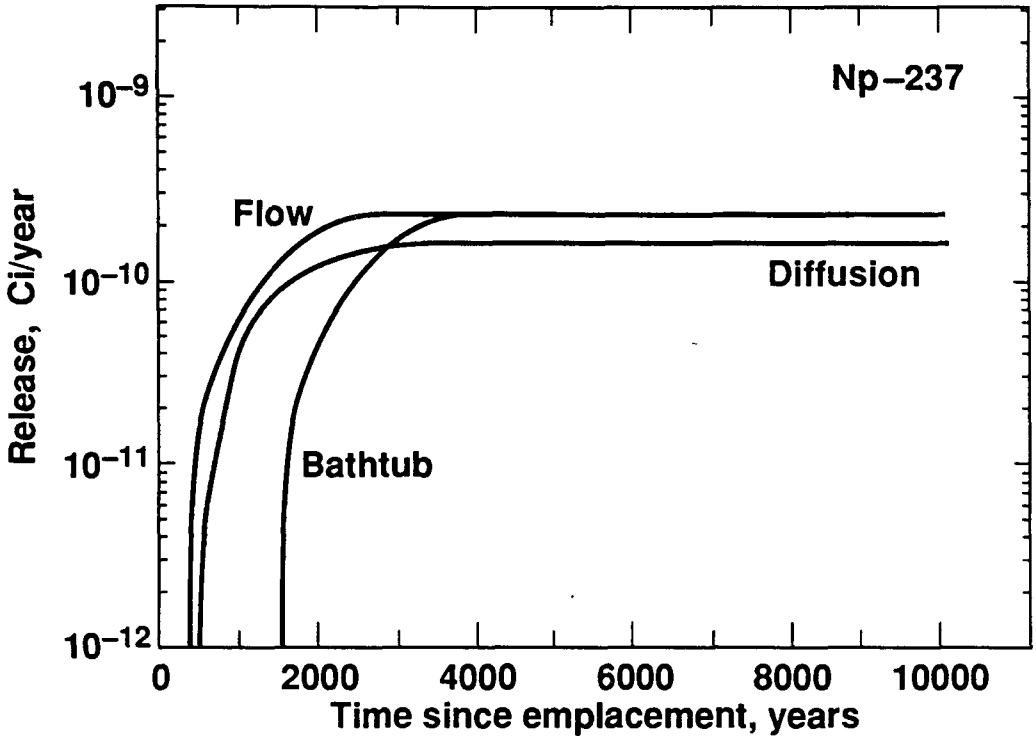
Representative long–lived radionuclides were selected for analysis

- Tc–99, I–129, Cs–135
  - — Highly soluble
  - — A fraction of inventory in fuel/cladding gap
  - — Retardations low (Tc, I) and high (Cs)
- Np–237
  - — Low solubility
  - — One predominant isotope
  - — Use as a representative for other major actinides

Other conservative or cautious assumptions

- Each container is assumed to breach 300 years after it cools down below the boiling point of water
- Fuel cladding's protective effects are neglected
- Diffusion resistance inside container is neglected

