Environmental Management Advisory Board

EM Tank Waste Subcommittee Report for SRS / Hanford Tank Waste Review

Report Number TWS #003
EMAB EM-TWS SRS / Hanford Tank Waste

June 23, 2011

We, the undersigned, have participated in the generation and review of the following Environmental Management Advisory Board Tank Waste Subcommittee Report and agree with the findings and recommendations therein.

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PREFACE

This is the second report of the Environmental Management Tank Waste Subcommittee (EM-TWS) of the Environmental Management Advisory Board (EMAB). The first report was submitted and accepted by the Assistant Secretary for Environmental Management (EM-1) in September 2010. The EM-TWS responded to three charges from EM-1 regarding the Waste Treatment and Immobilization Plant at Hanford (WTP) under construction in Richland, Washington. EM's responses were timely, and efforts have been put in place to address the recommendations that EMAB made.

This report addresses eight charges given to the EM-TWS earlier this fiscal year. The current version of this report addresses fully the first seven charges, and it is anticipated that the eighth charge will be fully addressed by the close of the fiscal year.

The EM-TWS extends its compliments and thanks to EM-1 and Headquarters staff and field offices at the Savannah River Site and the Office of River Protection at the Hanford Site for their willingness to support the Subcommittee's efforts as well as to provide timely responses to data requests made of them. We particularly want to thank the support staff in EM's Office of Public and Intergovernmental Accountability.

Dennis Ferrigno and Larry Papay, Co-Chairs, EM-TWS

June 23, 2011

CHAPTER ONE
Introduction and Summary of Recommendations

1.1 Background

In May 2010, the Department of Energy (DOE) established the Environmental Management Tank Waste Subcommittee (EM-TWS). The EM-TWS was established under the Environmental Management Advisory Board (EMAB), whose charter is in accordance with the provisions of the Federal Advisory Committee Act (FACA). The membership of the EM-TWS is given in Appendix 1.

The duties of the Subcommittee are solely advisory in nature. It reports to EMAB, which, in turn, is appointed by the Secretary of Energy to provide advice to the Assistant Secretary for Environmental Management (EM-1) on matters concerning the EM program. EMAB serves at the pleasure of the Secretary and EM-1In accordance with the requirements of EMAB and the Federal Advisory Committee Act, the Subcommittee may not work independently of EMAB and must report its recommendations and advice to the full Committee for full deliberation and discussion prior to any release of subject matter information.

The EM-TWS's initial assignment in May 2010 was to review the status of the Hanford Waste Treatment Plant (WTP) in terms of three specific charges. The results of the effort culminated in an EMAB-approved report[1] presented to and accepted by EM-1 in September 2010.

Subsequently, in November 2010, the EM-TWS was asked to respond to six additional charges summarized in 1.2 below (and detailed in Appendix 2), dealing with Life Cycle Cost Analysis and certain technology aspects of the DOE-EM tank waste management program at the Hanford and Savannah River sites. The tank waste program accounts for nearly 36 percent of the total forecasted EM cleanup cost and is the major contributor to EM's cleanup liability. EM estimates that retrieval and processing of waste contained within these tanks will be completed between the years 2050 and 2062. A number of strategies are being considered to accelerate these completion dates at both Hanford and Savannah River sites by applying operational lessons learned as well as incorporating advanced and innovative technologies. Several of the charges given to the EM-TWS explore the basis and potential for application of lessons learned and deploying advanced technologies.

After beginning its work for this fiscal year, the EM-TWS was asked in January 2011 to take on two additional tasks:

- Charge 7 responds to a request by EM-1 for an independent review of an Office of River Protection (ORP) management and operations plan to enhance the construction completion, commissioning, and early stage operations of the Hanford Waste Treatment Plant (WTP). This is contained in the Vision 2020 Plan prepared by ORP.

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[1] EMAB EM-TWS WTP-001, *EM Tank Waste Subcommittee Report for Waste Treatment Plant*, September 30, 2010.

- Charge 8 was requested by the DOE Office of the Chief Financial Officer (OCFO). This Life Cycle Cost Assessment for Various Hanford Tank Retrieval Options concerns the issues identified in a recent Government Accountability Office (GAO) report regarding the tank waste management program.

1.2 Charges

In support of these objectives, the EM-TWS has been tasked by EMAB to gather data and evaluate the eight charges described below (See Appendix 1 for the full charge document.) The EM-TWS has visited the Savannah River Site (SRS) and the Hanford Site (Hanford) to discuss these charges with DOE site and Headquarters personnel, to hold public meetings with stakeholders, and to meet in closed session as a Subcommittee. (See Appendix 3 for schedules and agendas). The EM-TWS also requested documents from each site to carry out its fact-finding investigations (See Appendix 4 for data calls). The composition of the subcommittee and its support staff for the current fiscal year is given in Appendix 2.

Charge 1 – Modeling for Life Cycle Analysis: This task entailed reviewing the modeling approaches and bases for determining tank waste remediation life cycle costs at both SRS and Hanford. This included evaluating assumptions in system plans for completing tank waste missions at Hanford and SRS, as well as the rigor of the models for identifying activities and costs through the end of each site's waste management program.

Charge 2 – Assess Candidate Low-Activity Waste Forms: At Hanford, the current WTP baseline is being designed, constructed, and commissioned to treat, via vitrification, all of the high-level tank waste and up to 50 percent of the low-activity tank waste, plus secondary waste streams. The Subcommittee was requested to evaluate potential candidate waste forms including vitrified glass, mineralized solids (such as that produced by fluidized bed steam reforming (FBSR)), and grout, as to their suitability for completing the Hanford tank waste mission. This assessment used information from data calls regarding: 1) waste loading in low-activity vitrified glass; 2) Tc-99 and I-129 capture in glass; and 3) whether tank waste samples from FBSR testing demonstrate the ability to meet required waste form performance.

Charge 3 – Assess At-Tank or In-Tank Candidate Technologies for Augmenting Planned Waste Pretreatment Capabilities: This includes use of technologies currently being considered to perform some at- or in-tank pretreatment activities at both Hanford and SRS, such as rotary microfiltration for solids separation and use of small-column ion exchangers for removal of cesium. At Hanford, these methods have been proposed as a supplement to other processing methods being incorporated within WTP.

Charge 4 – Evaluate Various Melter Technologies: Over the last 15 to 20 years, the EM program has considered various melter technologies and operational strategies to increase the efficiency of tank waste vitrification processes. This task entailed a review of the different approaches and technologies that would be considered for use as second-generation (at Hanford), or third/fourth-generation (at SRS) replacement melters. Examples of such technologies included cold crucible melters and advanced Joule-heated, ceramic lined melters. The

Subcommittee considered the merits of different glass formulations, both advanced borosilicate and other glass types; e.g., iron phosphate, as they apply to these advanced melter technologies.

Charge 5 – Evaluate the Reliability of Waste Delivery Plans: A key component of the tank waste programs at Hanford and SRS is the ability to reliably provide feed materials to existing and planned waste treatment facilities. At SRS, this has been demonstrated, but further reduction of life cycle costs will require enhancements to current waste retrieval and delivery processes. For Hanford, this would require an evaluation of proposed plans to finalize waste acceptance criteria (WAC) for treatment facilities, optimally sequencing tank waste delivery to meet the WAC, and identifying specific vulnerabilities to achieving waste delivery. The Hanford baseline waste feed delivery approach consists of two major phases of operation: 1) single-shell tank (SST) waste retrieval into the double-shell tank (DST) system for waste staging prior to treatment, and 2) mixing and delivery of DST waste to the treatment facilities.

Charge 6 – Identify Other Tank Waste Vulnerabilities at SRS and Hanford: During the course of performing the tasks above, the EM-TWS identified other vulnerabilities not specifically encompassed by those tasks and proposed recommendations to mitigate those vulnerabilities.

Charge 7 – 2020 Vision, Early Start-up of One (1) LAW Melter: The EM Construction Project Review Management Subcommittee (convened in November 2010 to review the WTP Project) strongly endorsed a proposed phased commissioning approach and consequential opportunities presented by accelerated low-activity waste operations (Vision 2020). This Charge, recommended by the ORP Federal Project Director, is to conduct a review of these proposed WTP and Tank Farms integration programs, which are intended to determine the optimal method for achieving cost and schedule savings available through these integration efforts. This review included evaluation of Vision 2020 planning documents with regard to the Tank Farms' ability to support options for sequential cold commissioning, initiation of radioactive waste processing, and transition to full operations at WTP. This Charge considered potential Tank Farm improvements, benefits and risks of tank farm operations to WTP project completion, and benefits and risks to the overall tank waste processing mission.

Charge 8 – Alternative Retrieval Strategies for the Hanford Waste Tanks: This task entails reviewing and assessing the potential alternative EM high-level waste (HLW) retrieval strategies that could impact overall budget and life cycle costing as compared to the current EM baseline. This assessment will include life cycle cost review for programmatic and technical strategy, environmental risk, human health risk, safety, waste disposition technology, and compliance with regulatory agreements.

1.3 Structure of this Report and Timing of Completion

This report, including its findings and recommendations, is to be considered as a final draft until it is approved by the full EMAB at the June 2011 EMAB meeting. If there are some issues that have not been totally resolved and that potentially impact the draft conclusions and recommendations, an open telephonic meeting of the EMAB will be called to resolve the open issues. It is anticipated that all work will be complete on or about August 31, 2011.

The EM-TWS's detailed review and considerations for each of the eight charges are given in individual Appendices to this report. Summaries of the key aspects of each charge are given in Chapters 2 through 9 in terms of Background, Findings and Observations, Conclusions, and Recommendations.

Definitions

In responding to the listed charges, there are certain "terms of art" that are critical to the timing and applicability of the technologies discussed in these charges. The definitions of these terms used as the bases for our analyses are:

Baseline: The current program as authorized by DOE that has a cost, schedule, and deliverables. The baseline is the current authorization cost funded by Congressional approval. This applies to both Savannah River and Hanford Tank Waste evaluations. For Hanford, this assumes that all pre-treatment is completed in the Pretreatment (PT) Facility and that a second low-activity waste (LAW) vitrification facility (ILAW) will be constructed to treat the remainder of the LAW feed.

Vision 2020: An accelerated program that is not currently authorized at the Hanford Tank Farms. It assumes a path to achieve the earliest possible hot operations of WTP facilities (e.g., sequential facility completion and Operational Readiness Reviews (ORRs)), starting with LAW / Balance of Facilities (BOF) / Laboratory (LAB). This strategy provides an opportunity to produce LAW glass early (2016) and continue until the PT Facility is commissioned. Pretreatment technologies (in- or at-tank filtration / ion exchange), new transfer lines to direct-feed LAW and lines from LAW to the Effluent Treatment Facility (ETF), a single LAW melter operating, and offgas recycle to the DSTs are needed.

Supplemental Treatment: This program would add treatment to current system plans for both Savannah River and Hanford Tank Farms waste.

- At Savannah River, this application of Small Column Ion Exchange (SCIX), Rotary Microfiltration (RMF), and resin grinding allows for a workaround for potential salt waste processing facility delays that will enable SRS to meet regulatory mandates. This program has been funded and is ongoing.

- At Hanford, Supplemental Treatment would either provide added process capability or allow a new waste form disposition strategy that could include the Integrated Disposal Facility (IDF) or other disposition pathway alternatives for LAW processing. This program application is in conceptual evaluation and is not funded as of the date of this EM-TWS report. It assumes that the second LAW treatment facility is selected from ILAW, Bulk Vitrification, Grouting, or Fluidized Bed Steam Reforming (FBSR), and is predicated on successful deployment of pretreatment technologies (in-tank RMF/SCIX or at-tank filtration/ion exchange).

Enhanced Treatment: This program includes substitution treatment technology for LAW at Hanford. It assumes that vitrification would not be used to treat *any* Hanford LAW—instead, three FBSR units would be used. This strategy is also predicated on successful deployment of in-tank pre-treatment technologies (RMF / SCIX). This would allow a different technology application for the processing and treatment of LAW. This waste form would be compliant with the “as good as glass” disposition that has been embraced by the Washington State Department of Ecology as the “bright-line” for LAW treatment. This program is not funded at this time.

Interim Pretreatment System (IPS): This is a Hanford pretreatment system to remove solids and cesium as necessary to provide feed to the WTP LAW vitrification facility until the PT Facility is commissioned as part of the Vision 2020 plan (approximately 15 months). It may or may not form a basis for supplemental pretreatment in association with development of Supplemental Treatment for LAW processing as defined above.

Tables 1.1A and 1.1B summarize the various mission objectives and issues as they relate to each of the treatment strategies (Vision 2020, Supplemental Treatment, and Enhanced Treatment for Hanford and SRS), where applicable.

Table 1.1A: Hanford Mission, Assumptions, and Issues concerning Tank Waste Treatment

Mission Requirements for the Three Major Scenarios			
Current Baseline	**(1) Vision 2020**	**(2) Supplemental Treatment Project**	**(3) Enhanced TW Strategy**
Current Baseline mission requirements are reflected in System Plan 5.	Earliest possible hot operations of completed WTP facilities (sequential facility completions starting with LAW/BOF/LAB). LAW operating hot while PT and HLW are being commissioned. Feed tank waste pretreated using filtration / ion exchange directly to LAW. Hot operations period for all facilities after completion of capital construction and before compliance date (2022) for WTP full operations milestone.	Supplement WTP PT and LAW capacity over and above current design to match HLW capacity and meet mission requirements. Additional LAW immobilization (selected from vitrification, FBSR, or grouting). Additional pretreatment options include in-/at-tank (using filtration / ion exchange).	Save seven years from baseline using transformational technologies. Deployment of 3 FBSR units (2 in 200 East Area, 1 in 200 West Area; no LAW vitrification). Deployment of in-tank pretreatment technologies (using filtration / ion exchange / other technologies). Upgraded WTP HLW vitrification capacity, and enhanced tank farm delivery capacity.

Key Assumptions for the Three Major Scenarios

Current Baseline	(1) Vision 2020	(2) Supplemental Treatment Project	(3) Enhanced TW Strategy
Current Baseline assumptions are reflected in System Plan 5.	Tank Farm pretreatment and LAW vitrification startup 12/16. Tank Farm PT runs until WTP PT startup in 3/18 (nominally 15 months). Early opportunity to debottleneck LAW operations and resolve potential startup and operational issues. Opportunity to accelerate staffing, training and certification, and gain operational and management experience. Accelerate commissioning of all WTP facilities to create a hot operations continuous period before continuous operations.	Tank Farm pretreatment and first alternative immobilization hot commissioning 1/18. Deployment of either an enhanced second LAW vitrification line or in-tank/at-tank pretreatment, alternatives plus alternative LAW immobilization technologies for full mission duration.	Tank Farm pretreatment and first alternative immobilization hot commissioning 1/18. Assumes deployment of in-tank pre-treatment technology for full mission duration to supplement WTP PT capacity. Assumes alternate LAW immobilization technology capacity will eliminate the requirement for WTP LAW facility. Assumes enhanced tank farm delivery capacity is greater than current baseline.

Major Issues that Relate to the Three Major Scenarios

Current Baseline	(1) Vision 2020	(2) Supplemental Treatment Project	(3) Enhanced TW Strategy
Baseline program mission is vulnerable to schedule and cost increases from potentially added construction and total project operations. Increases could be due to dilution of resources, complexity of additional engineering, added construction, and additional operational readiness requirements for added systems, risk mitigation measures, and inability to obtain increased funding over the near-term budget period.	Impact of WTP PT and HLW construction and commissioning in hot environment after LAW operations begin. Delays in commissioning of LAW and or other WTP facilities could delay startup. Potentially inadequate treatment of secondary waste from LAW vitrification facility Filtration / ion exchange integrated design and technology issues could delay startup. Delays in developing ETF upgrades could impact PT commissioning acceleration. Delays in HLW and PT operations could increase LAW-only operation beyond 15 months, creating problems in managing secondary LAW.	If FBSR is selected, it will be a first of a kind, large facility application, assuming Idaho facility is operational based on current baseline. Acceptance of a non vitrified, alternate waste form by the cognizant regulatory authorities. Regulatory "as good as glass" stakeholder and legal issues. Potential for substantially higher operating, transportation, and disposal costs due to increased waste volume of non-vitrified product.	Impact of WTP PT and HLW construction and commissioning in hot environment after LAW operations begin. Acceptance of a non vitrified, alternate waste form by the cognizant regulatory authorities. Regulatory "as good as glass" stakeholder and legal issues. Additional FBSR capacity would require rebalancing of integrated WTP operations. Cost and schedule and technical maturation may eliminate currently perceived benefits of FBSR deployment. Additional FBSR capacity would require revision to tank farm feed strategy. Abandonment of time and capital investment in WTP LAW facility would be a program change that could discredit DOE as it relates to Congressional and stakeholder confidence in DOE decision making.

Table 1.1B: SRS Mission, Assumptions, Issues Tank Waste Treatment

Mission Requirements for In-Tank Treatment and Fluidized Bed Steam Reforming		
Current Baseline	**(1) In-Tank Treatment SCIX**	**(2) Tank 48 FBSR Treatment**
Complete current baseline mission requirements are reflected in System Plan 16.	Accelerate treatment as workaround to SWPF delays and to align salt waste processing schedule with DWPF sludge processing schedule. Meet the STP commitment to remove tank waste by 2025 (three years early).	Treat and dispose of organic liquids from Tank 48 using FBSR.
Key Assumptions for SCIX and Tank 48 Treatment		
Complete current baseline assumptions are reflected in System Plan 16. SWPF operations initiation delayed to July 2014 from May 2013. Deploy next-generation extractant to SWPF to increase processing rate to a nominal 7.2 Mgal/year from 6.0 Mgal/yr.	SCIX provides additional salt processing capability of 2.5 MGal/yr beginning in October 2013. Accelerate liquid feed to SWPF / DWPF to recover three-year delay in schedule.	Steam reforming completed and Tank 48 returned to service October 2016.
Major Issues that relate to Two Major Scenarios		
Baseline program is vulnerable to increased construction schedule based SWPF delays.	Construction in a nuclear conduct of operations environment (Tank Farms). Technology Development for RMF may add additional risk of deployment.	Period of Rate of Return is a two-year campaign; the financial risk for funding is a major concern. DWPF operations improvements based on bubbler deployment and lessons learned have provided an alternate delivery potential that could eliminate the need for capital spending for FBSR. In a net present value (NPV) analysis, the increased canister requirements may in fact be tolerated due to significant savings based on eliminating capital construction and startup of the FBSR.

The tables included under Tables 1.2A and B summarize the various mission date baseline and alternate program strategy impacts for both Hanford and SRS.

Table 1.2A.1: Hanford Vision 2020 consideration as compared to current baseline sequential ORR Baseline Change Proposal (BCP) commissioning

	Construction Complete		Hot Commissioning	
	WTP Baseline[2]	Vision 2020	WTP Baseline[3]	Vision 2020
Laboratory	5/12	12/13	12/16	9/16
LAW	3/14	10/14	12/16	9/16
PT Facility	2/16	2/16	6/18	12/17
HLW Facility	5/16	5/16	7/18	5/18
Interim Pretreatment System	N/A	12/15	N/A	9/16
End Interim Pretreatment Operations	N/A	N/A	N/A	removal decision in 3/20

Table 1.2A.2: Hanford Supplemental Treatment consideration as compared to current baseline

	Construction Complete		Hot Commissioning	
	WTP Baseline	Supplemental Treatment	WTP Baseline	Supplemental Treatment
Laboratory	5/12	2/14	12/16	3/17
LAW Facility	3/14	5/15	12/16	3/17
PT Facility	2/16	3/16	6/18	3/19
HLW Facility	5/16	12/16	7/18	4/19
Supplemental Treatment Technology	N/A	N/A	N/A	1/18
Immobilization Technology	N/A	N/A	N/A	1/18

Table 1.2A.3: Hanford Enhanced Treatment consideration as compared to current baseline

	Construction Complete		Hot Commissioning	
	WTP Baseline	Enhanced Treatment	WTP Baseline	Enhanced Treatment
Laboratory	5/12	3/14	12/16	3/19
LAW	3/14	3/15	12/16	LAW does not operate
PT Facility	2/16	6/16	6/18	1/18
HLW Facility	5/16	12/16	7/18	4/19
Alternative LAW Treatment and Immobilization	N/A	1/17	N/A	1/18

[2] WTP baseline construction complete dates based on substantial completion.

[3] WTP start of hot commissioning dependent on successful ORR, which is outside the control of the project.

Table 1.2B: SRS- Summary of key baseline milestones and processing features from System Plan 16

Key Milestones		Processing Features	
Deploy next generation extractant at MCU	Jan 2012	Total Salt Solution Processed	96 Mgal
Initiate SCIX Processing	Oct 2013	Salt Solution Processed via ARP/MCU	5.4 Mgal
Initiate SWPF Processing	Jul 2014	Salt Solution Processed via SCIX	26.8 Mgal
Tank 48 Available	Oct 2016	Salt Solution Processed via SWPF	61 Mgal
Salt Processing Complete	2024	Total number of HLW canisters produced	7,557
SWPF facility removed from service	2025		
DWPF processing complete	2025		
DWPF facility removed from service	2026		

ARP/MCU -- Actinide Removal Process/Modular Caustic Side Solvent Extraction
SCIX – Small Column Ion Exchange
SWPF – Salt Waste Processing Facility
DWPF – Defense Waste Processing Facility

1.4 Interaction of Charges

Although each of the technologies is the subject of a separate charge, there are issues of interaction and interdependence between the charges. Any of the technologies considered in the charges can (1) stand alone, (2) counteract, and/or (3) complement other technologies depending on the option being considered. Charge 1 underpins all of the technologies under consideration since any decisions will be made based on life cycle cost analyses and the lowest cost, technically compliant solutions. Charge 8 extends the option space considerably, but several of the options considered here would require state and federal regulatory concurrence and potential renegotiation of existing multi-party agreements.

1.5 Summary Recommendations

1.5.1 Overarching Recommendations

2011-EM TWS 003-OA-01

It is recommended that DOE seek (with Office of Management and Budget support) multi-year appropriations with no control points from Congress (versus year-to-year funding with control points) for mission-critical projects for both SRS and the Hanford Tank Farms Program.

During deliberations and discussions with Savannah River and Hanford personnel, the negative impacts of year-to-year funding and technology alternatives on forecasted life cycle costs were a consistent theme. There are positive impacts and benefits of the "multi-year appropriations;" in particular, the flexibility to fund subprojects within a cleanup site without seeking Congressional reprogramming, as demonstrated by past EM projects such as Fernald and Rocky Flats. The reliability of stable, flexible funding was a key success factor for these closure sites. With this funding strategy, execution could be optimized and overall program costs reduced by as much as 15 percent due to elimination of funding risk and constraints. These programs also used proven technologies over higher risk, marginally proven technologies, resulting in schedule acceleration and subsequent cost savings.

The EM-TWS recognizes that DOE does not have the authority to unilaterally change the manner in which it is funded for project design, construction, and operations. The U.S. Congress could change the funding mechanism to something akin to block grants for major projects at the Hanford Site that would include the projects related to retrieval, treatment, and disposal of tank wastes. Using a block grant mechanism for funding tank waste treatment projects would provide greater certainty and reduce waste and inefficiency related to reacting to year-to-year allocations of funds. Thus, DOE, the Office of Management and Budget (OMB), and other stakeholders should encourage Congress to provide a more stable funding mechanism for major DOE projects.

2011-EM TWS 003-OA-02

It is recommended that DOE seek to standardize life cycle cost evaluations system-wide when evaluating alternatives for technology and/ treatment system capital projects, regardless of expenditure level.

The evaluation of alternative system solutions / design should be completed in an NPV methodology, that considers all program and ancillary costs, regardless of the budget code to which the cost would be allocated (e.g., Program, EM Headquarters, DOE Office of Civilian Radioactive Waste Management, HLW). Once the selection is made, program approvals are established, and a project is funded, life cycle cost savings should be reflected in current-dollar methodology.

2011-EM TWS 003-OA-03

It is recommended that DOE proceed with a preliminary design funding request for execution of Vision 2020 to allow a single LAW melter to operate significantly earlier than in the baseline; on or about 2016.

The EM-TWS recognizes that this justification would not be based on life cycle cost savings or on earlier milestone completions to current baseline program. The Vision 2020 justification is solely based on risk mitigation for the startup of the LAW and for startup of the WTP in compliance with baseline operation plans. Delay in startup of the WTP far outweighs any incremental capital cost associated with the fundamental design, startup, and operation of the Vision 2020 system for early LAW processing.

2011-EM TWS 003-OA-04

EM-TWS recommends that DOE-SRS and ORP be extra vigilant in applying resources to additional project developments to the detriment of mission-critical system construction and operations (i.e., SWPF and WTP).

EM-TWS has observed the expansion of the Vision 2020 scope to encompass other scenarios, such as the Supplemental Treatment and Enhanced Tank Waste strategies. This expansion must not be executed to the detriment of the major facility and system baseline operations execution. Key resources and dedicated staff must stay focused on the mission at hand and not risk delays and overruns due to splitting of key resources and loss of program focus.

1.5.2 Summary Recommendations by Charge

Charge 1 Recommendations – Modeling for Life Cycle Cost (LCC) Analysis

2011-01-A

It is recommended that a standardized methodology be used for analyses of LCC.

A standardized and consistent methodology using net present value should be used in the analysis of life cycle cost for evaluation and decision-making by all tank waste project offices. The software tool BLCC5, which is funded by DOE and maintained by the National Institute of Standards and Technology (NIST), is a logical, complete program that should be a candidate for this application.

A consistent methodology should be developed and adopted for uncertainty characterization, including sensitivity analyses and a validation process.

The methodology for uncertainty characterization needs to include (1) the ability to perform sensitivity analyses and (2) a validation process. The methodology for the validation process must include review by industry-based experts to provide cost realism and an evaluation of the uncertainty and sensitivity processes. This will allow management to assess overall system uncertainty in alternatives analyses.

A detailed sensitivity analysis be completed for both SRS and WTP based on full LCC modeling. The modeling should be based on an NPV evaluation as it relates to potential delays in SWPF or WTP operations.

This analysis should account for potential workarounds for SWPF delays, interference leading to potential WTP startup delays due to the complexity of Vision 2020 implementation at Hanford and potential nuclear conduct of operations stop-work / incident issues.

2011-01-B

It is recommended that the tank waste program focus on such matters as operational efficiencies, operational costs, and schedule completion for SWPF and WTP and not be distracted by the identification, testing, and implementation of new technologies.

The most significant life cycle impacts on the EM budget are the successful installation and operation of SWPF and WTP, process efficiency, and continuity of operations. The Vision 2020 and Supplemental Treatment program alternatives could distract the resources and top-level managers from delivering baseline performance and increased productivity of operations.

2011-01-C

It is recommended that EM develop guidance using a tiered approach to define the accuracy and role of computer models in the review process.

The guidance, which will define the accuracy and role of computer models using a tiered approach, must include (1) appropriate ways of dealing with uncertainty, (2) criteria for peer reviews, and (3) quality assurance (QA) procedures for computer modeling. Specifically, the methodology should include (1) QA requirements that include model effectiveness, limitations, performance, criteria, application to planning in cleanup alternatives, and inclusion of risk/uncertainty in the model; (2) assessment of the model's compliance with the QA requirements; and (3) an overall strategy to promote consistency, configuration control of data input to modeling processes, at-site and between-site reduction in duplication of modeling efforts, and inclusion of the findings in a lessons learned program across EM.

