APPENDIX B — KEY ASSUMPTIONS AND SUCCESS CRITERIA

CONTENTS

FIGURES

TERMS

ARF	Aluminum Removal Facility
BBI	best-basis inventory
BDGRE	buoyant displacement gas release events
BNI	Bechtel National, Inc.
BOF	balance of facilities
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CH-TRU	contact-handled transuranic
DOE	U.S. Department of Energy
DST	double-shell tank
Ecology	Washington State Department of Ecology
ETF	Effluent Treatment Facility
FY	fiscal year
HEME	high-efficiency mist eliminator
HEPA	high efficiency particulate air (filter)
HGR	hydrogen generation rate
HIHTL	hose-in-hose transfer line
HLW	high-level waste
HSF	Hanford Shipping Facility (for HLW canisters)
HTWOS	Hanford Tank Waste Operations Simulator
IDF	Integrated Disposal Facility
IHLW	immobilized high-level waste
ILAW	immobilized low-activity waste
IMUST	inactive miscellaneous underground storage tank
IHSF	Interim Hanford Storage Facility (for HLW canisters)
LAW	low-activity waste
LERF	Liquid Effluent Retention Facility
LLW	low-level waste
PMB	performance measurement baseline
PT Facility	Pretreatment Facility
PWD	plant wash disposal system
OPER	outyear planning estimate range
ORP	U.S. Department of Energy, Office of River Protection
RH-TRU	remote-handled transuranic

TERMS

RL	U.S. Department of Energy, Richland Operations Office
RLD	radioactive waste disposal system
ROD	Record of Decision
RPP	River Protection Project
SALDS	State-Approved Land Disposal Site
SBS	submerged bed scrubber
SST	single-shell tank
TEDF	Treated Effluent Disposal Facility
TOE	total operating efficiency
TRU	transuranic
TRUPACT-II	Transuranic Package Transporter II
TWINS	Tank Waste Information Network System
WESP	wet electrostatic precipitator
WIPP	Waste Isolation Pilot Plant
WRF	Waste Retrieval Facility
WRPS	Washington River Protection Solutions LLC
WTP	Waste Treatment and Immobilization Plant

B1.0 GENERAL INFORMATION

The key assumptions and success criteria document the approved[1] input for Hanford Tank Waste Operations Simulator (HTWOS) modeling and mission planning purposes as of March 2010. These assumptions and success criteria were developed after reviewing existing assumptions from the previous version of the River Protection Project (RPP) System Plan, the Waste Treatment and Immobilization Plant (WTP) contract (DE-AC27-01RV14136, *Design Construction and Commissioning of the Hanford Tank Waste Treatment and Immobilization Plant*), and recent HTWOS model runs. These assumptions and success criteria:

- Reflect the outcome of a series of meetings in December 2009 and January 2010 with the U.S. Department of Energy (DOE), including personnel from both Headquarters and the Office of River Protection (ORP), and incorporate ORP's verbal and e-mail guidance.
- Incorporate ORP's and DOE Headquarters' verbal comments on the draft assumptions.
- Reflect informal input from the Washington State Department of Ecology (Ecology) during three meetings[2] conducted with DOE-ORP and Washington River Protection Solutions LLC (WRPS) in December 2009 and January 2010.

This version of the System Plan evaluates two cases (i.e., mission scenarios) as requested by ORP, the Baseline Case and one sensitivity case called Sensitivity Case A. The assumptions apply to both cases unless explicitly stated otherwise.

The Baseline Case (BC) provides the basis for updating the existing[3] Performance Measurement Baseline (PMB) and Outyear Planning Estimate Range (OPER) with the current WTP Flowsheet, Integrated Waste Feed Delivery Plan, Single-Shell Tank (SST) Retrieval Plan and the new high-level waste (HLW) glass formulation model. As such, it continues to include management of sodium via the Aluminum Removal Facility, reduced HLW glass mass via enhanced blending in the double-shell tanks (DSTs). However, the potential contact-handled transuranic (CH-TRU) tank waste is assumed to be stored on-site until its final disposition is determined. A baseline change request (BCR) will be required to realign the PMB/OPER with the Baseline Case.

Sensitivity Case A (SCA) explores the impacts of eliminating supplemental CH-TRU treatment, thus treating the potential CH-TRU tank waste at the WTP and disposing of it along with the HLW. This is in anticipation of a potential future decision to dispose of this material as HLW rather than to dispose of this material at the Waste Isolation Pilot Plant (WIPP).

The implementation of this set of assumptions into the HTWOS model is described in detail in the *Hanford Tank Waste Operations Simulator (HTWOS) Version 5.0 Model Design Document* (RPP-17152, Rev 3 [DRAFT]) and associated model run requests.[4]

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[1] Original assumptions were approved by ORP.

[2] Cite formal meeting minutes.

[3] The current PMB / OPER is comprised of BCR-09-002, "Near-Term Baseline and Outyear Planning Estimate Range", as revised by subsequent BCRs.

[4] Cite final model run requests.

Caveats

A number of non-substantive changes to these key assumptions are expected during the preparation of the System Plan, the integration of the various cases with the other contract deliverables, and the alignment of the HTWOS model to current technical and programmatic assumptions. These changes will not require ORP review and approval apart from ORP's final review and approval of the RPP System Plan.

- The overall organization, format, and level of detail may be changed during the preparation of the System Plan.
- The wording of the assumptions, basis, and associated discussions may be clarified.
- Additional references may be provided or updated as needed.

B2.0 SUCCESS CRITERIA

Success criteria are metrics that will be used to evaluate how well each case meets its intended purpose and may include dates or other objectives; however, there is no guarantee that they will be met. Changes to the timing of certain activities, assumed facility capacities, or other process variables might be needed to meet the success criteria. If preliminary results indicate that the success criteria cannot be met using the approved assumptions, the reasons will be identified and discussed with ORP and agreement reached on how to proceed.

B2.1 BASELINE CASE

B2.1.1 The Baseline Case (BC) will be considered successful if it is consistent with the ORP-provided guidance dates for key mission activities identified in Assumption B2.1.2, the ORP-provided funding guidance in Assumption B2.1.3. In the event that the guidance cannot reasonably be met within the degrees of freedom discussed in Assumption B2.1.4, the reasons will be identified.

B2.1.2 The Baseline Case will meet the following guidance dates:[5]

- Complete C Farm retrievals by September 30, 2014
- Initiate startup of retrieval from 5 additional (i.e., non-C Farm) tanks by December 31, 2017 [6]
- Complete closure of C Farm by June 30, 2019
- Complete retrieval from 9 non-C Farm tanks by September 30, 2022[6]
- Retrieve all remaining single-shell tanks (SSTs) by December 31, 2040
- Complete closure of all SST farms by January 31, 2043
- Complete pretreatment processing and vitrification of Hanford HLW and LAW tank wastes by December 31, 2047
- Complete closure of all DST farms by September 30, 2052.

B2.1.3 The Baseline Case will meet the ORP provided funding targets[7] for FY 2010 through FY 2015. These targets are consistent with the most recent budget planning guidance and briefing materials. After FY 2015, a reasonable ramp-up may be assumed.

B2.1.4 The timing of activities in the Baseline Case may be shifted as needed to satisfy the guidance dates, even if this requires deviation from other programmatic assumptions, including deviating from the funding guidance.

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[5] These dates are an ORP-provided proxy for a subset of key potential future milestones that reflect draft provisions in the Proposed Consent Decree and Tri-Party Agreement Modifications for Hanford Tank Waste Treatment as submitted for public comment beginning October 1, 2009 (08-5085-FVS, 2009, *Proposed Consent Decree No. 08-5058-FVS between the U.S. Department of Energy and the State of Washington*).

[6] Not including the contact-handled transuranic waste (CH-TRU) tanks.

[7] Basche 2010, “RE: Please send funding targets ASAP”.

B2.2 SENSITIVITY CASE A

The purpose of Sensitivity Case A (SCA) is to explore the impacts of eliminating supplemental CH-TRU treatment, thus treating the potential CH-TRU tank waste at the WTP and disposing of it along with the HLW. As such, it is anticipated that the mission duration and number of HLW glass canisters may slightly increase relative to the Baseline Case along with a commensurate increase in lifecycle cost.

B2.2.1 The Sensitivity Case A will be considered successful if it is consistent with the ORP-provided guidance dates for key mission activities in Assumption B2.1.2 and the ORP-provided funding guidance in Assumption B2.1.3. In the event that the guidance dates or funding guidance are not met, the reasons will be identified.

B2.2.2 The timing of activities in the Sensitivity Case may be shifted as needed to approximate the cost profile in the PMB/OPER, even if this requires deviation from other programmatic assumptions.

B3.0 KEY ASSUMPTIONS

B3.1 WASTE TREATMENT COMPLEX

The overall configuration and process flow assumed for the waste treatment complex is shown in Figure B-1for the Baseline Case; the configuration for Sensitivity Case A is identical with the exception of the removal of the Supplemental CH-TRU Treatment System, Central Waste Complex, and associated streams.

