Oregon Hanford Cleanup Board
Finding Solutions for the Deep Vadose Zone

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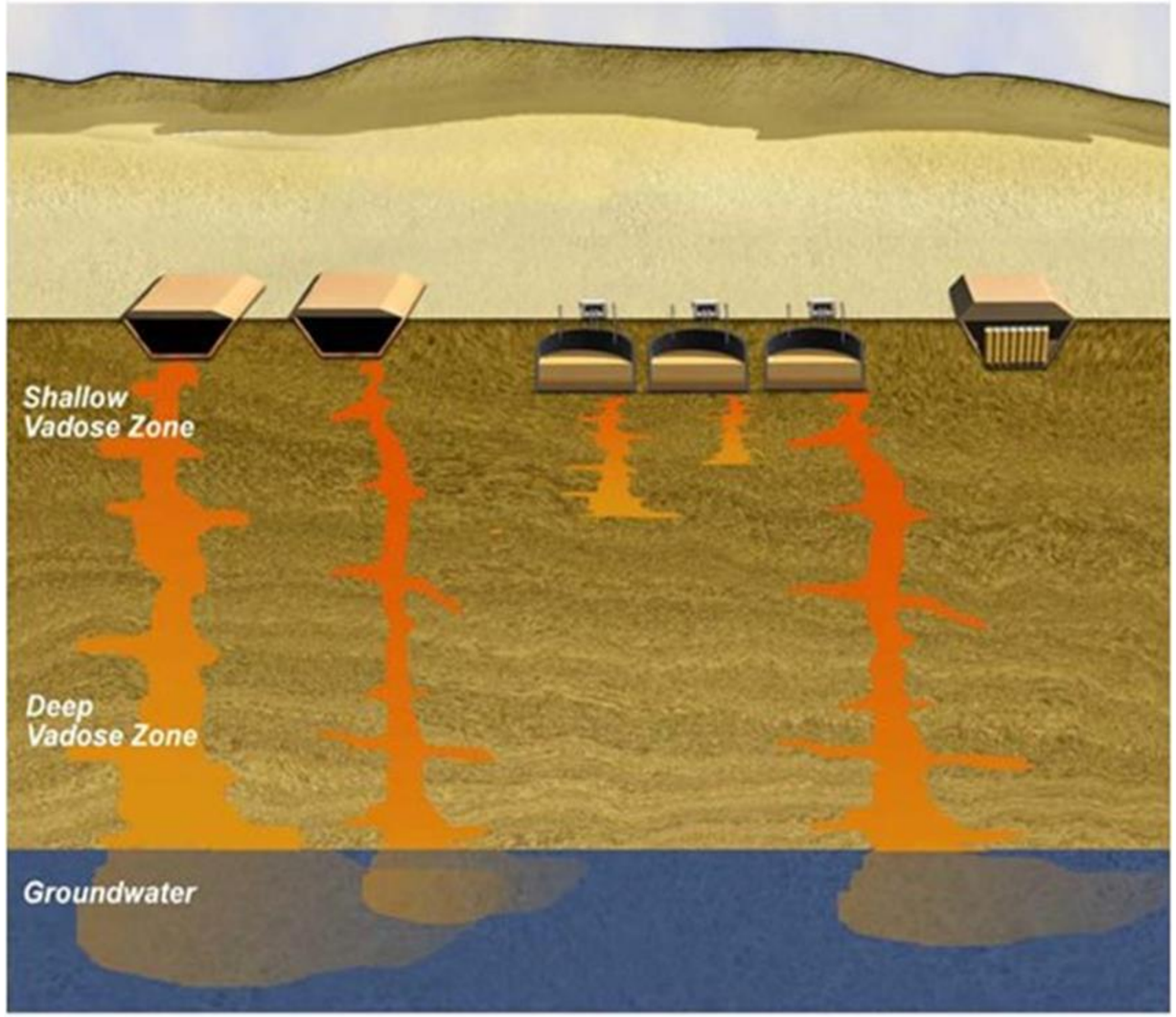
DEPARTMENT OF ECOLOGY
State of Washington

What is the “Deep Vadose Zone” ?

