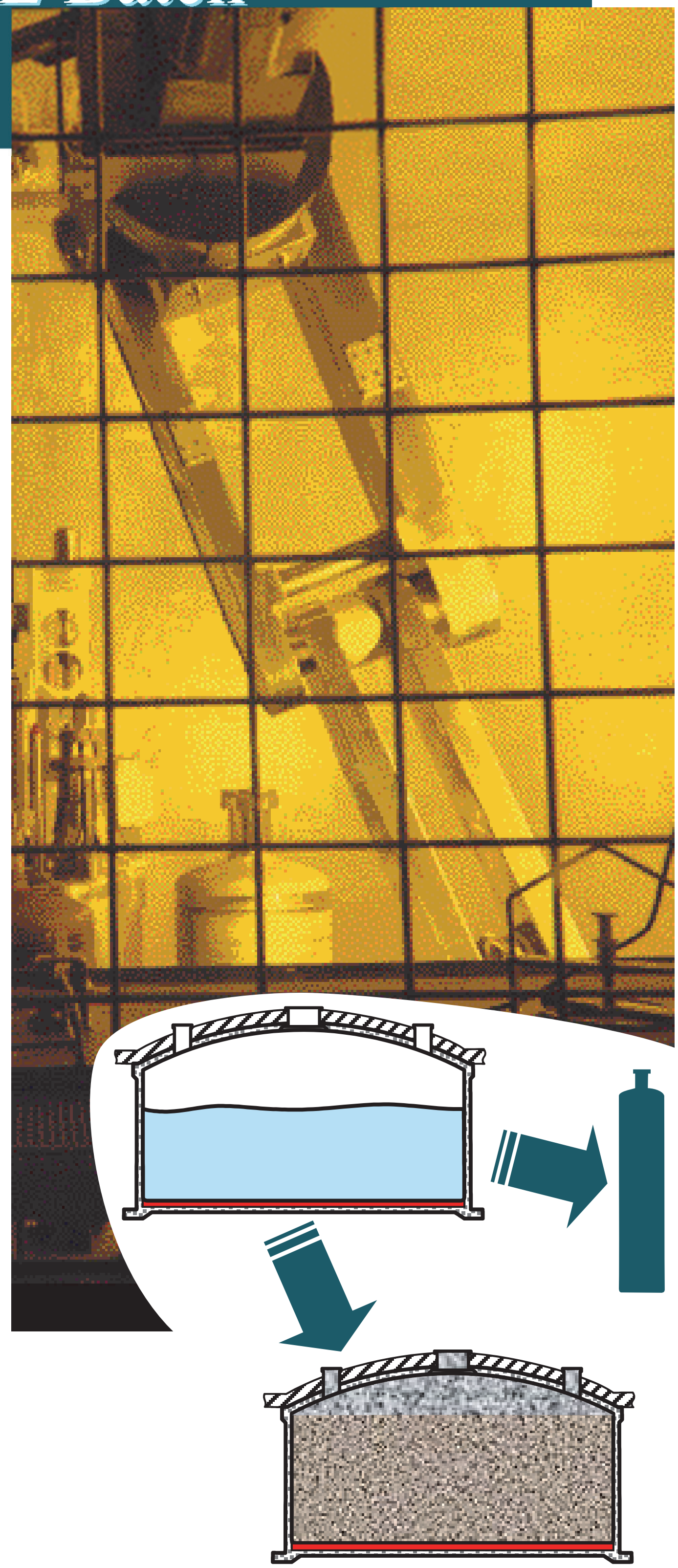
SRR-LWP-2016-00006

SLUDGE Batch Plan



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Savannah River Site Liquid Waste Planning Process

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Table of Contents

1 Executive Summary 6
2 Introduction 9
3 Inputs and Assumptions 11
3.1 Aluminum Dissolution 11
3.2 Tank Farm Current Conditions 12
3.3 Future Sludge Batch Washing Assumptions 13
3.4 Assumptions for Additional Sludge 15
3.5 Sludge Modifier Addition 16
3.6 Assumptions for Sludge Removal 17
3.7 Assumptions for DWPF Processing 18
3.8 Sludge Batch Preparation Details 19
3.9 DWPF Processing 22
3.10 PCCS Modeling 22
3.11 DWPF Waste Acceptance Criteria 23
4 Canister Production and Batch Need Dates 27
4.1 Estimated Canisters and Need Dates 27
5 Risks and Issues 29
5.1 Equipment and Infrastructure Problems 29
5.2 Sludge Characterization Uncertainty 29
5.3 Sludge Behavior Uncertainty 30
5.4 New Programs or Delays in Currently Planned Programs 30
5.5 Sludge Processing Uncertainty 30
6 Conclusions and Recommendations 32
7 References 33

List of Tables

Table 1: Sludge Batch Decant Volumes from Tank 51 22
Table 2: SB9-22 WAC Value Estimation: NOx, Hg, IDP, and Canister Fissile 24
Table 3: SB9-22 WAC Value Estimation: Criticality and Hydrogen Generation 25
Table 4: SB9-22 WAC Value Estimation: Canister Heat, Gamma, and Neutron 26
Table 5: Canister Production and Sludge Batch Feed Dates 28

List of Figures

Figure 1: Sludge Removal Sequence for Sludge Batch Preparation……………………21

List of Acronyms

ARP	Actinide Removal Process
CSMP	Commercial Submersible Mixing Pumps
CSSX	Caustic Side Solvent Extraction
DWPF	Defense Waste Processing Facility
HM	H-Modified PUREX Process
IDP	Inhalation dose potential
LTAD	Low temperature aluminum dissolution
LWSP	Liquid Waste System Plan
MCU	Modular CSSX Unit
MST	Monosodium Titanate
PCCS	Product Composition Control System
PRFT	Precipitate Reactor Feed Tank
PUREX	Plutonium Uranium Extraction process
Q-Time	Quiescent Time
R2O	Sum of Alkali Materials
ROMP	Risk and Opportunity Management Plan
SB	Sludge Batch
SEFT	Strip Effluent Feed Tank
SMP	Submersible Mixer Pump
SOL	Sludge Oxide Loading
SPTK	System Planning Toolkit
SRAT	Sludge Receipt and Adjustment Tank
SRNL	Savannah River National Laboratory
SRS	Savannah River Site
TiO2	Titanium Dioxide
SWPF	Salt Waste Processing Facility
WAC	Waste Acceptance Criteria
WCS	Waste Characterization System
wt%	weight percent

1 Executive Summary

This Sludge Batch Plan validates the near-term sludge processing sequence devised as part of the overall future processing scheme (Case 1) recommended by the Liquid Waste System Plan (LWSP) Revision 20 [Chew and Hamm, 2016]. It also includes estimates of The Defense Waste Processing Facility (DWPF) feed compositions, which are used to predict DWPF Waste Acceptance Criteria (WAC) compliance. In the course of modeling the sludge processing sequence, insights to potential operational challenges and opportunities are obtained. Future sludge batch preparation through Sludge Batch 14 (SB14), roughly ten years of processing, is examined.

Liquid Waste Planning routinely produces long-range planning documents such as the LWSP for the integrated Liquid Waste System. The Liquid Waste Planning group provides input to support the orderly planning of Liquid Waste System operation with regards to sludge batch preparation and qualification for feed to DWPF. Key outputs of the LWSP are the sludge batch sequence and timing, and DWPF canister production rate estimates. The Sludge Batch Plan supports those outputs and identifies associated program risks.

This document is intended for long-term planning and does not contain sufficient detail to guide operation of individual process steps. Any dates, volumes, and chemical compositions contained herein are planning approximations only. To guide actual execution of individual processing steps in the future, detailed plans will be developed. This document will be revised if significant changes occur in the planning bases that impact successful implementation of this Plan.