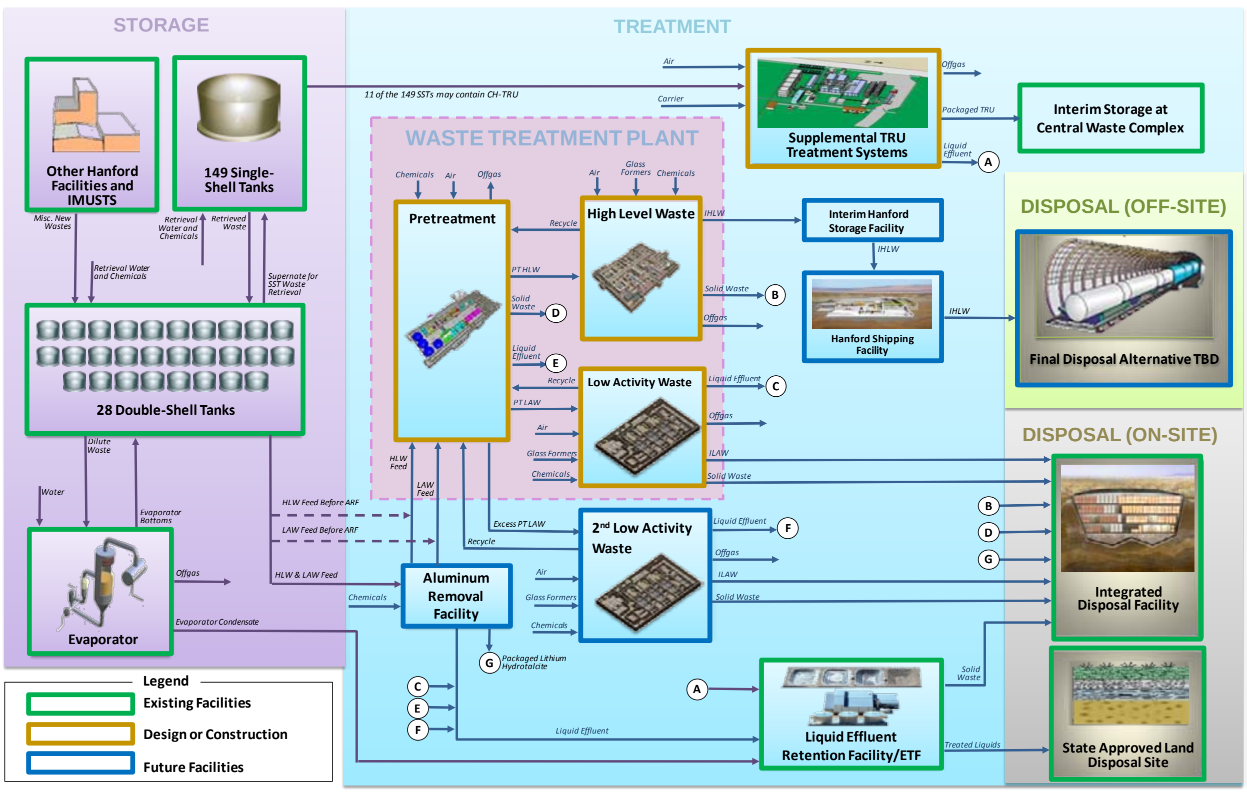

Figure B-1. River Protection Project Simplified Flow Diagram for the Baseline Case.

B3.2 TANK FARMS

B3.2.1 Single-Shell Tanks

B3.2.1.1 The integrity of the 149 SSTs is described in HNF-EP-0182, *Waste Tank Summary Report for Month Ending November 30, 2009* (Rev. 260).

B3.2.1.2 It is assumed that timely approval will be received to support interim closure (tank isolation and filling with grout) of each SST sometime after retrieval of that tank is complete.[8]

B3.2.1.3 It is assumed that timely approval will be received to support full closure of each tank farm sometime after all tanks in that farm are interim closed.

B3.2.2 Double-Shell Tanks

B3.2.2.1 The integrity of the 28 DSTs is as described in HNF-EP-0182. It is assumed that the DSTs will remain fully operational for the duration of the waste treatment mission.

B3.2.2.2 The maximum modeled operating liquid levels for the DSTs are the “normal operating limits” provided in OSD-T-151-00007, *Operating Specifications for the Double Shell Storage Tanks*, with the exception that the maximum modeled operating level for all AP Farm tanks is increased to 454 in. (1.2465 Mgal).[9] The “normal operating limits” for tanks AP-103 and AP-108 have already been increased to 454 in; it is assumed that the other AP Farm tanks will successfully pass the in-service leak testing required to use this increased operating level.

B3.2.2.3 The volume of DST space allocated for tank farm emergencies and emergency returns from the WTP is 1.265 Mgal (HNF-3484, *Double Shell Tank Emergency Pumping Guide*); this space may be distributed among multiple DSTs.

B3.2.2.4 No DST space will be reserved for non-emergency returns of pretreated low-activity waste (LAW) or liquid effluents to the DST system.

B3.2.2.5 Insoluble solids retrieved from SSTs are assumed to settle to approximately 40 wt% solids in the DSTs within 30 days, except for C Farm. Insoluble solids retrieved from C Farm are assumed to settle within 2 days to a solids-loading comparable to that in the source SST (see Section 4.3.5 of RPP-17152, Rev 3 [DRAFT]).

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[8] A draft closure integration plan (RPP-PLAN-40761, *Integrated Single-Shell Tank Waste Management Area Closure Plan*) has been prepared to better define the strategy and approach to be used to close the tanks. The cost and schedule for interim and final closure activities will be reflected in the PMB. Closure activities are not modeled in HTWOS.

[9] Note: At liquid levels above 426 in., the nominal 2,750 gal/in. of tank level begins to decrease, dropping to about 2,600 gal/in. at 454 in. The official spreadsheet tool for converting between liquid level and volume for both DSTs and SSTs is released under SVF-1770.

B3.2.2.6 The solids management strategy for the DSTs is to operate the DSTs so that they do not become Group A tanks (i.e., stay within acceptable buoyant displacement gas release event [BDGRE] criteria). For mission planning purposes, the following simplified proxy limits will be used:

- Existing BDGRE controls are assumed to apply to DSTs containing an accumulation of settled salts, including:
  - Restrictions on the use of currently existing Group A tanks will continue to be followed for those tanks until the waste has been retrieved.
  - Assumption B3.2.4.5 is assumed to prevent future accumulations of salts that might result in classifying a DST as Group A under existing BDGRE controls.
- The depth of settled sludge accumulated in each DST will be maintained less than 250 in.[10,11]

B3.2.2.7 The waste blending and segregation controls in the feed control list (HNF-SD-WM-OCD-015, *Tank Waste Transfer Compatibility Program*, Table A-1) will be followed, with the following exceptions and clarifications:

- "Blend-off high-sulfate supernate" – The blending actions in this feed control were completed in June 2008 and documented in RPP-CALC-38051, *241-AZ-102 Supernate Transfers and Blending Confirmation*.
- "Blend off high ^{233}U solids" – It is assumed that the blending strategy described in Section 7.2.4 of RPP-RPT-43828, *Enhanced Use of AN Farm for C Farm Single Shell Tank Retrieval*, will successfully mitigate the uranium enrichment issues with the C-104 solids.[12]
- "Segregate Envelope C" – It is assumed that the strontium and transuranic (TRU) constituents will be removed from the Envelope C waste currently stored in Tanks

[10] RPP-PLAN-30112, *Plan to Resolve Technical Issues Associated with Sludge Accumulation in Double-Shell Tanks*, states that the current limits on preventing BDGREs are based on the behavior of settled salts and therefore are not applicable to accumulations of sludge. A review of open literature suggests that high-shear strength sludge may not retain gas in a way that would lead to BDGREs. A technical basis for relaxing BDGRE-related controls on sludge is being developed, with plans to implement a revision to the BDGRE-related controls in the safety basis by September 2012. It is assumed that this work is successful in relaxing BDGRE-related controls on the accumulation of sludge and supernate in DSTs. Unpublished scoping calculations suggest that the allowable sludge depth is expected to range between 160 and 400 inches depending on the actual physical properties of the settled sludge.

[11] DSTs containing more than about 70 inches of settled solids will require incremental insertion or lowering of mixer-pumps per B3.2.3.16. An allowance for mixing up to a nominal 76 inches without incremental insertion will be assumed for the blending of C-104 sludge per assumption B3.2.2.7.

[12] Since AN-101 will contain nearly 250 inches of settled solids after retrieval of tanks C-104, C-111, C-112, C-101 and C-105, the waste will need to be retrieved layer-by-layer using incremental insertion of mixer pumps per RPP-40149, Rev 1, [DRAFT]. The intent is to fill two DSTs functioning as HLW staging tanks, each with half of the C-104 waste plus enough of the low-fissile blend stock to mitigate the uranium enrichment issue; the settled depth of the blended sludge in each of these two tanks is expected to be about 76 inches. Note that the bulk of the sludge from the last two tanks to be retrieved into AN-101 (currently assumed to be C-101 and C-105) would need to first be retrieved and transferred to other DSTs. The details are described in Section 7.2.4 of RPP-RPT-43828.

AN-102 and AN-107 in the DST system rather than in the WTP, at which time segregation is no longer required.