EM should implement and deploy a general planning model suited for uncertainty analysis, operator-based sensitivity analysis, and feasibility/optimization of retrieval, blending, and processing.

The implementation and deployment of a general planning model suited for uncertainty analysis, operator-based sensitivity analysis, and feasibility/optimization of retrieval, blending, and processing should include the capability to propagate uncertainties through the planning process, and characterize important uncertainties.

2011-01-D

It is recommended that SRS and Hanford use a standardized approach for applying DOE O 413.3B.

SRS and Hanford, including both EM Headquarters staff and its contractors, need to use a standardized approach in applying DOE O 413.3B to project planning and management and decision-making for alternatives analysis, including having a documented LCCA, for all tank waste processing projects. Consistent with DOE and OMB guidance, the LCC should include all life cycle costs, including deactivation and decommissioning and waste disposition.

2011-01-E

It is recommended that the cost for waste disposition and environmental legacy should be included in life-cycle cost alternatives analysis for CD-1 selection and documentation. This is in addition to inclusion of capital, operating, decommissioning, and risk uncertainty costs and analyses.

2011-01-F

It is recommended that performance and acceptance testing criteria for SWPF and WTP be documented and reviewed for potential risks and sensitivity analysis impacts to LCC.

2011-01-G

It is recommended that DOE investigate alternative paths for regulatory relief of milestones for SRS SWPF and WTP LAW processing and weigh the LCC options—based on possible partitioning of waste forms and their disposition—that could lead to expedited processing of the wastes and revisiting of the regulatory commitments.

2011-01-H

It is recommended that the cost for waste disposition be included in life cycle cost alternatives analysis for CD-1 selection and documentation. This is in addition to inclusion of capital, operating, decommissioning, and risk uncertainty analysis.

Charge 2 Recommendations – Assess Candidate Low-Activity Waste Forms

2011-02-A

It is recommended that prior to any downselection for Supplemental LAW treatment, DOE, in conjunction with its regulators, should develop an approach to development and implementation of a treatment process, waste form, and disposition pathway that explicitly addresses the challenging fractions of LAW that limit near-surface disposal options and provide a viable option to a second LAW vitrification facility. This will likely necessitate consideration of a separation of Tc-99, and possibly other constituents, that drive near-surface disposal risk to the extent that Tc-99 may not be incorporated into vitrified LAW using the WTP LAW vitrification facility.

The Washington State Department of Ecology designated vitrification as the preferred treatment technology for Hanford LAW under RCRA and has declared that "as good as glass" is the benchmark by which any successful supplemental treatment technology be judged. Based on the current milestones in the Tri-Party Agreement (TPA), these requirements leave little, if any, margin for successfully selecting an alternative LAW treatment technology, even one with potentially significant benefits. Based on the highly variable characteristics of the wastes and forms in the tanks and the contaminants most likely to limit near-surface disposal options, a more reasonable path would be to identify and address challenging LAW waste fractions to which a supplemental treatment technology can be successfully applied. Often the most challenging contaminants tend to be volatile, long-lived radionuclides like Tc-99 that are difficult to incorporate into the LAW waste glass and are mobile when released into the biosphere. Because of the difficulties that may be encountered in gaining acceptance of any non-glass waste form, this path forward may require the separation of such difficult-to-manage contaminants (especially Tc-99) in concert with technology and waste form development. Because there is only a brief window of opportunity, for this effort to succeed there will need to be upfront and ongoing collaboration with the Washington State Department of Ecology on the evaluation and development process if an alternative treatment pathway is to be developed. Issues that will need clear communication and thoughtful consideration include information needs, review criteria, consistency with schedule, and regulatory challenges.

2011-02-B

It is recommended that DOE include a targeted processing and treatment approach (that may include segregation and alternative treatment) based on an evaluation of waste characteristics including uncertainties in the system planning process.

There has often been a tendency in DOE to attempt global approaches to treat many different wastes when targeted approaches may make sense both programmatically and economically while meeting risk reduction and regulatory goals. Global approaches may allow DOE to reduce certain programmatic and budgetary risks; however, there are technical and operational trade-offs that may not provide adequate processing flexibility and have impacted prior choices regarding treatment technologies and waste forms.

There are large variations of composition, form, chemistry, and other important waste properties within the Hanford tank farm vessels. Previous evaluations of the best-basis inventories have indicated that some of the contents perhaps would be appropriate for treating and sending to the Waste Isolation Pilot Plant (WIPP) as transuranic (TRU) waste. Furthermore, contaminants of concern (e.g., Cs-137, Sr-90, Pu-239, Tc-99, I-129) and other important characteristics can vary widely from tank to tank. Because of previous reprocessing of Hanford wastes to capture Cs-137 and Sr-90, some tanks contain salt wastes with relatively low total activities. Thus, it may be possible to develop a targeted approach to treating Hanford LAW, for example:

- Treat high-risk wastes (e.g., those with large concentrations of long-lived, mobile radionuclides) with low concentrations of volatile contaminants of concern (e.g., Tc-99 and I-129) in the ILAW facility currently under construction.

- If the mineralized waste form is deemed acceptable by the Washington State Department of Ecology for onsite disposal, treat the remaining high-risk wastes that also have moderate to high concentrations of volatile contaminants of concern using FBSR. A second alternative would be to separate Tc-99 from select high-risk wastes for treatment with grout.

- If an off-site disposal location can be found, treat low-risk wastes using grouting for off-site disposal. Certain LAW streams (e.g., those from the offgas system) may be solidified for offsite disposal.

The above example is not exhaustive; however, it gives a flavor of the thought processes involved. A formal intentional blending evaluation (that also includes a cost-benefit analysis of constructing a new mixing / blending facility) should be conducted using the results of the targeted scenario analysis. Significant uncertainties should be accounted for in the evaluations to develop a robust strategy for treating Hanford LAW.

2011-02-C

It is recommended that ORP work with the Washington State Department of Ecology to develop strategies, infrastructure, models, and processes to provide adequate flexibility in waste treatment processing.

The EM-TWS observed that there appears to be limited flexibility in waste treatment processes and strategies that will be used to treat Hanford tank wastes. Two sources were identified in the EM-TWS review: 1) reacting to budgetary processes, limitations and uncertainties that resulted in process and infrastructure reductions and 2) not fully accounting for the uncertainties in designing the processes and control strategies for WTP.

To address potential issues related to not fully considering uncertainties, the EM-TWS recommends that significant uncertainties be identified, characterized, and managed in the planning process and control strategies based on the risks they pose to the ability to treat wastes efficiently.

2011-02-D

It is recommended that ORP work with the Washington State Department of Ecology to evaluate the potential application of alternative treatment technologies and resulting waste forms.

The Washington State Department of Ecology has designated vitrification as the preferred treatment technology for LAW under RCRA, and the TPA LAW treatment milestones are currently predicated on using vitrification, including the second facility need to treat the remaining Hanford LAW. Thus, Hanford stakeholders have mandated that the performance of a waste form resulting from any alternative treatment technology be “as good as glass.” Because there are no waste form-specific performance requirements for treated Hanford LAW, there is some degree of flexibility in how the evaluation is made. However, current TPA milestones leave little margin for error in selecting an alternative LAW treatment technology. Furthermore, the Washington State Department of Ecology has maintained that any alternative treatment technology would be applied to a “small increment.”

Charge 3 Recommendations – Assess At-Tank or In-Tank Candidate Technologies for Augmenting Planned Waste Pretreatment Capabilities

2011-03-A

It is recommended that SRS document the SCIX alternatives downselect process, including financial analysis, in support of the decision to select in-tank treatment over other options.

2011-03-B

It is recommended that, at SRS, steps must be taken to mitigate the risk of CST agglomeration.

- ***Only the caustic-washed version of CST, IONSIV® IE-911-CW should be used in the SCIX process.***
- ***Storage stability specifications should be established and requisite testing should be part of the QA process.***
- ***Provision should be made for robust on-site washing of CST ion exchange media using 3M NaOH shortly before the CST is transferred into the SCIX column, unless storage stability testing demonstrates this is not required.***

IONSIV® IE-911 is known to form agglomerates in salt waste service. Excess reagents from the IONSIV® IE-911 manufacturing process, such as Si, Ti, and Nb, are believed to be the main cause of this problem, although tank waste constituents may also contribute if pH is too low. It has been reported that Ti, Zr, and Nb leach from IONSIV® IE-911 during caustic washing. EM-TWS understands that a caustic-washed version of CST, IONSIV® IE-911-CW, will be used in the SCIX process. Additional leaching of IONSIV® IE-911-CW can be expected to occur during resin storage. Current SRS plans only include minimal on-site caustic pretreatment.

2011-03-C

It is recommended at SRS, that a detailed safety basis and HAZOP review be conducted to document passive safety design for the SCIX process.

Cesium-loaded CST ion exchange media will generate a significant amount of heat. Simultaneous losses of permeate feed and cooling water flow to a SCIX column, containing cesium-loaded CST, may result in column temperatures exceeding the boiling point of the process liquid. The SCIX Conceptual Safety Design Report identified ion exchange column over pressure and explosion as credible scenarios.

Wall temperatures exceeding 100°C may adversely affect the integrity of waste storage tanks. Based on the models used to assess thermal risks associated with discharging cesium-loaded CST (ground and unground) into SRS storage tanks, it was concluded that it may be possible to have wall temperatures exceeding 100°C.

Hydrogen generation from radiolysis caused by cesium-loaded CST ion exchange resin is also of concern in the ion exchange column and in storage tanks containing ground cesium-loaded CST.

2011-03-D

It is recommended at SRS, full-scale testing to ensure that a homogeneous bed of IONSIV® IE-911-CW can be established and operated without channeling which could adversely affect Cs-137 removal.

CST ion exchange media will be loaded in the 11-inch wide annular space between the vessel wall and the central cooling pipe. Although it is reasonable to expect that column hydraulics will be satisfactory, this is an unusual design that should be verified by testing at full scale using IONSIV® IE-911-CW and a salt solution with density and viscosity similar to that of actual salt waste.

2011-03-E

It is recommended at SRS, that the 1.3-million-gallon tank mixing design be reviewed by an external panel to assure the design will meet MST strike performance objectives.

Mixing technology/scaleup are critical technology elements of the SRS SCIX process. The current ARP/MCU process includes a monosodium titanate (MST) strike step, in which actinides and strontium are absorbed using MST in a 5,000-gallon, mechanically agitated process tank. The proposed SCIX process uses submerged mixing pumps to disperse MST in a 1.3-million-gallon storage tank. Although considerable work has been completed on scaleup strategy, and the mixing-related aspects of the MST strike have been studied in an 800-gallon tank, external design review should be completed by outside subject matter experts.

2011-03-F

At Hanford, spherical resorcinol formaldehyde (sRF) ion exchange resin meets the technical requirements for cesium removal in the short-duration Vision 2020 scenario. However, EM-TWS recommends evaluation of other potentially simpler options for Vision 2020, such as those presented in Appendix 11 of this report.

A significant amount of development work has been completed in support of the decision to use sRF ion exchange resin for the WTP PT cesium ion exchange process. While it is clear that a sRF-based cesium removal process would meet the technical objectives of the Vision 2020 scenario, other options such as those described in Appendix 11 (Vision 2020) may be simpler and less expensive to deploy.

DOE should further review the use of sRF ion exchange resin for long-term in-tank and at-tank cesium removal processes.

Spherical resorcinol formaldehyde is the preferred choice for the Hanford Tank Farm long-term pretreatment options using an ion exchange cesium removal process, based on the extensive development work already completed on sRF for use in WTP PT.

CST ion exchange is also being considered for in-tank and at-tank cesium removal processes at Hanford. Bench scale column testing of CST treating actual Hanford supernate indicates that CST can do an adequate job of removing cesium from Hanford salt waste. The high cost of CST and the fact that it cannot be eluted work against its selection for treating large quantities of Hanford waste.

Using CST for Vision 2020 at Hanford is complicated by the fact that cesium-loaded CST would be comingled with sludge in the Hanford waste storage tanks for many years before being treated in the WTP. Little if anything is known about the long-term behavior of CST mixed with Hanford tank waste, an environment that is high pH and saturated with aluminum and other compounds. There is potential for the CST to agglomerate and harden, making waste retrieval difficult. It is also not known how the presence of CST in sludge would affect the WTP PT performance.

2011-03-G

At Hanford, crossflow filtration (CFF) is recommended for processing Hanford AP tank farm supernate. Also, an in-tank CFF option should be evaluated for the Vision 2020 scenario.

Crossflow filtration has been tested using Hanford simulants at engineering scale in the Process Engineering platform. More importantly, CFF has been proven in similar service during three years of successful operation at SRS in the ARP/MCU process.

Based on permeate flux rates demonstrated at ARP/MCU, it may be possible to meet the Vision 2020 process requirements with a single filter bundle approximately 15 inches in diameter and ten feet long. A unit of this size could be installed inside a tank riser.

2011-03-H

It is recommended that a comprehensive experimental program be conducted at Hanford, with actual samples, prior to Vision 2020 CD-2 submission.

Crossflow filtration and sRF ion exchange resin are fully expected to meet the requirements of the Vision 2020 scenario. Bench-scale testing with samples of AP tank farm supernate is needed to validate and refine the design basis for the Vision 2020 scenario.

2011-03-I

It is recommended that at Hanford, the project proceed with additional RMF testing with a range of actual Hanford tank waste samples using the single disk RMF. Mechanical reliability and maintainability need to be demonstrated based on actual operation of the SRS Tank 41 SCIX process before deploying RMF technology at Hanford.

The SCIX project is a technology development and demonstration program that includes an integrated full-scale operational test to obtain data and determine the feasibility for long-term deployment in an operational tank farm environment. It would be premature to deploy a second RMF at Hanford before proving the first one at SRS. However, if additional testing of Hanford waste is done using the single disk 5RMF test unit in parallel with the SRS SCIX project; it should be possible to compress the schedule for advancing rotary microfiltration to TRL-6.

Charge 4 Recommendations – Evaluate Various Melter Technologies

2011-04-A

It is recommended that near-term technological development focus on Joule-heated, ceramic-lined melters and improvements thereto.

The main objective in the near term for DOE melter development funding should be improvements in the operation of Joule-heated, ceramic-lined melters. Such items as glass formulation, bubblers, molybdenum electrodes, and water-cooled skull technology are examples.

Cold operation in pilot test facilities (i.e., at least 1/10 scale) is necessary before hot operation. Hot operation at bench scale should then be carried out on actual waste to verify that there are no unexpected issues before larger-scale design work is initiated.

2011-04-B

It is recommended that a chemistry-based systems model be developed that would allow optimum scheduling of the tanks to be processed.

In order to minimize vitrified waste, installation of a flexible blending facility is recommended at WTP to allow potentially troublesome wastes (e.g., sulfates, phosphates) to be diluted. To aid in the scheduling, a chemistry-based systems model that would allow optimum scheduling of the tanks to be processed is also recommended.

2011-04-C

If an alternative melter technology is needed, EM-TWS recommends detailed development utilizing CCIM technology.

Cold crucible induction melter (CCIM) technology is the recommended alternative due to its more mature state of development compared with the other alternatives and its potential for higher temperature operation with new glass forms such as iron phosphate (FeP) that may be able to increase waste loading for certain waste streams.

Charge 5 Recommendations – Evaluate the Reliability of Waste Delivery Plans

2011-05-A

It is recommended that DOE, in conjunction with its regulators, establish consensus on strategies, infrastructure, models, and processes to provide adequate flexibility in waste feed preparation and treatment.

There will be a need at both SRS and Hanford to balance, as well as significantly increase, the retrieval, preparation, qualification, feed and treatment of high-level and low-activity wastes to meet treatment schedules and milestones. The variation in the characteristics of the tank wastes at both sites dictates that there should be adequate flexibility in the processes used to prepare, deliver, and treat tank wastes.

Because the window of opportunity at either site will likely be brief, an upfront and ongoing collaboration with regulators will be needed. Issues that will need clear communication and thoughtful consideration include information needs, review criteria, consistency with schedule, and regulatory challenges.

2011-05-B

It is recommended that DOE formally evaluate the single-point failure impact of the Hanford 242-A evaporator. DOE should address the need for additional capacity to supplement the 242-A evaporator in case of failure.

Continued operation of the 242-A Evaporator is critical to the River Protection Plan (RPP) mission. The likelihood of failure will increase as the evaporator ages. According to current plans, much higher availability of the evaporator will be required at a time when the evaporator is more than half a century old. The aggressive use of the evaporator to support tank farm operations may increase the likelihood of failure and impact the ability to make the continuous improvements planned to maintain the system. The technology currently being researched (i.e., thin or wiped-film evaporators) are not adequate replacements for the functionality provided by the 242-A Evaporator. Additional evaporative capacity of the type needed could be provided by building a new evaporator, using the existing evaporator facility in the 200 West Area, or employing off-the-shelf technologies that would supplement the 242-A Evaporator without the need for significant research and development. The construction of additional double-shell tanks would also help alleviate issues associated with potential failures of the 242-A Evaporator system.

2011-05-C

It is recommended that the waste acceptance criteria (WAC) for the Hanford tank waste treatment facilities and disposal facilities be finalized as soon as possible to reduce the potential impact on waste feed delivery and treatment schedules and milestones.

Before pretreated waste can be fed to Hanford treatment facilities, samples must be collected and tested to assure that the waste meets WAC for these facilities. Important aspects of the waste feed delivery interface are being resolved including the WTP waste acceptance data quality objectives and an evaluation of the ability to adequately mix, sample, and deliver individual feed batches to the WTP for treatment. The limits on and targets for Hanford waste feed delivery will remain uncertain until these key aspects of the feed delivery interface are finalized. Furthermore, the acceptance criteria and permits required for the disposal facilities for both the high-level and low-activity waste forms have not been finalized.

2011-05-D

It is recommended that DOE develop a mitigation strategy for the potential inability to adequately and efficiently mix, sample, and deliver wastes to the WTP.

Pretreated wastes at Hanford must be sampled and analyzed to demonstrate that they satisfy waste acceptance criteria and feed specifications for the corresponding treatment facility. These requirements translate into the need to satisfy appropriate requirements to high confidence (i.e., 95 percent confidence for fissile components and 90 percent for others). An evaluation is currently underway of the ability in the tank farm to adequately mix, sample, and deliver individual feed batches to the WTP for treatment. If methods cannot be identified or developed to allow limits to be satisfied to the high confidences required, additional sampling and analysis may be required that would potentially impact pretreatment, qualification, and delivery schedules and ultimately treatment milestones. A potential mitigation would be to implement the enhanced Waste Retrieval Facility to include mixing, blending, sampling, qualification and filtration of retrieved waste that would also provide a more uniform feed to WTP.

2011-05-E

It is recommended that DOE evaluate in the system planning process the various options for processing the SRS Tank 48H waste.

Tank 48H contains approximately 250,000 gallons of a salt solution containing 22,000 kg of tetraphenylborate (TPB) and 400,000 Ci of Cs-137. Fluidized bed steam reforming was originally selected to process this unique organic waste. However, a number of factors have resulted in a review of the costs, schedule, and technical maturity criteria. This review has led to the evaluation of competing technologies including direct vitrification and a copper-catalyzed chemical oxidation process that was not considered in previous evaluations. DOE should evaluate available technologies in the System Planning process, including:

- Fluidized bed steam reforming
- Copper-catalyzed process
- Direction vitritification as an end-of-mission campaign
- Direct vitrification by slow addition (or “bleeding”)

2011-05-F

It is recommended that DOE implement previous recommendations that potentially impact alternative treatment technologies and forms for Hanford LAW (cross-cutting).

Previous recommendations made by the 2009 External Technical Review (ETR) Team that evaluated Hanford modeling and simulation tools, and the 2010 EM-TWS that should be implemented include:

- Complete the enhancements to the Hanford Tank Waste Operations Simulator (HTWOS) model to support life-cycle cost modeling and future high-level planning.

Important tank waste and processing chemistries and significant uncertainties must be incorporated in the planning model to inform System Planning and the alternative treatment technology and waste form selection processes.

- Institute recommendations made by the ETR Team to capture the significant knowledge concerning SRS sludge feed preparation.

Charge 6 Recommendations – Identify Other Tank Waste Vulnerabilities at SRS and Hanford

2011-06-A

It is recommended that Vision 2020 be executed based on early startup of systems that are related to WTP startup. The supporting rationale is not based on LCC savings or schedule reduction, but with risk reduction of the WTP and its related commissioning.

2011-06-B

It is recommended that SRS perform a detailed review of use of FBSR technology for Tank 48 waste. EM-TWS believes there is significant cost savings merit in an alternative treatment technology or utilization of DWPF for this processing.

2011-06-C

It is recommended that DOE-EM continue focus on Joule-heated melter technology for both SRS and Hanford.

Charge 7 Recommendations – 2020 Vision, Early Start-up of One (1) LAW Melter

2011-07-A

It is recommended that the management realignment and integration between the Tank Farms and WTP proposed in the "Vision 2020 – One System Plan" be supported and encouraged.

The proposed management realignment and integration, including the reporting structure, risk management and coordination objectives represent a major positive step towards the fully integrated structure needed as WTP commences operations.

DOE management alignment needs to correspond with contractor alignments.

The currently proposed risk register for the One System Plan includes only additional risks posed by the One System proposal. It does not include those already considered by the WTP and Tank Farms. An integrated risk management system is needed that includes all of the risks associated with WTP completion and commissioning, including those associated with feed delivery and effluent management. Risk management should include identification, assessment and tracking of opportunities.

The management approaches to labor and staffing need to receive increased attention and priority. Areas of attention are labor agreements, staffing plans, jurisdiction, start-up schedule, and strategy for equipment turnover to operations, work plans, safety basis strategy, comingling of construction and operations staff, and cold and hot startup.

The cost of the Vision 2020 capital and early operating of the LAW, LAB, and related facilities should offset some of the risk contingency currently allocated in the WTP and Tank Farm commissioning and startup risk expenditures. The cost of a one-year delay in WTP startup could easily offset the capital and operating cost for Vision 2020 initial construction and 18 months of operation.

2011-07-B

It is recommended that the benefits and risks from the Vision 2020 - One System proposal be better articulated and quantified where possible to form a compelling business case for implementation. Probabilistic simulation of the cost and schedule uncertainties associated with the Vision 2020 – One System Plan should be part of the detailed Vision 2020 – One System proposal and summarized in the business case to provide improved clarity regarding the cost and schedule risks and confidence.

The primary benefits from the Vision 2020 – One System proposal are (i) management integration between WTP and TOC to achieve WTP startup; (ii) sequential commissioning of LAB/LAW, PT, and HLW facilities to provide a more achievable schedule and sequence for ramp-up and to demonstrate operability; (iii) initial production of LAW glass up to two years earlier than the current baseline plan; and (iv) the potential to de-link initial LAW and HLW facilities operations from PT commissioning, which will likely present the most serious commissioning schedule challenges. Together, these benefits substantially reduce the risk of schedule delays to the initiation of full WTP operations in 2020. However, the current plan assumes a "success-oriented" cost and schedule basis. A coupled assessment of uncertainties and risks is needed to provide quantification of the confidence in achieving the proposed schedule.

Programmatic priority should be to develop credible, defensible information to obtain broad-based support for adequate funding, including quantification of cost and schedule uncertainties, risks, and benefits.

2011-07-C

It is recommended that the technical path of sequential commissioning of WTP BOF, LAW, and Laboratory, followed by commissioning of PT and HLW, be supported.

Even though multiple technical and programmatic risks make the achievement of LAW glass production on the proposed schedule uncertain, the proposed technical path to completion of WTP commissioning and transition to hot operations represents a significant improvement over the baseline approach with substantially reduced risks in meeting the objective of achieving the earliest practical hot operations of LAW, PT, and HLW.

2011-07-D

It is recommended that the technical plan under Vision 2020 should focus on what is needed and essential to achieve LAW hot operations as soon as technically and programmatically feasible, along with WTP full commissioning by 2018 and IPO by 2022. Synergies of technology maturation and system development to support Supplemental LAW treatment or other needs should be clearly justified by the business case.

The minimum requirements for supporting LAW feed preparation and delivery prior to the availability of WTP-PT should be defined and alternative technical approaches to meet those requirements should be evaluated. Current commercial approaches and off-site disposal of depleted resin waste should be considered.

Short-term alternatives should be evaluated for disposal of LAW secondary liquid wastes during interim operation that do not require or reduce the return to the DSTs, including continuous concentration of secondary liquid effluents, direct recycle to LAW feed, separation of Tc-99 and other constituents, and off-site disposal.

Including development of an interim pretreatment system that also supports future Supplemental LAW options puts the Vision 2020 plan at high risk of failure because of (i) substantially increased costs and schedule, (ii) delays in regulatory approval, and (iii) technology maturation schedule requirements and risks.

There is not an advantage between in-tank or at-tank options for interim pretreatment with respect to regulatory permitting time or requirements. However, there may be distinctions with respect to DOE safety requirements.

2011-07-E

It is recommended that the highest priority for ORP and WTP be to achieve the earliest practical initial processing at WTP of LAW and HLW, including PT.

DOE should consider delaying the selection and procurement of Supplemental LAW treatment facilities by three to five years to enable focus on startup of WTP operations and level funding need. This should include, Supplemental Pretreatment. This delay would provide valuable lessons learned prior to technology downselect, design, and project commitment decisions. Such a delay will also reduce cost and schedule uncertainties for Vision 2020 technology deployment. Such a programmatic change would require agreement of all parties to the Consent Decree.

Delay in initiation of the Supplemental LAW Treatment project could reduce the peak ORP and WTP funding needs over the period of 2016 to 2020 and enable added financial focus on WTP start of operations.

Delay in the technology selection and design for supplemental pretreatment and supplemental LAW treatment will allow for lessons learned from (i) additional waste form performance characterization, (ii) WTP commissioning, including LAW and PT startup, (iii) implementation of rotary microfiltration and small column ion exchange at SRS, and (iv) FBSR at the Integrated Waste Treatment Facility at Idaho. Furthermore, knowledge gained from the operation of the LAW facility will allow for better-informed sizing of Supplemental Treatment facilities.

2011-07-F

It is recommended that DOE, TOC and WTP contractors make it a high priority to develop an integrated, fast-track permitting approach in active collaboration with regulators.

An integrated approach is needed to regulatory permitting, which presents one of the greatest risks to the Vision 2020 schedule.

DOE needs to determine if the draft TC&WM EIS provides adequate NEPA coverage for Vision 2020 activities. If the current analysis does not, DOE, on a fast track, will need to take steps available under NEPA to provide coverage.

If Vision 2020 is to succeed, DOE must move as expeditiously as possible to finalize the EIS (and any needed Supplemental EIS) and issue a Record of Decision. DOE and the TOC and WTP contractors will need to clearly articulate to stakeholders the need for NEPA coverage and the impacts on the Vision 2020 if the process is delayed.

Joint management of the permit process through a collaborative effort is key to mitigating schedule risk.