The LWSP devises a sequence of waste removal steps to best meet the goals, priorities, assumptions, and funding provided as inputs to that Plan. The Sludge Batch Plan builds further detail into the near term sludge processing sequence devised by the LWSP. The result is a verification of the feasibility of preparing the sludge batches in the way prescribed by the LWSP, sludge batch composition estimates to verify their processability by DWPF, and recognition of potential risks to be addressed.

In this Plan, DWPF produces canisters at rates coupled to the salt processing rates of the Plan. Up to 288 discrete canisters/year are produced during most years after the Salt Waste Processing Facility (SWPF) startup in December 2018, and until processing of the final sludge batches composed largely of waste tank heels. Sludge oxide loading (SOL) projected in the Plan is at 36 wt% in the near term, then increasing to as high as 40 wt% for some sludge batches. The final two batches, which consist of sludge tank heels, are projected at 30-32 wt%. DWPF outages are projected to occur July 2017 through December 2017 (Melter replacement, Modular Caustic Side Solvent Extraction Unit (MCU) contactor bearing replacement, and SWPF tie-in), October 2021 through December 2021 (Next Generation Solvent implementation for SWPF), June 2025 through September 2025 (Melter replacement), and June 2033 through September 2033 (Melter Replacement). Also, an 18-month outage is anticipated from October 2034 through March 2036 to collect heel material from seven different tanks and prepare SB21. The Plan also assumes modification of Glass Waste Storage Building #1 to accommodate storage of an additional 2251 canisters, and availability of supplemental canister storage beginning 2029.

To the extent practical, this Plan utilizes the low temperature aluminum dissolution (LTAD) process to reduce the mass of sludge from high-aluminum sources. LTAD has been successfully performed for Sludge Batch (SB) 5 and SB6 and also on the Tank 12 sludge heel. Leachate from those dissolutions is being processed by the Actinide Removal Process (ARP) and the MCU. SWPF is expected to be able to process the high-aluminum liquid decanted from the later dissolutions when blended with other tank farm solutions.

Aluminum dissolution will reduce the number of glass canisters otherwise produced, by reducing the sludge solids mass, increasing canister waste loading, and increasing DWPF melt rate.

LTAD is utilized for SB10 – SB13. Although it could possibly also become an option for some later sludge batches, in the overall LWSP there is insufficient space projected for aluminum leachate storage for higher aluminum sludge batches after SB13.

Sludge blending for makeup of sludge batches is devised to accommodate sludge movements for planned tank closure activities, to perform aluminum dissolution on high-aluminum content sludge from particular tanks, to wash the sludge as efficiently as possible, and to provide DWPF feed that will result in acceptable sludge processing and glass quality.

In the LWSP, spent monosodium titanate (MST) and strip effluent from ARP/MCU operation or SWPF operation is sent directly to DWPF. Given the uncertainty of where and how oxalic acid cleaning will be applied to reduce tank heel volumes, potential bulk oxalic acid/sodium oxalate has not been included in the sludge batch modeling after SB9.

The LWSP calls for addition of sludge modifier (synthetic sludge and/or iron) to SB14 through SB18. Iron is added to SB14 through SB17 in order to maintain a target aluminum/iron ratio. The LWSP also assumes addition of synthetic sludge to SB18 for incremental DWPF operation supporting salt processing.

Inclusion of the modifier is modeled in the System Planning Toolkit (SPTK). The additive form and the addition method have not yet been devised. This Plan does not model any impact of sludge modifier on sludge batch preparation in Tank 51, except as additional sludge mass realized after sludge batch preparation in Tank 51. Therefore, sludge modifier use will require further research and development, including ways to reduce or eliminate its need. Discussion on sludge modifier and options to reduce or eliminate its need is provided in Section 3.5 of this report.

Washing is examined in detail through SB14 of this Plan. That washing includes 50% of the estimated existing unprepared sludge inventory.

Differences in sludge batch sequencing, total number of canisters produced, and batch end dates between this Sludge Batch Plan and the previous Plan [Gillam, 2014] are mainly driven by the following:

(1) A canister production rate linked to the salt processing rate, as discussed above, with the objective of pouring the minimum number of canisters needed to support planned salt processing rates. As a result, less synthetic sludge is needed to support the Plan, 22 instead of 23 sludge batches are prepared, fewer canisters are poured, and more tanks are projected to be closed sooner rather than later.

(2) Less aluminum dissolution – 206,000 kg vs 318,000 kg in the previous plan. This is driven by less available storage for leachate from the LTAD process.

(3) SWPF startup is assumed in December 2018 instead of October 2018.

(4) Compared to the LWSP Rev. 19, heel removal for Tanks 4, 7, 8, 14, 26, 32, 33, 34, 35, 39, 40, 42, 43, and 51 will be sooner. The last F Tank Farm tank is emptied four years sooner, with Tank 33 heel removal completing November, 2030.

(5) Compared to the LWSP Rev. 19, heel removal for Tanks 11, 13, 21, 22, 23, and 47 will be later.

The plan reflects greater detail for processing of sludge solids entrained in the DWPF recycle stream. Accumulated Tank 22 sludge is planned for inclusion in SB10 – SB14. Thereafter, DWPF recycle will be sent to Tank 35.Tank 33 has a reduced role as a blend tank, receiving mostly just waste from heel removal. Tank 39 is also utilized as a sludge waste receipt tank in this Plan.

2 Introduction

Cleanup initiatives at the Savannah River Site (SRS) include sludge processing. Sludge is the highest risk component of liquid waste since it contains the majority of the long-lived radionuclides in the SRS waste. SRS has been immobilizing sludge since 1996 with the startup of DWPF; the Liquid Waste system has produced 4000 canisters as of December 31, 2015.

In September 2010, the Melter was retrofitted with bubblers to circulate the molten glass. The bubblers have increased the DWPF (short-term) production rate to as high as 480 canisters per year as demonstrated in a month of August 2013 and are capable of supporting an overall rate of 276 canisters per year at SOL of 36 wt%. This plan assumes that process improvements will lead to an increase of SOL to as high as 40 wt% by FY 2024 with SB13.

The SPTK Ver. 17 [Hamm (A), 2016] is a linked set of Excel workbooks used to calculate composition and identify possible processing constraints for each sludge batch. DWPF WAC [Ray, 2016] and Product Composition Control System (PCCS) limits were also evaluated within the SPTK. The limits which are not met are identified for each sludge batch in Section 3.10 and 3.11. It should be noted that although the current SPTK model indicates that the assumed batch compositions, SOL, and canister production rates are feasible, SPTK calculation runs do not account for processing rates within the Sludge Receipt and Adjustment Tank (SRAT), Slurry Mix Evaporator, Melter Feed Tank, or Melter within DWPF.

This document is for planning purposes. The purpose of this document is to describe the Sludge Batch Plan in sufficient detail to establish project objectives and execution schedules. This Plan provides input on sludge batch sequence and timing and estimates of canister production numbers, wash water volumes, and concentrations of soluble species. It documents major risks, inputs, and assumptions associated with sludge processing.

Several studies have been conducted to better predict the quantity of sludge in the Tank Farms. Adjustment of this prediction has a significant impact on the number of future canisters to be produced [Hill, 2006]. The studies used tank waste sample data and empirical processing data from sludge batch vitrification.
The first study quantified the magnitude of the disparity between Waste Characterization System (WCS) [Hester, 1996] predictions and measured sludge mass for sludge SB1A through SB4 [Elder and Hamm, 2006].
A second evaluation, "Estimating the Sludge Mass Remaining in SRS Waste Tanks after the Processing of Sludge Batch 4", performed a statistical analysis of the correlation between the WCS forecast and empirical experience for the first five sludge batches [Edwards, 2006].

A third study, "Sludge Characterization Model Using Dial-up Factors", analyzed sludge type, canyon processes, year of operation, existing sludge sample data, and the two studies mentioned above [Hamm and Elder, 2006]. The recommended sludge masses and compositions were developed by applying a series of dial-up factors to the WCS predictions. These 'recommended' dial-up masses were used in the previous version of the Sludge Batch Plan.

