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Federally Funded Research and Development Center (FFRDC) Team Overview and Approach

Bill Bates
Dep. Associate Laboratory Director,
Environmental and Legacy Mgt., SRNL
FFRDC Team Leader

Dr. Paul Dixon
Deputy Director,
Civilian Nuclear Program Office, LANL
FFRDC Senior Technical Advisor

Dr. David Tate
Senior Defense Analyst, IDA
FFRDC Decision Framework & Analysis Lead

SRNL-L3000-2021-00012

2021 NDAA-3125 Public Meeting #1

July 15, 2021

The information in this briefing represents the professional opinions of the FFRDC team, provided for review by the National Academies.

U.S. DEPARTMENT OF ENERGY

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Sec. 3125. Continued Analysis of Approaches for Supplemental Treatment of Low-Activity Waste at Hanford Nuclear Reservation

a) *IN GENERAL.—Not later than 60 days after the date of the enactment of this Act, the Secretary of Energy shall—*

   1) *enter into an arrangement with a federally funded re- search and development center to conduct a follow-on analysis to the analysis required by section 3134 of the National Defense Authorization Act for Fiscal Year 2017 (Public Law 114–328; 130 Stat. 2769) with respect to approaches for treating the portion of low-activity waste at the Hanford Nuclear Reservation, Richland, Washington, intended for supplemental treatment; and*

   2) *enter into an arrangement with the National Academies of Sciences, Engineering, and Medicine to review the follow-on analysis conducted under paragraph (1).*

b) *COMPARISON OF ALTERNATIVES TO AID DECISIONMAKING.— The analysis required by subsection (a)(1) shall be designed, to the greatest extent possible, to provide decisionmakers with the ability to make a direct comparison between approaches for the supplemental treatment of low-activity waste at the Hanford Nuclear Reservation based on criteria that are relevant to decisionmaking and most clearly differentiate between approaches.*

Sec. 3125. Continued Analysis of Approaches for Supplemental Treatment of Low-Activity Waste at Hanford Nuclear Reservation

c) *ELEMENTS. —The analysis required by subsection (a)(1) shall clearly lay out a framework of decisions to be made among the treatment technologies, waste forms, and disposal locations by including an assessment of the following:*

