Challenges to Cleanup

River Protection Project Technology Needs and Technical Challenges

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Outline

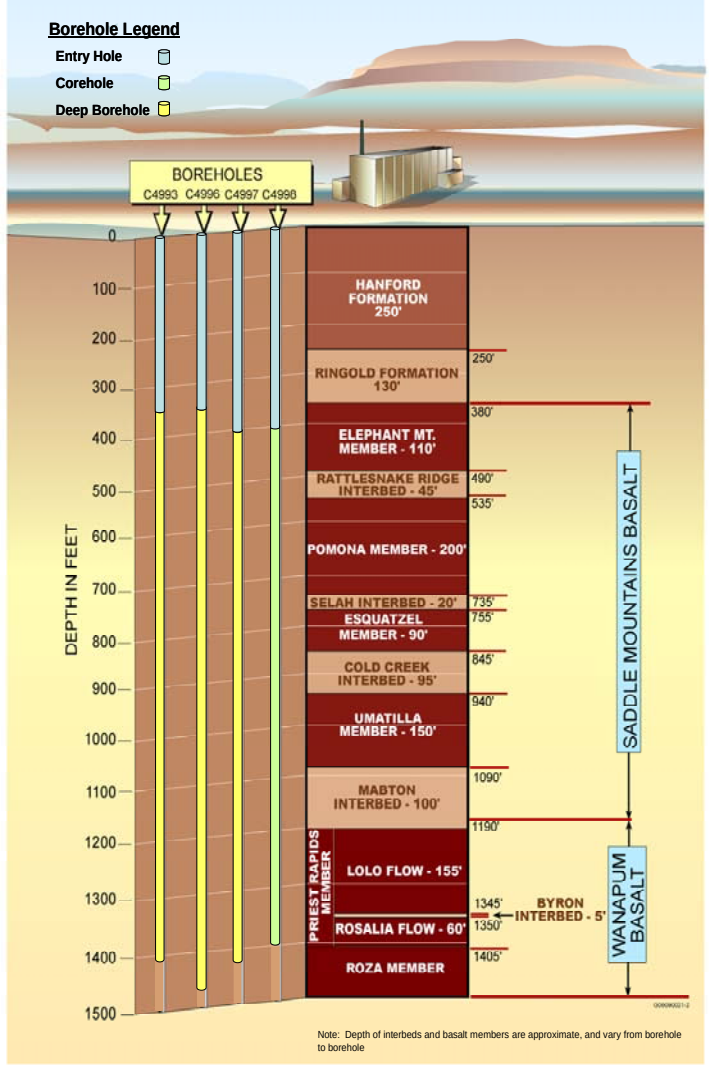
- Sources of currently identified needs
- Scope/purpose of investments
- Needs/challenges recently addressed (example)
- Current needs and responses (examples)
  - Challenge/problem
  - Near-term S&T
  - Longer-term challenges
- Needs list (handout)

Cleanup Challenges
River Protection Project Technical Needs

- Sources
  - Risk Management Plans (DOE Order 413.3) and risk lists
  - External reviews
    - External Flowsheet Review (EFRT) of WTP
    - Technology Readiness Assessments
  - Technology Maturation Plans and baseline projects
  - Technology needs identification and summaries
- Scope/Purpose of Investments to Address Needs
  - Reduce technical uncertainties in project baselines
  - Enhance technical defensibility of cleanup decisions
  - Develop/assess alternatives or supplements to the baseline
  - Lead transformational changes to the most intractable problems

Recent Needs Addressed: Resolution of WTP Seismic Issues

- Absence of directly-measured seismic data in deeper sediments underneath the WTP resulted in increased ground motion prediction
- Intensive effort to
  - drill four new boreholes
  - collect geophysical data from underlying basalts and sediments
  - Re-assess ground motion predictions with reduced uncertainty
- Involved PNNL geology and seismic experts, University/NSF Center, >12 subcontractors, and an expert panel
- Enabled Secretary of Energy to certify final WTP seismic criteria in August 2007



Cleanup Challenges
Current Technical Needs

- External Flowsheet Review
  - Identified flowsheet issues requiring analysis and/or testing to support near-term design and planned operations of the WTP
  - Baseline project supported
- Technology Needs Summary
  - 24 needs in in 7 program areas of Storage, Characterization, Retrieval, Waste Feed Delivery, Separations, Treatment, and Tank Closure
    Near- to Mid-term impact on RPP mission
  - Baseline and non-baseline supported

