Pacific Northwest
NATIONAL LABORATORY

Pacific Northwest National Laboratory: Introduction and Environmental Management Overview

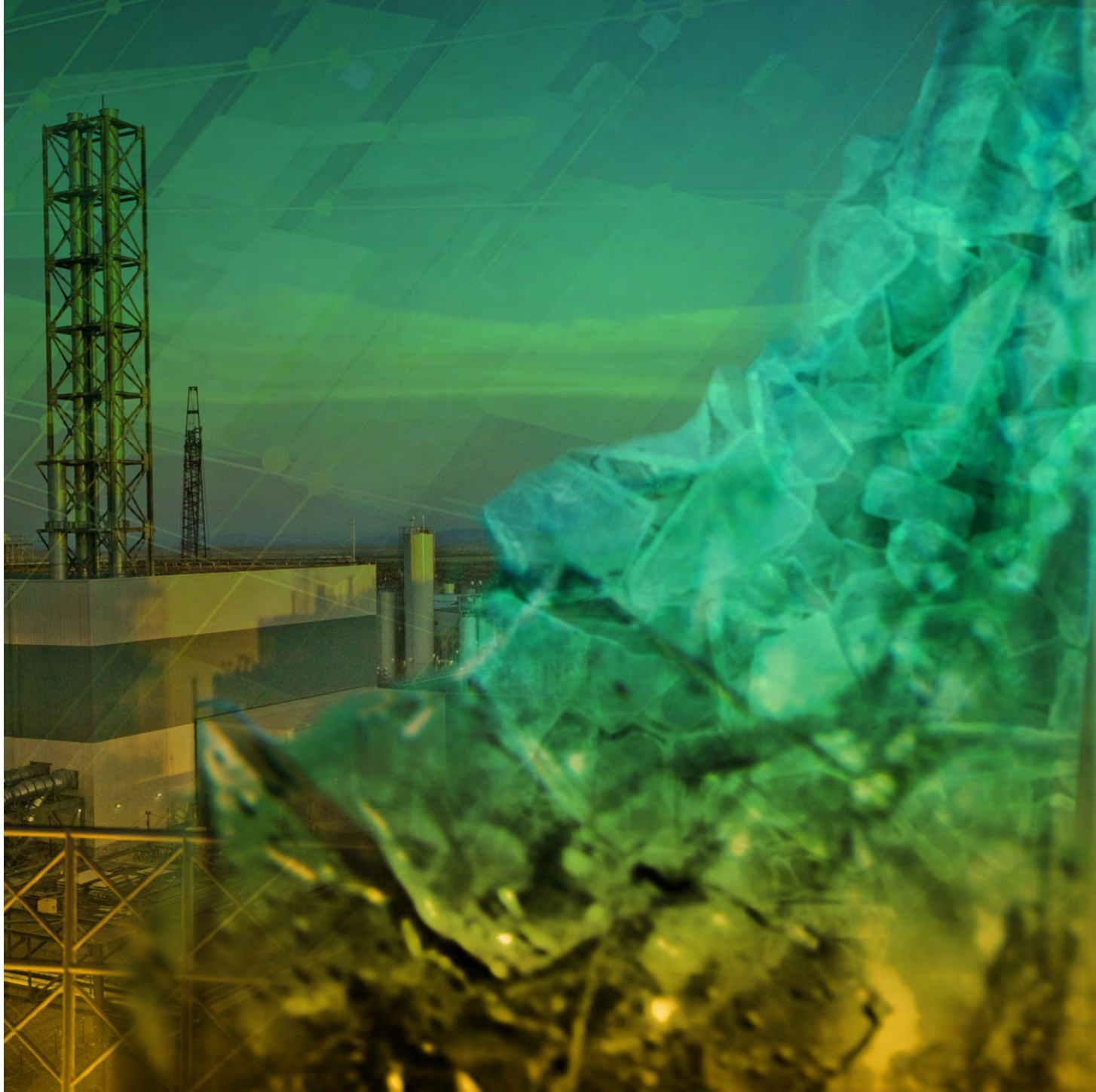
October 10, 2023

Tom Brouns
Sector Manager
Environmental Management

U.S. DEPARTMENT OF ENERGY BATTELLE

PNNL is operated by Battelle for the U.S. Department of Energy

PNNL-SA-190912



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PNNL was born out of the **Manhattan Project** at Hanford

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Today: DOE's 17 **national laboratories** tackle critical scientific challenges

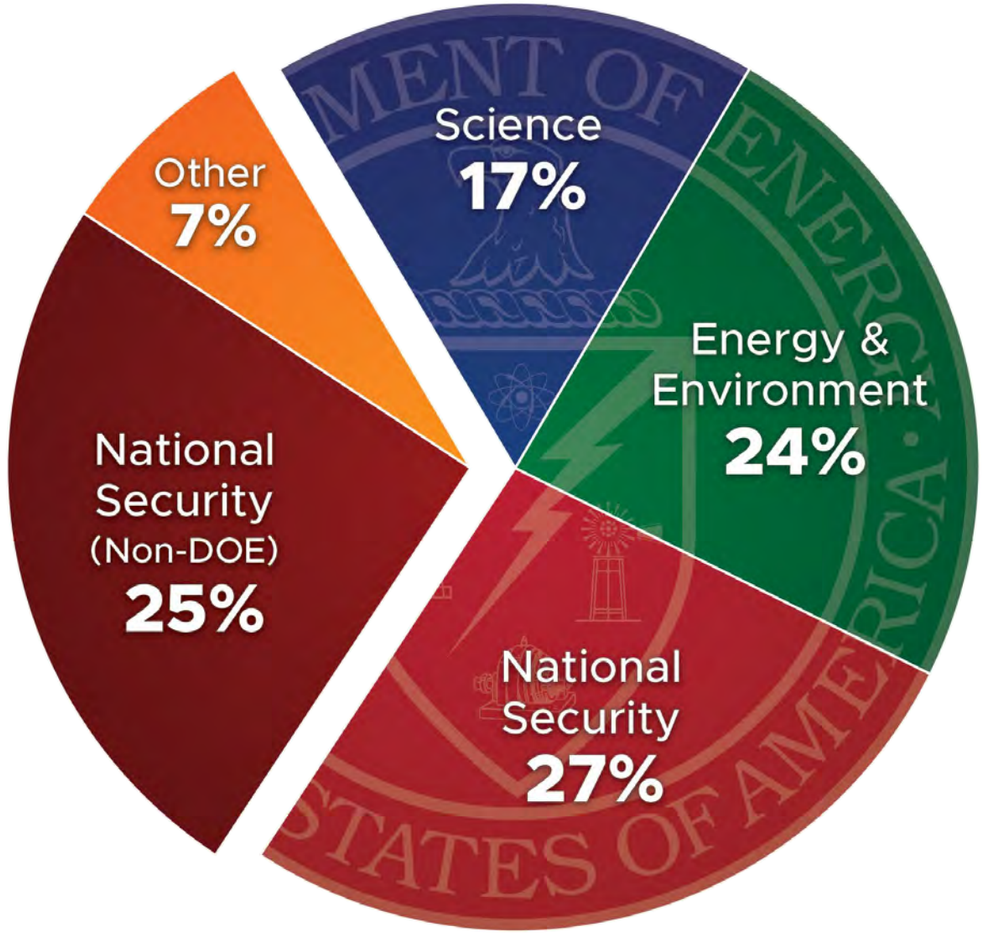
PNNL is one of DOE's **most diversified** national laboratories

