RPP-29981
Revision 1

Evaluation of Starting the Waste Treatment and Immobilization Plant (WTP) Low Activity Waste (LAW) Facility First

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

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-99RL14047

CH2MHILL
Hanford Group, Inc.

P.O. Box 1500
Richland, Washington

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M. G. Thien
CH2M HILL Hanford Group, Inc.

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J. D. Aardal 03/29/2007
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EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) River Protection Project (RPP) mission is to retrieve and treat Hanford's tank waste and close the tank farms to protect the Columbia River. The RPP is managed by the DOE Office of River Protection (ORP). The Waste Treatment and Immobilization Plant (WTP) is a major contributor in the treatment portion of the mission. The WTP is a first of a kind in terms of size and scale for the treatment of radioactive waste stored at the Hanford Site tank farms. The WTP has been reviewed from a technical, budget and schedule perspective by external review teams. The WTP baseline plans to have all WTP facilities operational by February 2019.

This report updates the July 2006 study (RPP-29981, Revision 0) that presented options for starting the WTP Low-Activity Waste (LAW) facility before completing construction and startup of the Pretreatment (PT) facility or High Level Waste (HLW) vitrification facility. This *"Start LAW First"* concept represents a decoupling of the baseline WTP startup plan that has all three processing facilities beginning operations concurrently in February 2019. This report describes a potential *Start LAW First* implementation scenario that is reflective of current WTP baseline scope and funding assumptions and expands on key programmatic risks that should be considered. This report was completed at the request of the ORP.

The *Start LAW First* concept includes a tank farms pretreatment facility that is tailored to pretreat selected tank waste to the extent necessary to directly feed the WTP LAW facility. The WTP LAW, Analytical Laboratory (LAB), and Balance of Facility (BoF) equipment and facilities are modified as necessary to support operation of the LAW facility independent of the PT or HLW facilities. The design concepts and cost estimates are intended to provide preconceptual design and rough-order-of-magnitude cost information sufficient to determine if further development of the *Start LAW First* concept is warranted.

The *Start LAW First* concept schedule suggests LAW treatment could begin as early as June 2014; with interim LAW operations running for nearly 5 years in advance of the February 2019 operational date for the entire WTP complex. This interim LAW operating period has the following potential benefits:

- More than 32,000 metric tons of LAW glass produced
  - ~ 5,500 containers
  - ~ 4,600 metric tons of sodium incorporated into glass (~8% of the total mission estimate of ~56,000 metric tons of LAW sodium.)
- More than 7 million gallons of double-shell tank (DST) waste processed
- Approximately 4.7 million gallons of DST space created to support accelerated single-shell tank (SST) retrieval
- Reduces WTP startup and operating resource hiring demand
- Increases WTP Operational Readiness Review (ORR) efficiency and success with lessons learned from the *Start LAW First* ORR applied to the PT and HLW facilities ORR
- Interim LAW operating experience gained would support supplemental LAW treatment capacity need decisions.

The *Start LAW First* concept has budget needs that are currently not included in the RPP life cycle budget plan or funding requests. Preliminary, rough-order-of-magnitude cost estimates are developed in this report and include the following budget needs:

- ~ $160 million to $220 million for the tank farms pretreatment project
- ~ $760 million for interim LAW operations
  - ~ $110 million for interim tank farms pretreatment operations
  - ~ $650 million for WTP interim LAW operations.

If adopted, the *Start LAW First* concept would represent a change in the current RPP baseline that includes a new tank farms construction project and adjustments to the WTP baseline work scope. The programmatic risks associated with these changes were qualitatively evaluated considering potential impacts to funding, regulatory, and stakeholder interests. Some of the key programmatic risks include the following:

- NEPA Coverage – The current WTP construction is authorized by the *National Environmental Policy Act* (NEPA) Record of Decision (ROD) issued as a result of the Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS) issued in 1997. This report assumes the tank farm pretreatment project will either be covered under the Tank Closure and Waste Management (TC & WM) EIS, currently scheduled for a record of decision in Fiscal Year (FY) 2009, or in a separate NEPA analysis. Path forward decisions should clearly spell out a NEPA coverage strategy as project planning matures to ensure that construction activities beginning in FY 2012 are supported.

- Secondary Waste – LAW glass product and secondary wastes will be disposed of at the Integrated Disposal Facility (IDF). Preliminary performance assessment data for the IDF identify a potential sensitivity to iodine and technetium components of disposed waste forms. The *Start LAW First* concept would likely shift some inventory of these components from the LAW glass waste form to the solidified secondary waste form. This will continue to be a sensitive issue with DOE, regulators, and stakeholders and should be identified as a priority area to develop more detailed information.

- Cost and Schedule Estimate Uncertainty – While the tank farms pretreatment project information included in this report is adequate for feasibility evaluation, it is not an adequate basis for a project cost or schedule baseline. DOE project management tools and critical decision processes outlined in DOE Order 413.3a, *Program and Project Management for the Acquisition of Capital Assets*, must be followed to develop, independently review, and validate conceptual design and project baseline cost information. Due to the preliminary nature of the tank farms pretreatment concept, project costs should be considered to be as high as $220 million based on doubling the allowed contingency costs.

  No conceptual design, hazards analysis, or preliminary safety analysis for the Tank Farm interim pretreatment capabilities has been performed. The current technical basis

for tank farms pretreatment consists of preliminary process flowsheet data, a conceptual equipment list, and simple equipment and facility layouts.

- Schedule Integration – Depending on the use of schedule contingency, the schedule described in this report shows the WTP LAW facility ready for hot commissioning from 9 to 24 months before the tank farm pretreatment project is completed. As the planning basis becomes more mature, this schedule misalignment needs to be resolved to optimize resource utilization. Future programmatic decisions to reduce the schedule misalignment should consider the overall integrated schedule risk.

- Technology Maturity – The pretreatment solids separation relies on filtration equipment (SpinTek™1) that has not completed full scale prototype testing. The schedule for completing the test is not clear. If the SpinTek™ testing is not successful, ultrafiltration could be developed adding $15-30 million additional in life-cycle cost.

  The cesium ion exchange technology is similar to that used in the WTP pretreatment facility. However, a less efficient, simpler design was studied for tank farms deployment. The simpler equipment design allows for a simple facility concept for tank farm deployment based on existing tank farms operations and maintenance practice. However, pretreatment operations of this type have not been run in the tank farms recently, so this deployment concept has more uncertainties when compared with other pretreatment facilities under construction by DOE (e.g. WTP, Salt Processing Facility).

- Funding – The Start LAW First concept costs are new and additional costs, (~ $920 million to $980 million through FY 2020) that would have to be included in the ORP annual budgets. These funding needs have yet to be identified in DOE budget planning.

  In addition to ORP funding identified above, there is a potential need for additional funding to support ETF system upgrades that could produce a better performing secondary waste form if further evaluation identifies the necessity.

- WTP Concurrent Operation and Construction – The WTP LAW, LAB, and BoF facilities are co-located with the PT and HLW facilities on the WTP site. Construction on PT and HLW will occur concurrently with interim LAW operations. Radioactive waste processing operations within an active construction site will result in complex logistical and security issues which could affect the productivity of the construction work forces.

- Operations Infrastructure – It has been over 15 years since the last radiochemical facility operated at the Hanford Site. The scope, complexity, and logistics associated with acquiring, training, and qualification of operating staff will be larger than recently experienced at the Hanford Site. Other complexities such as, assignment of an operating contractor, restructuring of labor contracts, development of necessary operating procedures, development of training and qualification programs, integration of

[1] SpinTek™ Filtration, Inc., Los Alamitos, California.

the training and qualification process with cold facility testing, performing ORRs, and final qualification for hot operations present new challenges to ORP and its contractors.

The *Start LAW First* concept has near-term RPP mission advantages as long as the WTP mission continues to be limited by the HLW processing mission. The programmatic risks identified impart different degrees of risk and impact on the potential success of the *Start LAW First* concept and should be carefully evaluated as part of any decision to move forward

LIST OF TERMS

Abbreviations and Acronyms

ALARA	As Low As Reasonably Achievable
BoF	Balance of Facility
CH2M HILL	CH2M HILL Hanford Group, Inc.
DB	diversion box
DCRT	double-contained receiver tank
DF	decontamination factor
DOE	U.S. Department of Energy
DST	double-shell tank
EA	Environmental Assessment
EAC	Estimate at Completion
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Statement
ETF	Effluent Treatment Facility
FONSI	Finding of No Significant Impact
FY	Fiscal Year
HEPA	high-efficiency particular air (filter)
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
HLW	high-level waste
HTWOS	Hanford Tank Waste Operations Simulation
HVAC	heating, ventilation, and air conditioning
IDF	Integrated Disposal Facility
ILAW	immobilized low activity waste
LAB	analytical laboratory
LBL	LAW/BoF/LAB
LAW	low-activity waste
NEPA	*National Environmental Policy Act*
NOD	Notices of Deficiencies
NOI	Notice of Intent
ORP	U.S. Department of Energy, Office of River Protection
ORR	Operational Readiness Review
PA	Performance Assessment
PT	Pretreatment
RCRA	*Resource Conservation and Recovery Act*
RL	U.S. Department of Energy, Richland Operations Office
ROD	Record of Decision
RPP	River Protection Project
SBS	Submerged Bed Scrubber
SRS	Savannah River Site
SST	single-shell tank
STU	Solidification Treatment Unit
TC & WM	Tank Closure and Waste Management
TFC	Tank Farms Contractor

TSD	treatment, storage, and disposal
TWRS	Tank Waste Remediation System
WIPP	Waste Isolation Pilot Plant
WTP	Waste Treatment and Immobilization Plant

Units

Ci	Curie
gal	gallon
Kgal	thousand gallons
L	liter
M	Molarity
MCi	million curies
MT	metric ton
MTG	metric ton glass
MTG/d	metric ton glass per day
wt%	weight percent

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1.0 INTRODUCTION

This report updates the July 2006 study (RPP-29981, Revision 0) that presented options for starting the Hanford Site Waste Treatment and Immobilization Plant (WTP), Low-Activity Waste (LAW) facility before completing construction and startup of the Pretreatment (PT) facility or High-Level Waste (HLW) vitrification facility. This *"Start LAW First"* concept represents a decoupling of the baseline WTP startup plan which has all three processing facilities beginning operations concurrently. This report describes a potential *Start LAW First* implementation scenario that is reflective of current baseline scope and funding assumptions and expands on key programmatic risks that should be considered. This update was completed at the request of the U.S. Department of Energy (DOE) Office of River Protection (ORP). This study provides summary technical, budget, and schedule information that may support future DOE programmatic decisions regarding the River Protection Project (RPP) at the Hanford Site.

