



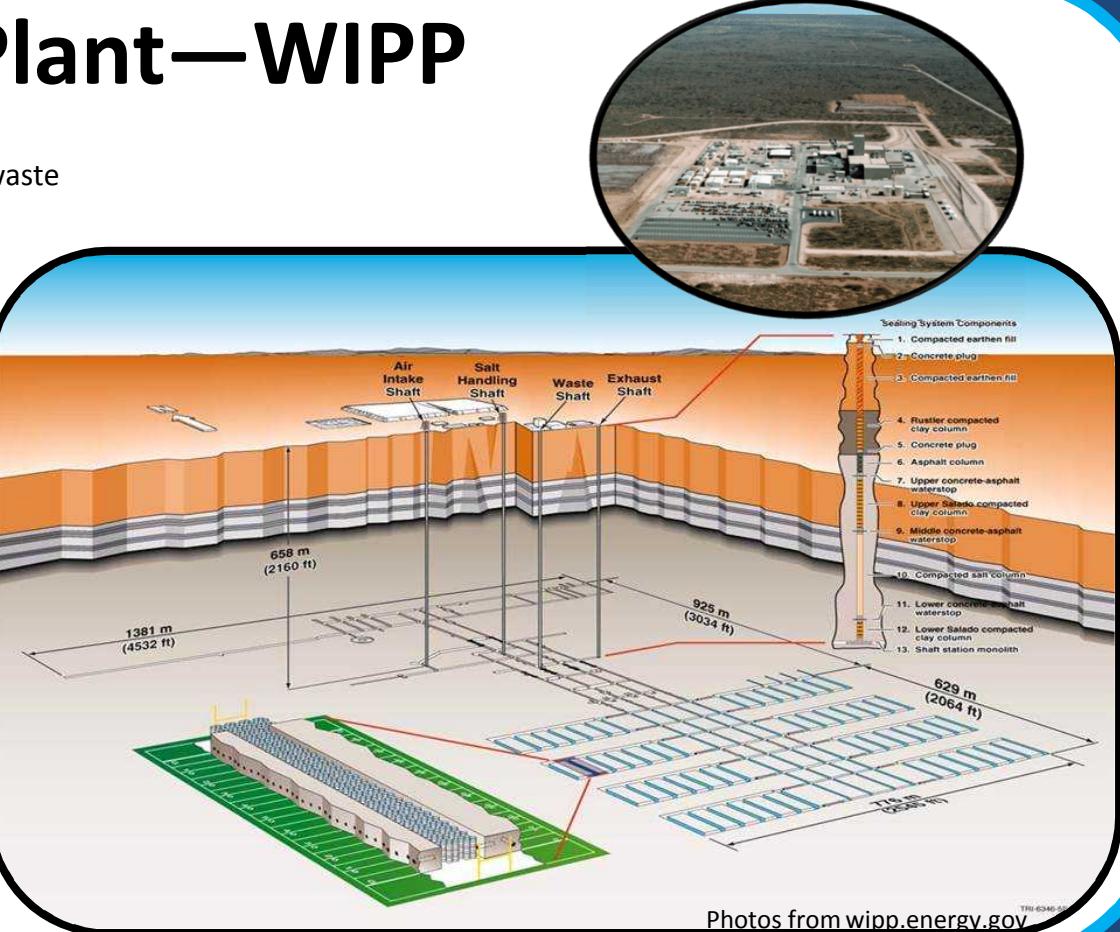
Waste Isolation Pilot Plant—WIPP

WIPP is the nation's only deep geologic repository for nuclear waste:
Permanent disposal site for defense-generated transuranic (TRU) waste
2,150 feet deep
6.2 million cubic feet of disposal capacity

Located in southeast New Mexico:
Bedded salt host rock:
Extremely low permeability
Creeping behavior
Geologically stable for more than 200 million years
Plastic-like quality and self-healing ability to encapsulate waste

Defense-generated TRU waste:
Contaminated radioactive and hazardous elements
Clothing, tools, rags, debris, residues, disposable items
Less than one percent liquid by volume