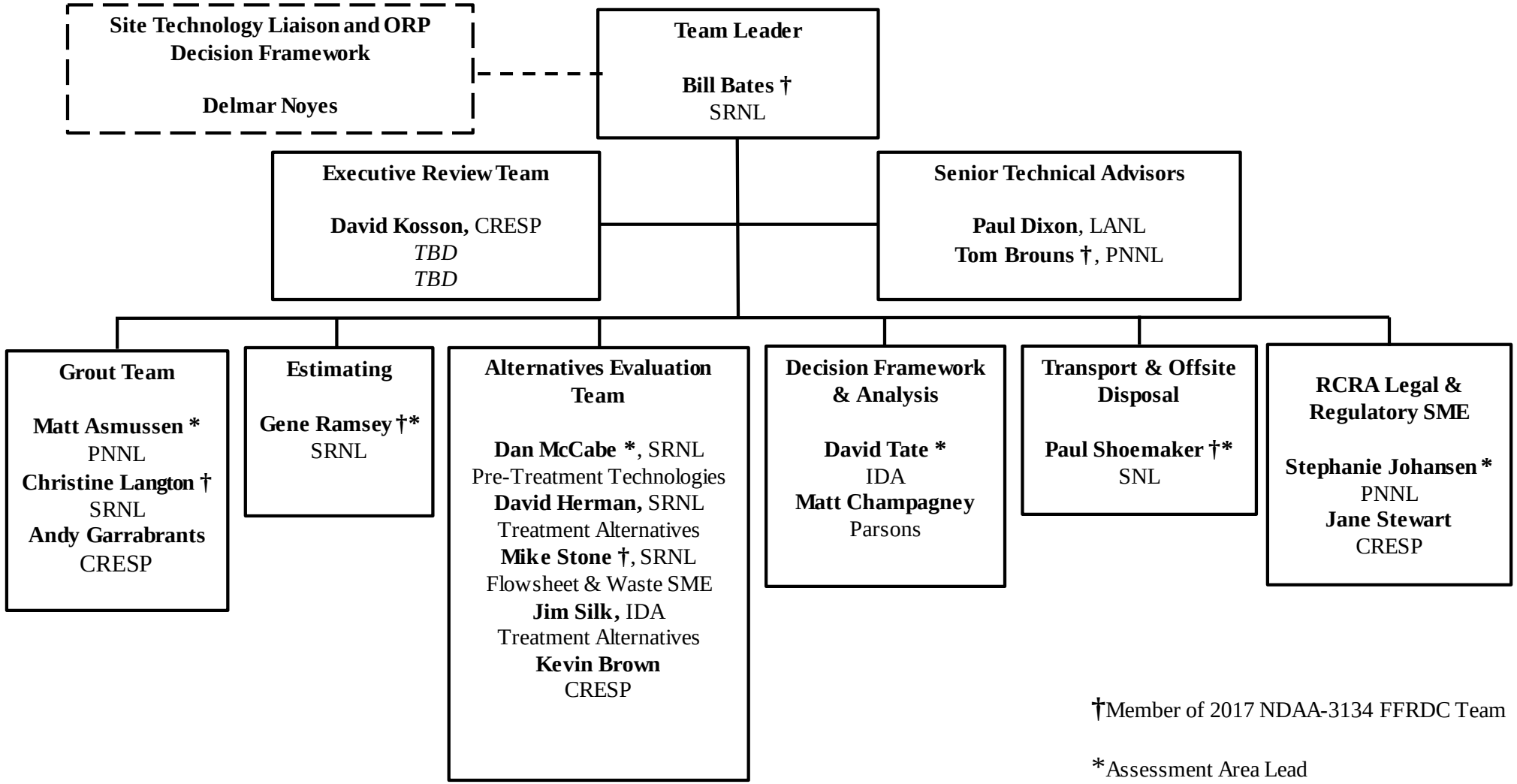
1) *The most effective potential technology for supplemental treatment of low-activity waste that will produce an effective waste form, including an assessment of the following:*
   - A. *The maturity and complexity of the technology.*
   - B. *The extent of previous use of the technology.*
   - C. *The life cycle costs and duration of use of the technology.*
   - D. *The effectiveness of the technology with respect to immobilization.*
   - E. *The performance of the technology expected under permanent disposal.*
   - F. *The topical areas of additional study required for the grout option identified in the analysis required by section 3134 of the National Defense Authorization Act for Fiscal Year 2017.*
2) *The differences among approaches for the supplemental treatment of low-activity waste considered as of the date of the analysis required by subsection (a)(1).*
3) *The compliance of such approaches with the technical standards described in section 3134(b)(2)(D) of the National Defense Authorization Act for Fiscal Year 2017.*
4) *The differences among potential disposal sites for the waste form produced through such treatment, including mitigation of radionuclides, including technetium-99, selenium-79, and iodine-129, on a system level.*

Sec. 3125. Continued Analysis of Approaches for Supplemental Treatment of Low-Activity Waste at Hanford Nuclear Reservation

5) Potential modifications to the design of facilities to enhance performance with respect to disposal of the waste form to account for the following:
   A. Regulatory compliance.
   B. Public acceptance.
   C. Cost.
   D. Safety.
   E. The expected radiation dose to maximally exposed individuals over time.
   F. Differences among disposal environments
6) Approximately how much and what type of pretreatment is needed to meet regulatory requirements regarding long-lived radionuclides and hazardous chemicals to reduce disposal costs for radionuclides described in paragraph (4).
7) Whether the radionuclides can be left in the waste form or economically removed and bounded at a system level by the performance assessment of a potential disposal site and, if the radionuclides cannot be left in the waste form, how to account for the secondary waste stream.
8) Other relevant factors relating to the technology de- scribed in paragraph (1), including the following:
   A. The costs and risks in delays with respect to tank performance over time.
   B. Consideration of experience with treatment methods at other sites and commercial facilities.
   C. Outcomes of the test bed initiative of the Office of Environmental Management at the Hanford Nuclear Reservation.

d) *REVIEW, CONSULTATION, SUBMISSION, AND LIMITATIONS. — The provisions of subsections (c) through (f) of section 3134 of the National Defense Authorization Act for Fiscal Year 2017 shall apply with respect to the analysis required by subsection (a)(1) to the same extent and in the same manner that such provisions applied with respect to the analysis required by subsection (a) of such section 3134, except that subsection (e) of such section shall be applied and administered by substituting ‘‘the date of the enactment of the William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021” for “the date of the enactment of this Act” each place it appears.*