1.1 Background

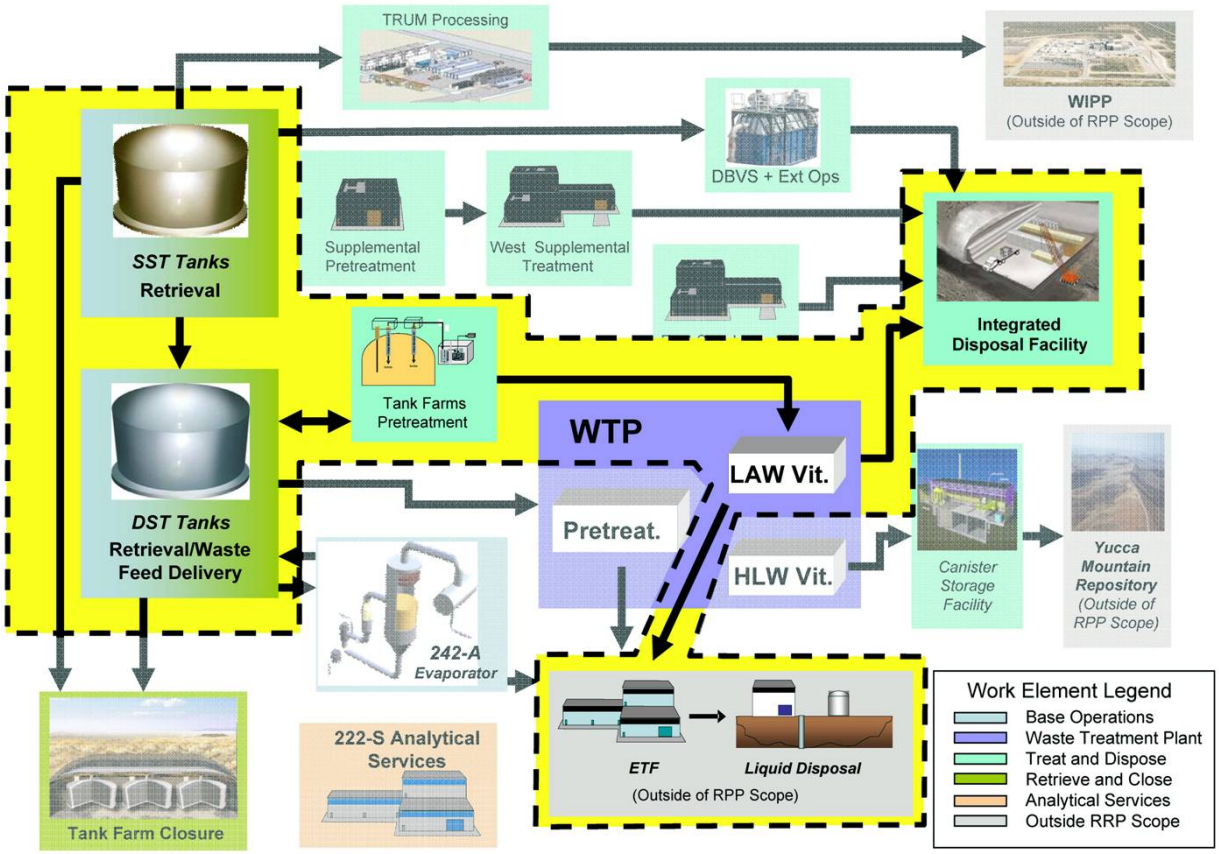
The RPP mission includes tank waste retrieval, waste treatment, waste disposal, and tank farms closure activities. Baseline mission plans rely on a concurrent startup of the three main WTP treatment facilities to begin treating the tank waste stored in the Hanford double-shell tanks (DSTs). The WTP May 2006 *Total WTP Project Estimate at Completion* (EAC) (24590-WTP-CE-PC-06,001-00,) contained a schedule that includes approximately 3 years of construction curtailment for the LAW facility. This curtailment allows all the WTP facilities to be completed and ready for startup at the same time while maintaining a level annual funding profile for the project.

The limited availability of space in the DSTs constrains the near-term RPP mission goal of retrieving waste from the Hanford single-shell tanks (SSTs). Sixty-seven of the SSTs are known or suspected to have leaked waste to the environment. Continued storage of waste in the SSTs represents a risk to the environment. The sooner LAW treatment is available, the sooner waste can be removed from the DST system, thus making room for additional SST waste retrievals. Beginning to process Hanford tank waste into its final waste form could have additional intangible benefits that could help build the momentum, confidence, and support of the entire RPP mission. These potentially significant positive benefits prompted the development of the *Start LAW First* concept.

The *Start LAW First* concept requires a tank farms pretreatment facility that is tailored to pretreat selected tank waste feed to the extent necessary to feed the WTP LAW facility directly. The WTP LAW, Analytical Laboratory (LAB), and Balance of Facility (BOF) equipment and facilities would be modified as necessary to support operation of the LAW facility independent of the PT or HLW facilities. This results in a treatment capability that focuses on starting the LAW portion of the total RPP mission as highlighted in Figure 1-1.[1]

[1] A decision for disposal at the Waste Isolation Pilot Plant (WIPP) will not be made until (1) the waste meets the WIPP Waste Acceptance Criteria, with special emphasis on the waste determination as delineated in the WIPP recertification decision by the U.S. Environmental Protection Agency in March 2006, and (2) it meets the regulatory eligibility requirements for disposal as described in the WIPP Hazardous Waste Facility Permit.

Figure 1-1 LAW focused portion of the RPP Baseline Mission



1.2 Initial Study Overview

The original study (RPP-29981, Revision 0) considered multiple pretreatment technologies and multiple operational configurations, and also developed two implementation scenarios representing a range of schedule and cost impacts. A summary of the options considered and selections carried forward in subsequent scenario evaluations are identified in Sections 1.2.1 through 1.2.3. More specific details can be found in RPP-29981, Revision 0.

1.2.1 Pretreatment Technology

The requirement to pretreat supernatant and saltcake tank wastes is derived from a provisional agreement issued by the U.S. Nuclear Regulatory Commission.[2] Removal of entrained solids and ^{137}Cs from supernatant and saltcake wastes is required to meet the

[2] Letter, C. J. Paperiello, U.S. Nuclear Regulatory Commission, to J. Kinzer, U.S. Department of Energy, "Classification of Hanford Low-Activity Tank Waste Fraction."

conditions of the NRC's 1997 provisional agreement for these wastes.[3] Furthermore, as low as reasonably achievable (ALARA) design considerations of the LAW facility further limit the allowable ^{137}Cs concentration in the feed to less than 0.000184 Ci/L. After removal of entrained solids and ^{137}Cs, supernatant and saltcake wastes are considered to be LAW and will be immobilized in glass; it is anticipated that this material will be disposed of at the Hanford Site Integrated Disposal Facility (IDF).[4]

Solids separation technologies considered include the following:

1. Gravity settling
2. Centrifugation
3. Mechanical filtration
   (a) Crossflow filtration
   (b) Rotary microfiltration.

Rotary microfiltration was selected as the reference technology because:

- It is readily adaptable to remote process operations in Hanford tank facilities
- It operates at a relatively lower pressure compared to the crossflow filtration
- Maintenance is expected to be similar to existing equipment maintenance practices used for tank farm pumps.

Cesium removal technologies considered include the following:

1. Selective dissolution
2. Fractional Crystallization
3. Precipitation
4. Ion exchange
   (a) Elutable resin
   (b) Non-elutable resin
5. Caustic Side Solvent extraction.

Elutable ion exchange was selected as the reference technology because:

- It has the ability to meet or exceed 137Cs removal requirements as demonstrated through technology testing sponsored by the WTP contractor

[3] Ibid.; ^{90}Sr and transuranic elements also need to be separated from the unique supernatant wastes contained in three DSTs. These unique supernatant wastes are not planned for processing in the proposed tank farms pretreatment systems and are not discussed in this report.
[4] The IDF will be evaluated under NEPA in the forthcoming TC & WM EIS. This document does not constitute a disposal decision and no decisions regarding this issue shall be made until the Final TC & WM EIS and Record of Decision (ROS) is issued.

- Application of WTP pretreatment reference cesium removal technology simplifies the engineering effort
- Simplified interim storage of the recovered 137Cs solution is possible.

1.2.2 Operational Configuration

The many LAW feed tank options and trade-offs of using existing or new facilities led to the consideration of the following tank farms operational configurations:

1. New tank farms ion exchange facility
2. Tank farms ion exchange in existing facilities
3. Direct feed from SSTs by dissolution of saltcake waste
4. Direct feed from SSTs by selective dissolution of saltcake waste.

A new tank farms ion exchange facility was selected for the reference operational configuration because:

- The pretreatment system can support operation of both melters in the LAW vitrification facility
- Additional waste can be processed and the LAW glass waste loading is prototypic (i.e., ~18 to 20 wt% waste sodium oxide) of that planned for the full WTP
- Additional DST space is gained
- There is minimal impact to tank farms operating logistics and ongoing operations (e.g., 242-A Evaporator and SST retrieval).

1.2.3 Implementation Scenario

To estimate the programmatic attributes of the *Start LAW First* concept, two specific implementation scenarios were defined in the previous study:

1. The first scenario was intended to allow for the start of LAW processing "as soon as practical" and was characterized by concentrating WTP resources on completion and startup of the LAW facility and immediately beginning work on the new tank farms pretreatment project. The schedule was generally driven by the completion of the tank farms pretreatment project, which was assumed to be authorized and funded for project startup activities (e.g., justification of mission need and conceptual design) in early Fiscal Year (FY) 2007.
2. The second scenario was intended to start LAW processing on a schedule that "minimizes WTP resource and budget fluctuations." The schedule was generally driven by demand for WTP startup resources on the PT and HLW facilities. This scenario had a later LAW processing start date but avoided the inefficiencies and operational risks caused by a demobilization and subsequent remobilization of WTP facility startup resources.

Schedules, annual cost profiles, and mission progress factors (i.e., amount of LAW product produced and amount of DST space recovered) were developed for both scenarios. This information was presented in RPP-29981, Rev. 0, to provide decision makers a range of benefits and impacts that could then help drive programmatic decisions on the path forward.

1.3 Objective

The objective of this report update is to capture the changes that have occurred since the initial report was issued, to define one *Start LAW First* reference scenario that integrates the current WTP planning baseline with the original scenarios, and to eliminate consideration of implementation scenarios that have been overtaken by events since the earlier document was issued. The technical, cost, and schedule details from the original report will be preserved to the extent practical to ensure consistency with the detailed backup information supporting the original report.

The objective of this report update is not to re-address the technology and deployment alternatives but rather to provide a reference case description that reflects the current state of WTP and tank farms planning baselines. The DOE programmatic risks and potential impacts are presented to help determine if the mission scenarios warrant evaluation at a greater level of detail.