Charge 8 Recommendations – Alternate Retrieval Strategies for the Hanford Waste Tanks

The EM-TWS has not reviewed this effort in sufficient detail to make recommendations as of the date of this report.

CHAPTER TWO
Charge 1: Modeling for Life-Cycle Cost (LCC) Analysis

2.1 Background

This charge entails reviewing the modeling approaches for determining tank waste remediation LCCs at both SRS and Hanford. This includes evaluating assumptions in system plans for completing tank waste missions at Hanford and SRS, as well as the rigor of the models for identifying activities and costs through the end of each site's program.

In our opinion, the rigor for LCC analysis, as defined by OMB and DOE O 413.3B, and recommended by GAO, is not being executed to the degree that is identified in the guidelines. This rigor needs to be utilized throughout the project decision-making process.

LCCs currently being utilized or reviewed do not seem to always include costs beyond facility shutdown (i.e., deactivation, decontamination, decommissioning, waste disposition, and post-decommissioning reclamation).

In particular, waste disposition is not included in the Site alternative technology evaluations for LCC analysis. It would be expected that the decision-making process of alternative technology solutions and system / facility choices (CD-0; CD-1) would include capital, operating, decommissioning, potential environmental legacy, and waste disposition costs modeled at the appropriate cost of money and escalation with net present value modeling over the life cycle period. Once a decision is made, budgeting should be based on current dollars.

EM programs at Hanford and SRS, as well as the site direction itself, are not uniformly following LCC protocols in a consistent and disciplined manner. The communication between sites appears to be good; however, the end product in how and what tools deployed for the appropriation of funds as well as representation of LCC savings and justifications needs additional review for consistency. Furthermore, the integration of analysis between the WTP and the Tank Farm Operation requires additional uniformity and discipline to establish similar methodology and consistency of analysis.

2.2 Findings and Observations

Managing uncertainty and risk, as well as the sensitivity of the parameters affecting risk, are key to the project management. With the duration between full operations and closure being quite lengthy, these uncertainties and risks can be <u>missed or not paid full attention</u> to during the baseline preparation and validation. A number of risk and uncertainty factors have been identified that could impact LCC:

2.2.1 The strategy that addresses uncertainty in alternative plans in the event of failure needs to be clearly identified; based on current review, there is limited documentation of potential failure and alternate options as a "Plan B."

Technology deployment has uncertainties and unknowns that are inherent to the process; it appears there is limited technology strategy that addresses alternative plans in the event of failure. Thus, technology development has uncertainty that is introduced into the LCC and this uncertainty is not generally factored in the LCC in a manner that reflects operational contingency and backup planning.

2.2.2 Cost estimates tend to be optimistic and/or do not recognize the degree of complexity involved.

The estimates for the structures, components, and controls (SC&Cs) appear to be underestimated. The SC&Cs are one-of-a-kind (in some cases, first-of-a-kind application) and are generally more complicated than currently presented.

Radioactive waste treatment inevitably involves auxiliary systems (e.g., off-gas systems and treatment systems for secondary waste streams) that could turn out to be far more complicated and costly than first thought. It appears that the secondary treatment costs for operations are modeled in a simplistic manner without detailed operations backup.

Project and program estimates frequently include vendor estimates that are sometimes underestimated when it comes to applying the technology to a new situation and nuclear quality standards. This should be emphasized and observed even at the CD-0 and CD-1 stages of project review.

Most estimates are based on technology maturation plans that are success-oriented where each test is expected to produce the desired result. This is unrealistic and results in underestimation of the LCC. This approach needs a greater element of realism.

Some LCC estimates and associated risks, as included in risk management plans, are optimistic. The cost realism occurs mostly in the design and construction portion of the LCC, while technology immaturity lacks sufficient operational experience in the present system plans. Other operational optimism can greatly underestimate LCC. For example, rates for transfers from single-shell tanks to double-shell tanks are projected at more than three times what has been achieved to date.

2.2.3 There are many operational aspects that can have major impacts on LCCs.

Long-term tank farm viability and subsequent interruptions to overall schedules have been optimistically estimated. The overly optimistic approach to LCC currently used continues to erode confidence in the program. As a result, DOE, Congress, and the public cannot be assured that DOE's present strategy appropriately balances risk reduction with cost.

The LCC effect of facility processing rate can be significant—overwhelming all other parameters—since operating costs tend to dominate capital costs and are most sensitive to operational efficiency. WTP pretreatment contains many first-of-a-kind applications for process technologies, has uncertainty in the waste feed characteristics and waste form acceptance, and involves high solids content processing. Based on the experience of the EM-TWS members in first-of-a-kind chemical processing and at other DOE nuclear process facilities, the odds are not great that the facility could reach nameplate capacity. That low probability of reaching nameplate capacity translates to possibly extending the treatment mission resulting in substantial increases in LCC. Operations, decommissioning, and waste disposition LCC costs should be considered when evaluating each of the alternatives in the processing and disposition of wastes. The uncertainty of the physical and chemical properties of the wastes, waste form acceptance after treatment, their disposal characteristics, and regulatory compliance directly affect LCC.

GAO recognized technology uncertainty and introduced the TRA (TRL) Program and the associated requirements for TRL 6 for CD-2. DOE O 413.3B only requires a TRA be performed for CD-2. EM has held to the TRL/TMP Guide for CD-1 and CD-2 recommendations.

2.2.4 The EIS for Hanford will impact LCC and mission success.

DOE is preparing an EIS at the Hanford Site evaluating a number of potential strategies for permanently closing the tanks after the waste has been retrieved. This study will include an analysis of (1) the costs and risks posed by waste left in tanks under a number of different closure configurations; (2) the contamination associated with other waste sites at Hanford; and (3) risks under various treatment, disposal, and closure scenarios to workers, the public, and the environment. This study, when completed, will greatly affect Hanford's total LCC and, ultimately, mission success.

2.2.5 The Building Life Cycle Costs system could be a valuable asset.

DOE's Federal Energy Management Program (FEMP) sponsors a system for Building Life Cycle Costs (BLCC5) that is maintained by the U.S. National Institute of Standards and Technology (NIST) to build LCC for capital projects. BLCC5 provides comprehensive economic analysis of proposed capital investments. NIST also provides guidance on LCC methodology in their guide to reporting and computing LCC of environmental management programs. DOE should review this model for cost estimating, the databases on cost that could be derived for use within DOE, and evaluate its application for the tank waste alternatives analyses.

2.2.6 The positive impact of multi-year funding would be significant.

During discussions with SRS and Hanford personnel, the impacts of year-to-year funding and technology alternatives on LCC planning were a consistent theme. We understand the positive impacts and benefits of "multi-year appropriations" on past EM projects such as Fernald and Rocky Flats. Not only was the closure site funding stable year to year, but there were no Congressional control points within each site's total funding to constrain how that funding was expended at each site. The reliability of total project multi-year funding, as well as flexibility in expending that funding, was a key success factor for these closure sites, along with no Congressional control points so that project managers had the flexibility to move funding within a site's budget without Congressional reprogramming action.

With this funding strategy, execution could be optimized and costs reduced. These programs also used proven technologies over higher risk, marginally proven technologies resulting in schedule acceleration and subsequent cost savings.

2.2.7 An overall integrated model would be extremely helpful in estimating LCC.

Discussions were held on efforts being made to develop an overall model at Hanford of WTP and Tank Farm process reliability, availability, and maintainability. Without such a planning tool, scenario development, bottlenecks, and quantification of uncertainties in the development of LCC are not possible. It is recognized by the sites that such a tool would also help in maintaining and modifying the system plans and allow for linkage of cost and schedule to such parameters as retrieval, waste processing, disposal, etc., to an overall LCC.

2.2.8 A more rigorous and disciplined approach to decision-making on tank waste projects should ensure an overall lower LCC.

With annual operating budgets used to achieve progress on tank waste technology projects where significant expenditures (i.e., more than $100 M) are required, particularly in the small-column ion exchange (SCIX) project, the lack of rigor and compliance to Federal requirements and guidelines in the use of LCC in overall alternatives down-selects may lead to non-optimal decisions. It appears that there is inconsistency between Operations Office and contractor submittals in the approach to secure appropriated funding for the capital/operating funds for the tank waste programs. Some projects (e.g., the proposed in-tank SCIX separations project at SRS) are to be funded within the operating budgets of the site and are not being treated as line-item capital asset acquisitions (i.e., not formally completing project data sheets; not compliant with OMB Exhibit 300; and seem to not be planning to utilize the CD process steps per DOE O 413.3B).

EM-TWS noted varying degrees of rigor and methodology in how Hanford and SRS project staff executed decision-making to select alternatives for tank waste treatment, filtration, and waste disposition. EM-TWS felt that 413.3B provides an effective and rigorous methodology that should be adopted, regardless of if the cost triggers that mandate use of the guideline.

2.3 Recommendations

2.3.1. It is recommended that DOE seek (with OMB support) multi-year appropriations with no control points from Congress (versus year-to-year funding with control points) for mission-critical projects for both SRS and the Hanford Tank Farms Program. The positive impacts and benefits of "multi-year appropriations," as well as having the flexibility to fund subprojects within a cleanup site without seeking Congressional reprogramming, on past EM projects such as Fernald and Rocky Flats, is well-documented. The reliability of stable, flexible funding was a key success factor for these closure sites. Thus, DOE, OMB, and other stakeholders should encourage Congress to provide a more stable funding mechanism for major DOE projects.

2.3.2. EM-TWS recommends a standardized and consistent methodology, such as the software tool BLCC5, which is funded by DOE and maintained by NIST, for analysis of life-cycle cost expressed in NPV for evaluation and decision-making. In addition, the GAO 12-step cost estimating process should be applied to all capital projects for tank waste processing—both line item-funded and operating expense-funded.

2.3.3. EM-TWS recommends that SRS and Hanford (both within the contractors and within DOE) use the standardized approach applying DOE O 413.3B to project planning/management and decision-making for alternatives analysis, including having a documented LCC, for all tank waste processing projects. Consistent with DOE and OMB guidance, EM-TWS recommends that the cost for waste disposition be included in life-cycle cost alternatives analysis for CD-1 selection and documentation. This is in addition to inclusion of capital, operating, decommissioning, and risk uncertainty analysis.

2.3.4. EM-TWS recommends that a consistent probabilistic methodology be developed and adopted for uncertainty characterization that includes sensitivity analysis and a validation process for schedule and cost. Inclusive in the methodology is a validation process that uses a review by industry-based experts to provide cost realism and an evaluation of the uncertainty and sensitivity process. This will allow management to assess overall system uncertainty in alternatives analysis. In addition, while the programmatic baseline is reviewed annually, the risk register and the uncertainty analysis need to be updated or addressed quarterly for risk reduction and prioritization of resources.

2.3.5. The successful installation and operation of SWPF and WTP, including efficiency and continuity of operations, has significant life-cycle cost and schedule impact. The added programs such as supplemental treatment and in-tank treatment could distract the resources and top-level managers from delivering baseline performance and increased productivity of operations. EM-TWS recommends that DOE keep diligent focus on the schedule and cost delivery in accordance with baseline mission requirements as it contemplates added system focus in the potential implementation of new technologies.

2.3.6. EM-TWS recommends DOE-EM develop guidance that defines the accuracy and role of computer models, using a tiered approach, in the public policy process, discusses appropriate ways of dealing with uncertainty, establishes criteria for peer review, and addresses quality assurance procedures for computer modeling. Specifically, 1) quality assurance requirements including model effectiveness, limitations, performance, criteria, application to planning in cleanup alternatives, and inclusion of risk/uncertainty in the model; 2) assessment of the model's compliance with the quality assurance requirements; and 3) an overall strategy to promote consistency, configuration control of data input to modeling processes, at-site and between-site reduction of duplication of modeling efforts; and inclusion of the findings in a lessons-learned program across EM.

2.3.7. EM-TWS recommends the implementation and deployment of a general planning model suited for uncertainty and scenario-based analysis (See 1, 2, and 3), and feasibility/optimization of retrieval, blending, and processing. This would include the capability to propagate uncertainties through the planning process, and characterization of important uncertainties (Reference: *External Technical Review for Evaluation of System Level Modeling and Simulation Tools in Support of Hanford Site Liquid Waste Process*, September 2009, 72 pp).

2.3.8. EM-TWS recommends that DOE EM consider conducting a detailed sensitivity analysis for both SRS and Hanford based on full LCC modeling on both a current-year dollars basis and an NPV basis to allow development of a business case for decision-making purposes.

2.3.9. EM-TWS recommends that performance and acceptance testing criteria for SWPF and WTP should be documented as well as reviewed for potential risks and sensitivity analysis impacts to LCC.

2.3.10. EM-TWS recommends that DOE investigate alternative paths for regulatory relief of milestones for SRS SWPF and WTP LAW processing and weigh the LCC options—based on possible partitioning of waste forms and their disposition—that could lead to expedited processing of the wastes and revisiting of the regulatory commitments.

CHAPTER THREE
Charge 2: Assess Candidate Low-Activity Waste Forms

3.1 Background

The EM-TWS has been charged with evaluating alternative LAW forms that have the potential for treating the low-activity fractions of the high-level tank wastes at the Savannah River Site (SRS) and Hanford Site. Because of the advanced stage of LAW treatment at SRS and the construction of the Salt Waste Processing Facility (SWPF), the EM-TWS review focused on Hanford LAW treatment; however, any potential relevance to SRS LAW treatment is considered.

High-level tank wastes at both SRS and Hanford will be separated into high-level and low-activity fractions for treatment and ultimate disposal. The HLW fraction at SRS and Hanford will be treated using vitrification into borosilicate glass for on-site storage until a national geologic repository is ready for disposal. The LAW fraction at SRS has been treated using a cementitious waste form (denoted Saltstone) and disposed of on-site since 1990, whereas the Hanford HLW Vitrification Facility was designed to treat the entire high-level fraction of the tank wastes, the Hanford LAW immobilization facility (ILAW), which is well over 90 percent constructed was designed to treat less than 50 percent of the expected LAW feed. This first LAW facility will use vitrification to immobilize the LAW in a borosilicate glass waste form for on-site disposal at the Hanford Integrated Disposal Facility (IDF).

The Hanford Federal Facility Agreement and Consent Order (also known as the Tri-Party Agreement or TPA) mandates that all Hanford tank wastes be treated (currently using vitrification) by 2047 (including retrieval from all single-shell tanks and their closure by 2040 and 2043, respectively). Meeting the treatment completion date (including deciding how the remaining LAW will be treated especially if not by vitrification) presents significant programmatic, budgetary, and technical challenges. The high initial capital and operating costs of a second ILAW facility (especially if it is like that currently under construction) has resulted in the consideration of strategies to accelerate the treatment schedule and supplemental treatment alternatives to vitrification. A summary of the results of one such evaluation is provided in Table 1.1A; this and other evaluations resulted in further evaluations of ILAW, bulk vitrification, grouting, and FBSR for possible alternatives to treat the remaining Hanford LAW

3.2 Findings and Observations

The findings and observations enumerated were derived from a review of the presentations and technical reports provided by DOE personnel during face-to-face meetings and from data calls. The impacts related to the various scenarios for accelerating Hanford tank waste treatment are also considered.

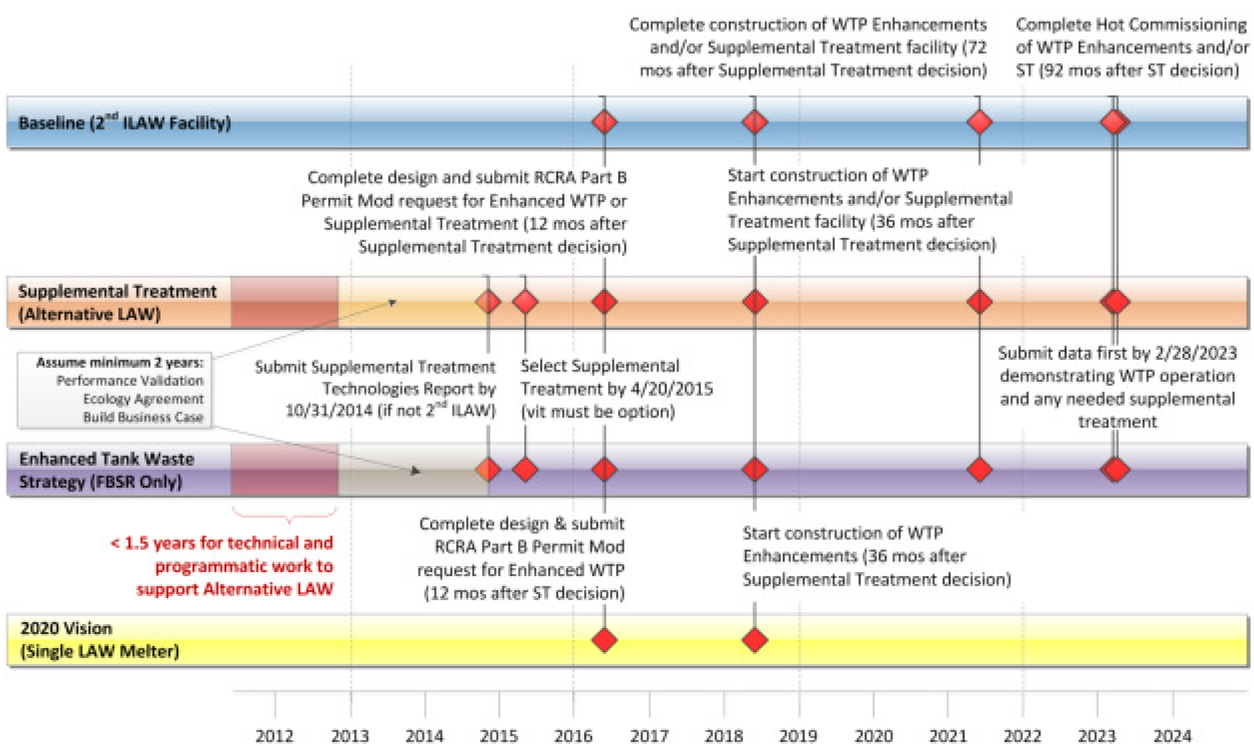
3.2.1 Previous experience indicates there may be insufficient time to develop an acceptable alternative LAW treatment process and waste form.

The information for previous DOE tank waste treatment projects indicates that years have been required to develop treatment technologies and waste forms and to construct and commission these types of facilities for treating HLW and LAW. Based on the milestones in the TPA, DOE must submit a technology report during 2014 if a treatment process other than vitrification is an option for treating the remainder of the Hanford LAW. A decision concerning an alternative treatment for Hanford LAW must be made in 2015.

Alternative treatment technologies (e.g., fluidized steam bed reforming) have been researched; however, as noted by the EM-TEG, these alternative treatment technologies and corresponding waste forms have not been developed to an adequate level allowing for a conclusive evaluation of performance or cost-benefit analysis relative to vitrification / glass. There appears to be little time in the schedule and little available funding to develop the information to support the critical decision of an alternative waste form.

Figure 3.1 demonstrates the critical time period that the Hanford Site has to determine an acceptable path forward for an alternate LAW treatment process. DOE and the stakeholders essentially have less than 1½ years (and perhaps less because of necessary design needs) as of this writing to make a decision on technology application to proceed with permitting and final design / construct to comply with current programmatic milestone dates.

Figure 3.1: Key Dates and Milestones related to Alternative LAW Forms



3.2.2 There appears to be inadequate flexibility in waste treatment processes and strategies.

There has often been a tendency to attempt global approaches (including treatment processes and corresponding waste forms) where possible even if targeted solutions may be available. Global approaches may allow DOE to reduce certain programmatic and budgetary risks; however, there are technical and operational trade-offs that often may result in inadequate processing flexibility. These decisions also appear to have impacted choices of treatment technologies and waste forms; e.g., selecting vitrification of Hanford LAW despite the high initial capital and operating costs of such projects and the potential availability of other viable technologies. There appears to have been some improvements in the selection process with the recent pursuit of advanced glass formulations, in-tank and at-tank pretreatment technologies, and alternative treatment technologies and waste forms.

3.2.3 Vitrification appears to be seen by the Washington State Department of Ecology as the only acceptable technology for Hanford LAW treatment.

The preferred treatment path for both HLW and LAW at Hanford has been defined by the Washington State Department of Ecology as vitrification, with retrievable on-site storage for treated LAW. The Washington State Department of Ecology has maintained for some time that Hanford LAW must be vitrified, or that the waste form produced from any supplemental treatment technology (that is not vitrification) must satisfy the requirements for the glass produced from WTP. Predicting the performance of any waste form for the period of compliance (often millennia) is highly uncertain for any waste form—even one as well known as glass. The selection of a best available technology (which is usual and customary under RCRA) instead of using a performance criterion such as being protective of human health and the environment may unnecessarily restrict treatment options for Hanford LAW. Reasonable alternatives should be considered that could treat the Hanford LAW in a way that meets or exceeds appropriate requirements for land disposal *under relevant uncertainties*. These alternatives may also be tank-specific in nature (i.e., limited to waste in a subset of Hanford tanks).

3.2.4 Modeling that captures relevant controlling processes and conditions must be used to determine the relative performance of an alternative LAW form to that of glass requiring careful management of uncertainties.

There is no single standard test or suite of standard tests that alone can determine the performance of a waste form for a given disposal facility over a period of performance that is very long when compared to available experimental data.

Standard tests such as ASTM C1285 (a.k.a., the Product Consistency Test or PCT), the single-pass flow-through (SPFT) test, and the Vapor Hydration Test (VHT) can provide valuable information concerning the behavior of some waste forms (e.g., for parameterizing models), but do not determine the performance of a given waste form over the many years—often, millennia—required of the waste form. These tests were developed specifically for glass waste forms and have limited applicability to non-glass waste forms. US EPA is developing additional test methodologies that are intended to relate to calibrating performance assessments for a wider range of waste forms, but these tests do not necessarily capture long-term degradation mechanisms. The use of field tests and natural analogues may build confidence in a waste form for a given application; however, modeling must be performed to predict the performance of a waste form for the required centuries or millennia. Available standard tests can be used to parameterize the performance models; however, there are large uncertainties in both the parameters and the models themselves that must be adequately addressed to compare the performance of waste forms over long periods of time that might make such comparisons problematic.

3.2.5 The difficulty in capturing volatile contaminants of concern (e.g., Tc-99) in LAW glass should be taken into account when considering alternative treatment processes and waste forms for Hanford LAW.

The EM-TEG noted the "surprisingly large gap and large uncertainties" in understanding the fate of Tc-99 given the amount of research conducted (albeit largely with simulants like rhenium) and the relative maturity of the treatment processes. The apparent inability to incorporate Tc-99 and other volatile, long-lived radionuclides in waste forms created at high temperatures (e.g., borosilicate glass melted at 1150 °C in ILAW or sodium silicate glass melted at 1300-1350 °C in a bulk vitrification facility) would impact Hanford LAW melter off-gas and recycle streams. The accumulation of these volatile radionuclides and other constituents (e.g., glass formers) may impact the process equipment and the ability to efficiently produce subsequent product batches. The lack of capturing Tc-99 and other volatile radionuclides in the LAW form may also have an impact on the Effluent Treatment Facility (ETF) because there are currently only two outlets for Hanford tank wastes—treated glass and the ETF. This may require additional treatment for the ETF streams as significant quantities of Tc-99 or other radionuclides would violate the ETF Waste Acceptance Criteria (WAC). Off-site disposal, alternative treatment technologies that would immobilize volatile and mobile contaminants of concern, and techniques for better incorporating these contaminants in the current LAW glass are under evaluation

3.3 Conclusions

3.3.1 Recommendations from previous EM-TWS and other reviews that might impact alternative LAW forms have not been fully implemented.

There are various recommendations made in previous reviews that might impact the selection of alternative LAW forms that have not yet been fully implemented. For example, both the 2010 EM-TWS Review and the 2009 DOE External Technical Review (ETR) Team that evaluated Hanford and SRS modeling and simulation tools recommended the development of additional planning models incorporating chemistry. Such tools would allow the facile evaluation of the impacts of treatment and waste form alternatives on the overall disposition path for Hanford tank wastes. However, as noted by the EM-TEG, the Hanford tank waste modeling efforts are not as well-funded, organized, integrated, or focused as in other DOE areas and lack the detailed chemistry and uncertainty information needed. During one of the presentations given by ORP, it was stated that structural enhancements were being made to the Hanford Tank Waste Operations Simulator (HTWOS) Model (used to support System Plan development) to support life-cycle cost modeling and future high-level planning. The enhancements to the HTWOS model are scheduled to be completed by the end of FY2011, which will be useful to support future System Plans and cost analyses but may have little impact on supporting alternative LAW forms. Furthermore, the detailed chemistry and uncertainty management capabilities are not part of the enhancements to the HTWOS model.

3.3.2 Loss of knowledge and expertise in critical areas.

There will be a significant amount of time (more than a decade) between when Hanford LAW treatment processes and corresponding waste forms are first selected (where vitrification has already been selected and an alternative technology may be selected in 2015) and the beginning of WTP operations. This time lag can result in the loss of significant knowledge concerning waste forms and product acceptance. Some evidence of this knowledge loss was observed at SRS during the External Technical Review of modeling and simulation tools.

3.4 Recommendations

3.4.1 Prior to any down-selection for Supplemental LAW treatment, DOE, in conjunction with its regulators, should develop an approach to development and implementation of a treatment process, waste form, and disposition pathway that explicitly addresses the challenging fractions of LAW that limit near surface disposal options and provides a viable option to a second LAW vitrification facility. This will likely necessitate consideration of a separation of Tc-99, and possibly other constituents, that drive near-surface disposal risk to the extent that Tc-99 may not be incorporated into vitrified LAW using the WTP LAW vitrification facility.

Ecology designated vitrification as the preferred treatment technology for Hanford LAW under RCRA and has declared that “as good as glass” is the benchmark by which any successful supplemental treatment technology would be judged. Based on the current milestones in the TPA, these requirements leave little, if any, margin for successfully selecting an alternative LAW treatment technology, even one with potentially significant benefits. Based on the highly variable characteristics of the wastes and forms in the tanks and the contaminants most likely to limit near surface disposal options, a more reasonable path would be to identify and address challenging LAW waste fractions to which a supplemental treatment technology can be successfully applied. Often the most challenging contaminants tend to be volatile, long-live radionuclides like Tc-99 that are difficult to incorporate into the LAW waste glass and are mobile when released into the biosphere. Because of the difficulties that may be encountered in gaining acceptance of any non-glass waste form, this path forward may require the separation of such difficult to manage contaminants (especially Tc-99) in concert with technology and waste form development. Because there is only a brief window of opportunity, for this effort to succeed there will need to be upfront and ongoing collaboration with Ecology on the evaluation and development process if an alternative treatment path way is to be developed. Issues that will need clear communication and thoughtful consideration include information needs, review criteria, consistency with schedule, and regulatory challenges.

3.4.2 DOE should include a targeted processing and treatment approach (that may include segregation and alternative treatment) based on an evaluation of waste characteristics including uncertainties in the system planning process.