Based on lessons from Tank 13 waste removal, the 'recommended' dial-up factor for the projected sludge mass of H Area low activity waste has been scaled back to correspond to the original WCS mass for this Plan.

Other sludge masses in this Plan are re-estimated in some cases. The current estimated Tank 22 sludge inventory was reduced from 210,000 kg to 99,000 kg of insoluble solids, mostly as a result of a sludge mapping after removing some sludge and most of the liquid from the tank, instead of estimating from the measured sludge height at one riser in the tank. The relatively uncertain Tank 15 sludge inventory estimate was reduced from 317,000 kg to 158,000 kg, in order to conservatively plan for near-term sludge removal needs to supply DWPF feed.

The LWSP assumes that modifier is added to sludge feed. In total, 90,000 kg of insoluble iron is added to the DWPF feed stream as part of SB14-SB17. Synthetic sludge addition is part of the plan for SB18, in the amount of 40,000 kg.

Sludge mass estimates will continue to be evaluated as future waste removals and sludge batches are completed to determine whether general dial-up factors need to be readjusted. The extent of those evaluations will depend on the tank sampling, mappings, and sludge soundings performed.

This document is intended for long-term planning and does not contain sufficient detail to guide operation of individual process steps. Any dates, volumes, and chemical compositions contained herein are planning approximations only. To guide actual execution of individual processing steps in the future, detailed flowsheets will be developed. This document will be revised when significant changes occur in the planning bases that impact successful implementation of this Plan. Revisions to this document will be managed by issuing a revision to the document approved by all indicated organizations.

3 Inputs and Assumptions

Inputs and assumptions used in this Plan for the detailed SB10 – SB14 modeling are summarized in the following sections. Assumptions are shown for aluminum dissolution, current Tank Farm conditions, sludge washing, amounts of additional sludge to be realized, sludge removal from storage tanks, and DWPF processing.

3.1 *Aluminum Dissolution*

Aluminum solids in the sludge are believed to be present in at least three forms – aluminum trihydrate or gibbsite, alumina monohydrate or boehmite, and aluminosilicate. Only the first two forms are soluble in caustic solutions. Aluminum dissolution is performed by adding 50wt% NaOH to the process tank (Tank 51), while agitating the tank contents and heating to approximately 70 degrees Celsius for about one month.

The LTAD process was successfully implemented for SB5, SB6, and Tank 12 heel removal achieving an estimated reduction of 310 to 344 canisters at 36% SOL. This plan assumes the use of LTAD for SB10 through SB13. This plan assumes no high temperature aluminum dissolution for sludge batch preparation (greater than 85 degrees Celsius).

Aluminum dissolution inputs and assumptions are as follows:

3.1.1 LTAD will be used for processing of almost all the sludge from Tanks 15 and 35, and much of the Tank 39 inventory. Smaller amounts originating from Tanks 13 and 22 get included due to the planned transfer sequence, but are not specifically targeted. Some of the sludge from Tank 39 and the sludge in Tank 32 will not be subjected to aluminum dissolution due to the projected lack of storage space for aluminum leachate.

3.1.2 Aluminum dissolution will be performed in Tank 51.

3.1.3 LTAD will dissolve 70% of the mass of the aluminum solids added to SB10, 60% of the aluminum solids in SB11 and SB12, and 40% of the aluminum solids in SB13. These are the amounts selected in the LWSP [Hamm (B), 2016].

3.1.4 Enough 50wt% caustic is added for LTAD that after dissolution, the [OH]/[Al] molar ratio in the supernate is at least 6.0, which is assumed to be sufficient to keep the aluminum dissolved through the subsequent washing.

3.1.5 Tank 51 will utilize conventional style slurry pumps, which have greater operating range than Submersible Mixer Pumps (SMPs) with respect to liquid height, fluid density, and slurry temperature.

3.1.6 A six inch separation between the settled sludge layer and the decanting jet suction will be employed to maximize the leachate decant volume.

3.2 *Tank Farm Current Conditions*

Assumptions specific to sludge recently or currently being processed or moved from storage tanks are as follows:

3.2.1 Sludge Tank waste volumes, other than Tanks 22, and 51 are those as of January 11, 2016.

3.2.2 Tank 51 is assumed to retain 7.7 inches of sludge slurry after SB9 transfer to Tank 40, as assumed in the LWSP.

3.2.3 Tank 22 is assumed to have 190 inches of waste at the times of transfers into Tank 51.

3.2.4 Supernate compositions of sludge tanks 14, 22, 26, 32, 33, 34, 35, and 39 use the latest available Ntank sample database entries as of January 11, 2016. For Tanks 51, 40, and 13, running material balances are employed to account for the impact of waste transfers since the time of the latest sampling, which include samples analyzed at Savannah River National Laboratory (SRNL).

3.2.5 The Tank 15 composition is estimated by accounting for the analyzed composition at the time of the 1982 sludge removal campaign [Woolsey, 1980; Hamm, 1983; Ator, 1984; Wiersma and Zapp, 1998], the recent water and chemical additions for the Tank 15 rewet campaign, and the apparent volume of water evaporation in between those activities.

3.2.6 The composition of the current Tank 40 SB8 supernate composition and solids concentration is based on the SB8 WAPS sample taken in July 2013 [Bannochie, 2013], and adjusted for subsequent feed transfers to DWPF and dilution with slurry pump bearing water using material balances.

3.2.7 The Tank 51composition is determined from sample analysis [Pareizs (A), 2016; Pareizs (B) 2016].

3.2.8 The Tank 13 remaining solids mass has been estimated assuming that the remaining wet sludge volume [Clark (A), 2014] is 22% insoluble sludge solids with a density of 2.4 kg/L.

3.2.9 Tank 22 solids mass is estimated using the mapped wet sludge volume [Clark (B), 2014], and applying a settled compaction of 0.425 kg/L [Shafer, 2013], and then adding the additional solids mass projected to be received before Tank 22 sludge transfer into SB10. The solids mass to be received in each subsequent and projected recycle transfer is estimated at 45 gallons (at the SB8 WAPS sample [Bannochie, 2013] concentration), an average obtained from the RCT Tracking Log [RCT Tracking Log, 2016]. Sludge solids masses to be removed for SB11, SB12, and SB13 are from the LWSP [Hamm (B), 2016].

3.2.10 Sludge tank solids masses in Tanks 11, 14, 26, 32, 33, 34, 35, and 39 are from the adjustment of the WCS1.5 inventory database, adjusted using the chosen "dial-up" factors, as described in Section 2.

3.2.11 The Tank 40 radiolytic heats results from a running material balance beginning at the time of the Tank 40 SB7b slurry sample, December 2012 [Crawford and DiPrete, 2013], used for radiolytic heat calculation. The material balance accounts for subsequent feed transfers to DWPF and the SB8 receipt from Tank 51. That receipt from Tank 51 uses the radiolytic heat determined by the WCS1.5 database as of April 15, 2013.

3.2.12 The Tank 13 and Tank 15 radiolytic heats, are from WCS 1.5 of October 10, 2015, with one exception. The supernate beta-gamma heat is calculated from a 1985 gross gamma analysis and waste volume [Wiersma and Zapp, 1998].

3.2.13 Initial radiolytic heats of all tanks other than Tanks 13, 15, and, 40 come from WCS1.5 of January 11, 2016 [WCS1.5, 2016].

3.2.14 SB9 preparation is complete, and will be transferred to Tank 40 with its current composition.

3.3 *Future Sludge Batch Washing Assumptions*

Future sludge batch washing for SB10 through SB14 is modeled using general assumptions, as follows:

3.3.1 All Sludge batches are prepared in Tank 51, and then stored in Tank 40, except the final batch, SB21, which is prepared in Tank 40.