1.4 Approach

The definition of the *Start LAW First* reference scenario starts with the concepts presented in the original report and makes adjustments to reflect the current state of baseline progress and planning. This definition encompasses two distinct areas, one that applies to each of the involved contractors, the tank farms contractor and the WTP contractor.

1.4.1 Tank Farms

The tank farms portion of the *Start LAW First* scenario involves a new DOE Order 413.3a, *Program and Project Management for the Acquisition of Capital Assets*, project. This tank farm pretreatment project provides the necessary pretreatment and feed delivery capability necessary to ensure the WTP LAW facility is provided with adequate feed. The cost estimate and schedule assumptions developed for the original study will be maintained except that the project will not be assumed to be funded until the beginning of FY 2008. This would result in a 1-year change from the schedule developed for the original Scenario 1, with the tank farm pretreatment capability ready to deliver feed to the WTP in June 2014. This includes approximately 3 months of tank farm schedule contingency meaning there is a potential to begin delivering feed as early as March 2014.

1.4.2 Waste Treatment and Immobilization Plant

The WTP portion of the *Start LAW First* reference scenario involves concentrating construction resources on tasks that allow the WTP LAW facility to start up prior to PT and HLW facility startup. This involves modifying the LAW facility systems to receive waste directly from the tank farms feed lines and discharge effluent directly to the Hanford Effluent Treatment Facility (ETF). Additional WTP scope includes completion of the LAB facility and modification of various BoF systems to support startup and independent operation of the LAW facility with a future transition to fully integrate WTP operations with all facilities operational. While the WTP has not yet implement a *Start LAW First* concept, much of the baseline planning accomplished since the May 2006 EAC has been focused on acceleration of LAW construction and startup. The WTP has developed a baseline planning case that closely resembles the needs of a *Start LAW First* concept that will be used to define the reference case. The WTP portion of the reference case has a ready for LAW operations date of October 2013. This includes approximately 11 months of schedule contingency and approximately 4 months of hot commissioning meaning there is a potential to be ready for LAW feed as early as July 2012.

While the tank farms pretreatment project schedule presented is not supportive of the WTP baseline planning schedule these schedules are used to define the *Start LAW First* reference scenario to preserve the details of the cost estimates and scheduling assumptions used to develop them. This report is intended to reflect programmatic cost and schedule changes that have occurred since the original report was issued and is not intended to validate or change the technology recommendations from the original report. Section 4.0 addresses options for aligning schedules and balancing budget demands.

1.5 Assumptions

This study is a preconceptual level evaluation of options considered feasible to implement with proven technologies. The following assumptions were used to bound the scope of the evaluation while providing a timely response to the study request:

1.5.1 Tank Farm Assumptions

a. Waste feed for the LAW facility will be provided by the Hanford Site Tank Farm Contractor (TFC) from easily retrievable wastes from the 200 East Area tank farms which will meet LAW feed specifications after pretreatment.

b. New interim pretreatment capability will be provided external to the WTP by the TFC.

c. Incremental budget required to implement the TFC portion of any selected scenario are in addition to the TFC baseline budget.

d. The current waste feed specifications for the LAW facility will be met.

e. All new facilities required for interim LAW operations will meet current design requirements as dictated by the Tank Farms prime contract.

f. Supplemental Treatment activities will not be impacted by the proposed WTP scenarios.

g. Additional Hanford Site infrastructure budget [funded through the DOE Richland Operations Office (RL)] to support the various operating scenarios are not a significant decision discriminator and not included in this evaluation.

h. It is assumed that NEPA documentation for the new tank farms pretreatment project will be provided by the Tank Closure and Waste Management EIS or subsequent NEPA analysis on a schedule supportive of the tank farms pretreatment construction needs.

1.5.2 Waste Treatment and Immobilization Plant Assumptions

a. WTP project funding will be limited to $690 million per FY for FY 2007 and beyond.

b. WTP project funding will be used for all construction activities within the 65-acre WTP site.

c. After LAW hot commissioning is complete, LAW interim operations will be turned over to a yet-to-be-specified operating contractor. Interim LAW operating budgets will be an additional increment to the RPP baseline budget and are not considered part of the WTP project cost.

d. All new facilities or facility modifications required for interim LAW operations will meet current design requirements as dictated by the WTP prime contract.

e. Liquid effluents generated at the WTP facilities during interim LAW operation will not be returned to the tank farms.

f. The planned upgrade of the Hanford Site ETF will be completed prior to start of interim LAW operations and is capable of processing the interim WTP effluent.

g. It is assumed that documentation will be completed to evaluate the *Start LAW First* concept in compliance with NEPA on a schedule supportive of WTP construction needs.

h. The *Start LAW First* concept would be operated with two melters. A spare melter would be available if needed in FY 2016.

2.0 PROCESS DESCRIPTION

Operating the WTP LAW facility before the WTP PT facility is operational requires the LAW facility feed to be pretreated to remove cesium and solids somewhere within the tank farms to meet LAW feed requirements and facility safety limits. In addition to the interim pretreatment capability added to the tank farms, the WTP facilities must be reconfigured to allow independent operations of the WTP LAW facility and the WTP LAB with minimal impact to the continuing construction and startup of the WTP PT and HLW facilities.

2.1 Tank Farm Description

There are no existing tank wastes which meet WTP feed specifications without pretreatment. Supernatant and dissolved saltcake from nine DSTs in the 200-East Area were identified as available feeds based on ease and cost of retrieval within the existing waste transfer system. Waste in these tanks contains little or no insoluble solids which reduces the burden on the LAW solid-liquid separation operation. Providing feed from tanks containing primarily supernatant also maximizes the rate of DST space recovery by processing in the LAW vitrification facility for future retrieval of waste from SSTs.

Table 2-1 summarizes the LAW feed inventory in the nine DST supernatants. The DSTs are listed in the sequence they would be expected to be retrieved and treated during a 4-year and 8-month interim LAW operations period.

Table 2-1 Summary of Identified LAW Feed Sources and Quantities

LAW Source Tank	Retrieved Volume (Kgal)	Na_2O loading in ILAW Glass (Wt %)	Na in LAW (MT)	LAW Glass (MT)	LAW Containers	Cumulative Treatment Time (Years)[a]
AP-104	1,051	20.6%	511	3,341	564	0.5
AP-102	1,021	16.8%	602	4,827	815	1.1
AP-101	1,065	18.7%	522	3,756	634	1.6
AP-103 (1st batch)	593	21.0%	400	2,566	433	2.0
AP-103 (2nd batch)	252	21.0%	170	1,090	184	2.2
AP-108	1,093	20.8%	825	5,350	904	3.0
AP-105	1,000	17.4%	506	3,922	663	3.5
AN-101	877	20.7%	711	4,631	782	4.2
AP-107	160	18.7%	74	533	90	4.3
AN-104 (1st batch)	310	18.5%	325	2,374	401	4.7
Totals	**7,422**	N/A	**4,646**	**32,390**	**5,470**	N/A

[a] Two 15 MTG/day LAW melters operating at 70% total operating efficiency (TOE) and 20 wt% sodium oxide loading; LAW Treatment rate is assumed to be 1,000 MT Na/year.

ILAW = immobilized low-activity waste

As described in Section 1.2, the DST waste must be pretreated to remove solids and to reduce the ^{137}Cs concentration to less than 0.000184 Ci/L. To meet this LAW feed acceptance requirement for the feeds identified in Table 2-1, the pretreatment system must demonstrate an average decontamination factor (DF) of approximately 2000.

These pretreatment needs should not be confused with the planned 200-West Area supplemental pretreatment system, which uses different feed and supports a different LAW treatment process. The current tank farms planning baseline includes a 200-West Area supplemental pretreatment system that feeds a bulk vitrification supplemental LAW treatment facility. Table 2-2 contrasts requirements of the two pretreatment systems.

Table 2-2 Contrasting Pretreatment System Requirements

Pretreatment System	Tank Waste From	Pretreated Feed Provided to	^{137}Cs Feed Limit (Ci/L)	Average Pretreatment DF Required
Tank Farm Pretreatment Project (*Start LAW First*)	200 East DSTs	WTP LAW	0.000184	~2000
200 West Supplemental Pretreatment	200 West DSTs and SSTs	200 West BV	0.00861	~30

The lower DF requirement for the 200 West Supplemental Pretreatment system is primarily because the bulk vitrification systems shielding concept results in a higher tolerance for ^{137}Cs in the feed compared to that of the WTP LAW facility. In contrast, the WTP PT facility receives both HLW and LAW tank waste, must achieve a ^{137}Cs DF approaching 10,000, and must process and treat high solids content feeds for HLW vitrification, as well as be prepared to remove transuranic (TRU) waste and soluble ^{90}Sr from some feeds.

The concept for pretreatment of the *Start LAW First* waste feed uses rotary microfiltration to remove solids containing insoluble radionuclides from the LAW waste stream and elutable ion exchange to remove soluble Cs^{137}. The elutable ion exchange system will be deployed in new below-grade vault structures of similar design to existing and previously used facilities for waste pretreatment at the Hanford Site. The ion exchange system is prototypic of the ion exchange system planned for the WTP Pretreatment facility and is capable of supporting the operation of two LAW vitrification melters. A conceptual flow diagram for the tank farms pretreatment project is shown in Figure 2-1 and a list of major new equipment is included in Table 2-3.

Under this pretreatment concept, rotary microfilter units (SpinTek^{TM}) used for solids removal from the LAW stream are installed within DST AP-104, which is part of the 241-AP Tank Farm. The two rotary microfilter modules, each with two rotary SpinTek^{TM} filter units, are installed in DST AP-104 through separate 42-inch diameter risers. A new pump pit is installed around an existing 42-inch riser to house one of the filter modules while an existing pump pit is used to contain the second filter module. This design concept is similar to the SpinTek^{TM} filtration unit jointly designed and demonstrated by ORNL and SRS personnel for planned use at the SRS. All waste selected for LAW pretreatment would be fed forward through tank AP-104 and the SpinTek^{TM} filtration modules.

Clarified LAW feed from the rotary microfilter units is transferred to a vessel used to feed the two ion exchange columns, which are located within a new underground concrete vault that also contains a double-contained receiver tank (DCRT). The ion exchange feed vessel also receives and transfers to the ion exchange columns all of the chemicals used to elute and regenerate the resin. The ion-exchange columns contain a total of 1,290 liters (340 gallons) of resin. The ion-exchange columns are loaded in series (lead column and polishing column) to remove cesium from the LAW solutions. The DCRT receives the cesium eluate from the ion exchange column which is neutralized with the column regeneration solutions and additional sodium hydroxide and sodium nitrite solutions and then transferred to an existing DST for interim storage. The pretreated LAW solution exiting the ion exchange columns is collected into one of two additional DCRTs for sampling and analysis prior to transfer to the LAW facility. Spent ion

exchange resin is periodically fluidized from the columns and collected in a vessel located in the vault containing the ion exchange columns and feed vessel. Spent resin is then sampled and transferred to an above ground load-out facility (not shown in Figure 2-1) where it is then transferred for treatment and burial as solid waste.