There has often been a tendency in DOE to attempt global approaches to treat many different wastes when targeted approaches may make sense both programmatically and economically while meeting risk reduction and regulatory goals. Global approaches may allow the DOE to reduce certain programmatic and budgetary risks; however, there are technical and operational trade-offs that often may not provide adequate processing flexibility and have impacted choices regarding treatment technologies and waste forms.

There are large variations of composition, form, chemistry, and other important properties within the Hanford tank farm vessels. Previous evaluations of the best basis inventories have indicated that some of the contents perhaps would be appropriate for treating and sending to WIPP as TRU waste. Furthermore, contaminants of concern (Cs-137, Sr-90, Pu-239, Tc-99, I-129, etc.) and other important characteristics can vary widely from tank to tank. Because of previous reprocessing of Hanford wastes to capture Cs-137 and Sr-90, some tanks contain salt wastes with relatively low total activities. Thus it may be possible to develop a targeted approach to treating Hanford LAW, for example:

- Treat high-risk wastes (e.g., those with large concentrations of long-lived, mobile radionuclides) with low concentrations of volatile contaminants of concern (e.g., Tc-99 and I-129) in the ILAW facility currently under construction[4].
- If the mineralized waste form is deemed acceptable by Ecology for on-site disposal, treat the remaining high-risk wastes that also have moderate to high concentrations of volatile contaminants of concern using fluidized bed steam reforming (FBSR). A second alternative would be to separate Tc-99 from select high-risk wastes for treatment with grout.
- If an off-site disposal location can be found, treat low-risk wastes using grouting for off-site disposal. Certain LAW streams (e.g., those from the off-gas system) may be solidified for off-site disposal.

The above example is not exhaustive; however, it gives a flavor of the thought processes involved. A formal intentional blending evaluation (that also includes a cost-benefit analysis of constructing a new mixing / blending facility) should be conducted using the results of the targeted scenario analysis. Significant uncertainties should be accounted for in the evaluations to develop a robust strategy for treating Hanford LAW.

[4] It may be found to be advantageous to the overall treatment schedule to manage a "small increment" of very difficult-to-treat wastes outside the vitrification facilities currently under construction using specialized treatment techniques.

3.4.3 Implement previous recommendations that potentially impact alternative treatment technologies and forms for Hanford LAW.

Previous recommendations were made by the 2009 External Technical Review (ETR) Team that evaluated Hanford modeling and simulation tools and the 2010 EM-TWS that should be implemented:

- Complete the enhancements to the HTWOS model to support life-cycle cost modeling and future high-level planning; important tank waste and processing chemistries and significant uncertainties must be incorporated in the planning model to inform System Planning and the alternative treatment technology and waste form selection processes.
- Institute recommendations made by the ETR Team to capture the significant knowledge concerning waste forms and product acceptance that may be lost because of the significant lag (more than a decade) between when Hanford LAW treatment processes and corresponding waste forms are first selected and the beginning of WTP operations.

CHAPTER FOUR
Charge 3: Assess At-Tank or In-Tank Candidate Technologies for Augmenting Planned Waste Pretreatment Capabilities

4.1 Background

The SRS Actinide Removal/Modular Caustic Side Solvent Extraction process (ARP/MCU) has treated nearly 1.5 million gallons of salt waste since beginning operations in April 2008. Full-scale deployment of ARP/MCU technology in the Salt Waste Processing Facility (SWPF) has been delayed from May 2013 to July 2014, albeit with nameplate capacity increasing from 5.7 million gallons per year to 6.8 million gallons per year due to the introduction of an improved cesium extractant.

Without additional salt waste processing capacity, SRS will be unable to meet the Federal Facility Agreement commitment to remove the last old style tank from service by 2022 or the Site Treatment Plan goals of completing waste removal operations by 2028. The construction, commissioning, and operation of the Small Column Ion Exchange Process (SCIX) are expected to not only eliminate this shortfall, but to accelerate the end of waste removal operations by three years to 2025.

The River Protection Plan (RPP) System Plan 5 Base Case is predicated on the entire Hanford Waste Treatment Plant (WTP) starting hot commissioning in 2019. It is now expected that the WTP LAW facility will be available for hot commissioning in 2016. The Vision 2020 scenario has been proposed to take advantage of the early availability of the WTP LAW facility. This would require having a supply of treated LAW before the WTP PT facility starts hot operations.

The SRS SCIX project and Vision 2020 both utilize tank waste processing capacity technologies suitable for installation in or near existing storage tanks. Two other Hanford scenarios, Supplemental Treatment and the Enhanced Tank Waste Strategy, also include tank farm processes for producing treated LAW. The SCIX project pretreatment scheme has three steps: (1) actinide removal, (2) filtration, and (3) cesium removal. Hanford requires two steps: (1) filtration and (2) cesium removal.

4.2 Findings and Observations

Savannah River Site

4.2.1 The EM-TWS is not aware of any formal cost analysis supporting the choice of an in-tank option over an at-tank option.

It has been reported that the in-tank SRS SCIX process is the lowest capital investment option because it can be deployed in the SRS tank farms in existing facilities with minimal construction. This is consistent with the explanation presented to the EM-TWS during fact-finding meetings at SRS in March 2011 that an in-tank option would cost considerably less to build than an at-tank configuration.

4.2.2 The spherical resorcinol formaldehyde ion exchange option was eliminated during the SCIX downselect process for several reasons.

First, CST was considered to be a more mature cesium removal technology. It was concluded that an sRF ion exchange system would be operationally more complex because of the additional processing steps required to elute the media. It was determined that sRF technology could not be implemented at SRS without additional evaporator capacity, a strong disincentive. Finally, it was found that the most of the nitrate stream from the evaporator would return to the tank farm in the form of condensate, requiring storage and eventual treatment in SWPF.

4.2.3 CST is known to form agglomerates in salt waste service.

This has been attributed to leaching of materials from the IONSIV® IE-911 and the formation of aluminosilicate bridges between individual particles. Excess reagents from the IONSIV® IE-911 manufacturing process, such as Si, Ti, Nb, are believed to be the main cause of this problem, although tank waste constituents may also contribute if pH is too low. It has been reported that Ti, Zr, and Nb leach from IONSIV® IE-911 during caustic washing. Three molar NaOH was found to be effective at removing these materials, although they were difficult to wash away completely.

4.2.4 Heat generation due to the high cesium loading capacity of CST has been addressed by limiting the use of CST to small ion exchange column applications.

Process liquid flow and cooling water flow to the SCIX ion exchange column are required to keep the temperature inside the column around 35°C. In the absence of permeate flow and cooling water flow, the temperature in a five foot diameter CST ion exchange column would increase to 130°C, the boiling point of the process liquid, in a little more than one day. Reducing the column diameter to around 30 inches increases this to six days.

4.2.5 Crossflow filtration is a mature technology that has performed well during three years of operation in the ARP/MCU process.

Crossflow filtration is currently being used at SRS where it has been operating in the ARP/MCU process since April 2008. During that time, roughly 1.5 million gallons of salt waste have been treated at a demonstrated filter flux of 0.03 gpm/sq ft. Filter availability has exceeded 90% since the beginning of ARP/MCU hot operation.

4.2.6 The SCIX MST strike process is significantly different from the process currently being used in ARP/MCU.

The ARP/MCU actinide removal process begins with batch mixing of MST and salt waste in a 5,000-gallon mechanically agitated process tank. The MST absorbs strontium and actinides. This is followed by filtration to separate the actinide loaded MST and other solids from the process stream prior to cesium removal using solvent extraction.

In SCIX, the MST strike will occur in a 1,300,000-gallon tank. Mixing will be through the use of three submersible mixing pumps. Although submersible mixing pumps have been used elsewhere in SRS, the combination of changing the mixing technology and significantly increasing the process scale contributes uncertainty to the SCIX process. The SCIX MST strike process has been extensively studied in an 800-gallon prototype tank. Due to the large size difference between the prototype tank and the actual tank, considerable work has been done to establish valid scaleup parameters. Process parameters, such as the number and size of the submersible mixing pumps, have been established based on scaleup from the prototype tank.

Hanford Site

4.2.7 CST and sRF ion exchange processes are both capable of removing cesium from Hanford salt waste.

The sheer quantity of development work already done on sRF for use as an ion exchange resin for Hanford and its selection for use in WTP PT weigh heavily in its favor. Computer modeling was used to analyze the consequences of various scenarios in small column ion exchange including loss of both permeate flow and cooling water flow to a cesium-loaded sRF column. It was determined that the temperature would not reach the permeate boiling point.

CST ion exchange is being considered for in-tank and at-tank cesium removal processes at Hanford. During bench scale column testing of Hanford AW-101 supernate over 700 bed volumes were treated with CST before reaching fifty percent cesium breakthrough.

In the SRS SCIX process, spent CST, loaded with Cs-137 will be ground using an immersion mill installed in one of the Tank 41 risers. A similar process, using an immersion mill installed inside a tank riser, has been used before at SRS for processing zeolite. No significant problems were encountered. Presumably, a similar arrangement would be used at Hanford. The EM-TWS does not have any specific information on the deployment of a CST process at Hanford.

4.2.8 Crossflow filtration is a mature technology well suited for treating Hanford salt waste.

Crossflow filtration was tested at engineering scale using Hanford simulant in the Process Engineering Platform (PEP). The Process Engineering Platform includes a prototype of the crossflow filters being installed in the Hanford WTP PT process, but with a reduced number of full-size filter elements. Crossflow filtration has been used successfully in the ARP/MCU process at SRS since April 2008. It is reasonable to expect it will also perform well treating Hanford salt waste.

4.3 Conclusions

Savannah River Site

4.3.1 EM-TWS concurs with the Savannah River Site's characterization that SCIX is a developmental process.

SRS provided EM-TWS with the following description of the SCIX project:

> SCIX is a technology development and demonstration program. The SCIX activity will conduct an integrated full-scale operational test in order to obtain data and determine the feasibility for long-term deployment in an operational tank farm environment. Following that, DOE will make a determination (based on the results of testing and data evaluation) as to the potential for continued operations, or what if any capital improvements (engineering development) are needed to conduct long-term operations.

4.3.2 CST is the preferred on exchange medium for SRS.

An engineered form of CST, IONSIV® IE-911, was used in skid mounted ion exchange columns, one foot in diameter, at Melton Valley. About 30,000 gallons of radioactive supernate was processed with minimal difficulty during the ORNL Cesium Removal Demonstration Process. After the demonstration, the skid-mounted ion-exchange system was modified and operated from 1997 through 2000, where it was successfully deployed for 14 operational campaigns. During this period, the system processed more than 215,000 gallons of radioactive supernate. In all, over 250,000 gallons of radioactive waste were treated at ORNL using CST.

Laboratory-scale testing has been completed using IONSIV® IE-911 to treat SRS simulants and actual waste. In tests using salt solution from SRS Tank 44F, it was found that the treated waste met all Saltstone requirements for Cs-137.

Tests using a caustic washed version of CST, IONSIV® IE-911 CW, with bounding simulants resulted in only weak clumping over several weeks with minimal impacts expected for real waste processing.

The sRF ion exchange system would be operationally more complex because of the additional processing steps required to elute the media. It was also determined that sRF technology could not be implemented at SRS without additional evaporator capacity, a strong disincentive. Finally, it was found that the most of the nitrate stream from the evaporator would return to the tank farm in the form of condensate, requiring storage and eventual treatment in SWPF.

Spent CST, loaded with cesium, will be ground using an immersion mill installed in one of the Tank 41 risers. A similar process, using an immersion mill installed inside a tank riser, has been used before at SRS for processing zeolite. No significant problems were encountered in that service.

4.3.3 The potential exists to generate high temperature and pressure in the SCIX ion exchange column.

Computer modeling, completed in 2010, provided an estimate of conditions that would result from two scenarios: loss of permeate flow to a loaded CST column and loss of both permeate and cooling water flow to a loaded CST column. Loss of permeate flow could possibly occur due to loss of electricity, feed pump mechanical failure or CST an ion exchange column. The loss of cooling water flow could be caused by the loss of electricity or cooling water pump failure, among other things. The SCIX Conceptual Safety Design Report identified ion exchange column over-pressure and explosion as a credible scenario if this occurs.

4.3.4 Rotary microfiltration is a promising technology that needs to be demonstrated on actual wastes in a tank farm.

Rotary microfiltration has not yet been used to process actual salt waste at full scale in an operating environment. Single disk units have been run using actual waste from SRS and Hanford. Full size filters have operated for over 3500 hours on simulants, demonstrating both salt waste filtration and sludge washing capabilities. Operation on actual wastes in a tank farm environment will occur during the SCIX system start-up beginning in June 2012.

The rotary microfilter contains two rotating seals and a bottom bearing, all of which have been modified based on problems encountered over more 3,500 hours of operation with full size units. The most recent 1000 hours of operation has been uneventful, with no seal leaks observed during sludge washing trials using simulant up to 15 weight-percent solids. While these results are very encouraging, mechanical reliability and maintainability have not been demonstrated during hot operation in an actual tank farm environment.

Hanford Site

4.3.5 In general, sRF ion exchange resin is a better choice than CST for the Hanford in-tank pretreatment cesium removal step. An exception is the use of disposable CST canisters in the Vision 2020 scenario.

In 2002, due to ORP concerns over the risk posed by reliance on a single supplier, Bechtel National began work to find an alternative to SuperLig® 644 ion exchange resin. Batch and column testing of ground resorcinol formaldehyde (sRF) resin was conducted at Pacific Northwest (National) Laboratory and the Savannah River Laboratory. The RF resin was found to have high cesium loading capacity and selectivity for Hanford tank waste. Side by side testing of spherical RF, ground RF, and SL-644 using AZ-102 simulant showed that the spherical resin had adequate capacity and kinetics, better elution performance, and lower pressure drop during column operations than the ground RF and SL-644. In addition to concerns about lack of multiple suppliers, the physical breakdown of SuperLig® 644 during repeated loading, elution, and regeneration cycles was a serious problem. Ultimately, spherical RF resin was chosen over SuperLig® 644.

Results for two bench-scale sRF ion exchange tests using actual Hanford waste from AP-101 and AN-102 were reported to be acceptable. The results agreed with models and simulant testing. Exhaustive testing has been performed with Hanford simulants, including tests in a two-foot diameter column, which is close to the size proposed in the Hanford in-tank and at-tank conceptual designs.

CST ion exchange is being considered for in-tank and at-tank cesium removal processes at Hanford. During bench scale column testing of Hanford AW-101 supernate over 700 bed volumes were treated with CST before reaching fifty percent cesium breakthrough.

The models that were used to assess thermal risks associated with discharging fully loaded, ground, CST into SRS storage tanks do not apply to the Hanford tanks, which differ from SRS tanks in a number of ways, including sludge properties, potential number of mixing pumps, and tank internals.

Using CST at Hanford is complicated by the fact that cesium-loaded CST will be comingled with sludge in the Hanford waste storage tanks for many years before being treated in the WTP. Little if anything is known about the long-term chemical behavior of CST mixed with Hanford tank waste, an environment that is high pH and saturated with aluminum and other compounds. There is also a potential for the CST to agglomerate and harden, making waste retrieval difficult. It is not known how the presence of CST in sludge would affect the WTP PT performance.

4.3.6 Rotary microfiltration is a promising technology that needs to be proven treating actual wastes in a tank farm environment before being deployed at Hanford.

Rotary microfiltration is a developmental technology that has not yet been used to process actual supernate or dissolved saltcake at full scale in an operating environment. Operation on actual wastes will occur during the SCIX system startup beginning in June 2012. Routine operations at SRS are expected to begin in November 2013.

4.4 Recommendations

Savannah River Site

4.4.1 EM-TWS recommends that SRS document the SCIX alternatives down- select process, including financial analysis, in support of the decision to select in-tank treatment over other options.

4.4.2 Steps must be taken to mitigate the risk of CST agglomeration.

a. Only the caustic-washed version of CST, IONSIV® IE-911-CW should be used in the SCIX process.

b. Storage stability specifications should be established and requisite testing should be part of the QA process.

c. Provision should be made for robust on-site washing of CST ion exchange media using 3M NaOH shortly before the CST is transferred into the SCIX ion exchange column, unless storage stability testing demonstrates this is not required.

IONSIV® IE-911 is known to form agglomerates in salt waste service. Excess reagents from the IONSIV® IE-911 manufacturing process, such as Si, Ti, Nb, are believed to be the main cause of this problem, although tank waste constituents may also contribute if pH is too low. It has been reported that Ti, Zr, and Nb leach from IONSIV® IE-911 during caustic washing. EM-TWS understands that a caustic washed version of CST, IONSIV® IE-911-CW, will be used in the SCIX process. Additional leaching of IONSIV® IE-911-CW can be expected to occur during resin storage. Current SRS plans only include minimal on-site caustic pre-treatment.

4.4.3 EM-TWS recommends that a detailed safety basis and HAZOP review be conducted to document passive safety design for the SCIX ion exchange process.

Cesium-loaded CST ion exchange media will generate a significant amount of heat. Simultaneous losses of permeate feed and cooling water flow to a SCIX ion exchange column, containing cesium-loaded CST, would result in column temperatures exceeding the boiling point of the process liquid. The SCIX Conceptual Safety Design Report identified ion exchange column over pressure and explosion as credible scenarios.

Wall temperatures exceeding 100°C may adversely affect the integrity of waste storage tanks. Based on models used to assess thermal risks associated with discharging cesium-loaded CST (ground and unground) into SRS storage tanks, it was concluded that it may be possible to have wall temperatures exceeding 100°C.

Hydrogen generation from radiolysis caused by cesium-loaded CST ion exchange resin is also of concern in the ion exchange column and in storage tanks containing ground cesium-loaded CST.

4.4.4 EM-TWS recommends full scale testing to ensure that a homogeneous bed of IONSIV® IE-911-CW can be established and operated without channeling which could adversely affect Cs-137 removal.

CST ion exchange media will be loaded in the 11-inch wide annular space between the vessel wall and the central cooling pipe. Although it is reasonable to expect that column hydraulics will be satisfactory, this is an unusual design that should be verified by testing at full scale using IONSIV® IE-911-CW and a salt solution with density and viscosity similar to that of actual salt waste.

4.4.5 EM-TWS recommends that the 1.3-million-gallon tank mixing design be reviewed by an external panel to assure the design will meet MST strike performance objectives.

Mixing technology/scale up are critical technology elements of the SRS SCIX process. The current ARP/MCU includes a step called MST strike, in which actinides and strontium are absorbed using monosodium titanate in a 5,000-gallon, mechanically agitated process tank. The proposed SCIX process uses submerged mixing pumps to disperse MST in a 1.3-million-gallon storage tank. Although considerable work has been completed on scale up strategy and mixing related aspects of the MST strike have been studied in an 800-gallon tank, external design review should be completed by outside subject matter experts.

Hanford Site

4.4.6 Spherical resorcinol formaldehyde ion exchange resin meets the technical requirements for cesium removal in the short-duration Vision 2020 scenario. However, EM-TWS recommends evaluation of other potentially simpler options for Vision 2020, such as those presented in Appendix 11 of this report.

A significant amount of development work has been completed using sRF ion exchange resin in support of the decision to use it for the WTP PT cesium ion exchange process. While it is clear that an sRF based cesium removal process would meet the technical objectives of the Vision 2020 scenario, other options such as those described in Appendix 11 (Vision 2020) may be simpler and less expensive to deploy.

4.4.7 EM-TWS recommends the use of sRF ion exchange resin for long-term in-tank and at-tank cesium removal processes.

Spherical resorcinol formaldehyde is the preferred choice for the Hanford tank farm long-term pretreatment options using an ion exchange cesium removal process. This choice is based on the extensive development work already completed on sRF for use as an ion exchange resin for Hanford and its selection for use in WTP PT.

CST ion exchange is being considered for in-tank and at-tank cesium removal processes at Hanford. Bench scale column testing of CST treating actual Hanford supernate indicates that CST can adequately cesium from Hanford salt waste. The high cost of CST and the fact that it cannot be eluted work against its selection for treating large quantities of Hanford waste.

Using CST at Hanford is complicated by the fact that cesium-loaded CST will be comingled with sludge in the Hanford waste storage tanks for many years before being treated in the WTP. Little if anything is known about the long-term behavior of CST mixed with Hanford tank waste, an environment that is high pH and saturated with aluminum and other compounds. There is potential for the CST to agglomerate and harden, making waste retrieval difficult. It is also not known how the presence of CST in sludge would affect the WTP PT performance.

4.4.8 EM-TWS recommends crossflow filtration for processing Hanford AP tank farm supernate. An in-tank CFF option should be evaluated for the Vision 2020 scenario.

Crossflow filtration (CFF) has been tested using Hanford simulants at engineering-scale testing in the Process Engineering Platform. More importantly, CFF has been proven in similar service during three years of successful operation at SRS in the ARP/MCU process.

Based on permeate flux rates demonstrated at ARP/MCU, it may be possible to meet the Vision 2020 process requirements with a single filter bundle approximately 15 inches in diameter and ten feet long. A unit of this size could be installed inside a tank riser.

4.4.9 EM-TWS recommends a comprehensive experimental program with actual samples of AP tank farm supernate using the CFF module and bench-scale sRF ion exchange columns before declaring Vision 2020 as having reached the CD-2 milestone.

Crossflow filtration and sRF ion exchange resin are fully expected to meet the requirements of the Vision 2020 scenario. Bench-scale testing with samples of AP tank farm supernate is needed to validate and refine the design basis for the Vision 2020 scenario.

4.4.10 EM-TWS recommends proceeding with additional RMF testing with a range of actual Hanford tank waste samples using the single disk RMF. Mechanical reliability and maintainability need to be demonstrated during actual operation of the SRS Tank 41 SCIX process before deploying RMF technology at Hanford.

The SCIX project is a technology development and demonstration program that includes an integrated full-scale operational test to obtain data and determine the feasibility for long-term deployment in an operational tank farm environment. It would be premature to deploy a second RMF at Hanford before proving the first one at SRS. However, if additional testing of Hanford waste is done using the single disk RMF test unit in parallel with the SRS SCIX project; it should be possible to compress the schedule for advancing rotary microfiltration to CD-2.

CHAPTER FIVE
Charge 4: Evaluate Various Melter Technologies

5.1 Background

Over the last 30 years, the EM program has considered various melter technologies and operational strategies to increase the efficiency of tank waste vitrification processes. The EM-TWS has considered different approaches and technologies that could be considered as next-generation replacement melters to the currently used (or planned for use) Joule-heated melters. The merits of different glass formulations—both advanced borosilicate and other glass types; e.g., iron phosphate—as they apply to the advanced melter technologies are given in Appendix 8.

5.2 Findings and Observations

5.2.1 Joule-heated technology is the preferred technology.

Joule-heated, ceramic-lined melter technology without bubblers has been proven a reliable process in both the SRS and West Valley operations.

Increasing the operating temperatures of Joule-heated melters to improve waste loading is likely to result in unintended negative consequences in fission product loading in the glass.

5.2.2 Alternative technologies to Joule-heated melters are in various stages of maturity.

Cold crucible induction melting (CCIM) is the most advanced alternate melter technology and has the greatest potential for producing significant changes in terms of increased temperature and alternate glass performance.

CCIM may be useful for increasing the waste loading through increased operating temperature without the negative effects on refractories and electrodes that would be experienced by Joule-heated melters.

Implementation of new melter technologies in order to achieve major increases in throughput are likely to be limited by other bottlenecks in the system such as retrieval rates from the tank farms, pretreatment, waste handling, off gas treatment, and canister cooldown.

5.2.3 Melter technology calls for certain operational considerations.

Implementing a new technology in an already operating hot facility is very risky.

Supplemental LAW vitrification melter technology will be based on limited feed stream data; therefore, the EM-TWS recommends current Joule-heated technology with continuous improvement for process efficiency and performance.

Waste feed sequencing must be established with evaluation of various blending strategies prior to consideration of any new melter technology decision process.

Implementation of melter improvement technology to improve waste loading, other than for new glass formulations, is the modification least likely to encounter bottleneck issues.

The use of bottom drains would allow for better removal of residual HLW glass, reducing the radioactive fields resulting from a melter failure.

An upstream change that could be made to improve the operation of the melters at WTP is the installation of a flexible tank blending system.

5.3 Conclusions

5.3.1 Operating experience/history is the most important factor in choosing a technological option.

The choice of melter technology will not significantly affect the capital or operating costs of the projects at any site. It is far more important to choose technology that has significant operating experience and is more likely to keep the projects on schedule.

Joule-heated melter technology is still the only proven technology for use in the vitrification of U.S. high-sodium wastes; it is recommended that it should remain the baseline technology for vitrification until another technology has been proven superior in an appropriate operating environment.

5.3.2 The Joule-heated melter is the preferred treatment for supplemental treatment.

Such a facility should be built with enough flexibility to accommodate new technology in the future if there is a compelling need for doing so. Development of an alternative technology should only be pursued if the compelling need is adequately defined, including the business case. Any alternative technology should be demonstrated in a separate facility at or near full scale before being implemented in one of the primary processing facilities.

5.3.3 Backfitting of alternate technologies in operating HLW facilities is not recommended unless the technologies are sufficiently mature.

Backfitting of alternate technologies in operating HLW facilities is not recommended unless the technologies are sufficiently mature; that is, the replacement technology has a TRL of no lower than 7 in similar service in a Critical Decision (CD) process and it offers very significant advantages in terms of waste loading and reliability.

Backfitting to LAW facilities using new technology with a TRL of not lower than 7 may be cost-effective as long as there are no other rate-limiting processes, adequate allowances have been made for the downtime and cost of working in radioactive facilities, and there are significant advantages in terms of waste loading and reliability. To aid the future use of an alternate technology, allowance for space, power supplies, etc. could be made in the construction of additional LAW facilities at Hanford.

Fluid Bed Steam Reforming (FBSR) technology shows some promise. However, it has not yet been operated for a significant time on Hanford LAW waste and the waste form it produces has not yet been accepted by the Washington State regulatory body. Due to the time that it would take to accomplish these two tasks, it would be better to go forward with a technology such as the advanced JHCM or CCIM that is well proven and produces a waste form that already acceptable to all.

5.4 Recommendations

5.4.1 It is recommended that near term technological development focus on Joule-heated melters and improvements therein.

The main objective in the near term for DOE melter development funding should be improvements in the operation of Joule-heated melters. Such items as advanced glass formulation, bubblers, molybdenum electrodes, and water-cooled skull technology are examples.

Cold operation in pilot test facilities (i.e., at least 1/10 scale) is necessary before hot operation should be contemplated at any scale. Hot operation at bench scale should then be carried out on actual waste to verify that there are no unexpected issues before larger-scale design work is initiated.

5.4.2 To aid in the scheduling, a chemistry-based systems model that would allow optimum scheduling of the tanks to be processed is also recommended.

To minimize vitrified waste, installation of a flexible blending facility is recommended at WTP to allow potentially troublesome wastes (e.g., sulfates, phosphates) to be diluted. To aid in the scheduling, a chemistry-based systems model that would allow optimum scheduling of the tanks to be processed is also recommended.

5.4.3 If an alternative is needed, CCIM is the recommended technology.

CCIM is the recommended alternative due to its more mature state of development compared with the other alternatives and its potential for higher temperature operation with new glass forms such as iron phosphate (FeP) that can increase waste loading for certain waste streams.