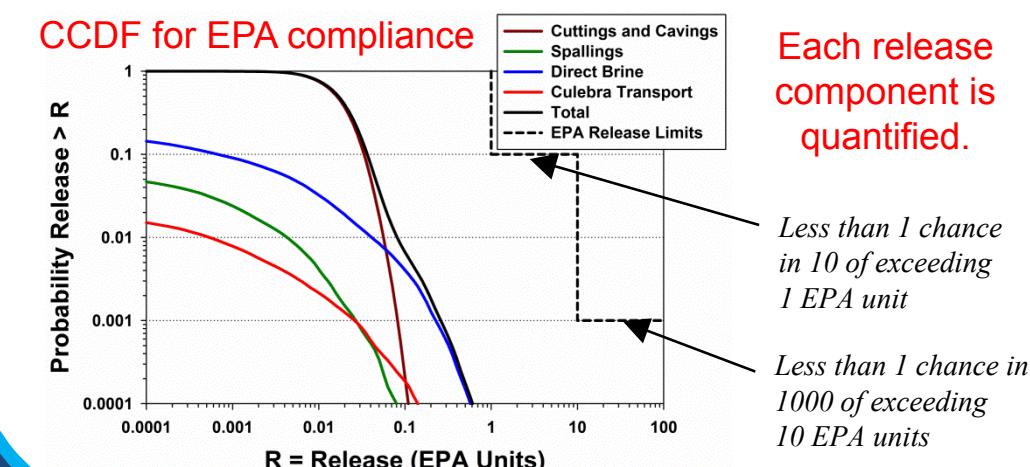
Operated by U.S. Department of Energy (DOE)
Long-term performance regulated by U.S. Environmental Protection Agency (EPA)
Requires periodic performance assessment analysis from DOE



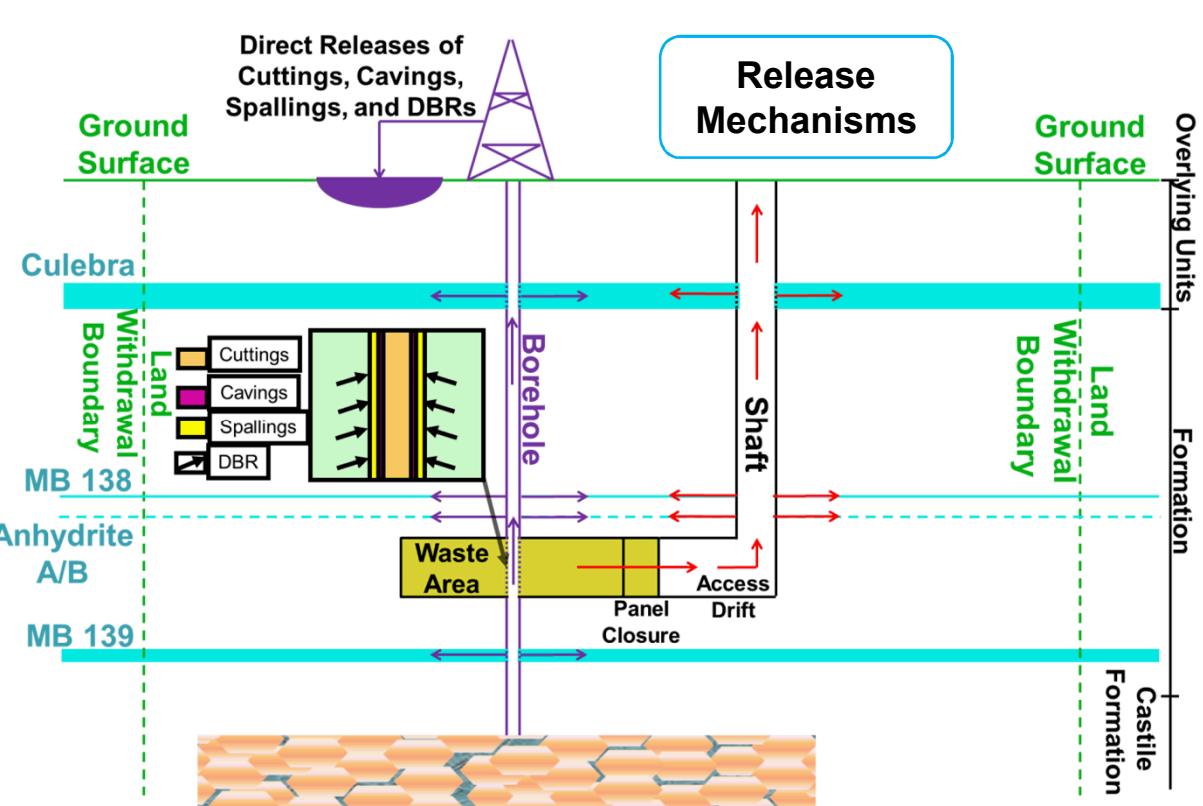
WIPP PA is a probabilistic framework to estimate the future performance of the repository system that:

- calculates releases to the accessible environment over 10,000 years.
- uses a collection of site-specific conceptual models, process models, and scenarios.
- explicitly includes both epistemic and aleatory uncertainty.

CCDF for mean total releases is the measure of WIPP compliance with EPA release limits.
PA continues to be refined and enhanced to ensure longevity into the future.



Performance Assessment Calculations

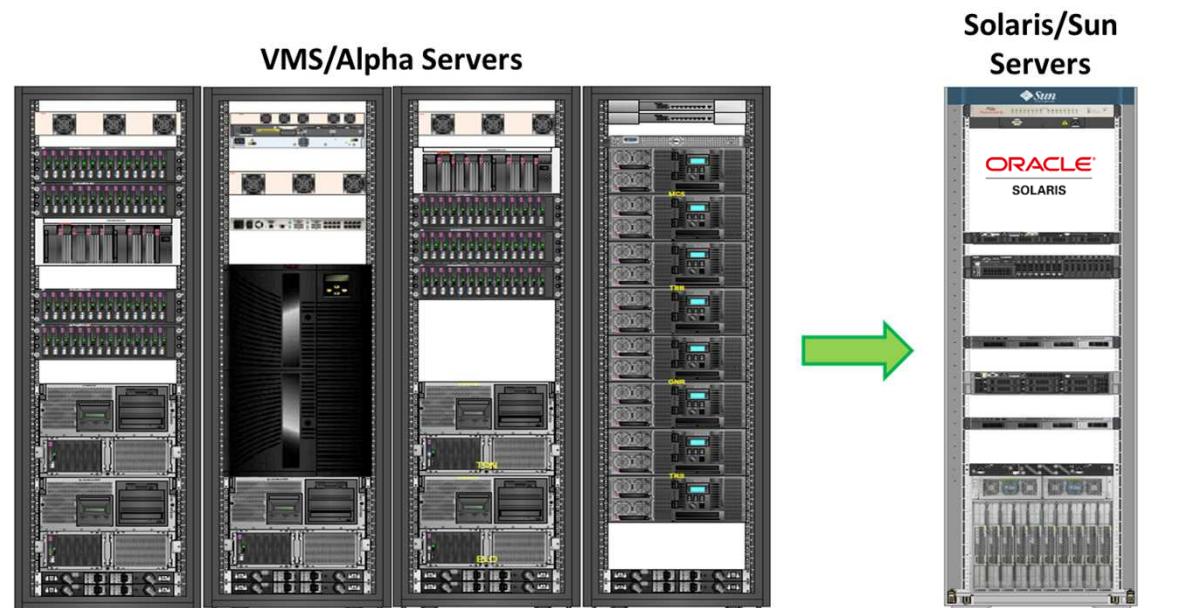


WIPP process models are implemented in a suite of numerical codes.

1. Hardware and Operating System Update

The principal hardware update is a change from an Open VMS/Alpha processor platform to a modern UNIX (Solaris)/Intel processor platform.