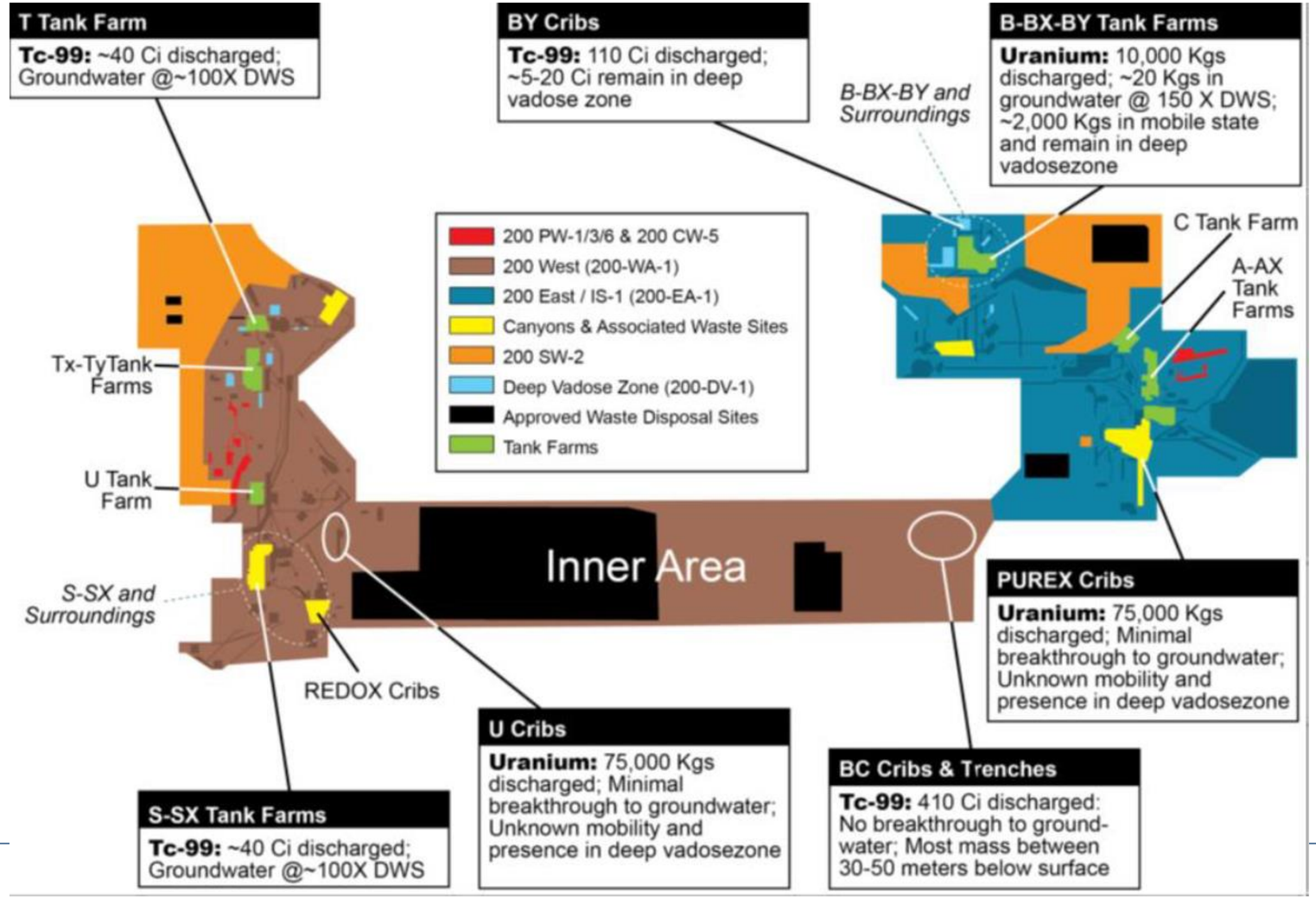
- The unsaturated geology layers between the ground surface and the water table are called the vadose zone
  - In central Hanford (aka Central Plateau, aka 200 Area) the vadose zone can be 240 to 300 feet thick
- The “deep”vadose zone is the geology layers more than 80 to 120 feet below ground surface
  - Contamination to that depth can be dug up (following)
  - Problems with digging deeper include moving clean soil (“lay back”) and undermining adjacent infrastructure