FFRDC Team Structure

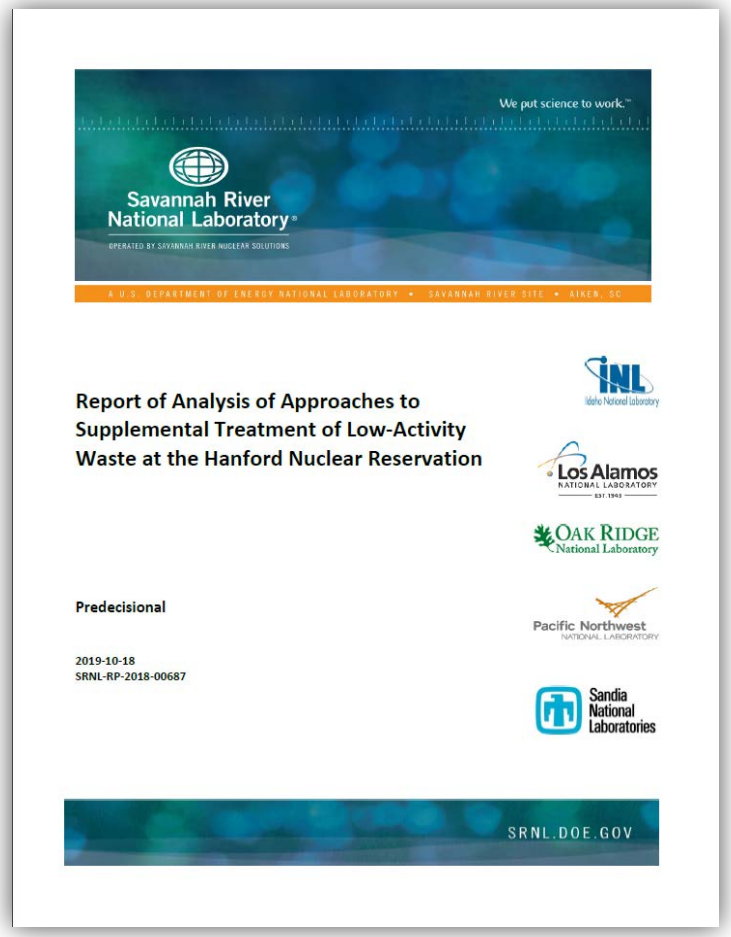


†Member of 2017 NDAA-3134 FFRDC Team

*Assessment Area Lead

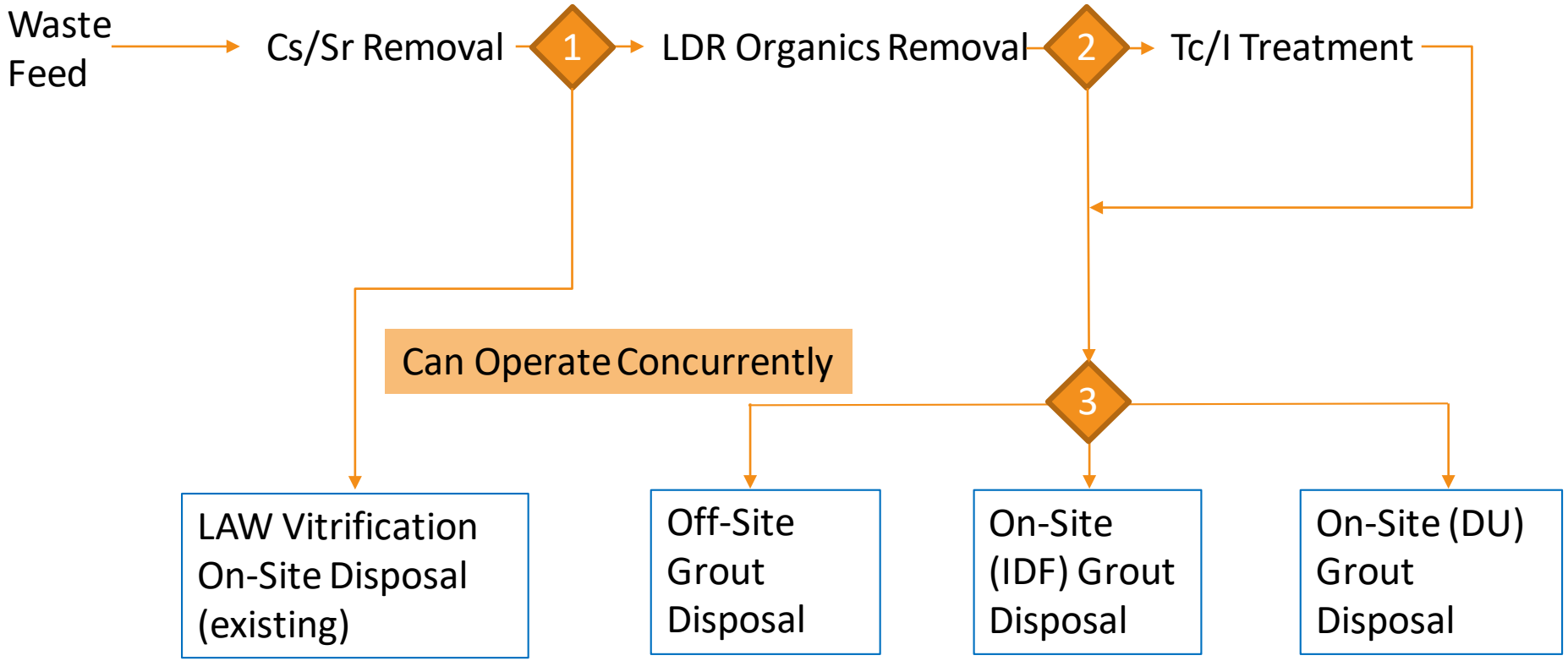
FFRDC Team Approach

- Review Relevant Research and Developments since 2019
  - Evaporation Treatment of Organics
  - Crystalline Silicotitanate (CST) Capture of Sr-90
  - Etc.
- Address Final 2020 NAS Report (2017 NDAA-3134)
- Develop Assumptions and Alternatives
  - Focus on Grout Alternative Development
    - *"Assess…Topical Areas of Additional Study Required for the Grout Option…"*
  - Utilize NDAA-3134 Vitrification and Steam Reforming Alternatives
    - *Based on DFLAW and INL Experience*
- Develop Decision Framework
  - Include Decision Elements from NDAA-3125
  - Incorporate GAO Best Practices
  - Adapt DOE Analysis of Alternatives Guidance
  - Present for Ease of Comparison of Alternatives



https://www.nationalacademies.org/event/10-31-2019/supplemental-treatment-of-low-activity-waste-at-the-hanford-nuclear-reservation (PDF can be found in the "Meeting Materials" section as the third link listed.)

Simplified Notional Supplemental LAW Treatment and Disposal Decision Tool



DU – (monolith) disposal unit
Cs/Sr – cesium/strontium
IDF – Integrated disposal facility
LAW – low activity waste
Tc/I – technetium / iodine
LDR – Land Disposal Restricted

1. LDR organics removal treatment decision
2. Tc/I treatment decision based on disposal facility waste acceptance criteria
3. Disposal location & configuration decision