Release of low–solubility Np–237 was of low amplitude, long duration



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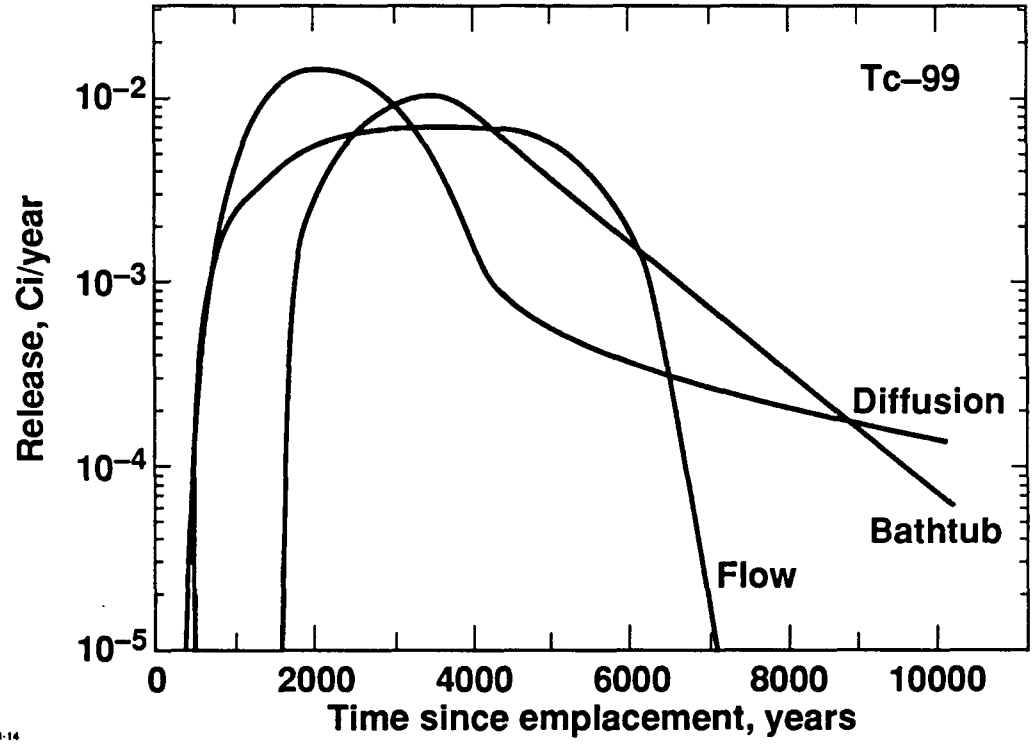
Release of Tc–99 from wet waste packages was of relatively short duration and high amplitude



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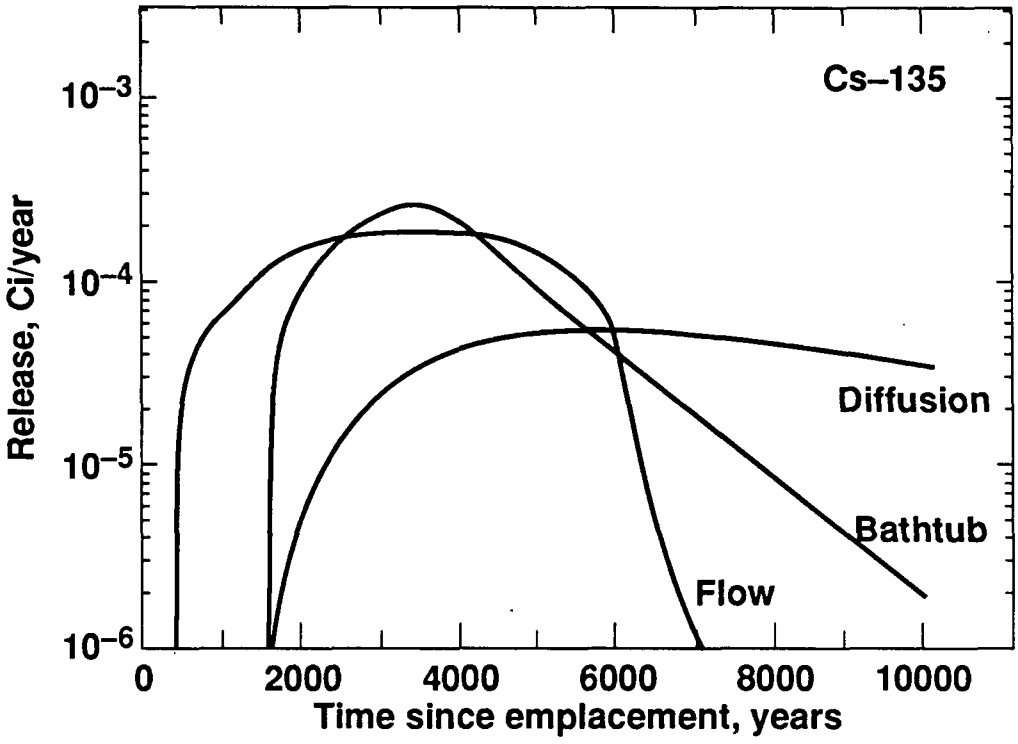
Diffusion–based release was lower for Cs–135 due to retardation