Conceptual Model

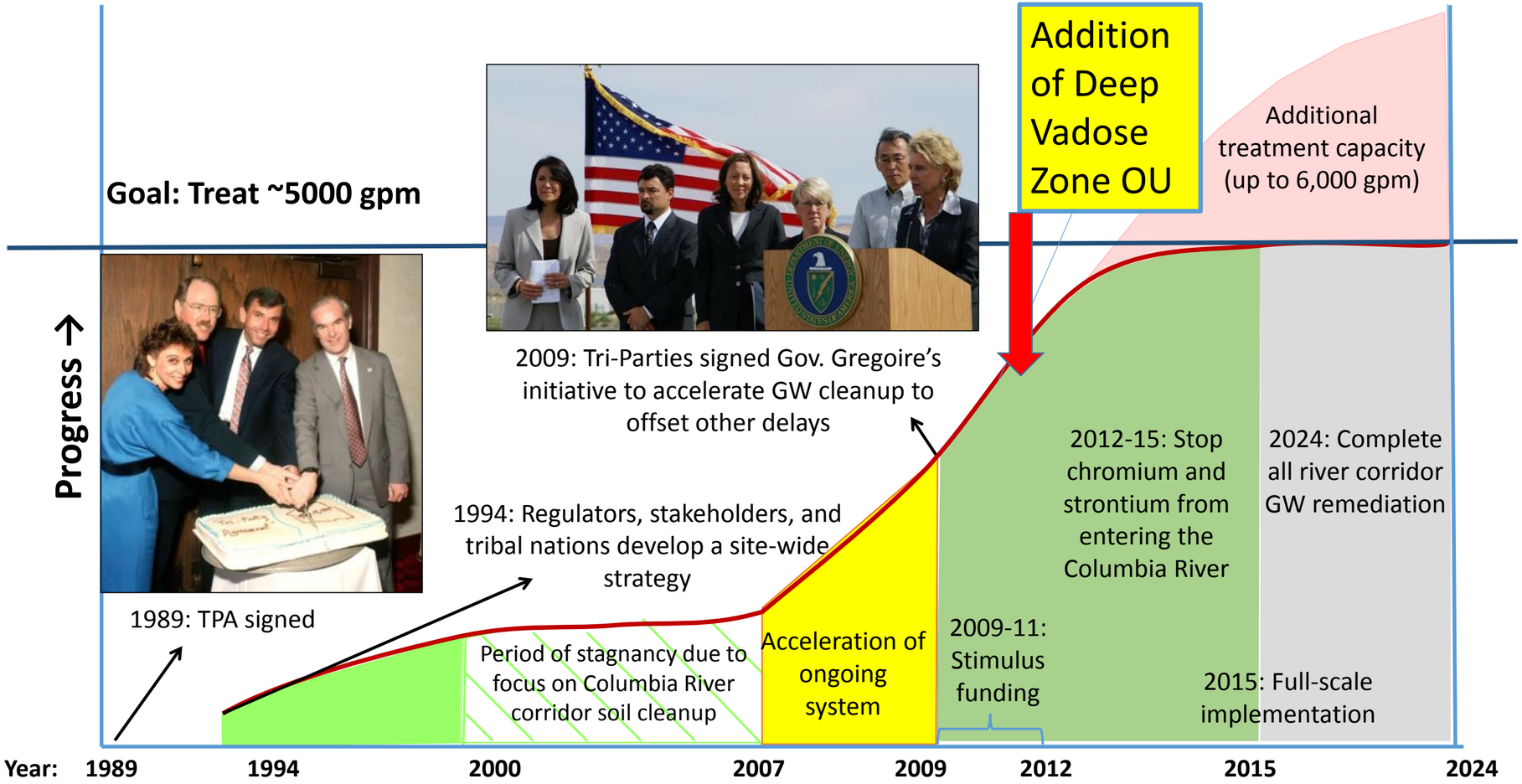


Hanford “Big Dig” 85 feet deep!