Open VMS/Alpha	UNIX (Solaris)/Intel
<ul style="list-style-type: none"> used for PA calculations since 1996 increasingly limited OS and hardware support HP Alpha systems no longer in production 	<ul style="list-style-type: none"> low cost hardware and OS support easily expandable widely-used in academia and industry

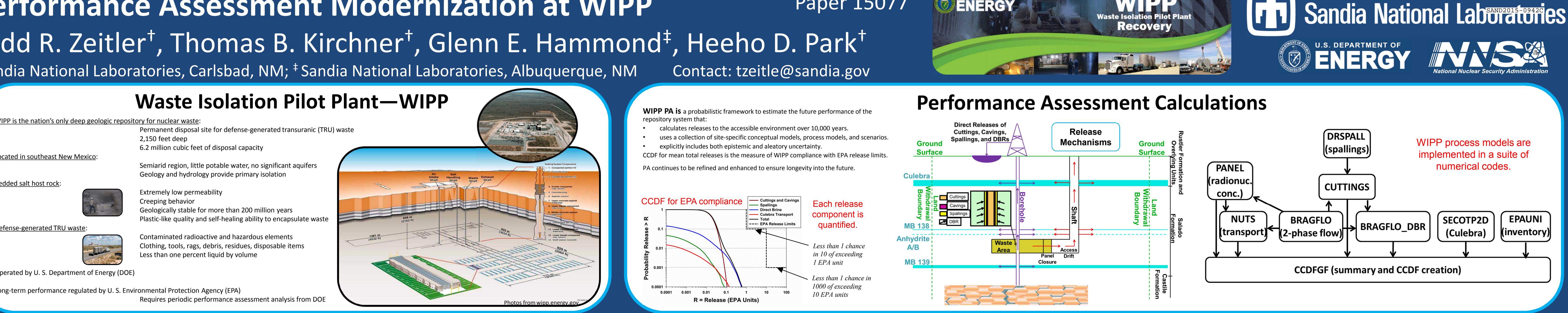


2. Code Migration from VMS to Solaris

The quality assurance (QA) process intrinsic to PA work requires that each code be "requalified" following any change to the source code, or any significant change to the operating system or hardware system.

Requalification requires recompiling each code and submitting each code to a series of test problems intended to confirm that the code implements requirements specified in its Requirements Document as quantified by criteria specified in its Verification and Validation Plan.

The code migration process is complete following documentation of all test case results, as well as updates to user's manuals.



Performance Assessment Modernization Effort

3. Implementation of PFLOTRAN for Subsurface Flow and Transport Calculations

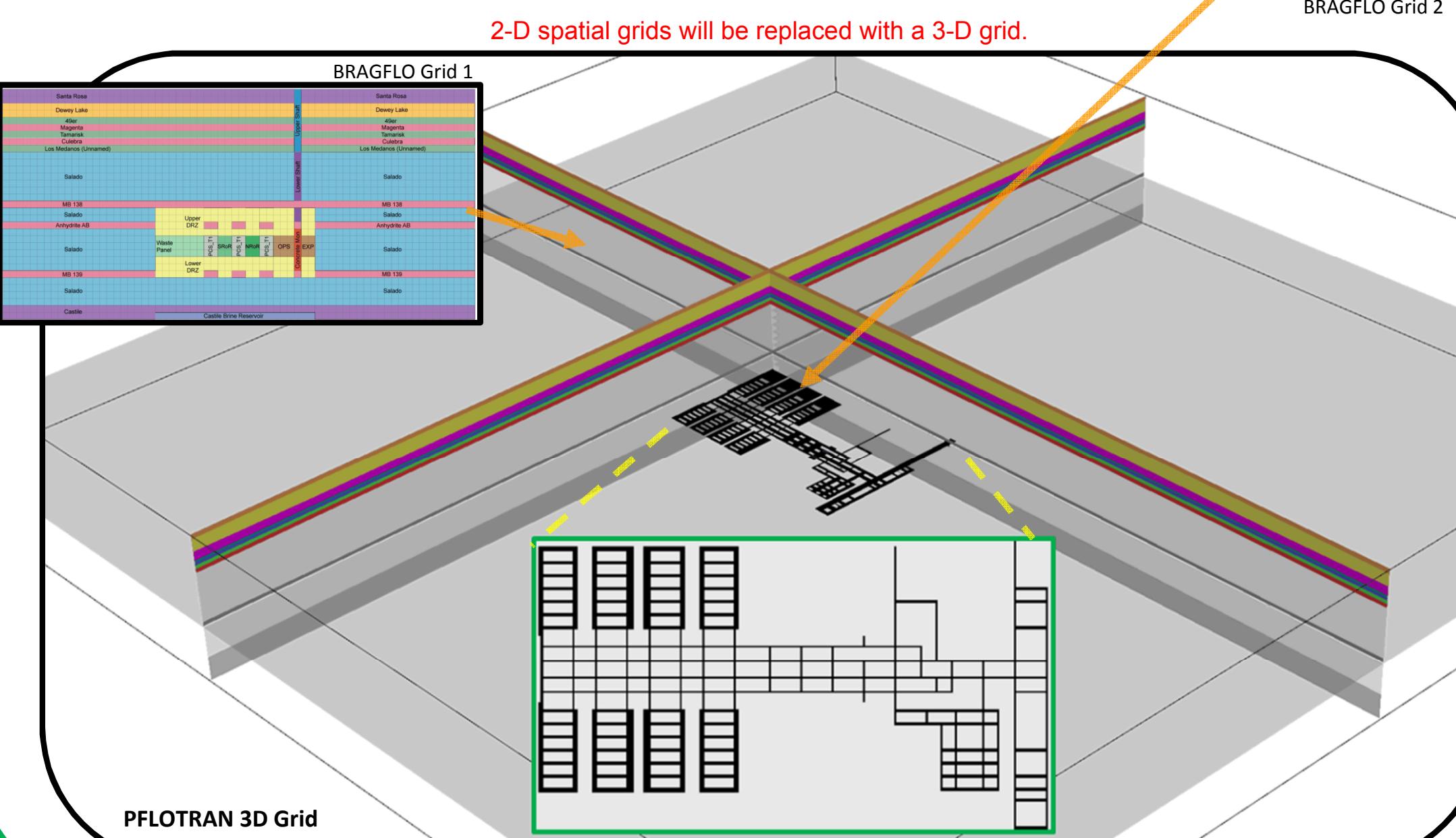
Subsurface two-phase flow and transport codes will be replaced by the open-source code PFLOTRAN.