The process vessel and ion exchange columns are sized to supply pretreated LAW solution to support operation of two LAW vitrification melters. The average production rate of pretreated LAW is estimated to be ~20 liters per minute (~5.4 gallons per minute) at 70% operating efficiency. Since the pretreated LAW solution will be 5.5 to 6 M sodium, approximately 950 to 1,040 metric tons of sodium is estimated to be pretreated annually. This production rate of pretreated LAW is sufficient to support operation of two LAW Vitrification melters producing 30 MTG per day with an average waste sodium oxide loading of ~18 wt% and an operating efficiency of 70%.

Figure 2-1 Conceptual Diagram for Cesium Ion Exchange Process Located in New Vaults in the Tank Farms

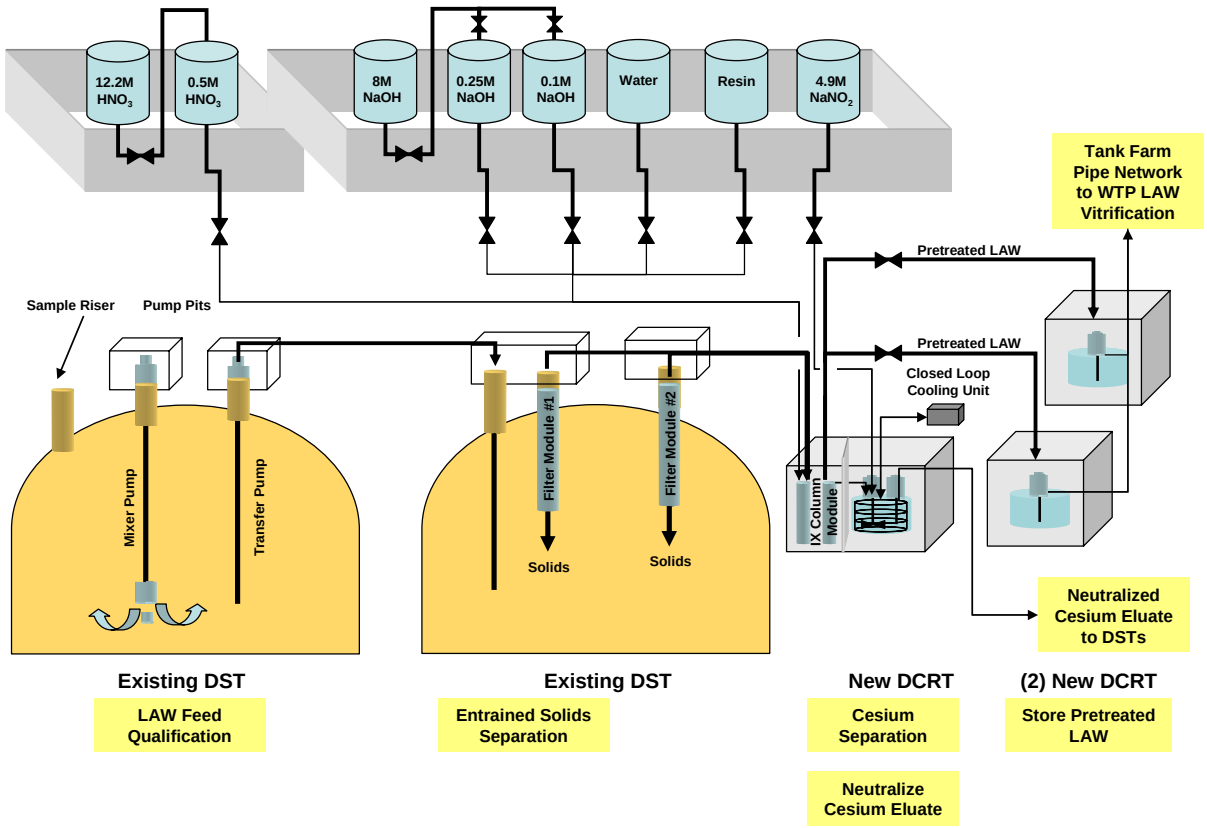


Table 2-3 Summary of new Equipment for Tank Farms Pretreatment Project (2 sheets)

Component	Features
Valve Vault	• Concrete below-grade structure with 3-ft-thick walls and cover blocks • Stainless-steel-lined floor and walls up to bottom of cover blocks • (1) sump, each with (1) remote read-out leak detector • PUREX-type Jumpers
IX Equipment Vault	• Concrete below-grade structure with 3-ft-thick walls and cover blocks • Stainless-steel-lined floor and walls up to bottom of cover blocks • (1) sump, with (1) remote read-out leak detectors
Two (2) Ion Exchange Columns	• (2) resin retention screens internal to column • Resin fluidization / extraction cone • Hard piping connections
IX Feed Vessel	• Hard piping connections • Pump
Spent Resin Vessel	• Hard piping connections • Pump • Mixer / agitator
DCRT-3 Vault	• Concrete below-grade structure with 3-ft-thick walls and cover blocks plus • Stainless-steel-lined floor and walls up to bottom of cover blocks • (1) sump, with (1) remote read-out leak detector
Cesium Eluate DCRT-3	• Internal cooling coil • Hard piping connections • Closed loop cooling unit • Pump • Mixer / agitator • Sampler
Vessel Off-gas Treatment System Structures for IX Equipment and DCRT-3	• Concrete below-grade structure with 1-ft-thick walls and cover blocks • Stainless-steel-lined floor and walls up to bottom of cover blocks • Condenser • Heater • (2) filter units, each containing (2) 2-ft x 2-ft high-efficiency particulate air (HEPA) filters • Exhaust fan with damper controller and stack • Continuous emission monitoring system
DCRT-1 Structure	• Concrete below-grade structure • 3-ft-thick concrete cover blocks at grade • Stainless-steel-lined floor and walls up to bottom of cover blocks • (1) sump, with (1) remote read-out leak detector
Pretreated LAW DCRT-1	• Hard piping connections • Pump • Mixer / agitator • Sampler
Vessel Off-gas Treatment System Structures for DCRT -1 and DCRT-2	• Concrete below-grade structure with 1-ft-thick walls and cover blocks • Stainless-steel-lined floor and walls up to bottom of cover blocks • PUREX-type Jumpers • Condenser • Heater • (2) filter units, each containing (2) 2-ft x 2-ft HEPA filters • Exhaust fan with damper controller and stack • Continuous emission monitoring system

Table 2-3 Summary of new Equipment for Tank Farms Pretreatment Project (2 sheets)

Component	Features
DCRT-2 Structure	• Concrete below-grade structure • 3-ft-thick concrete cover blocks at grade • Stainless-steel-lined floor and walls up to bottom of cover blocks • (1) sump, with (1) remote read-out leak detectors •
Pretreated LAW DCRT-2	• Hard piping connections • Pump • Mixer / agitator
(2) SpinTek™ Micro-rotary Filter Modules	• (2) filter units per module (~ 0.1-μm sintered metal disks) • PUREX-type jumpers
Resin Dewatering Building	• Steel structure on concrete foundation • Heating, ventilation, and air conditioning (HVAC) supply system • Radioactive HVAC exhaust treatment system • Carbon-steel vessel for collection of water • Transfer pump
Vaults Structures Ventilation System	• Concrete below-grade structure with 1-ft-thick walls and cover blocks • Stainless-steel-lined floor and walls up to bottom of cover blocks • PUREX-type jumpers • Condenser • Heater • (2) HEPA filter units • Exhaust fan with damper controller and stack • Continuous emission monitoring system
Emergency Generator	• Approximately 100-kW generator and fuel storage tank

2.2 Waste Treatment and Immobilization Plant Description

The WTP LAW facility is not currently connected to the tank farm system. In the existing WTP baseline design, all waste coming to the LAW facility is transferred from the PT facility, and all recycles are routed back to the PT facility. Changes to the WTP facilities that are necessary to allow the WTP LAW facility to operate before the WTP PT facility comes on-line include piping modifications to allow the feed from the tank farms to be routed directly to the WTP LAW facility and to allow the effluents from the WTP LAW and WTP LAB facilities to be routed directly to the Hanford Site ETF where they will be treated and immobilized. The ETF solidified secondary waste will be disposed in the IDF. Other WTP modifications include fencing and utility system modifications to isolate the operating facilities from the facilities still under construction. An alternate control room is required to accommodate accident scenarios that would otherwise rely on a functional control room in the WTP PT facility. A conceptual layout of the WTP site segregating the operational areas from the construction areas is presented in Figure 2-2 and major WTP capital improvements are identified in Table 2-4.