Inner Portion of Hanford's Central Plateau Showing Principal Deep Vadose Zone Regions of Interest



Hanford Site Groundwater Remediation



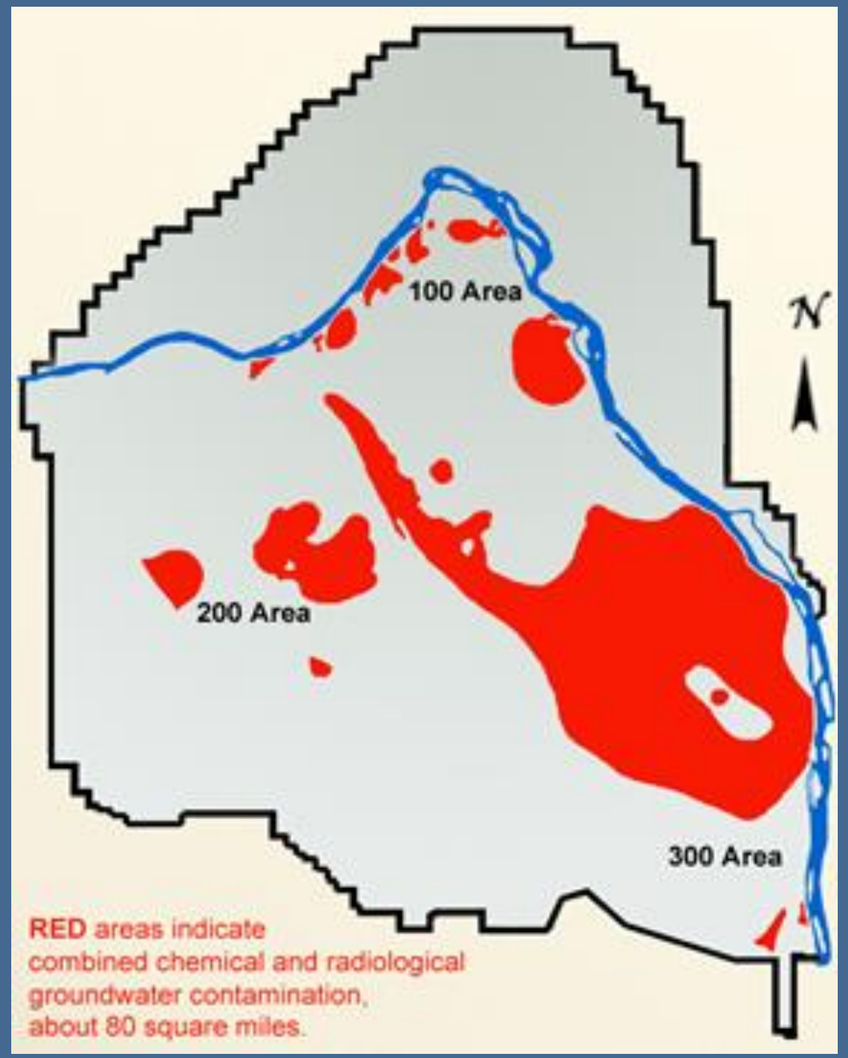
Hanford by the Numbers

- 3,500+ locations where waste was spilled, leaked, or intentionally disposed
  - 1,500+ central Hanford locations
- 43 locations in 200-DV-1 operable unit
  - 200-DV-1 operable unit has a Tri-Party Agreement milestone for an investigation report, feasibility study, and cleanup decision
  - Deep vadose zone at Single Shell Tanks managed separately
  - 200-BC cribs and trenches managed separately
  - Common technologies would be evaluated for all 3 divisions

Magnitude of the Vadose Contamination

Why does it matter?

What’s the problem?