WTP Flowsheet Review – Key Technical Issues (baseline-supported)

- M1 – Plugging in Process Piping
- M2 – Mixing Vessel Erosion
- M3 – Mixing System Design
- M6 – Process Operating Limits
- M12 – Scale-up Demonstration of Sludge Leaching and Filtration

WTP Flowsheet Issues (examples)

- M3 – Mixing System Design
  - Challenge: Mixing system designs may results in insufficient mixing, especially with large particles and rapidly settling Newtonian slurries. Insufficient testing of the selected designs.
  - Near-term S&T: Testing of scaled mixing systems with prototypic configurations of process vessels. Analysis of critical scale-up parameters.
  - Science challenges: Understanding of time-dependent fluid dynamic behavior of waste slurries. Lack of validated computational fluid dynamic (CFD) methods to predict waste behavior under wide range of waste and mixing configurations

WTP Flowsheet Issues (examples)

- M12 – Scale-up Demonstration of Sludge Leaching and Filtration
  - Challenge: Neither the caustic leaching nor the oxidative leaching process has been demonstrated at greater than bench scale.
  - Near-term S&T:
    - Radiochemical characterization of actual waste solutions
    - Radiological bench-scale testing of leaching and filtration
    - Large engineering-scale process testing of leaching and filtration
  - Science challenges: Understanding of solution composition and solution stability that enables optimization of leaching conditions

Technology Needs – Treatment

- Bulk Vitrification Process Validation and Enhancement
- Improved Secondary Waste Treatment
  - Secondary waste forms selection
  - Technical basis for long-term performance
- HLW Glass Development Studies
- LAW and HLW Glass Waste Loading

Supplemental Treatment Needs (examples)

- Bulk Vitrification Process Validation and Enhancement
  - Challenge: Demonstrate effective treatment technology to supplement capacity of WTP LAW vitrification. Resolve technical risks with Tc migration during bulk vitrification processing.
  - Near-term S&T:
    - Demonstrate effectiveness of mitigation methods for Tc migration
    - Demonstrate waste feed drying and offgas treatment system effectiveness and control
    - Develop formulations/test glass performance with variable waste feeds
  - Science challenges: Understanding of waste and glass chemistry, including high-temperature behavior of waste constituents. Ability to model/predict melter and waste form performance under varying feed and process conditions.

Supplemental Treatment Needs (examples)

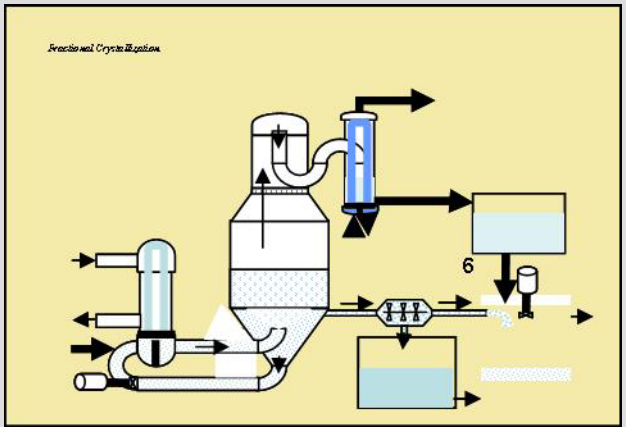
- Improved Secondary Waste Treatment
  - Challenge: Secondary waste from vitrification contain contaminants of concern (e.g., I, Tc) that can impact disposal system performance. Selection of appropriate waste form(s) and development of a technical basis for long-term performance is needed to disposition secondary waste.
  - Near-term S&T:
    - Scoping study of alternative waste forms (complete)
    - Roadmap of critical technology, engineering, and science efforts necessary to establish path forward (proposed)
  - Science challenges: Understanding of long-term performance of waste forms from low-temperature immobilization processes (e.g., cement-based). Development of representative testing methods for accelerated aging/testing of waste forms.