Tank Farm or ***Tank-by-Tank*** or ***Consolidated Waste Feed*** basis

Hanford Tank and Tank Farm Geographical Considerations

Initial Observations, Considerations, and Assumptions

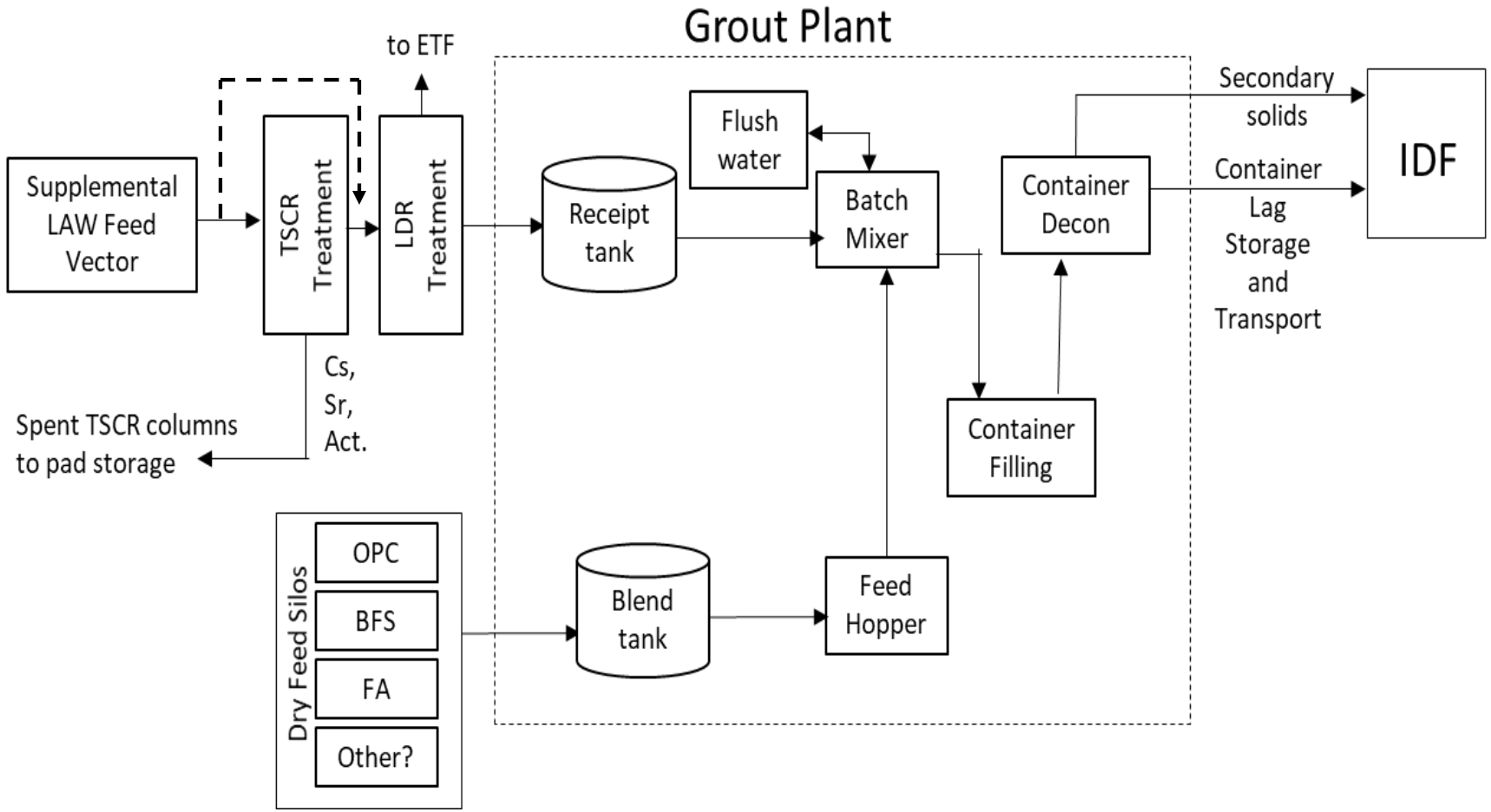
- More Waste Stream Feed Considerations than Assumed in 2019 Report
  - By Tanks and Tank Farms
  - Capability to Match Small Scale System/Technology with Waste Chemistry
- Not Necessarily a Single Approach – Hybrid Approaches Will Be Considered
- Alternatives Must not Impact DFLAW Schedule
- Must be Compatible with HLW Processing
- Alternatives are not Reliant on the WTP Pretreatment Facility
  - Tank-Side-Cesium-Removal (TSCR) Use is Assumed
    - *Cs/Sr removal required to the max extent technically & economically practical under the DOE M 435.1-1 waste incidental to reprocessing process.*
    - *TSCR Likely to Result in Class A Waste for Most Feed Material*
    - *DOE's HLW interpretation under DOE M 435.1-1 does not require removal of key radionuclides if the waste already meets packaging, transportation, and disposal facility WAC requirements. The NDAA 2021 currently prohibits use of the HLW interpretation at Hanford.*
- Land Disposal Restricted Organics Must be Addressed for Waste that Exceed LDR Standards
- Remote B & T Areas *may* Require Transfer Facilities
- Grout Formulations can be Tailored to Process Needs
  - Tc/I removal may not be required for off-site disposal [2019 Report Conclusion]

Some of These May Become Evaluation Criteria, Ground Rules, etc.

Preliminary Grout Alternatives

1. Single Grout Plant for Supplemental LAW – Onsite Disposal
   - 2019 FFRDC Report Alternative
   - Tank Side Cs Removal (TSCR) – Cs, Sr, and Some Other Constituent Removal
   - LDR Organic Pretreatment (Possibly Evaporator)
   - Disposal of Primary Waste in Grout Containers – Onsite IDF
   - Disposal of Secondary Waste (Hardware) in Grout Containers– Onsite IDF
   - Use Double-Shell Tanks (DST) for Transfers/Staging

Preliminary Simplified Alternative 1 Flowsheet



Will include transfer, storage, pretreatment, processing and disposition facilities and projects

Intent to Add General Mass Balance Assumptions

Preliminary Grout Alternatives (cont.)