3.3.2 SB10 through SB14 are washed to 1.25 M sodium in the supernate.

3.3.3 Settling characteristics of SB10 through SB14 are estimated by:

- Determining the mass of "high-heat" "H-Modified" (HM) sludge solids, in the sludge batch (sludge from Tanks 11, 14, 15, 32, 35, or 39). Any mass originating from Tank 13 or Tank 22 is considered to be half "high-heat" HM for settling purposes, based on observed settling rates between that of slow-settling "high-heat" HM sludge and fast-settling sludge from the Plutonium-Uranium Extraction Process (PUREX).

- Settling of HM sludge without aluminum dissolution is projected using the pre-dissolution SB4 / SB5 settling model [Gillam, 2008].

- Settling of the post-dissolution HM sludge is projected using the observed SB4/pre-dissolution SB5 settling model [Gillam, 2008] using a mass input to the model that only credits dissolution of 42% of the actual mass to be dissolved. This is from SB5 dissolution experience.

- Solids other than HM solids in the sludge are assumed to settle like PUREX sludge , which is projected using a PUREX settling model [Lee, 1996] with an H_{∞} input corresponding to a 20-day settled compaction of 292 grams of insolubles per liter of slurry [Ades, 2010].

- Settling of combinations of "HM" and "PUREX-like" solids is modeled using a technique that assumes independent settling behavior two different sludges [Gillam, 2013].

3.3.4 Slurry pump run frequencies for Tanks 40 and 51 are estimated using the "gas release" quiescent times (Q-times) calculated as prescribed in the CSTF Flammability Control Program [Bui, 2016]. However, the proposed hydrogen retention fractions proposed in response to the Trapped Gas PISA [WSRC-IM-99-00009] were applied.

3.3.5 Available sludge settling time is the projected Q-time, less the time required to reposition the decanting jet (or pump), execute the decant transfer, perform subsequent Q-time pump runs, plus some operating margin to ensure that the decant can be completed before the pump runs must begin. This difference between the Q-time and settling time is managed to be at least six days.

3.3.6 Jet decants to evaporator system tanks are generally from a tank elevation at least 24 inches above the projected turbidity level to comply with Evaporator Feed Qualification Program [Bui, 2015] requirements. Separations of 6 inches are assumed for decants of leachate after LTAD steps. For SB13 washing, a 6 inch separation with decanting to Tank 39 was assumed, in order to offset some impact of short Q-times/settling times. No significant sludge entrainment is expected for these decants.

3.3.7 The waste tank high liquid level conductivity probes in Tanks 51 and 40 must be at least eight inches above the waste level.

3.3.8 Corrosion inhibitor adjustments are assumed as necessary to comply with the Corrosion Control Program [Martin, 2015]. Addition of 50wt% sodium hydroxide and 40wt% sodium nitrite is assumed. A sufficient margin over the minimum inhibitor requirements for final washed sludge is provided by a [NO2]/[NO3] molar ratio of 1.90 or greater for an assumed 40^{o}C supernate temperature. In the case of SB14, a 35^{o}C supernate temperature was assumed to partially mitigate a large nitrite addition.

3.3.9 A supernate temperature of 40^{o}C is generally assumed when applying the Corrosion Control Program [Martin, 2015] and Flammability Control Program [Bui, 2016] criteria. A temperature of 35^{o}C with respect to corrosion control was assumed for SB14 washing. Higher temperatures are encountered during LTAD, but due to frequent slurry pump operation, no additional corrosion inhibitor is required for LTAD.

3.3.10 Evaporator capacity is maintained to support the Plan.

3.4 *Assumptions for Additional Sludge*

Assumptions pertaining to anticipated additional sludge being processed are as follows:

3.4.1 The LWSP assumes that sludge modifier is added to DWPF feed as necessary to support processing. In total, 90,000 kg of iron is added to the DWPF feed stream as part of SB14-SB17 in order to maintain a target iron to aluminum ratio. The LWSP also assumes use 40,000 kg of a modifier using simulated PUREX sludge for SB18 to target acceptable physical properties and a favorable iron to aluminum ratio for the DWPF feed.

3.4.2 Tank 39 receives new receipts from H-Canyon at the rate of 10,000 kg of insoluble solids per year until July 2026. The impact of the associated additional liquid on the washed sludge batch composition will be slight, so is not accounted for. However, any future additions to sludge batches will be evaluated before being approved for impacts to the washing, DWPF criticality, and total fissile limit in glass.

3.5 *Sludge Modifier Addition*

The LWSP calls for the addition of sludge modifiers (synthetic sludge and/or iron to SB14 through SB18). This is to maintain an aluminum/iron ratio of 0.6 or less. In the case of SB18, the additional sludge mass supports SWPF operation.

Processing Sludge Batches 5 and 6 demonstrated that maintaining an Al/Fe ratio less than 0.6 helps sludge settle faster thereby enabling sludge washing to be performed within the scheduled duration for sludge batch preparation. Maintaining the proper Al/Fe ratio also helps to attain canister waste loadings of 36% and higher. Therefore, in this plan and in previous plans, sludge batches are planned with Al/Fe ratios close to 0.6 through the addition of sludge modifiers when necessary. The major portion of the high-iron sludge (PUREX) will have been dispositioned before preparation of later sludge batches. Later sludge batches (mainly HM) will be high in aluminum, and will therefore need iron based sludge modifier.

Historically, high aluminum sludge negatively affected processability at DWPF at higher waste loading. Thus, a lower Al/Fe ratio is required to maintain acceptable productivity. Since the major portion of iron sludge is going to be used up by 2022, addition of iron is needed.

Inclusion of the modifier is modeled in the SPTK as dry material added to Tank 51 during sludge batch assembly. The additive form and the addition method have not yet been devised. This Plan does not model any impact of sludge modifier on the physical aspects of sludge batch preparation in Tank 51.

While sludge modifier use is currently in the Plan, options to reduce or eliminate the need for it include:

- Develop a frit formulation that will enable processing high aluminum sludges at higher waste loading at DWPF
- Develop sludge washing methods to reduce high aluminum sludge batch preparation time (e.g., Rotary Micro-filtration)
- Increase aluminum to iron ratio >0.6
- Develop methods to process more strip effluent per CPC batch at DWPF

3.6 *Assumptions for Sludge Removal*

The following assumptions pertain to the strategies and methods of waste removal from storage tanks, which impact the waste composition and process during sludge batch preparation:

3.6.1 Saltcake dissolution from sludge tanks is modeled when applicable, in order to project supernate composition during sludge removal. Amounts and composition of salt in sludge tanks are from the WCS database of August, 2013 [WCS1.5, January 2016].

3.6.2 It takes 1.93 gallons of water to dissolve one gallon of saltcake, resulting in a combined post-dissolution volume of 2.8 gallons [Nguyen, 2004].

3.6.3 Sludge removal is to be accomplished with SMPs or "Commercial" Submersible Mixing Pumps (CSMPs), except in the case of Tanks 11 and 22.

3.6.4 SMPs and CSMPs require 120 inches of suction head to operate. While CSMPs might be shown to be operable with less suction head, that operating range has not yet been demonstrated.

3.6.5 Sludge solids have a density of 2.4 g/ml.

3.6.6 Insoluble solids concentration for newly slurried sludge slurry transfers into Tank 51 or sludge blend tanks will be no greater than 8wt%.

3.6.7 About 5000 kg of insoluble solids are assumed to represent the residual quantity for future sludge heel removal.

3.6.8 Transfers to and from sludge tanks in the transfer modeling are managed to maintain compliance with the Corrosion Control Program [Martin, 2015].