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Source term behavior depends on radionuclide type

- Tc–99, I–129
  - — Release can be of relatively short duration (thousands of years)
  - — Limiting factors are UO_2 alteration rate or hydrological factors
- Cs–135
  - — Release can be of short or long duration depending on water contact mode
  - — Limiting factors are as for Tc–99 and also retardation
- Np–237
  - — Release is of long duration, low amplitude
  - — Limiting factors are solubility and hydrology

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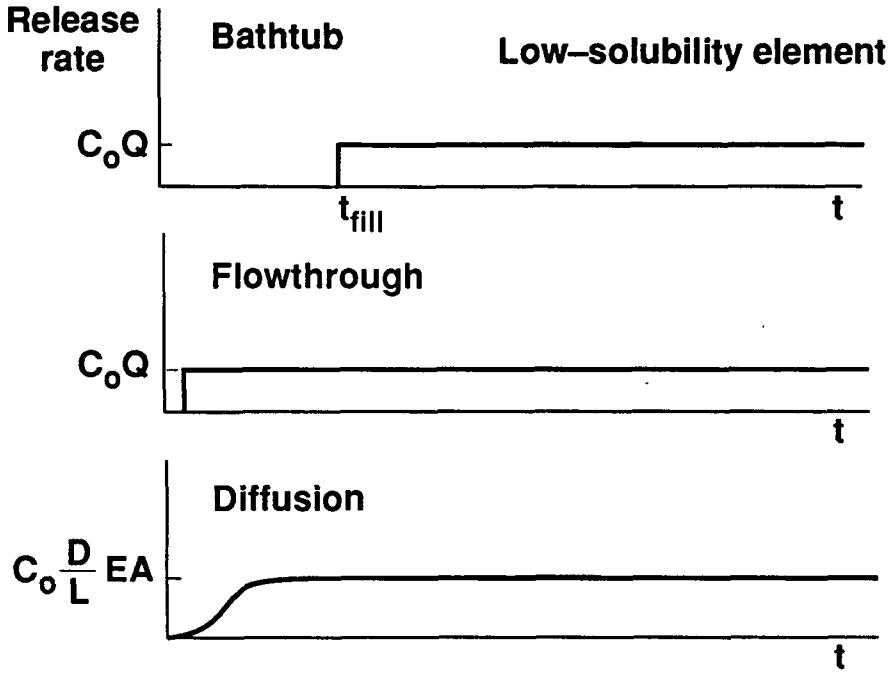
Sensitivity of our simplified model can be done by inspection in some cases



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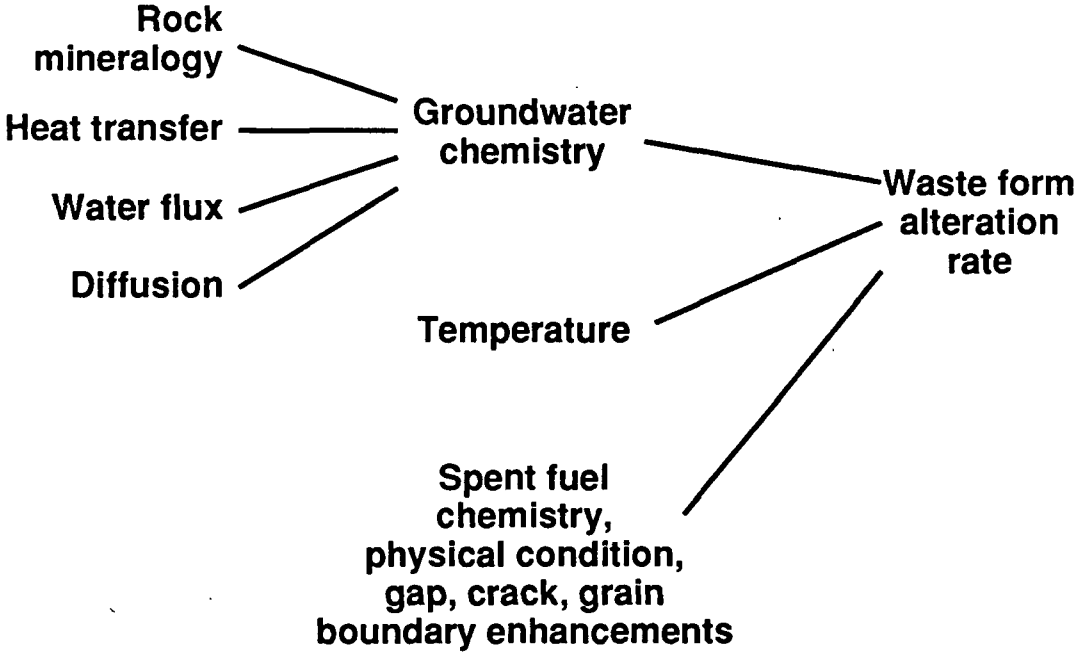
Further attention is directed to sensitive inputs to our inputs



