Savannah River Remediation
AECOM | BECHTEL | CH2M | B&W | AREVA

December 15, 2015

SCALING OF SALTSTONE DISPOSAL FACILITY TESTING

Kent Rosenberger

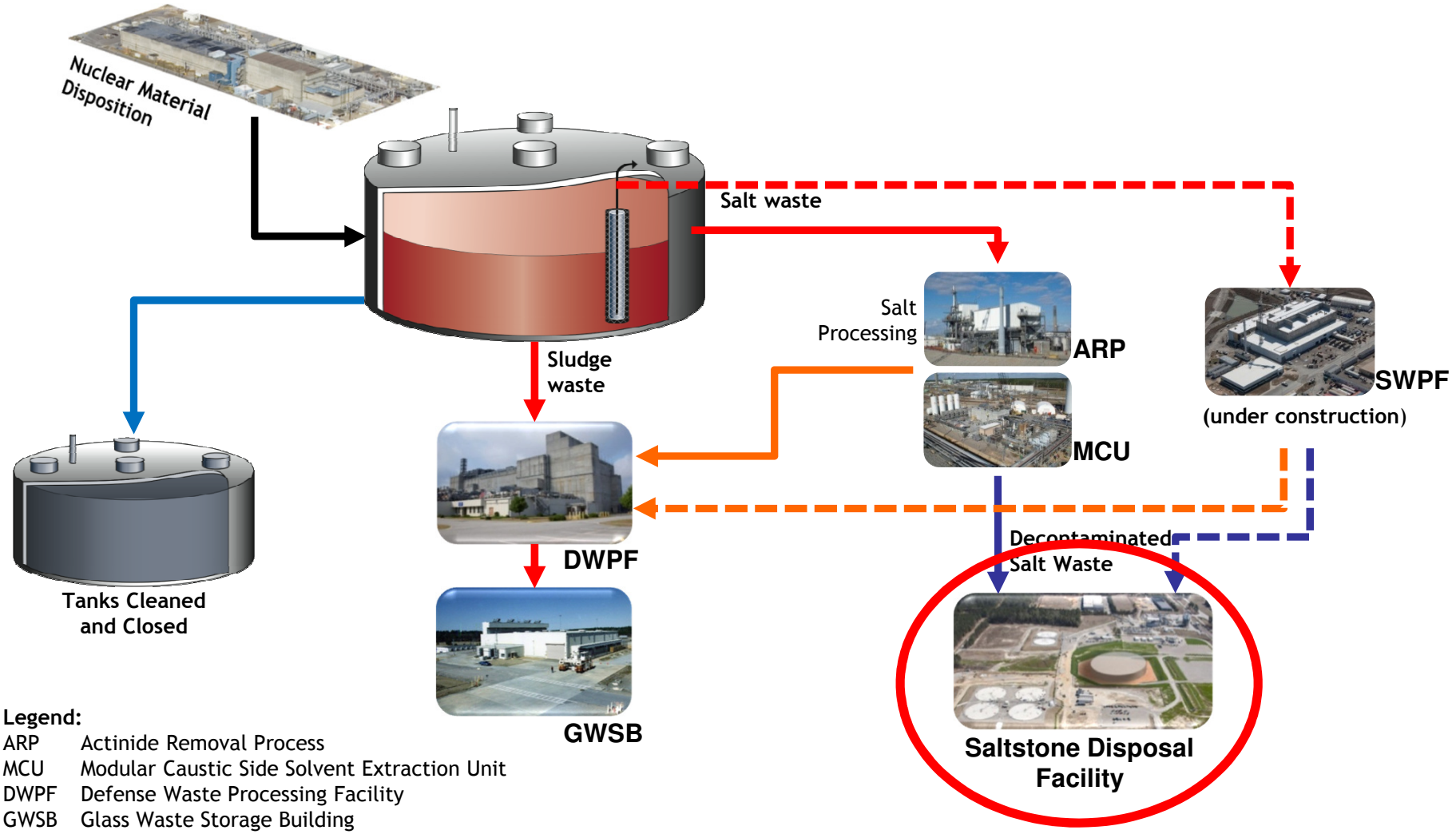
Performance and Risk Assessment Community of Practice Annual Technical Exchange

Performance Assessments

- Saltstone Disposal Facility is a low-level waste disposal facility which incorporates liquid low-level waste from the SRS Tank Farms with cement, fly ash and slag to form cementitious waste form - saltstone
- Liquid waste and dry feeds mixed in the Saltstone Production Facility and saltstone pumped to the disposal units in the Saltstone Disposal Facility

SRS Liquid Waste System

We do the right thing.



Legend:

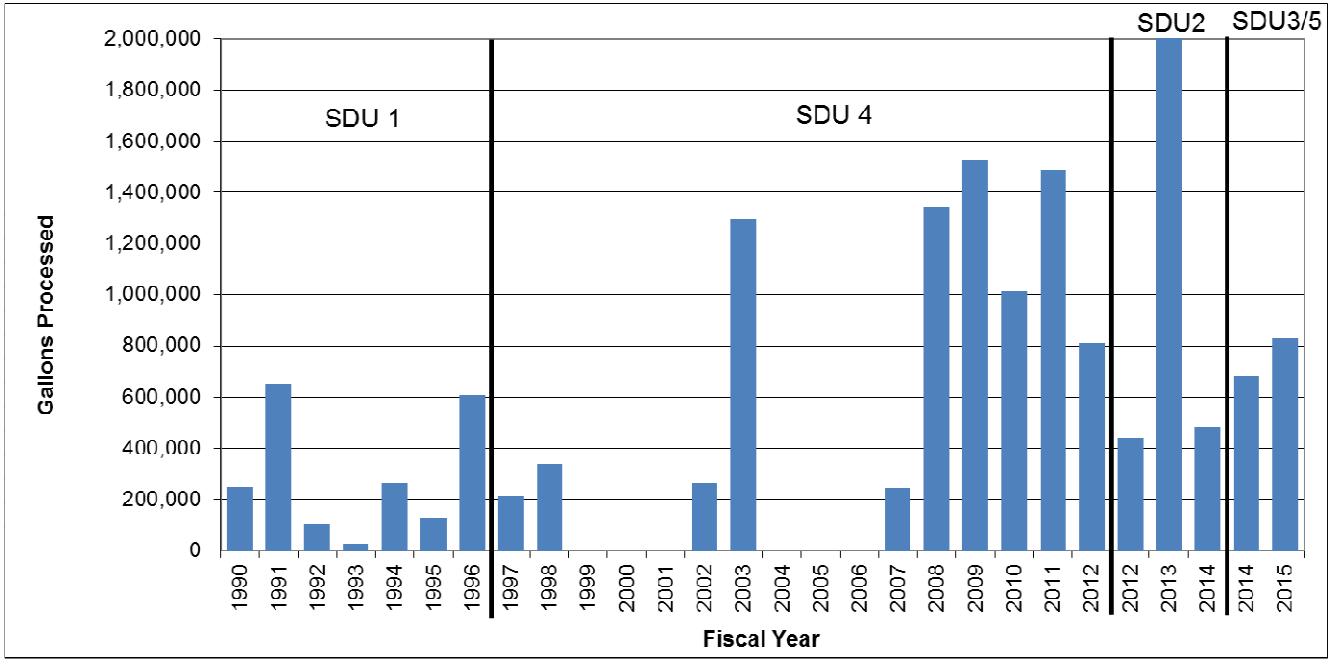
ARP	Actinide Removal Process
MCU	Modular Caustic Side Solvent Extraction Unit
DWPF	Defense Waste Processing Facility
GWSB	Glass Waste Storage Building
SWPF	Salt Waste Processing Facility

Saltstone Facilities

We do the right thing.

Saltstone Disposal Facility

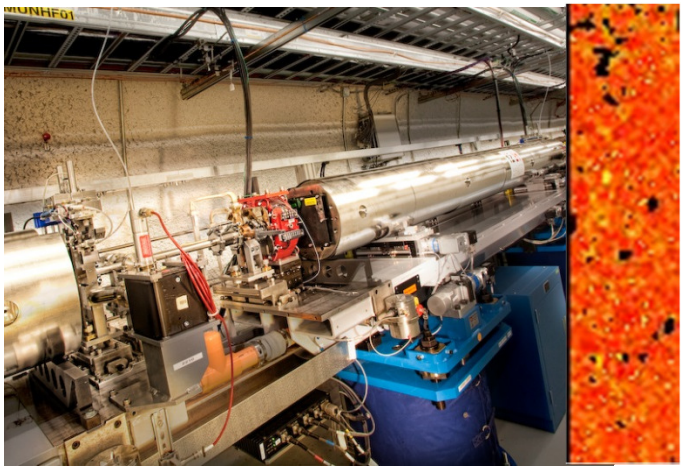
- SDF been operating since 1990.



- As discussed in previous presentation the modeling results are used to inform R&D activities

Scale of Testing

Testing related to the Saltstone Disposal Facility has been performed at the molecular level, at laboratory scale / predictive modeling and at the disposal unit scale.



Scale of Testing

- Testing at each scale consists of inherent pros and cons.
- Need to evaluate those pros and cons with the anticipation of wanting testing to focus on the laboratory scale supported by predictive modeling.

Testing on Molecular Scale

- Focus on information needed to support laboratory scale testing and predictive modeling.

- Fe, Tc, S speciation using X-Ray Absorption Spectroscopy, Scanning Electron Microscopy & Energy Dispersive Spectroscopy to investigate phase and microstructure

Scanning Electron Microscopy/Energy Dispersive Spectroscopy

We do the right thing.

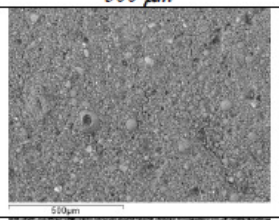
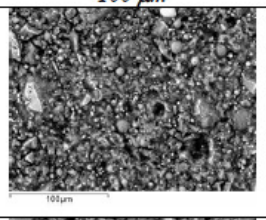
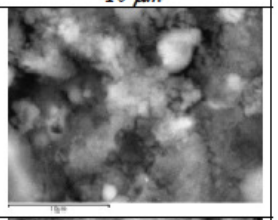
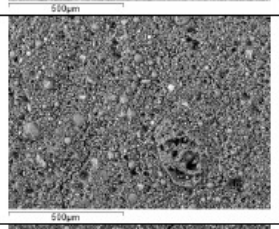
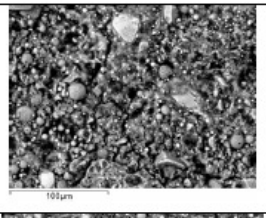
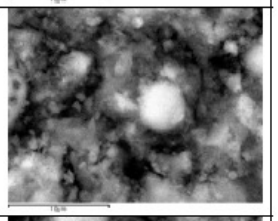
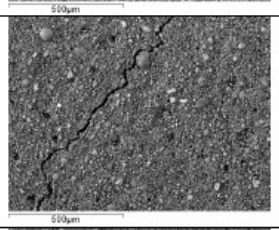
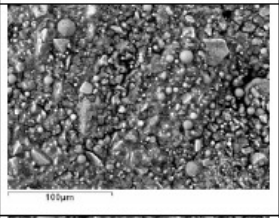
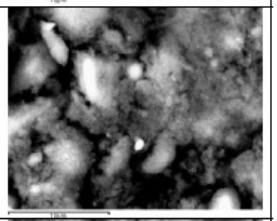
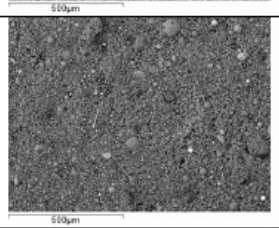
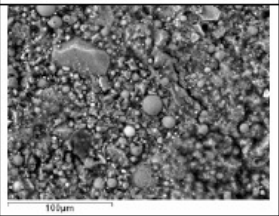
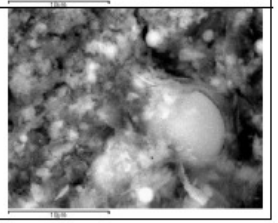
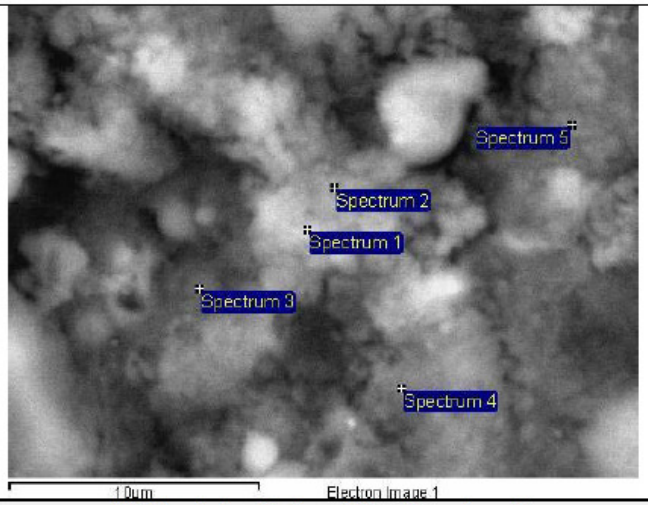
Grout ID	SEM Images		
	500 μm	*100 μm*	*10 μm*
GL0-RT			
GL1-RT			
GL2-RT			
GL3-RT			