3.6.9 Salt solution is added to some sludge tanks during their bulk waste removal period based on the LWSP transfer sequence [Hamm (C), 2016]. For the sludge batch preparation modeling, addition of future Tank 37 salt solution to Tank 26 and Tank 35, and addition of future Tank 30 salt solution to Tank 26 is modeled using a representative recent Tank 37 supernate composition based on laboratory analyses. Addition of future Tank 41 and Tank 27 salt solution to Tank 35 is modeled based on historical laboratory analyses of Tank 41 supernate. Details of each such adjustment are noted in the sludge preparation spreadsheets [Gillam, 2016].

3.7 *Assumptions for DWPF Processing*

The following assumptions pertain to the DWPF processing rate:

3.7.1 Future dilution of DWPF sludge slurry feed from Tank 40 due to slurry pump bearing purge water is not accounted for.

3.7.2 Canister production rates are matched to the amount to support ARP/MCU production until SWPF startup, resulting in 383 total cans for FY2016 and until SWPF startup in December 2018. Shortly after SWPF startup, rates ramp up to an average of about 270 canisters per year until residual tank heel waste predominates DWPF feed beginning with SB20 in FY33. Greater detail from the LWSP is shown in Table 5.

3.7.3 Waste loading of 40% SOL is projected when high SWPF rate are expected, during feed of SB13 – SB17. Otherwise, 36% SOL is projected, except for the final "heel" material in SB21 and subsequent flushes Tank 40.

3.7.4 DWPF outages are projected for July 2017 through December 2017 (Melter replacement, MCU contactor bearing replacement, and SWPF tie-in), October 2021 through December 2021 (Next Generation Solvent implementation for SWPF), June 2025 through September 2015 (Melter replacement), and June 2033 through September 2033 (Melter replacement). Also, an 18 month outage is anticipated from October 2034 through March 2036 while collecting sludge heels from multiple tanks.

3.7.5 Glass Waste Storage Building #1 will be modified to accommodate 2251 additional canisters.

3.7.6 Supplemental canister storage will be available in December 2029.

3.7.7 Frit 803 is selected for glass compositions of all batches in this Plan. During qualification of a specific batch it is possible that a different frit will be used to meet the glass acceptance constraints.

3.7.8 Strip effluent is received in the Strip Effluent Feed Tank (SEFT) from both SWPF and MCU. It is currently anticipated that MST will no longer be needed for ARP operation. Washed MST/sludge slurry from SWPF operation is received in the Precipitate Reactor Feed Tank (PRFT).

3.7.9 The impact of future neptunium or plutonium campaigns by H-Canyon operations beyond SB9 are currently unknown, and not accounted for in the DWPF feed stream. Any proposed special neptunium or plutonium campaigns will be evaluated for impacts to the Sludge Batch Plan, ensuring that the limit of total fissile of 897 g/m^3 in glass and DWPF criticality constraints are met.

3.8 *Sludge Batch Preparation Details*

Excel spreadsheets are used to model a corresponding set of sequential material balances that track the movement of sludge slurry to and from waste removal tanks, to preparation of sludge batches in Tank 51, and to feed Tank 40 in a way that estimates interim and final quantities of insoluble sludge solids, supernate, associated alpha and beta-gamma heat rates, supernate composition, and other parameters that correspond to operating limits and constraints. In addition to transfers, these "Washing Spreadsheets" [Gillam, 2016] model chemical adjustment, aluminum dissolution, solids settling, hydrogen generation, and batch washing. This modeling demonstrates the feasibility of bringing the prescribed sludge batch ingredients to the target composition, identifies potential processing constraints, and provides supernate compositions used for projected glass evaluations.

The current sludge mass inventory used is based on the "recommended dial-up estimates" [Hamm and Elder, 2006]. Based on experience from Tank 13 bulk waste removal, dial-up factors for H Canyon low heat waste streams to the Tank Farm were removed beginning with the LWSP Rev. 18. Tanks 13, 22, 39, 40, and 51 sludge mass inventories have been updated in accordance with the latest available samples, sludge volume mappings, and transfer data, as described in Section 3.2.

Several key inputs to this modeling are specified by an overall liquid waste transfer sequence [Hamm (B), 2016], [Hamm (C), 2016] devised to meet the key input bases and assumptions of the LWSP [Chew and Hamm, 2016]. This sequence considered volume constraints, processing rates, and key compositional constraints. The information therein utilized for this Sludge Batch Plan includes the sequence of transfers to remove sludge stored in sludge tanks, the source and quantity of solids included in each sludge batch, a description other additions to sludge tanks assumed when managing waste volumes, and the quantity of aluminum compounds dissolved in each sludge batch.

The modeling for this Sludge Batch Plan in turn verifies that the nearer-term (SB8 through SB14) planned batches are manageable, and determines the final washed composition of each prepared batch.

Those batch characterizations are used as inputs to the SPTK to project compositions for the sludge batch blends (including any sludge modifier), and the resultant glass compositions in DWPF.

The plan modeled for processing and blending of sludge feed, including batch aluminum dissolution, is shown in Figure 1 in an abbreviated schematic depicting the sources of sludge for each sludge batch and each aluminum dissolution batch.

The size and number of decants to prepare the sludge in Tank 51, including those for sludge concentration/washing and for LTAD leachate removal, are listed in Table 1. For each sludge batch of the Plan washed, the number and total decant volumes are given. Sometimes the washing strategy modeled involved directing some concentration/washing decants to sludge storage tanks to utilize for removal of sludge for a subsequent sludge batch. This comprised 17% (SB10 through SB14) of the decant volume generated from concentration/washing. That amount would not comprise part of the immediate evaporator load.