Figure 2-2 WTP Site Layout Showing Proposed Boundary of Operating Area

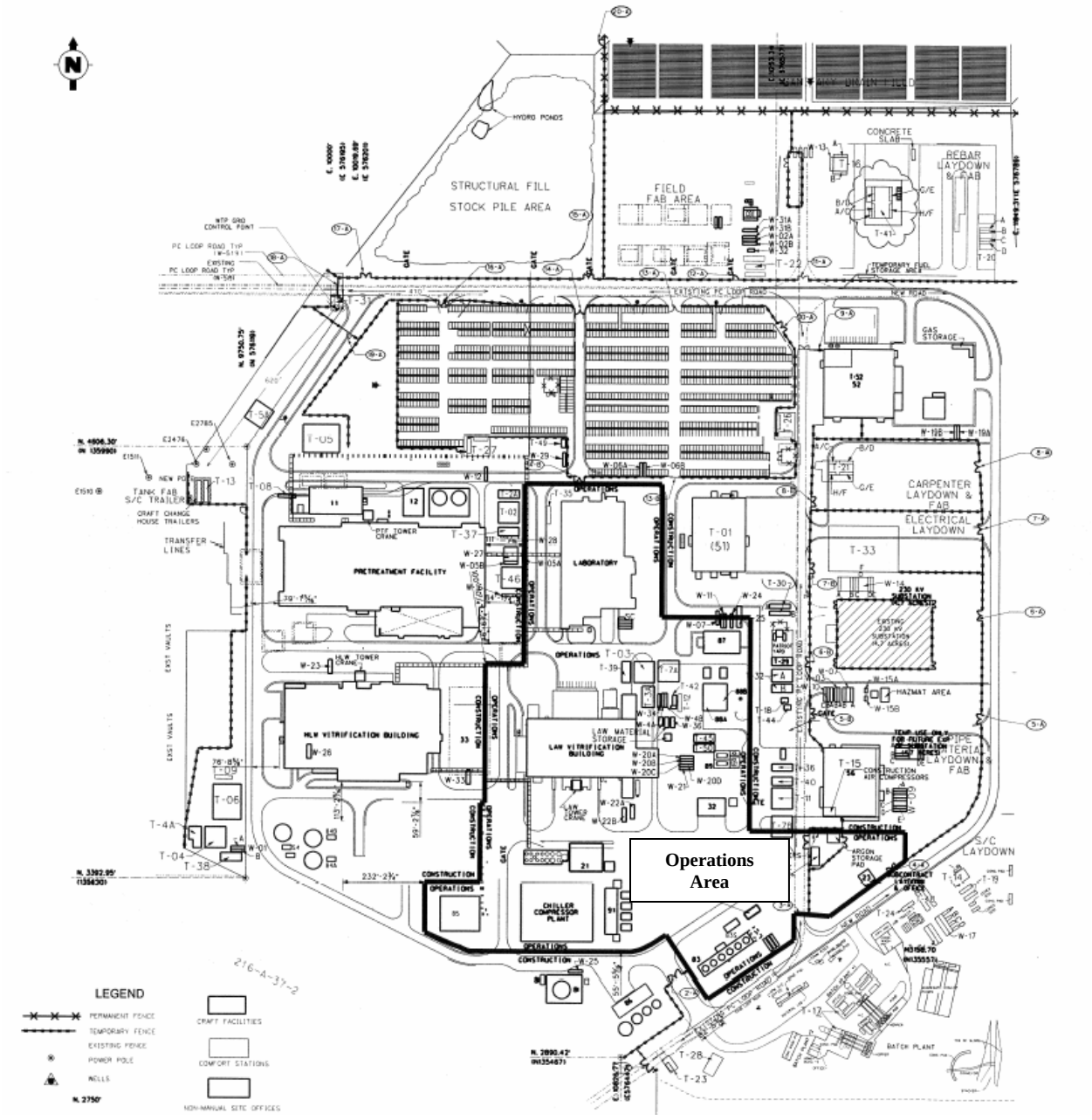


Table 2-4 Summary of WTP Capital Improvements to Support *Start LAW First*

Capital Improvement Item	Features
Diversion (valve) box located to the west of the HLW facility to support waste transfer to and from the Tank Farms	• Below grade • Fitted with jumpers • Connections for both feed and effluent lines • Include leak detection, duct bank to diversion box (DB), and sump
Waste transfer piping	• LAW Feed – 3-inch diameter, stainless steel (SS), double contained; reroute existing underground line from Tank Farms to Pretreatment facility to DB; above ground from DB to LAW facility, new shielded pipe rack 20 feet above ground • Process effluent – 3-inch diameter, SS, double contained; reroute existing underground line from Tank Farms to Pretreatment facility to DB; above ground from DB to LAW facility, utilize new shielded pipe rack (same as for feed line) • Laboratory Waste – 3-inch diameter, SS, double contained, above ground on rack • Utility piping, above ground on new pipe rack
Filtration skid in LAW facility for submerged bed scrubber (SBS) condensate effluent	• Filter skid with pumping provisions (redundant, 5 micron filter, 50 gallon per minute nominal flow) • Add piping connections to existing system • Add controls (differential pressure, flow, sample point, radiation monitoring)
Filtration skid in LAW for Caustic Scrubber effluent	• Add filter skid with pumping provisions (redundant, 5 micron filter, 50 gallon per minute nominal flow • Add piping connections to existing system • Add controls (differential pressure, flow, sample point, radiation monitoring)
Low point leak detection box and instrumentation	Needed to support waste transfer piping design. Include sump and leak detection instrumentation.
Control room building (non-hardened, 5000 square feet)	• Control room relocated from PT facility for BoF and backup for LAW facility • Utilities for the control building (steam, steam condensate return, sanitary sewer, drinking water, chilled waste, service air, fire protection water, electricity, and data communications) • Add control system hardware and software licenses
Replace LAW effluent pumps with higher head pumps	• Radioactive Liquid Waste Disposal System (RLD) discharge pumps (SBS Condensate) • RLD discharge pumps (Plant Wash) • LAW Secondary Offgas/Vessel Vent Process System (LVP) discharge pumps (Caustic Scrubber).
Add valves to isolate services to other BoF facilities not on line.	• Steam, condensate, domestic water, cooling water, demineralized water, non-radioactive effluent, sample lines
Control system tie-in to the tank farm for receiving and sending waste.	• Control system located in LAW facility on concentrate receipt vessels
Add and/or relocate site boundary fencing and controls	• New site boundary to support operations and construction. • Chain link fences with controlled access for personnel and trucks • Access locations have guard shacks to support controlled access for safety and security

3.0 SCENARIO EVALUATION

The proposed *Start LAW First* concept was evaluated in the context of the RPP mission budget and schedule baseline. Schedule and annual budget profiles were developed for the WTP, the tank farms pretreatment project, and for the interim operations that would occur up until the full WTP complex is operational. Because of the preliminary nature of the tank farms pretreatment concept, schedule and parametric cost estimates were developed based on historical information from similarly scoped DOE projects. WTP schedule and cost estimates were developed based on modification of the May 2006 EAC components to reflect the current WTP planning baseline. While the *Start LAW First* concept would require additional funding, as identified in Table 3-1, it does allow for earlier RPP mission progress. Estimated RPP mission progress indicators are included in Section 3.2.

3.1 Schedule and Budget Profile

Table 3-1 shows the annual budget (not including the existing tank farms workscope) needed to support the reference scenario. The annual budget needs for the WTP project are grounded in the May 2006 EAC but have been adjusted to accommodate emerging *Start LAW First* scope, adjustments due to WTP seismic considerations, and WTP External Flowsheet Review Team (EFRT) response activities. It should be noted that the current RPP baseline budget request does not include budget for FY 2008 or FY 2009 necessary to support the proposed tank farms pretreatment project. The reference scenario results in 4 years and 8 months of interim LAW operations prior to the full operation of the WTP complex.

Budget profiles include escalated budgets for each fiscal year in the following categories:

WTP Project – Includes costs aligned with the WTP engineering, design, procure, construct, and commission contractor work scope.

1. WTP BoF – WTP costs associated with the design, construction, and commissioning of the WTP BoF.
2. WTP LAB – WTP costs associated with the design, construction, and commissioning of the WTP Analytical Laboratory (LAB).
3. WTP LAW – WTP costs associated with the design, construction, and commissioning of the LAW facility.
4. WTP PT – WTP costs associated with the design, construction, and commissioning of the WTP Pretreatment facility.
5. WTP HLW – WTP costs associated with the design, construction, and commissioning of the WTP HLW facility.

Other RPP Scope – Includes tank farm pretreatment project and operating costs beyond the current TFC work scope and WTP interim and full operating costs. This does not include existing tank farms baseline costs.

1. TFC Project – TFC project costs associated with the TFC pretreatment and feed delivery systems.
2. TFC Operations – Operating costs associated with the TFC pretreatment and feed delivery systems.
3. WTP Interim Operations – WTP costs associated with the early operation of the LAW facility. Includes BoF and LAB costs up until the time the entire WTP complex begins full operation.
4. WTP Full Operations – WTP costs associated with full operation of the entire WTP complex. Includes the RPP baseline costs for ramp up of the WTP operating contractor and the full WTP operating costs.

Budget associated with FY 2006 and earlier, WTP fee, and WTP Government Technical and Programmatic Risk Assessment are not included in the funding profiles presented here. The operating budget for the full operation of the WTP is assumed to be equivalent to the current RPP baseline value of $293 million per year (expressed in FY 2006 dollars). The operating budget for full operation of the WTP has been escalated to the appropriate year needed to support operation of the full WTP beginning in February 2019. While the contracting strategy for WTP turnover to an operating contractor is not yet defined, the budget profile assumes full WTP operations begins upon completion of hot commissioning.

The summary schedule for implementing the reference scenario and the remainder of the WTP construction and startup is presented in Figure 3-1. This summary schedule groups the startup activities for the WTP facilities needed to support LAW startup into the LAW/BOF/LAB (LBL) category. The schedules for the remaining two facilities (PT and HLW) are identified separately. Schedule contingency has been included separately to provide an indication of potential schedule improvement. Important schedule points to note include WTP ready for LAW hot commissioning in June 2013, start of tank farms pretreatment and interim LAW operations in June 2014, and full WTP operations in February 2019.

Table 3-1 Reference Scenario Budget by Fiscal Year

($M – escalated)

Fiscal Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
WTP BOF	45	94	72	110	102	142	82	46	37	0	0	0	0	0	730
WTP LAB	55	61	77	43	54	72	31	0	0	0	0	0	0	0	392
WTP LAW	179	120	94	93	98	93	29	32	30	34	-23*	0	0	0	779
WTP PT	181	246	302	323	279	219	301	351	291	322	274	202	22	0	3,313
WTP HLW	156	182	169	120	127	147	184	235	263	209	228	109	35	0	2,164
WTP Sub-Total	**615**	**703**	**714**	**689**	**660**	**673**	**627**	**664**	**621**	**565**	**479**	**311**	**57**	**0**	**7,378**

* Represents the LAW portion of WTP spare equipment (e.g. melters) planned to be transferred to the operating contractor by the May 2006 EAC