CHAPTER SIX
Charge 5: Evaluate the Reliability of Waste Delivery Plans

6.1 Background

The EM-TWS has been charged to evaluate the reliability of high-level tank waste feed delivery plans for the Hanford and Savannah River Sites. These wastes are considered to pose the highest environmental and human health risks in their corresponding States. At both sites, tank wastes are *retrieved*, *pretreated* including separation of the waste into higher and lower activity fractions and then *treated* in separate facilities before the resulting waste forms are *disposed* in different locales.

Differences between these major DOE sites impact the ability of each site to reliably deliver feeds for treatment, The differences between sites include the stage of tank waste processing, the nature of the wastes to be processed, the retrieval methods and endpoints for closure, the pretreatment and treatment methods and waste forms, and the interim storage and disposal options. There is also a critical balancing act in terms of retrieving, pretreating, qualifying and treating the different types of tank wastes at the two sites to assure processing effectiveness and a timely end of mission without a preponderant need for special treatment (e.g., producing salt-only waste forms).

The primary differences between the two sites are the stage of the waste treatment processing at each site and the corresponding need and schedule for waste feed delivery. At the Savannah River Site (SRS), treatment and disposal of low-activity waste (LAW) in the Saltstone Processing and Disposal Facilities began in 1990. Vitrification of the high-level, insoluble sludge portion of the tank waste began in the Defense Waste Processing Facility (DWPF) in 1996. To date six of the projected 17 total sludge batches have been treated at SRS. Processing of the high-activity salt portion of the tank waste began in 2007 with the Deliquification, Dissolution, and Adjustment (DDA) process on the Tank 41H waste (completed in 2008). Additional salt processing began in 2008 with the Actinide Removal Process (ARP) / Modular Cesium Removal Unit (MCCU) and will continue until the Salt Waste Processing Facility (SWPF) begins production. To balance the treatment of the high-activity salt and sludge tank wastes through the SWPF and DWPF will require a significant increase in the retrieval, pretreatment and qualification of SRS tank wastes.

Construction of the Hanford Tank Waste Treatment and Immobilization Plant (WTP) is approximately over 50 percent complete. The WTP is scheduled to begin radioactive operations in 2019. The WTP will treat (using vitrification) the entire high-activity fraction of the tank wastes (for off-site disposal) and up to 50 percent of the corresponding LAW fraction for on-site disposal. Of the 177 high-level waste tanks at the Hanford Site, 149 are single-shell tanks (SSTs) many of which have leaked or were suspected of leaking in the past. These single-shell tanks were declared a non-compliant treatment, storage, and disposal (TSD) facility under the Resource Conservation and Recovery Act (RCRA). Because of concerns with risks associated with the SSTs, the tank waste retrieval process planned at Hanford consists of two general phases: 1) retrieving wastes from SSTs for transfer to double-shell tanks (that are RCRA-compliant) for staging and subsequent tank closure activities and 2) mixing, staging, and delivery of the SST waste to treatment facilities.

Tank waste characterization, retrieval, and consolidation operations have been continuing at the Hanford Site in preparation for beginning WTP radioactive operations. The wastes from seven Hanford single-shell tanks (SSTs) have been retrieved to the criteria defined in the Hanford Federal Facility Agreement and Consent Order (also known as the Tri-Party Agreement or TPA). A maximum of three retrievals were completed in 2006. However, waste retrievals must increase dramatically over the next two decades (to a maximum of 12-14 in a single year) to support the current treatment schedule [ORP-11242, Rev. 5] and to satisfy TPA milestones. The waste acceptance criteria (WAC) for the Hanford tank waste treatment facilities and the disposal facilities have not been finalized making the limits on and targets for Hanford waste feed delivery uncertain.

Successful treatment of Hanford and SRS tank wastes would require improvements in various feed delivery processes including retrieval, pretreatment, and qualification. Treatment improvements would be needed at Hanford and would help SRS accelerate its treatment schedule and reduce life-cycle costs. Because of the advanced state of operations at SRS, reasonable options include improved separations and filtering technologies (Appendix 7 of this report), waste glass formulations, and Joule-heated, ceramic-lined melters (Appendix 8 of this report). The potential options for improving feed delivery and treatment at Hanford are more open-ended, especially because operations have not yet begun and some facilities have not been selected. Alternative scenarios are being evaluated for completing and accelerating the Hanford treatment schedule as indicated in Table 1.1A.

6.2 Findings and Observations

The findings and observations enumerated here were derived from a review of the presentations and technical reports provided by DOE personnel during face-to-face meeting and from data calls for this charge.

6.2.1 There is a critical need to balance the retrieval, pretreatment, and qualification processes and the treatment of the resulting low-activity and high-activity tank waste feeds at both the Savannah River and Hanford Sites.

A requisite balance must be established and maintained between the preparation of tank waste feed material (retrieval, pretreatment, and qualification) and its subsequent treatment to satisfy various contract requirements and programmatic needs including minimizing the potential mismatch between the treatment of the higher and lower activity waste fractions. At SRS, such a balance appears to have been struck between the production of qualified sludge and salt feed batches in the tank farm (including DDA and ARP / MCCU for salt treatment) and the treatment processes in DWPF and Saltstone Processing and Disposal Facilities. The changes that have been made to the DWPF melter to increase throughput (and potentially waste loading) and the construction and startup of the Salt Waste Processing Facility (SWPF) will require an increase in the production and qualification of waste material for subsequent treatment and the striking of a new balance between feed preparation and treatment at SRS.

A balance similar to that which was struck at SRS must be established and maintained at the Hanford Site. The delivery of qualified feed to the WTP is more complicated than that at SRS because there are more tanks at Hanford with more waste types—some of which are inter-mixed and recalcitrant, resulting in more complicated characterization, retrieval, pretreatment, and qualification to produce feeds for the much higher contract rates for treatment at the WTP. As more information is obtained, the second Hanford LAW treatment facility can be sized to help strike such a balance. The valuable information that has been learned from the pretreatment and delivery of waste at SRS for the past 15+ years can be applied at both sites.

6.2.2 To satisfy current schedules and milestones and to balance feed delivery and treatment of LAW and HLW, there will be a need to increase the production of qualified salt and sludge feeds at both the Savannah River and Hanford Sites.

In terms of waste feed delivery for subsequent treatment, the primary differences between the Savannah River and Hanford Sites are the stage of the waste treatment processing at each site and the corresponding need and schedule for waste feed delivery. At the Savannah River Site (SRS), treatment and disposal of low-activity waste (LAW) in the Saltstone Processing and Disposal Facilities began in 1990 and the corresponding vitrification of high-activity, insoluble sludge portion of the tank waste began in the Defense Waste Processing Facility (DWPF) in 1996. Processing of the high-activity salt portion of the tank waste began in 2007 and will accelerate when the Salt Waste Processing Facility (SWPF) begins production. To balance the treatment of the SRS high-activity salt and sludge tank wastes through the DWPF and Saltstone Disposal Facility as currently planned will require a significant increase in the retrieval, pretreatment and qualification of SRS tank wastes.

The Hanford Tank Waste Treatment and Immobilization Plant (WTP) is under construction and is currently scheduled to begin Hot operations in 2019. The WTP is designed to treat the entire soluble fission products as well as insoluble fraction of the tank wastes and perhaps 50 percent of the corresponding low-activity salt fraction. Of the 177 high-level waste tanks at the Hanford Site, 149 are single-shell tanks (SSTs), many of which were overfilled, have leaked, or were suspected of leaking in the past and represent the majority of the risk posed by tank wastes at the site. Tank waste characterization, retrieval, and consolidation operations have been ongoing at the Hanford Site in preparation for commencing WTP radioactive operations. To date the wastes from seven single-shell tanks (SSTs) have been retrieved to the criterion defined in the TPA with a maximum of three retrievals in 2006. However, the waste retrievals (with corresponding pretreatment and qualification) must increase dramatically over the next 2½ decades (to a maximum of 12-14 in a single year) to support the current treatment schedule and to satisfy TPA milestones.

6.2.3 The feeds and tank farm operations (especially those involving single-shell tanks) at the Hanford Site are complex, interdependent, and highly constrained, which may impact waste feed delivery and thus treatment.

At SRS, the Plutonium Uranium Reduction Extraction or PUREX process (which included the H-Area Modified or HM PUREX process) was used to separate plutonium; whereas at Hanford the PUREX process was used in conjunction with the Bismuth Phosphate and Reduction Oxidation (REDOX) separations processes. At SRS the resulting PUREX and HM sludge wastes were neutralized and stored in separate tanks to the extent possible. At Hanford many of the tank wastes were reprocessed to recover uranium and fission products, and wastes were often intermixed based on tank availability. Thus, when compared to SRS, there are more waste tanks containing more waste types (that often were mixed) resulting in more variable wastes, including some that are recalcitrant, making characterization, retrieval, processing, and qualification more difficult than at SRS. There are also significant constraints on the order that waste tanks (i.e., the single-shell tanks) will be processed based on the milestones in the Consent Decree in *Washington v. DOE*, Case No. 08-5085-FV and Hanford TPA.

6.2.4 Upgrades will be needed to the Hanford Effluent Treatment Facility (ETF) to treat liquid wastes generated from the WTP.

The Effluent Treatment Facility is a state-permitted facility that receives (via the Liquid Effluent Retention Facility) and treats liquid wastes from various sources on the Hanford Site. The ETF treatment processes remove radioactive and hazardous contaminants from the wastewater for storage until tests confirm that various contaminants have been removed or lowered to levels making it acceptable for discharge to a state-approved disposal site in Hanford's 200 Area. Treating wastewater from the WTP will require upgrades at ETF to manage increased throughput (approximately twice the 28 Mgal currently treated) and increased corrosion potential from WTP effluents. There may also be a concern with the level of volatile radioactive constituents (e.g., Tc-99 and I-129) from the LAW melter off-gas system that may exceed acceptable levels for ETF treatment.

6.2.5 The WAC for the Hanford tank waste treatment facilities and corresponding disposal facilities have not been finalized, which may impact waste feed delivery.

Before pretreated waste can be fed to Hanford treatment facilities, samples must be collected and tested to assure that the waste meets WAC for the treatment facility. Two such treatment facilities are currently under construction at the Hanford WTP. The high-level waste vitrification (IHLW) facility has been designed to treat the entire expected high-activity insoluble portion of the Hanford tanks wastes and the Cs-137 in the salt wastes that poses the major source of radiation. The low-activity vitrification (ILAW) facility currently under construction is designed to treat a portion of the low-activity fraction of the salt wastes, and thus supplemental treatment will be necessary to treat the remaining salt waste to meet TPA milestones.

The key interface for success of the ORP tank waste treatment mission is the waste feed delivery interface that ensures the timely, efficient, and compliant delivery of feed from the tank farm to the WTP. The WAC and physical and administrative details for the feed delivery interface are described in *ICD 19 – Interface Control Document for Waste Feed* [Hall 2008]. Important aspects of this critical interface are being resolved including the WTP waste acceptance data quality objectives and an evaluation of the ability to adequately mix, sample, and deliver individual feed batches to the WTP for treatment. Because key aspects of the feed delivery interface have not been finalized, the limits on and targets for Hanford waste feed delivery are uncertain. Furthermore, the acceptance criteria and permits required for the disposal facilities for both the high-level and low-activity waste forms that will be produced from the Hanford WTP have not been finalized (or, in some cases, have not been started).

6.2.6 Representative mixing and sampling in the large Hanford tank farm tanks that will be necessary to support waste feed delivery for treatment in the WTP will likely be problematic.

Pretreated wastes at Hanford must be sampled and analyzed to demonstrate that they satisfy WAC and feed specifications for the corresponding treatment facility per *ICD 19 – Interface Control Document for Waste Feed*. These requirements translate into the need to satisfy appropriate requirements to high confidence (i.e., 95 percent confidence for fissile components and 90 percent for others). Representative sampling cannot be assured in the large tanks that will be used to stage wastes for delivery to WTP. An evaluation is currently underway of the ability in the tank farm to adequately mix, sample, and deliver individual feed batches to the WTP for treatment. If methods cannot be identified or developed to allow limits to be satisfied to the high confidence required, additional sampling and analysis may be required that would impact pretreatment, qualification, and delivery schedules. Resulting delays would impact treatment schedules and possibly jeopardized the making of important treatment milestones.

6.2.7 Options may be needed to temporarily store treated TRU, low-activity and high-level waste forms at the Hanford Site to manage waste feed delivery and treatment schedules and to satisfy milestones.

The current plan is to send treated TRU waste to the Central Waste Complex (CWC) in the Hanford 200 West Area assuming that the waste would be acceptable for interim storage at the CWC (an interim status RCRA facility) pending a determination of final disposition. The treated LAW would be sent to the Hanford Integrated Disposal Facility (IDF) and disposed in the cell permitted as a RCRA Subtitle C landfill system; however, the IDF performance assessment is pending completion of the Tank Closure and Waste Management (TC & WM) Environmental Impact Statement (EIS) and Record of Decision (ROD). The treated HLW will be stored at the Interim Hanford Storage Facility (IHSF) in the 200 East Area, which is expected to be operational by 2018 even though the design and construction of this facility have not been planned in detail.

Current schedules indicate that if sufficient funding is provided and no unforeseen difficulties arise during permitting activities, then the required storage and disposal facilities will be available to support WTP operation. However, if there are difficulties in funding, building or permitting the HLW storage facilities or in permitting the Integrated Disposal Facility for treated LAW or the CWC for planned TRU wastes, then options may be needed to temporarily store treated TRU, HLW and/or LAW forms. Under these circumstances, a lack of such storage would impact WTP treatment operations as well as feed delivery and ultimately tank farm operations.

6.2.8 The Hanford 242-A Evaporator is a single point of failure that may impact waste feed delivery even if additional evaporator capacity is introduced.

The 242-A Evaporator must continue to operate throughout the lifetime of the River Protection Project (RPP) mission as it is the only such facility to support SST retrieval operations, to maintain the appropriate sodium concentration in the feed delivered to WTP, and to manage space in the DSTs. Additional evaporator capacity is being researched (e.g., wiped or thin film evaporation technologies). System sizing and throughput of proposed technologies being considered do not appear to be of sufficient capacity nor does the technology selection appear to be effective for back-up for evaporation of significant water process needs to replace the 242-A Evaporator.

Without additional evaporative capacity of the type provided by the 242-A Evaporator, a significant failure of the 242-A Evaporator requiring a long-term outage might impact available DST space, SST retrievals, and ultimately the timely delivery of feed to the WTP for treatment. Furthermore, plans will require much higher annual availability of the 242-A Evaporator beginning in 2030 when the Evaporator will be over 50 years old through 2040 where the risk of failure would likely increase with the age of the evaporator.

6.2.9 Fouling may still be an issue in the Savannah River 242-16H (2H) Evaporator System.

The 242-16H or 2H-Evaporator system at SRS is used to evaporate the recycle stream coming from DWPF. In 1997 the 2H-Evaporator began processing silicon-rich wastes from the DWPF recycle that were mixed with an alumina-rich stream from H-Canyon reprocessing operations. The evaporator became fouled and was finally shut down in October 1999. A method was developed to successfully clean the evaporator pot with dilute nitric acid. Despite improvements in cleaning the evaporator pot, fouling still occurs in the 2H-Evaporator system and the need to increase feed production and/or changes in recycle composition resulting from possible melter and off-gas changes as well as waste composition and frit changes may impact fouling in the evaporator system.

6.2.10 Factors have changed that may make fluidized bed steam reforming (FBSR) not the most appropriate technology to destroy organics in the SRS Tank 48H waste.

Tank 48H contains approximately 250,000 gallons of a salt solution containing 22,000 kg of tetraphenylborate (TPB) and 400,000 Ci of Cs-137. Fluidized bed steam reforming was selected to process this unique organic waste. Since the selection of FBSR to treat the Tank 48H waste, a number of factors have resulted in a review of the costs, schedule, and technical maturity criteria. This review has led to the evaluation of competing technologies including direct vitrification and a copper-catalyzed chemical oxidation process that was not considered in previous evaluations.

6.2.11 A large number (approximately 30) of projects must be completed to pretreat and feed low-activity waste to the ILAW facility.

There are numerous projects (perhaps as many as 30) that must be completed before Hanford low-activity tank wastes can be retrieved, pretreated, qualified, and staged for treatment in the LAW vitrification facility currently under construction in the WTP. According to the information obtained from presentations and data calls, there is a reasonable chance that each of these projects can be completed to meet the TPA milestones as long as budget requests are met. However, difficulties in securing the proper funding and/or attempting to accelerate treatment in the ILAW facility may significantly decrease the chance of completing all the necessary projects by the time needed.

6.3 Conclusions

6.3.1 Because of the potential difficulties in balancing the retrieval, pretreatment, qualification, and treatment of tank waste at both the Savannah River and Hanford Sites, there is a risk of needing special treatment for a large quantity of waste (e.g., salt-only glass at Savannah River), extending the operation of the tank farm and treatment facilities past current schedule dates, or both.

A requisite balance must be established and maintained between the preparation of waste feed material and its treatment to satisfy various contract and programmatic requirements including the minimization of the potential mismatch between the treatment of the high-level and low-activity waste fractions. The changes that have been made to the DWPF melter to increase throughput and the construction of the Salt Waste Processing Facility (SWPF) would require an increase in the production and qualification of waste material for subsequent treatment including infrastructure and operational changes that may make striking the appropriate balance difficult. Improved planning models and requisite financial support should help mitigate the impacts from these issues. Because of the large expense in operating the DWPF (assuming $140 million per year) and support facilities, any significant production of salt-only waste glass would likely present a very high cost and schedule impact to SRS.

The delivery of qualified feed to the WTP will be more complicated than that at SRS because there are more tanks at Hanford with more waste types—some of which are inter-mixed and recalcitrant, resulting in more complicated characterization, retrieval, pretreatment, and qualification to produce feeds for the much higher contract rates for treatment at the WTP. There are also significant constraints imposed on the SST retrieval from both the TPA and Consent Decree that may make balancing the operations problematic. This vulnerability can be mitigated by additional tank characterization efforts, uncertainty management, improved planning models (that incorporate chemistry and uncertainties), continued Operations Research and modeling, and additional DST space. The valuable information that has been learned from the pretreatment and delivery of waste at SRS for the past 15+ years can be applied. This vulnerability is pertinent to the WTP acceleration strategies considered by the EM-TWS except the Vision 2020. Because of the significantly higher operating cost expected for the WTP (assuming $1 billion per year), even a modest need to produce salt-only or other special waste forms using the WTP presents very high schedule and cost risks.

6.3.2 Because of likely difficulties in increasing the production of qualified salt and sludge feeds, there may be difficulties in satisfying current schedules and milestones at both the Savannah River and Hanford Sites.

To balance the treatment of the high-activity salt and sludge tank wastes through the DWPF and SWPF as currently planned will require a significant increase in the retrieval, pretreatment and qualification of SRS tank wastes including additional tankage. The necessary increase in the production of qualified waste feed for future SRS operations to accommodate increased HLW treatment throughput and SWPF has not been demonstrated with the existing infrastructure. Pretreatment is performed in the tank farm and often suffers from a lack of tank space; furthermore, when tanks are emptied, they are not typically used for processing, but instead readied for closure. The various steps needed to plan the pretreatment and qualification of feeds are highly labor-intensive and not completely understood, often by only a few (and perhaps one). A mentoring program and committing more of the expert information to the model may help mitigate potential impacts. These conditions may make a significant increase in the production of qualified feeds for treatment at SRS problematic.

The Hanford WTP is under construction and is currently scheduled to begin radioactive operations in 2019. The WTP is designed to treat the entire high-level waste fraction and a portion of the corresponding low-activity waste fraction. Of the 177 high-level waste tanks at the Hanford Site, 149 are single-shell tanks (SSTs) many of which are known or suspected leakers; the wastes in the SSTs represent the majority of the risk posed by the tank wastes. Tank waste characterization, retrieval, and consolidation operations have been continuing at Hanford in preparation for commencing WTP radioactive operations. To date the wastes from seven single-shell tanks (SSTs) have been retrieved with a maximum of three retrievals in 2006. However, the waste retrievals (with corresponding pretreatment and qualification) must increase dramatically to support the current treatment schedule and to satisfy TPA milestones, which may be difficult due to logistics and funding limitations. If possible, a slower and earlier ramping up of retrievals, if possible, might help mitigate the potential impacts. This vulnerability applies to both baseline and the Vision 2020 scenario.

6.3.3 Because of the complex, interdependent, and highly constrained nature of the feeds and tank farm operations at the Hanford Site may impact waste feed delivery as well as current schedules and milestones.

At Hanford, the PUREX process was used in conjunction with the bismuth phosphate and REDOX separations processes. Many of the tank wastes were reprocessed to recover uranium and fission products and wastes were intermixed often based on tank availability. Thus, when compared to SRS (where only the PUREX process used and wastes were segregated), there are more waste tanks at Hanford containing more waste types (that often have been mixed) resulting in more variable wastes, including some that are recalcitrant, making characterization, retrieval, processing, and qualification more difficult than at SRS. There are also significant constraints on the waste tanks that will be processed (e.g., the single-shell tanks) and their order based on the Hanford Consent Decree and TPA. Additional characterization activities, improved modeling, and intentional blending may help mitigate the impacts of this issue. This vulnerability applies to the baseline, STS, and ETWS scenarios.

6.3.4 The need to upgrade the Hanford Effluent Treatment Facility (ETF) to treat liquid wastes generated from the WTP may impact treatment and thus feed delivery schedules and milestones.

The Effluent Treatment Facility (ETF) is a state-permitted facility that receives and treats liquid wastes from various sources on the Hanford Site. The ETF treatment processes remove radioactive and hazardous contaminants from the wastewater for storage until tests confirm that various radioactive and hazardous contaminants have been removed or lowered to levels making it acceptable for discharge to a state-approved disposal site.

Treating wastewater from the WTP would require upgrades at ETF to manage significantly increased throughput and increased corrosion potential. These upgrades must be funded and completed on time to treat effluent from the WTP. There may also be a concern with the level of volatile radioactive constituents (e.g., Tc-99 and I-129) from the LAW melter off-gas system that may exceed acceptable levels for ETF. Alternative treatment of the off-gas streams may be considered to help mitigate the impacts of this issue.

6.3.5 The WAC for the Hanford tank waste treatment facilities and corresponding disposal facilities have not been finalized introducing significant uncertainties in the limits on feed delivery and treatment; significant delays in finalizing these criteria may impact waste feed delivery and treatment schedules and milestones.

Before pretreated waste can be fed to Hanford treatment facilities, samples must be collected and tested to assure that the waste meets WAC for these facilities. The key interface for success of the ORP tank waste treatment mission is the waste feed delivery interface that ensures the timely, efficient, and compliant delivery of feed from the tank farm to the WTP [ORP-11242, Rev. 5]. The WAC and physical and administrative details for the feed delivery interface are described in *ICD 19 – Interface Control Document for*

Waste Feed [Hall 2008]. Important aspects of this critical interface are being resolved including the WTP waste acceptance data quality objectives and an evaluation of the ability to adequately mix, sample, and deliver individual feed batches to the WTP for treatment [ORP-11242, Rev. 5]. The limits on and targets for Hanford waste feed delivery will remain uncertain until these key aspects of the feed delivery interface have been finalized. Furthermore, the acceptance criteria and permits required for the disposal facilities for both the high-level and low-activity waste forms that will be produced from the Hanford WTP have not been finalized (and, in some cases, have not been started). The potential impact of violating these acceptance criteria, once finalized, include resampling and return of feeds to the tank farm and corresponding delays in treatment schedules. The necessary acceptance criteria must be defined as soon as possible to allow their potential impacts to be taken into account during in planning. These concerns apply to all scenarios considered (i.e., baseline, STS, ETWS, and Vision 2020).

6.3.6 The inability to representatively mix and sample the large Hanford tank farm tanks needed to support waste feed delivery for treatment will impact waste treatment schedules and milestones.

Wastes at Hanford must be sampled and analyzed to demonstrate that they satisfy waste acceptance criteria and feed specifications for the corresponding treatment facility per *ICD 19 – Interface Control Document for Waste Feed* [Hall 2008]. These requirements translate into the need to satisfy appropriate requirements to high confidence (i.e., 95% confidence for fissile components and 90% for others). An evaluation is currently underway of the ability in the tank farm to adequately mix, sample, and deliver individual feed batches to the WTP for treatment [ORP-11242, Rev. 5]. If methods cannot be identified or developed to allow limits to be satisfied to the high confidences required, additional sampling and analysis may be required that will impact pretreatment, qualification, and delivery schedules. Resulting delays would impact treatment schedules and possibly jeopardized the making of TPA milestones. One way to potentially mitigate the impacts of this issue would be to implement the enhanced Waste Retrieval Facility to include mixing, blending, sampling, qualification and filtration of retrieved waste that would also provide a more uniform feed to WTP. The technical risk associated with mixing, sampling, and delivery of feed from these large tanks for slurries in very high. Because of the very high operating expense for WTP, any delays from additional sampling or return of feed to the tank farm for additional processing translates into very high cost and schedule risks. These concerns apply to all scenarios considered (i.e., baseline, STS, and ETWS) except for the Vision 2020 scenario.

6.3.7 The potential lack of temporary storage for treated low-activity and high-activity waste forms at the Hanford Site may impact treatment and thus waste feed delivery and treatment schedules and milestones.

Current schedules indicate that if sufficient funding is provided and no unforeseen difficulties arise during permitting activities, then the required storage and disposal facilities will be available to support WTP operations. However, if there are difficulties in either funding, building or permitting the HLW storage facilities, in permitting the

Integrated Disposal Facility for treated LAW, or changing the permit for the Central Waste Complex (CWC), then options may be needed to temporarily store treated HLW, LAW, or TRU waste forms. A lack of such storage might impact WTP treatment operations as well as feed delivery and ultimately tank farm operations. Early planning is needed to mitigate potential impacts. These concerns apply to all scenarios considered (i.e., baseline, STS, ETWS, and Vision 2020).

6.3.8 The Hanford 242-A Evaporator system is a single-point of failure; long-term outages of this system would impact waste feed delivery and thus treatment schedules and TPA milestones.

The 242-A Evaporator must operate throughout the lifetime of the River Protection Project (RPP) mission as it is the only such facility to support SST retrieval operations, to maintain the appropriate sodium concentration in the feed delivered to WTP, and to manage space in the DSTs. Additional evaporator capacity is being researched (e.g., wiped or thin film evaporation technologies); however, the technologies being research would not replace the 242-A Evaporator functionality. A significant failure in the 242-A Evaporator system would impact the timely delivery of feed to the WTP for treatment. Furthermore, plans would require much higher annual availability of the 242-A Evaporator beginning in 2030 when the Evaporator will be over 50 years old through 2040 where the risk of failure would likely increase with the age of the evaporator. The aggressive schedule for Evaporator use may make the continuous upgrades planned for the facility difficult to execute in a timely enough fashion. Because of the critical nature of the operations carried out using the 242-A Evaporator, any failures requiring longer than anticipated outages present very high cost and schedule risks. Construction of a new evaporator with functionality akin to that of the 242-A Evaporator or additional DST space would help mitigate the potential impact of a failure in the 242-A Evaporator system. This vulnerability is pertinent to the strategies considered by the EM-TWS (i.e., baseline, STS, and ETWS) except the Vision 2020.