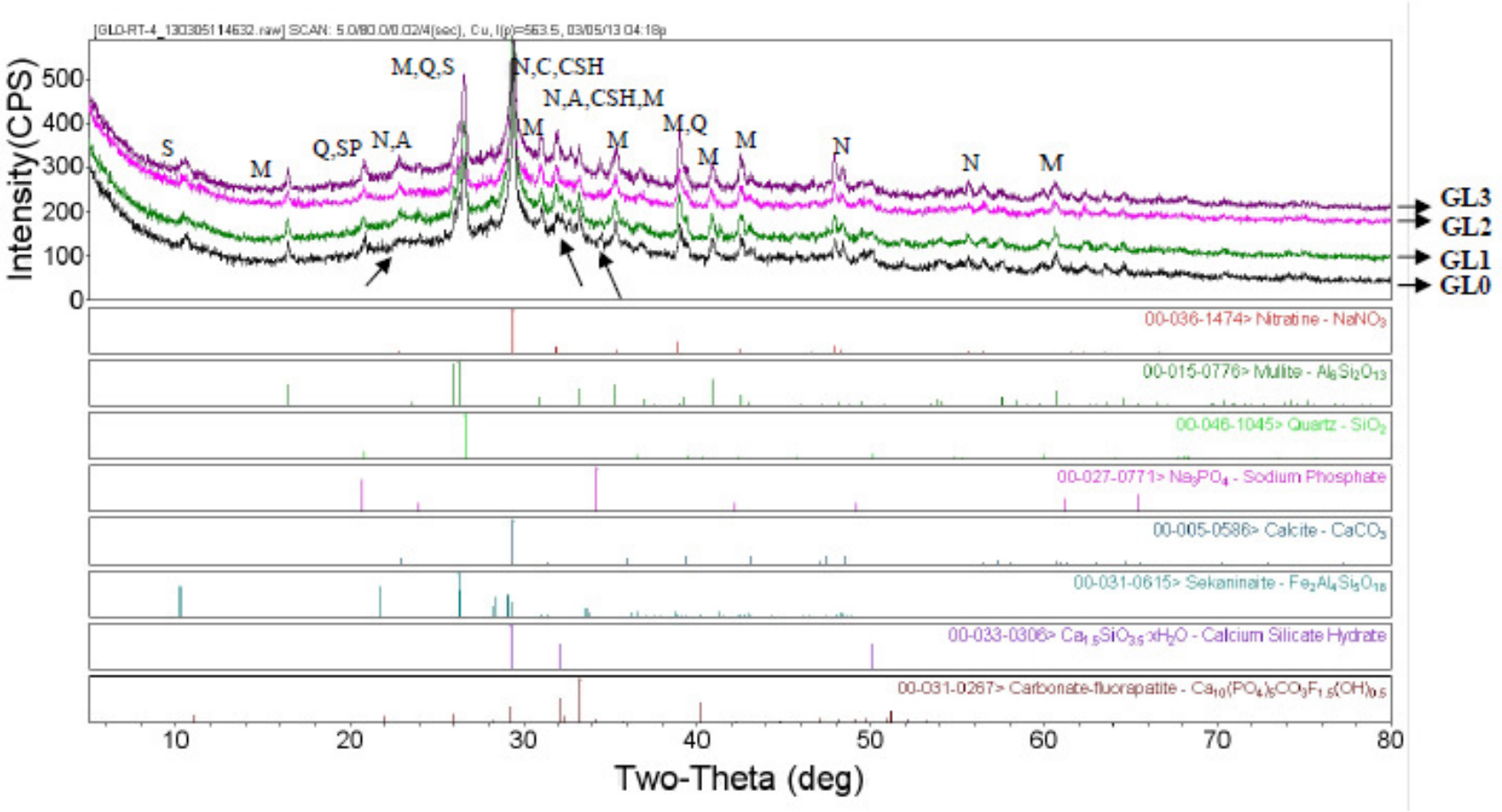
Figure 5.20. SEM images of grouts GL0-RT, GL1-RT, GL2-RT, and GL3-RT at various magnifications.