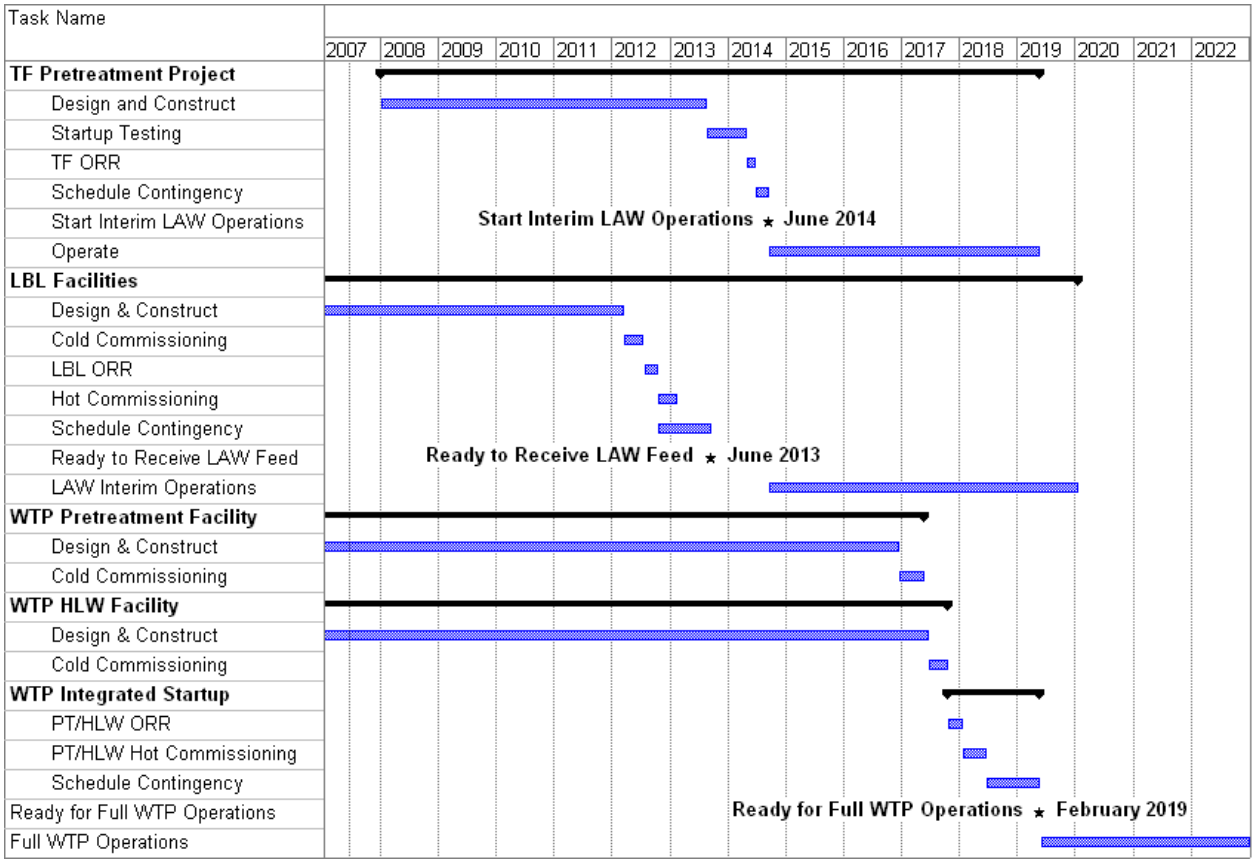
TF Project	0	5	23	30	41	34	26	3	0	0	0	0	0	0	163
TF Operations	0	0	0	0	0	0	0	7	22	23	23	24	11	5**	115
WTP Interim Ops	0	0	0	0	0	0	0	90	123	126	130	133	46	0	648
WTP Full Ops	0	0	0	0	0	0	0	0	0	0	10	76	455	425	966
Other Sub-Total	**0**	**5**	**23**	**30**	**41**	**34**	**26**	**100**	**145**	**149**	**163**	**233**	**512**	**430**	**1,892**

** Includes D&D and project closeout costs

Total ***	**615**	**708**	**737**	**719**	**701**	**707**	**653**	**764**	**766**	**714**	**642**	**544**	**569**	**430**	**9,270**

*** Does not include existing tank farm costs

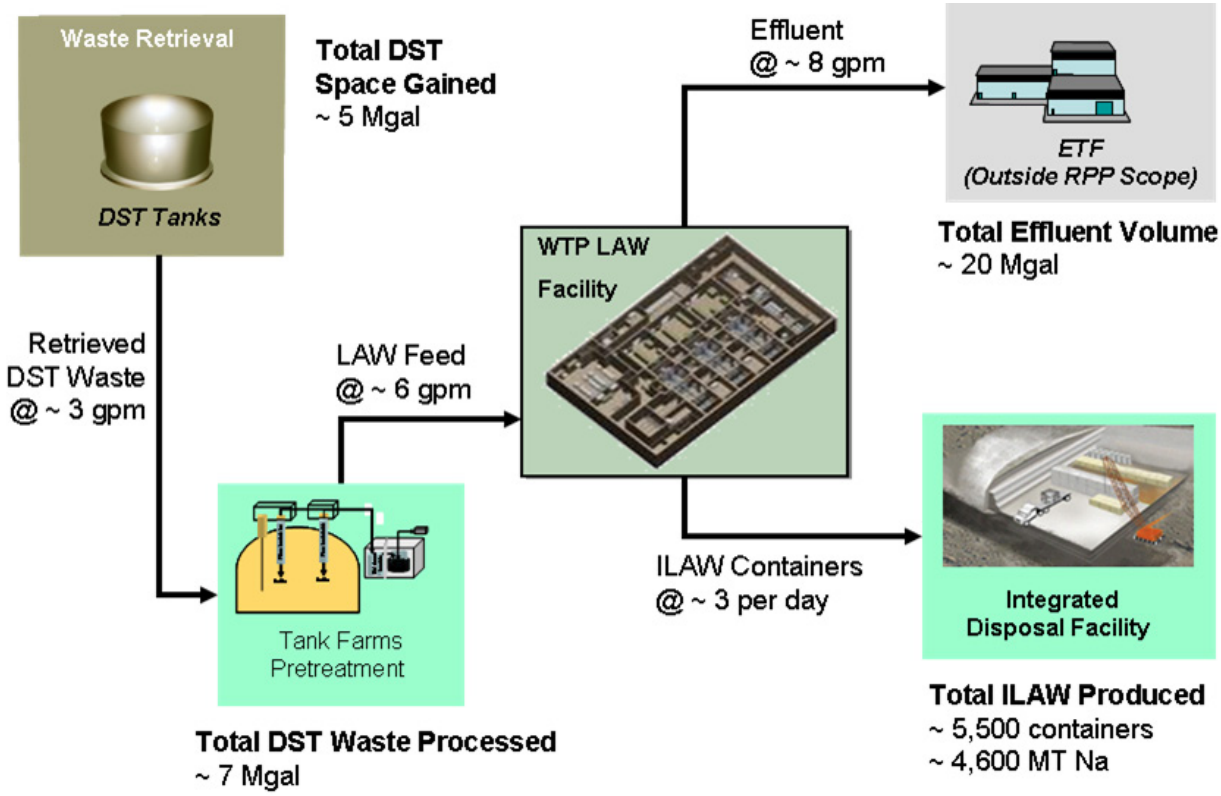
Figure 3-1 Reference Scenario Schedule



3.2 Mission Progress

Figure 3-2 presents a summary of major LAW material flows. Progress towards completion of the RPP mission can be measured by the number of immobilized LAW and HLW containers produced. The number of immobilized HLW containers produced over the lifetime of the RPP mission is not expected to be impacted by the *Start LAW First* reference scenario; however, it will result in earlier LAW treatment and disposal than could otherwise be accomplished. The 4 years and 8 months of interim LAW operations described by the reference scenario is estimated to produce approximately 5,500 LAW canisters containing approximately 4,600 metric tons of LAW sodium by the start of full WTP operations in February 2019. This represents approximately 8% of the total mission LAW sodium, which is currently modeled to include approximately 56,000 metric tons of sodium.[5]

Figure 3-2 Interim LAW Material Flows



One of the RPP mission goals is to retrieve waste from and close SSTs. One limiting component in SST retrieval scheduling is the availability of DST space to receive the retrieved waste. Currently, DST space is at a premium and is projected to be fully committed before the WTP is operational. Earlier operation of the LAW facility would create additional DST space that could be used to support more and earlier SST retrievals. The reference scenario is estimated to free approximately 4.7 million gallons of DST space by the start of full WTP operations in

[5] From Table 3-1, HNF-WM-SD-012, Tank Farm Contractor Operation and Utilization Plan, Revision 6, January 2007.

February 2019. While supporting earlier retrievals may not affect the RPP mission end date, it reduces the risk to the environment from storing waste in the SST system and it reduces the schedule risk associated with completing SST closures by the mission end date. Note that the funding profile discussed here does not include additional budget to accelerate SST waste retrievals that could utilize the additional space in the DST system. While the additional cost of potential accelerated SST retrievals is dependant on the specific tank and retrieval technologies selected, a typical cost range is $15-20 million per SST retrieval.

The *Start LAW First* scenario also has the potential to enhance the RPP mission progress by its affect on the following less measurable but potentially significant attributes of the WTP start up and transition to full operations:

- **Start-up and Operations Hiring** – Because not all of the WTP facilities would be commissioned at the same time the size of the startup and operating crews would be smaller. The feasibility of hiring and training the specialized resources needed to support startup of the LBL facilities is improved when compared to starting the entire WTP complex at the same time.
- **Operational Readiness Review Efficiency** – The startup of the entire WTP complex represents a startup size and complexity not yet experienced in the DOE complex. The Operational Readiness Review (ORR) for the LBL facilities alone would be simpler and involve smaller and fewer hazards than an ORR associated with the PT and HLW facilities. The experience gained with this smaller and earlier ORR would be invaluable for improving the success of the future ORR for the PT and HLW facilities.
- **Early LAW Process Experience** –The LAW treatment mission processes more than 18 times the amount of sodium than the HLW treatment mission. The planned WTP LAW capacity alone is not sufficient to complete processing all LAW waste in the same time as the HLW waste. The RPP mission includes the construction of a supplemental LAW treatment facility to augment the capacity of the WTP LAW facility. Early operation of the WTP LAW facility would provide invaluable process and operational information that could help DOE determine the supplemental LAW treatment capacity necessary to complete the RPP mission.

4.0 PROGRAMMATIC CONSIDERATIONS

The *Start LAW First* concept presented here represents a change in the current RPP baseline that includes a new tank farms construction project and adjustments to the WTP baseline work scope. These changes involve programmatic decisions impacting financial, regulatory, and stakeholder interests. While this report is not intended to be a decision-making document, this section qualitatively addresses some of the key factors that influence the programmatic decision-making process.

4.1 Funding

The funding profiles presented in Table 3-1 represent the cost estimates necessary to implement the *Start LAW First* reference scenario. While the costs presented for the WTP project are consistent with the current planning baseline, the costs associated with the tank farms pretreatment project and the interim LAW operations costs represent new and additional costs that would have to be included in the ORP annual budgets. Additional RPP funding would also be required to realize the benefits of accelerated SST retrievals that could be supported by the DST space gains. These funding needs have yet to be identified in DOE budget planning activities. It should be noted that current RPP baseline planning consumes all expected DOE target funds even without the addition of *Start LAW First* scope. Additional funds are required.

A portion of the funds needed to support interim LAW operations comes from outside the ORP. Many Hanford Site infrastructure services (e.g. water supply, road maintenance, effluent treatment and disposal) are funded and managed through DOE's RL. While it is assumed that these Hanford Site infrastructure services will continue to be available, the disposition of effluent from the WTP LAW facility is dependant on completing necessary ETF upgrades before the start of interim LAW operations. While some ETF upgrades are planned, the sufficiency of these upgrades will not be known until a more thorough evaluation of WTP effluent and IDF performance criteria are completed. The funding for any additional ETF upgrades (if needed to provide WTP effluent treatment capability) are not defined at this time and represent a major risk to the *Start LAW First* concept.