6.3.9 Significant fouling, which has been known to occur in the SRS 242-16H (2H) Evaporator System, may impact waste pretreatment and treatment activities.

The 2H-Evaporator system at SRS is used to evaporate the recycle stream coming from DWPF. In the past, the evaporator has become fouled requiring it be shut down for cleaning. Despite improvements in cleaning the evaporator pot, fouling still occurs in the 2H-Evaporator system and the need to increase feed production and changes in recycle composition resulting from possible melter and off-gas changes as well as waste composition and frit changes may impact fouling in the evaporator system. Periodic cleaning of the evaporator (especially during outages) may help mitigate potential impacts.

6.3.10 Fluidized bed steam reforming (FBSR) may not be the most appropriate technology to destroy organics in the SRS Tank 48H waste based on cost, schedule, and technical maturity.

Tank 48H contains approximately 250,000 gallons of a salt solution containing 22,000 kg of tetraphenylborate (TPB) and 400,000 Ci of Cs-137. TPB can release sufficient benzene to the tank head space potentially creating flammable conditions and a resulting safety hazard. Fluidized bed steam reforming was selected to process this unique organic waste. Since the selection of FBSR to treat the Tank 48H waste, a number of factors have resulted in a review of the costs, schedule, and technical maturity criteria. This review has led to the evaluation of competing technologies including direct vitrification and a copper catalyzed process that was not considered in previous evaluations. Since return of Tank 48H to service is no longer on the critical path, using FBSR instead of a competing technology could have a significant cost impact on SRS operations. To help mitigate this vulnerability, competing technologies should be evaluated in the System Planning process including:

- Fluidized bed steam reforming
- Copper catalyzed process
- Direction vitritification as an end-of-mission campaign
- Direct vitrification by slow addition (or "bleeding")

6.3.11 A large number of projects must be completed to pretreat and feed low-activity waste to the Hanford ILAW vitrification facility by 2016 to support the Vision 2020 scenario.

There are numerous projects (perhaps as many as 30) that must be completed before Hanford low-activity tank wastes (LAW) can be retrieved, pretreated, qualified, and staged for treatment in the LAW vitrification facility currently under construction in the WTP. There appears to be a reasonable chance that each of these projects can be completed on time as long as budget requests are met. However, difficulties in securing proper funding and/or attempting to accelerate treatment in the ILAW facility may significantly decrease the chance of completing all the necessary projects, especially when so many projects must be completed on such a compressed schedule to support the Vision 2020 scenario under increasingly tight fiscal conditions. The impact to the schedule by as may be as much as 12 months including delay of starting the single ILAW melter until 2017 or later.

6.4 Recommendations

These are the recommendations to address the various findings and observations and conclusions identified above.

6.4.1 DOE, in conjunction with its regulators, should establish consensus on strategies, infrastructure, models, and processes to provide adequate flexibility in waste feed preparation and treatment.

There will be a need at both SRS and Hanford to balance as well as significantly increase the retrieval, preparation, qualification, feed and treatment of high-level and low-activity wastes to meet treatment schedules and milestones. The variation in the characteristics of the tank wastes at both sites dictates that there should be adequate flexibility in the processes used to prepare and deliver as well as treat tank wastes. DOE, in conjunction with its regulators, should establish a consensus on strategies, infrastructure, models, and processes to provide the flexibility needed. Because the window of opportunity at either site will likely be brief, an upfront and ongoing collaboration with regulators will be needed. Issues that will need clear communication and thoughtful consideration include information needs, review criteria, consistency with schedule, and regulatory challenges.

6.4.2 DOE should formally evaluate the single-point failure impact of 242-A in the planned mode requiring much higher annual availability versus the current campaign mode and also address the need for additional capacity to supplement the 242A evaporator in case of failure.

Continued operation of the 242-A Evaporator is critical to the RPP mission. The likelihood of failure will increase and the evaporator ages. According to current plans, much higher availability of the evaporator will be required at a time when the evaporator is more than half a century old. The aggressive use of the evaporator to support tank farm operations may increase the likelihood of failure and impact the ability to make the continuous improvements planned to maintain the system. The technology currently being researched (i.e., thin or wiped-film evaporators) are not adequate replacements for the functionality provided by the 242-A Evaporator. Additional evaporative capacity of the type needed could be provided by a building a new evaporator, using the existing evaporator facility in 200 West Area, or employing off-the-shelf technologies that would supplement the 242-A Evaporator without the need for significant research and development. The construction of additional double-shell tanks would also help alleviate issues associated with failures of the 242-A Evaporator system.

6.4.3 The WAC for the Hanford tank waste treatment facilities and disposal facilities should be finalized as soon as possible to reduce the potential impact on waste feed delivery and treatment schedules and milestones.

Before pretreated waste can be fed to Hanford treatment facilities, samples must be collected and tested to assure that the waste meets waste acceptance criteria (WAC) for these facilities. Important aspects of the waste feed delivery interface are being resolved including the WTP waste acceptance data quality objectives and an evaluation of the ability to adequately mix, sample, and deliver individual feed batches to the WTP for treatment. The limits on and targets for Hanford waste feed delivery will remain uncertain until these key aspects of the feed delivery interface are finalized. Furthermore, the acceptance criteria and permits required for the disposal facilities for both the high-level and low-activity waste forms have not been finalized. These acceptance criteria must be finalized as soon as possible to reduce the potential impact on Hanford treatment milestones.

6.4.4 DOE should develop a mitigation strategy for the potential inability to adequately and efficiently mix, sample, and deliver pretreated wastes to the WTP.

Pretreated wastes at Hanford must be sampled and analyzed to demonstrate that they satisfy waste acceptance criteria and feed specifications for the corresponding treatment facility. These requirements translate into the need to satisfy appropriate requirements to high confidence (i.e., 95% confidence for fissile components and 90% for others). An evaluation is currently underway of the ability in the tank farm to adequately mix, sample, and deliver individual feed batches to the WTP for treatment. If methods cannot be identified or developed to allow limits to be satisfied to the high confidences required, additional sampling and analysis may be required that would potentially impact pretreatment, qualification, and delivery schedules and ultimately treatment milestones. A potential mitigation would be to implement the enhanced Waste Retrieval Facility to include mixing, blending, sampling, qualification and filtration of retrieved waste that would also provide a more uniform feed to WTP.

6.4.5 DOE should evaluate in the System Planning process the various options for processing the SRS Tank 48H waste.

Tank 48H contains approximately 250,000 gallons of a salt solution containing 22,000 kg of tetraphenylborate (TPB) and 400,000 Ci of Cs-137. Fluidized bed steam reforming was originally selected to process this unique organic waste. However, a number of factors have resulted in a review of the costs, schedule, and technical maturity criteria. This review has led to the evaluation of competing technologies including direct vitrification and a copper catalyzed process that was not considered in previous evaluations. DOE should evaluate available technologies in the System Planning process including:

- Fluidized bed steam reforming
- Wet air oxidation
- Copper catalyzed process
- Direction vitritification as an end-of-mission campaign
- Direct vitrification by slow addition (or "bleeding")

6.4.6 Implement previous recommendations that potentially impact alternative treatment technologies and forms for Hanford LAW (crosscutting).

Previous recommendations were made by the 2009 External Technical Review (ETR) Team that evaluated Hanford modeling and simulation tools and the 2010 EM-TWS that should be implemented:

- Complete the enhancements to the HTWOS model to support life-cycle cost modeling and future high-level planning; important tank waste and processing chemistries and significant uncertainties must be incorporated in the planning model to inform System Planning and the alternative treatment technology and waste form selection processes.

- Institute recommendations made by the ETR Team to capture the significant knowledge concerning SRS sludge feed preparation.

CHAPTER SEVEN
Charge 6: Identify Other Tank Waste Vulnerabilities at SRS and Hanford

7.1 Background

Vulnerabilities were assessed for both Hanford and SRS with a systematic approach to the ranking of issues. The following comparison of baseline and various schedules for both Hanford and SRS were reviewed. Tables 7.1.1 through 7.1.4 summarize the schedules for both Hanford and SRS.

Table 7.1.1
Hanford Vision 2020 consideration as compared to current baseline sequential Operational Readiness Review (ORR) Baseline Change Proposal (BCP) commissioning

	Construction Complete		Hot Commissioning	
	WTP Baseline[5]	**Vision 2020**	**WTP Baseline[6]**	**Vision 2020**
Laboratory	5/12	12/13	12/16	9/16
Low Activity Waste Facility (LAW)	3/14	10/14	12/16	9/16
Pretreatment Facility (PT)	2/16	2/16	6/18	12/17
High-Level Waste (HLW) Facility	5/16	5/16	7/18	5/18
Interim Pretreatment System	N/A	12/15	N/A	9/16
End Interim Pretreatment Operations	N/A	N/A	N/A	removal decision in 3/20

[5] WTP baseline construction complete dates based on substantial completion

[6] WTP start of hot commissioning dependent on successful ORR which is outside the control of the project

Table 7.1.2
Hanford Supplemental Treatment consideration as compared to current baseline

	Construction Complete		Hot Commissioning	
	WTP Baseline	**Supplemental Treatment**	**WTP Baseline**	**Supplemental Treatment**
Laboratory	5/12	2/14	12/16	3/17
Low Activity Waste Facility (LAW)	3/14	5/15	12/16	3/17
Pretreatment Facility (PT)	2/16	3/16	6/18	3/19
High Level Waste Facility W)	5/16	12/16	7/18	4/19
Supplemental Treatment Technology	N/A	N/A	N/A	1/18
Immobilization Technology	N/A	N/A	N/A	1/18

Table 7.1.3
Hanford Enhanced Treatment consideration as compared to current baseline

	Construction Complete		Hot Commissioning	
	WTP Baseline	**Enhanced Treatment**	**WTP Baseline**	**Enhanced Treatment**
Laboratory	5/12	3/14	12/16	3/19
Low Activity Waste Facility (LAW)	3/14	3/15	12/16	LAW does not operate
Pretreatment Facility (PT)	2/16	6/16	6/18	1/18
High Level Waste Facility (HLW)	5/16	12/16	7/18	4/19
Alternative LAW Treatment & Immobilization	N/A	1/17	N/A	1/18

Table 7.1.4
SRS Summary of key baseline milestones and processing features from System Plan 16

Key Milestones		Processing Features	
Deploy next generation extractant at MCU	Jan 2012	Total Salt Solution Processed	96 Mgal
Initiate SCIX Processing	Oct 2013	Salt Solution Processed via ARP/MCU	5.4 Mgal
Initiate SWPF Processing	Jul 2014	Salt Solution Processed via SCIX	26.8 Mgal
Tank 48 Available	Oct 2016	Salt Solution Processed via SWPF	61 Mgal
Salt Processing Complete	2024	Total number of HLW canisters produced	7,557
SWPF facility removed from service	2025		
DWPF processing complete	2025		
DWPF facility removed from service	2026		

7.2 Findings and Observations

The issues in Tables 7.2.1 through 7.2.5 summarize significant vulnerabilities as they relate to meeting mission requirements as well as compliance with technical performance, schedule, cost, regulatory compliance, and safety.

Table 7.2.1
Hanford Vulnerability Assessment: Vision 2020

Issue	Vulnerability	Comment	Potential Mitigation
Very Aggressive Schedule	Schedule, Regulatory	The ability of the project to successfully implement a very tight schedule, so that it does not lose its mission effectiveness. The risk of not being able to obtain multiple permits and approval of the Tank Closure and Waste Management EIS and ROD. The Performance Assessment that is required for the IDF cannot be started until the EIS and ROD are completed (EM-1 position).	Focus on the Vision 2020 deliverables and the schedule. Review and modify a complete Risk Register (maintain currency). The EM-TWS recommends a quarterly Risk Register review and execution. Permitting: start partnering with the Washington State Department of Ecology immediately. Establish single-line accountability with the Washington State Department of Ecology to execute permit

Issue	Vulnerability	Comment	Potential Mitigation
			agreements. Establish program strategy that the PA does not delay operations.
LCC methodology is not defensible	Schedule, Cost, Regulatory	This project is pre-CD-1. There are no approved cost and schedule estimates.	Develop detailed CD-2 cost and schedule estimates and baseline with appropriate programmatic approval.
DOE LCC System-wide process and process application are lacking consistency for cost estimating	Schedule, Cost	EM does not uniformly apply a system-wide LCC Methodology (process) for cost estimating such as that maintained by the National Institute for Standards and Technology (NIST) (BLCC5) for DOE. Planning models are lacking for development and testing of scenarios.	Use a system-wide process for cost and schedule estimating such as BLCC5. Provide documented NPV calculations when selecting alternatives and report baseline LCC cost savings and monetized risks in current year funded dollars.
Selection of technology alternatives may not be ideal based on failure to use NPV calculations	Technology, Cost	GAO 12-step cost estimating process recommends utilization of NPV cost analysis for selection of alternate technologies (Reference: *GAO Cost Estimating and Assessment Guide (Best Practices for Developing and Managing Capital Program Costs)*, GAO-09-3SP, March 2009, 440 pp. Technology selection, based on cost needs to be made on total cost which includes system costs, facilities, regulatory and other related costs for total system LCC.	Use of Net Present Value to compare scenarios

Issue	Vulnerability	Comment	Potential Mitigation
Long-term workforce jurisdiction determination will be driven by short-term 2020 requirements	Schedule, Cost	Accelerating the institutional decision may weaken DOE's best value determination of workforce jurisdiction.	Start workforce jurisdiction analysis now.
Lack of required funding eliminates the benefit of the 2020 option	Cost	Elimination of the 2020 option does not impact the current System Plan 5 baseline; however, the execution of the 2020 option could significantly decrease the risk associated with the baseline.	
Unanticipated difficulties in construction of new systems in an operating nuclear conduct of operations area	Schedule, Cost	Based on experience, delays could be expected for executing new capital construction in nuclear conduct of operation controlled areas.	Review all areas system-wide of lessons learned and establish clear owner/operator control for capital construction of nuclear facilities.
Work stoppage at WTP due to spills, Notices of Violation, or operational incidents	Schedule, Cost	Unanticipated work stoppage could shut down the construction site for unknown periods of time.	N/A
Difficulty retrieving sludge from Hanford DSTs when using CST ion exchange	Technology, Schedule, Cost, Safety	If CST is used, discharging ground CST, loaded with ^{137}Cs, may adversely affect sludge retrieval.	Use disposable high integrity containers configured as ion exchange canisters
CST IX column overheating	Schedule, Cost, Safety	If CST is used, simultaneous loss of permeate feed and cooling water flow may cause unacceptably high temperatures.	HAZOP or equivalent work process
A large number of modification projects are needed to support needed transfers	Schedule	Approximately 30 project modifications needed to support necessary transfer operations must be completed to support Vision 2020.	Order and base funding on those needed to support accelerated operations without compromising WTP startup

Issue	Vulnerability	Comment	Potential Mitigation
		Completion of the necessary projects by the original 2018 date appeared reasonable; however, the acceleration needed for 2020 drives this to high risk.	

1. Vision 2020 would achieve earliest possible hot operations of WTP facilities (e.g., sequential facility completions, ORRs and CD-4s, starting with LAW/BOF/LAB) and the opportunity to produce LAW glass early (2016) and continue until Pretreatment is commissioned. Pre-treatment technologies (in-tank RMF / SCIX or at-tank filtration / ion exchange), new lines to direct feed LAW and lines from LAW to ETF, a single LAW melter operating, and off-gas recycle to the DSTs are needed to support Vision 2020.

2. Delay in selecting the operating contractor for the combined Tank Farms and WTP operations, has a risk of labor disruption, with negative consequences on schedule and lifecycle costs.

3. Completion of the mission in the scheduled time depends on the ability of the Tank Farms to retrieve the SST into the DSTs to then feed the WTP.

4. The SST tank retrieval, does not directly impact Vision 2020, but it does impact the long-term mission and Consent Decree milestones. Effort should be made to provide the requisite enhancements so that the DST space does not become full. Early operation of the LAW Facility at some considerable capacity, limited by a concomitant (if staged) upgrade of the throughput of ETF, provides the best assurance that the DSTs will not reach capacity, and enable continued retrieval of the SSTs.

5. Some of the modifications required to feed the LAW will be co-located with the PT Facility. When interim LAW operations are initiated, it will be necessary to continue commissioning activities in the PT concurrently with this operation. Radioactive operations within an active commissioning site (and possibly one where construction is not yet complete) will result in more complex logistical, safety, and security issues.

Table 7.2.2
Hanford Vulnerability Assessment: Supplemental Treatment

Issue	Vulnerability	Comment	Potential Mitigation
LCC methodology is not defensible	Schedule, Cost, Regulatory	This project is pre-CD-1. There are no approved cost and schedule estimates.	Develop detailed CD-2 cost and schedule estimates and baseline with appropriate programmatic approval.
LCC System-wide processes are lacking for cost estimating	Schedule, Cost	EM does not uniformly apply a system-wide LCC Methodology (process) for cost estimating such as that maintained by the National Institute for Standards and Technology (NIST)	Use a system-wide process for cost and schedule estimating such as BLCC5. Provide documented NPV calculations when selecting alternatives and report baseline

Issue	Vulnerability	Comment	Potential Mitigation
		(BLCC5) for DOE. Planning models are lacking for development and testing of scenarios.	LCC cost savings and monetized risks in current year funded dollars.
Selection of technology alternatives may not be ideal based on failure to use NPV calculations	Technology, Cost	GAO 12-step cost estimating process recommends utilization of NPV cost analysis for selection of alternate technologies Technology selection, based on cost needs to be made on total cost, which includes system costs, facilities, regulatory and other related costs for total system LCC.	Selection of technology alternatives may be incorrect based on failure to use NPV calculations.
CST IX column overheating	Schedule, Cost, Safety	If CST is used, simultaneous loss of permeate feed and cooling water flow may cause unacceptably high temperatures.	HAZOP or equivalent work process
Difficulty retrieving sludge from Hanford DSTs when using CST ion exchange	Technology, Schedule, Cost, Safety	If CST is used, discharging ground CST, loaded with Cs-137, may adversely affect sludge retrieval.	Use disposable high integrity containers configured as ion exchange canisters.
FBSR mineralized Waste Form	Cost, Schedule, Regulatory	All LAW assume treated by FBSR; thus mineralized waste form must be acceptable (including Tc-99 and other COCs). “Good as glass” and prescriptive nature of RCRA obfuscates important issues. There is no single test to qualify waste form performance so performance comparisons are difficult.	There could be a general acceptance of a mineral waste form, benchmarks, and testing requirements for a treatment technology similar to that for HLW (borosilicate glass). Should provide performance-based instead of technology-based. Defense-in-depths strategies could be pursued (as with HLW).
Grouting / Cast stone	Regulatory	Grout and glass were identified in the original	Identify treatment technologies (under

Issue	Vulnerability	Comment	Potential Mitigation
		TPA for treating Hanford LAW. The prescriptive nature of RCRA makes the use of grouting difficult.	RCRA) / performance-based criteria that would be protective of human health and the environment for a RCRA disposal.
Alternate Melter Technology	Schedule, Cost, Regulatory	Risk comes from limited experience with any alternative with Hanford waste.	Testing program that provides large experience base for feeds in any new technology, preferably a TRL of at least 7.
Retention of Tc99 in LAW Glass	Technology, Regulatory	Tc is not retained in LAW glass as planned. There are likely to be technological fixes for this issue.	Determine thermodynamic gas/liquid equilibrium of Tc and then verify in testing. If an issue, then experiment with various technological fixes (such as redox control) at small scale and implement when TRL is 6.
Need to balance (logistics) LAW / HLW pretreatment and treatment processes	Schedule, Cost	Need to achieve feed rates that balance treatment of LAW / HLW	Additional tank waste characterization, intentional blending at ORP, planning models, Operations Research (OR) models and research, gap analyses, etc.
242-A Evaporator is a single point of failure	Schedule, Cost	This is an issue even if wiped-film evaporators are introduced.	Wiped-film evaporators can offset some of the load and risk, but do not replace 242-A functionality. Other pretreatment and treatment options may reduce the need and risk.

Table 7.2.3
Hanford Vulnerability Assessment: Enhanced Treatment

Issue	Vulnerability	Comment	Potential Mitigation
LCC methodology is not defensible	Schedule, Cost, Regulatory	This project is pre-CD-1. There are no approved cost and schedule estimates.	Develop detailed CD-2 cost and schedule estimates and baseline with appropriate programmatic approval.
LCC System-wide processes are lacking for cost estimating	Schedule, Cost	EM does not uniformly apply a system-wide LCC Methodology (process) for cost estimating such as that maintained by the National Institute for Standards and Technology (NIST) (BLCC5) for DOE. Planning models are lacking for development and testing of scenarios.	Use a system-wide process for cost and schedule estimating such as BLCC5. Provide documented NPV calculations when selecting alternatives and report baseline LCC cost savings and monetized risks in current year funded dollars.
Selection of technology alternatives may not be ideal based on failure to use NPV calculations	Technology, Cost	GAO 12-step cost estimating process recommends utilization of NPV cost analysis for selection of alternate technologies. Technology selection, based on cost needs to be made on total cost which includes system costs, facilities, regulatory and other related costs for total system LCC.	Selection of technology alternatives may be incorrect based on failure to use NPV calculations.
FBSR mineralized Waste Form	Schedule, Regulatory	All LAW treated by FBSR; thus mineralized waste form must be acceptable (including Tc-99 and other COCs). “Good as glass” and prescriptive nature of RCRA obfuscates important issues. There is no single test to qualify waste form	There could be a general acceptance of a mineral waste form, benchmarks, and testing requirements for a treatment technology similar to that for HLW (borosilicate glass). Should provide performance-based instead of technology-based. Defense-in-

Issue	Vulnerability	Comment	Potential Mitigation
		performance so performance comparisons are difficult.	depths strategies could be pursued (as with HLW).
Difficulty retrieving sludge from Hanford DSTs when using CST ion exchange	Technology, Schedule, Cost, Safety	If CST is used, discharging ground CST, loaded with Cs-137, may adversely affect sludge retrieval.	Use disposable high integrity containers configured as ion exchange canisters.
Grouting / Cast stone	Regulatory	Grout and glass were identified in the original TPA for treating Hanford LAW. The prescriptive nature of RCRA makes the use of cast stone difficult.	Identify treatment technologies (under RCRA) / performance-based criteria that would be protective of human health and the environment for a RCRA disposal.
Alternate Melter Technology	Schedule, Cost, Regulatory	Risk comes from limited experience with any alternative with Hanford waste.	Testing program that provides large experience base for feeds in any new technology. Prefer a TRL of at least 7.
Retention of Tc99 in LAW Glass	Technology, Regulatory	Tc is not retained in LAW glass as planned. There are likely to be technological fixes for this issue.	Determine thermodynamic gas/liquid equilibrium of Tc and then verify in testing. If an issue, then experiment with various technological fixes (such as redox control) at small scale and implement when TRL is 6.
Sampling in and transfer from high level tanks is problematic	Technology, Schedule, Cost	Representative sampling in 10^6-gal tanks is not practicable. This also makes it difficult to consistently transfer waste during operations. Because of potential segregation, there may also be a safety issue.	Change safety and/or feed acceptance criteria. Construct a set of mixing and blending tanks. Implement wiped-film evaporator technology (2013) to add freeboard.
Meeting waste compliance requirements for feed to WTP may be	Technology	System Plan 5 indicates that projected feeds do not meet screening criteria	Develop reasonable and credible feed requirements. Separate wastes by treatment

Issue	Vulnerability	Comment	Potential Mitigation
problematic		including LAW / HLW envelopes, H_2 generation and criticality limits (while requirements are being developed). The criticality limits may be overly conservative.	difficulty and investigate specific treatment options.
Need to balance (logistics) LAW / HLW pretreatment and treatment processes	Schedule, Cost	Need to achieve feed rates that balance treatment of LAW / HLW	Additional tank waste characterization, intentional blending at ORP, planning models, Operations Research (OR) models and research, gap analyses, etc.
242-A Evaporator is a single point of failure	Schedule, Cost	This is an issue even if wiped-film evaporators are introduced.	Wiped-film evaporators can off-set some of the load and risk, but do not replace 242-A functionality. Other pretreatment and treatment options may reduce the need and risk.

Table 7.2.4
SRS Vulnerability Assessment: In-Tank Treatment (SCIX Program)

Issue	Vulnerability	Comment	Potential Mitigation
LCC methodology is not defensible	Schedule, Cost, Regulatory	This project is pre-CD-1. There are no approved cost and schedule estimates.	Develop detailed CD-2 cost and schedule estimates and baseline with appropriate programmatic approval.
LCC System-wide processes are lacking for cost estimating	Schedule, Cost	EM does not uniformly apply a system-wide LCC Methodology (process) for cost estimating such as that maintained by the National Institute for Standards and Technology (NIST) (BLCC5) for DOE. Planning models are lacking for	Use a system-wide process for cost and schedule estimating such as BLCC5. Provide documented NPV calculations when selecting alternatives and report baseline LCC cost savings and monetized risks in current year funded dollars.

Issue	Vulnerability	Comment	Potential Mitigation
		development and testing of scenarios.	
Selection of technology alternatives may not be ideal based on failure to use NPV calculations	Technology, Cost	GAO 12-step cost estimating process recommends utilization of NPV cost analysis for selection of alternate technologies Technology selection, based on cost needs to be made on total cost which includes system costs, facilities, regulatory and other related costs for total system LCC.	Selection of technology alternatives may be incorrect based on failure to use NPV calculations.
Budget restrictions greater than one year	Schedule, Cost, Regulatory	Very high regulatory risk because of the need to renegotiate regulatory commitments. Cost risk is very high due to extension of mission.	Renegotiating regulatory commitments Technical workarounds

Table 7.2.5
SRS Vulnerability Assessment: Tank 48 Treatment Strategy

Issue	Vulnerability	Comment	Potential Mitigation
LCC methodology is not defensible	Schedule, Cost, Regulatory	This project is pre-CD-1. There are no approved cost and schedule estimates.	Develop detailed CD-2 cost and schedule estimates and baseline with appropriate programmatic approval.
LCC System-wide processes are lacking for cost estimating	Schedule, Cost	EM does not uniformly apply a system-wide LCC Methodology (process) for cost estimating such as that maintained by the National Institute for Standards and Technology (NIST) (BLCC5) for DOE. Planning models are lacking for	Use a system-wide process for cost and schedule estimating such as BLCC5. Provide documented NPV calculations when selecting alternatives and report baseline LCC cost savings and monetized risks in current year funded dollars.