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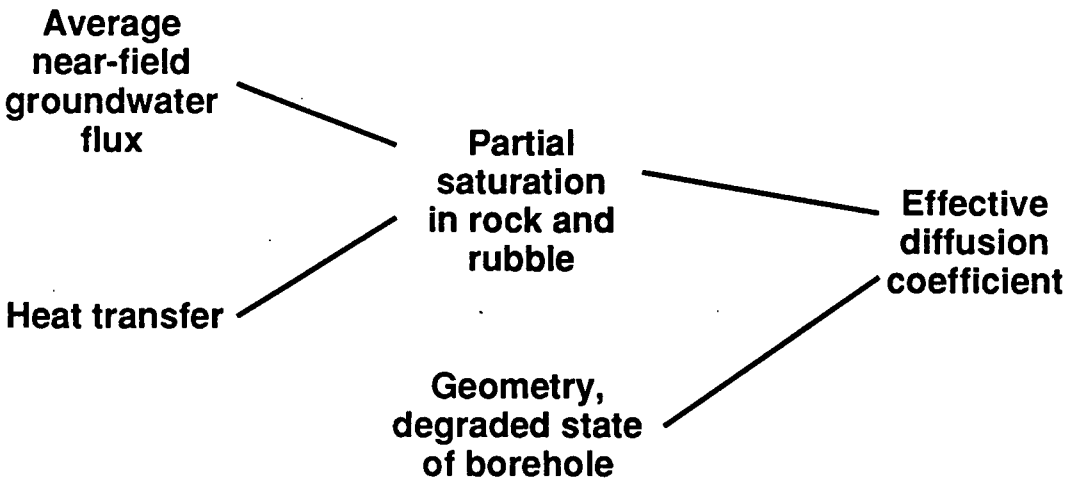
Inputs to our inputs (continued)