Figure 1: System Plan Sludge Removal Sequence for Sludge Batch Preparation

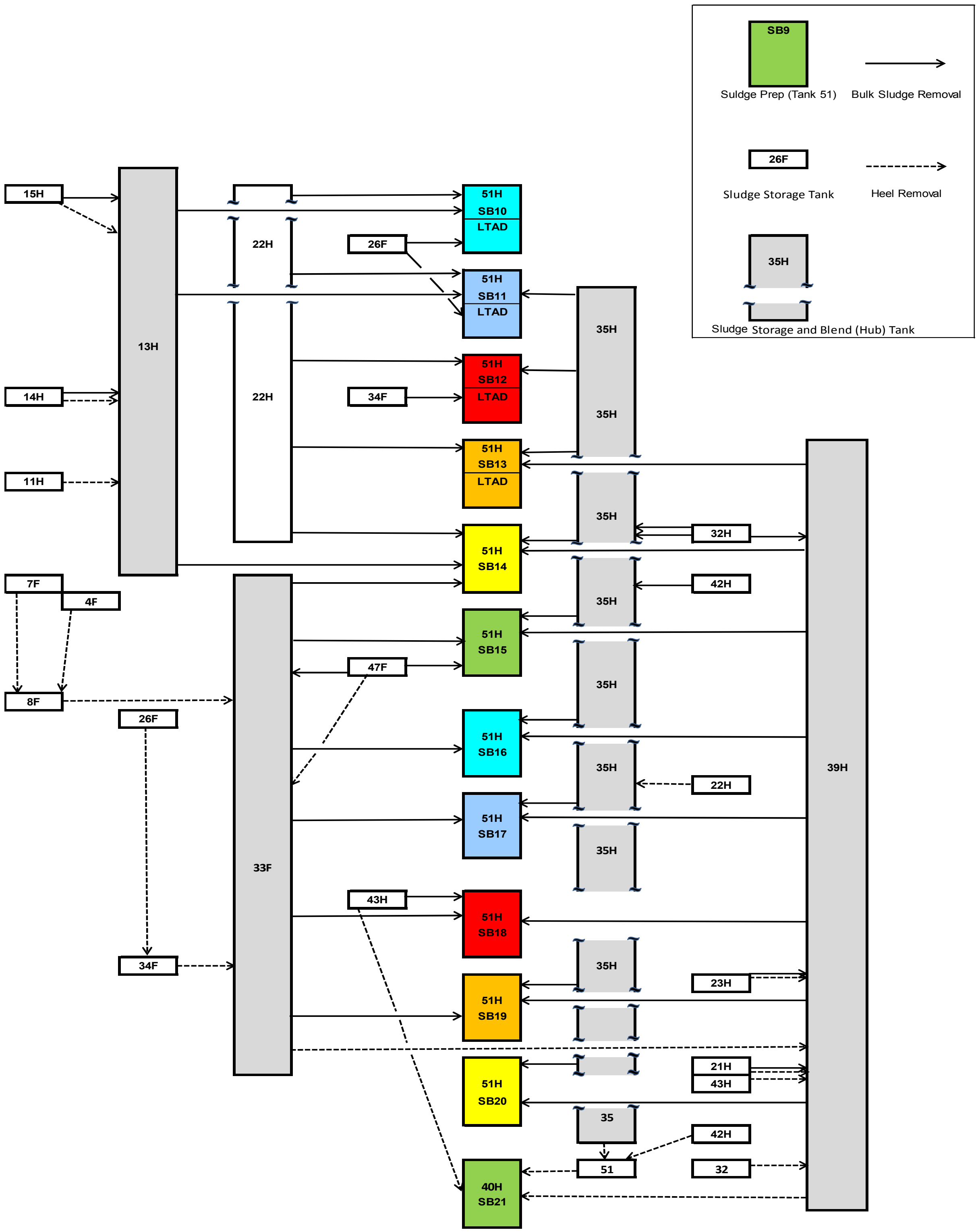

Table 1: Sludge Batch Decant Volumes from Tank 51

SB No.	Source/Reason	Volume (gallons)
10	Washing and Supernate Removal Decants (9)	1,727,000
	Aluminum Leachate (1)	264,000
11	Washing and Supernate Removal Decants (12)	2,187,000
	Aluminum Leachate (1)	334,000
12	Washing and Supernate Removal Decants (11)	2,304,000
	Aluminum Leachate (1)	174,000
13	Washing and Supernate Removal Decants (18)	2,432,000
	Aluminum Leachate (2)	302,000
14	Washing and Supernate Removal Decants (12)	2,058,000

Note: The Sludge washing does not modelled Sludge Batch 15 through 22.

3.9 *DWPF Processing*

In this Plan, canister production rates are matched to the amount to support ARP/MCU production until SWPF startup, resulting in 383 total cans for FY2016 and until SWPF startup in December 2018. Shortly after SWPF startup, rates ramp up to an average of about 270 canisters/year until residual tank heel waste predominates DWPF feed beginning with SB20 in FY33. .

Assumptions pertaining to DWPF processing of feeds, including timing of planned outages, are given in Section 3.7.

3.10 *PCCS Modeling*

The PCCS modeling algorithms from the SPTK [Hamm (A), 2016] are used to determine whether each sludge batch (including frit) as currently planned produces acceptable glass. Frit 803 is utilized for all batches in this Plan.

Total MST and strip effluent additions from SWPF and ARP/MCU are added to the SRAT on a monthly basis. This is the most logical approach, as the LWSP [Chew and Hamm, 2016] calls for SWPF and ARP/MCU additions to be made incrementally during the batches.

The PCCS algorithm analyzes high and low liquidus temperatures, high and low viscosities, homogeneity (minimum amount of aluminum/alkaline oxides in the sludge), R2O (sum of alkali materials), and glass solubility limits (a maximum wt% is allowed in glass for certain compounds, such as titanium dioxide, TiO2) [Ray, 2016]. Homogeneity constraint was not met for SB10 through SB12, and SB19. SB10 through SB19 did not meet the TiO2 limit. SB21 and SB22 failed the high frit limit. [Hamm (A), 2016]. These conclusions were obtained using input generic slurry supernate compositions generated by the System Plan development for all sludge batches, and also using the slurry supernate compositions determined by the more detailed SB9 through SB14 modeling [Gillam, 2016].

Although several PCCS constraints are not met with the assumptions in this Plan, in the past PCCS constraints such as homogeneity have been relaxed as a result of paper studies at SRNL [Raszewski and Edwards, 2009]. Before startup of SWPF in 2018, further studies will be required to reduce those PCCS constraints which are challenged in this Plan, especially the 2wt% TiO2 limit. Use of frits other than Frit 803, refining the limits and logic in the PCCS modeling algorithms, and revisions to processing strategy will allow all PCCS constraints in future batches to be met. As per our current practice, each batch should be evaluated by SRNL to ensure PCCS limits are met.

3.11 *DWPF Waste Acceptance Criteria*

Several DWPF WAC criteria are evaluated using the SPTK [Hamm (A), 2016]. These criteria include NO_x emissions, Hg concentration, canister heat generated due to Tank 40 sludge transfers, gamma shielding, neutron shielding, inhalation dose potential (IDP), nuclear criticality limits, radiolytic hydrogen generation, and fissile mass per cubic meter of glass. Although there are several other criteria included in the DWPF WAC, some must be directly measured by SRNL during sludge batch flowsheet and glass qualification runs and cannot be accurately estimated. These criteria are not analyzed in this Plan.

The SPTK Engineering Evaluations Workbook [Hamm (A), 2016] is used to evaluate compliance to WAC limits. Each limit is evaluated on a monthly basis in the DWPF Engineering Evaluations Workbook. To determine slurry volumes, insoluble solids wt% and slurry specific gravity are estimated using the same generic value for each batch. A generic supernate composition is also employed in determining the WAC values tabulated here. For SB9 through SB14, SPTK evaluations were also performed using composition data generated from the more detailed sludge batch modeling [Gillam, 2016], giving WAC values that were insignificantly different from the tabulated values.

It is estimated that the WAC limits that have been evaluated meet the acceptance criteria. Table 2 shows averages of monthly values for SB9-22 for NOx Emissions, Hg Concentration, IDP, and Canister Fissile. Based on assumptions of wt% insoluble solids, specific gravity and supernate concentration, the limits for these acceptance criteria are met.

Table 2: SB9-22 WAC Value Estimation: NOx, Hg, IDP, and Canister Fissile

	NO_x Emissions (Tank 40 Contribution)	Hg Concentration (Tank 40 Slurry)	Inhalation Dose Potential (Tank 40 Slurry)		Canister Fissile Limits (all contributors)
Batch	≤103.52 ton/yr	< 21 g/l	≤2.47E8 total rem/gal	≤1.34 Ci Cs-137/gal	(≤897 g fissile/m3) 0.61 kg fissile/can
SB9	27.4	2.6	2.01E+07	0.5	0.2
SB10	30.6	2.8	2.06E+07	0.4	0.2
SB11	45.4	4.4	6.50E+07	0.5	0.2
SB12	45.4	5.1	1.11E+08	0.9	0.2
SB13	66.1	6.2	1.90E+08	0.9	0.5
SB14	50.7	4.5	8.98E+07	0.6	0.4
SB15	44.2	3.3	7.55E+07	0.5	0.3
SB16	45.3	3.7	7.06E+07	0.4	0.3
SB17	48.0	4.1	6.92E+07	0.4	0.3
SB18	34.3	2.4	5.87E+07	0.4	0.2
SB19	35.9	3.8	5.88E+07	0.4	0.2
SB20	28.9	4.0	6.56E+07	0.3	0.2
SB21	29.8	5.4	6.73E+07	0.3	0.2
SB22	26.4	5.4	6.70E+07	0.3	0.1

Table 3 shows the estimated WAC calculations for Criticality Limits and Radiolytic Hydrogen Generation. The acceptance limits for all of these criteria are met.