4.2 Schedule

The reference scenario described in Section 3.0 includes individual project implementation schedules that are misaligned by 9 to 24 months (depending on how schedule contingency is applied). In the reference scenario, the WTP LAW facility would be scheduled to be ready for hot commissioning before the tank farm pretreatment facility is completed and is ready to send feed to the WTP LAW. As the planning basis becomes more mature, it is anticipated that this schedule misalignment will be resolved to optimize resource utilization. Some of the options for reducing the schedule misalignment follows.

a. **Pretreatment Project Acceleration** – The tank farms pretreatment project schedule is estimated based on the standardized project steps identified in DOE Order 413.3a and recent experience with projects of similar scope. Since the tank farms pretreatment project is still in the pre-project authorization stages, there is little detail available to identify specific areas to target schedule acceleration, however, areas that warrant consideration include:
    1. Early initiation of project development activities – the initial project engineering studies, conceptual designs, and baseline schedules will provide the necessary detail and basis for identifying potential schedule acceleration and risk mitigations strategies. Early integration of hazard identification, quality, regulatory, and safety system issues could potentially shorten critical decision timelines.

2. Accelerate permitting cycle – early and collaborative cooperation with the regulating agencies could reduce the permitting cycle and allow earlier start of construction.

b. **Increase WTP LAW Schedule Confidence** – The planning baseline schedule that focuses resources on LAW facility completion is considered a medium to medium-high risk schedule. A more balanced WTP schedule would allow additional resources to be assigned to the PT and HLW facilities. The LAW facility schedule could be shifted toward a completion date linked to the tank farms pretreatment project readiness-to-deliver feed date. These schedule adjustments should be considered as soon as sufficient engineering studies and conceptual designs have been completed to gain more confidence in a ready-to-deliver feed date. Moving LBL completion to FY 2014 would avoid spending interim operating dollars to maintain LBL facilities in a standby mode while waiting for feed delivery.

Any programmatic decisions to reduce the schedule misalignment should consider the overall integrated schedule risk. Specific risk values have not been estimated for this report; however, accelerating the tank farms pretreatment project will generally increase schedule risk, and adjusting LAW readiness to more closely couple to tank farms pretreatment readiness will generally reduce schedule risk. Due to the preliminary nature of the *Start LAW First* design concept and associated cost estimates, specific identification of schedule improvement opportunities should not be evaluated until preliminary designs and baseline schedules have been established.

4.3 National Environmental Policy Act

The current WTP construction is authorized by the *National Environmental Policy Act* (NEPA) Record of Decision (ROD) issued as a result of the TWRS Environmental Impact Statement (EIS) issued in 1997. Work is underway on the TC & WM EIS which is scheduled for completion in FY 2009. To implement the *Start LAW First* concept with its requirement for a phased pretreatment capability located near tank farms, DOE will need to prepare updated NEPA analysis either by modifying the ongoing TC & WM EIS to include the *Start LAW First* concept or develop specific NEPA coverage documents separately.

Construction on the tank farms pretreatment system would not start until a ROD based on the TC & WM EIS or separate NEPA analysis covering this specific scope is issued. Depending on the completion of appropriate NEPA analysis, the actual startup schedule could be limited.

4.4 Permitting

The tank farms pretreatment project ion exchange system and temporary tank storage units will constitute *Resource Conservation and Recovery Act* (RCRA) treatment, storage, and disposal (TSD) units, and will require submittal of a Part B Permit Application pursuant to Washington State Administrative Code (WAC) 173-303-806 and Washington State Department of Ecology (Ecology) issuance of a final status RCRA Part B permit prior to operation (WAC 173-303-840).

Newly constructed permitting requirements are assumed to apply. One-hundred-fifty days prior to submitting a RCRA Part B Application, DOE will be required to submit to Ecology a Notice of Intent (NOI) to construct and operate a new dangerous waste treatment and storage facility. Ecology will send a copy of the NOI to the elected officials of the lead local government and all local governments within the potentially affected area as required by WAC 173-303-902. If requested by the public, discussions over the siting of the new facility must also occur between DOE and the affected public.

Prior to Part B Permit application submittal, a public notice and meeting are required. At the time of Part B Permit application submittal to Ecology, Ecology will provide a public notice on the proposed facility that the application has been submitted.

Permitting of a new treatment and storage facility will be done in accordance with the process defined in Section 9.2.2 of the *Hanford Federal Facility Agreement and Consent Order* (HFFACO) (Ecology et al.). The contents of the Part B Permit Application will be as required in WAC 173-303-806. DOE will need to submit a draft permit application (Revision 0) to Ecology. The time required for preparation of this permit is highly variable depending on the amount of information available for satisfying the regulatory requirements of a permit application. It is expected that a permit application for this treatment and storage unit would require approximately 1 year to complete. Once completed, the Revision 0 Part B application must be submitted to Ecology based on the following HFFACO review cycle:

a. DOE issues Rev 0 Part B Application to Ecology. Ecology has 120 days to review and submit comments back to DOE
b. DOE provides responses to the Notices of Deficiencies (NODs) (120 days)
c. Ecology reviews DOE response (120 days)
d. NOD workshops begin (210 days)
e. DOE issues Rev 1 Part B Application (120 days)
f. Ecology Reviews Rev 1 and issues NODs (60 days)
g. Project Manager issue resolution and page changes (90 days).

On resolution of all NODs, Ecology will prepare a draft permit for public notification, review, and, as required, a public meeting. On resolution of public comments, the Part B Permit will be issued for the new treatment and storage units. The schedule for this Part B process varies with each project and often does not follow the timeline contained in Figure 9-2 of the HFFACO (Ecology et al.), which requires over 2 years to complete. It is anticipated that a permitting plan will be signed by DOE and Ecology that lays out the schedule and deliverables for completion of the Part B Permit in a more timely manner.

4.5 Secondary Waste

In the *Start LAW First* scenario, the recycle of LAW effluent to the WTP PT facility cannot occur during interim LAW operations since the PT facility will not be available, and DST radioactive waste space is not available to store this large volume until the balance of WTP starts operation. The reference scenario would filter these effluents and transfer them to ETF for treatment.

Preliminary PA work has indicated that the quantity of iodine and technetium in the various primary and secondary waste forms disposed in IDF will likely be dominant sources of long term environmental risk. The radionuclides of specific interest are ^{129}I and ^{99}Tc. As an example, the feed tanks identified for interim LAW operations contain approximately 4,400 Ci of technetium (approximately 16% of the total technetium inventory contained in Hanford tank waste). Based on WTP flowsheet modeling,[6] approximately 63% of the technetium in the feed to the LAW melter is retained in the LAW glass. The remaining 37% (1,630 Ci) would be sent to ETF for treatment and disposal in a solidified secondary waste form.

Scenario-specific modeling would have to be conducted to quantify the differences if the equivalent interim LAW operations feed was processed through the full WTP complex with HLW treatment and recycle. It is likely that in the *Start LAW First* scenario some additional iodine and technetium would be disposed in a solidified secondary waste form rather than in an immobilized LAW glass waste form. This shift in iodine and technetium fate represents an incremental change to baseline planning assumptions; however, the impact of this shift cannot be fully evaluated until the IDF PA is completed and a comparison made to the standards identified in the TC & WM EIS ROD.

When the on site disposal waste acceptance criteria are finalized after the completion of the TC & WM EIS, it might be possible that an enhanced secondary solid waste form system would have to be developed and installed in the ETF facility to ensure adequate IDF performance. While this issue must be resolved in the current program regardless, the *Start LAW First* scenario would accelerate the time when this decision must be addressed and when funds would need to be provided to support closure of this issue in the near future. To date, only exploratory studies have been completed on developing enhanced secondary solid waste forms.

4.6 Waste Treatment and Immobilization Plant Concurrent Operation and Construction

The LBL facilities are co-located with the PT and HLW vitrification facility on the WTP site. If interim LAW operations are initiated, it will be necessary to continue construction concurrently with this operation. Radioactive operations within an active construction site will result in complex logistical and security issues. First, personnel and access control limitations (e.g., fencing with controlled access) will need to be established to ensure that the uncleared construction forces do not have access to the operating facility or key supporting infrastructure.

[6] WTP *Flowsheet Bases, Assumptions, and Requirements*, 24590-WTP-RPT-PT-02-005, Rev. 3.

Operator change facilities, operations, and engineering management office space and infrastructure will need to be established, and facility maintenance workshops will need to be provided separately from current construction facilities. A plant operating contractor will need to be assigned or contracted for, training and qualification plans developed, and operating procedures written. Operating staff will need to be hired, trained, and qualified. A work control system that deals with operations and maintenance within the facility, along with key construction interfaces, will need to be established and integrated between the operations and construction contractors.

Construction and essential operational materials will need to be received, controlled, and managed separately with separate site access routes and storage areas established. Overall construction labor productivity will likely be affected by the site segregation associated with the operations/construction boundary. Utilities and supporting infrastructure (electrical power, raw water, cooling towers, etc.) will need to be configured and controlled to ensure continuity of ongoing operation while construction is underway. Any potential upset operating condition in the LAW or LAB facilities could impact ongoing construction work.

While WTP planning associated with the *Start LAW First* scenario has attempted to identify and minimize the interferences described here, it is likely that the cost and schedule to complete PT and HLW facilities could be further affected by interim LAW operations. It is not possible at this time to effectively quantify this risk and its impact, but it is important to know that it will exist.

4.7 Operations Infrastructure

It has been over 15 years since the last radiochemical facility operated at the Hanford Site. As a result, the Hanford Site has a very limited number of qualified nuclear operators today. The scope, complexity, and logistics associated with acquiring, training, and qualification of operating staff will be larger than recently experienced at the Hanford Site. Other complexities such as, assignment of an operating contractor, restructuring of labor contracts, development of necessary operating procedures, development of training and qualification programs, integration of the training and qualification process with cold facility testing, performing ORRs, and final qualification for hot operations present new challenges to ORP and its contractors. Cost, schedule, and risk mitigating activities for these items should be carefully evaluated.

Additional WTP cost and schedule risk results from the creation of two distinct facility testing and start up periods, one for LBL and one for PT and HLW integrated with the LBL facilities. As noted in Section 3.2, this split startup arrangement also has potential mission advantages. The risks and advantages associated with multiple startup crews, multiple ORRs, and multiple transitions to an operating contractor must be considered and mitigated.