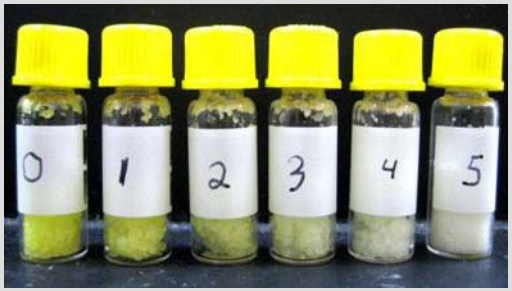
Technology Needs - Separations

- Review of WTP Ultrafiltration System Design and Sludge Leaching Process
- Supplemental Pretreatment Technology Development
  - Fractional Crystallization
  - Near Tank Cs Ion Exchange
- Caustic Management
- Solid-Liquid Separations in Support of Waste Pretreatment
- HLW Slurry Concentration Equipment Development
- Alternative Reagents for Caustic and Oxidative Leaching

Separations Needs (examples)

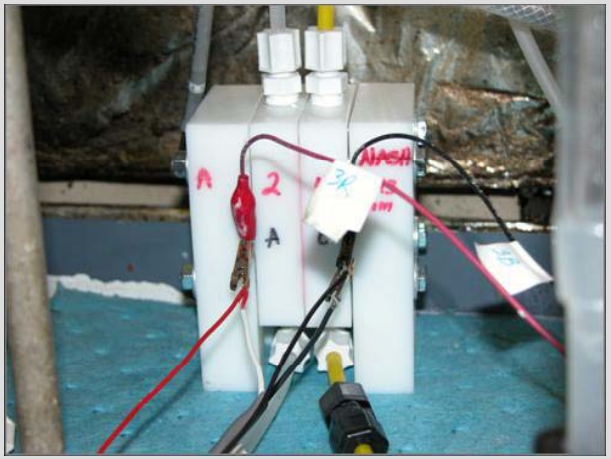
- Supplemental Pretreatment Technology Development
  - Challenge: Early start of LAW vitrification via WTP or supplemental treatment requires supplemental pretreatment for Cs removal.
  - Near-term S&T:
    - Development and demonstration of fractional crystallization process at lab- and pilot-scale
    - Development and demonstration of near-tank Cs ion exchange process
  - Science challenges: Understanding of waste and processing chemistry, solution compositions, and solution stability that enables prediction and control of pretreatment processing under varying feed conditions





Separations Needs (examples)

- Caustic Management
  - Challenge: Estimated amount of caustic (NaOH) required to process HLW is increasing, and directly impacts the amount of immobilized LAW produced.
  - Near-term S&T:
    - Expert assistance in evaluating options for NaOH reduction
    - Develop, test, and evaluate methods for reduction of the amount of additional caustic required (e.g., recycle, nitrate destruction/NaOH generation)
  - Science challenges: Understanding of solution composition and solution stability that reduces need for caustic addition.



Summary

- Current needs and supporting investments are:
  - Primarily baseline-focused to resolve near-term uncertainties/risks and establish the technical basis for decisions
  - Supplemented with non-baseline funds, primarily focused on near- and mid-term alternatives development and technical assistance
- A robust engineering and technology roadmap should:
  - address the near-, mid-, and long-term challenges including transformational changes to the most intractable problems
  - integrate baseline and non-baseline activities
  - renew high-level waste science investments to underpin the technical bases and transformational changes

Backup Slides

Technology Needs - Storage

- Double Shell Tank Integrity
  - Incomplete understanding of all corrosion mechanisms (e.g., vapor phase, liquid line, etc.)
- Advanced Approaches for Increasing DST Waste Storage Capacity
- Remote Inspection System for DSTs
  - Ultrasonic testing over larger areas

Technology Needs - Retrieval

- Alternative Retrieval Technologies
- Improve Operational Life for In-tank Cameras and Lights
- Develop Improved Techniques of Installing of New Tank Risers

Technology Needs - Characterization

- Residual Tank Waste Measurement
- HLW Slurry Hardness and Abrasivity Determination – hot cell application
- Hanford Double Shell Tank Mixing and Sampling
- On-Line Monitoring of Percent of Solids in Slurry
- Waste Slurry Transport Characterization and Pipeline Unplugging

Technology Needs – Tank Closure

- Post Retrieval Tank Residual Waste Long-term Immobilization
- Pipeline Characterization in Support of Tank Farm Closure
- Waste Area Closure Demonstration and Performance Monitoring
  - Tanks, pipelines, etc.
  - Monitor release of contaminants