$1.34B Spending

5,700 Staff

1,905 Peer-reviewed Publications*

272 Invention Disclosures



FY 2022 Spending

*Available peer-reviewed publication data are from FY 2021

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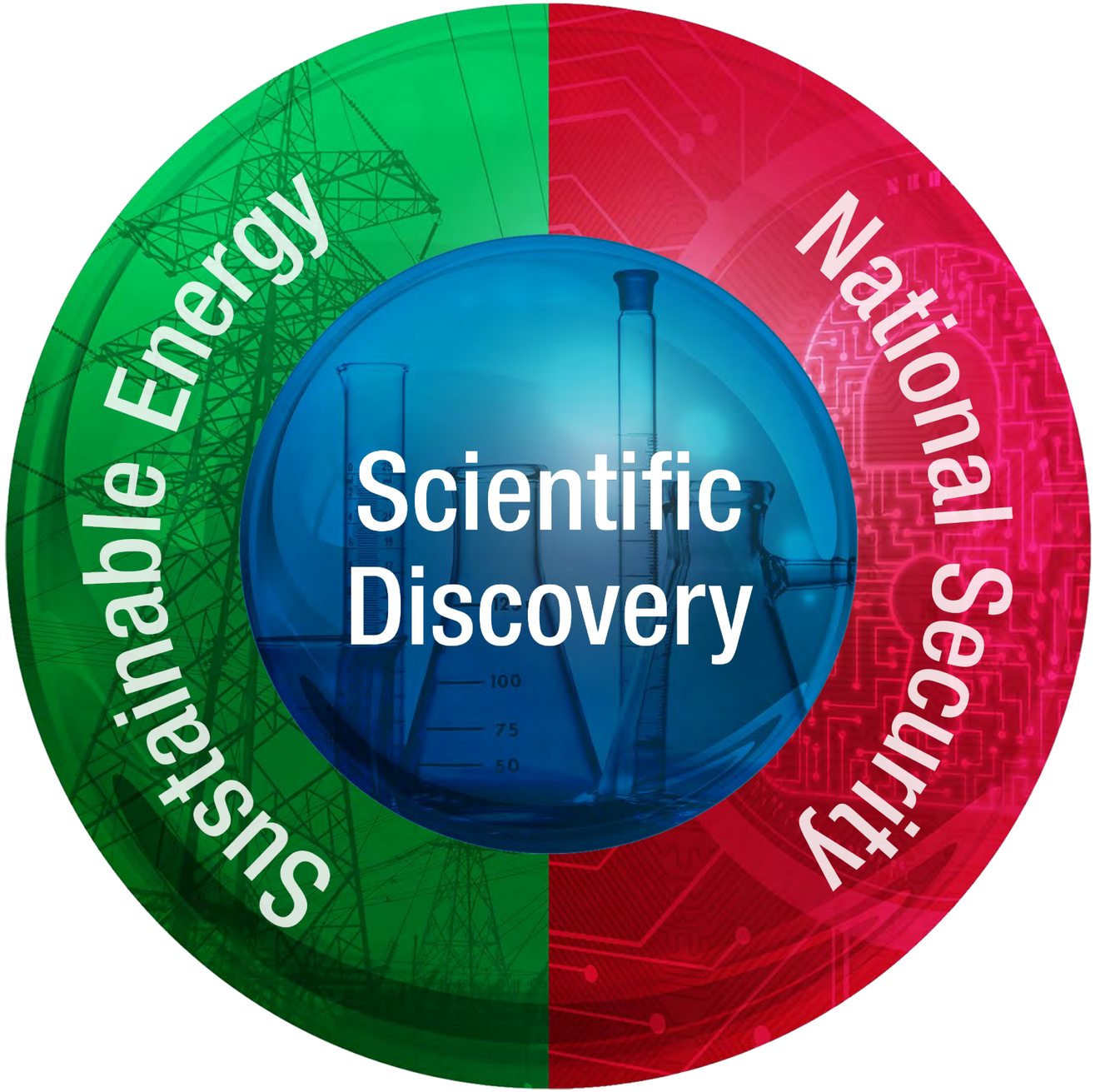
PNNL is advancing scientific frontiers and **providing solutions** to critical national needs



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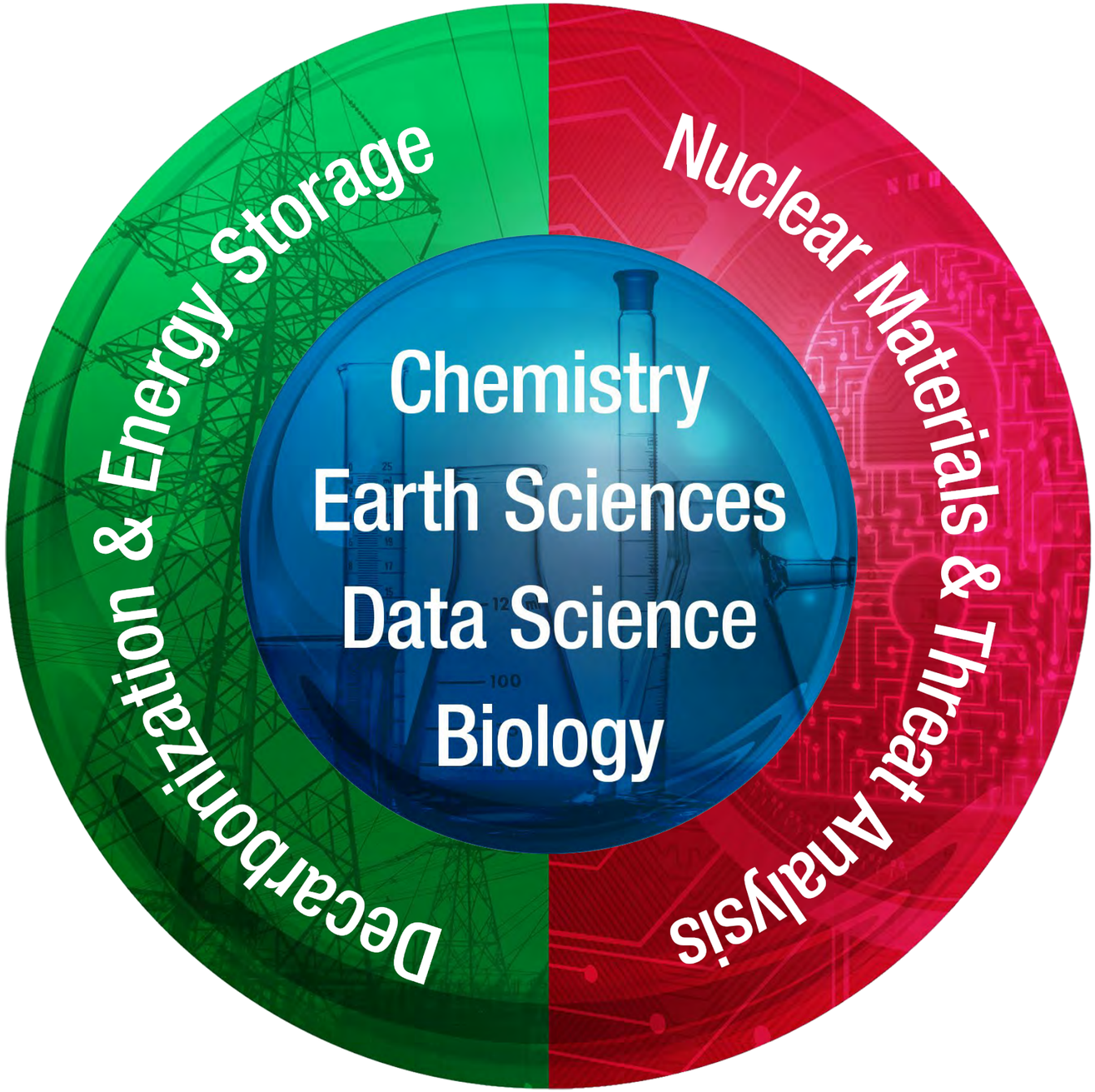
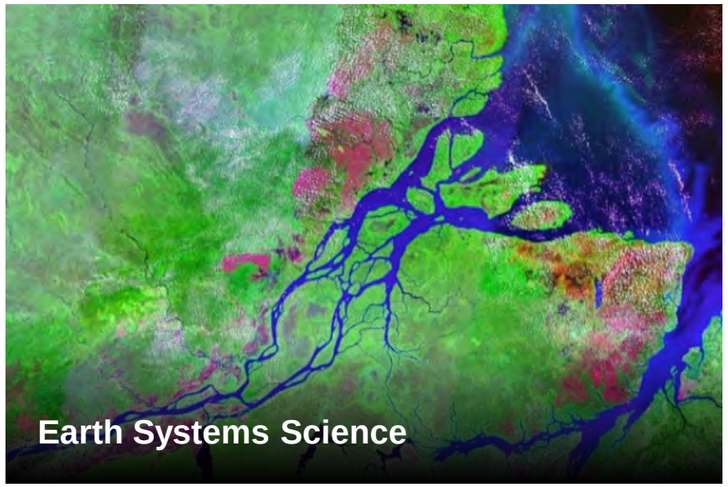
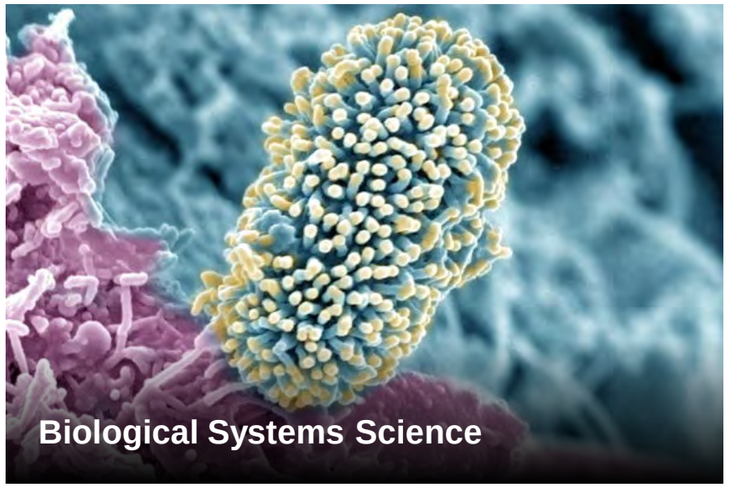
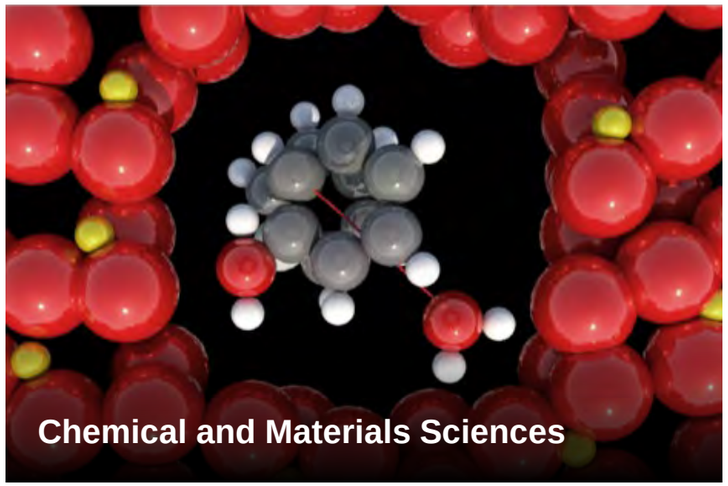
PNNL's distinguishing strengths enable **mission impact**