2. Single Grout Plant for Supplemental LAW – Offsite Disposal

- 2019 FFRDC Report Alternative
- LDR Organic Pretreatment (Possibly Evaporator)
- Primary Waste Disposal in Grout Containers at Waste Control Specialists (WCS) in Texas or Clive, Utah
- Disposal of Secondary Waste (Hardware) in Grout Containers– Onsite IDF

3. Separate Grout Plants for East and West Areas

- May be Modular and Mobile to Reduce D&D Waste
- Analogous to LERF/ETF Commercial Modular Grout System
- TSCR for Cs Removal - Cs, Sr, and Some Other Constituent Removal
- LDR Organic Pretreatment (Possibly Evaporator)
- Primary Waste Disposal in Grout Containers – Onsite or Offsite (3A/3B)
- Disposal of Secondary Waste (Hardware) in Grout Containers– Onsite IDF
- Use Double-Shell Tanks (DST) for Transfers/Staging

Preliminary Grout Alternatives (cont.)

4. Individual Grout Plants for Groups of Tanks ("Tank to Tank")
   - Mobile or Duplicate Small-Batch TSCR-Grout Plants
   - Additional Small Tank for Supernate Management (possibly DSTs)
   - Analogous to LERF/ETF Commercial Modular Grout System
   - LDR Organic Pretreatment (Possibly Evaporator)
   - Primary Waste Disposal in Grout Containers – Onsite or Offsite (4A/4B)
   - Disposal of Secondary Waste (Hardware) in Grout Containers– Onsite IDF

5. Offsite Contractor Grout Processing
   - Transfers Liquid LAW Offsite
   - Primary Waste Disposal in Grout Containers – Onsite or Offsite (5A/5B)
   - Likely Only for Some LAW

Other Preliminary Considerations – Possible Variant Alternatives

- Monolith Grout Vault – Similar to Salt Disposal Units at SRS
  - May have Engineered Liner Designs
- Waste Form Tailored to Disposal Siting
  - Tc/I Getters for Radionuclide Retention
  - Pumpable Grout for Large Vaults
- Various LDR Organic Treatment Options Being Evaluated
  - Evaporation
  - Hydrolysis
  - Low Temperature Oxidation
  - Sampling and Selectively Routing Some SLAW to Vitrification
- Could Apply to Most of the Alternatives Discussed

Salt Disposal Units at Savannah River Site

Preliminary Report Outline

Executive Summary

Acronyms

Section 1: Background and Motivation

- 1.1 Mission Need
- 1.2 2019 Study and Report (Appendix will Address Final 2017 NDAA-3134 NAS Report Findings/Recommendations)
- 1.3 What Has Changed Since Then

Section 2: Scope

- 2.1 §3125 Tasking
  - *2.1.1 FFRDC Study Methodology*
  - *2.1.2 Data Sources*
- 2.2 Deliverables

Section 3: Ground Rules and Assumptions

- 3.1 Ground Rules
- 3.2 Assumptions
- 3.3 Constraints

Preliminary Report Outline (cont.)

Section 4: Alternatives Identified and Described

- 4.1 Description of Primary Alternative Decision Variables
  - *4.1.1 Pretreatment*
  - *4.1.2 Immobilization Technology*
  - *4.1.3 Disposition Location*
- 4.2 Secondary Decision Variables
- 4.3 Complete List of Combinations Considered
  - *4.3.1 Alternatives Included in 2019 FFRDC Report*
  - *4.3.2 New Alternatives*
- 4.4 Overview of Alternative Advantages, Disadvantages, And Risks

Section 5: Initial Screening of Alternatives

- 5.1 Screening Criteria
- 5.2 Application of Screening Criteria to Alternatives
  - *5.2.1 Alternative 1 – [Name]*
  - *5.2.N Alternative N – [Name]*
- 5.3 Final List of Alternatives and Variants Analyzed