- "Segregate waste destined for TRU or low-level waste (LLW) packaging":
  - Baseline Case: It is assumed that only the contact-handled transuranic (CH-TRU) waste will be segregated. The remote-handled transuranic (RH-TRU) waste may be commingled with other tank waste.
  - Sensitivity Case A: All transuranic tank waste may be commingled with other tank waste solids.
  - Both cases: The RH-TRU solids from Tanks AW-103 and AW-105 may be blended with other high-level waste (HLW) solids to reduce the zirconium concentration if possible and beneficial.
- "Segregate low-cesium SST waste for non-WTP supplemental treatment" – No waste needs to be segregated as low cesium feed.

B3.2.2.8 Enhanced blending of sludge (increases in incidental blending and/or implementation of a small degree of intentional blending) will be used to reduce the projected mass of HLW glass in order to meet the success criteria for the completion date of waste treatment.

B3.2.3 Waste Retrieval and Transfers

B3.2.3.1 The next group of SSTs to be retrieved in the near-term will be the C Farm tanks.

B3.2.3.2 The goal for sequencing the retrieval of SST waste is to minimize the waste treatment mission duration[13] by attempting to provide sufficient HLW or LAW feed to keep the limiting facilities operating at or near assumed capacity and by maintaining as high an average waste oxide loading of the limiting facility product as reasonably achievable.

B3.2.3.3 The retrieval of the SSTs will be sequenced using a staggered, overlapping, farm-by-farm approach, described in RPP-RPT-40145, Rev 1, [DRAFT], that considers the following:

- Simultaneous retrieval constraints resulting from infrastructure or operational considerations
- Retrieval technologies and performance, including learning curves and anticipated difficulty in retrieval based on unique tank and waste conditions
- Available DST space
- Special handling for the CH-TRU waste (Baseline Case only)
- Providing a balanced feed to the WTP, with priority given to feeding the more limiting facility

[13] It is asserted that minimizing treatment mission duration significantly reduces the risk to human health and the environment. This input is consistent with discussions held with Ecology.

B3.2.3.4 Updated SST retrieval assumptions (assumed technology, minimum retrieval duration, and as-retrieved waste volumes) will be provided by SVF-1647, "SST Retrieval Assumptions Rev 3.xlsx" (SVF-1647).[14]

B3.2.3.5 Retrieval of waste from B-Complex (B, BX and BY-Farms), except that waste handled as CH-TRU (see B3.4.3.1), will be transferred to a tank in the B-Complex Waste Retrieval Facility (WRF), with supernate routed back and forth from the WRF tank to the SST as required. Retrieved waste will be transferred from the WRF tank to DST storage via new double-encased hose-in-hose transfer lines (HIHTLs) or stainless-steel lines. (RPP-PLAN-40145 Rev 0).

B3.2.3.6 Retrieval of waste from T-Complex (T, TX and TY-Farms), except that waste handled as CH-TRU (see B3.4.3.1 and B3.4.3.3), will be to a tank in the T-Complex WRF, with supernate routed back and forth from the WRF tank to the SST as required. Retrieved waste will be transferred from the WRF tank to DST storage via new double-encased HIHTLs or stainless-steel lines. (RPP-PLAN-40145 Rev 0).

B3.2.3.7 Each WRF will consist of 6 tanks, each tank with a 150,000-gallon operating volume, along with all needed ancillary equipment per RPP-17152, Rev 3 [DRAFT].

B3.2.3.8 The B-Complex WRF will be available for operations on 7/2/2019; the T-Complex WRF will be available for operations on 6/30/2020.[15]

B3.2.3.9 All SSTs (except those specifically retrieved into WRFs per Assumptions B3.2.3.5 and B3.2.3.6 or those handled as CH-TRU per Assumptions B3.4.3.1 and B3.4.3.3) will be retrieved directly into the DST system.

B3.2.3.10 During retrieval of waste from SSTs to the DST system, sodium hydroxide and sodium nitrite will be added as needed so that the as-retrieved liquid phase composition satisfies the DST waste chemistry limits given in Table 3-2 of HNF-SD-WM-OCD-015. Caustic additions for intra-DST transfers and for depletion of caustic over time are not modeled.

B3.2.3.11 All feed delivered to the WTP before the start-up of the Aluminum Removal Facility (ARF) will be via the DST system; all feed delivered to the WTP after the start-up of the ARF will be via that facility.

B3.2.3.12 Allow 210 days[16] to sample the staged feed and verify compliance with permits and the safety authorization basis before delivery to the WTP, starting from when each

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[14] The SST retrieval performance assumptions are being updated by Washington River Protection Solutions, LLC (WRPS) as part of the integration effort. The final reference will be incorporated once it is available.

[15] These dates are taken from PMB / OPER and may be adjusted to meet success criteria.

[16] The 210-day dwell time comprises the 180 days required by ICD-19 (24590-WTP-ICD-MG-01-019, *ICD 19 – Interface Control Document for Waste Feed*) with an additional 30 days allocated for the Tank Operations Contractor to mix and sample the staged waste.

staging tank (DST) is filled with feed, but no earlier than the availability of suitable mixing and sampling capability.

B3.2.3.13 Allow 120 days[17] to sample the staged feed and verify compliance with permits and the safety authorization basis before delivery to the ARF, starting from when each staging tank (DST) is filled with feed, but no earlier than the availability of suitable mixing and sampling capability.

B3.2.3.14 The feed for LAW hot commissioning will be delivered by decanting a portion of the supernate from Tank AY-102 and transferring it to the WTP; the feed for HLW hot commissioning will be delivered by remobilizing the solids in Tank AY-102 with the remaining supernate and additional dilution water and then transferring them to the WTP.

B3.2.3.15 Subsequent deliveries of feed to the WTP will be timed and sequenced to balance the production of HLW glass and LAW glass.

B3.2.3.16 The use of the DSTs to receive retrieved SST waste, manage stored waste, and stage and deliver feed to the ARF and the WTP will be revisited as part of the integration with RPP-40149, *Integrated Waste Feed Delivery Plan*, and RPP-PLAN-40145, *Single-Shell Tank Retrieval Plan*. Key areas of alignment include (subject to change during the integration effort):

- Planned configuration of each DST.
- The maximum settled solids level that can be effectively mobilized and well-mixed using two mixer-pumps without incremental insertion capability is 70 inches. An allowance for mixing up to a nominal 76 inches will be assumed for the blending of C-104 sludge per assumption B3.2.2.7.
- During normal operations, mixer-pumps will not be operated with less than 72 inches of waste in the tank for deliveries of HLW feed to insure well-mixed feed.
- During normal operations, mixer-pumps will not be operated with less than 36 inches of waste in the tank for DST to DST transfers to prevent damage to the pumps.
- When used to stage HLW solids, the DSTs in AZ and AY Farms will each be limited to a maximum of 9 complete fill-mix-empty cycles to avoid fatigue damage to in-tank components, not including final DST clean-out.[18]

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[17] The 120-day dwell time comprises an assumed 90 days to verify compliance with as-of-yet to be established permit conditions and authorization basis requirements with an additional 30 days allocated for the Tank Operations Contractor to mix and sample the staged waste.

[18] Leonard 2010, "RE: Mixer Pump Jet Forces on Internal Equipment in Aging Waste Tanks". This is an enabling assumption pending the outcome of the mixing demonstration program.

- Key transfers needed to prepare the initial batches of feed for delivery to the WTP and to position the DST system to continue Waste Feed Delivery operations (bootstrap transfers).

B3.2.3.17 All HLW batches delivered to the WTP should be between 52,834 and 158,503 gal before line flushes[19] whenever possible and contain between 10 and 200 gm of unwashed solids per liter of slurry.[20]

B3.2.3.18 The residual waste remaining in the SSTs and DSTs after retrieval is complete will be estimated as follows:

- The residual inventory in a 200 Series SST will be best-basis inventory (BBI) data for that SST where waste retrieval actions have already been completed, when that information is available, or will be estimated as 25 ft^3 of residual containing 83 wt% water washed solids with liquids at 5E-4 times the concentration of the bulk as-retrieved supernate.[21, 22, 23]
- The residual waste inventory in a 100 Series SST will be BBI data for that SST where waste retrieval actions have already been completed, when that information is available, or will be estimated as 300 ft^3 of residual containing 83 wt% water-washed solids with liquids at 5E-4 times the concentration of the bulk as-retrieved supernate.[21, 22, 23]
- DSTs: 100 gal with composition of the last waste contained in the tank.[24]

B3.2.3.19 No waste is assumed to leak from the SSTs during retrieval.[25]

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[19] This operational consideration reduces the number of transfers needed to deliver staged HLW from a DST to the WTP. ICD-19 (24590-WTP-ICD-MG-01-019) allows transfers between 52,834 and 158,503 gal before line flushes. The System Plan will attempt to target a total delivered batch volume, including flushes, of at least 130,000 gal to facilitate more efficient WTP operations.

[20] The WTP contract (DE-AC27-01RV14136), Section C, Specification 8, Paragraph 8.2.2.1, establishes the range of acceptable solids concentration in the delivered HLW feed. The System Plan will attempt to target a nominal 8 wt% solid concentration to facilitate more efficient WTP operations.