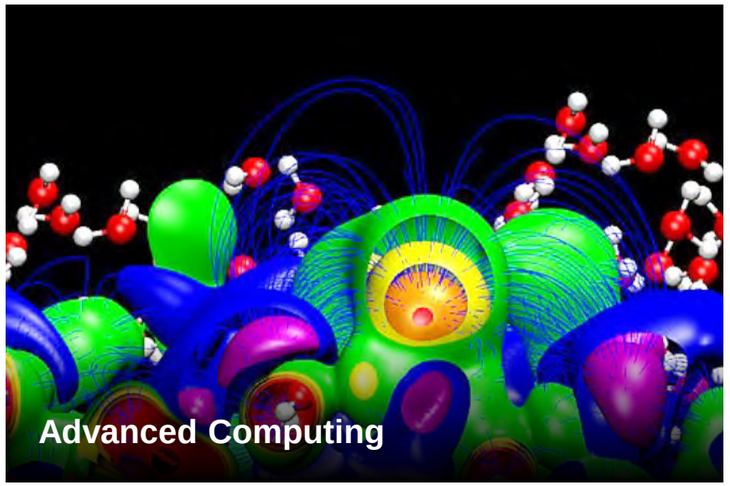


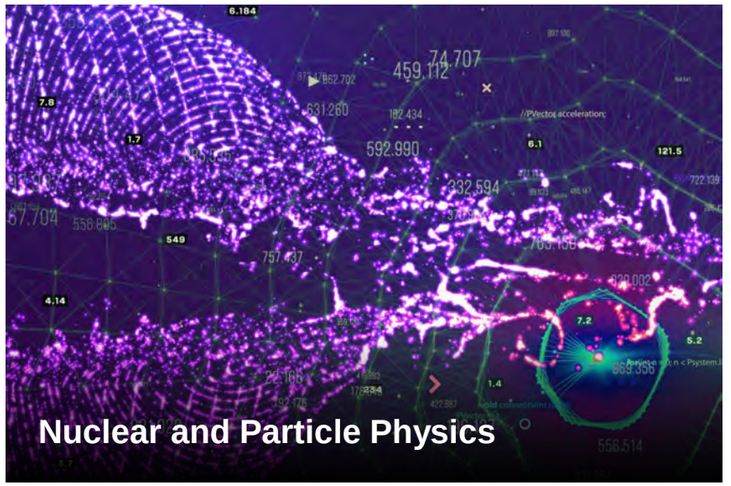
PNNL's **Science** mission advances understanding of the world around us



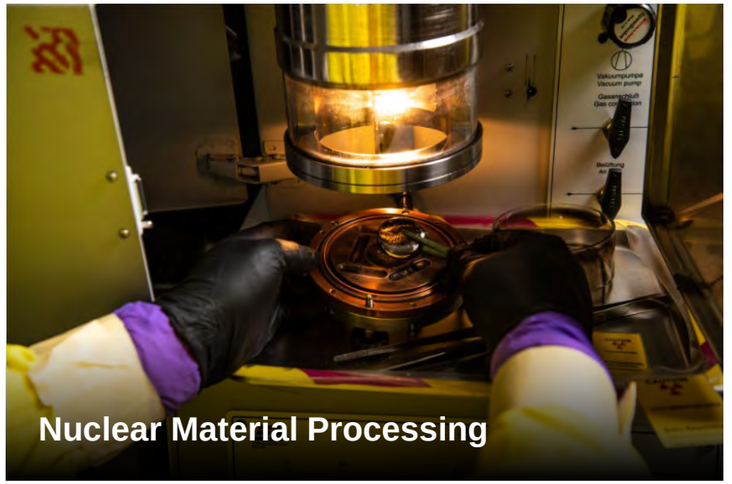


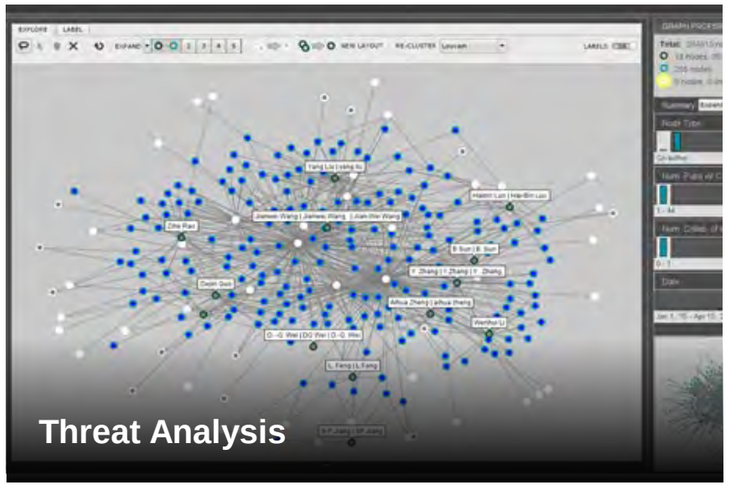


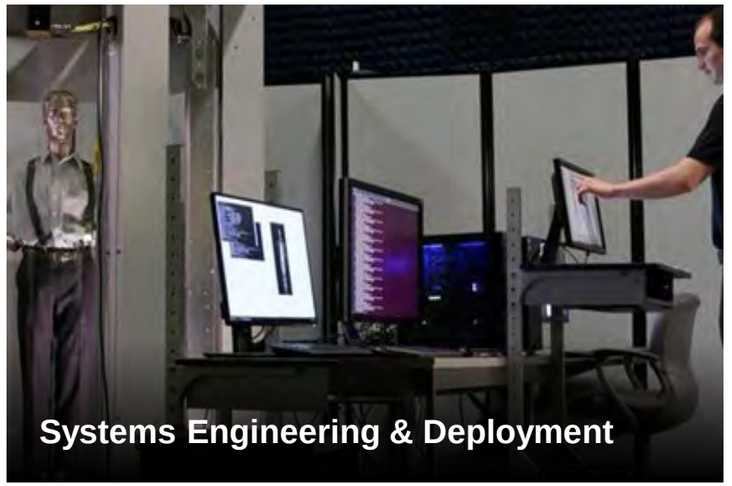




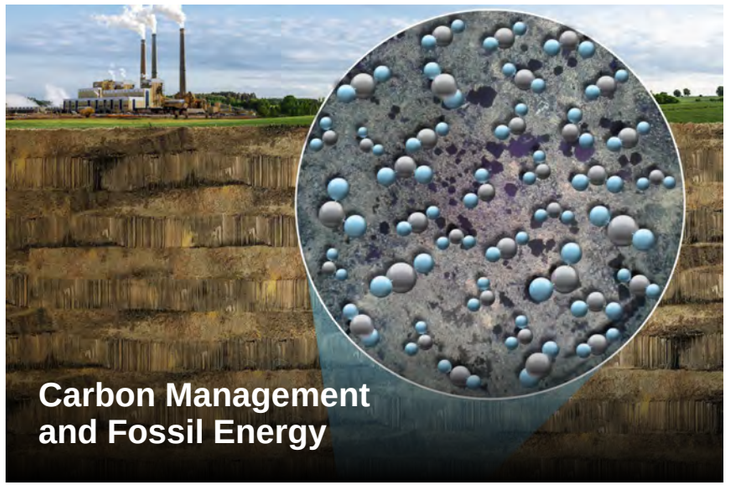
PNNL's **National Security** mission is reducing the threat from weapons of mass effect







PNNL's **Energy and Environment** mission delivers innovations for our energy future



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Investing $1 billion over 10 years to modernize PNNL facilities and infrastructure

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RPL

Radiochemical Processing Laboratory

$150 MILLION
NNSA-SC MOA

PNNL's **Energy and Environment** mission

1,300 Staff

More than **230** Energy and Environment staff support PNNL's National Security mission