EDS Analysis at Indicated Locations, Atom %												
Spectrum	N	Na	Mg	Al	Si	P	S	K	Ca	Ti	Fe	Total
1	18.9	10.1	2.5	13.6	30.3	0.2	2.2	0.6	21.0	-	1.0	100
2	-	8.6	1.4	15.9	38.7	-	2.4	0.8	29.6	1.0	1.6	100
3	-	8.6	7.7	19.6	41.5	-	2.0	1.5	15.2	1.2	2.9	100
4	-	11.3	1.9	21.0	45.5	-	1.9	1.4	14.4	1.0	1.7	100
5	-	10.5	10.6	18.7	36.3	-	2.1	1.0	18.5	0.8	1.6	100

Figure 5.21. EDS analysis of the interstitial matrix formed in grout GL0-RT.

X-Ray Diffraction



X-Ray Absorption Spectroscopy

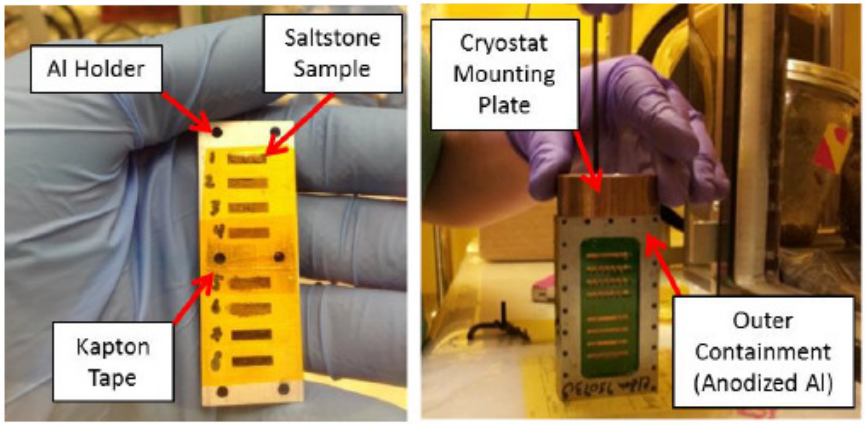
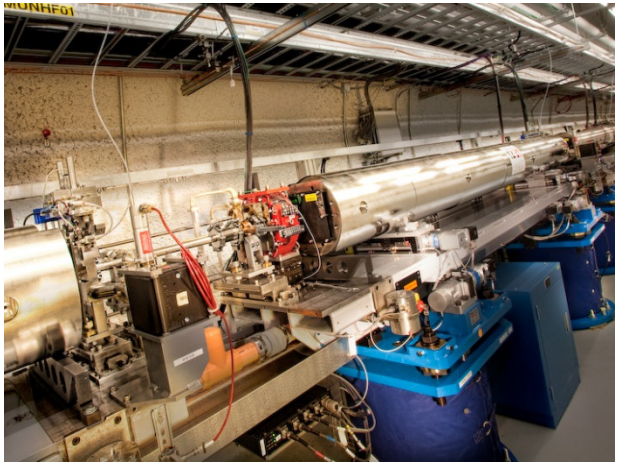
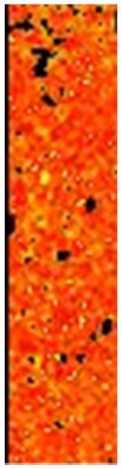
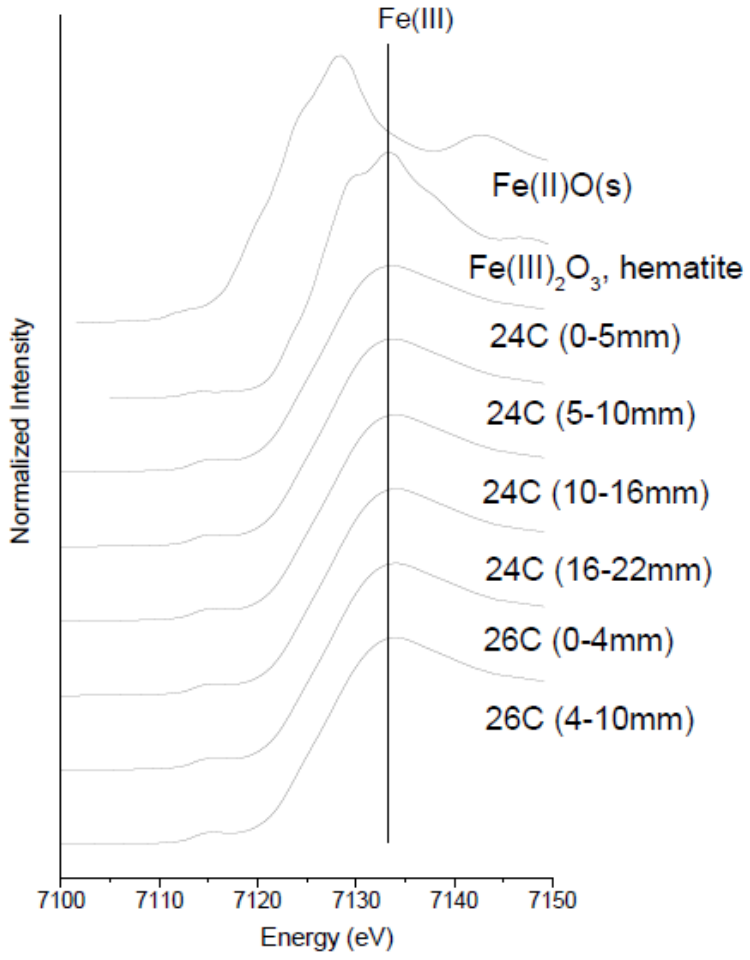


Figure 3: Photograph of Al XAS sample holder (left, sample Tc-SS-I-27E) within the anaerobic chamber and sample contained within secondary housing being mounted onto the cryostat base (right).