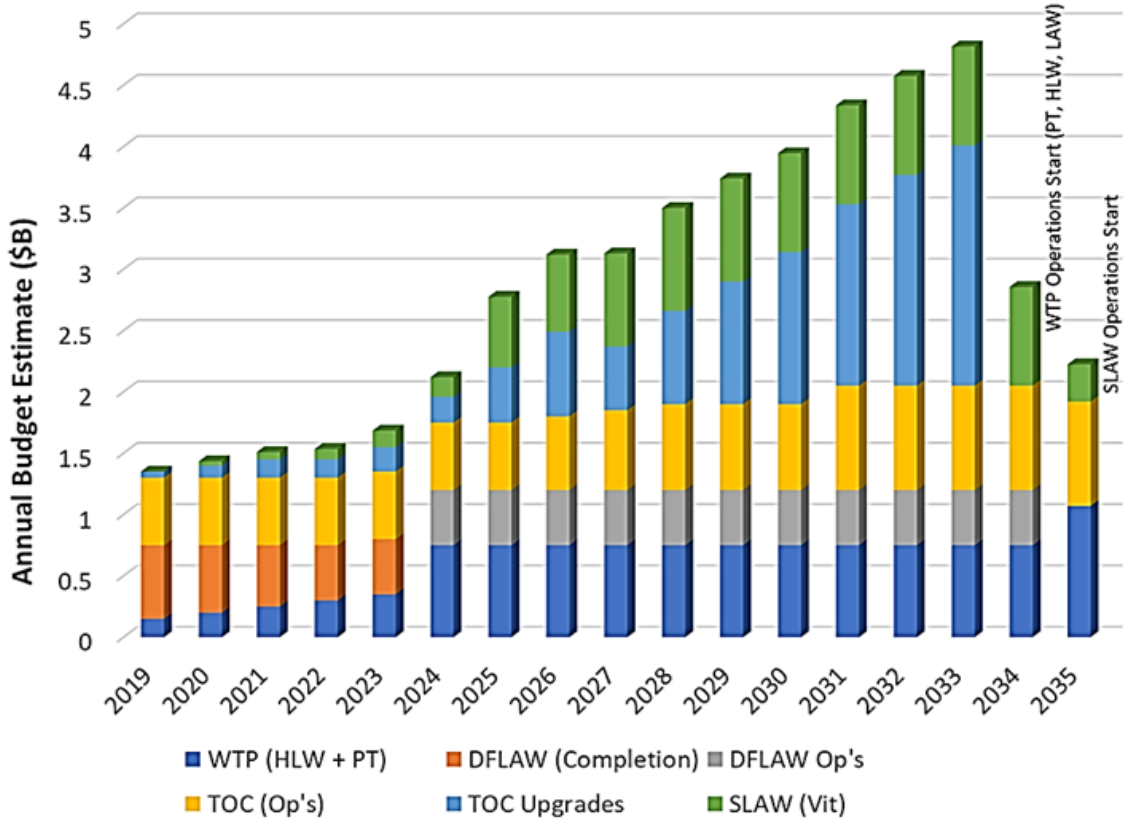
Preliminary Report Outline (cont.)

Section 6: Evaluation Criteria

Section Under Development and will cross-walk to NDAA

Section 7: Cost and Schedule Estimates

- 7.1 General Assumptions
- 7.2 Bases of Estimates
- 7.3 Capital Costs
- 7.4 Operations Costs
- 7.5 Schedule Estimates
- 7.6 Life Cycle Cost Estimates



Preliminary Report Outline (cont.)

Section 8: Alternative Evaluation

- 8.1 Decision Framework Overview
- 8.2 Treatment of Uncertainty
- 8.3 Breakout of Risks by Selection Criterion
- 8.4 Evaluation of Alternatives Against Selection Criteria
  - *8.4.1 Alternative 1*
  - *8.4.2 Alternative 2*
  - *8.4.K Alternative K*
- 8.5 Secondary Screening of Alternatives
- 8.6 Sensitivity Analysis

Section 9: Findings

- 9.1 Value Tradeoffs Among Alternatives
- 9.2 Important Sensitivities
- 9.3 Primary Risks