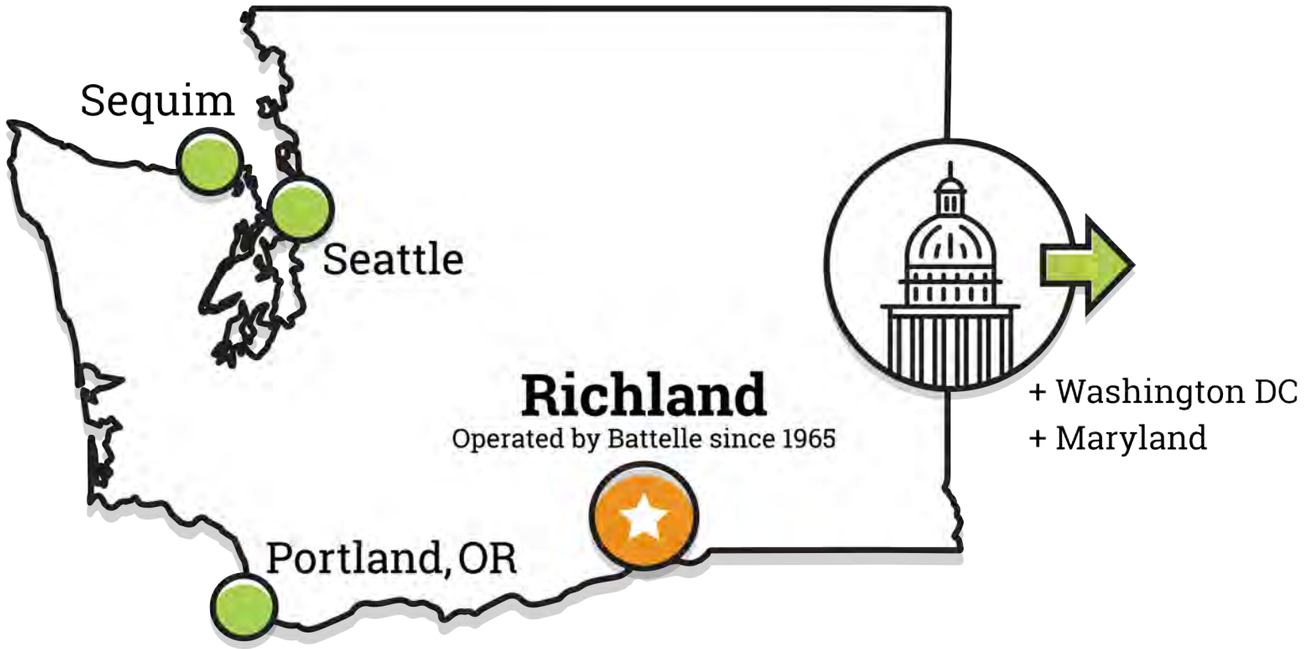
Mission Sponsors

Environment

- Environmental Management
- Nuclear Regulatory Commission

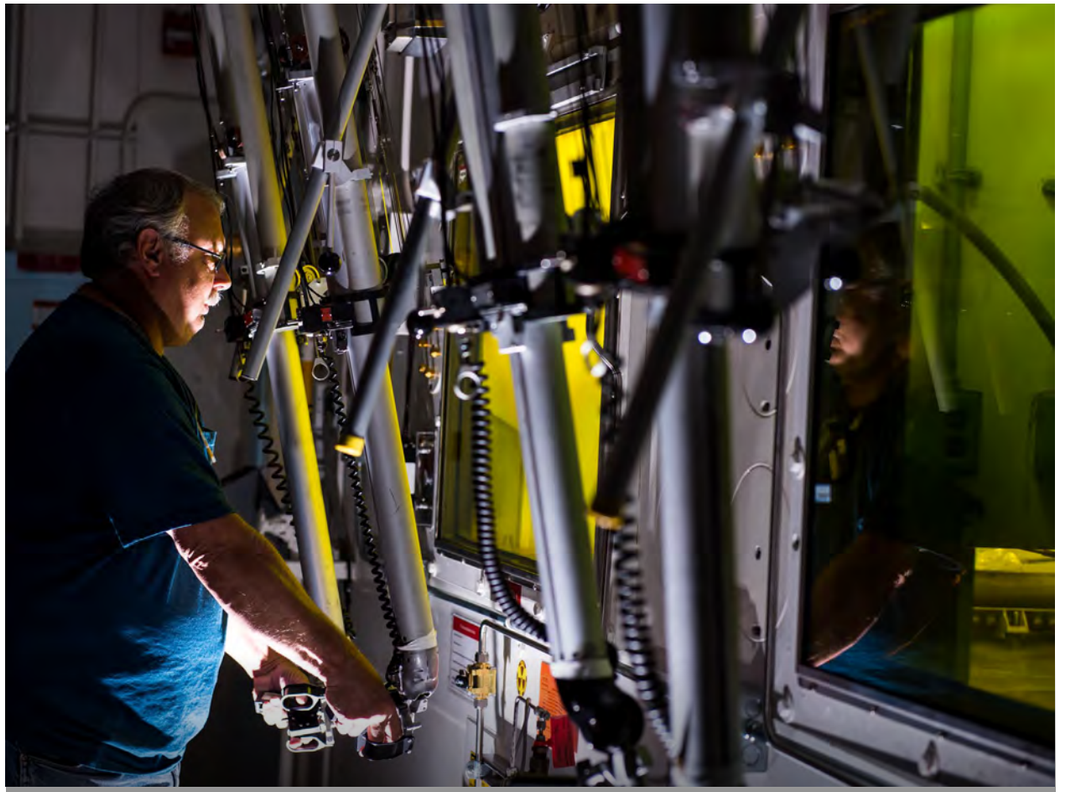
Energy

- Energy Efficiency & Renewable Energy
- Office of Electricity
- Cybersecurity & Energy Security
- Nuclear Energy
- Fossil Energy & Carbon Management
- ARPA-E



PNNL has a long history and strong commitment to supporting remediation of the Hanford site

- PNNL delivers S&T continuity for the Hanford Site
  - Five decades of objective scientific data to DOE, regional, and community stakeholders
  - Enabling technology innovations to support the cleanup mission
  - Approx. $40M annual EM business volume, ~50% DOE-direct
- Core capabilities:
  - Waste Processing
  - Subsurface Remediation



PNNL uses its Radiochemical Processing Laboratory to receive and analyze radioactive samples and conduct groundbreaking nuclear science. RPL is a Hazard Category II non-reactor nuclear research facility located on the edge of the Hanford Site.

Key Historic PNNL Contributions to Tank Waste Processing

- Invented, matured, and transferred Joule Heated Ceramic Melter technology
  - Baseline for West Valley, Savannah River (SRS), and Hanford
  - Enhanced glass formulations, waste loading for SRS
- Developed and maturated tank waste pretreatment technologies
  - Filtration, cesium ion exchange, sludge washing and settling
  - Baseline for West Valley, technology selection for SRS, Hanford flowsheets from early baseline to WTP and now DFLAW
- Led EM national tank waste technology development program (1995-2002) technical team
  - Safety, waste mobilization/retrieval, characterization, pretreatment, immobilization, and tank closure
- Mitigated Hanford tank hydrogen flammable gas issues
  - Hanford's burping tank (SY-101)
  - Deep sludge mixing (C-farm waste transfer to AN-farm)

PNNL helped pioneer nuclear waste vitrification efforts starting in the late 1960s. Our research now includes a variety of activities related to commercial glass and materials science, including grout, metals, and ceramics.

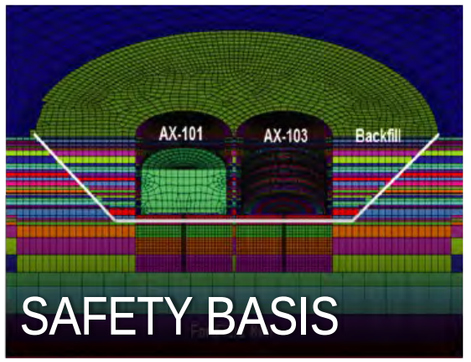
PNNL provides technical foundation for key waste processing technologies and approaches