[21] The residual volumes are conservatively assumed to be the maximum allowed by the Tri-Party Agreement (Ecology et al. 1996), adjusted downward for a nominal 20% estimating uncertainty (per RPP-37110, *Computer/ CAD Modeling System Test Results*), until better estimates can be developed. The residual volume estimate is not meant to define the limits of any particular retrieval technology nor replace the procedures established in Appendix H of the Tri-Party Agreement.

[22] The weight percent solids and liquid remaining in the residual is based on an informal review of post-retrieval waste volume estimates for Tanks C-103, C-106, S-112, C-201, C-202, C-203, and C-204 (Sasaki 2008).

[23] The reduction in liquid phase concentration relative to the pre-rinse composition is based on rinsing the 100 series residual with three rinses, each of 10,000 gal, and on rinsing the 200 series residual with three rinses, each of 833 gal. The pre-rinse composition is assumed to equal the bulk as-retrieved liquid phase composition. These are placeholder assumptions until better estimates are developed.

[24] The 100-gal DST residual volume is a placeholder assumption that has been used in the HTWOS model since 1997, and is not based on any evaluation of DST waste retrieval capability or end-of-mission flushing strategy. Use of this value is not meant to imply that the end-of-mission DST retrievals are efficient enough to leave this small of a residual.

B3.2.4 Tank Farm Waste Evaporator (242-A)

B3.2.4.1 The 242-A Evaporator will be available, as needed, to support SST retrieval and to attempt to maintain the sodium concentration in the delivered feed within WTP feed specifications. The evaporator will not be available during scheduled maintenance outages.[26]

B3.2.4.2 If there are periods greater than 11 months during which the 242-A Evaporator is not used to concentrate waste, a “cold run” of 82,000 gal of water will be performed to maintain personnel qualifications and avoid the need for a full readiness review (HNF-SD-WM-SP-012, Assumption A4.3.2, “Evaporator Operation”). A full readiness review will be assumed if the 242-A Evaporator sits idle for more than 12 months.

B3.2.4.3 A 4-month period is allocated for the sampling and analysis of dilute feed staged in one or more DSTs, and for preparation of the process control plan before that feed can be run through the evaporator (HNF-SD-WM-SP-012, Assumption A4.3.2).[27] This assumes that the sampling and analysis effort is given high priority.

B3.2.4.4 When processing waste, the evaporator is assumed to run at the lesser of 40 gpm boil-off or 140 gpm feed.[27]

B3.2.4.5 Dilute waste will be concentrated until it reaches a bulk concentration of 1.43 g/mL (HNF-SD-WM-SP-012, Assumption A4.3.2).[28]

B3.2.4.6 The composition of process condensate from the 242-A Evaporator and the releases from the condenser to the atmosphere will be estimated using the formulas, partition coefficients, and split factors given in HNF-SD-WM-SP-012, Assumption A4.3.3, “Evaporator Process Chemistry.” The volume of process condensate will be 1.15 times the waste volume reduction to account for the vacuum system steam jets (HNF-SD-WM-SP-012, Assumption A4.3.3).

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[25] While performance assessments assume nominal leakage during retrieval operations, the System Plan assumes no leakage occurs to ensure that maximum waste inventory is modeled through the Waste Treatment Complex.

[26] The schedule of evaporator outages and availability will be established by WRPS as part of the integration effort.

[27] These are estimates of recent 242-A Evaporator performance (Conner 2008).

[28] This density is expected to be the average density selected for future evaporator campaigns – it is not an inherent limitation of the evaporator. The feed for each evaporator campaign will be evaluated and a target density specific for that feed will be determined considering the ability of the transfer system to maintain solids in suspension and the DSTs ability to stay within BDGRE controls. In the future, a lower value may be used for waste containing high concentrations of phosphates. Precipitation of solids is not modeled.

B3.3 WASTE TREATMENT PLANT

The assumptions for the performance of the WTP used in this System Plan are consistent with the ORP assessment of the potential performance of the WTP after specific enhancements in design, flowsheet, or operating modes have been made.

B3.3.1 General

B3.3.1.1 The WTP will be operable for 40 years, from the start of hot commissioning through 2058.

B3.3.1.2 The balance of facilities (BOF), laboratory, and other support facilities are assumed to be capable of supporting the WTP. The WTP sampling and analysis times are assumed to support production.

B3.3.1.3 Hot commissioning will begin on May 1, 2018,[29] and end on December 1, 2019 (Babel 2008).

B3.3.1.4 Delivery of the first batch of LAW feed will begin on May 1, 2018.[30]

B3.3.1.5 Delivery of the first batch of HLW feed will begin on May 15, 2018.[31]

B3.3.1.6 Routine WTP operations will begin on December 2, 2019,[32] and continue until the end of the treatment mission.

B3.3.1.7 The WTP is assumed to not return any waste streams or wastewater back to the tank farms.

B3.3.1.8 The technical issues previously identified in several design oversight reviews, external reviews, and a comprehensive independent review either have been resolved or are assumed to be resolved without adverse impact to the assumed performance of or the schedule for the WTP.

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[29] The current WTP schedule has hot commissioning beginning in September 2017, with about 14 months of schedule contingency. The May 1, 2018 date assumes the use of about one-half of this contingency.

[30] The date is set to match the start of hot commissioning (see Assumption B3.3.1.3).

[31] The date is set to allow receipt of the first batch of LAW feed before the delivery transfer of the first batch of HLW is started.

[32] One day after the end of the hot commissioning date specified in Babel 2008. There may be a contractor transition once hot commissioning has been completed, the effects of which are assumed to be reflected in various facility ramp-ups and not explicitly modeled.

B3.3.1.9 It is assumed that the delivered feed and internal WTP material flows and accumulations will be consistent with the WTP authorization basis.[33]

B3.3.1.10 The temperature of LAW feed delivered to the WTP is assumed to be less than 120°F; the temperature of HLW feed delivered to the WTP is assumed to be less than 150°F as an enabling assumption.[34]

B3.3.1.11 For the Baseline Case only, feed projected to be delivered to the WTP will be screened[35] against several sets of requirements to proactively identify potential issues for future resolution. These screenings are not directly suitable for safety basis or design decisions—they serve to identify areas of further inquiry. The criteria sets to be used are the following:

- Specification 7: LAW envelope definition from DE-AC27-01RV14136, Section C.[36]
- Specification 8: HLW envelope definition from DE-AC27-01RV14136, Section C.
- WTP hydrogen generation rate limits.[37]
- The criticality safety limits in Section 8.1 of 24590-WTP-CSER-ENS-08-0001, *Preliminary Criticality Safety Evaluation Report for the WTP*. This screening will be based on point estimates of the as-delivered feed; confidence limits and uncertainty will not be addressed.

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[33] This assumption is not necessarily true for all feed to the WTP. It is assumed that the integrated management process for ICD-19 (24590-WTP-ICD-MG-01-019), as described in 24590-WTP-PL-MG-01-001, *Interface Management Plan*, will be used to successfully address any feed not consistent with this assumption. New tank-specific controls, if any, would be incorporated into the feed control list. For example, the feed control list (HNF-SD-WM-OCD-015, Table A-1) already requires blending of the solids in Tank AZ-101 to reduce the hydrogen generation rate and blending of the solids in Tank C-104 to reduce the concentration of ^{233}U.

[34] Revision 4 of ICD-19 (24590-WTP-ICD-MG-01-019) currently states a limit of 120°F for LAW feed and 190°F for HLW feed. The IPT team for ICD-19 has agreed to reduce the limit for HLW feed to 150°F (Pell 2009, *ICD 19 Team Meeting – Finalize Issues to be Included in Rev 5*). When that change is formally approved and promulgated, the impacts on waste feed delivery systems and operations will need to be assessed.

[35] Based on previous feed screening, some delivered feed is expected to fall outside of the screening criteria and may require multiple iterations with ORP, BNI and WRPS over several years to fully define an acceptable set of feed requirements.

[36] For batches delivered via the ARF, the permitted volume of batches delivered to the WTP LAW feed receipt tanks will be adjusted to match Assumption B3.4.1.5.

[37] The projected WTP feed will be screened against hydrogen generation rate (HGR) criteria to flag batches of feed that are potentially problematic and may require special consideration. This simplified screening will only be applied to the feed as projected to be delivered to the WTP feed receipt tanks. The HGR calculation will be performed using screening criteria, provided by Bechtel National, Inc. (BNI) and approved by ORP, documented in RPP-39811, *Waste Treatment and Immobilization Plant Hydrogen Generation Rate Screening Criteria for System Modeling*. BNI has recommended the continued use of the existing screening criteria in RPP-39811, including the continued use of 120°F and 190°F as the LAW and HLW MOT, until new HGR criteria are established (Eager 2010, "RE: Updated HGR Screening – HLW MOT").