Issue	Vulnerability	Comment	Potential Mitigation
		development and testing of scenarios.	
Selection of technology alternatives may not be ideal based on failure to use NPV calculations	Technology, Cost	GAO 12-step cost estimating process recommends utilization of NPV cost analysis for selection of alternate technologies Technology selection, based on cost needs to be made on total cost which includes system costs, facilities, regulatory and other related costs for total system LCC.	Selection of technology alternatives may be incorrect based on failure to use NPV calculations.
FBSR planned to be designed, built, operated, and mission completed by 2016	Technology, Schedule, Cost	Actual waste has not been tested with this process technology. The proposed approach seems to be far more optimistic than all past history would suggest is reasonable.	Evaluate alternate approach using DWPF or chemical oxidation.
FBSR potentially not appropriate treatment technology	Cost, Safety	Handling a feed that is high in benzene and other combustible material may pose a safety hazard. Tank 48 would not be available to be used as a salt batch blend tank in early 2017.	Explore the potential of 2 types of campaigns that are direct feed to DWPF: 1) Establish a safety basis that allows a small bleed to the DWPF concurrently while the current campaigns for sludge is processed; or 2) Establish a separate campaign later in System Plan and not use Tank 48 as a salt batch feed tank. Use a different tank as substitute for tank 48 as feed to Salt waste. Evaluate potential use of wet-air oxidation.

Issue	Vulnerability	Comment	Potential Mitigation
			Continue to use Tank 21 for salt batch blending.

7.3 Conclusions

7.3.1 Vulnerabilities are noted above in tabular form. The detailed review of the vulnerabilities and methodology is found in Appendix 10 as well as detailed discussion in the Appendices as they relate to specific charges.

7.3.2 For both SRS and Hanford, the single most impacting vulnerability is the risk of not meeting schedule and cost baselines for SWPF at SRS and WTP at Hanford. The impact of new initiatives (e.g., SCIX, Vision 2020) could divert resources and senior management attention. If these initiatives cause delays such as a year, the impact of a year's delay for either SWPF or WTP overshadows any of the other vulnerabilities that are technology- or program-specific.

7.4 Recommendations

7.4.1 It is recommended that Vision 2020 be executed based on early startup of systems that are related to WTP start-up. The rationale is not based on LCC savings, or Schedule reduction. The justification is focused on risk reduction of the WTP and its related commissioning.

7.4.2 It is recommended that SRS perform a detailed review of use of FBSR technology for Tank 48 materials. It is the EM-TWS opinion that there is significant merit in utilization of DWPF for this processing or an alternative treatment technology. Merit is in cost savings.

7.4.3 It is recommended that DOE EM continue focus of Joule-heated melter technology for both SRS and Hanford.

CHAPTER EIGHT
Summary of Charge 7 – 2020 Vision, Early Start-up of One (1) LAW Melter

8.1 Background

DOE-ORP (WTP and Tank Farms) and its contractors have been developing plans and management organizational changes to provide project sequencing and integration between WTP and Tank Farms necessary to achieve WTP commissioning and initiate radioactive operations.

This is partly in response to several past Construction Project Reviews and EMAB recommendations supporting the need to transition (pivot point) WTP and ORP focus from WTP "engineering design and construction" to "construction completion and commissioning."

DOE-ORP developed the *Vision 2020 for WTP Project Transition to Operations* (*Vision 2020*)[7] to provide a framework for specific objectives and the DOE organizational approach to achieve those objectives.

The WTP Design Build Contractor and Tank Farm Operations Contractor jointly developed a management and technical approach to implement early LAW operations, accelerate commissioning of WTP and transition into a hot startup and hot operations organization through full capacity demonstration. This management and technical approach has been designated *One System 2020 Vision* (*One System Plan*)[8]. The *One System 2020 Vision* concept reviewed by the EMAB-TWS was a draft plan that is evolving and reflects significant evolution from the draft *Vision 2020* reviewed as part of the November 2011 WTP Construction Project Review.

Key DOE objectives:

- Maintain WTP Design Build Contractor accountability for demonstrating WTP facility performance that achieves the contract defined values as a minimum;
- Implement a contract-compliant and consistent contracting strategy/approach that is construction efficient and addresses the operational transition needs of WTP;
- Provide sustainability in the management team and provide continuity of staffing through transition;
- Develop an appropriate labor operations strategy;
- Ensure terms and conditions of the TOC and WTP contracts are consistent and integrated as necessary to provide a single system for feed delivery to and startup and operations of the WTP;

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[7] DOE/ORP-2010-02.

[8] *One System 2020 Vision*, DE-AC27-01RV14136, DE-AC27-08RV14800, March 21, 2011.

- Ensure contract incentives and fee structures include incentives for making glass no-later-than 12/31/2016 and ensure initial plant operations no later than 12/31/2022; and,

- Ensure that WTP maintains a line item project cost less than $12.263B.

To achieve the stated DOE objectives, the *One System Plan* proposes:

- Several project management and contractual changes to achieve improved management integration between TOC and WTP;

- LAW Facility hot commissioning and subsequent operations start up of one of its two melters in 2016, ahead of PT Facility hot commissioning, along with simultaneous hot commissioning of LAB and WTP Balance of Facilities; and

- Startup and hot commissioning of all WTP facilities to IPO in 6/2018.

8.2 Findings and Observations

Achieving LAW Facility hot commissioning in 2016 requires, in addition to completing LAW, Laboratory and BOF facilities on the necessary schedule, addressing the following challenges in a timely manner:

- Providing LAW waste feed;
- Managing the produced vitrified LAW canisters;
- Disposing of secondary waste effluents from LAW;
- Securing necessary environmental permits; and,
- Ensuring safe radioactive operations at LAW and LAB facilities and ongoing tank farm operations while construction and commissioning is ongoing at HLW and PT facilities.

There are a series of additional projects and activities that must be completed for the *One System Vision 2020* to be successful, which are discussed in the sections of this report that follow.
The primary benefits of proposed plan, if successful, are:

- Providing a programmatic victory by achieving treatment of LAW and production of vitrified LAW 15 months earlier than the baseline plan;
- Reducing the risk registry carrying costs for WTP startup;
- Reducing the risk of delays to complete WTP hot commissioning and achieving the Consent Decree milestone for full capacity hot operations by providing a more graded approach to commissioning and initiating hot operations;
- Reducing pressure on the WTP line item project cost of $12.263B by transferring hotel and startup costs from project construction costs to operational expenses.

The proposed plan will neither significantly reduce the timeframe for completion of waste treatment mission at Hanford nor reduce lifecycle costs.

The primary risks of the proposed plan are:

1. Schedule delays in completion or startup of the WTP LAW or LAB facilities or completion of necessary supporting projects in the Tank Farms will reduce or eliminate the proposed timeframe for WTP LAW hot operations prior to start up of WTP PT and HLW facilities. However, if delays in WTP LAW start up are realized, the earlier initiation of startup will allow for additional lead time to resolve currently unforeseen problems.

2. Schedule delays in completion of WTP PT or HLW could require extended operation of WTP LAW on a minimal feed from tank farm pretreatment, with attendant hot operations costs, and without substantial reduction in LAW inventory.

3. Unplanned incidents associated with interim LAW feed preparation and delivery operations, including hose-in-hose transfers, as well as on-site hot operations while other WTP facilities undergo completion, may delay overall WTP completion.

PROVIDING LAW WASTE FEED

The *One System Plan* proposes development of an Interim Pretreatment System (IPS) to prepare feed for the LAW facility, with LAW provided from the current inventory of supernate contained in the double shell tanks (e.g., Tanks AP-104, AP-107, etc.). The intent of the proposed IPS is to provide LAW feed during the start up of the LAW facility, prior to the availability of the WTP PT facility, and then have capability to provide LAW feed to the LAW Supplemental Treatment facility (required to be available by FY 2022 according to the consent decree with the State of Washington)[9]. However, if the only intention for IPS is to provide feed to LAW prior to the availability of WTP PT, then options for simplifying IPS should be evaluated.

The current *One System Plan* for IPS requires:

- Retrieval of supernate from one or more DSTs in the AP tank farm. Of the eight AP DSTs, one contains sludge and supernate, four contain saltcake and supernate, and three contain supernate only.
- At or in tank pretreatment of the liquid waste feed using filtration (cross flow or rotary microfiltration) to remove solids and ion exchange to remove Cs-137.
- Transfer of the pretreated waste to the LAW plant for vitrification and disposition.

The proposed IPS would include technology maturation and use of rotary microfiltration (RMF) installed in Tank AP-107 for solids removal, including actinides, and small column ion exchange (SCIX) using sRF resin installed in Tank AP-105 for Cs-137 removal prior to transfer to surge tanks and then feed to the LAW facility. Solids removed by filtration would be returned to the tank farm. The preferred resin by ORP is sRF resin. Loaded resin would be eluted using dilute nitric acid and the Cs-137 rich eluant returned to the tank farm. Both RMF and SCIX are technologies under development first for application at SRS as part of the accelerated salt waste

[9] U.S. DOE-ORP, *Justification of Mission Need for the Hanford Tank Waste Supplemental Treatment Project*, September 2010.

processing strategy, and have not been tested in full operations. Both technologies would require engineering modification to be adapted to the tank configurations at Hanford, and the SCIX system would require substantial design changes if an elutable cesium resin was selected for use at Hanford, in contrast to the non-elutable resin planned for use at SRS.

The One System Plan requires ~ 500,000 gallons of feed for fifteen months of operation of the LAW plant. Seven of the AP tanks have supernate volumes in excess of 1,000,000 gallons; see Appendix 9 for a discussion of the radionuclide concentrations in AP tanks that potentially may provide LAW feed.

Pretreated feed would be transferred to the LAW facility through approximately 4,500 feet of transfer lines at a rate of approximately 15,000 gallons per week. Routing of the transfer lines would be to isolate them from the other WTP facilities undergoing completion. This length of hose-in-hose transfer has not been used previously at Hanford and represents one of the challenges to achieving One System Plan. However, unlike several other hose-in-hose transfers, these transfer lines would be transporting minimal quantities of suspended solids.

The following addresses options for simplifying the pretreatment process as presented by ORP in EM-TWS fact-finding meetings:

Option 1: No Pretreatment

This option would involve direct feed of DST supernate to the LAW plant. Feed sequence would be determined by choosing supernate with the lowest concentrations of radionuclides, primarily Cs-137 and Tc-99.

Option 2: Deliquification, Dissolution, and Adjustment (DDA)

This option, also known as selective dissolution, has been used to produce more than 5,000,000 gallons of salt solution for processing into Saltstone at SRS and also has been used at Hanford when retrieving wastes from single shell tanks.

The DDA process involves the following:

- Removing the supernate from above the saltcake;
- extracting interstitial liquid within the saltcake matrix;
- dissolving the saltcake and transferring the resulting salt solution to a settling tank;
- transferring the salt solution to the Saltstone Facility feed tank where, if required, the salt solution is aggregated with other Tank Farm waste to adjust batch chemistry. Chemistry adjustment may be required to ensure the salt solution feed stream meets processing parameters (e.g., sodium concentration, organic content, facility shielding limitations) for processing at SPF.[10]

[10] *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*, DOE-WD-2005-001, January 2006.

At Hanford, feed would come from a tank or tanks containing saltcake with very low concentrations of Cs-137 and Tc-99. The dissolved and adjusted salt solution would be fed to the LAW plant.

Option 3: Current 2020 Plan Using CST for Ion Exchange and Either Storage or Direct Disposal of Loaded CST

The current One System Plan uses an option for filtering, and ion exchange similar to the technology developed at SRS, the SCIX Process. The SRS SCIX process combines RMF for solids removal with CST ion exchange for Cs-137 removal. The loaded CST is then ground, stored in a waste tank, and eventually fed directly to DWPF for immobilization in HLW glass. If the SRS SCIX process was used at Hanford, the ground CST would have to be returned to a DST where it would have to remain for a number of years until the WTP HLW vitrification facility comes on line.

There are concerns that long term storage in a Hanford DST could lead to clumping of the CST and subsequent waste transfer difficulties. Possible CST interference with the WTP pretreatment leaching processes is also a concern. To avoid these potential difficulties, this option would be either store disposable CST cartridges for later treatment at WTP or directly dispose of the loaded CST. This option has the potential to significantly simplify an in-tank SCIX process and reduce technology maturation risk because of elimination of CST grinding and in-tank accumulation or resin regeneration if an elutable resin was used.

Regulatory Considerations: The 3116 Process and Shallow Land Burial

Tank waste that would be processed under the *One System Plan* originated in the reprocessing of spent fuel and is therefore classified as high level waste (HLW). Section 3116 of the FY05 National Defense Authorization Act[11] lays out the process (3116 Process) whereby some tank waste at SRS and INL may exit the HLW source-based classification and be disposed in a shallow land burial site, if they meet certain characteristics, under regulations resembling those for low level waste (LLW). Such wastes are generally referred to as low activity waste (LAW).

To exit the HLW classification under the 3116 Process, DOE in consultation with the NRC must agree that the waste meets the following criteria:

- It does not require permanent isolation in a deep geologic repository for spent fuel or high-level radioactive waste;
- It has had highly radioactive radionuclides removed to the maximum extent practical; and
- The waste either (a) does not exceed concentration limits for Class C low-level, or (b) if it exceeds Class C concentrations, it will be disposed of in compliance with the performance objectives set out in 10CFR61. Class C limits, specified in 10CFR61, are 4,600 Ci/m^3 for Cs-137 and 3 Ci/m^3 for Tc-99.

[11] Section 3116 of the *Ronald W. Reagan National Defense Authorization Act for fiscal year 2005*, November, 2006, pages 43-44.

The 3116 Process for classifying WIR covers the SRS and INL tank wastes and has been successfully implemented at those sites.[11,12] Although from the State of Washington is not included within the legislation, DOE and Washington State have agreed to follow a yet to be defined waste incidental to reprocessing (WIR) process for any portions of Hanford tank wastes that will be disposed on the Hanford site. Reclassification will require State approval. It is not clear how the WIR process would be carried out for wastes derived from the Hanford tanks that might be disposed outside of Washington.

Examination of Options

Three options for LAW feed preparation are worthy of consideration.

Option 1: No Pretreatment

This option must overcome three major hurdles. The first is the waste acceptance limits for cesium content fed to the LAW facility, which are established based on the total in-process inventory limitations and worker safety limits for a contact maintained facility. It does not appear that any DSTs contain undiluted supernate with Cs-137 concentrations low enough to be accepted in the WTP LAW vitrification facility.

It may be possible to adjust the WTP WAC limits during initial start up of hot operations given that:

- the facility will only be operating one melter;
- the inventory of vitrified canisters in the facility would be limited;
- the amount of feed in the facility would be limited.

The second hurdle is obtaining concurrence from Washington State Department of Ecology that the glass that results from direct feed qualifies as LAW. It could be a challenge to obtain stakeholder agreement through the WIR process that highly radioactive radionuclides have been removed to the maximum extent possible, although accommodation may be practical to achieve early facility start up.

The third hurdle is that disposal of the LAW glass in the IDF must meet the yet to be developed performance assessment (PA), which will set limits on the total amount of radionuclides that can be disposed in IDF. Although it is unlikely that the amount of radioisotopes contained in 500,000 gallons of direct feed waste would exceed the IDF PA limits, it might use up a substantial fraction of the limits, imposing strict limits on LAW subsequently produced during full WTP operations.

Option 2: Deliquification, Dissolution, and Adjustment (DDA)

The first two steps, removal of supernate from above the saltcake and extraction of interstitial liquid within the saltcake matrix, have already been carried out for all Hanford SSTs. According to presentations given to the EMAB TW Subcommittee, a number of SSTs contain radionuclide concentrations that are less than class C. Dissolution and adjustment would further lower radionuclide concentrations. A search of the BBI coupled with sampling and testing of the saltcake in low Cs-137 and Tc-99 tanks may identify tanks that could provide feed that would satisfy the WTP LAW facility WAC. The fact that DDA has already been found acceptable under the 3116 Process and been used at SRS increases the probability that Washington State approval could be obtained under the waste incidental to reprocessing regulatory process to be used for Hanford.

This option also requires that enough tank space can be found to allow DDA processing. It may be that there is not enough DST space to allow processing. However, it may be possible to install several small tanks or use existing WTP tanks to act as LAW feed tanks. This option would also require that the retrieval sequence of the SSTs be revisited and be agreed upon with the State.

Option 3: Current *One System Plan* Using CST for Ion Exchange and Either Storage or Direct Disposal of Loaded CST

Tests with SRS and Hanford supernate indicate a CST capacity of ~ 700 bed volumes (BV) for Cs-137. The amount of CST required for the *One System Plan* can be calculated as follows:

- Volume of supernate to be processed is ~ 500,000 gallons
- Volume of CST = 500,000 gallons/700 BV = 720 gallons = 100 cu ft

The commercial nuclear power industry frequently uses ion exchange to process its waste water. Typical ion exchange vessels are 3 ft in diameter, about 6 ft high and contain about 30 cu ft of ion exchange mixed bed media. *One System Plan* processing would require fewer than four such vessel loadings using inorganic resin materials. The commercial nuclear industry dries the loaded media in the ion exchange vessel and disposes the vessel directly in a LLW burial site, or sluices the loaded media out of the ion exchange vessel into a high integrity container (HIC), dries it, and disposes it in a LLW burial site. Sometimes grout or polymer solidification material is added to the disposal container to establish a matrix and stabilize the waste in the matrix materials. For cesium, sorption onto a non-elutable ion exchange resin presents an additional barrier to leaching into the environment. One hundred cubic feet of loaded CST media could be loaded into a single HIC. The HIC or disposable ion exchange columns could either be interim stored on site for processing and later disposition or disposed in a shallow land burial site on or off site. The shallow land disposal of loaded ion exchange media in HICs has been previously employed at Hanford.

Based on EM-TWS fact finding, Tank AP-104 has a Cs-137 concentration of 0.12 Ci/l = 120 Ci/m^3, the lowest in the AP tank farm. If AP-104 waste were processed using CST, the fully loaded CST would have a concentration of (120 Ci/m^3)(700 BV) = 84,000 Ci/m^3, a figure that is almost twenty times the Class C limit. It may be possible to dispose of such material in a shallow land burial site if the material is solidified and the burial site WAC can accommodate the total Curie loading. The Nevada Test Site (NTS) has accepted greater than Class C waste in the past. NTS does not have a concentration dependent WAC. DOE would have to work with NTS to determine whether loaded CST could be accepted for burial. This possibility would require programmatic concurrence for shipment of Hanford LAW to the State of Nevada and a possible section 3116 concurrence process in that State.

A second possibility is that Washington State would allow the loaded CST in a HIC to be stored for later processing with HLW or to be disposed at Hanford if PA requirements can be met.

From a safety perspective, the total in-process inventory of Cs-137 would need to be maintained at less than 8.9E+4 curies to be maintained as a Category 2 facility (DOE-STD-1027-92). Processing ca. 500,000 gallons of supernate based on the reported concentration in Tank AP-104 would involve a total of 2.3 E+5 curies of Cs-137, thus restricting in-process inventory to less than approximately one third of the total quantity to be processed if implemented in a near-tank scenario. Thus, an in-tank implementation would likely be preferable. Implementation in the Tank Farms would most likely require a major modification to the Documented Safety Analysis under DOE Standard 1189.

VITRIFIED LAW AND SECONDARY WASTE MANAGEMENT

Initiation of radioactive operation of the LAW facility beginning in 2016 will result in production of approximately 500 canisters of vitrified LAW prior to the current baseline start of hot operations. This will require accelerated purchase of the LAW transporter vehicles, which also serve the function of holding the canisters after production until sufficient cooling has occurred for transfer to the disposal facility. In addition, the WIR determination must be accelerated to allow for on-site disposal, as well as executing the accelerated completion of the Integrated Disposal Facility (IDF) performance assessment and permitting as called for in the Vision 2020 plan. Otherwise, an interim storage facility would be needed for vitrified LAW canisters.

WTP secondary solid waste produced by the LAB and operation of the LAW facility are proposed to be disposed of at the Mixed Waste Burial Ground. The LAW facility will produce primarily two liquid secondary waste streams. The first is from the submerged bed scrubber (SBS). This is the smaller of the two, but it contains virtually all the Cs-137 and Tc-99 that comes off the melter.

The second liquid stream is the condensate from the LAW melter, which should be relatively clean water. The proposed plan for managing both of these liquid effluent streams is to route them back to the DST tank farm using hose-in-hose transfer. DST storage capacity would be maintained through intermittent operation of the 242-A evaporator.

In addition, liquid effluent from the WTP laboratory would be trucked to the Effluent Treatment Facility.

Options for liquid secondary waste management worthy of consideration include:

- Use of a continuous, skid mounted small-scale evaporator to reduce the quantity of effluent to be managed and eliminate reliance on the 242-A evaporator;

- Separation of Tc from the submerged bed scrubber bleed stream followed off-site disposal, or off-site disposal of the entire submerged bed scrubber secondary waste stream;
- Concentration of one or both of the effluent streams followed by solidification using grout and off-site disposal;
- Concentration of the submerged bed scrubber effluent followed by direct recycle to the LAW feed.

For any of these options, the objectives would be to (i) minimize the need to handle the same constituents multiple times through the tank farms and treatment processes (which occurs if liquid secondary waste is returned to the tank farms), and (ii) minimize the volume of secondary waste requiring management.

Currently, there is a skid mounted wiped film evaporator undergoing evaluation testing for Hanford that may meet the needs for evaporation capacity. Separation and immobilization processes for Tc also have been previously developed and are being considered for further development within the systems planning process. Ultimately, full WTP operation will require selection and implementation of modifications and upgrades to the Effluent Treatment Facility or new treatment facilities for management of liquid secondary wastes, including the fraction of Tc-99 not incorporated into vitrified LAW.

TANK FARM AND SYSTEM MODIFICATIONS REQUIRED TO ENABLE VISION 2020

Table 8.1 provides a listing of the specific projects and activities required in the Tank Farms to support implementation of the Vision 2020.

Table 8.1. Tank Farms projects and activities required to achieve the proposed *One System Plan*.

Activity	Comment
2.1 Tank Operations Execution Strategy	
2.1.1 Interim Pretreatment System	Principal activities include: • conceptual design and technology down select • design and engineering • permitting • procurement, construction, and installation • commissioning • operations • placement in standby
2.1.2 Interim LAW Feed Delivery	Principal activities include: • design and engineering • permitting • procurement and construction

	• commissioning • operations • placement in standby
2.1.3 Interim Secondary Liquid Waste Handling	Principal activities include: • design and engineering • permitting • procurement and construction • commissioning • operations • placement in standby
2.1.4 ILAW Product and Secondary Solid Waste Handling and Disposal	This includes items that are in common with the baseline such as: WIR preparation and approval, IDF permit modifications, and procurement of ILAW transporters. However, these activities must be completed on an accelerated schedule to achieve the Vision 2020.
2.1.5 Secondary Liquid Waste Disposal/ETF Upgrades (Baseline)	Baseline ETF upgrades and operations.
2.1.6 Waste Feed Delivery (Baseline)	Baseline upgrades and infrastructure required for waste feed to the WTP baseline operations, i.e., feed for commissioning and operation of the entire WTP
2.1.7 Interim Hanford HLW Storage (Baseline)	Baseline storage facilities for HLW canisters
2.2 Waste Treatment Plan Projects	These are the activities required for baseline commissioning and operations
2.2.1.1 Low Activity Waste Facility	
2.2.1.2 Balance of Facilities	
2.2.1.3 Analytical Laboratory	
2.2.2.1 Pretreatment Facility	
2.2.2.2 High-Level Waste Facility	
2.2.2.3 WTP Integrated Waste Treatment	

Source: One System Level 1 Schedule presented to EMAB by Martin Wheeler (WRPS) and Ken Wells (BNI), May 2-4, 2011

REGULATORY CONSIDERATIONS

Complex Regulatory Backdrop

The Hanford tank waste program is heavily regulated under numerous statutes including:

- National Waste Policy Act and Amendments, the Resource Conservation and Recovery Act (RCRA)[12],
- Clean Air Act (CAA)[13],

[12] *Resource Conservation and Recovery Act of 1976*, 42 U.S.C. 6901, *et seq.*

- Clean Water Act (CWA)[14]
- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)[15]
- National Environmental Policy Act (NEPA)[16].

For some of these, the State of Washington has adopted corresponding state statutes and received delegation to implement USEPA programs. In addition to these external requirements, DOE has the authority to regulate its own radioactive waste management under the Atomic Energy Act[17], and this is accomplished through DOE O 435.1[18], which was crafted to ensure that DOE radioactive waste is managed in a manner that is protective of worker and public health and safety and the environment, and also under several other related DOE Orders, standards, and Guides which relate to nuclear facilities design construction, operations, quality control, and incorporation of technologies.

Regulatory Importance of the Vision 2020:

The Vision 2020 offers a number of regulatory benefits. Most importantly, it has the potential to increase the likelihood that DOE will successfully achieve the two key (A1) waste treatment regulatory milestones mandated by the 2010 Consent Decree[19]. These milestones call for "Hot Start of Waste Treatment Plant" by 12/31/2019 and "Initial Plant Operations" (IPO) by 12/31/2022.

The milestones are a principal mandate of the Consent Decree, a binding legal agreement with judicial oversight. As such, non-compliance could result in a state motion for potential sanctions that could include issuing orders, penalties, and holding responsible parties in contempt[20]. EM-TWS considers this to increase the likelihood of successful compliance with these milestones and provide significant value to DOE and its stakeholders. As outlined elsewhere in this report, overall WTP project start–up and operational readiness risk is reduced by accelerating low activity waste operations and using a phased commissioning approach.

In addition to the above primary milestones, there are numerous additional "interim" milestones included in the Consent Decree to assure that DOE is on track to meet the WTP Hot Start and IPO milestones. Specifically, the decree spells out interim milestones for construction, cold commissioning and hot commissioning of WTP components including LAW, LAB, PT, HLW and BOF. The Vision 2020 calls for acceleration in many of these areas including achieving hot start of WTP operations (PT, LAW and HLW) 18 months ahead of the interim milestone date.

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[13] *Clean Air Act of 1970*, 42 U.S.C. 7401, et seq.

[14] *Clean Water Act of 1972*, 33 U.S.C. 1251, et seq.

[15] *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 U.S.C. 9601, et seq.

[16] *National Environmental Policy Act of 1969*, 42 U.S.C. 4321, et seq.

[17] *Atomic Energy Act of 1954*, 42 USC 2011 et seq.

[18] *DOE Order 435.1, Radioactive Waste Management, Change 1*, August 28, 2001.

[19] *Consent Decree No. 08-5085-FVS*, U.S. District Court Eastern District of Washington, State of Washington v. Steven Chu, Secretary of Energy, U.S. Dept. of Energy, October, 2010.

[20] Responsiveness Summary on Proposed Consent Decree and Tri-party Agreement Settlement Package, State of Washington v. Chu, U.S.D.C. E.D. WA CV-08-5085-FVS, October, 2010.

Because of this, the Vision 2020 also has the potential to increase regulator and stakeholder confidence that DOE is on a path to meet tank waste regulatory requirements.

Vision 2020 Regulatory Challenges

Despite the regulatory benefits of the Vision 2020, there are regulatory challenges for regarding implementation of the Vision 2020. As discussed above, the tank waste management area is heavily regulated with multiple regulatory agencies and processes. Numerous permits or authorizations will be required and there is minimal schedule contingency available. Not surprisingly, according to DOE-RPP, two of the four identified critical risks regarding the One System Plan/Vision 2020 from the ORP's Directors Review are regulatory-related. The EM-TWC agrees that these are critical risks as described below:

1. Delays in Finalizing the Tank Closure and Waste Management Environmental Impact Statement (TC&WM EIS):

   The TC & WM EIS is being prepared pursuant to NEPA and Washington's State Environmental Policy Act (SEPA) and is the outgrowth of a 2006 legal settlement between DOE and the State of Washington. For this EIS, DOE is the Federal Lead Agency and the Washington Department of Ecology (Ecology) is a Cooperating Agency. Once finalized and after a Record of Decision (ROD) is issued, the EIS will serve as the environmental planning basis for all matters pertaining to the closing of the tanks and management of the wastes within the tanks.