Leader in tank waste chemistry, processing, and waste forms

52 Staff; >300Pubs
DOE-EM, DOE-SC, DOE-NE

55 Staff; >700 Pubs
DOE-EM, DOE-SC, DOE-NE

34 Staff; >200 Pubs
DOE-EM, DOE-SC, DOE-NE

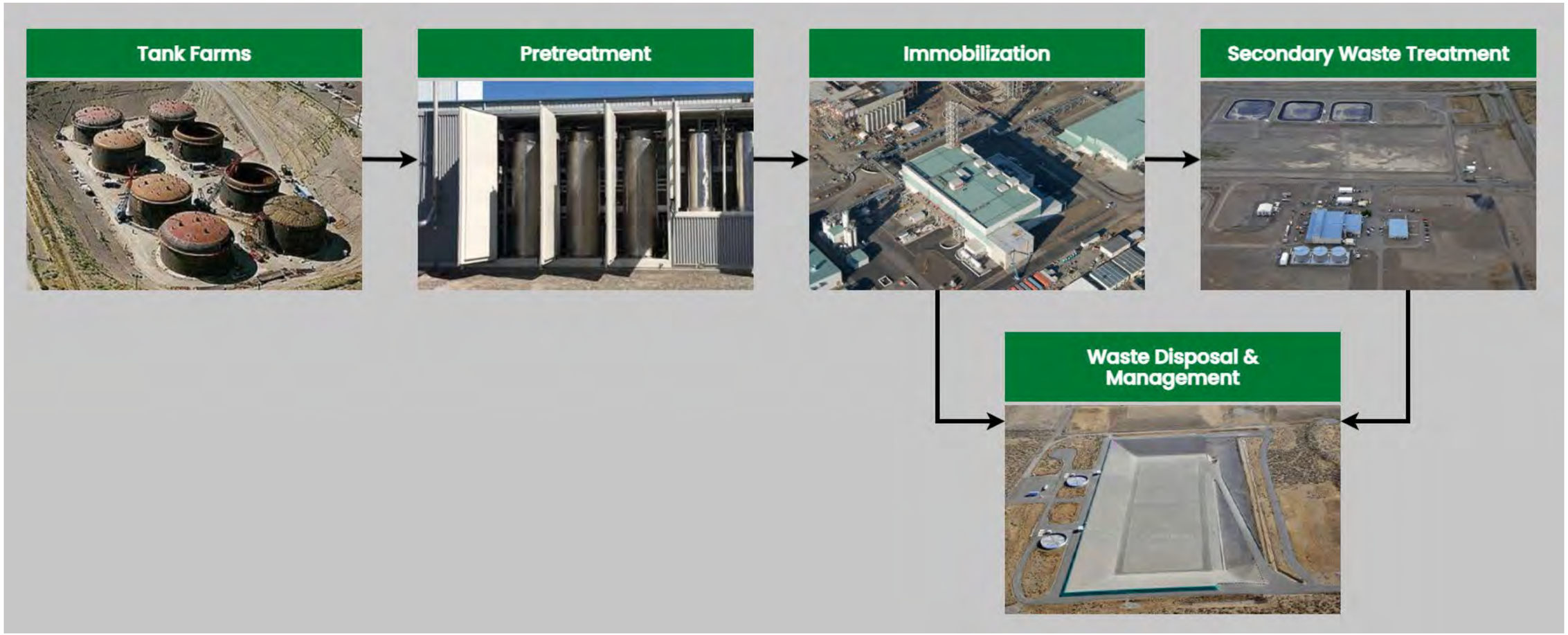


100+ Staff; >100 Pubs
DOE-EM, DOE-NE

Primary clients

- DOE Office of River Protection
- DOE-EM
- Tank operations and waste treatment contractors:
  - ✓ Washington River Protection Solutions
  - ✓ Bechtel National Inc.

PNNL S&T Underpins Waste Treatment Flowsheet



PNNL S&T Underpins Waste Treatment Flowsheet

- Waste sampling and characterization
- **Tank life extension**
- **Tank integrity**
- On-line monitoring
- Tank vapors
- Retrieval technologies
- Chemical speciation
- Slurry mixing and transfer
- Flammable gas safety

PNNL S&T Underpins Waste Treatment Flowsheet

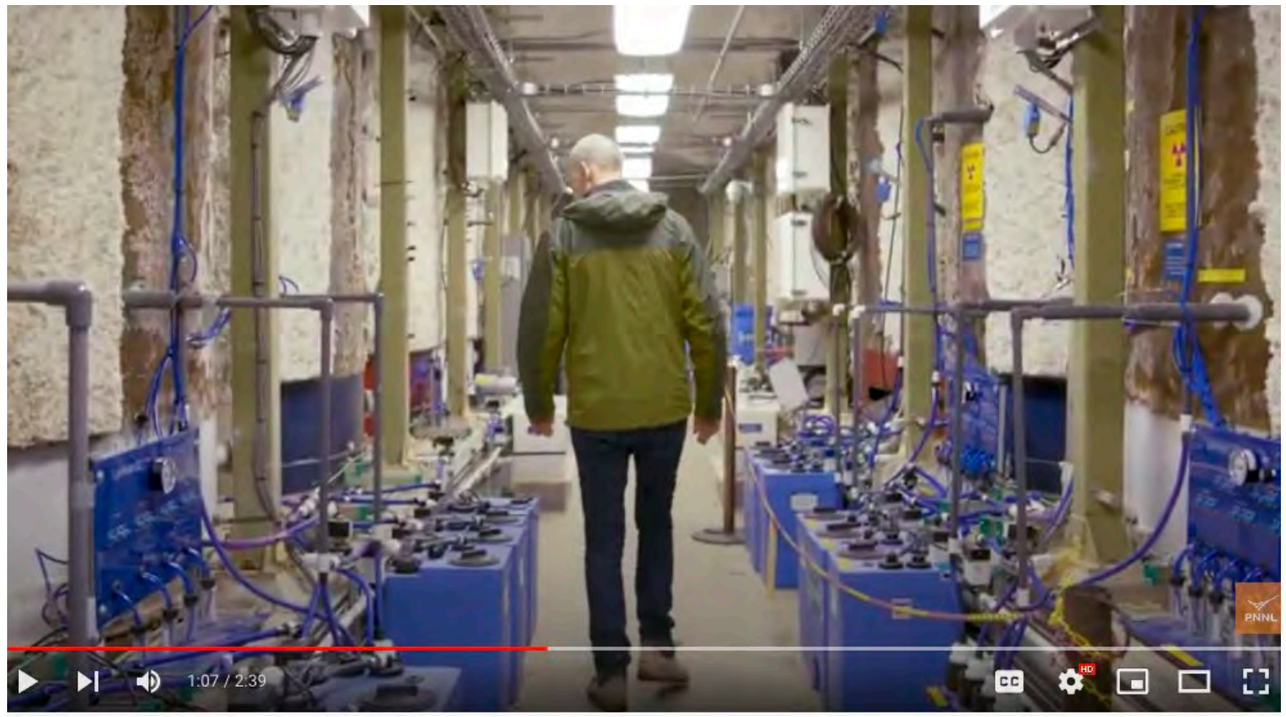
- **Filtration**
- **Ion exchange**
  - **H_2 generation**
- Evaporation
- I-129/Tc-99/Hg management
- Sludge leaching and washing
- On-line monitoring

PNNL S&T Underpins Waste Treatment Flowsheet

- **Glass and grout waste form development**
- **Waste form design, testing, and qualification**
- Process control and system planning models
- **Melter dynamics and cold cap behavior**
- Tc, I, Hg partitioning
- On-line monitoring

PNNL S&T Underpins Waste Treatment Flowsheet

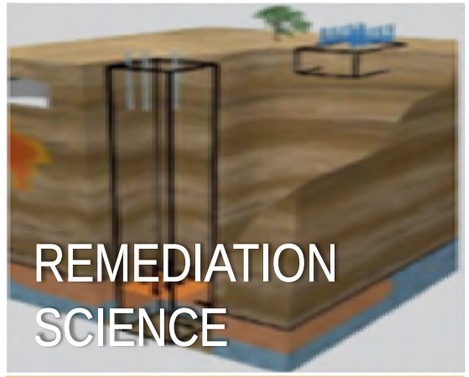
- **Waste form development and qualification**
- **Long-term waste form evolution and corrosion**
- PA data inputs and modeling
- Long term disposal facility and subsurface transport modeling
- Alternate Disposal Scenario Evaluation
- Regulatory Support



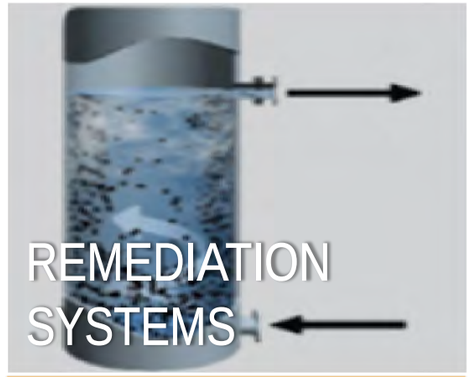
PNNL provides technical foundation for key soil and groundwater remediation approaches

Experts in subsurface science, geochemistry, and environmental remediation

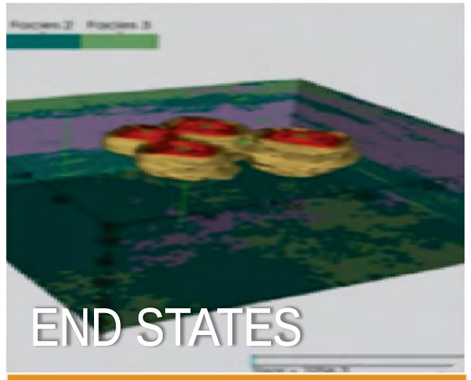
114 Staff; >1300 Pubs
DOE-EM, DOE-SC, DOE-FE, NRC, EPA