Table 3: SB9-22 WAC Value Estimation: Criticality and Hydrogen Generation

	Criticality Limits (Tank 40 Slurry)					Radiolytic H_2 generation (SRAT)
	≤0.59 g Pu-239 Eq./gal.	Ratio of Weight of Fe/Pu-239 ≥ 160	wt% U-235 Eq. Enrichment ≤0.93% or ≤5% with Mn/U-235 Eq. ≥70	Ratio of Weight of Mn/U-235 ≥ 70	Ratio of Mass of Pu-240/Pu-241 >1	≤8.95E-5 Cu. Ft./hr/gal
SB9	0.08	1241	0.74%	120	51	1.54E-05
SB10	0.10	1058	0.62%	150	50	2.24E-05
SB11	0.12	772	0.49%	213	18	3.08E-05
SB12	0.13	745	0.29%	70	18	4.53E-05
SB13	0.22	370	1.41%	104	12	4.81E-05
SB14	0.17	472	0.24%	56	15	3.08E-05
SB15	0.17	539	0.23%	88	17	2.66E-05
SB16	0.14	709	0.25%	83	18	2.49E-05
SB17	0.12	791	0.26%	79	20	2.41E-05
SB18	0.11	921	0.30%	119	16	2.24E-05
SB19	0.12	834	0.25%	98	20	1.51E-05
SB20	0.11	1037	0.38%	78	18	1.25E-05
SB21	0.08	1138	0.60%	60	21	1.22E-05
SB22	0.08	1138	0.60%	60	21	1.21E-05

Table 4 shows the estimated WAC calculations for Canister Heat generation based on Tank 40 contribution and all contributors, gamma shielding and Neutron Shielding. The Sludge Batches meet these criteria limits except for Sludge Batch 13. Sludge Batch 13 does not meet the Neutron Shielding limit of 1.5E-03 Ci Alpha Emitters/ g IS.

Table 4: SB9-22 WAC Value Estimation: Canister Heat, Gamma, and Neutron

	Canister Heat Generation (Tank 40 Contribution)	Canister Heat Generation (All contributors)	Gamma Shielding (for Tank 40 Slurry)		Neutron Shielding (for Tank 40 Slurry)
	≤437 Watts/canister	≤834 Watts/canister	≤3.7 mR/hr/g IS	≤4070 mR/hr/gal	≤1.50E-3 Ci Alpha Emitters/g IS
SB9	64	98	0.39	203	2.25E-04
SB10	54	134	0.33	174	2.30E-04
SB11	72	173	0.45	233	7.25E-04
SB12	123	236	0.83	432	1.26E-03
SB13	181	276	0.96	500	2.28E-03
SB14	105	188	0.58	302	1.06E-03
SB15	83	164	0.45	236	8.83E-04
SB16	77	156	0.41	212	8.16E-04
SB17	75	151	0.39	202	7.97E-04
SB18	54	118	0.34	180	6.77E-04
SB19	57	75	0.35	181	6.79E-04
SB20	62	62	0.33	171	7.61E-04
SB21	51	51	0.31	160	7.68E-04
SB22	46	46	0.30	158	7.65E-04

Several risks to future sludge processing have been identified and evaluated against the WAC criteria. Uncertainty remains as to total sludge mass in the tanks, sludge compositions, processability, and supernate concentrations. Heel batch compositions (SB20-21) may pose future challenges as their makeup is not well-known at this time.

4 Canister Production and Batch Need Dates

Estimates of the total number of canisters produced from each sludge batch and batch need dates are shown in the following section. Information contained herein is to be used as an input to the LWSP.

The Sludge Batch Plan continues to evolve as new technologies are evaluated for reducing the total mass of solids sent to DWPF and increasing the rate at which the sludge is processed. This Plan includes detailed washing calculations and rearrangement of the waste removal plans shown in the previous Sludge Batch Plan.

4.1 *Estimated Canisters and Need Dates*

Table 5 [Chew and Hamm, 2016] provides the estimated number of canisters produced from each sludge batch and batch need dates. The aluminum dissolution process modeled for SB10 through SB13 provides processable sludge feed and reduces the number of canisters poured, shortening the life cycle. It is to be noted that the projected waste loadings listed for each batch are have a high degree of uncertainty. The source tanks and Sludge Removal Sequence (Figure 1) should be viewed for clarification on how hub tanks are utilized to prepare sludge batches.

Producing canisters requires washing sludge feed batches in time for each new batch to be ready when sludge in the previous batch has been made into glass. This washing schedule requires maintaining enough tank space to support continued evaporator operations to receive and evaporate decants from sludge washing in a timely manner, ensuring that canister production is not interrupted.

Melter #2 replacement is shown during a DWPF feed outage beginning in July 2017 and ending December 2017. That outage also includes MCU contactor bearing replacement and SWPF facility tie-in. Later Melter replacement outages of four months duration are planned beginning in June of 2025 and June of 2033. An outage for Next Generation Solvent implementation for SWPF is planned for October 2021 through December 2021. Bubbler replacement outages each year are accounted for as part of the attainment for DWPF.

Table 5: Canister Production and Sludge Batch Feed Dates

Sludge Batch	Source Tanks [a]	Projected SOL (weight %)	Actual Cans @ Projected SOL	Date Batch Finished @ Projected SOL[b]
Actual canisters poured through December 2015 (Sludge Batches 1 through 8)			4,000	
SB8 (to completion)	13, 12 Heel Removal	36%	35	Feb 2016
SB9	13, 12 Chemical Cleaning, 22 (solids from DWPF)	36%	175	Jun 2017
DWPF Melter Replacement — July 2017 thru December 2017 (with SWPF Tie-ins)				
SB9 (to completion)	(cont'd)	36%	26	Feb 2018
SB10	22 Solids from DWPF, 15 (via 13) (HM HAW), LTAD, 26 (PUREX); Iron	36%	417	May 2020
SB11	14, 15 (via 13) (HM HAW), 35 (HM HAW), LTAD, 26 (PUREX)	36%	352	Sep 2021
Next Generation Solvent Outage for SWPF — October 2021 thru December 2021				
SB11 (to completion)	(cont'd)	36%	44	Feb 2022
SB12	22 Solids from DWPF, 35 (HM HAW), LTAD, 34 (PUREX)	36%	396	Aug 2023
SB13	22 Solids from DWPF, 39 (HM HAW), LTAD, Sludge Modifier (Iron)	40%	418	Mar 2025
SB14	22 Solids from DWPF, 35 (HM HAW plus DWPF Solids), 39 (HM HAW), 33 (PUREX), Sludge Modifier (Iron)	40%	48	May 2025
DWPF Melter Replacement — June 2025 thru September 2025				
SB14 (to completion)	(cont'd)	40%	288	Sep 2026
SB15	35 (Incl 42 HM HAW plus DWPF Solids), 39 (Incl 32) (HM HAW), 33, 47 (PUREX), 22 Solids from DWPF, 24 Zeolite, Sludge Modifier (Iron)	40%	360	Dec 2027
SB16	35 (HM HAW plus DWPF Solids), 39 (Incl 32) (HM HAW), 33, 47 (PUREX)	40%	360	Mar 2029
SB17	35 (HM HAW plus DWPF Solids), 39 (Incl Zeolite From 24, 32), 33 (PUREX),	40%	360	Jun 2030
SB18	39 (Incl MST from 21, 32), 33 (PUREX), 43H (HM LAW)	36%	330	Sep 2031
SB19	35 (HM HAW plus DWPF Solids), 39 (Incl 32 HM HAW, 43 HM LAW), 33 (PUREX), Sludge Modifier (Iron)	36%	284	Jan 2033
SB20	35, 39 (32, 42, 43), (Mixed HM HAW, HM LAW), 33 (PUREX), Sludge Modifier (Iron)	36%	40	May 2033
DWPF Melter Replacement — June 2033 thru September 2033				
SB20 (to completion)	(cont'd)	36%	120	Sep 2034
Outage to collect and prepare final heels in Tank 40 - October 2034 thru March 2036				
SB21 (Heel Batch in Tk40)	43 (incl 33, 35, 51, 39 Heels) (Mixed HM HAW, HM LAW)	32%	60	Sep 2036
SB22 Tk40 Clean and Flush	40 Heel Flush Material	30%	57	Mar 2037
			8,170	

[a] The indicated tanks are the sources of the major components of each sludge batch, not necessarily the sludge location just prior to receipt for sludge washing. Tanks 33 and 35, for example, are also used to stage sludge that is removed from other tanks. Some BWRE may be accelerated with respect to this table as conditions dictate.