- 550,000 Curies of Radioactivity
- 150 Million kilograms (165, 000 tons) of metals and hazardous chemicals
- A significant portion of this contamination sits above the groundwater-mostly in deep vadose zone

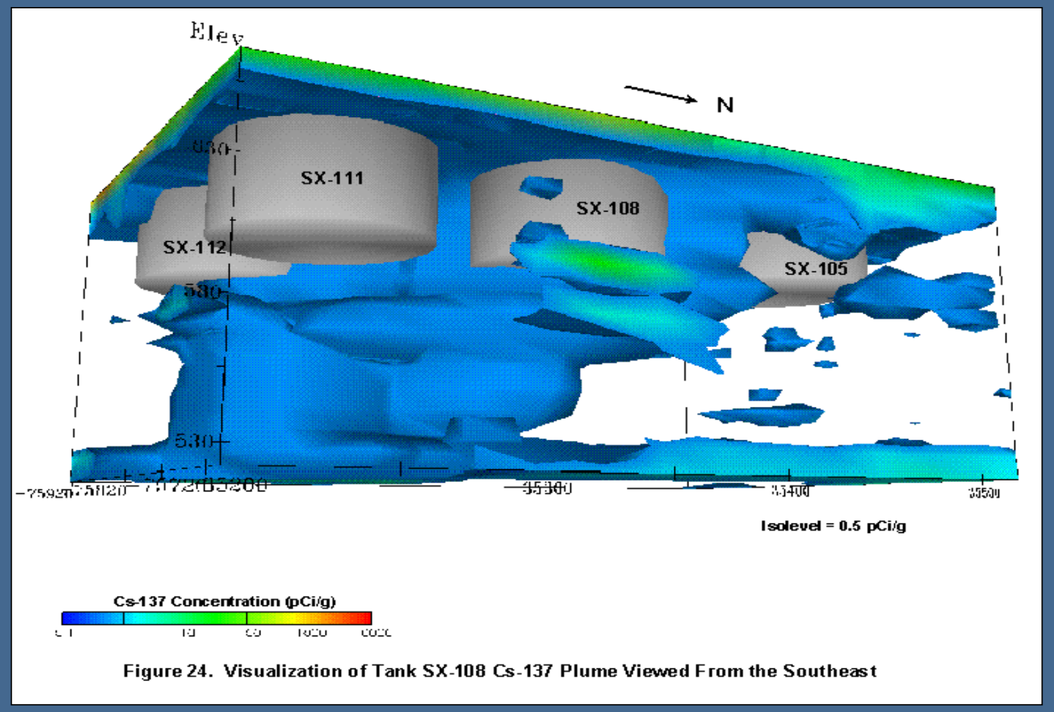
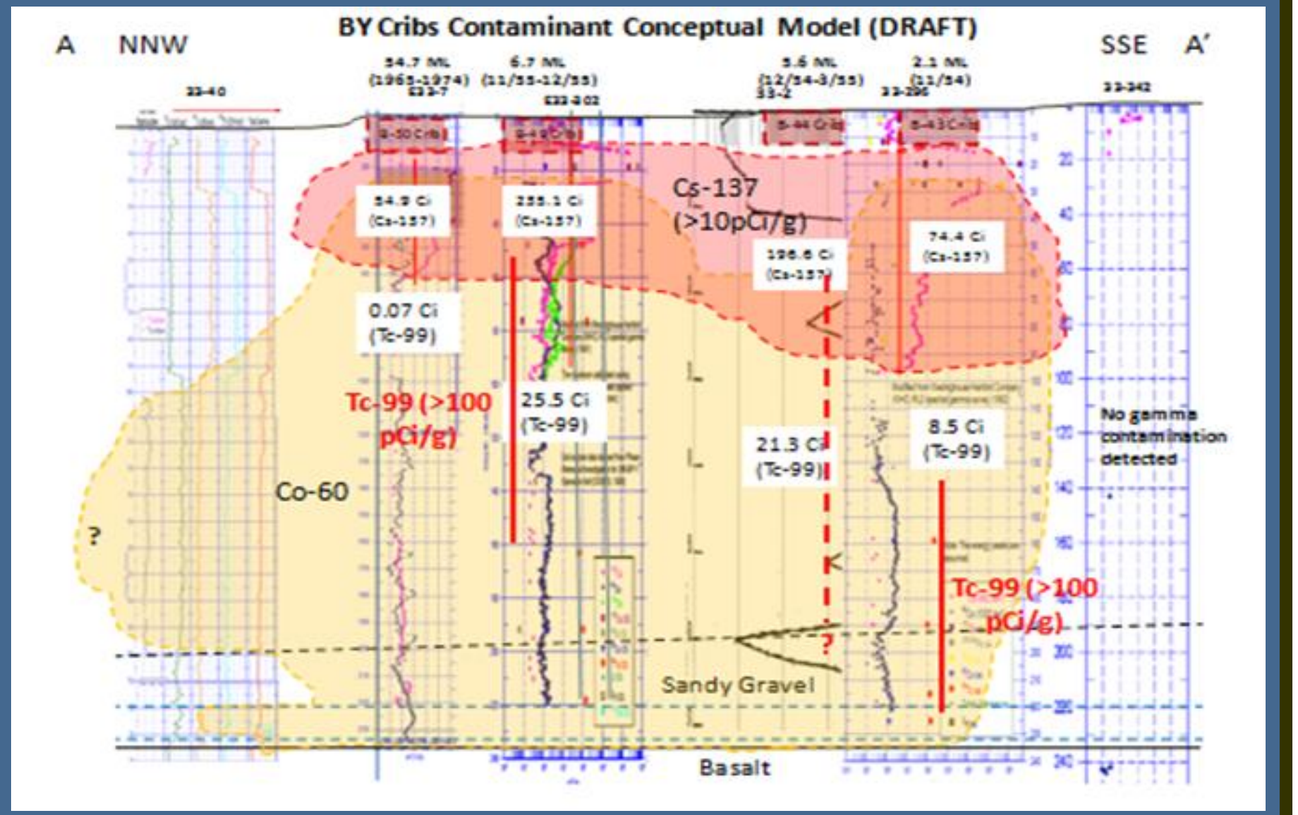