B3.3.1.12 Key features of the WTP that will be modeled for purposes of mission planning and estimation of secondary waste streams include the following:

- Pretreatment Facility
  - LAW feed receipt tanks (lumped)
  - HLW feed receipt tank
  - Front-end evaporators:
    - Recycle evaporator
    - Feed evaporator (modeled, but turned off per B3.3.1.13)
  - Two ultrafilter process trains (full cycle):
    - Caustic leach
    - Concentration
    - Oxidative leach
    - Post-leach wash
  - Pretreated HLW lag storage tanks
  - Cesium ion-exchange:
    - Four-column carousel
    - Resin replacement, regeneration and acid recovery simplified
  - Back-end evaporator and pretreated LAW storage
  - Aluminum solubility modeled (but uses ORP-provided correlation)
  - Neither oxalate nor phosphate solubility modeled
- HLW Vitrification Facility
  - Both melter trains are lumped
  - Both off-gas treatment systems are lumped
  - HLW melter feed preparation (simplified; uses 2009 HLW glass formulation model)
  - HLW melter
  - HLW canister (but use thin-wall canister)
  - HLW melter off-gas system
  - Recycle of HLW condensate (from submerged bed scrubber [SBS], wet electrostatic precipitator [WESP], and high-efficiency mist eliminator [HEME]), canister wash water and decontamination chemicals to the front end recycle evaporator via the plant wash disposal system (PWD).
- LAW Vitrification Facility
  - Both melter trains are lumped
  - Both off-gas treatment systems are lumped
  - LAW melter feed preparation (simplified)
  - LAW melter
  - LAW container
  - LAW melter off-gas system
  - Recycle of both LAW SBS and WESP condensate to the back-end evaporator

- Discharge of LAW caustic scrubber effluent and evaporator condensate to the Liquid Effluent Retention Facility (LERF)/Effluent Treatment Facility (ETF) via the radioactive liquid waste disposal system (RLD).

- General
  - Internal equipment and line flushed not modeled.
  - Facility and process vessel vents not modeled.
  - Sample hold times not modeled.
  - Aqueous and solid phase densities (use tank farm assumptions rather than WTP)
  - Total operating efficiency (TOE) includes downtime for major facility equipment change-out such as LAW and HLW melters.

B3.3.1.13 The basis for WTP flowsheet (equipment configuration, capacities, chemical reactions and extents, operating modes and logic, process splits and decontamination factors) used for mission modeling will be the 24590-WTP-MDD-PR-01-002, *Dynamic (G2) Model Design Document* (Rev. 10), with flowsheet and operating mode modifications as needed to implement the other assumptions in this System Plan. Additional details will be provided by 24590-WTP-RPT-PT-02-005, *Flowsheet Bases, Assumptions, and Requirements* (Rev. 4).

B3.3.2 Pretreatment

B3.3.2.1 For planning purposes, the solids in each ultrafilter feed batch will be screened to determine if they will undergo caustic leaching.[38] The screening criteria are provided in Section 4.8.3 of 24590-WTP-MDD-PR-01-002 and are interpreted by MMR-09-025 and RPP-17152, Rev 3 [DRAFT].

B3.3.2.2 When the WTP requests delivery of HLW feed, the HLW feed receipt tanks at the WTP will have sufficient space to receive 160,000 gal (600 m^3) of HLW feed from the ARF HLW product tanks (or the DST system before the ARF is available) without interruption.[39]

B3.3.2.3 When the WTP requests delivery of LAW feed, the LAW feed receipt tanks at the WTP will have sufficient space to receive a nominal 0.355[40] Mgal of feed from the ARF LAW product tanks (or 1 Mgal of feed from the DST system before the ARF is available) without interruption.[39]

B3.3.2.4 The WTP PT Facility will be configured so that a portion of concentrated pretreated LAW from the treated LAW concentrate tank can be transferred to the second LAW

[38] After the ARF begins operating, it is anticipated that no solids will require caustic leaching in the WTP since the solids will be caustic leached in the ARF before delivery to the WTP.

[39] These are operational considerations and may need to be adjusted depending on the design of the ARF. The intention is to match the size of the delivery from the ARF to a single WTP LAW or HLW feed receipt tank.

[40] The working volume of a single LAW feed receipt tank is about 0.355 Mgal per 24590-WTP-MDD-PR-01-002.

vitrification facility as feed. This is downstream of the point to which LAW SBS/WESP condensate is recycled, so the feed to the second LAW vitrification facility will include a proportional fraction of recycled condensate from both LAW facilities.

B3.3.2.5 The extent of sludge dissolved by caustic leaching will be defined by the caustic leach factors associated with each delivered feed batch.

B3.3.2.6 An oxidative leach process that removes chromium from the HLW sludge will be implemented in the ultrafilter process system. Reaction stoichiometry and endpoint (5000 μg Cr/g dried solids) are described in RPP-15552, *Hanford Tank Waste Oxidative Leach Behavior Analysis*.[41]

B3.3.2.7 For modeling purposes, the solubility of aluminum in supernates present in the WTP PT Facility will be approximated using the correlation shown in Equation 4 from CCN 160514 (Reynolds and Adelmund 2007).[42] This aluminum solubility correlation will be used to determine the amount of sodium hydroxide added to the waste during pretreatment, with the goal of ensuring that feed to the cesium ion-exchange system is not supersaturated with aluminum at 25 ºC.

B3.3.2.8 The number of times the cesium ion-exchange resin is replaced will be tracked.

B3.3.2.9 The constituents that remain on the spent cesium ion-exchange resin are assumed to be negligible for system planning purposes and will not be modeled at this time.

B3.3.3 High-Level Waste Vitrification

B3.3.3.1 HLW vitrification at the WTP will begin on May 31, 2018.[43]

B3.3.3.2 During hot commissioning, the WTP will produce 84 MTG[44] of HLW glass.

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[41] Given that the oxidative leach process is currently being refined, the same oxidative leach endpoint from System Plan Revision 4 is being maintained for use in Revision 5. The oxidative leach assumptions should be updated after the WTP flowsheet is revised to incorporate the refined process.

[42] The WTP baseline correlation in Equation 9 of the same reference is believed to provide overly conservative (biased high) estimates of required sodium additions. This is discussed in more detail in Reddick 2008. ORP has requested that Equation 4 be used instead of the WTP baseline as “a temporary estimate of nominal caustic additions until a better correlation is available.” ORP has an ongoing effort to assess sodium use in the WTP. An approved sodium management plan and recent assessment (A-09-AMWTP-RPPWTP-002, “Design Oversight Report, Basis for Sodium Estimate”) may further refine this assumption. The use of the reference equation 4 is appropriate until further revision/improvement is supported.

[43] This includes the hot commissioning period. The 15-day lag after delivery of the HLW feed is an estimate of the time needed to characterize, pretreat, and transfer the pretreated waste to the LAW and HLW Vitrification Facilities. Also see Assumption B3.3.1.3 and associated footnote 29.

[44] DE-AC27-01RV14136, Standard 5, (g)(4) and (g)(5), requires that 4.2 MTG/day of HLW glass be produced for 20 days. For modeling purposes, the average glass production rate during hot commissioning is set so that the contract goal (rounded up to the next whole canister) is just met by the end date for hot commissioning.

B3.3.3.3 After hot commissioning, the net WTP HLW vitrification capacity will be ramped as follows:

Starting On	Rate MTG/d
12/2/2019	3.0
1/1/2021	4.0
1/1/22	4.2[45]
2/6/2025	5.25[45]

B3.3.3.4 The average bulk[46] density of immobilized high-level waste (IHLW) glass will be 2.66 Kg/L at 20°C; the average density of the molten glass will be 2.40 Kg/liter (24590-WTP-RPT-PT-02-005, Sections 4.2.3.6 and 4.2.3.2, respectively).

B3.3.3.5 On the average, each canister of IHLW will be filled to 1.1806 m^3 (41.692 ft^3).[47]

B3.3.3.6 Each canister of IHLW will contain 3.14 MT of HLW glass on the average.[48]

B3.3.3.7 The composition, properties, and waste oxide loading of HLW glass will be estimated[49] using the "2009 Glass Formulation Model" (GFM) documented in *"Glass Property Data and Models for Estimating High-Level Waste Glass Volume"* (PNNL-18501). For modeling purposes, the glass-forming chemicals are assumed to be supplied as pure oxides rather than impure minerals.[50] For planning purposes, the allowable glass forming chemicals are: Al_2O_3, B_2O_3, Fe_2O_3, Li_2O, Na_2O, and SiO_2.[51]

[45] DE-AC-27-01RV14136, Section C.7(b), "Waste Treatment Capacity Requirements," specifies that the HLW Vitrification Facility will support a combined design capacity of 6 MTG/d with the original two melters and 7.5 MTG/d with two replacement melters, with a minimum integrated total operating efficiency (TOE) of 70%.

[46] This is based on crucible density data and estimated volume percent void content per Section 4.2.3.6 of 24590-WTP-RPT-02-005 and is consistent with Section 4.6 of 24590-WTP-MDD-RP-01-002.

[47] DE-AC-27-01RV14136, Section C, Specification 1, Section 1.2.2.1.2, requires that on the average, the canisters will be filled to 95% of the volume of an empty canister; the corresponding glass volume for nominal canister dimensions is estimated by Appendix C of 24590-HLW-M0C-30-00003, *HLW Canister Weight and Volume Calculations*. This is also consistent with the estimate provided in 24590-HLW-M0-30-00001001, *HLW Test Canister Assembly*.

[48] This is based on filling a canister with 10 gauge thick walls (sometimes referred to as a "thin-walled" canister) to 95% fill (1.1806 m^3 or 41.692 ft^3) of glass with a bulk density of 2.66 kg/L per assumptions B3.3.3.4 and B3.3.3.5.