34 Staff; >400 Pubs
DOE-EM, EPA, DoD



74 Staff; >900 Pubs
DOE-EM, EPA, DoD

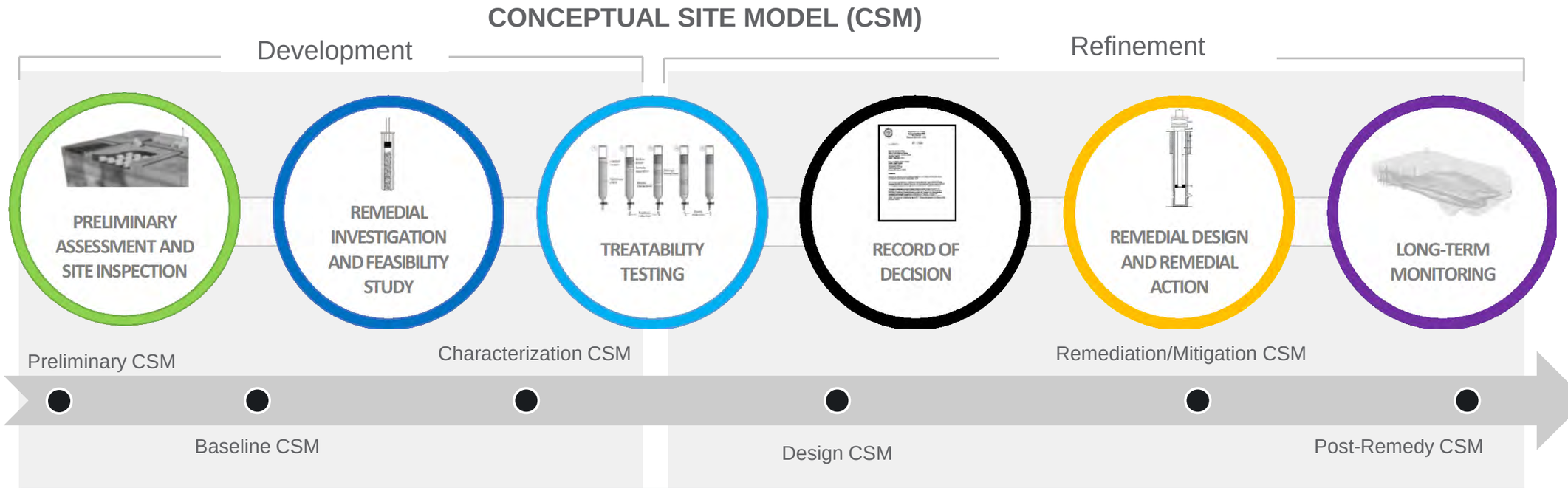


96 Staff; >600 Pubs
DOE-EM, EPA, NRC

Primary clients

- DOE Richland Operations
- DOE-EM, DOE-LM
- Plateau remediation contractor: Central Plateau Cleanup Company

CERCLA/RCRA Process Support

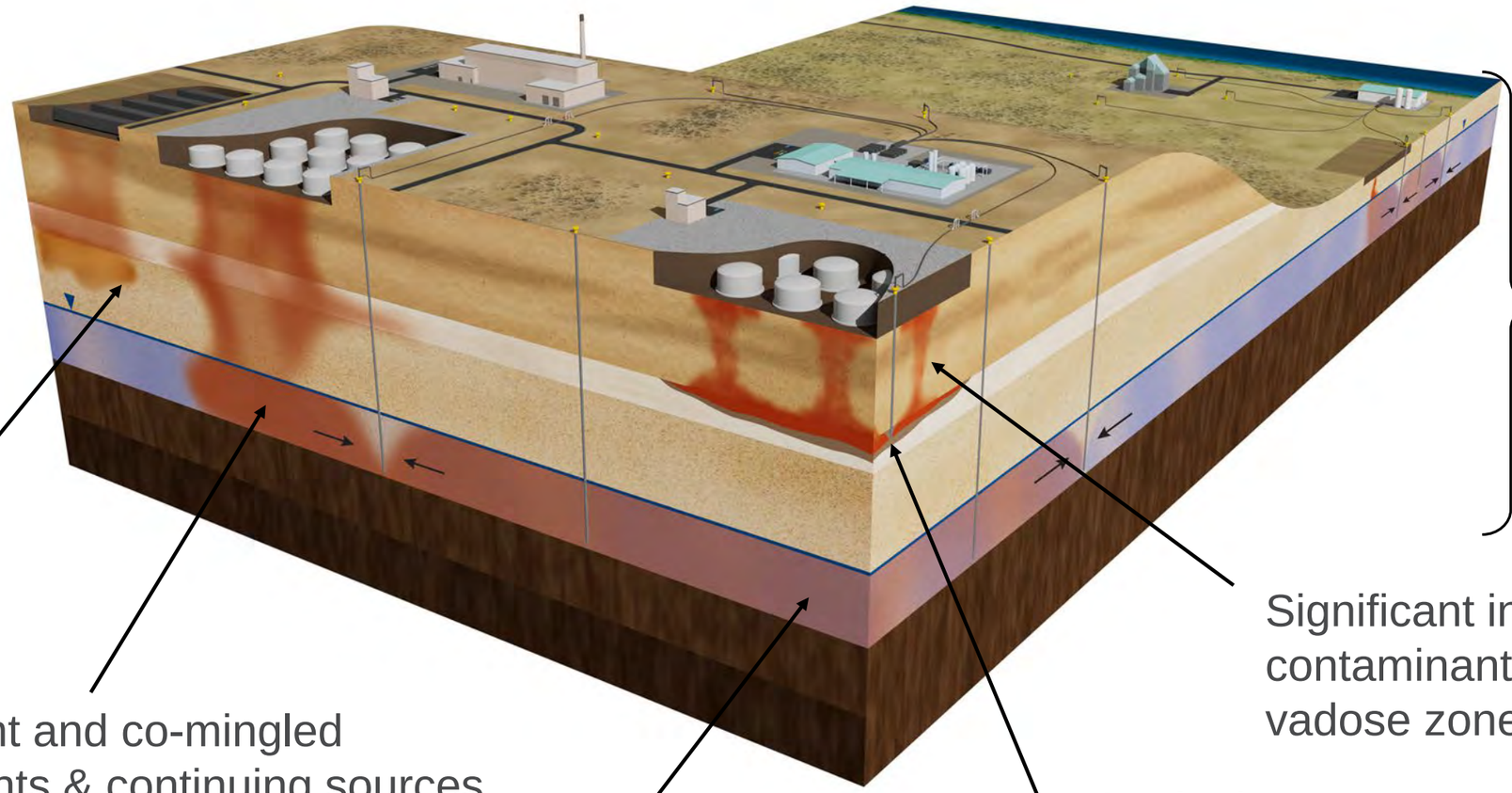


PNNL core capabilities target developing risk-based, actionable information to support QCSM development and refinement throughout the cleanup timeframe

- Define features and processes that control contaminant mobility and risk
- Quantify contaminant interaction in the environment
- Assess natural attenuation and evaluate risk

- Enhance technology maturation and develop technical basis for remedy selection, implementation
- Develop technical approach for remedy performance assessment and optimization, and long-term monitoring

Site CSM and Remediation Challenges



Vadose Zone

Groundwater

Complicated contaminant behavior

Recalcitrant and co-mingled contaminants & continuing sources

Large-scale contamination & uncertain amount and distribution

Geologic heterogeneity and complexity

Significant inventory of contaminants in the deep vadose zone soil column

Management of uncertainty

Implementation and integration of exit strategies

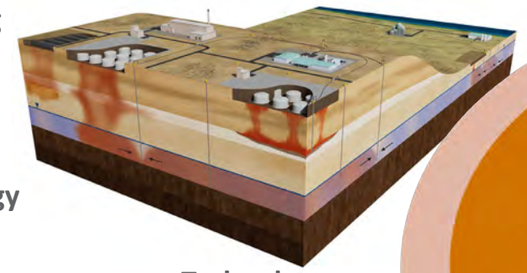
PNNL's Contributions to Hanford Subsurface Cleanup