[b] Dates are approximate and represent when Tank 40 gets to heel level. Actual dates depend on canister production rates

[c] Longer processing assumed for dilute heel processing

Note: Dates, volumes, and chemical or radiological composition information are planning approximations only.

5 Risks and Issues

Risks and issues that could impact this plan are documented herein. Most of these risks and issues are addressed in the "Risk and Opportunity Management Plan" (ROMP) [Winship, 2016] and detailed here with the cross referenced risk number of the plan. Note that plans devised for specific activities (i.e., plans for individual sludge batches, waste removal campaigns, etc.) will provide focused programmatic risk assessments and identify risk handling strategies.

5.1 *Equipment and Infrastructure Problems*

5.1.1 Discovery of additional leak sites in a sludge tank. Risk #149 addresses this risk in the ROMP.

5.1.2 SMP or conventional slurry pumps failure. Risk #011 addresses this risk in the ROMP.

5.1.3 Failure of Tank 51 or Tank 40 slurry pumps. Risk #011 addresses this risk in the ROMP.

5.1.4 Excessive bearing water leakage into Tank 40. Risks #011 and #094 address this risk in the ROMP.

5.1.5 Inadequate availability or reduced performance of evaporators. Risks #030, #116, #102, #344, and #094 address this risk in the ROMP.

5.2 *Sludge Characterization Uncertainty*

5.2.1 Differences between expected sludge mass estimates and masses actually realized. This impact of this uncertainty has been and is still expected to be manageable without additional risk mitigation strategies.

5.2.2 The extent of application of oxalic acid chemical cleaning is not known. Large amounts of oxalic acid usage and subsequent oxalate receipt into sludge batches increases the amount of sludge washing necessary and deposits sodium oxalate in evaporator tanks. The method for eventual disposition of those sodium oxalate solids is uncertain. Risks #33, #117, and #426 address this risk in the ROMP.

5.2.3 Uncharacteristic solids that could be encountered in waste removal tanks could result in washing constraints. Risks #484, #048, and #120 address this risk in the ROMP.

5.3 *Sludge Behavior Uncertainty*

5.3.1 Unanticipated difficulty in removing the high level waste sludge from waste removal tanks. Risk #048 addresses this risk in the ROMP.

5.3.2 Rheological properties of the sludge slurry could result in higher or lower slurry concentrations than predicted. Risk #048 addresses this risk in the ROMP.

5.3.3 Lower than expected settling rates could result in additional wash water volume and Q-time constraints. Risk #120 addresses this risk in the ROMP.

5.3.4 The aluminum dissolution process may be more or less successful than assumed for planning. Risk #484 addresses this risk in the ROMP.

5.4 *New Programs or Delays in Currently Planned Programs*

5.4.1 Inclusion of additional waste streams in the sludge batches could increase the washing volume requirements. Risk #394 addresses this risk in the ROMP.

5.4.2 The process for addition of sludge modifier (synthetic sludge and/or iron) to DWPF feed is not defined. As a result, impacts to tank space for sludge batch preparation and DWPF feed storage are not evaluated.

5.5 *Sludge Processing Uncertainty*

5.5.1 Actual assessed Tank 40 Q-times could constrain the transfer volume of sludge batches into Tank 40. This could cause transfers into Tank 40 to be delayed, or cause sludge batches to be somewhat smaller than assumed in this Plan.

5.5.2 Non-routine constituents in sludge could be encountered that adversely impact sludge batch preparation. Risks #083 and #175 address this risk in the ROMP.

5.5.3 Some sludge batches in this Plan do not comply in full with the current PCCS Limits [Hamm (A), 2016]. It is also possible that sludge batches may not meet WAC Limits. Risk #034 addresses this issue in the ROMP.

5.5.4 This Plan only models detailed washing sequences through SB14, resulting in supernate compositions specific to each of those batches. Later sludge batches utilize a standard but reasonably representative supernate composition. Those later batches could potentially introduce more uncertainty in the sludge batch compositions. Also, the final sludge batches will have a higher proportion of tank heel sludge from various tanks, also introducing compositional uncertainty. These sources of uncertainty could mask potential processing difficulties. Risk #33 partially addresses this risk in the ROMP.

6 Conclusions and Recommendations

Changes in inputs and assumptions to the LWSP have resulted in changes from the previous Sludge Batch Plan. The major change is that the canister production rates are now coupled to salt processing rates, minimizing the number of canisters to be produced.

Sludge processing is completed slightly sooner in this Plan, in March 3037, compared to September 2038 for Revision 19 of the LWSP.

In this Plan, LTAD will be performed for SB10 through 13.

Preparation of sludge batches through SB14, modeled in greater detail than in the LWSP, appears feasible.

The total canister production decreases from 8582 in Revision 19 of the LWSP to 8170 for the current Plan. This is largely due to the addition of much less sludge modifier to sludge batches than was needed to maintain the assumed canister production rate for Revision 19. Many factors can affect future liquid waste operations, so actual canisters produced may be more or less than the amount projected here.

This Plan's success is dependent upon on-time start-up and operation of SWPF implementation as planned. Some PCCS criteria are not met by projections for some sludge batches, as described in Section 3.8. WAC criteria meet the current limits, except for SB13 Neutron Shielding, as discussed in Section 3.11. If WAC or PCCS limits are not met in the future, there are options available such as utilizing frits other than Frit 803, less constrained PCCS modeling algorithms, relaxation of certain WAC constraints, and future modifications to DWPF chemistry and processing strategy.

Risk mitigation strategies should continue to be developed. Equipment and infrastructure related problems are likely to dominate risks that are within the control of the program. These will be the focus of planned risk mitigation efforts.

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Distribution

Amidon, I. P. 704-56H
Barker, J. W., 241-248H
Barrowclough, E. P., 766-H
Blackford, L. T. 704-56H
Blocker, B. D., 766-H
Borders, M. N., 704-56H
Boyd, H. P., 707-7E
Brass, E. A., 241-121H
Bumgardner, D. C., 704-56H
Campbell, G. G., 766-H
Cantrell, J. R., 704-S
Chapman, N. F., 766-H
Chew, D. P., 766-H
Contardi, J. S., 704-56H
Edwards, T. B., 999-W
Edwards, R. E., 766-H
Fellinger, T. L., 766-H
Freed, E. J., 704-S
Fortenberry, J. K., 766-H
Foster, T. A., 766-H
Gilbreath, K. D., 766-H
Gillam, J. M., 766-H
Hamm, B. A., 766-H
Harp, K. D., 766-H
Hauer, K. A., 766-H
Hess, B. N., 241-156H
Hill, P. J., 766-H
Holtzsheiter, E. W., 766-H
Hubbard, M., 241-162H
Iaukea, J. W., 704-S
Keefer, M. K., 766-H
Le, T. A., 766-H
Ledbetter, J. S., 704-56H
Mahoney, M. J., 766-H
Marra, S. L., 773-A
Matis, G. J., 704-S
Morris, P. W., 241-152H
Occhipinti, J. E., 704-56H
Pennebaker, F. M., 773-42A
Ray, J. W., 704-27S
Rios-Armstrong, M. A., 241-197H
Shah, H. B.,766-H
Schmitz, M. A. 766-H
Schwenker, J. P., 241-156H
Shafer, A. R., 766-H
Thomas, S. A., 705-1C
Tihey, J.R., 241-162H