[49] This model defines a constrained, non-linear programming problem which is then solved in HTWOS by iterating over a linearized version of the model.

[50] A comparison of the 2009 GFM with the model used in previous System Plans is provided in *"High-Level Waste Glass Formulation Model Sensitivity Study, 2009 Glass Formulation Model versus 1996 Glass Formulation Model,"* (RPP-RPT-42649).

[51] The HTWOS implementation of the 2009 GFM allows the user to specify which glass forming chemicals may be used. In addition to the six stated above, the user can specify CaO, MgO, TiO_2, ZnO, and ZrO_2. However, for System Plan Rev 5, the allowable glass forming chemicals is being aligned to those used by BNI per Gimpel 2009, *Incorporation of HLW Glass Shell V2.0 into the Flowsheets – Supersedes CCN 153245*.

B3.3.3.8 One HLW melter is assumed to be replaced every 2.5 years on the average and contains approximately 823 gal of glass.[52] For purposes of this System Plan, spent HLW melters are assumed to be disposed of at the IDF per Assumption B3.5.6.2 and Footnote 80 pending determination of their final disposition.

B3.3.4 Low-Activity Waste Vitrification

B3.3.4.1 LAW vitrification at the WTP will begin on May 31, 2018.[53]

B3.3.4.2 The LAW Vitrification Facility will receive all of its feed from the WTP PT Facility.

B3.3.4.3 During hot commissioning, the WTP will produce 480 MTG[54] of LAW glass.

B3.3.4.4 After hot commissioning, the net WTP LAW vitrification capacity will be ramped as follows for all cases:

Starting On	Rate MTG/d
12/2/2019	9.0
1/1/2021	18.0
1/1/2022	21.0[55]

B3.3.4.5 The average bulk[56] density of immobilized low-activity waste (ILAW) glass will be 2.58 Kg/liter at 20°C; the average density of the molten glass will be 2.45 Kg/liter (24590-WTP-RPT-PT-02-005, Sections 3.2.3.2 and 3.2.3.7).

B3.3.4.6 On the average, each package of ILAW will be filled to 2.135 m^3 (564 gal).[57]

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[52] Replacement of spent melters is already accounted for in the assumed net production capacity assumptions. Assumes two melters, each with a 5-year minimum design life per 24590-HLW-3PS-AE00-T0001, *Engineering Specification for High Level Waste Melters*. The volume of glass in the melter is assumed to reflect the 25-in. heel remaining after the maximum pour and includes an allowance for increased volume due corrosion of refractory (CCN 102476 [Hall 2004]); other contributions to source term are neglected. No credit is taken for purging the melter with "cold" glass prior to removal from service.

[53] This includes the hot commissioning period. The 15-day lag after delivery of the HLW feed is an estimate of the time needed to characterize, pretreat, and transfer the pretreated waste to the LAW and HLW Vitrification Facilities. Also see Assumption B3.3.1.3 and associated footnote 29.

[54] DE-AC27-01RV14136, Standard 5, (g)(4) and (g)(5), requires that 24 MTG/day of HLW glass be produced for 20 days. For modeling purposes, the average WTP glass production rate during hot commissioning is set so that the contract goal (rounded up to the next whole package) is just met by the end date for hot commissioning.

[55] Assumes two LAW melters, each 15 MTG/d design at a 0.7 TOE. DE-AC-27-01RV14136, Section C.7(b), "Waste Treatment Capacity Requirements," specifies that the LAW Vitrification Facility will support a combined design capacity of 30 MTG/d using two melters, with a minimum integrated TOE of 70%.

[56] This is based on crucible density data and estimated volume percent void content per Section 3.2.3.7 of 24590-WTP-RPT-02-005 and is consistent with Section 4.6 of 24590-WTP-MDD-RP-01-002.

B3.3.4.7 Each package of ILAW will contain 5.51 MT of LAW glass on the average.[58]

B3.3.4.8 The total sodium loading of LAW glass from pretreated feed will be determined using the "DOE 2004" model (D-03-DESIGN-004, *An Assessment of the Factors Affecting the Ability to Increase the Na_2O Loading in the Waste Treatment and Immobilization Plant (WTP) Low Activity Waste (LAW) Glass*), which maximizes the sodium oxide loading in the LAW glass subject to the following constraints:[59]

$$[Na_2O] \leq 20wt\%$$

$$[SO_3] \leq 0.8wt\%$$

B3.3.4.9 The composition of the LAW glass will be estimated using a glass recipe model similar to that described in Table B-2 of 24590-WTP-MRQ-PO-04-0065, *Model Run Request, Supplemental LAW Data Collection*.

B3.3.4.10 One LAW melter is assumed to be replaced every 2.5 years on the average and contains approximately 1,875 gal of glass.[60] For purposes of this System Plan, spent melters will be managed and disposed of at the IDF as MLLW.

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[57] DE-AC-27-01RV14136, Section C, Specification 2, Section 2.2.2.5, requires that the packages will be filled to at least 90% of the volume of an empty package; the corresponding volume is obtained from 24590-WTP-PT-02-005, Section 3.2.3.7.

[58] This is based on filling a package to 90% (2.135 m^3) of glass with a bulk density of 2.58 kg/L per assumptions B3.3.4.5 and B3.3.4.6.

[59] LAW glass formulation work reviewed in D-03-DESIGN-004 suggests that the sodium loading projected by the DOE model can be achieved. To that end, DOE is continuing to fund LAW glass development at the Vitreous State Laboratory (Catholic University, Maryland) to improve sodium oxide loadings beyond the WTP baseline model.

[60] Replacement of spent melters is already accounted for in the assumed net production capacity assumptions. Assumes two melters, each with a 5-year minimum design life per 24590-LAW-3PS-AE00-T0001, *Engineering Specification for Low Activity Waste Melters*. The volume of glass in the melter does not include an allowance for increased volume due to corrosion of refractory and reflects the heel remaining after the maximum pour; other contributions to source term are neglected. No credit taken for purging melter with "cold" glass prior to removal from service.

B3.4 SUPPLEMENTAL TREATMENT

B3.4.1 Aluminum Removal Facility

B3.4.1.1 The ARF is assumed to start-up on July 19, 2022, and will condition all feed to the WTP PT Facility from that date on.

B3.4.1.2 Feed is assumed to be sampled in the DSTs and qualified for delivery to the ARF LAW and HLW feed receipt tanks per assumption B3.2.3.13; samples from the ARF LAW and HLW product lag-storage tanks are used as feed qualification samples prior to delivery of the conditioned feed to the WTP per assumption .

B3.4.1.3 Allow 190 days[61] to sample the staged product and verify compliance with permits and the safety authorization basis before delivery to the WTP, starting from when each product staging tank is filled with feed.

B3.4.1.4 The ARF is assumed to be a standalone facility that uses a process based on the lithium hydrotalcite process described in RPT-3001622-000 [DRAFT], *Alumina Removal and Sodium Hydroxide Regeneration from Hanford Waste by Lithium Hydrotalcite Precipitation*, to caustic leach all of the solids in the delivered feed. Standalone means that the facility contains all necessary unit operations and will not rely on the DST system, the 242-A Evaporator, or the WTP PT Facility for support, that all recycles are internal, and that it includes any needed lag-storage.

B3.4.1.5 The ARF will be modeled as a black-box, with the following attributes:

- There will be 4 LAW feed receipt tanks, 2 HLW feed receipt tanks, 3 LAW product staging tanks, and 7 HLW product staging tanks; each set of tanks will be operated as a first-in first-out queue. Operating volumes will be selected to match the nominal WTP feed receipt tank operating volumes.[62]
- The extent of sludge dissolved by caustic leaching will be defined by the associated caustic leach factors. Excess OH^- from the lithium hydrotalcite precipitation reaction will be recycled to support the caustic leaching.
- Approximately 80% of the liquid phase aluminum (after sludge leaching) will be removed from the waste per the following reaction[63]:

$$2LiOH_{(AQ)} + Na_2CO_{3(AQ)} + 4NaAl(OH)_{4(AQ)} + 3H_2O \rightarrow Li_2CO_3 \cdot 4Al(OH)_3 \cdot 3H2O_{(S)} + 6NaOH_{(AQ)}$$

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[61] The 190-day dwell time comprises the 180 days required by ICD-19 (24590-WTP-ICD-MG-01-019, *ICD 19 – Interface Control Document for Waste Feed*) with 10 additional days allocated for the Tank Operations Contractor to mix and sample the staged waste.

[62] This is an estimate of the number and size of the lag storage tanks to insure an adequate supply of feed to the ARF and WTP. These may be adjusted based on preliminary model runs.

[63] Shuford 2010, "Aluminum Removal Facility Performance Assumptions for System Planning Purposes". Adjustments for substitution of other anions that compete with the CO_3^- in the lithium precipitate may be made.

- The LiOH reagent will be added in 25% excess of stoichiometric amounts as a 10 wt% aqueous solution.[63]

B3.4.1.6 The capacity of the ARF is assumed to be selected so that it does not drive the mission duration.