DVZ Program Focus Areas

Enhanced Subsurface Characterization and Monitoring

Data Analytics & Computational Tools

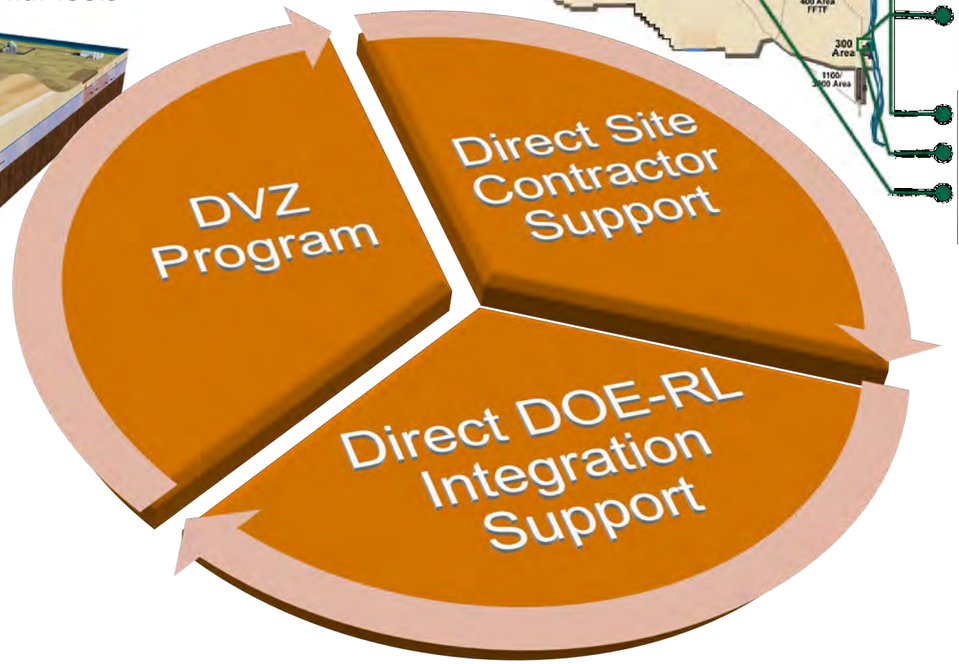
Source Characterization

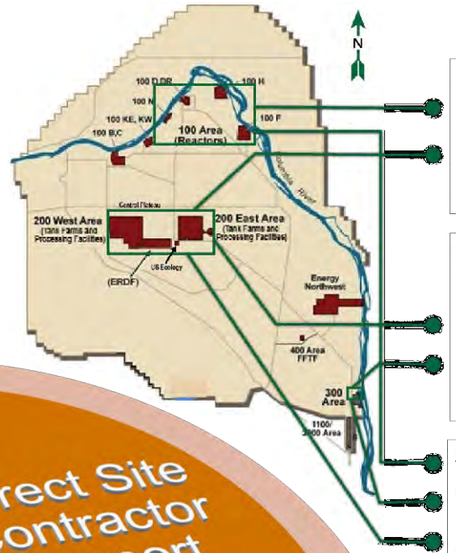


Remedy Technology Maturation and Optimization

Technology Treatability Testing

Exit Strategies & Adaptive Management





Technical Basis for Remediation Decisions and Implementation

- RI/FS support for investigating controlling subsurface behavior, transport, and fate of contaminants
- Provide mass-flux basis and source characterization

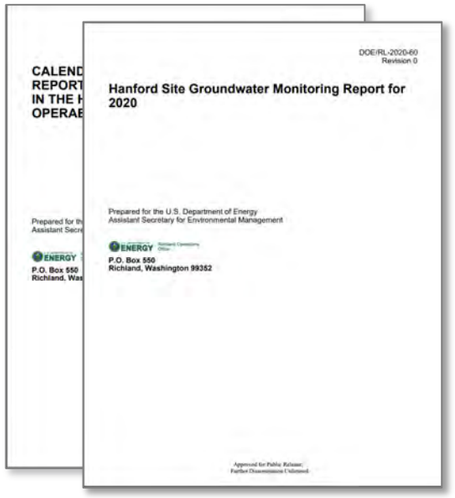
Systems-Based Assessment for Optimized and Effective Remediation

- Evaluate and mature remediation technologies that provide sustainable remediation of co-mingled contaminants
- Provide technical framework for MNA
- Demonstrate P&T optimization and exit strategies

Systems-Based Monitoring and Predictive Analysis

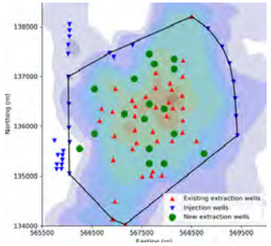
- Advance geophysical monitoring technologies through integration of predictive analysis to quantify contaminant flux to groundwater
- Provide technologies for streamlined and long-term monitoring for the VZ and groundwater

- Consultation on technical scope/planning
- Technical integration activities
- Technical reviews



PNNL's Core Capabilities

- Wide range of analytical site characterization capabilities
- Expertise to interrogate, evaluate, and interpret data



Data Analytics and Modeling

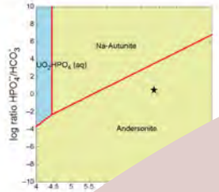
Remedy Implementation and Performance Monitoring

Field Remedy-Scale

Bench-Scale

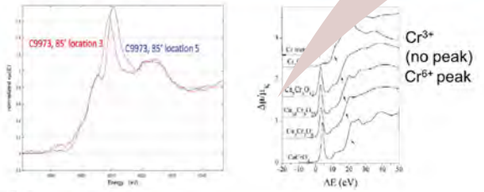
Molecular-Scale

Geochemical Simulations

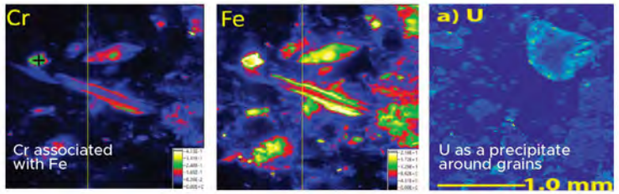


Scanning Electron Microscopy

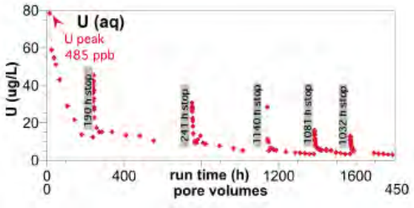
EXAFS/XANES



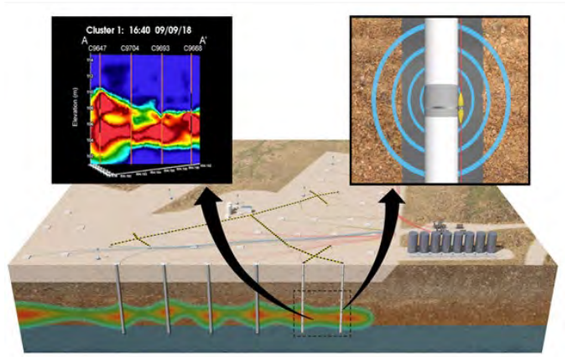
X-Ray Fluorescence (micron scale)



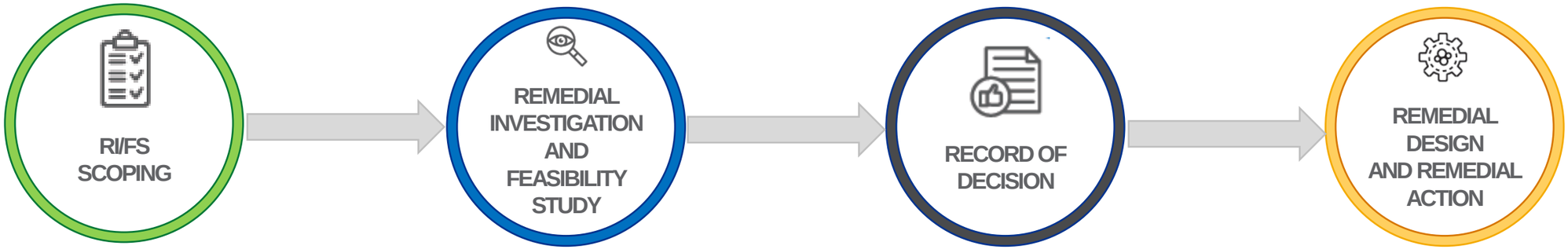
Geochemical Reactions and Contaminant Mobility



Advanced Geophysics and Deep Learning



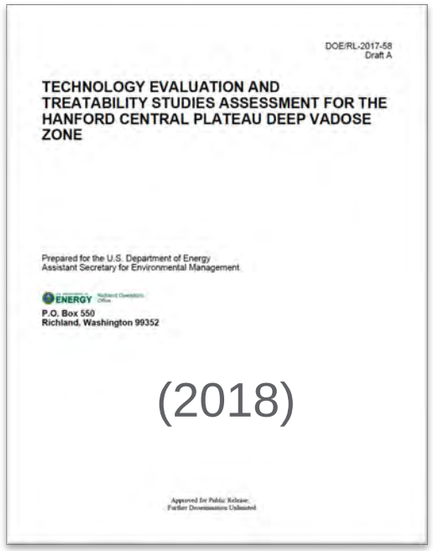
CERCLA Remedy Screening/Treatability Study: DV-1 OU



Site Characterization and Technology Pre-screening/Screening	Identification of Alternatives	Evaluation of Alternatives	Remedy Selection	Remedy Implementation
Treatability Study Scoping Remedy Screening Treatability (To determine potential feasibility)	Remedy Selection Treatability (To develop performance and cost data)			RD/RA Treatability (To develop detailed design and cost data and to confirm performance)

Goals/Objectives of technology pre-screening :

- Identify potentially applicable technologies that may require further evaluation through treatability studies and/or additional analyses
- Technologies demonstrated/proven as viable and do not require additional evaluation during RI is carried forward to FS.