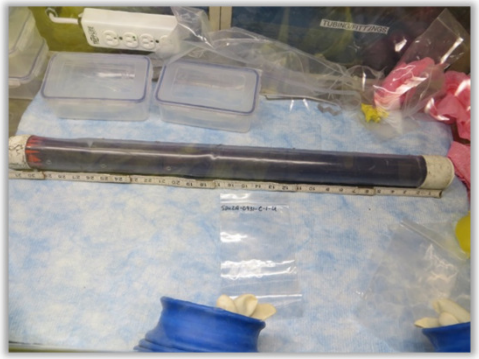


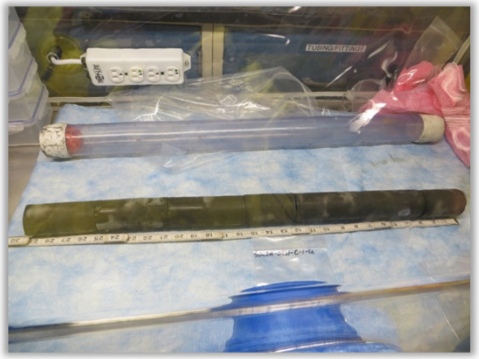
Testing on Molecular Scale

Pros	Cons
Detailed understanding of physical properties.	Looking at small sample section making it difficult to judge applicability to large facility.
	Costs and/or availability of equipment and facilities.
	Cementitious material not homogeneous.
	Specialized analysis.

Testing on Disposal Unit Scale

- Focus on information needed to support laboratory scale testing and predictive modeling.





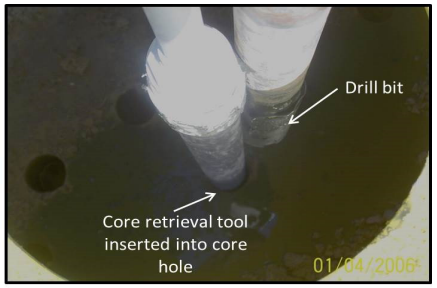
Sample Analysis	Sample Configuration	Required Sample Mass or Dimensions
Saturated Hydraulic Conductivity	Cylindrical sample with little or no observable surface damage	2 inch x 2 inch (Diameter x Height)
Density, Porosity, Moisture Content	Fractured samples – exposure to oxygen will not affect data	≈10 grams
Total Activity (Tc-99, Sr-90, Se-79, I-129, Ra-226)	Fractured samples – exposure to oxygen will not affect data	≈10 grams for each isotope
Distribution Coefficient (K_d) (Tc, Sr, Se, I, Ra)	Sub-sample removed from intact sample interior to ensure minimal oxygen exposure – sub-sample ground for measurement	≈10 grams for all elements – leachate separated for individual element measurements
Tc(VII) / Tc(Total) Ratio	Sub-sample removed from intact sample interior to ensure minimal oxygen exposure – sub-sample ground for measurement	≈10 grams
pH / Eh	Fractured samples ground for measurement	≈10 grams
Toxicity Characteristic Leaching Procedure (TCLP) (reduced sample)	Sub-sample removed from intact sample interior to ensure minimal oxygen exposure – sub-sample crushed for measurement but must be maintained in an anoxic environment for transfer and measurement	≈50 grams
TCLP (oxidized sample)	Fractured samples – sample should be proximately located to reduced TCLP sample – sample should be crushed and exposed to air during transfer and measurement	≈50 grams

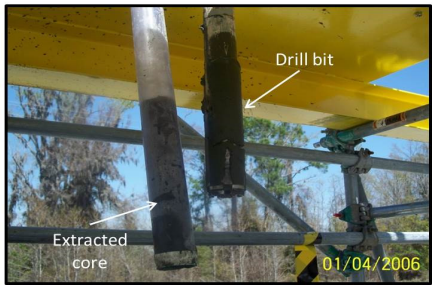
Mock-Ups


B25


Sonotube®


Extension rod


Drill bit
Core retrieval tool inserted into core hole
01/04/2006


Drill bit
Extracted core
01/04/2006


01/04/2006


TOP

Procedures, Training, Personnel

We do the right thing.

Procedures
Developed New Procedure based on Mock up Activities
Conducted tabletop review with entire team prior to imp
hours)

Training
Developed Training Plan and Analysis
Developed OJT / JPM
Conducted Training for target operators and backups
Incorporated support organizations in mockup and training activities

Materials and Equipment
Investigated capabilities of various drill motors and drill bits
Developed and fabricated anaerobic chamber for storage at laboratory
Developed and fabricated core extraction tools
Developed and fabricated anaerobic transportation tubes
Developed grout monolith to mimic SDU 2A grout pours
Qualified new transportation containers for shipment
Fabricated containment huts over SDU 2A Risers
Fabricated shielding plates for drill and camera access

Briefings
Conducted daily pre-job, post job & lessons learned briefings

Cell Access: Containment Huts

We do the right thing.

Main hut: 12'w x 15'l x 12'h

Air lock: 12'w x 5'l x 12'h

Summary of Dose Received

Camera Port	Dose (mrem)
Preparation and Support	822
A	716
B	587
C	589
TOTAL→	**2,714**