Section 10: Recommendations

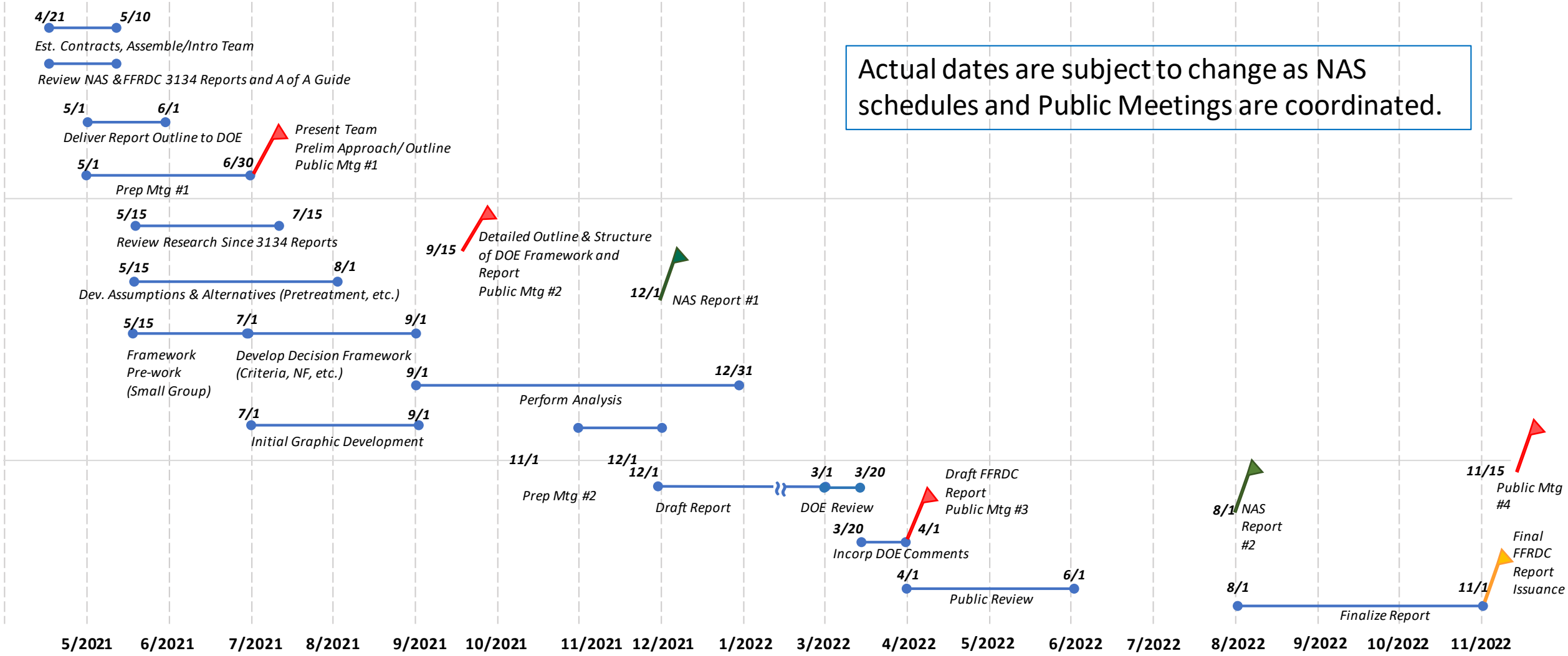
- 10.1 Comparison Methodology
- 10.2 Application of Methodology to Remaining Alternatives
- 10.3 Recommendation(s)

Preliminary Report Outline (cont.)

Appendices:

- References
- Approach to Recommendations and Findings from Final NAS Report (NDAA-3134)
- Decision Framework Details
- FFRDC Team Structure
- FFRDC Team Program Plan
- 2021 NDAA Section 3125
- Team Members and Subject Matter Experts
- Alignment of Report with GAO Best Practices
- [TBD]

FFRDC Preliminary Team Schedule



Actual dates are subject to change as NAS schedules and Public Meetings are coordinated.

Back up Slides

FFRDC 2017-NDAA-3134 Report—Comparison Table

NDAA CRITERIA	VITRIFICATION CASE: DISPOSAL ONSITE AT HANFORD	GROUTING CASE 1: DISPOSAL ONSITE AT HANFORD	GROUTING CASE 2: DISPOSAL OUT OF STATE AT WASTE CONTROL SPECIALISTS (WCS)	STEAM REFORMING CASE 1: SOLID MONOLITH PRODUCT DISPOSAL ONSITE AT HANFORD	STEAM REFORMING CASE 2: GRANULAR PRODUCT DISPOSAL OUT OF STATE AT WCS
RISKS/ OBSTACLES	• Difficult to build and operate because highly complex process	• Requires pretreatment of organics • Requires wasteform validation	• Requires pretreatment of organics	• Requires most technology maturation • Requires wasteform validation	• Requires most technology maturation
BENEFITS	• Similar to technology being built for first LAW	• Low integrated complexity • No liquid secondary waste	• Low integrated complexity • No liquid secondary waste	• No liquid secondary waste	• No liquid secondary waste
COST	~$20B to ~36B	~$2B to ~$3B	~$5B to ~$8B	~$6B to ~$12B	~$9B to ~$17B
YEARS NEEDED BEFORE STARTUP	10-15 years	8-13 years	8-13 years	10-15 years	10-15 years
REGULATORY COMPLIANCE	• Primary waste is compliant • Secondary waste may require Iodine mitigation	• Likely meets requirements after organics pretreatment • May require iodine mitigation	• Compliant following organics pretreatment	• Likely meets technical requirements	• Compliant

FFRDC 2017-NDAA-3134 Report—Key Areas for Further Grout Technical Analysis

- Treatment of Organics Restricted from Land Disposal (Onsite and Offsite Grout Cases)
- Treatment of Technetium and Iodine (Onsite Grout Case)
- Performance of Grouted Waste Forms (Onsite Grout Case)