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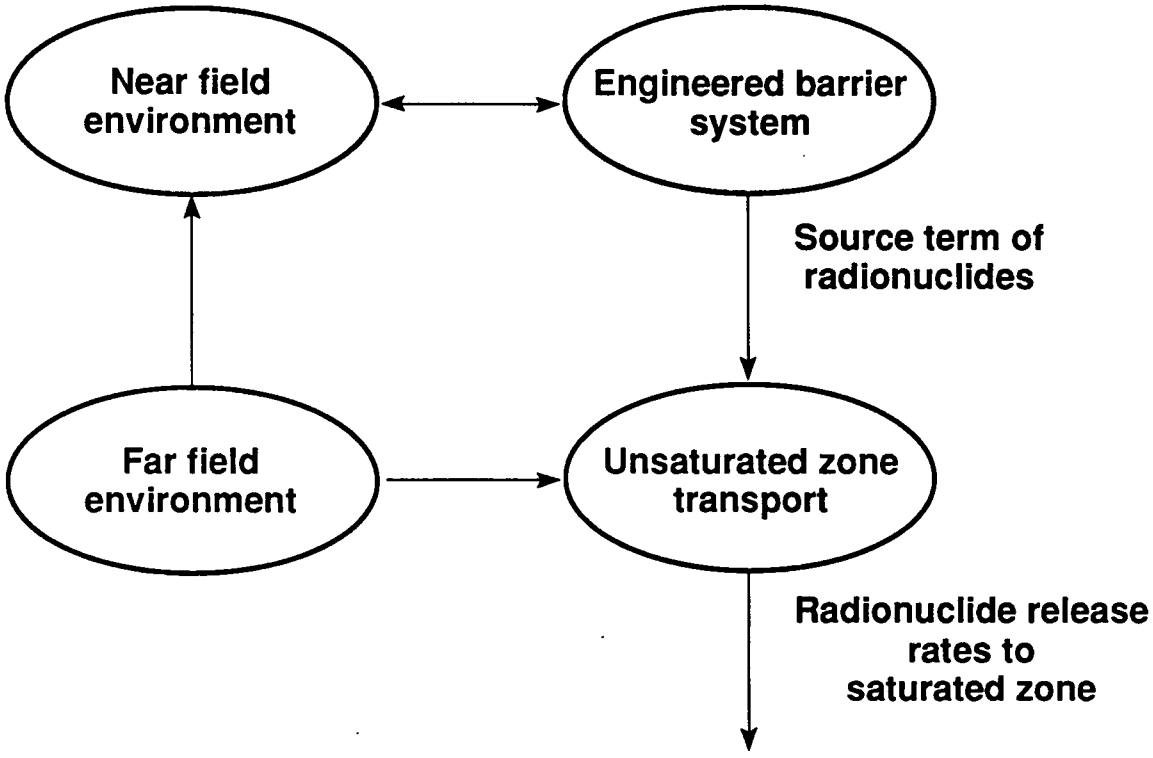
The PACE–90 nominal case focused on selected barriers



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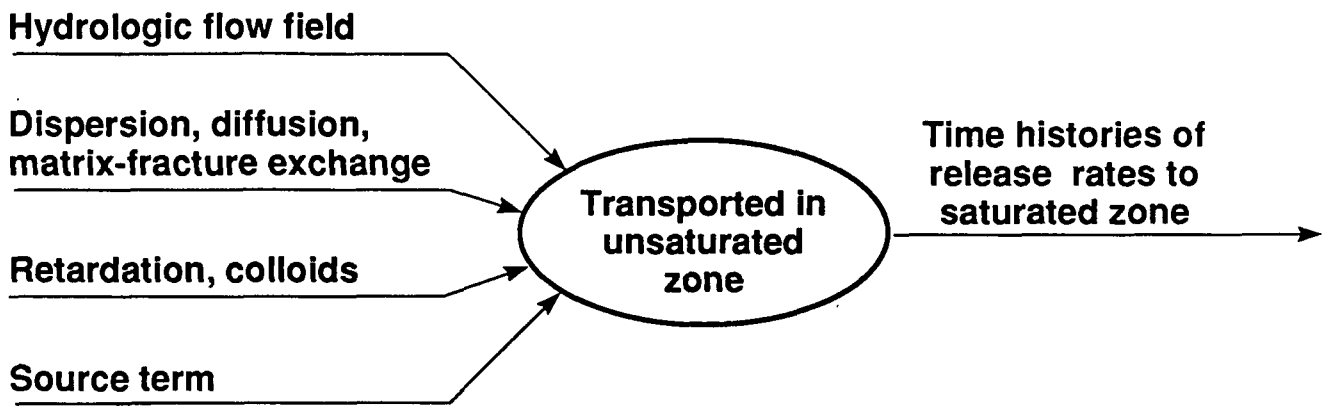
Hydrologic and geochemical inputs control transport output



Los Alamos National Lab is the primary source for site-specific transport processes and parameters.

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Source term subsystem summary

- Source term concepts and results to PACE-90 total system assessment
- Sensitivity analysis
- Transport subsystem inputs

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