Highest Individual Dose

- Core Drill 253 mrem
- Preparation & Support 144 mrem

NOTE: Doses do not include demobilization

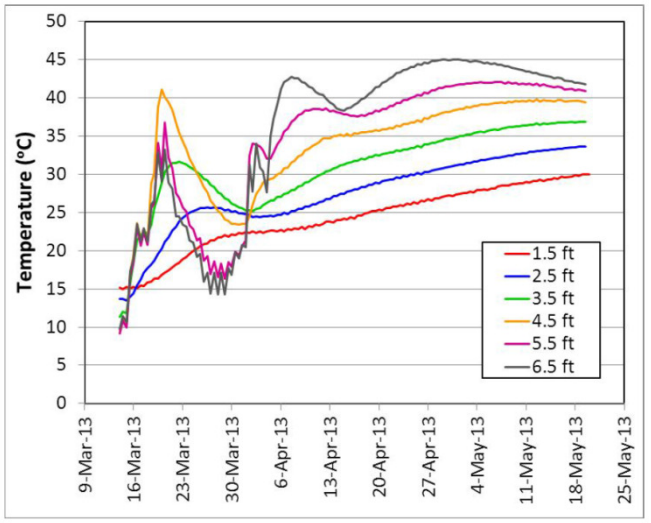
Testing on Disposal Unit Scale

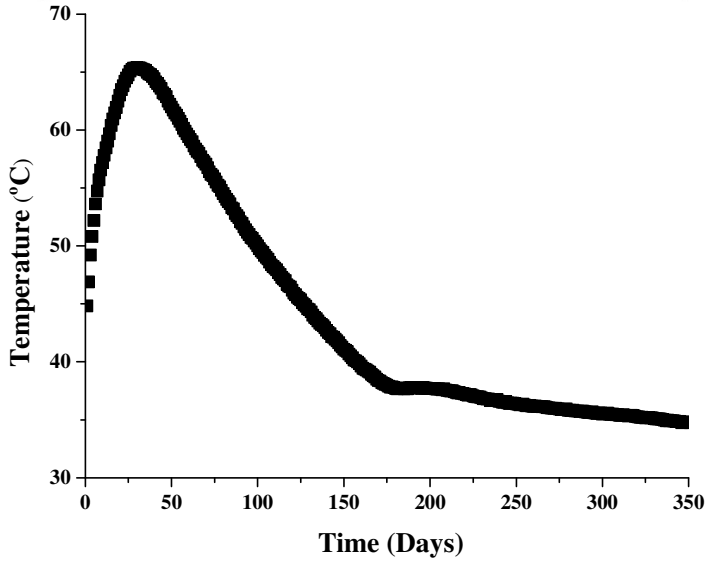
Pros	Cons
Represents actual waste form cured under actual disposal conditions.	Looking at snap shot of material properties in time.
	High cost in terms of dollars, radiological exposure, schedule and human capital.

Testing on Laboratory Scale

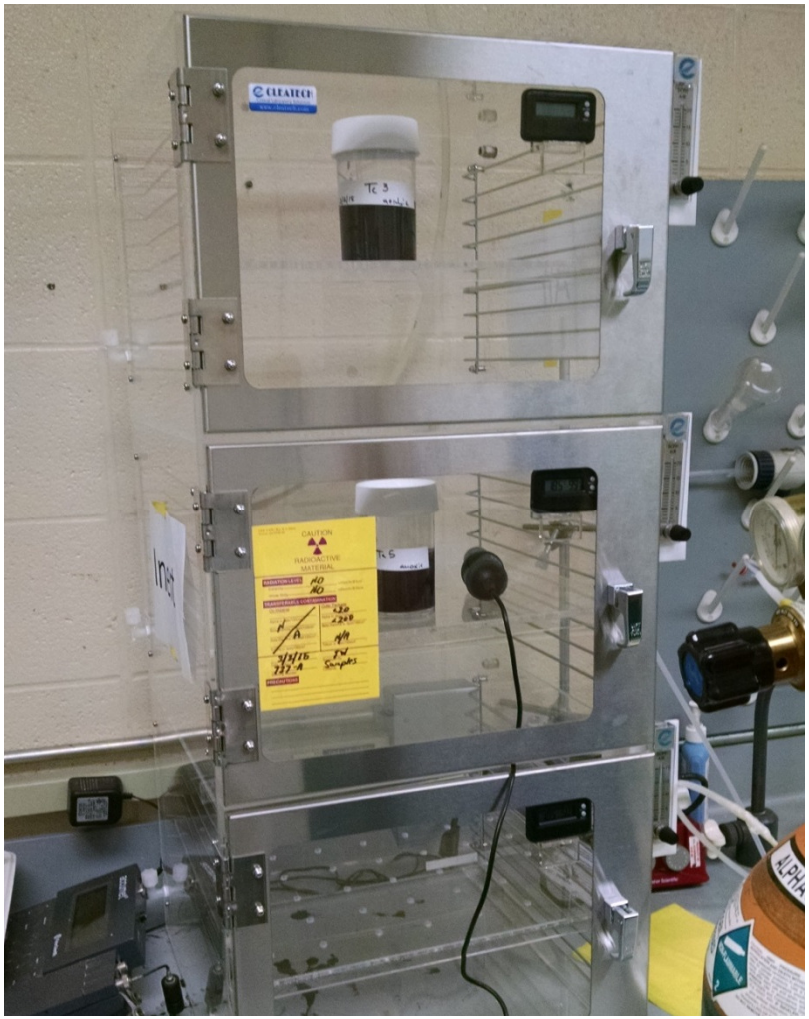
- Lab scale testing has been ongoing for almost 30 years.
- Hydraulic conductivity, distribution coefficients, semi-dynamic leaching, dynamic leaching, physical properties, heat of hydration, chemically-induced degradation are tested at lab scale over a range of conditions
- Predictive modeling used as supported by lab analysis including solubility limits (Geochemist Workbench) and cementitious material degradation (CBP Toolbox).