PFLOTRAN has capabilities that are new to WIPP PA, including:

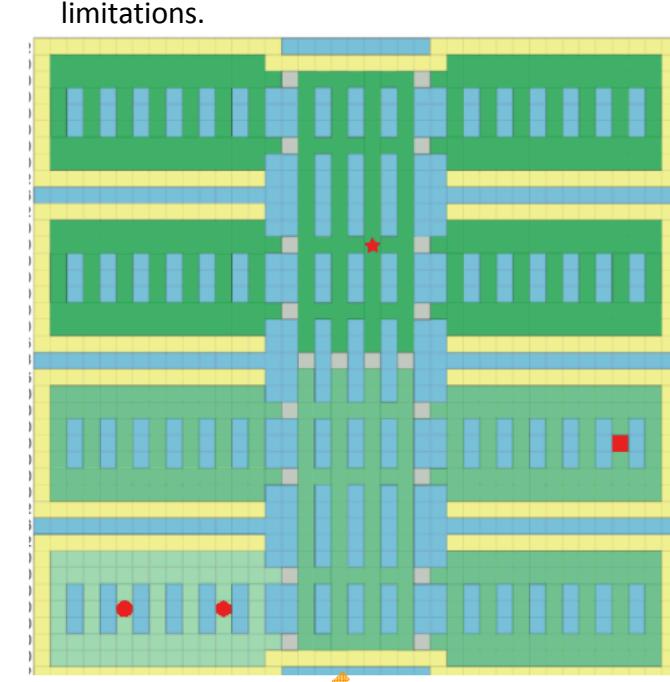
- 3-D spatial gridding
- parallel processing
- 2-phase miscible flow
- heat transfer

In order to add PFLOTRAN to the list of approved codes for WIPP PA calculations, it must go through the QA process of qualification.

A final critical step to the qualification of PFLOTRAN will be submission of the code to a peer review process, in which the conceptual models implemented in PFLOTRAN will be reviewed by a panel of experts.



Two-dimensional grids have been used to date in WIPP PA due to computational limitations.