4.8 Design and Cost Estimate Uncertainty

The current technical basis for the tank farms pretreatment project consists of a (1) preliminary feed tank assessment based on existing characterization data, (2) preliminary process flowsheet based on process data generated supporting WTP pretreatment design, (3) preliminary conceptual equipment list and facility layout, and (4) parametric cost estimate based on recent tank farm construction costs and the Demonstration Bulk Vitrification System construction estimate with the application of typical DOE cost estimating guidelines for contingency. The initial critical decision data development to support project decision-making has not yet been prepared, no conceptual design has been initiated to establish a reasonable project baseline, and no formal hazards analysis or preliminary safety analysis has yet been authorized nor completed, since there is no conceptual design to evaluate.

While the tank farms pretreatment project information included in this document is adequate for feasibility evaluation, it is not prudent to consider this information as an adequate basis for a project cost or schedule baseline until a conceptual design and project baseline have been developed and independently reviewed and validated using formal DOE project management tools and critical decision process outlined in DOE Order 413.3a. Cost estimate increases are likely as the facility design is developed, a more detailed understanding of the safety and operational requirements is developed, and the needed technology demonstrations are completed.

Recent DOE experience has demonstrated project cost growth after pre-conceptual planning efforts identify a new concept's first cost estimates. In order to account for this cost growth that is often a result of unplanned issues (technical, safety, regulatory, schedule, funding etc.) that materialize as the project's scope and design details mature, the tank farms pretreatment project costs have also been estimated using additional contingency. The tank farms pretreatment project cost estimates presented in Table 3-1 include a 50% cost contingency that is typical for estimates of this preliminary nature. A cost estimate using twice this contingency (100%) can account for cost growth trends experienced in recent DOE projects. This results in a tank farms pretreatment cost (not including interim operations) ranging from $163 million (50% contingency) to $217 million (100% contingency).

In contrast, the modifications to the WTP include relatively minor changes to a facility with an advanced design, which is already under construction. As such, DOE has a much stronger basis for establishing a cost and schedule basis for the needed facility modifications for the WTP facilities. Even so, the proposed modifications have not gone through a rigorous design review and validation process such as has been recently completed for the balance of the WTP facility.

4.9 Technology Maturity

The technologies envisioned to implement the *Start LAW First* concept were selected to allow the simplest implementation pathway for production facilities located at or near the tank farms, and to avoid construction of additional massive complex facilities to support LAW operations for a limited timeframe. The primary technologies used for this concept are the following:

a. In-tank riser solid-liquid separation using SpinTek™ filter technology
b. Simple series column cesium ion exchange deployed in an in-ground vault
c. LAW vitrification using the existing WTP LAW melters
d. WTP secondary waste effluent filter (allowing direct discharge to the ETF)
e. Storage of the neutralized cesium eluate product in existing DSTs.

The maturity and potential risks associated with these technology selections are discussed in Sections 4.9.1 through 4.9.5.

4.9.1 In-tank Solid-liquid Separation using SpinTek™ Filter Technology

DOE's Office of Environmental Management has been funding the development and demonstration of a "nuclear capable" adaptation of the commercial SpinTek™ rotating filter technology since 1996. The technology holds the promise of sustaining higher filter flux rates over a longer period of time than use of ultrafiltration, with a simpler flow system and a smaller installation footprint required. A series of design studies and cold tests conducted jointly by Oak Ridge National Laboratory and Savannah River National Laboratory has produced a version of the SpinTek™ filter with stainless-steel membranes that will withstand radioactive conditions in tank waste service. Full-scale cold tests with surrogates have been successfully operated for over 1,000 hours of continuous operations with excellent filter flux and no identified failure mechanisms. A twin-unit full-scale prototype has been designed for initial application at Savannah River in an existing HLW tank riser. It is not clear when this prototypical demonstration will be conducted. While the work to date is promising, the SpinTek™ filter should not be considered fully demonstrated for operation of the *Start LAW First* alternative until the following are completed:

a. Full scale tests with materials that more closely bound the planned application at Hanford tank farms
b. An extended hot prototype operation is conducted at SRS or elsewhere
c. Adequate testing has been completed to reliably estimate unit operational life, required maintenance, and frequency of replacement.

If testing of SpinTek™ concepts for this particular application at Hanford is not successful, an ultrafiltration system could be deployed in a near-farm vault to achieve the required separation. It is estimated that the cost impact of ultrafiltration versus at-tank filtration is in the range of 15-30 million dollars in additional lifecycle costs.

4.9.2 Series Column Cesium Ion Exchange Deployed in an In-ground Vault

The 200-East Area DSTs that contain staged LAW feed materials require cesium decontamination to meet the shielding safety criteria of the WTP LAW facility. DOE has deployed a wide range of cesium removal technologies for a number of different

applications. These technologies were reviewed and elutable cesium ion exchange was selected. The ion exchange media selected as baseline for the WTP pretreatment facility has been extensively tested under bench and full-scale operations using feed sample materials that are the same as those feeds selected for the early LAW operations. While both spherical resorcinol-formaldehyde and IBC[7] resin materials have been demonstrated to exceed the performance requirements for this specific application, it is likely that WTP will standardize on the resorcinol-formaldehyde material, and the near farm facility would use the same technique. The technology risk for use of this material is considered to be low.

There is more uncertainty in the deployment facility concept. To simplify the ion exchange equipment for use near tank farms, a less efficient but simpler, two column design loaded in upflow configuration was selected over the multiple column carousel used in the WTP. This eliminates concerns about complex valving, seals, and column airspace venting to control hydrogen buildup. The first column is the primary cesium removal system with the backup column providing a degree of redundancy. The process flow rate and a pair of decontaminated product storage tanks are sized to assure steady feed delivery even during regeneration cycles. The cesium is eluted from the columns using a nitric acid solution. The eluted cesium solution is neutralized and transferred to existing DSTs. All tanks and vessels require ventilation to control hydrogen buildup in any vacant vapor headspace. The vaults where the equipment is deployed require separate ventilation as well.

The equipment is deployed in process vaults that are similar to DCRTs or valve manifold pits currently widely used at the Hanford Site and SRS. The intent is to utilize electrically operated valves, in-pit pumps, and control systems with a degree of complexity similar to those used during the recently completed interim stabilization campaigns and in some of the ongoing SST waste retrievals. Pump and rotating equipment replacement would be done using techniques identical to what is being done today in tank farms (crane lifts of failed equipment with water flushes and contamination control structures [glove bags], and PPE as required). It is believed that these structures will ultimately be evaluated as hazard category 2 facilities due to cesium inventory. A similar facility approach is being taken at SRS to deploy caustic side solvent extraction in a demonstration facility. However, no detailed design exists for these tank farms pretreatment facilities, so no formal hazards categorization evaluations have been done. While in-ground structures have been shown to be highly resistant to seismic damage, the ultimate set of design features and controls that will be necessary to construct and operate the interim pretreatment facilities under DOE regulation and Defense Nuclear Facilities Safety Board review will remain uncertain until detailed designs are completed and a Preliminary Documented Safety Analysis is developed. Until this design and safety work is completed, the ultimate cost and schedule for the near tank farm pretreatment facilities remains uncertain.

[7] IBC Advanced Technologies Inc, American Fork, Utah.

4.9.3 Low-Activity Waste Vitrification using the Existing Waste Treatment and Immobilization Plant Low-Activity Waste Melters

The LAW melter systems will operate with feeds, glass formulations, and operating conditions that are identical to its current design basis. Melter operation in the *Start LAW First* scenario adds no incremental technical uncertainty or risk.

4.9.4 Waste Treatment and Immobilization Plant Secondary Waste Effluent Filter

In the WTP baseline design and planned operations, all secondary waste effluents from WTP LAW are routed to the WTP PT facility for recycle and ultimate treatment by the Hanford Site ETF. In the *Start LAW First* scenario, the lines that return to PT must be rerouted and the effluent collected for direct transfer to the ETF facility. It is expected that the LAW offgas secondary wastes will contain additional solids which exceed the acceptance criteria of the ETF. The chemical and radionuclide content of the effluent stream remains uncertain until scenario specific process modeling can be completed. The extent of effluent treatment required at the LAW facility or the ETF is uncertain. Until the IDF PA and scenario specific process modeling are completed, the design of the *Start LAW First* effluent treatment system is considered a high technical risk.

An alternative to this approach could route the dilute effluent (~20 million gallons) back to tank farms for evaporation using the 242-A Evaporator and then routing the evaporated condensate to ETF for treatment and disposal. The logistics of transferring and evaporating 20 million gallons of LAW effluent within the less than 5 million gallons of space created in the DST system is considered not feasible. Additionally, returning the LAW effluent to the DST system would limit the ability to retrieve additional SSTs, which is one of the primary benefits of interim LAW operations.

4.9.5 Storage of the Neutralized Cesium Eluate Product in Aging Waste Double-Shell Tanks

Ultimately, the separated cesium must be routed to the WTP for incorporation into the HLW glass. In the *Start LAW First* scenario, the extracted cesium is eluted from the ion exchange media by a nitric acid solution. This nitric acid-cesium nitrate solution is stored in a 50,000 gal, ventilated stainless-steel vessel until a batch of solution is collected. This batch is neutralized with caustic in the storage vessel to meet DST specifications, and is transferred to storage in AZ or AY farm. Since adequate DST tank space will be available in the option and all safety requirements and waste compatibility specifications will be met prior to transfer, this function is considered to have low technical risk.

5.0 CONCLUSION

This study updates the information developed in the previous revision and provides a reference scenario that could implement a *Start LAW First* concept in a manner that is compatible with WTP's current planning baseline. Assuming funding availability, this study also identifies the need to begin DOE Order 413.3a-based project mission justification activities in FY 2008. The benefits of the reference scenario include beginning LAW processing nearly 5 years ahead of the current WTP schedule and creating additional DST space to support more and accelerated SST retrievals. The impact of the *Start LAW First* reference scenario can be summarized as follows:

- Frees ~4.7 million gal of DST space
- Starts LAW processing nearly 5 years earlier than WTP baseline
- Produces ~5,500 LAW canisters containing 4,600 MT of sodium (~8% of the total mission estimate of ~56,000 MT of LAW sodium)
- Reduces WTP startup and operating resource hiring demand
- Increases WTP Operational Readiness Review (ORR) efficiency and success with lessons learned from the Start LAW First ORR applied to PT and HLW facility ORRs
- Interim LAW operating experience gained would support supplemental LAW treatment capacity need decisions.

The additional incremental RPP funding of ~ $926 million to $980 million through FY 2020 necessary to implement the *Start LAW First* concept is clearly one of the challenges that must be weighed in the decision-making process. Other risks to be considered and evaluated as the implementation and decision process moves forward include the following:

- Schedule Integration
- NEPA Compliance
- Permitting
- Secondary Waste Impacts
- WTP Construction and Startup Impact
- Operations Infrastructure
- Design and Cost Estimate Uncertainty
- Technology Maturity.

6.0 REFERENCES

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