B3.4.1.7 The lithium hydrotalcite is assumed to be washed, dried, solidified and drummed, and is further assumed to be suitable for disposal at the IDF as a new secondary waste stream; contaminants will not be modeled nor will the mass of any additives required to solidify this byproduct.[64]

B3.4.1.8 The supernate, containing the excess recovered hydroxide, is assumed to be delivered to the WTP LAW feed receipt tanks. The caustic leached sludge, along with a portion of the supernate, is assumed to be delivered to the WTP HLW feed receipt tank.

B3.4.1.9 Any excess condensate (all process water added in the ARF, plus a portion of the water in the feed) is assumed to be delivered to the LERF/ETF for treatment as a secondary waste; contaminants will not be modeled.[65]

B3.4.2 Second LAW Vitrification Facility

B3.4.2.1 For purposes of this System Plan, supplemental LAW treatment capacity is assumed to be provided by a second LAW vitrification facility, located in 200 East Area adjacent to the WTP.[66]

B3.4.2.2 The second LAW vitrification facility is assumed to have the same technical assumptions as the WTP LAW Vitrification Facility.

B3.4.2.3 The second LAW vitrification facility will receive "excess" pretreated LAW from the WTP Pretreatment facility per assumption B3.3.2.4.

B3.4.2.4 Condensate from the SBS and WESP will be recycled via pipeline transfer through the back-end evaporator in the WTP Pretreatment Facility.

B3.4.2.5 Caustic scrubber effluent will be discharged to the LERF/ETF via the WTP Pretreatment RLD system.

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[64] This is an enabling assumption that may be revised as the process matures. The lithium hydrotalcite by-product may also be considered for use as glass formers at the WTP LAW Vitrification Facility or the second LAW vitrification facility.

[65] This is an enabling assumption that may be revised as the process matures.

[66] This is a placeholder assumption pending a final decision circa 2015 as to how the needed LAW treatment capacity will be provided—by using a second LAW vitrification facility or by using bulk vitrification or another process in one or more supplemental treatment plants.

B3.4.2.6 The net capacity of the second LAW vitrification facility will be selected with the goal that the combined LAW vitrification capacity will be large enough so as to not drive the mission duration. The second LAW vitrification facility will complete hot commissioning on September 30, 2022 (hot commissioning will not be modeled) and begin routine operations on October 1, 2022. The facility will be ramped as follows:[67]

Starting On	Rate MTG/d
10/1/2022	9.0
1/1/2025	Per B3.4.2.6

B3.4.2.7 One LAW melter is assumed to be replaced every P[68] years on the average and contains approximately 1,875 gal of glass.[69] Spent melters will be managed and disposed of at the IDF as MLLW.

B3.4.3 Supplemental Transuranic Sludge Treatment

B3.4.3.1 The supplemental CH-TRU treatment and packing process applies only to the Baseline Case; no waste will be handled as CH-TRU in Sensitivity Case A.

B3.4.3.2 The supplemental CH-TRU treatment and packaging process will be available on April 2, 2018[70] and will treat a maximum of 8,040 gal of CH-TRU slurry from retrieved CH-TRU tank waste per day.[71]

B3.4.3.3 The SSTs assumed to provide CH-TRU sludge are [B-201, B-202, B-203, B-204], [T-201, T-202, T-203, T-204], T-111, T-110, and T-104, in the stated order except that the tank order within the [brackets] can be changed (RPP-21970, *CH-TRUM WPU&SE 11-Tank Material Balance*, Sections 3.0 and 5.0, Assumption 2).[72]

B3.4.3.4 The supplemental CH-TRU treatment and packaging system for CH-TRU waste will first be located near B Farm and then moved to T Farm. There will be a minimum

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[67] TBD.

[68] Each melter is assumed to have a 5-year design life and therefore the average replacement period, P, will be 5-years divided by the number of melters.

[69] Replacement of spent melters is already accounted for in the assumed net production capacity assumptions. Assumes two melters, each with a 5-year minimum design life per 24590-LAW-3PS-AE00-T0001, *Engineering Specification for Low Activity Waste Melters*. The volume of glass in the melter does not include an allowance for increased volume due to corrosion of the refractory and reflects the heel remaining after the maximum pour; other contributions to source term are neglected. No credit has been taken for purging melter with "cold" glass prior to removal from service.

[70] This is the date assumed by the life-cycle PMB / OPER.

[71] The assumed rate is based on 1:1 dilution of solids with water during retrieval and a 0.67 TOE per RPP-21970, "CH-TRUM WPU&SE 11-Tank Material Balance," Section 3.0.

[72] These are operational considerations. Order and timing may be adjusted to match the PMB.

10-day outage between tanks and a minimum 180-day outage to move equipment between farms.

B3.4.3.5 It is assumed that waste previously assumed to be RH-TRU[73] waste will be retrieved and treated at the WTP together with the HLW (Harp 2008).

B3.4.3.6 The process flowsheet for the CH-TRU sludge treatment is described in the material balance for the CH-TRU waste tanks and is assumed to use the "dry batch mode" (RPP-21970). For modeling purposes, the two dryers may be lumped into one continuous dryer of equivalent treatment capacity. Additional modeling details and simplifications are provided in Chapter 13 of RPP-17152, Rev 3 [DRAFT].

B3.4.3.7 The dried waste product from the CH-TRU waste process is assumed to be packaged in 55-gal drums containing 620 lb_m product per drum (RPP-21970).

B3.4.3.8 Although not explicitly modeled, the CH-TRU waste drums are assumed to be stored on-site at the Central Waste Complex until their final disposition has been determined.

B3.4.3.9 Liquid effluent will either be transferred to the LERF via tank truck or recycled to the retrieval project. For planning purposes, it will be assumed that the liquid effluent is transferred only to LERF (no recycle) and will be modeled as a continuous pipeline transfer.

[73] The SSTs previously assumed to contain RH-TRU sludge are Tanks T-105, T-107, T-112, B-107, B-110, and B-111; the DSTs previously assumed to contain RH-TRU sludge are Tanks SY-102, AW-103, and AW-105.

B3.5 INTERFACING FACILITIES

B3.5.1 Liquid Effluents

B3.5.1.1 The capacities and capability of the ETF, LERF, State-Approved Land Disposal Site (SALDS), and 200 Area Treated Effluent Disposal Facility (TEDF) will be driven by the needs of the waste treatment mission and are assumed to be available when needed. If the treatment mission requires that changes be made to the ETF, LERF, SALDS, or TEDF or their operating plans, ORP is assumed to successfully drive the changes.

B3.5.1.2 The LERF consists of three basins, each with an operating volume of 7.8 Mgal (HNF-SD-WM-SAD-040, *Liquid Effluent Retention Facility Final Hazard Category Determination*), which are used to provide lag-storage of liquid effluent. For planning purposes, only two of the basins will be allocated to supporting the waste treatment mission; the third basin will be reserved for *Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)* (42 USC 103) effluents.

B3.5.1.3 The ETF will be modeled as a black-box. Overall partitioning of feed into solid waste and treated effluent will be approximated per HNF-4573, *Liquid Effluent "Retention Facility Basin 44 Process Test Post-Report*, Appendix A. Chemicals (such as those for bulking or stabilization of the solid waste form) will not be tracked.

B3.5.1.4 The SALDS will not be modeled; however, the demand on the SALDS from ETF will be estimated.

B3.5.1.5 The 200 Area TEDF[74] will not be modeled.

B3.5.2 Central Waste Complex

B3.5.2.1 The Central Waste Complex is assumed to support the needs of the waste treatment mission and is assumed to be available when needed; the demand on the Central Waste Complex will not be modeled.

B3.5.2.2 For the Baseline Case only, the packaged CH-TRU is assumed to be stored at the Central Waste Complex until the final disposition of the CH-TRU has been determined.

B3.5.3 Interim Hanford Storage Facility

B3.5.3.1 The mission[75] of the Interim Hanford Storage Facility (IHSF) is to receive and temporarily store canisters of IHLW and eventually retrieve and transport those

[74] The 200 Area TEDF treats and disposes of nonradioactive, non-dangerous liquid effluents such as 242-A and WTP evaporator condenser cooling water and WTP cooling tower blow-down.

[75] Justification of Mission Need for an Interim Hanford Storage Facility, Non-Major System Acquisition Project, December 2009, DRAFT.

canisters to the Hanford Shipping Facility (HSF) in preparation for shipment to a potential national repository (RPP-23674).

B3.5.3.2 The IHSF will be located in 200 East Area in the proximity of the HLW Vitrification Facility and provide interim storage for a minimum of 4,000 IHLW canisters. The IHSF will be expandable in increments (modules) of 2,000 canisters up to a maximum of 16,000 canisters, if needed, to mitigate the risk from the availability of offsite geologic storage. (RPP-23674)

B3.5.3.3 The need date for the IHSF will be the date on which the first radioactive HLW canister is produced. The Baseline PMB / OPER schedule assumes:

- January 2010: CD-0
- October 11, 2017: First 2,000 canister module operational
- November 15, 2018: Second 2,000 canister module operational
- Each additional module will be operational 1.5 years in advance of projected need date.
- A decision to construct each additional module will be made 4 years in advance of the projected operational need date.