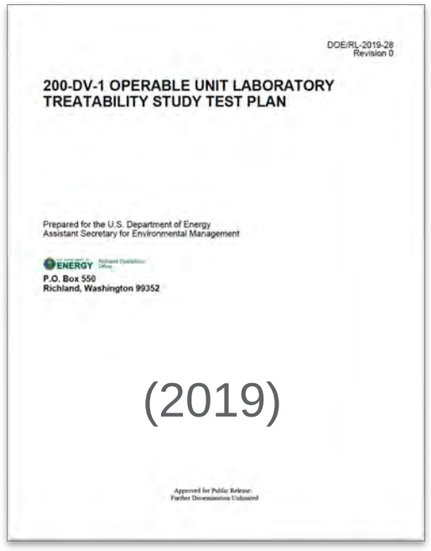

DOE/RL-2017-58
Draft A

TECHNOLOGY EVALUATION AND TREATABILITY STUDIES ASSESSMENT FOR THE HANFORD CENTRAL PLATEAU DEEP VADOSE ZONE

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

P.O. Box 550
Richland, Washington 99352

(2018)


DOE/RL-2019-28
Revision 0

200-DV-1 OPERABLE UNIT LABORATORY TREATABILITY STUDY TEST PLAN

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

P.O. Box 550
Richland, Washington 99352

(2019)

Adopted from Guidance For Conducting Treatability Studies Under CERCLA (EPA/540/R-92/071a)

DV-1 Treatability Study

- Laboratory treatability study for the testing of eight selected technologies was recommended for DV-1 OU
  - In situ technologies relying on biochemical manipulation of contaminants to enhance and control the attenuation processes such as:
    - ✓ Reduction of redox sensitive contaminants to enhance precipitation
    - ✓ Sequestration of precipitated contaminants by coating
- A test plan was developed in 2019 and the study was initiated in FY22
  - Four-year effort, initiated in FY22
  - Final deliverable to Ecology in 2026 per M-015-110E due 02/28/2026

Recommended laboratory studies by the TTER (reproduced from DOE/RL-2017-58; DOE/RL-2019-28)

Technology Process Option	COI to Study	Examples of Potentially Applicable 200-DV-1 Waste Sites	Examples of Other Potentially Applicable Waste Sites
Technologies for Unsaturated Zone Applications			
Gas-phase combined bioreduction and chemical sequestration	Tc-99	BY Cribs	BC Cribs and Trenches
Gas-phase bioremediation	Nitrate	Unknown	Unknown
	CN	BY Cribs	Unknown
	Cr(VI)	Unknown	216-S-10, 216-S-8, 216-T-4
Gas-phase chemical sequestration	I-129	Unknown	216-A-10, 216-A-5, 216-S-7
Technologies for the 200-DV-1 Perched Water and Use as a Horizontal Permeable Reactive Barrier at the Water Table			
Particulate-phase chemical sequestration	U and Tc-99	Perched Water, below Perched Water, and below BY Cribs	216-U-1&2, S-SX Tank Farm, C Tank Farm, BC Cribs and Trenches
	Cr(VI)	Unknown	216-S-10, 216-S-8, 216-T-4
	I-129	Unknown	216-A-10, 216-A-5, 216-S-7
Particulate-phase combined chemical reduction and sequestration	U and Tc-99	Perched Water, below Perched Water, and below BY Cribs	216-U-1&2, S-SX Tank Farm, C Tank Farm, BC Cribs and Trenches
Liquid-phase chemical sequestration	U and Tc-99	Perched Water, below Perched Water, and below BY Cribs	216-U-1&2, S-SX Tank Farm, C Tank Farm, BC Cribs and Trenches
	Cr(VI)	Unknown	216-S-10, 216-S-8, 216-T-4
	I-129	Unknown	216-A-10, 216-A-5, 216-S-7
Liquid-phase combined chemical reduction and sequestration	U and Tc-99	Perched Water, below Perched Water, and below BY Cribs	216-U-1&2, S-SX Tank Farm, C Tank Farm, BC Cribs and Trenches
Liquid-phase combined bioreduction and chemical sequestration	U, Tc-99, nitrate	Perched Water, below Perched Water, and below BY Cribs	216-U-1&2, S-SX Tank Farm, C Tank Farm, BC Cribs and Trenches
	CN	BY Cribs	Unknown

3D Soil Flushing Monitoring (CPCCo)

Surface
ERT Electrodes

Drip Lines
(40-90 GPM)

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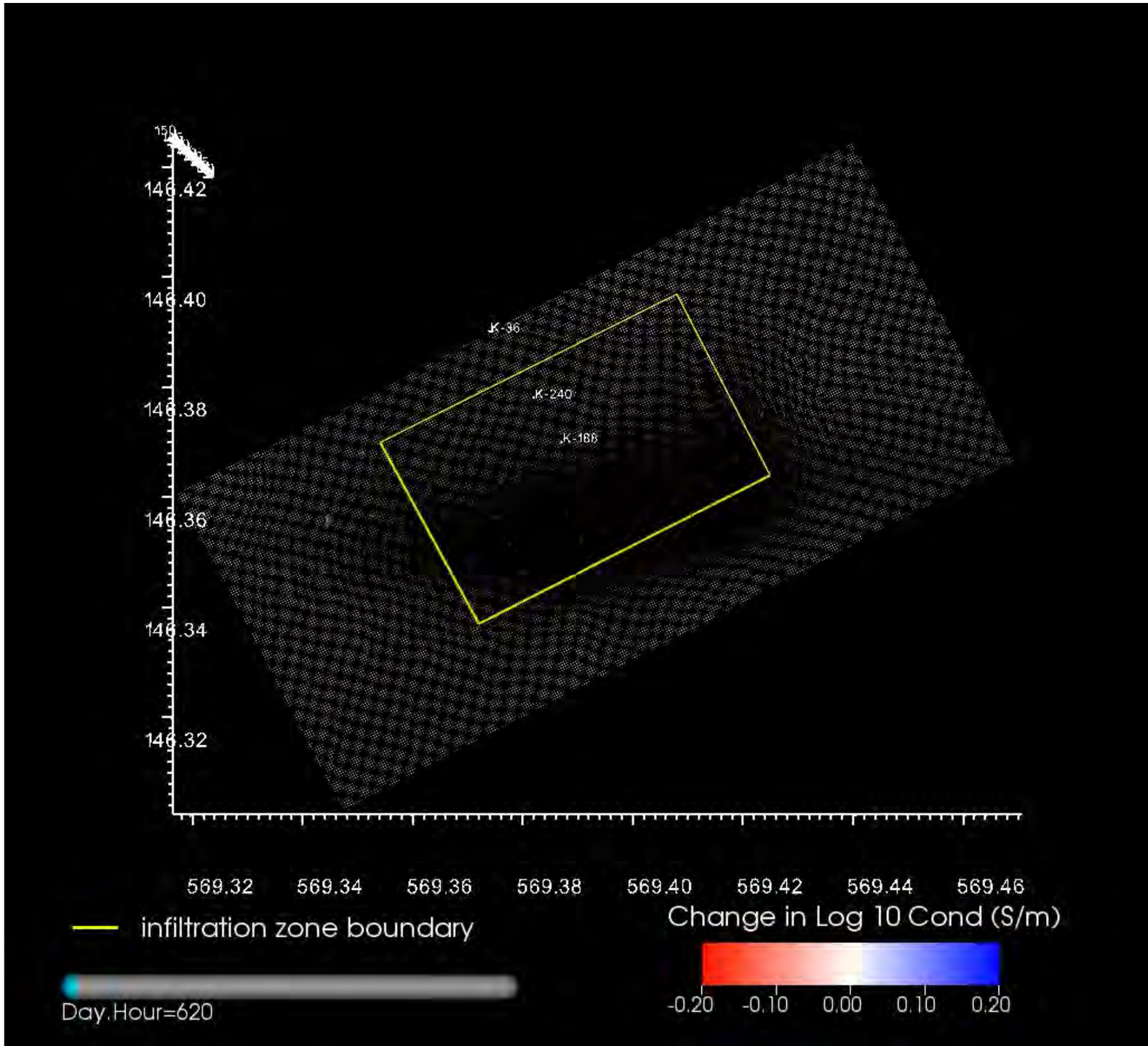
Soil Flushing 4D Imaging Results: June-July 2022



PNNL commitment to enable effective treatment, reduce costs, and accelerate schedules

- PNNL has supported the Hanford mission and cleanup effort since EM inception
  - Maintaining core nuclear capabilities for waste treatment and environmental remediation
  - Drawing upon strong science base and capabilities to underpin technology solutions
  - Key resource for objective data to DOE and stakeholders
  - Direct support to DOE—helping define future technical direction, long-lead strategies for alternate site cleanup paths
  - Partnership with contractors—reducing technical risks, providing enabling technology to meet baseline performance
- Committed to working with DOE and EM's laboratory network to support complex-wide challenges

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Thank you