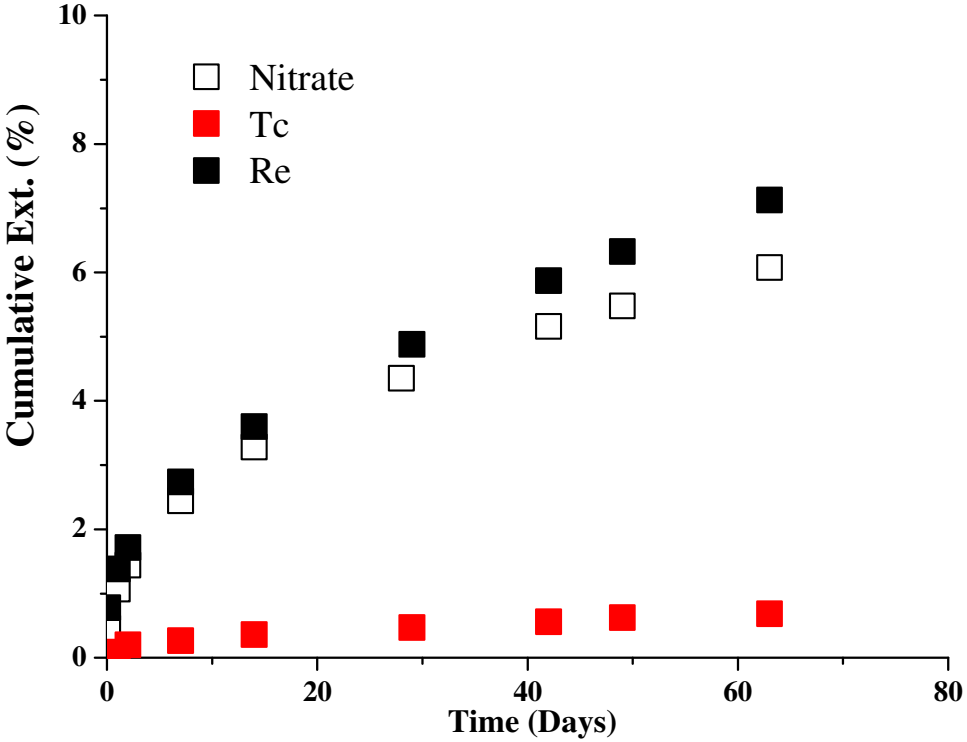
Simulating SDU Environment



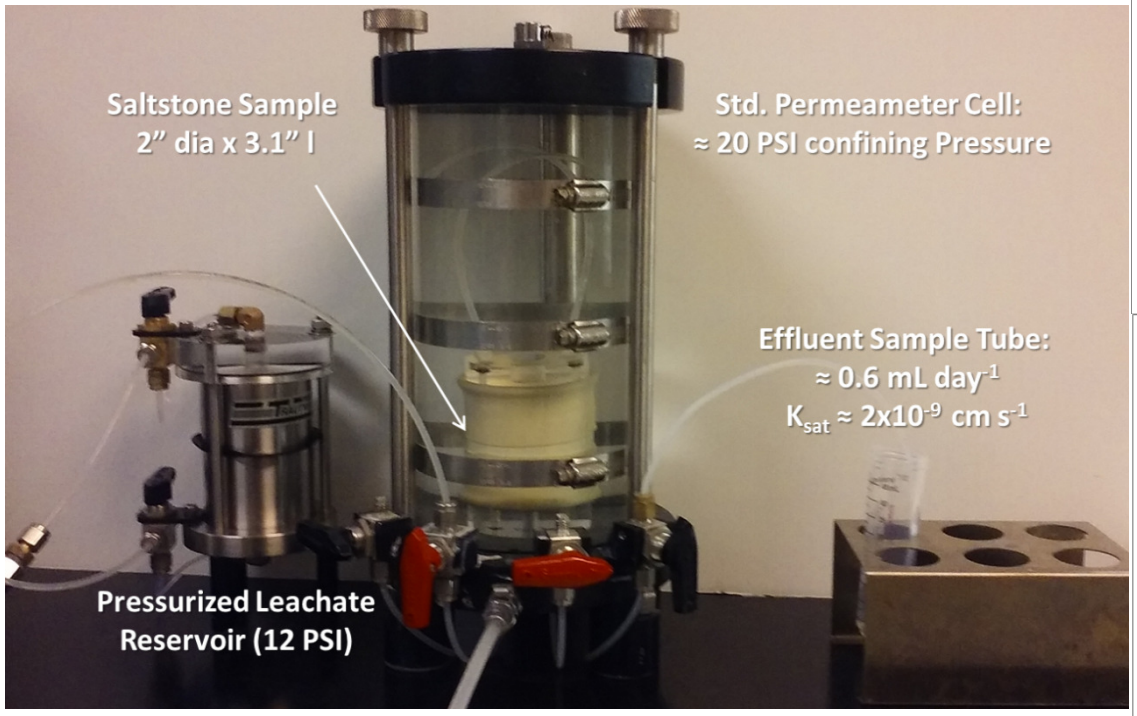


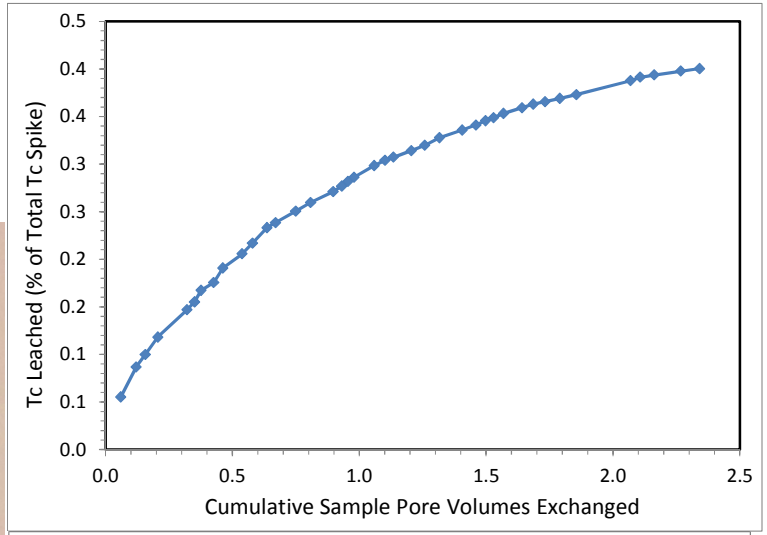
EPA Leaching Studies

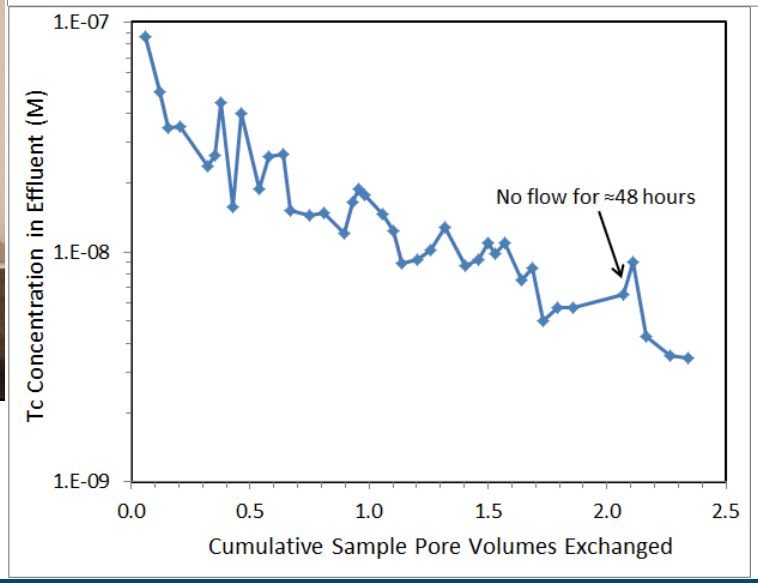




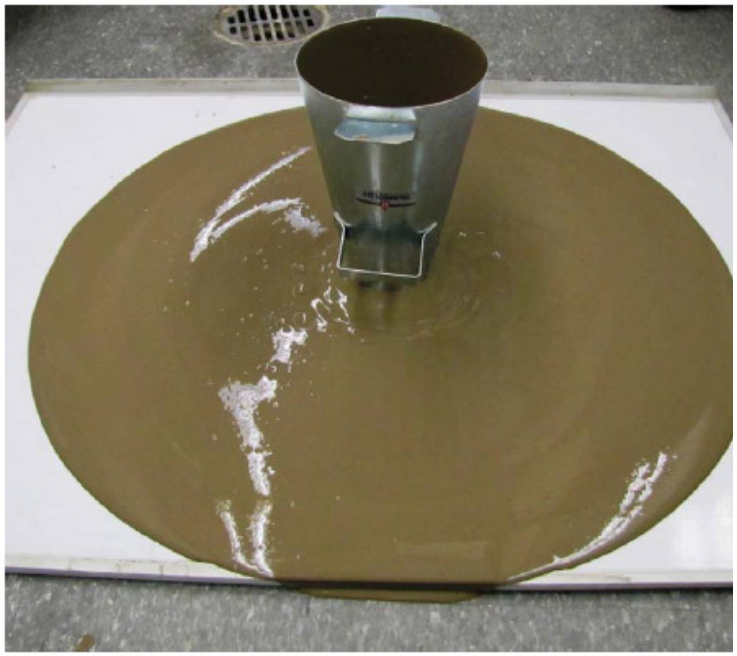
Dynamic Leaching







Fresh Properties



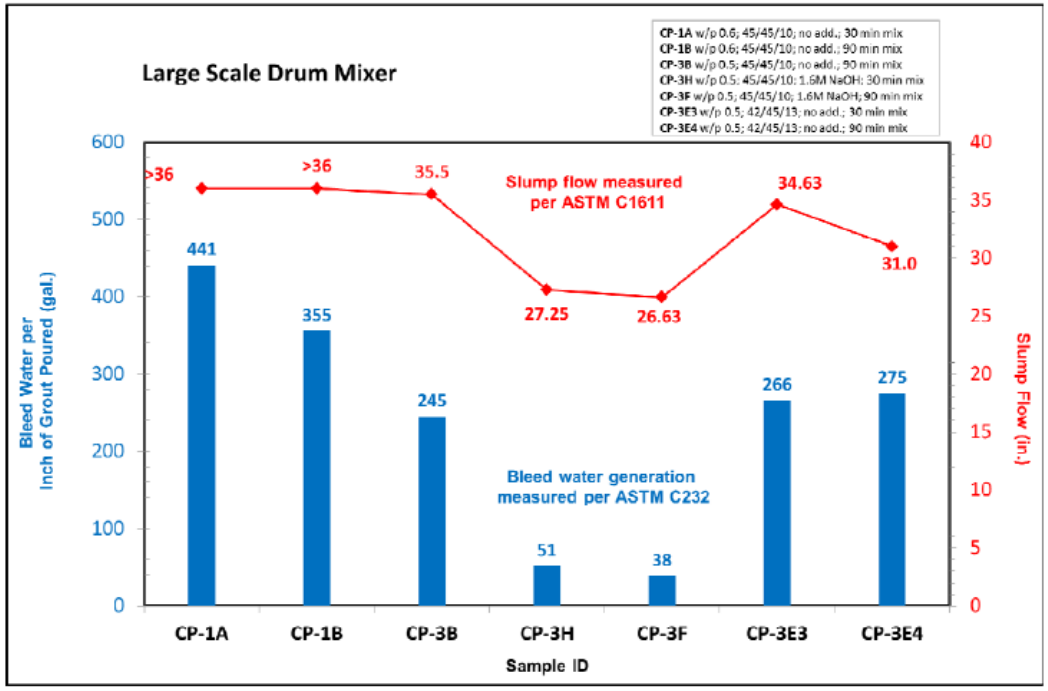


Figure 5.2. Visual comparison of bleed, expressed as volume of bleed water per inch of grout poured in a 100ft x 100ft SDU, and slump flow of grouts prepared in the large-scale testing and mixed using the drum mixer.

Testing on Laboratory Scale

Pros	Cons
Allows testing over wide range of conditions.	Need support by other testing scales to provide laboratory scale validity.
Relatively inexpensive compared to other testing scales.	Smaller scale sample processing may not mimic field processing (different mixer type, transfer, drop into tank, etc.)

Testing on Laboratory Scale

- Smaller scale processing – in SPF saltstone is mixed in a high shear mixer for a few minutes and then pumped down a transfer line and dropped in an SDU; in the lab the mixing technique is often different and the grout is not subjected to line transfer and drop.

Lab-Scale Plus

- Mimic "true" processing to extent feasible.

Scaled Continuous Processing Facility (SCPF) at SRNL

Approx. 720 gal. simulant saltstone processed using SRNL scaled grout mixer & hopper equipment.

Conclusions

- A comprehensive testing program should include facets at various scales to provide the level of model support necessary to reduce performance assessment uncertainty.

- Pros and cons of testing scales should be examined with anticipation of bulk of testing on the laboratory scale / predictive modeling.