B3.5.3.4 No credit will be taken for the 24 canisters of WTP-provided storage for cooling IHLW canisters, nor for the 24 canisters of WTP-provided buffer capacity.[76, 77]

B3.5.3.5 The average canister receipt and retrieval capability of the IHSF will <u>each</u> be 800 canisters per year[78] with a peak handling rate of 3 canisters per day (RPP-23674).

B3.5.4 Hanford Shipping Facility

B3.5.4.1 It is assumed that on or before June 2022, a decision will be made to either continue to build additional IHSF modules or to construct the Hanford Shipping Facility (HSF). For planning purposes, the outcome of this decision is assumed to be that the HSF will be constructed and HLW canisters are shipped to an off-site final disposal alternative (see assumption B3.5.5). However, the PMB / OPER will include scope for both potential outcomes to help mitigate the uncertainty.

B3.5.4.2 The HSF will be located in 200 East Area either as a stand-alone facility or a module attached to the IHSF. It will provide for shipping of HLW canisters to a potential national repository.

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[76] Cooling and buffer capacity obtained from 24590-HLW-3YD-HPH-00001, *System Description for HLW System HPH Canister Pour Handling*.

[77] Operating the HSF half-full decouples the production of HLW glass canisters from the shipping of those canisters.

[78] This is about 25% above the average net production capacity required to support the assumed HLW glass production rate in assumption B3.3.3.3.

B3.5.4.3 The canister shipping capability of the HSF is assumed to match the retrieval capability of the IHSF in Assumption B3.5.3.5. If and when the HSF begins shipping, the first priority will be given to shipping newly created IHLW canisters beyond those stored at the IHSF and second priority is given to emptying the IHSF after HLW vitrification is finished; shipping needs will be estimated with the IHSF operated at approximately 1,000 canisters less than capacity to decouple canister receipt from the WTP from shipping to a national repository.

B3.5.5 Final Disposal Alternative

B3.5.5.1 The final disposal alternative for HLW glass canisters is assumed to be at an unidentified off-site national repository.

B3.5.6 Integrated Disposal Facility

B3.5.6.1 The Integrated Disposal Facility (IDF) will be operational on October 1, 2010[79] and will provide permanent disposal for the ILAW, other mixed low-level waste, and LLW.

B3.5.6.2 The IDF will receive LAW glass packages from the WTP; solid waste from the WTP, including spent LAW and HLW[80] melters; the lithium hydrotalcite by-product from the ARF; and solid waste from the ETF from treating liquid effluent. Only that portion of the primary and secondary waste streams directly related to treatment of the tank waste will be modeled.[81]

B3.5.6.3 For planning purposes, the IDF can be expanded as needed to support the mission without interference from other users.

B3.5.7 222-S Laboratory

B3.5.7.1 It is assumed that the laboratory services required to support waste characterization for Tank Operations Contract projects and operations are available and provided in a timely manner.

B3.5.7.2 Any required facility life-extension upgrades will be aligned with the PMB.

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[79] The stated date is the current baseline. However, an updated date will be established by U.S. Department of Energy (DOE), Richland Operations Office (RL), to support approved end uses of the IDF, pending the outcome of the Tank Closure and Waste Management Environmental Impact Statement. For planning purposes, it is assumed that ORP mission needs will drive this date. The PMB will be adjusted to match this date.

[80] The final disposition of the spent HLW melters has not yet been determined. The many alternatives in the draft EIS assume that these spent HLW melters will be packaged in an overpack and stored at the HLW Melter Interim Storage Facility until they could be removed for disposition and final disposal. For planning purposes, the final disposition of the spent HLW melters is assumed to be at the IDF to maintain consistency with the current PMB / OPER. Plans will be updated as needed after a Record of Decision (ROD) is published.

[81] For example, the inventory that is retained on a disposable filter will be modeled, but the mass, composition, and overall volume of the filter itself will not be tracked.

B3.5.7.3 The 222-S Laboratory is assumed to transfer 5 kgal/yr of waste (see Assumption B3.6.3) to the tank farms before the start-up of the WTP and 10 kgal/yr thereafter.

B3.5.8 Waste Encapsulation and Storage Facility

B3.5.8.1 Cesium and strontium capsules are assumed to be dispositioned outside of the WTP and tank farm facilities by the U.S. Department of Energy, Richland Operations Office (RL).[82]

B3.5.9 Waste Isolation Pilot Plant

B3.5.9.1 Permitting and operational requirements to accept Hanford CH-TRU tank waste at WIPP will not impact schedule critical path, if it is determined that the final disposition of the packaged CH-TRU tank waste is disposal at WIPP.

B3.5.10 Other Hanford Site Facilities

B3.5.10.1 Sludge generated from the cleanup of the K Basins is assumed to be dispositioned outside of the WTP and tank farm facilities by RL.

B3.5.10.2 The Plutonium Uranium Extraction (PUREX) facility is assumed to transfer a one-time 15 kgal of waste circa 2025 (see Assumption B3.6.3) to the tank farms as part of its deactivation.

B3.5.10.3 The T-Plant Facility is assumed to transfer a one-time 15 kgal of waste circa 2025 (see Assumption B3.6.3) to the tank farms as part of its deactivation. The transfer will include a flush equal to 22 vol% of the waste transferred.

B3.5.10.4 Waste from the retrieval of the inactive miscellaneous underground storage tanks (IMUST) (see Assumption B3.6.3) will be transferred to the tank farms in a series of transfers between 2020 and 2030,[83] or sooner if practical.

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[82] Pretreatment can connect to a potential new facility designed to receive and treat the Hanford cesium and strontium capsules prior to incorporation into the HLW feed for immobilization in the HLW Vitrification Facility, Section C.7(c)(2) of DE-AC27-01RV14136. All options in the draft EIS, except the “Do Nothing” alternative, assume that the contents of the cesium and strontium capsules are treated at the WTP. Therefore, this assumption may be revised when the disposition of the cesium and strontium capsules and their contents are formally established by the ROD and subsequent changes to the PMB / OPER

[83] The dates and timing of the transfers will be integrated with the PMB.

B3.6 CROSS-CUTTING ASSUMPTIONS

B3.6.1 The decay date used for reporting all radionuclides is January 1, 2008, unless explicitly stated otherwise (RPP-33715, *Double-Shell and Single-Shell Tank Inventory Input to the Hanford Tank Waste Operations Simulator Model - 2010 Update*).

B3.6.2 The starting tank inventory, as documented in RPP-33715, reflects the contents of the SSTs and DSTs as of October 2009. This is called the "FY 2010" inventory and is based on the BBI downloaded from the Tank Waste Information Network System (TWINS) circa February 2010, with adjustments to reflect improvements in the estimation and reporting of bound hydroxide and bound oxygen. Adjustments will be made in the HTWOS model for historical transfers as needed.

B3.6.3 Estimates of the inventory for the IMUSTs, the waste resulting from deactivation of other Hanford facilities, and operation of the 222-S Laboratory are provided in RPP-33715.

B3.6.4 The water wash factors[84] in TWINS circa February 2010 will be used to partition waste into solid and liquid phases during retrieval and staging; strontium partitioning will be modeled per RPP-21807, *Strontium-90 Liquid Concentration Solubility Correlation in the Hanford Tank Waste Operations Simulator*. The feed vector will be reported on a fully water-washed basis.

B3.6.5 The caustic leach factors[84] in the TWINS circa February 2010 will be used as the basis for computing the caustic leach factors associated with each delivered batch of HLW solids.

B3.6.6 For modeling purposes, the approximations to waste chemistry in the tank farms are described in RPP-17152, Rev 3 [DRAFT], Section 2.8.7, "Waste Chemistry and Mass Balances."

B3.6.7 Liquid density and specific gravity will be estimated using the correlations described in Section 2.5.1, "Liquid Specific Gravity", of RPP-17152.

B3.6.8 For modeling purposes, solid particulate density is assumed to be a constant 3 g/mL[85] per Section 2.4.2 "Volume of In-Process Streams", of RPP-17152.

B3.6.9 Total organic carbon will not be speciated.[86] However, for modeling purposes, all total organic carbon will be treated as oxalate once it enters the WTP to allow for reaction stoichiometry.

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[84] Uncertainties and biases in the water wash and caustic leach factors can significantly influence the canister counts and treatment end dates. Water wash factors and caustic leach factors are a zero order approximation to complex solid-liquid equilibrium; this is a known limitation of this methodology.

[85] The value of this constant is being reevaluated and may be changed if warranted.

B3.6.10 The modeled composition of waste retrievals from SSTs will be homogeneous. The modeled composition of waste transferred from a DST will reflect the overall composition of the specific layers (e.g., supernate, dissolved salts, mobilized solids) being transferred.[87]

B3.6.11 The design, flowsheet, operating modes, and operating plans of all facilities or processes will drive the permit conditions, and the permits will be modified as the processes evolve.

B3.6.12 All cases are assumed to be consistent with and bounded by the outcome of the *National Environmental Policy Act of 1969* (42 USC 4321) process.

B3.6.13 All cases are assumed to be consistent with and bounded by the appropriate facility authorization basis.

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[86] An enabling assumption for speciating total organic carbon into its constituent organic compounds is not available. Therefore, the organic content of the various secondary waste streams will not be estimated.

[87] This is a simplifying assumption required for a tractable model.

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