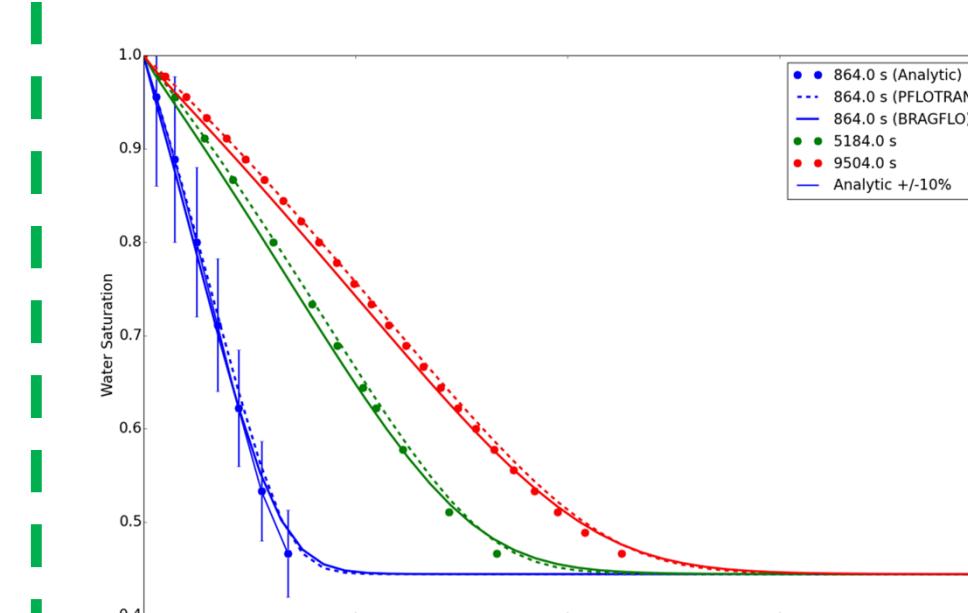


2-D spatial grids will be replaced with a 3-D grid.

Test Case Results

Test 1: Flow through a Porous Medium

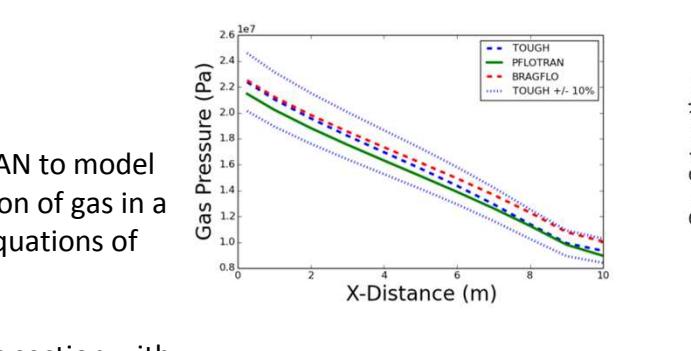
The purpose of this test is to verify that PFLOTRAN can accurately track a propagating wetting profile in a horizontal, partially saturated, one-dimensional system.



PFLOTRAN results are compared to BRAGFLO results and an analytical solution.

Test 2: Gas Migration

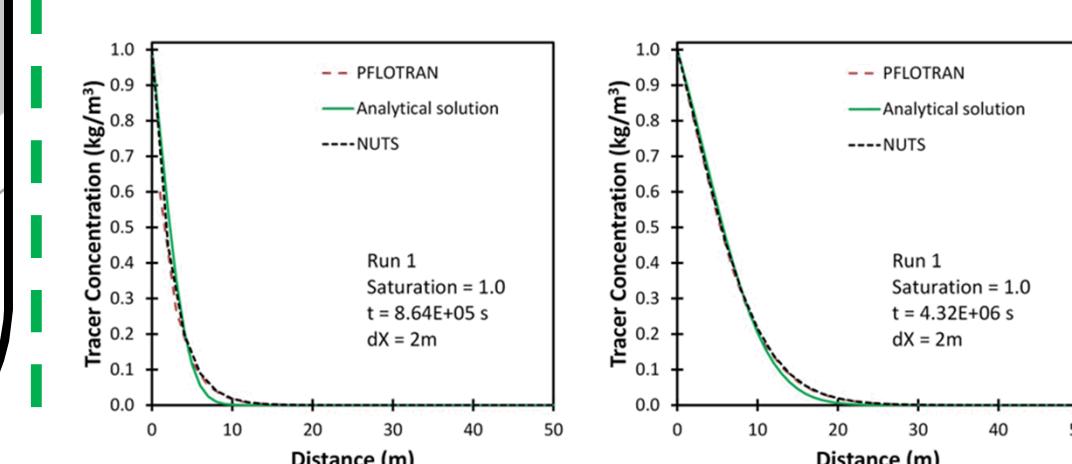
The purpose of this test is to verify the ability of PFLOTRAN to model gas injection (or generation) and the subsequent migration of gas in a two-phase system. In addition, this test case tests the equations of state for fluids.