Figure 24. Visualization of Tank SX-108 Cs-137 Plume Viewed From the Southeast

- *Deep Vadose Zone Remediation Challenges:*
- Limited data (with huge uncertainties!)
- Costly to characterize, limited number of technologies to implement (lack of proven technologies!)

Why Does it Matter (continued…)

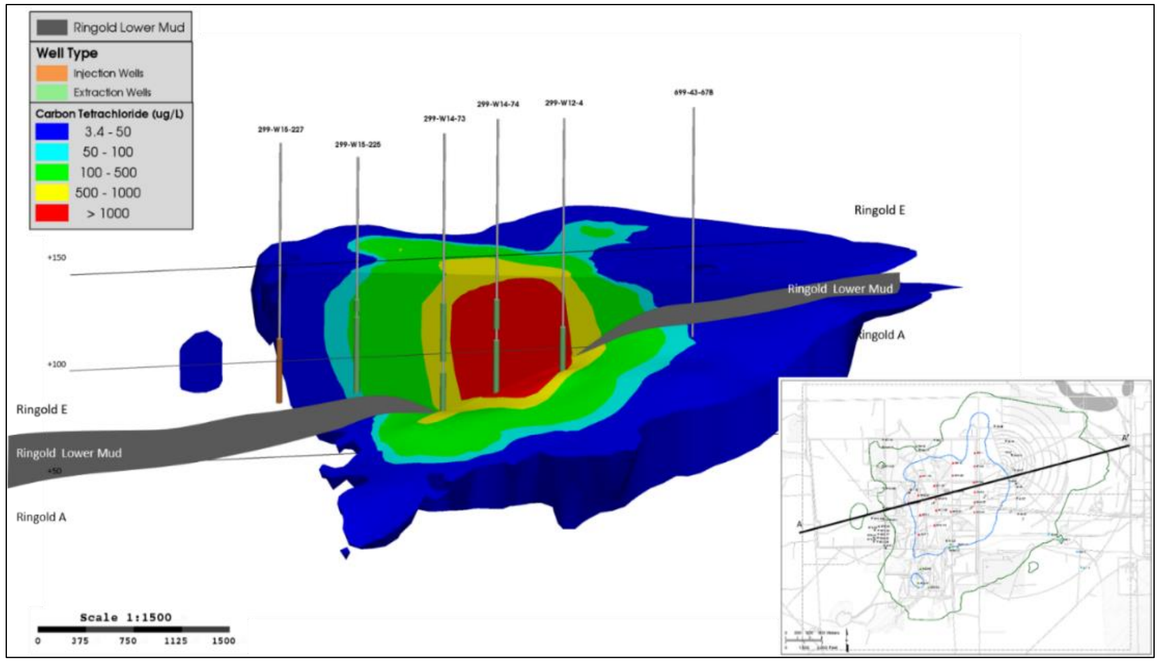


- General conclusion by national experts: " ….long term success of groundwater cleanup in the 200 West area depends on successful remediation of deep vadose zone contamination to avoid recontamination of aquifer during and after years of groundwater withdrawal".
- *Note: Oregon DOE, Ecology, EPA, National Lab, independent experts, HAB members, tribal nations contributed and participated in the above studies through participation in technical workshops, presentations, group discussions, etc.*