   In addition to the NEPA regulatory significance, DOE (EM-1) has made a programmatic decision that no related Performance Assessments will proceed until a ROD has been issued. The finalization of the EIS and issuance of the ROD is a time critical step that impacts the Integrated Disposal Facility (IDF) and Waste Incidental to Reprocessing (WIR) determinations in addition to the issuance of state permits.

   Specific to the Vision 2020, there is also a question of whether there is adequate NEPA coverage in the draft EIS to support some activities in the Vision 2020. Should NEPA coverage be deemed to be inadequate, DOE will need to take steps available under NEPA to provide such coverage. Since those steps range from a documented internal analysis to creation of a Supplemental EIS, DOE will need to move as expeditiously as possible to avoid a delay in schedule.

   Scoping for the EIS commenced in 2006 and the process experienced delays in subsequent years. A draft EIS was released in 2009 and DOE now plans to issue the final EIS in December, 2011, and a Record of Decision (ROD) is planned for May or June, 2012. ***Any substantial delay in these actions will put the Vision 2020 schedule at risk since ROD issuance is on the critical path of several waste management aspects of the program.***

   The threat of legal challenge that could impact the validity of the ROD is also a concern. The EIS has a broad scope with many controversial issues, including some that are not specifically related to the Vision 2020. Examples include tank closure options, disposal of defense waste from other DOE sites in the Central Plateau at Hanford, and supplemental LAW treatment scenarios. Despite these complexities, it is clear that the issuance of the final EIS and ROD is a critical step that must occur in the next 12 months if the Vision 2020 is to be successful.

2. Obtaining Required Permits and Authorizations

In order to achieve the Vision 2020, DOE and/or their operations contractors will need to obtain additional permits or authorizations; many are complex.

The *One System Plan* has proposed an ambitious schedule of permit application preparation and regulatory agency review. Permitting activity for the WTP has been ongoing given that construction commenced in 2001. Because of the size and nature of the facilities, the permits are often complex and the permitting and authorization activity has been dynamic to take into account periodic design changes.

One System Plan calls for expedited permitting or authorizations, some of which have significant complexity. Examples include RCRA modifications for the Interim Pretreatment System, AP105/AP107, Interim LAW feed delivery and interim secondary liquid waste handling, authorization to receive LAW/LAB secondary waste in the Mixed Waste Burial Grounds and numerous Clean Air Act permits.

State regulators, during discussions with EM-TWS, indicated their intentions, within the limit of their resources and established approval process, to work constructively with DOE in considering these permits and authorizations. It will be critical to the success of the Vision 2020 that the permit and authorization processes perform as efficiently as possible.
Internal Coordination: There are measures that DOE can take to improve coordination between the organizations involved in permit preparation and internal review. These organizations include DOE-ORP, WTP DESIGN BUILD CONTRACTOR, TANK FARM OPERATIONS CONTRACTOR, DOE-RL, and DOE-HQ among others.

DOE has recognized the need for a coordinated effort that will include setting site-wide permitting priorities, ensuring there is an engineering strategy in place to support early design permit submittals, communicating with regulators, negotiating permitting strategies, providing timely supplemental information and coordinating with other site organizations regarding related processes.

To achieve this, DOE-ORP has proposed that an Integrated Project Team coordinate the activities of DOE and the TOC and WTP contractors and has solicited contract modification proposals from its two prime contractors to achieve that goal. That coordination will be critical because of the interrelated nature of processes and permits and the lack of any "cushion" in most of the project and permitting schedules.

External Coordination: Frequent and candid communication with the regulatory agencies will be needed for the following:

- Strategic discussions at the design phase regarding permit needs, options and challenges;

- Early identification of target timelines for submission of applications and reviews;

- Prioritization of permit applications so that those most critical to the mission are given appropriate attention by all parties;

- Efficient use of permit writer and permit reviewer resources;

- Minimization of miscommunication, surprises and the lost time in the review process that can result; and

- Coordination of design, construction and permitting functions that often proceed concurrently.

DOE has proposed a Core Team approach to help facilitate communication and collaboration with the regulators on managing the permitting process. The Core Team approach has been used successfully at other DOE sites and is especially valuable when there are a large number of parties involved as is the case at Hanford.

DOE and the contractors will need to work together with the regulators to understand regulator limitations and concerns. The regulators will need to proactively raise issues to assist DOE and their contractors in meeting their expectations. One important Core Team responsibility will be to develop permitting plans and schedules consistent with the overall project needs. The team can also provide early identification and communication of areas of disagreement or data gaps and facilitate a more expeditious response.

Over time the Core Team can instill a sense of joint ownership in the permitting process and the resolution of issues, while continuing to assure that sound regulatory decisions are made.
<u>Keeping the Focus:</u> Because of the tight timelines, DOE needs to keep the permitting focus on the Vision 2020 necessities and not get sidetracked with peripheral issues.

It is important that DOE focus on those permits and facilities that are critical to achieving LAW hot operations as soon as feasible along with full commissioning of WTP.

Using the Vision 2020 as a platform for technology maturation or system development to support Supplemental LAW treatment has the potential to increase the complexity of the permits and lower the priority that regulators are willing to give the permit for expedited review.

Both DOE and the regulators appear to have much to gain by the success of the Vision 2020. Both acknowledge that the sequencing of commissioning and the expertise gained by early LAW treatment enhance the capability of DOE to be successful in meeting the all-important 2022 deadline for full WTP operation.

Additional Observations Concerning Regulatory Challenges

- LAW Secondary Solid Waste Disposal: Due to the long lead time to prepare the IDF PA and the associated regulatory permit, another disposal alternative is needed for LAW secondary waste disposal through 2017. The *One System Plan* calls for disposal in the 200 West Mixed Waste Burial Ground (MWBG) through 2017. The issues that need to be resolved include whether the Tank Waste Remediation System EIS (TWRS EIS) provides adequate NEPA coverage, whether the current regulatory permit accommodates that waste stream and whether there is sufficient operational capacity in MWBG.

- WIR determination for ILAW Disposal at IDF: While confirming the acceptability of MWBG for secondary solid waste, the technical basis document will be prepared, along with other WIR documentation to demonstrate how the ILAW product treatment, followed by disposal in the IDF meets the three evaluation criteria in DOE M 435.1-1. This demonstration would be best supported by an IDF PA which will be prepared by DOE-RL and their contractor, but cannot move forward until the TC&WM EIS and ROD are in place. If the ROD is not issued by June, 2012, an alternative approach being considered is to update the 2001 ILAW PA and use it to support a WIR for ILAW disposal only.

  - A WIR would be issued at a later date, once the IDF PA was complete to cover secondary WTP waste that is not already covered by a WIR determination. The PA used to support the WIR is reviewed by the DOE-ORP management and the DOE Low-Level Waste Federal Review Group. The WIR documentation is reviewed by ORP management concurred with by DOE-EM-1, published as a draft for public comment in the federal register, undergoes consultative review by the Nuclear Regulatory Commission and is signed by the DOE Secretary to finalize.

- In-Tank vs. At-Tank Interim Pretreatment: There does not appear to be an over-whelming advantage between in-tank or at-tank options for interim pretreatment with respect to state regulatory permitting time or requirements based on discussions with representatives from the Washington State Department of Ecology.

  From the State perspective, the primary discriminator with respect to permitting will be the scale and intended use of the IPS, with smaller processing capacity and focus on supporting LAW facility startup enabling more rapid permitting. Twelve to eighteen months appears to be a minimum time frame for permit approval.

  There may be distinctions with respect to the time required for permit preparation and DOE safety requirements or other factors with respect to in-tank vs. near-tank design of IPS. While an in-tank option would be considered a modification to an existing permit, it is unclear whether a near-tank option would be similarly allowed to be covered as a modification to the existing tank farm permit. It is EM-TWS opinion that a near-tank facility would need to be designed, constructed and operated as a Hazard Category 2 facility.

Operations Management

From the management perspective, the significant aspects of the "One System" approach can be summarized as:

- Very active involvement of the DOE-ORP in all aspects of the Vision 2020 and in particular in the *One System Plan* management approach;
- Identification of all of the potential interfaces between Tank Farms and WTP by an Integrated Project Team;
- Joint management of WTP and Tank Farms of interfacing activities, coordinated via the Integrated Project Team, with emerging issues raised to an Issue Resolution Team; and
- Management of WTP and Tank Farms of non-interfacing activities by the respective contractors.

One System Organization

One System mission focused organization represents a significant and positive step forward in being able to realize the Vision 2020:

- Deliver LAW glass in 2016;
- Ramp up hot operations, while providing an adequate learning process from early LAW operations to full WTP operations;
- Potential for freeing up DST space allowing accelerated retrieval of SSTs (if liquid secondary waste is not recycled to the DSTs); and
- Reduce the risk for meeting Consent Decree milestones

While initial results of the One System are encouraging, until the integration is complete, the One Mission has a responsible manager, and the WTP and TANK FARM OPERATIONS CONTRACTOR contracts are realigned to be consistent with and to incentivize both contractors to perform the Vision 2020 mission, one should expect some temporary difficulties in the implementation of whatever scenario is selected to achieve the mission. Specifically to the completion of the integration, the *One System Plan* approach should include the regulatory approach as an aspect to be fully integrated.

Risk Management Vulnerabilities

The One System IPT has identified a number of risks (see Chapter 7, Vulnerabilities) that potentially jeopardize the achievement of the Vision 2020 selected scenario. The risks that are unique to changes arising from the One System plan are presented in an integrated One System risk register, to be managed by a One System risk team.

Based on EM-TWS fact-finding, the risks in the register are limited to those additional risks posed by the One System proposal, and do not include those already considered by the WTP and Tank Farms, many of which can impact implementation of the One System plan. A holistic system for managing risks, clearly identifying which mission objectives are vulnerable from each risk, would provide a more effective risk management system and preclude the possibility that different management approaches could result in conflicting outcomes.

All risks and opportunities associated with WTP completion and commissioning and operations, specifically including those associated with feed delivery, effluent (secondary waste) and waste disposition, should be maintained as an integrated risk and opportunities management system, and managed accordingly. In addition, while there is intention of adding a One System opportunity register, at present no opportunities have been identified.

Labor Strategy

The workforce approach for the Vision 2020 entails two key and distinct approaches:

- The workforce required to operate and maintain any interim feed and waste disposition systems and then the full operations feed systems will be hired, trained and deployed per the existing TANK FARM OPERATIONS CONTRACTOR labor agreement
- The WTP project will recruit and train the commissioning workforce that will ultimately transition as the operations and maintenance workforce to the WTP operations contractor.

The later approach is silent as to what will be the appropriate terms and conditions of employment for WTP operations. While it may be premature to define those terms and conditions, it is an uncertainty or gap that has to be filled as soon as practical.

Contracts and Funding

The present contracts with WTP DESIGN BUILD CONTRACTOR and TANK FARM OPERATIONS CONTRACTOR have specific work scopes that are not always consistent with the objectives of the Vision 2020. The contract scopes and incentives are not aligned with the integrated problem solving that is needed to achieve the Vision 2020. DOE-ORP is well aware of this situation and is working diligently to develop a solution to this problem. Similarly, funding to both contracts may have to be modified to increase confidence in achievement of the mission.

COST CONSIDERATIONS FOR VISION 2020

The funding required for implementation of the Vision 2020 can be considered as the following categories

- Funding and timeline for the current baseline WTP scope;

- Funding and timeline for the current baseline TOC scope;

- Funding for accelerated TOC scope (e.g., funds expended earlier than planned in the baseline, ca. $330 M);[21] and

[21] All cost estimates indicated here are rough order of magnitude based on “success oriented” assumptions and were provided to the EMAB TWS with limited supporting information.

- Additional funding for TOC needed specifically for Vision 2020, as opposed to other tank farm operations improvements (ca. $230 M).

Current TOC scope that would need to be accelerated as proposed includes:

- Design, construct, start-up and operate the WTP Pretreatment Facility Waste Feed Delivery System;

- Design, construct, start-up and operate the WTP Secondary Liquid Waste Treatment and Disposal system; and

- Design, construct, start-up and operate the Interim Hanford HLW Storage Facility.

New scope that would be needed as proposed to implement the Vision 2020 includes:

- Design, construct, start-up and operate an Interim Pretreatment System in the tank farms to remove solids (including actinides) and cesium to meet the LAW Facility waste acceptance criteria;

- Design, construct, start-up and operate an interim Low Activity Waste Feed Delivery to directly feed tank waste directly to the WTP LAW Facility; and

- Design, construct, start-up and operate a Secondary Liquid Waste Handling System to return WTP LAW secondary liquid wastes to the tank farms for treatment and storage.

Based on EM-TWS fact-finding, it is understood that cost estimates are rapidly evolving and a clear, coherent and integrated financial business case for Vision 2020 and *One System Plan* has not yet been provided. However, the following observations can be made:

- Start up of the WTP LAW facility according to the Vision 2020 shifts significant scope and costs forward withinTank Farms operations, from the time of completion of cold commissioning to the time of completion of overall WTPIPO, and at a time when other baseline costs for completion of WTP EPC and tank farm improvements are peaking;

- Given that there is no change in the mission length under Vision 2020 and that the fully integrated WTP will be operating during an extended hot operations period (relative to the current baseline) it would appear that substantial additional WTP operational expenses would be incurred prior to IPO, relative to the current baseline;

- Currently there are two forms of accelerated TOC scope that should be distinctly different considerations: (i) costs associated with needing facilities and operations earlier than planned in the baseline, and (ii) projected potential savings over the full Tank Farms and WTP operating life-cycle because of the potential for an accelerated completion of mission. The schedule for completion of mission will be affected by many interdependent factors that are highly uncertain and several decades in the future; therefore, it would be inappropriate to credit projected end-of-mission savings against costs associated with accelerating completion of Tank Farms facilities and earlier operations.

- Significant new costs are associated with design, construction and operation of an Interim Pretreatment Facility in the Tank Farms. The design objectives for the Interim Pretreatment Facility presented to the EMAB TWS included providing LAW feed for both (i) interim operations during WTP startup, and (ii) a Supplemental LAW treatment facility. Part of a business case for the Vision 2020 should include a cost, schedule and risk evaluation that compares the (i) the minimum interim pretreatment facilities required to satisfy interim pretreatment to enable WTP start up, and (ii) a more robust set of facilities required to satisfy both interim pretreatment and supplemental LAW treatment needs.

- Significant new and accelerated costs are associated with managing the secondary liquid waste effluent from the WTP LAW facility. The viability and cost and risk benefits of off-site disposal of secondary liquid effluent should be part of the business case evaluation.

- As discussed earlier, the risks to WTP commissioning that are reduced by Vision 2020 have not been quantified and included in the financial evaluation. The costing of risk reduction should include those associated with reduction in the probability of delay of WTP startup, the improvement in overall operability and operational efficiency during the early years (when historically most large process facilities are slow to ramp up to their full potential (e.g., DWPF), and associated reduction in the contingency required in the WTP cost estimate.

- The schedule and costs presented for Vision 2020 are “success oriented” both for WTP and Tank Farms construction and activities, and therefore can be considered optimistic. A more thorough evaluation of schedule and cost uncertainties and risks should be made to present both success oriented, 50 percent and 80 percent confidence schedule and cost estimates. This will provide a firmer foundation for decision making and establish a basis more realistic expectations amongst diverse constituencies.

- There is a significant increase and peak in funding required for Office of River Protection during the interval between FY2016 to FY2020 (ca. $1 B), which to a large extent is associated with the design, construction and commissioning of a Supplemental LAW treatment facility, and occurring concurrently with increased funding required for WTP completion and startup as projected for Vision 2020.

  Given current budget constraints and technical considerations, it may be prudent to delay implementation of a Supplemental LAW for 3 to 5 years from the current baseline. This would facilitate improved understanding of (i) performance of the WTP LAW facility (including Tc retention), (ii) performance of fluidized bed steam reforming based on the Idaho Integrated Waste Treatment Facility, both of which may influence the capacity and design specifications for Supplemental LAW treatment facility, and (iii) more thorough analyses of other supplemental LAW treatment technologies and strategies to produce waste forms acceptable to the State.

8.3 Conclusions

8.3.1 The Vision 2020 increases the likelihood that DOE will successfully comply with the key 2010 Consent Decree milestones for "Hot Start of Waste Treatment Plant" by 12/31/2019 and "Initial Plant Operations" (IPO) by 12/31/2022. Failure to meet these milestones could have serious consequences for the Department.

8.3.2 A clear, coherent, and integrated financial business case for Vision 2020 has not been provided.

8.3.3 The proposed plan will not significantly reduce the timeframe for completion of waste treatment at Hanford nor reduce lifecycle costs.

The primary benefits of proposed plan, if successful, are:

- Providing a programmatic victory by achieving treatment of LAW and production of vitrified LAW 15 months earlier than the baseline plan;
- Reducing the risk registry carrying costs for WTP startup;
- Reducing the risk of delays to full WTP commissioning and hot operations by providing a more graded approach to commissioning and initiating hot operations; and
- Reducing pressure on the WTP line item project cost of $12.263B by transferring hotel and startup costs from project construction costs to operational expenses.

8.3.4 The primary risks of the proposed plan are:

- Schedule delays in completion or startup of the WTP LAW or LAB facilities or completion of necessary supporting projects in the Tank Farms will reduce or eliminate the proposed timeframe for WTP LAW hot operations prior to startup of WTP PT and HLW facilities. However, if delays in WTP LAW startup are realized, the earlier initiation of startup will allow for additional lead time to resolve currently unforeseen problems;

- Schedule delays in completion of WTP PT or HLW require extended operation of WTP LAW on a minimal feed, with attendant hot operations costs, without substantial reduction in LAW inventory.

- Unplanned incidents associated with interim LAW feed preparation and delivery operations, including hose-in-hose transfers, as well as on-site hot operations while other WTP facilities undergo completion, may delay overall WTP completion.

8.4 Recommendations

8.4.1 The management realignment and integration between the Tank Farms and WTP proposed in the "Vision 2020 – One System Plan" should be supported and encouraged.

The proposed management realignment and integration, including the reporting structure, risk management and coordination objectives represent a major positive step towards the fully integrated structure needed as WTP commences operations.

DOE management alignment needs to correspond with contractor alignments.

The currently proposed risk register for the One System Plan includes only additional risks posed by the One System proposal, not including those already considered by the WTP and Tank Farms. An integrated risk management system is needed that includes all of the risks associated with WTP completion and commissioning, including those associated with feed delivery and effluent management. Risk management should include identification, assessment and tracking of opportunities.

The management approaches to labor and staffing need to receive increased attention and priority.

The cost of the Vision 2020 capital and early operating of the LAW, LAB, and related facilities should offset some of the risk contingency currently allocated in the WTP and Tank Farm Commissioning and Start-up risk expenditures. In review of a downside delay of one year of WTP start-up, risk could easily offset the capital and operating cost for Vision 2020 in the initial construction and 18 months of operation.

8.4.2 The benefits and risks from the Vision 2020 –One System proposal need to be better articulated and quantified where possible to form a compelling business case for implementation. Probabilistic simulation of the cost and schedule uncertainties associated with the Vision 2020 – One System Plan should be part of the detailed Vision 2020 – One System proposal and summarized in the business case to provide improved clarity regarding the cost and schedule risks and confidence.

The primary benefits from the Vision 2020 – One System proposal are (i) management integration between WTP and TOC to achieve WTP startup, (ii) sequential commissioning of LAB/LAW, HLW and PT facilities to provide a more achievable schedule and sequence for ramp-up and demonstrate operability, (iii) initial production of LAW glass up to two years earlier than the current baseline plan, (iv) the potential to de-link initial LAW and HLW facilities operations from PT commissioning, which will likely present the most serious commissioning schedule challenges. Together, these benefits substantially reduce the risk of schedule delays to the initiation of full WTP operations in 2020. However, the current plan assumes a “success-oriented” cost and schedule basis, while coupled assessment of uncertainties and risks is needed to provide quantification of the confidence in achieving the proposed schedule.

Programmatic priority should be to develop credible, defensible information to obtain broad based support for adequate funding, including quantification of cost and schedule uncertainties, risks and benefits.

8.4.3 The technical path of sequential commissioning of WTP Balance of Facilities, LAW, and Laboratory, followed by commissioning of PT and HLW, should be supported.

Even though multiple technical and programmatic risks make the achievement of LAW glass production on the proposed schedule uncertain, the proposed technical path to completion of WTP commissioning and transition to hot operations represents a significant improvement over the baseline approach with substantially reduced risks in meeting the objective of achieving the earliest practical hot operations of LAW, PT, and HLW.

8.4.4 The technical plan under Vision 2020 should focus on what is needed and essential to achieve LAW hot operations as soon as technically and programmatically feasible, along with WTP full commissioning by 2018 and IPO by 2022. Synergies of technology maturation and system development to support Supplemental LAW Treatment or other needs should be clearly justified by the business case.

The minimum requirements for supporting LAW feed preparation and delivery prior to the availability of WTP PT should be defined and alternative technical approaches to meet those requirements should be evaluated. Current commercial approaches and off-site disposal of depleted resin waste should be considered.

Short-term alternatives should be evaluated for disposal of LAW secondary liquid wastes during interim operation that do not require returning material to the DSTs or reducing the amount returned, including continuous concentration of secondary liquid effluents, direct recycle to LAW feed, separation of Tc-99 and other constituents, and off-site disposal.

- Including development of an interim pretreatment system that also supports future Supplemental LAW options puts the Vision 2020 plan at high risk of failure because of (i) substantially increased costs and schedule, (ii) delays in regulatory approval, and (iii) technology maturation schedule requirements and risks.

- There is not an advantage between in-tank or at-tank options for interim pretreatment with respect to regulatory permitting time or requirements. However, there may be distinctions with respect to DOE safety requirements.

8.4.5 Achievement of the earliest practical initial processing at WTP of LAW and HLW, including PT, should be the highest priority for ORP and WTP.

Delay the selection and procurement of Supplemental LAW treatment facilities by 3 to 5 years, including Supplemental Pretreatment. This should be considered to enable focus on start up of WTP operations, level funding needs and provide additional lessons learned prior to the needed technology selection, design and project commitment decisions, including reducing cost and schedule uncertainties with both Vision 2020 and Supplemental LAW technology deployment. Such a programmatic change would require agreement of all parties to the Consent Decree.

- Delay in initiation of the Supplemental LAW Treatment project will reduce the peak ORP and WTP funding needs by ca. $1 B over the period of 2016 to 2020 and enable focus on WTP start of operations.

- Delay in the technology selection and design for supplemental pretreatment and Supplemental LAW treatment will allow for lessons learned from (i) additional waste form performance characterization, (ii) WTP commissioning, including LAW and PT startup, (iii) implementation of rotary microfiltration and small column ion exchange at SRS, and (iv) FBSR at the Integrated Waste Treatment Facility at Idaho. Furthermore, knowledge gained from the operation of the LAW facility will allow for better informed selection and sizing of Supplemental Treatment facilities.

8.4.6 DOE and the TOC and WTP contractors should make it a high priority to develop an integrated, fast-track permitting approach in active collaboration with regulators.

An integrated approach is needed to regulatory permitting, which presents one of the greatest risks to the Vision 2020 schedule.

DOE needs to determine if the draft TC&WM EIS provides adequate NEPA coverage for Vision 2020 activities. If the current analysis does not, DOE, on a fast track, will need to take steps available under NEPA to provide coverage.

If the Vision 2020 is to succeed, DOE must move as expeditiously as possible to finalize the EIS (and any needed Supplemental EIS) and issue a Record of Decision. DOE and the TOC and WTP contractors will need to clearly articulate to stakeholders the need for NEPA coverage and the impacts on the Vision 2020 if the process is delayed.

Joint management of the permit process through a collaborative effort is key to mitigating schedule risk.

CHAPTER NINE
Charge 8: Alternative Retrieval Strategies for the Hanford Waste Tanks

Charge 8 was the last charge given to the EM-TWS in February 2011. As such, it is not completed; fact-finding is still being conducted. It is anticipated that it will be complete some time before the close of the current fiscal year. What follows is the background rationale for the charge.

9.1 Background

At the request of EM-1, based upon discussions with the DOE CFO's Office, EM-TWS was asked to look at alternative retrieval strategies for the Hanford tank wastes and the impacts of those alternatives on LCC and any constraints that exist for these alternatives.

The principal drivers for looking at alternatives are the cost, schedule, regulatory compliance, safety, and public health. The main focus is:

> Will the alternatives being evaluated impact public safety (exposure to and uptake of radioactivity or other contaminants) while shortening the length of time required for clean up and closure of the Hanford tanks thereby potentially reducing the total life cycle costs for the cleanup?

There are four historical examples of successful DOE site cleanups or cleanup approaches that demonstrate the Department's ability to overcome seemingly entrenched regulatory status-quo positions, while delivering on cost-effective public health and safety and fulfilling DNFSB safety oversight expectations — all within appropriation "realities." These four sites were[22]:

1. Rocky Flats (total site cleanup)
2. Savannah River Site (tank salt waste treatment technical approach)
3. Idaho (site cleanup strategy)
4. Fernald (total site cleanup)

There are several key aspects to these successes, which can and should be considered going forward with the Department's current cleanup program at Hanford:

1. A strong public-private partnership between the Department and all of the contractors;

2. The opportunity and encouragement for "thinking out of the box" and implementing more effective approaches to both the technical and managerial aspects of running the program;

3. A fresh review of the regulatory requirements, re-evaluating which are health- and safety-based, and which are based on "public policy" considerations

[22] When completed, Appendix 12 will include summary descriptions of what was done at each of these sites.

4. Involvement of all of the stakeholders early and often in the alternatives evaluation and decision-making processes;

5. Use of highly credible independent review bodies, such as the National Academy of Sciences, to evaluate/critique proposed DOE approaches to assure regulators and stakeholders that a new approach to cleanup is, in fact, reasonable and feasible;

6. Close coordination with the authorization and appropriation committees in the House and Senate to demonstrate that an assured funding profile providing stability and flexibility can significantly reduce life-cycle costs; and

7. Provide adequate incentives to all stakeholders such that a faster, more cost effective closing that still provides long-term environmental protection is in everyone's interest, and economic benefit.

While these operating and management considerations seem reasonable, they are not always thought of or followed. When implemented consistently, however, they have resulted in the aforementioned cleanup successes.

While these seven factors were helpful in the past, the present fiscal and budget environments (which will make cleanup funding even more constrained) make their implementation even more critical. The increases, decreases and uncertainties in annual appropriations have been estimated to increase life cycle costs.

Status of Charge 8 Report

The charge has been documented; a team has been formed and is currently reviewing and analyzing existing materials. The review of materials is the required fact finding necessary to establish observations, findings, and recommendations. Neither findings nor recommendations are provided at this time.

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