This problem consists of a two-dimensional vertical cross section with a gas injection well located at the center of a 22m by 21m region. Because of symmetry with respect to a vertical plane through the well, only the solution on the right half of the region needs to be obtained, so a 11m by 21m region is modeled. The reservoir is initialized to gravity/capillary equilibrium. Gas is injected at a constant rate.

PFLOTRAN results are compared to BRAGFLO and TOUGH results.

A set of initial tests have been conducted early in the development phase to show that PFLOTRAN can mirror BRAGFLO (above) and NUTS (below) results.



Test 3: Decay and Dispersion

The purpose of this test case is to simulate decay and dispersion in constant velocity flow field and constant porosity and saturation. A brine fully or partially saturated one dimensional semi-infinite column of porous media is assumed to be adjacent to a reservoir containing a tracer solution of constant concentration. The flow in the column is maintained at a constant rate in the x direction, while the tracer in the column continuously undergoes radioactive decay, but no sorption.

PFLOTRAN results are compared to NUTS results and an analytical solution.

Summary

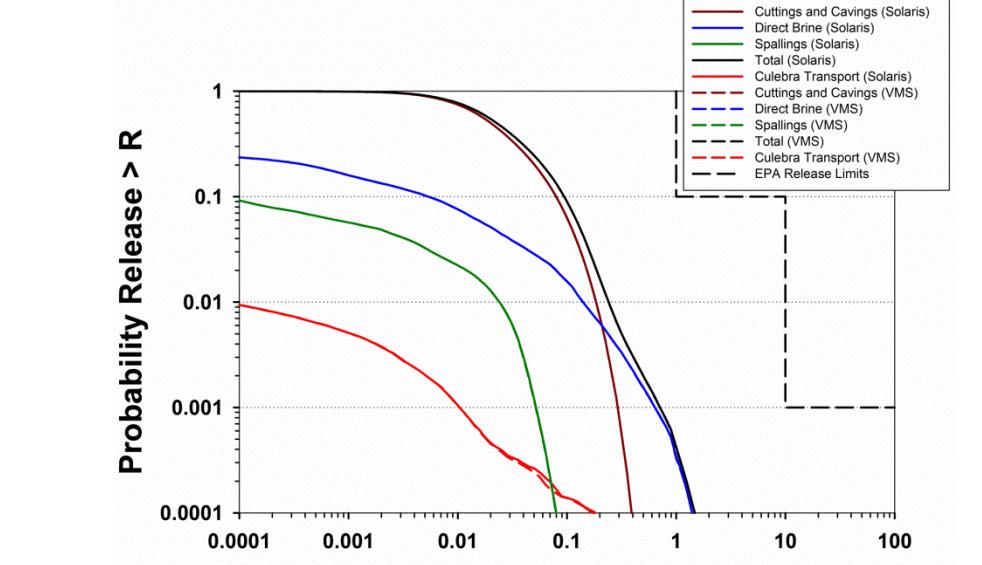
The WIPP PA program is currently driving a modernization effort in three principal areas:

Hardware and OS update

- Have successfully switched from Open VMS/Alpha platform to UNIX (Solaris)/Intel platform.
- New system has lower costs and is more easily expanded.

Code Migration from VMS to Solaris

- Computational codes have been recompiled and tested on the new platform.
- A complete PA analysis has been performed, confirming the proper migration of the codes.



Implementation of PFLOTRAN for Subsurface Flow and Transport Calculations

- PFLOTRAN offers a number of new capabilities for WIPP PA, including 3-D spatial gridding, parallel processing, and heat transfer.
- Currently testing capabilities of PFLOTRAN and comparing results with current PA codes for confirmation.

The result of the modernization effort will be a state-of-the-art subsurface flow and transport capability that will serve WIPP PA into the future.

Acknowledgement

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