- Also Note:

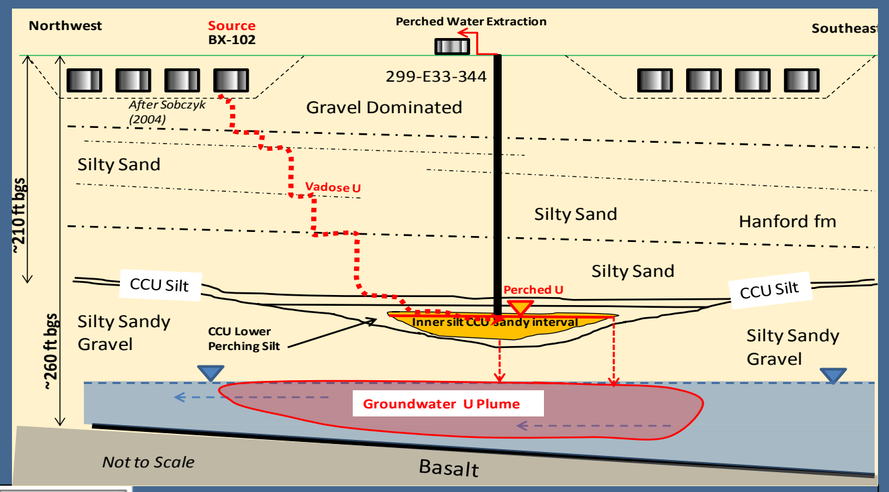
  Hanford Tank Closure & Waste Management EIS shows that, absent action, the deep vadose zone will threaten Columbia River for thousands of years

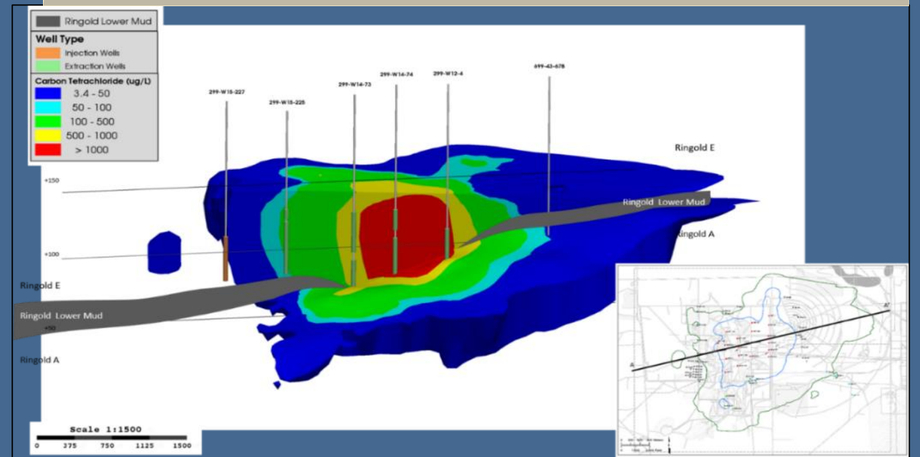
Complexity of the Vadose Zone and Technology Needs

- Multiple contaminants: rad and non-rad
- Present at multiple zones: sometime from the surface to water table
- Co-mingled plumes ; the nature and extent are yet to be determined
- Unknown inventories and sources
- Base line technologies are not expected to provide solutions



Knowledge Gap and Complexity: Specific Examples





- Perched water extraction of Uranium, nitrate and Tc-99: Originally thought to last only ~3 months with one well.

  Running for the 5th year with no end in sight!

- Carbon Tetrachloride (CCL-4) inventory: After about 3 decades of study/remediation, now we are finding that our inventory of CCL-4 is more than twice the amount assumed in FS below the lower mud (2019 report!).

  Working on the nature and extent of the contamination!

- Abiotic hydrolysis of CCL-4 is slower than FS assumption (630 vs. 41 years)
- Spent to-date in central Hanford (200 ZP-1) Pump and treat: $ 383M (through FY17)

  Cost to treat nitrate is ~50%

How do we get technologies to clean up Hanford deep vadose zone?

- Hanford River Corridor examples
  - New technologies were developed for chromium, radioactive strontium-90, radioactive uranium
  - Cycle of technology identification, testing, failure (sometimes), successful application typically took 10 – 15 years
- Hanford Groundwater/Vadose Zone Project was started in 1990s
  - Project had some starts & stops
  - Nature & extent of contamination was sampled, characterized and increased our understanding to some extent
  - Limited research on technologies, approaches was done

Last 10 years of developing technologies to clean up deep vadose zone

- 2008 Treatability Test Plan for Hanford deep vadose zone
- 2010 Deep Vadose Zone operable unit (OU) created for 43 waste sites
- 2016 200-DV-1 operable unit RI/FS work plan
- 2018 uranium reactive gas field test terminated *before start-up after 12 years of studies!*
- 2018/2019 draft, revised draft Technology Evaluation and Treatability Studies Assessment submitted. Ecology is expected provide comments by April, 2019.

What's a treatability test?

- Superfund law and regulations require EPA to select remedial actions involving treatment that "permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants"
- The performance, reliability, and cost of treatment alternatives can be uncertain
- It is essential to conduct laboratory or pilot-scale tests on actual wastes from the site, prior to remedy selection

Source: EPA guidance on "Guidance for Conducting Treatability Tests under CERCLA"

Deep Vadose Zone Technology Evaluation: Ecology Evaluation (draft)

USDOE identified no technologies to field test. Further laboratory testing recommended

- Ecology's findings and Recommendation
  - Failed to meet regulatory process of treatability test evaluation in gathering necessary information to write a credible feasibility study (FS) and a proposed plan (PP).
  - More robust field scale demonstrations are required to address deep vadose contaminations in 200 DV-1 OU. We have known knowledge gaps!
  - FS-ready doesn't mean deployment ready

Deep Vadose Zone Technology Evaluation: Ecology Evaluation (draft)

- Ecology's findings and Recommendation, continued…
  - Lack of information on the cost, uncertainty and implementability of any particular technology
  - Without field data, laboratory information is not enough to move forward with FS/PP
  - Laboratory data doesn't provide enough information on cost & uncertainties
  - Need more characterization data through drilling and sampling to understand the nature and extent of contamination to do a proper FS/PP

What are the next steps?

Tri-Party Agreement milestone M-15-110B (9/30/2023)

Submit Corrective Measures Study & Feasibility Study Report and Proposed Plan/Proposed Corrective Action Decision for the 200-DV-1 OU to Ecology.

Ecology believes DOE can't identify a cleanup plan by milestone date

Ecology agrees DOE should do additional lab studies

Lab studies should be followed by field tests

Ecology recommends delaying the milestone

How can OHCB influence the work ahead?

DOE approach to deep vadose zone includes*:

- **Implement the risk-informed, systems-based endpoint framework to:**

  1) define priorities for cleanup activities
  2) define the technical specifications for cleanup approaches, and
  3) provide critical assessments of proposed solutions for the remaining cleanup challenges for the DOE Office of Environmental Management

OHCB can identify and communicate its priority for deep vadose zone cleanup.

Including OHCB priority for DOE to test additional technologies.

*PNNL-22618 (2013) Mitigating the Risks of Contamination within Vadose Zone Environments

Questions?

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